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(54) Title: APPLICATIONS FOR A MOBILE, BROADBAND, ROUTABLE INTERNET

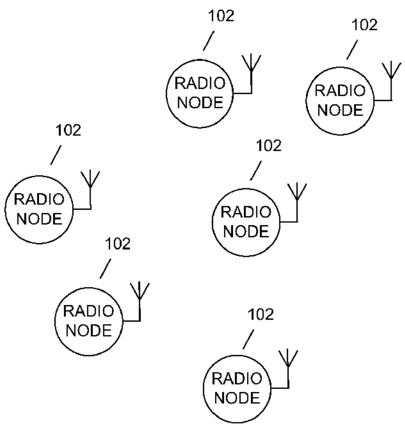

FIG. 1A

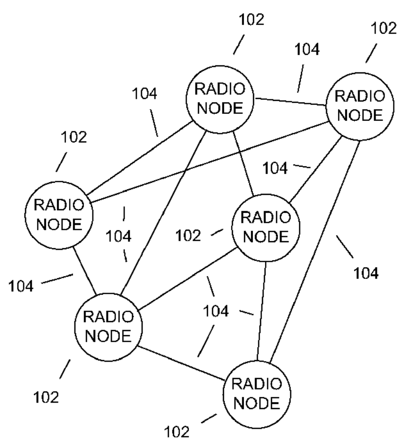

FIG. 1B

(57) Abstract: In embodiments of the present invention improved capabilities are described for a mobile, broadband, routable internet in environments, markets, management systems, web applications, mobile applications, devices, and the like, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements. Certain environments may be enabled on the mobile broadband routable internet by one or more enablers associated with the mobile broadband routable internet.

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APPLICATIONS FOR A MOBILE, BROADBAND, ROUTABLE INTERNET

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to the following patent applications, each of which is hereby incorporated by reference in its entirety: U.S. App. No. 61/094,394 filed September 4, 2008; U.S. App. No. 61/094,546 filed September 5, 2008; U.S. App. No. 61/1 18,232 filed September 5, 2008; U.S. App. No. 61/094,584 filed September 5, 2008; U.S. App. No. 61/094,591 filed September 5, 2008; U.S. App. No. 61/094,594 filed September 5, 2008; U.S. App. No. 61/094,61 1 filed September 5, 2008; U.S. App. No. 61/095,298 filed September 8, 2008; U.S. App. No. 61/095,310 filed September 9, 2008; U.S. App. No. 61/094,183 filed September 4, 2008; U.S. App. No. 61/094,203 filed September 4, 2008; U.S. App. No. 61/094,279 filed September 4, 2008; U.S. App. No. 61/094,294 filed September 4, 2008; U.S. App. No. 61/094,231 filed September 4, 2008; U.S. App. No. 61/094,247 filed September 4, 2008; U.S. App. No. 61/094,310 filed September 4, 2008; U.S. App. No. 61/103,106 filed October 6, 2008; U.S. App. No. 61/1 11,384 filed November 5, 2008; U.S. App. No. 61/112,131 filed November 6, 2008; U.S. App. No. 61/121,169 filed December 9, 2008; and U.S. App. No. 61/187,656 filed June 16, 2009.

FIELD OF THE INVENTION

[0002] The invention herein disclosed generally refers to networking, and more particularly to mobile networking.

BACKGROUND

[0003] Existing wireless communications used in carrier-grade networks typically consist of a cell-based infrastructure where all mobile subscriber nodes must communicate directly with a network base station. As an alternative, wireless communications may utilize a mobile ad-hoc network, where any mobile node can communicate with any other node, either directly or through multiple hops across the network topology. However, existing mobile ad-hoc networks sometimes operate without any network infrastructure on a single fixed spectrum channel. Currently used techniques do not provide sufficient Quality of Service (QoS) needed to offer carrier-grade service in a heterogeneous broadband media environment containing both delay-sensitive (e.g., voice over Internet Protocol, VoIP) and delay-tolerant (e.g., internet browsing) traffic. Therefore, there exists a need to provide carrier-grade QoS in mobile networks.

SUMMARY

[0004] In embodiments of the present invention improved capabilities are described for a mobile broadband routable internet (MBRI) providing for carrier-grade, networked, broadband, IP-routable

communication among a plurality of mobile devices, where the mobile devices may represent a plurality of nodes that are linked together through a mobile ad-hoc network (MANET). Mobile devices may operate as peers in a peer-to-peer network, with full IP routing capabilities enabled within each mobile device, thereby allowing routing of IP-based traffic, including deployment of applications, to the mobile device without need for infrastructure conventionally required for mobile ad hoc networks, such as cellular telephony infrastructure. Full IP-routing to mobile devices may allow seamless integration to the fixed Internet, such as through fixed or mobile access points, such as for backhaul purposes. Thus, the MBRI may function as a standalone mobile Internet, without connection to the fixed Internet, or as an IP-routable extension of another network, whether it be the Internet, a local area network, a wide area network, a cellular network, a personal area network, or some other type of network that is capable of integration with an IP-based network. In embodiments of the present invention improved capabilities are described for an MBRI in a wide spectrum of application areas, such as in environments, markets, management systems, web applications, mobile applications, devices, and the like.

[0005] In an aspect of the invention, methods and systems include establishing a mobile, broadband, routable internet in an environment, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing geo-location coding of device nodes in the network, wherein geo-location is based at least in part on a network location of a device node relative to other devices in the network; and facilitating at least one location-based service by using geo-location of device nodes in the environment.

[0006] In an aspect of the invention, methods and systems include establishing a mobile, broadband, routable internet in an environment, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing fixed radio installations that facilitate connection of the plurality of mobile devices, wherein the fixed radio installations are based at least in part on meeting a criteria associated with network radio propagation and performance; and facilitating the use of the fixed radio installation for backhaul communication in the environment.

[0007] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and providing multiple fixed-network gateway interfaces connecting the mobile ad hoc network to a fixed network.

[0008] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and providing an automated network design tool to facilitate low cost and fast network design engineering and deployment planning of the fixed infrastructure elements of the network.

[0009] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and providing small form factor nodes that allow for low cost and fast capacity expansion and network upgrade.

[0010] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and routing data packets through the mobile ad hoc network.

[0011] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements.

[0012] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation.

[0013] In an aspect of the invention, methods and systems include establishing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing support for peer-to-peer traffic within the network.

[0014] Because of MBRI's ability to control, manage, and shape data traffic amongst network nodes, these nodes may also be able provide direct device-to-device peering with symmetrical throughput, where traffic and data transfers are managed to maintain an even flow of data amongst the nodes of the MBRI network.

[0015] In an embodiment, a mobile broadband internet network solution may facilitate distributed data for enterprise web applications in a mobile broadband routable internet device within the enterprise environment. The exchange of data structures between web applications and the application server may be facilitated by the mobile broadband routable internet where the network is augmented with subscriber nodes.

[0016] In an aspect of the invention, methods and systems include establishing a mobile, broadband, routable internet for a market, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing an adaptive transmit power control facility for a device within a market-based network, the adaptive transmit power control facility adapted to adjust transmission power of the device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device and an application requirement of the device.

[0017] In an aspect of the invention, methods and systems include establishing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing dynamic spectrum access capabilities within the network by determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination; and enhancing use of spectral bandwidth by a market using the dynamic spectrum access capabilities.

[0018] In an aspect of the invention, methods and systems include establishing a mobile, broadband, routable internet in the environment, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing multimedia support within the network through a hybrid frame structure that includes variable slot duration and sub-channelization of bandwidth; and facilitating market-related multimedia services using the multimedia support.

[0019] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements.

[0020] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation, wherein the method is directed at a traffic management method.

[0021] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds, wherein the method is directed at a traffic management method.

[0022] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation, wherein the method is directed at a traffic control lighting method.

[0023] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds, wherein the method is directed at a traffic control lighting method.

[0024] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation, wherein the method is directed at a parking meter method.

[0025] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds, wherein the method is directed at a parking meter method.

[0026] In an aspect of the invention, methods and systems may include establishing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing support for peer-to-peer traffic within the network.

[0027] In an aspect of the invention, methods and systems may include establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing a facility for distributing data among a plurality of mobile broadband routable internet devices.

[0028] In an aspect of the invention, methods and systems may include establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing a facility for distributing application components among a plurality of mobile broadband routable internet devices.

[0029] In an aspect of the invention, methods and systems may include establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing remote monitoring through the network.

[0030] In an aspect of the invention, methods and systems may include establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing remote control over the network.

[0031] In an aspect of the invention, methods and systems may include establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing remote upgrade of at least one of software and services associated with the network.

[0032] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; routing data packets through the mobile ad hoc network.

[0033] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; applying swarm intelligence to determine at least some parts of at least some routes through the mobile, broadband, routable internet; providing a swarm based search web application that communicates via the mobile ad hoc network.

[0034] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing direct device-to-device peering with symmetrical throughput between at least two nodes of the mobile broadband routable internet; providing a search web application co-operating on the at least two nodes, wherein a search web application utilizes the symmetrical throughput between the at least two nodes.

[0035] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; facilitating direct-to-device application deployment over the mobile broadband routable internet; providing an e-commerce web application that is deployed directly to a device in the mobile broadband routable internet using direct-to-device application deployment.

[0036] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing the routable internet to a node in the network, wherein the node also communicates with a cellular network through at least one of the fixed infrastructure elements and the routable internet is provided outside the cellular network; providing a search web application that communicates both through the cellular network and the mobile ad hoc network.

[0037] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as sending and receiving nodes in a mobile ad hoc network and in which packets are IP routable to the individual devices independent of fixed infrastructure elements; providing routing priority within the network, wherein the routing priority is provided by granting channel access to a node for which prioritized routing is identified and sending delay-sensitive data from the node before sending delay-tolerant data from the node; and providing a voice over ip mobile application that uses the routing priority to manage routing of data within the mobile, broadband, routable internet.

[0038] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing direct device-to-device peering with symmetrical throughput between at least two nodes of the mobile broadband routable internet; and providing a video conferencing mobile application co-operating on the at least two nodes, wherein the mobile application utilizes the symmetrical throughput between the at least two nodes.

[0039] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing multicast routing within the network by allowing a data object to be transmitted by a device to a plurality of destinations over a plurality of routes; and providing a video conferencing mobile application that uses the multicast routing to at least distribute application-related updates.

[0040] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing an adaptive transmit power control facility for a device within the network, the adaptive transmit power control facility adapted to adjust transmission power of the device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device and an application requirement of the device; and providing a point to point communication mobile application that uses adaptive transmit power control to adapt the transmit power associated with the application based on at least a density of devices.

[0041] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing forwarding error correction on at least long IP packets; and providing a surveillance mobile application that is enabled at least in part by utilizing forwarding error correction on the mobile broadband routable internet.

[0042] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing dynamic spectrum access capabilities within the network by determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination; and providing a distributed computing mobile application that uses the dynamic spectrum access capabilities to provide enhanced use of spectral bandwidth.

[0043] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; applying swarm intelligence to determine at least some parts of at least some routes through the mobile, broadband, routable internet; and providing a local ip-based swarming mobile application that communicates via the mobile ad hoc network.

[0044] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing the routable internet to a node in the network, wherein the node also communicates with a cellular network through at least one of the fixed infrastructure elements and the routable internet is provided outside the cellular network.

[0045] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements; and providing a web service deployed with MANET mobile application that communicates solely within the mobile ad hoc network.

[0046] In an aspect of the invention, methods and systems include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements; and providing a locally deployed mobile application that communicates solely within the mobile ad hoc network.

[0047] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing peer to peer connectivity within the mobile broadband routable internet; and providing a device associated with the network that uses the peer to peer connectivity to facilitate mobile, fixed-infrastructure-independent, peer-to-peer application connection among at least a subset of the plurality of mobile devices.

[0048] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing file sharing over the mobile broadband routable internet; and providing a device associated with the network that supports file sharing without degrading system performance.

[0049] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing user-generated applications over the mobile broadband routable internet; and providing a device associated with the network that receives a deployment of a user-generated application.

[0050] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing peer-to-peer applications over the mobile broadband routable internet; and providing a device associated with the network facilitates uses peer-to-peer application execution without degrading performance of the mobile broadband routable internet.

[0051] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing direct device-to-device peering with symmetrical throughput between at least two nodes of the mobile broadband routable internet; and wherein at least one of the two nodes is a device associated with the mobile broadband routable internet.

[0052] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing an adaptive transmit power control facility for a device within the network, the adaptive transmit power control facility adapted to adjust transmission power of the device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device and an application requirement of the device; and providing a device that uses adaptive transmit power control to adapt the transmit power of the device based on at least a density of devices.

[0053] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing dynamic spectrum access capabilities within the network by determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination; and providing a device that uses the dynamic spectrum access capabilities to provide enhanced use of spectral bandwidth.

[0054] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; communicating among the plurality of devices over a radio communication spectrum and reusing portions of the spectrum for communication based on availability of time frequency rectangles within portions of the spectrum; and providing a device that reuses spectrum allocated for at least one other device.

[0055] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and communicating wirelessly among at least a portion of the plurality of mobile devices, wherein the at least a portion of the plurality of mobile devices communicate independent of which radio frequency is used for the wireless communication; wherein a device communicates over the mobile broadband routable internet independent of the radio frequency.

[0056] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing an IP-compatible plug connection to at least one wired infrastructure type; and providing a device that uses the connection.

[0057] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing small form factor nodes that allow for low cost and fast capacity expansion and network upgrade; and providing a device that communicates at least in part via the small form factor nodes.

[0058] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing at least one base station controller function in at least one subscriber device, the base station controller function including at least one of an air interface management function, a signaling function, a concentration logic function, and a signal propagation function; and providing a device employing the at least one base station controller function.

[0059] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing full radio resource management functions in at least one device, the radio resource management functions including at least one of radio management, handover, handoff, and foreign device cooperation functions, wherein the at least one device is a subscriber device; and wherein the at least one device operates responsively to a state of a managed radio resource.

[0060] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing IP router functions at individual mobile devices of the network, wherein the individual mobile devices are subscriber devices; and providing a device that uses the IP router functions to communicate via the ad hoc network.

[0061] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing the routable internet to a node in the network, wherein the node also communicates with a cellular network through at least one of the fixed infrastructure elements and the routable internet is provided outside the cellular network; and providing a device that communicates both through the cellular network and the mobile ad hoc network.

[0062] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing IP application deployment to a device in the network, wherein the device also communicates with a cellular network through at least one of the fixed infrastructure elements and the IP application is deployed outside the cellular network; and providing a device that receives applications deployed over IP and that communicates via the cellular network.

[0063] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation; and providing a device that uses the communications.

[0064] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds; and providing a device that uses the communications.

[0065] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; applying swarm intelligence to determine at least some parts of at least some routes through the mobile, broadband, routable internet; and providing a device that communicates via the mobile ad hoc network.

[0066] In an aspect of the invention, methods and systems may include providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; allowing layer 2 forwarding among at least some of the plurality of mobile devices; and providing a device that communicates via the layer 2 forwarding, wherein the device facilitates parking.

BRIEF DESCRIPTION OF THE FIGURES

[0067] The invention and the following detailed description of certain embodiments thereof may be understood by reference to the following figures:

[0068] Figs. IA and IB depict an embodiment of a mobile ad-hoc wireless network according to an embodiment of the present invention.

[0069] Figs. 2A and 2B depicts an embodiment of a wireless mesh network according to an embodiment of the present invention.

[0070] Fig. 3 depicts an embodiment of a wireless network with access points back to the fixed Internet.

[0071] Fig. 4 depicts an embodiment of a wireless network showing multiple pathways from a particular mobile network node to the fixed Internet.

[0072] Fig. 5 depicts an embodiment of the MBRI stack showing layers from device down to physical layer.

[0073] Fig. 6 depicts an embodiment of the MBRI stack showing the addition of DYSAN capabilities.

[0074] Fig. 7 depicts an embodiment of the use of dynamic spectrum access technology to wireless communication according to an embodiment of the present invention.

[0075] Fig. 8 depicts an embodiment of the mobile ad-hoc wireless network using dynamic spectrum access technology according to an embodiment of the present invention.

[0076] Fig. 9 depicts an embodiment of DYSAN spectrum aware routing.

[0077] Fig. 10 depicts an embodiment for providing prioritization of delay-sensitive traffic across the network protocol stack in a mobile ad-hoc wireless network according to an embodiment of the present invention.

[0078] Fig. 11 depicts a graphical representative embodiment for providing network support for peer-to peer traffic in a MANET according to an embodiment of the present invention.

[0079] Fig. 12 depicts an embodiment for providing a peer-to-peer routing between nodes in a MANET.

[0080] Fig. 13 depicts an embodiment for providing multiple fixed network gateway interfaces in a mobile ad-hoc wireless according to an embodiment of the present invention.

[0081] Fig. 14 depicts an embodiment for providing multicast routing in a mobile ad-hoc wireless according to an embodiment of the present invention.

[0082] Fig. 15 depicts an embodiment representation of a receiver oriented multicast.

[0083] Fig. 16 depicts an embodiment representation of a receiver oriented multicast with multiple mode queues.

[0084] Fig. 17 depicts an embodiment of basic peer-to-peer communications including internet access.

[0085] Fig. 18 depicts an embodiment of a node to node multicast routing configuration.

[0086] Fig. 19 depicts an embodiment of various multicast routing paths through the MBRI network.

[0087] Fig. 20 depicts an embodiment for providing remote network monitoring, control and upgrade in a mobile ad-hoc wireless network according to an embodiment of the present invention.

[0088] Fig. 21 depicts an embodiment of sample network topology for adaptive transmit power control.

[0089] Fig. 22 depicts an embodiment of a one-hop and two-hop neighborhood adaptive transmit power control configuration.

[0090] Fig. 23 depicts a second embodiment of a one-hop and two-hop neighborhood adaptive transmit power control configuration.

[0091] Fig. 24 depicts an embodiment for providing adaptive transmit power control in a mobile ad-hoc wireless network according to an embodiment of the present invention.

[0092] Fig. 25 depicts an embodiment of adaptive transmit power control showing the overlap of two-hop neighborhoods of two nodes when operating full power.

[0093] Fig. 26 depicts an embodiment of adaptive transmit power control showing the overlap of two-hop neighborhoods of two nodes when operating a 10 dB below full power.

[0094] Fig. 27 depicts an embodiment of adaptive transmit power control showing the overlap of two-hop neighborhoods of two nodes when operating a 20 dB below full power

[0095] Fig. 28 depicts an embodiment for providing adaptive link data rate in a mobile ad-hoc wireless network according to an embodiment of the present invention.

[0096] Fig. 29 depicts an embodiment for adaptive link data rate where the waveform mode of each link may be determined independently.

[0097] Fig. 30 depicts an embodiment for providing location information of network nodes to neighboring nodes in a mobile ad-hoc wireless network according to an embodiment of the present invention.

[0098] Fig. 31 depicts an embodiment of different time slot widths in relation to a multimedia data stream.

[0099] Fig. 32 depicts an embodiment of a hybrid slot structure in relation to the transmission of a diversity of media streams.

[00100] Fig. 33 depicts a mobile ad-hoc wireless network embodiment of the present invention for implementing for time synchronization.

[00101] Fig. 34 depicts a mobile ad-hoc wireless network embodiment of the present invention for implementing for time synchronization, where some of the communications between nodes are illustrated.

[00102] Figs. 35 through 35H depict an embodiment of a time synchronization algorithm.

[00103] Fig. 36 depicts an embodiment of radio resource management in a subscriber device.

[00104] Fig. 37 depicts an embodiment of a multi-session enabled subscriber device.

[00105] Fig. 38 depicts an embodiment of a subscriber device with enhanced performance.

[00106] Fig. 39 depicts an embodiment of a fully enabled IP router in a subscriber device.

[00107] Fig. 40 depicts an embodiment of a subscriber device with enhanced power control, such as a whisper mode.

[00108] Fig. 41 depicts an embodiment of a subscriber device with enhanced adaptive data rate capabilities.

[00109] Fig. 42 depicts an embodiment of how nodes may communicate in association with adaptive data link rate.

[00110] Fig. 43 depicts an embodiment of a route cost function.

[00111] Fig. 44 depicts an embodiment of a least cost routing function.

[00112] Fig. 45 depicts an embodiment of quality of service priority queuing.

[00113] Fig. 46 depicts an embodiment of quality of service de-queuing order to maintain quality of service using strict priority de-queuing discipline.

[00114] Fig. 47 depicts an embodiment of quality of service priority channel access.

[00115] Fig. 48 depicts an embodiment of quality of service priority-based routing.

[00116] Fig. 49 depicts an embodiment of quality of service priority-based differentiated quality of service.

[00117] Fig. 50 depicts an embodiment of local IP-based swarming.

[00118] Fig. 51 depicts an embodiment of the MBRI layered stack.

[00119] Fig. 52 depicts an embodiment of SLSR link cost based routing domain concept.

[00120] Fig. 53 depicts an embodiment of SLSR link cost based routing protocol with extra information.

[00121] Fig. 54 depicts an embodiment of SLSR link cost based routing different topology based on different criteria.

[00122] Fig. 55 depicts an embodiment of distributed data and applications within MBRI.

[00123] Fig. 56 depicts an embodiment of a local mobile application, with all data links shown.

[00124] Fig. 57 depicts an embodiment of a local mobile application, with the mobile based application shown common to all four subscriber devices.

[00125] Fig. 58 depicts an embodiment for admission control MANET to Internet data flow.

[00126] Fig. 59 depicts an embodiment for admission control MANET data flow.

[00127] Fig. 60 depicts an embodiment for admission control data flow across different BAP domains.

[00128] Fig. 61 depicts an embodiment for admission control messages for admission control.

[00129] Fig. 62 depicts an embodiment of a layer 3 fast pipe handling of data flows through layer 3.

[00130] Fig. 63 depicts an embodiment for forward error correction associated with multi-layer FEC encoding of IP packets for transmission over a wireless link.

[00131] Fig. 64 depicts an embodiment for forward error correction associated with burst errors upon reception.

[00132] Fig. 65 depicts an embodiment for forward error correction associated with packet length.

[00133] Fig. 66 depicts an embodiment for proactive router handoff.

[00134] Fig. 67 depicts an embodiment for proactive router handoff showing a preferred route associated with a first BAP encountered.

[00135] Fig. 68 depicts an embodiment for proactive router handoff showing a preferred route associated with a second BAP encountered.

[00136] Fig. 69 depicts an embodiment for vehicular mobility.

[00137] Fig. 70 depicts an embodiment for logic associated with layer 3 fast pipe handling payload data.

[00138] Fig. 71 depicts an embodiment for layer 2 forwarding.

[00139] Fig. 72 depicts an embodiment for layer 2 forwarding associated with forwarding a table update from a router.

[00140] Fig. 73 depicts an embodiment of a header table for layer 2 forwarding.

[00141] Fig. 74 depicts an embodiment for segmentation and reassembly associated with transmission across multiple TDMA time slots.

[00142] Fig. 75 depicts an embodiment for segmentation and reassembly associated with reassembly of received segments into the original IP packet.

[00143] Fig. 76 depicts an embodiment for Multi-channel for MAC associated with TDMA time slot structure.

[00144] Fig. 77 depicts an embodiment for Multi-channel for MAC associated with scheduling of sub-channels.

[00145] Fig. 78 depicts an embodiment associated with MBRI being Web 2.0 capable.

[00146] Fig. 79 depicts a first embodiment for seamless indoor/outdoor broadband coverage.

[00147] Fig. 80 depicts a second embodiment for seamless indoor/outdoor broadband coverage.

[00148] Fig. 81 depicts a third embodiment for seamless indoor/outdoor broadband coverage, showing the node topology.

[00149] Fig. 82 depicts environments of a mobile broadband routable internet.

[00150] Fig. 83 depicts markets of a mobile broadband routable internet.

[00151] Fig. 84 depicts management systems of a mobile broadband routable internet.

[00152] Fig. 85 depicts web applications of a mobile broadband routable internet.

[00153] Fig. 86 depicts mobile applications of a mobile broadband routable internet.

[00154] Fig. 87 depicts devices of a mobile broadband routable internet.

DETAILED DESCRIPTION

[00155] The features of the present invention, which are believed to be novel, are set forth with particularity in the appended claims. The invention may best be understood by reference to the following description, taken in conjunction with the accompanying drawings.

[00156] While the specification concludes with the claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawings figures, in which like reference numerals are carried forward.

[00157] As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting but rather to provide an understandable description of the invention.

[00158] The terms "a" or "an", as used herein, are defied as one or more than one. The term "another", as used herein, is defined as at least a second or more. The terms "including" and/or "having" as used herein, are defined as comprising (i.e. open transition). The term "coupled" or "operatively coupled" as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically.

[00159] The present disclosure provides a mobile broadband routable internet (MBRI) for providing carrier-grade, networked, broadband, IP-routable communication among a plurality of mobile devices, where the mobile devices may represent a plurality of nodes that are linked together through a mobile ad-hoc network (MANET). Mobile devices, also referred to herein where context permits as subscriber devices, may operate as peers in a peer-to-peer network, with full IP routing capabilities enabled within each subscriber device, thereby allowing routing of IP-based traffic, including deployment of applications, to the subscriber device without need for infrastructure conventionally required for mobile ad hoc networks, such as cellular telephony infrastructure. Full IP-routing to subscriber devices allows seamless integration to the fixed Internet, such as through fixed or mobile access points, such as for backhaul purposes. Thus, the MBRI may function as a standalone mobile Internet, without connection to the fixed Internet, or as an IP-routable extension of another network, whether it be the Internet, a local area network, a wide area network, a cellular network, a personal area network, or some other type of network that is capable of integration with an IP-based network. The capabilities that enable the MBRI are disclosed herein, such capabilities including the software, technology components and processes for physical layer, MAC layer, and routing layer capabilities that allow all IP-based traffic types and applications to use the MBRI, embodied across a set of mobile devices, as if it were an 802.1 through 802.3 compliant fixed network, without reliance on, or intervention by,

fixed network infrastructure components such as application-specific Internet servers or cellular infrastructure components.

[00160] In contrast to existing wireless and fixed wired access networks, MBRI may provide a solution where every subscriber device and infrastructure node may have routing capabilities to allow for intelligent routing decisions, enabling intra-network peer to peer communications. Traffic between nodes of the MBRI may not need to leave the MANET network for routing or switching purposes. Instead, because MBRI is routing enabled, local traffic including required signaling may stay within the MBRI. In addition, because of its neighbor discovery management, adaptive data rate power management, and the like capabilities as described further herein, the MBRI may enable local intelligence to be shared across its member nodes, leading to the creation and deployment of new classes of services and applications. Further, because of its MANET characteristic the MBRI may be independent of fixed traffic aggregation points such as base stations or cell towers, and instead may leverage multiple backhaul access points in a load leveling and self-healing manner. Because of the MANET waveform characteristics and the MANET architectural flexibility to deploy additional backhaul access points (BAP) or to upgrade existing MANET Access Points with backhaul capability, the MBRI may better assure broadband bandwidth to the individual nodes, such as in excess of conventional 3G/4G networks. Further, if combined with dynamic spectrum access (DYSAN) technology the MBRI may coexist within existing defined spectrum with associated active network operations.

[00161] In embodiments, the MBRI may be implemented in a plurality of configurations, such as an MBRI basic configuration including the MANET protocol stack that may bring Internet access and routing capability to a subscriber device; an MBRI enhanced configuration that takes the MBRI basic configuration and combines it with selected media transport enhancements, such as to improve multimedia transport of the MBRI network; an MBRI comprehensive configuration that may consist of a the MBRI basic configuration with transport enhancements targeted at high quality service, such as for multimedia, multi-session applications, and the like; an MBRI comprehensive configuration with dynamic spectrum awareness, which may consist of enhancements to the MANET protocol stack to allow for spectrum co-sharing between non-cooperative spectrum users or dissimilar spectrum technologies, and coordination between cooperative systems; and the like.

[00162] In embodiments, the MBRI basic configuration may include a plurality of capabilities, such as ad-hoc network creation and self forming, self healing, load leveling, packet size indifference, unicast, routing enabled, peer-to-peer communications, mobility, broadband, Internet protocol plug compatible, neighbor aware, geo location, radio resource management, openness for Java web applications, enablement for private and public networks, security, spectrum independence, scalability (e.g., for bandwidth, backhaul, users, and the like), structured or unstructured network architecture, different levels of network spanning,

waveform variants (e.g., such as slotted/half duplex, synchronization on each slot separately, and the like), multi-session capability, and the like.

[00163] In embodiments, the MBRI enhanced configuration may include MBRI basic capabilities, plus a plurality of enhancements, such as adaptive data rate (ADR), quality of service (QoS), flexible transport (such as for both sensitive and delay tolerant traffic, sub-queues, traffic based scheduling, optimized short/medium/large packet support, and the like), scoped link state routing (SLSR) link cost based routing, SLSR domain management, multicasting, layer 2 forwarding, layer 3 fast pipe, segmentation and reassembly (SAR), hybrid slot structure, multi-channel MAC, adaptive power control (APC), distributed data for web applications in an MBRI device, local intelligence (such as through caching, local content and services, and the like), distributed applications, vehicular mobility vector based routing, sleep mode, assured bandwidth, admission control, traffic policing, traffic shaping (such as per flow, per node, per MAP, per BAP, and the like), automatic retransmission request (ARQ), forward error correction (FEC) on long IP packets, proactive router handoff, and the like.

[00164] In embodiments, mobile devices, and other hardware devices, may be enabled by MBRI, such as chips, chip sets, a personal computer manufacturer interface adaptor (PCMIA) card, network components, a personal portal (e.g., a chip that may go in any device), an ASIC, and the like. In embodiments the MBRI may be provided connectivity to fixed communication facilities through a backhaul access point (BAP). In addition, connections from the MBRI network to the BAP may be made through a MANET or mesh access point (MAP), a customer access point (CAP), and the like. In addition, the BAP may attach to a fiber access point (FAP), and the like, In embodiments, a BAP may be a network access point with wire-line backhaul capabilities, such as via fiber, wired, microwave, and the like; a MAP may be a network access point with wireless relay capabilities, such as to a BAP; a CAP may be a customer device with mains power and capable of connecting to a BAP; and the like. In embodiments, the MBRI may provide significant advantages over current mobile network systems, where MBRI capabilities, MBRI enabled devices, and MBRI access point facilities may enable improved performance and quality of service to users.

[00165] In embodiments, the use of CAPs may provide for a more robust MBRI system, where a CAP may be owned by a customer but remains an integral part of the MANET network. The CAP may allow 'hopping' of other network traffic through it, and thus providing additional route diversity for network traffic. This system of CAPS may extend the network coverage into new areas and also enable new traffic routes that can avoid occlusions and provide additional route diversity security. The CAP may contain a MANET radio, power supply, antennae, power outlet, and the like. In embodiments, the CAP may be an indoor unit and thus provide coverage in the customer premises as well as access to other MANET radios. By utilizing a customer-owned device for a CAP, the cost of deploying a network for the network builder may be reduced at the same time as the coverage is extended to places where the customer particularly wants coverage. In embodiments, the CAP may be self-installed by the customer, self-configured to operate on a MANET

network, act as a node on the network by allowing network traffic from other sources to 'hop' through the CAP, provide greater network coverage and route diversity that improves quality of service, and the like.

[00166] Fig. 1 illustrates a mobile ad-hoc wireless network according to an embodiment of the present invention. As shown in Fig. 1, the wireless network may have a set of wireless devices capable of communicating wirelessly. Each wireless device may be termed as a node. A node may communicate with any other node, and links may be formed between nodes. The mobile ad-hoc network may include nodes that are mobile, as well as nodes that are fixed. In embodiments, the fixed nodes may enable the creating of a spanning network to establish initial wireless coverage across a geographic area. In addition, a subset of these nodes may have connectivity to a fixed (i.e., wired) network. In a mobile ad-hoc wireless network, routing through the network may find the 'best' path to destination including 'multi-hop' relay across multiple wireless nodes. The wireless network may be capable of autonomously forming and re-forming links and routes through the network. This dynamic forming and re-forming of links and routes may be made to adjust to changing conditions resulting from node mobility, environmental conditions, traffic loading, and the like. Thus, mobile ad-hoc wireless network's wireless topology may change rapidly and unpredictably.

[00167] Establishing a quality of service may be an essential quality for the mobile ad-hoc wireless network. In embodiments, quality of service for a mobile ad-hoc wireless network may be measured in terms of the amount of data which the network successfully transfers from one place to another over a period of time. Currently used mobile ad-hoc networks may have a number of issues with respect to network quality of service, such as application routing-focused communication without the ability to provide service-level agreements for quality-of-service, providing only unicast services, link-focused power control, providing a single data rate only, providing contention-based access (e.g., focus on inefficient unlicensed band radios), focused on military or public safety applications, congestion and dynamic and unpredictable latency (especially with multi-hop scenarios), and the like. In embodiments the present invention may provide for a mobile ad-hoc network that significantly improves on the shortcomings of current systems.

[00168] Fig. 2 illustrates a wireless mesh network according to an embodiment of the present invention. As shown in Fig. 2, the wireless mesh network may be a type of wireless ad-hoc network which allows multi-hop routing. A wireless mesh network architecture may sustain communications by breaking long distances into a series of shorter hops. The wireless mesh network may have a subset of nodes designated as access points to form a spanning network to establish initial wireless network coverage across a geographical area. In an embodiment, one or more access points may have a connection interface to a fixed network. In embodiments, the fixed network that the access points connect to may be any known fixed network, such as the Internet, a LAN, a WAN, a cell network, and the like. As shown, a subset of nodes may be designated as 'subscriber nodes' that may form links among themselves and to the spanning network to augment wireless coverage. This may allow nodes connectivity to the fixed network via multiple hops across

wireless topology. This topology may also change with node mobility. In embodiments, a wireless mesh network may be termed as a mobile ad-hoc network if the nodes in a wireless mesh network are mobile.

[00169] Fig. 3 depicts a mobile ad-hoc network with backhaul to a fixed network. Here, the mobile ad-hoc network is shown to include a plurality of mobile nodes 16, a plurality of fixed nodes 14, a plurality of access points 14, a plurality of mobile node to fixed node links 18, a plurality of mobile node to mobile node links 20, the fixed network 12, and a plurality of fixed node to fixed network links 22a-c. In embodiments, the fixed nodes 14 may provide network structure, such as to provide a spanning network that enables the establishment of the ad-hoc network, as well as connectivity to the fixed network. Mobile nodes 16 may then establish links 18 to both fixed nodes 14 and to other mobile nodes 20, where all of the nodes 14,16 and links 18, 20 establish the mobile ad-hoc network with links 22a-c to the fixed network 12. Fig. 4 illustrates three example network pathway routings 24a-c for a mobile node 16 establishing connectivity to the fixed network 12, including a link combination 24a from the fixed network 12 to a fixed node 14 and then to the destination mobile node 16, a link combination 22b to a fixed node 14 through an intermediate mobile node 16 and then to the destination mobile node, and an alternate link combination 22c to a fixed node 14 through an intermediate mobile node 16 and then to the destination mobile node. In embodiments, the link combinations may include any number of mobile nodes 16, fixed nodes 14, subscriber nodes, access points, and the like.

[00170] In embodiments, the mobile ad-hoc network may also provide a plurality of network services and attributes, such as autonomous neighbor discovery and maintenance, distributed network timing reference dissemination, dynamic frame structure, distributed scheduling with dynamic selection of scheduling algorithms (e.g., such as based on network topology, traffic load, spectrum availability), link-by-link autonomous data rate selection, traffic differentiation across the protocol stack (e.g. priority queuing and priority channel access), ARQ automatic repeat and request capability, geo-location capability for E-91 1 and location-based services, power control for intra-network interference management and spectrum reuse, unicast and multicast routing, interfacing in a standard way to existing IP core network nodes, encryption and authentication, OSS with EMS and NMS, and the like.

[00171] Fig. 5 depicts the MBRI as a hierarchical stack. At the top of the MBRI stack are the devices, including mobile subscriber devices (SD), fixed node communication devices, access points, and the like. The next two layers down represent applications and use scenarios, and multi-session applications using different traffic types, which may be utilized or executed by the devices in conjunction with the MBRI. Continuing down to the next layer, are data applications that may be carried across the MBRI, including data, voice, video, video on demand (VOD), and the like. Next, the MBRI stack shows a representative subset of the MBRI functional enhancements, as described herein, which may be provided as optional elements in the MBRI system. The MBRI thus far, may then be enabled from the stack elements below, including a core stack of routing, MAC, and physical layers, as shown in the middle, which may provide fixed Internet

equivalency in a mobile network. In addition, connectivity is also shown to other communication facilities, such as the fixed networks as described herein. In embodiments, the MBRI may be built up from various combinations and sub-combinations of the various components of the MBRI stack, which may enable various applications, devices, and the like, the ability to deploy applications directly to the device. In embodiments, the MBRI stack may provide a solution with high quality of service transport for multi-session applications, replicate functions that may be effectively analogous to the foundation standards of the IETF defined internet within the mobility sector, enable functions analogous to each of the functions in the IETF 802.1-3 fixed Internet stack, and the like. In embodiments, the MBRI may represent a mobile ad-hoc network with true Internet routing capability.

[00172]

[00173] Fig. 6 shows the MBRI stack as introduced in Fig. 5, but with dynamic spectrum access (DYSAN) added as an option. Currently dynamic spectrum access technologies may be focused on limited aspects of network performance, such as on TV bands, finding spectrum for the whole network, trying to avoid interference through power control, and the like. Dynamic spectrum access, as a part of MBRI may provide spectrum used to communicate wirelessly between nodes changes in a non-pre-determined manner in response to changing network and spectrum conditions. In embodiments, the time scale of dynamics may be typically less than can be supported by engineering analysis, network re-planning, optimization, and the like. For instance, in response to manual or automated decisions, where there may be centralized decisions (e.g., network partitioning) or distributed local decisions of the individual nodes. Dynamic spectrum access may be able to avoid interference to/from geographically proximate spectrum users internal or external to their own wireless network. Dynamic spectrum access may also be able to access and utilize spectrum otherwise unavailable for wireless network use. In embodiments, local spectrum decisions may be coordinated and/or communicated using a fixed or logical control channel in an over-the-air wireless network.

[00174] Fig. 7 illustrates the use of dynamic spectrum access technology to wireless communication according to an embodiment of the present invention. A wireless network may use dynamic spectrum access that provides a dynamic allocation of wireless spectrum to network nodes. The spectrum may be used to communicate wirelessly between nodes in a non-pre-determined manner in response to changing network and spectrum conditions. Dynamic spectrum access technology may use the methodology of coordination of a collection of wireless nodes to adjust their use of the available RF spectrum. In embodiments, the spectrum may be allocated in response to manual or automated decisions. The spectrum may be allocated in a centralized manner (e.g., network partitioning) or in a distributed manner between individual nodes. The spectrum may be allocated dynamically such that interference to/from geographically proximate spectrum users internal or external to the wireless network may be avoided. The local spectrum decisions may be coordinated/communicated using a fixed or logical control channel in the over-the-air wireless network. This may increase the performance of wireless networks by intelligently distributing segments of available radio frequency spectrum to wireless nodes. Dynamic spectrum access may provide an improvement to wireless communications and spectrum management in terms of spectrum access, capacity, planning requirements, ease of use, reliability, avoiding congestion, and the like.

[00175] Fig. 8 illustrates a mobile ad-hoc wireless network using dynamic spectrum access technology according to an embodiment of the present invention. In this embodiment, a mobile ad-hoc wireless network may be used in conjunction with dynamic spectrum access technology to provide carrier grade quality of service. A collection of wireless nodes in a mobile ad-hoc network is shown dynamically adapting spectrum usage according to network and spectrum conditions. Individual nodes in the mobile ad-hoc wireless network may make distributed decisions regarding local spectrum usage. In embodiments, quality of service for a mobile ad-hoc wireless network may be measured in terms of the amount of data which the network may successfully transfer from one place to another in a given period of time, and DYSAN may provide this through greater utilization of the available spectrum. In embodiments, the dynamic spectrum access technology may provide a plurality of network services and attributes such as, coordinated and uncoordinated distributed frequency assignment, fixed or dynamic network coordination control channel, assisted spectrum awareness (knowledge of available spectrum), tunable aggressiveness for co-existence with uncoordinated external networks, policy-driven for time-of-day frequency and geography, partitioning with coordinated external networks, integrated and/or external RF sensor, and the like. Fig. 9 shows how a spectrum aware path may be selected based on carrier to inter-modulation ratio, in this instance measured in db (xθ to x3). BER may be used as well.

[00176] In embodiments, the MBRI may provide enhancements that better enable carrier-grade service, such as through prioritization of latency-sensitive traffic across multiple layers of the networking protocols to reduce end-to-end latency and jitter (such as by providing priority queuing within node, priority channel access at MAC across nodes and priority routing across topology), providing network support for peer-to-peer connections bypassing network infrastructure, unicast and multicast routing with multiple gateway interfaces to fixed (i.e., wired) network, providing security to protect control-plane and user data and prevent unauthorized network access, traffic shaping and policing to prevent users from exceeding authorized network usage, remote monitoring, control, and upgrade of network devices, automatic re-transmission of loss-sensitive traffic , transparent link and route maintenance during periods of spectrum adaptation, rapid autonomous spectrum adaptation to maintain service quality, avoid interference, and maximize capacity, scalability of network protocols for reliable operation with node densities (e.g., hundreds to thousands of nodes per sq. km.) and node mobilities (e.g., to 100 mph) consistent with commercial wireless networks, using adaptive wireless network techniques to maximize scalable network capacity (e.g., adaptive transmit power control to reduce node interference footprint, adaptive link data rate, dynamic hybrid frame structure, dynamic distributed scheduling techniques, multi-channel operation using sub-channels and super-channels,

load-leveling routing), simultaneous support of multiple broadband, high mobility network subscribers, interfaces with fixed carrier network (e.g., to support VoIP, SIP, etc.), and the like.

[00177] In embodiments, an enhancement may be prioritization. Fig. 10 illustrates a method of providing prioritization of delay-sensitive traffic across the network protocol stack in a mobile ad-hoc wireless network according to an embodiment of the present invention. As shown, the prioritization of delay-sensitive traffic may be done by granting prioritized channel access to nodes with delay-sensitive data and sending the delay sensitive data before sending the delay tolerant data from the same node. This may enable the provision of service level performance agreements.

[00178] In embodiments, an enhancement may be network support for peer-to-peer traffic. Fig. 11 illustrates a method of providing network support for peer-to peer traffic in a mobile ad-hoc wireless network according to an embodiment of the present invention. Providing network support for peer-to-peer traffic without forcing routing through the fixed network may decrease the amount of wireless network capacity required to deliver service. This may allow the network to offer more service with the same amount of capacity. Fig. 12 illustrates one embodiment of how peer to peer MANET may be utilized in MBRI.

[00179] In embodiments, an enhancement may be multiple fixed network gateway interfaces. Fig. 13 illustrates providing multiple fixed network gateway interfaces in a mobile ad-hoc wireless according to an embodiment of the present invention. In this embodiment, multiple connections to the fixed network may enable backhaul load leveling, and increases fault-tolerance by providing alternate routing paths.

[00180] In embodiments, an enhancement may be multicast routing. Fig. 14 illustrates providing multicast routing in a mobile ad-hoc wireless according to an embodiment of the present invention. In this embodiment, multicast routing may improve efficiency of network capacity by avoiding multiple transmissions of common data along a common path. This may allow the network to offer more service with the same capacity. In embodiments, MBRI may implement receiver oriented multicast (ROM). ROM may be a modified version of the On-Demand Multicast Routing Protocol (ODMRP) with three significant changes. First, ROM may be Receiver Oriented rather than Sender Oriented. That is to say that the receivers in a multicast group may initiate the process of forming the multicast routes. Second, ROM may construct a multicast tree, whereas ODMRP is a mesh protocol. Third, ROM may not generally operate in On-Demand mode; rather it sets up the required multicast groups and then maintains them on a periodic basis. ROM may be designed to reduce overall control message traffic on the network when a network has more source nodes than receiver nodes. This is because the ROM protocol may flood JRP control packets from the receivers of a multicast group rather than from senders. For instance, if there are 20 nodes in the network, 20 nodes are senders, and 1 node is a receiver, then there will be one JRP flood versus 20 JRP floods with ODMRP. To route the multicast traffic of a certain multicast group, ROM enabled nodes may create a tree that comprises a forwarding group. First, receiver nodes belonging to the multicast group flood the entire network with Join Request Packets (JRP's). When the JRP's are received by nodes sourcing multicast data, Join Table Packets

(JTP's) are transmitted back towards the receiver nodes through the same paths of the JRP's. The nodes that are part of the path between receivers and senders are designated as Forwarders in the Forwarding Group for that particular multicast group's traffic. In embodiments, when a set of nodes form a multicast group, they may use their data link mode queues to send multicast traffic. Multicast traffic may use most common highest mode queues to send the traffic; this may reduces traffic replication by each node as all one hop neighbors supporting that mode see the traffic at the same time. Highest mode queue may ensure that multicast traffic travels at the best possible rate without overwhelming nodes to replicate traffic for different nodes. In embodiments, MANET domains may be used to limit the scope of multicasting network thus partitioning the multicast traffic. In addition, BAP may backhaul the multicast traffic to the other BAP domains that need that multicast traffic, thus further optimizing multicast traffic. For example, consider the node configuration in Fig. 15. In this example A is connected to B, C, D and E with their modes listed next to nodes. When A broadcasts information to B, C, D and E, the least common mode is 1, so broadcast packet is put on Mode 1 queue. When A wants to multicast to B, C, D, and E (assuming they all are in receive group). A will copy the packet to Modes 1, 3, and 5. This copy may be done using smart pointer (reference counts) so it saves on some extra copies. Fig. 16 shows multiple mode queues supporting different levels of QoS. Fig. 17 provides a more detailed view of a basic peer to peer interconnection of mobile nodes. Fig. 18 now shows how the peer to peer network may accommodate multicast routing, and where Fig. 19 provides a flow diagram for several possible routes through the network shown in Fig. 18. In this example, multicasting is shown from LF106 to a group of nodes interconnected via LFl 16 and LFl 18. Alternate paths are shown as paths B and C, as well as other possible routings.

[00181] In embodiments, an enhancement may be remote network monitoring, control, and upgrade. Fig. 20 illustrates providing remote network monitoring, control and upgrade in a mobile ad-hoc wireless network according to an embodiment of the present invention. In this embodiment, remote monitoring of network elements may enable proactive and reactive network maintenance. Remote control may enable reduced cost network upgrades and tuning. Remote upgrade may dramatically reduce labor content of network-wide upgrade.

[00182] In embodiments, an MBRI enhancement may include adaptive transmit power control. For instance, a MANET may provide transmissions that may typically occur at a fixed transmit power. The slot capacity depends on the modulation, coding, bandwidth, and TDMA time slot duration. Consider a sample network topology as shown in Fig. 21. Yellow Circles indicate nodes, and gray lines indicate links between nodes in the MANET. A link exists if two nodes are within direct communications range of one another. These nodes are called one-hop neighbors. Similarly, a collection of nodes within two hops of a node form its two-hop neighborhood. Fig. 22 and Fig. 23 show the one-hop and two-hop neighborhoods from the differing perspectives of two nodes in the network - highlighted in red in each picture. The two-hop neighborhood may be an important concept for some channel access scheduling algorithms. These channel

access scheduling algorithms coordinate the transmissions considering all nodes in the two-hop neighborhood. Nodes outside the two-hop neighborhood may be scheduled independently. On average, a node may transmit proportionally once for every N2 slots where N2 is the number of nodes in the two-hop neighborhood. Hence, the smaller the two-hop neighborhood, the more often each node can transmit, resulting in increased network capacity. Adjusting the transmit power can be an effective way to reduce the size of the two-hop neighborhood. This concept is illustrated in Fig. 24 where the connectivity zone and the interference zone are shown for full power (left) and reduced power (right). Fig. 25 shows the outlines of the two-hop neighborhoods for the two nodes for links operating at full power. Notice that the neighborhoods overlap, resulting in relatively poor slot scheduling efficiency. When the transmit power is reduced, some links between nodes remain, and others disappear. Fig. 26 shows the link topology for the same network when the transmit power is reduced, such as by 10 dB. The two-hop neighborhoods are reduced and no longer overlap, allowing the different neighborhoods to be scheduled independently. This results in an increased number of simultaneous transmissions in the network. Effectively, the reuse distance has been decreased due to the reduction in transmit power. Fig. 27 shows the further reduction and isolation between two-hop neighborhoods that may be possible when the transmitter power is reduced further, say by 20 dB. The trade-off is that as the power is reduced, the set of nodes that are viable receivers (i.e., possible links) is also reduced. Some nodes have no links that can be supported at all at the lower power. As a result, a combination of transmit power levels for different TDMA time slots are used in order to maintain full end-to-end routability across the network. The router maintains "next hop" options for each of the different transmit power levels and uses the "first available" transmission opportunity that gets the data closer to its destination, subject to QoS constraints.

[00183] In embodiments, an MBRI enhancement may include adaptive data rate (ADR). For instance, a MANET may autonomously discover links between neighboring nodes in order to exchange data over the network. Initial link establishment may occur using a fixed data rate. Links may be established when two nodes are within communications range of one another. The data rate that can be supported over a link may be roughly proportional to the distance between the transmitter and receiver, as determined by the path loss. Over shorter links (i.e., smaller path loss), increased data rates can be supported. In a cellular network, mobile nodes always communicate only with a base station. This allows the base station to act as a central controller for adjusting the link data rates for the nodes it is communicating with. In a MANET, all nodes may be able to communicate with all other nodes, and there may be no centralized controller. A distributed protocol may be needed to adjust link rates. Once neighbors are discovered and links established, an ADR adjustment algorithm may adjust the data rate on the link to the maximum rate that can be reliably sustained (i.e., low slot error rate) based on link conditions. Fig. 28 shows a depiction of how different data rates may be supported for different link conditions (e.g., range and blockage) based on relative node locations. The red circles indicate two nodes in a MANET. The blue shaded areas indicate the nominal locations where different

data rates can be supported between the left-most red node and any other node in the MANET. The darker shaded areas indicate higher data rate that can be supported. For example, in a network with three available data rates, suppose the right-most red node is traveling along the dotted line path (to the right) away from the left-most red node. When the two nodes are nearby, a "high data rate" can be supported (dark blue). As the node moves away, a "medium data rate" can be supported (medium blue) as shown in the Fig. 28. With continued motion, a "low data rate" is supported. At distances beyond where the low data rate can be supported, the link is dropped and a multi-hop route through the MANET is needed to exchange data between the nodes.

[00184] In relation to ADR, each waveform mode may be parameterized by a combination of parameters that represent a trade-off between data rate and demodulation performance. The link data rate may be adjusted to maintain adequate demodulation performance in the presence of changing link conditions. When link conditions degrade below a certain threshold, the ADR algorithm may rapidly decrease the link rate to a reliable mode to reduce the amount of data that is lost. When link conditions support higher data rates, the ADR algorithm may increase the link data rate to increase payload delivered by each slot. The multiple possible combinations of waveform parameters may be organized into a one-dimensional ordered list of monotonically increasing data rate with correspondingly decreasing signal robustness. The ADR algorithm may "walk up and down" the list dynamically as a function of observed link performance. A combination of measurements characterizing link performance may be used to drive adjustments. For each received time slot, the modem may return estimates of received signal strength (RSSI), Eb/No (SNR), pre-FEC bit-error rate (BER), and the like, along with the slot payload data, transmitting node ID, transmitted waveform mode and the like. An Adaptive Data Rate Control Message (ADRCM) may include the number of slots transmitted during each interval (e.g. one second) for each waveform mode, allowing the receiving node to calculate the slot error rate for each waveform mode. These link observation statistics may be grouped by transmitting node and mode to adjust the receiving node's suggested waveform mode for each link. The waveform mode of each link may be adjusted independently in each link direction. Fig. 29 shows different waveform modes from the node in the center to each of the surrounding one-hop neighbor nodes. Once a link is established, the ADR algorithm may adjust the waveform mode on the link to optimize the data rate. Relative link quality is a measure of link quality relative to the link quality needed to maintain the selected link data rate. As two nodes move closer together or farther apart, the ADR algorithm adjusts the link rate in order to maintain sufficient relative link quality. At the lowest data rate (most robust) waveform mode, relative and absolute link qualities are identical. Once nodes become too far apart to maintain their direct link, they must route through a relay node to exchange data.

[00185] In an example, an ADR algorithm runs concurrently for all one-hop links, but is computed independently for each receiver-transmitter pair. The ADR algorithm processes measured SNR data and computes a weighted average value on one second intervals. The algorithm then determines if the new

value supports an increase in "mode", or no change. The "suggested" mode value and packet reception counts are relayed back to the transmitter in an ADRCM. If sufficient data were transmitted during the one second interval, the transmitter compares the number of received slots counted at the receiver to the number of slots transmitted to compute a reliability estimate. In this example, three cases may be possible: 1) the reliability was acceptable; 2) the reliability was unacceptable; or 3) no decision can be made because there are insufficient measurements. If reliability is acceptable, then ADR uses the suggested mode value for the next one-second interval. If reliability is unacceptable, then ADR compares the suggested mode to the current mode. If the suggested mode is inferior to the current mode, it is put to use. Otherwise it is ignored. As part of the process for determining whether ADR can "step up" in mode, it is sometimes necessary to insert ADR Maintenance Messages into the data queues to "force" transmissions at waveform modes needed to determine whether that mode can be supported over the link.

[00186] In embodiments, an enhancement may be network geo-location. Fig. 30 illustrates providing location information of network nodes to neighboring nodes in a mobile ad-hoc wireless network according to an embodiment of the present invention. In this embodiment, providing geo-location of network nodes to the neighboring nodes may facilitate public safety and may enable location-based services.

[00187] In embodiments, an enhancement may be multimedia capability. Fig. 31 depicts the use of increased slot rate in communication in a mobile ad-hoc wireless network as a means of better accommodating carrier grade service delivery of multimedia content in mobile ad-hoc networks. In embodiments, slot time is defined as the duration of a single opportunity that may be used for transmission. In an embodiment, an increased slot rate may be used to transmit data in a mobile ad-hoc wireless network. In an example, the slot rate used may be 1000-2000 slots/sec. As shown, an increased slot rate may allow more distinct opportunities for multiple nodes to access the channel. An increased slot rate may also reduce the delay between the opportunities available for the mobile nodes. An increased slot rate means a reduced slot time. A reduced slot time results in more number of devices sharing the network. The reduced slot time also reduces jitter in the network.

[00188] Continuing with multimedia capabilities as a MBRI enhancement. In a network running TDMA in the MBRI, transmissions may typically occur with fixed duration time bursts running at the fundamental slot rate. The slot capacity may depend on the modulation, coding, bandwidth, TDMA time slot duration, and the like. The TDMA time slots are shown at the top of Fig. 32. Multimedia internet data can have widely varying characteristics and delivery requirements including data rate, latency, jitter requirements, and the like. While a TDMA time slot structure with a single slot duration and bandwidth can effectively transport this data, efficiency improvements can be achieved by providing a more flexible transport structure that is better matched to the different types of data being carried by the network. The method described here to achieve improved efficiency is to create a hybrid frame structure that utilizes a combination of time slot durations and bandwidth sub-channels. The bottom of Fig. 32 shows an example hybrid frame structure for

short (Ix the fundamental slot rate), medium (2x), and long (4x) slot durations and bandwidth sub-channelization into 1, 2, or 4 sub-channels. This represents just an example, the method is generally expandable into any number of slot durations and sub-channels, not necessarily integer multiples of the fundamental slot rate. Both high capacity and scalability may be needed to enable the MBRI. Network design is a balance between providing high transport capacity and enabling methods that allow that capacity to be shared among a large number of simultaneous users. The hybrid frame structure may accomplish this by creating both high capacity transport slots and a larger number of schedulable transmissions (i.e., slot and sub-channel combinations) during a fixed interval. Note that a length 2x transmission may be more than twice as efficient as a length Ix transmission due to the elimination of slot timeline overhead for propagation guard time and preamble acquisition sequence. At the top of Fig. 32, the fundamental slot rate shows 12 individual full bandwidth schedulable transmissions at the fundamental slot rate. By moving to the hybrid frame structure shown at the bottom of Fig. 32, the number of schedulable transmissions in the network has increased to 24, allowing more nodes to transmit data during the same time interval. This may improve the latency characteristics of the network. Additionally, some of the slots are longer than the fundamental slot duration, allowing a few nodes to transmit more data more efficiently than with a fixed slot rate. This approach simultaneously enables both capacity and scalability across the network. This approach is analogous to shipping a large number of various size items in different size boxes, rather than always using the same size box to package every item. Different channel access scheduling algorithms may be matched to the different slot duration and sub-channel configurations. Full bandwidth slots are well-matched for scheduling using algorithms that select the transmitting node. Slots with multiple sub-channels are well-matched for scheduling algorithms that first select the receiving node, and then select the multiple transmitters for the different sub-channels.

[00189] In embodiments, an enhancement may be time synchronization. Fig. 33 depicts a mobile ad-hoc wireless network is shown where embodiments of the present invention may be implemented for providing time synchronization. The network shown is a simple mobile ad-hoc network where nodes 1-4 are user nodes and the nodes A, B are access point (AP's). The AP's may have knowledge of network timing to insignificant levels compared to the timing needs. A method for enabling timing synchronization may include communicating a sense of network timing at all the nodes with sufficient accuracy to enable reliable communications. The network timing may include slot timing and carrier frequency timing. In an aspect of the present invention, it may be assumed that each node may be designed so that the slot timing and the carrier frequency is derived from the same local reference. In an example, frequency error in the slot timing may be directly proportional to the carrier frequency error. The carrier frequency may be an integer multiple of slot rate. In an example, the slot rate may be 1 kHz. Referring to Fig. 1, the nodes 3 and 4 may use the APs 'A' and 'B' for obtaining timing information for synchronization. The nodes 1 and 2 may use an indirect approach by obtaining the timing information derived from the nodes 3 and 4 for synchronization. In an

embodiment, the timing information may be obtained by comparing the incoming packet timing relative to the local timing reference. In this embodiment, the relative timing of all of the neighbor nodes may be tracked and the local node timing is set to match the mean of these tracked times. The tracking may be accomplished using a Kalman filter with two states. In an example, the two states may be the time offset of the slot and the incoming carrier frequency (the number of states may be increased and the delay as an additional state may be introduced later). This method may be used by each node to synchronize to the network time and estimate the error in this local timing reference. Fig. 34 illustrates how time synchronization may be based on the time difference between synchronization packets and GPS based time reference. Delta time lookup table may be maintained for each node within MBRI and updated as required.

[00190] Continuing with multimedia capabilities as a MBRI enhancement, Fig. 35 illustrates an example topology for evaluating the algorithm. Estimating the relative time of each node, correcting for time offsets and estimating delay of each link in two mobile ad-hoc networks in accordance with an embodiment of the present invention is discussed. As shown, a simple three-node mobile ad-hoc network 202 and a mesh network 204 that was also used for evaluating the algorithm performance. The algorithm estimates the relative time of each node, corrects for time offsets and estimates the delays of each link in the network.

[00191] In embodiments, the MBRI may provide functions and capabilities that enable improvements over existing systems. For instance, MBRI may provide functions and capabilities in the subscriber device that may ordinarily be a part of a base station, such as air interface management, signaling, concentration logic, signal propagation algorithms, and the like. MBRI may enable the creation of a mobile Internet, including routing implemented in the subscriber device, MAC layer functionality in the subscriber device, peer-to-peer communication (e.g., communications between subscriber devices), and the like, that may provide a communications protocol stack equivalency within the subscriber device. MBRI may enable full radio resource management in the subscriber device, such as the subscriber device acting unilaterally, the subscriber device cooperating with other nodes, interference mitigation, handover / handoff functionality, backhaul capabilities such as access to the public Internet, IP-RAN capabilities, and the like. Fig. 36 provides one embodiment of how radio resource management may be implemented in an MBRI subscriber device. In addition, MBRI may be OFDMA enabled, and subscriber devices may be multisession enabled, where a node may perform multiple transmissions simultaneously, such as with a session-tagged interleaving of packets to identify one session transmission from the other. In embodiments, multisession transmissions may be the result of multiple applications on the node, performing tasks simultaneously, sending out communications across the network, and the like, where the simultaneous transmission of the data is sent in a multisession transmission.

[00192] In embodiments, performance of the MBRI may be enhanced over current systems, such as through adaptive power control, intelligent route diversity, least cost routing on the subscriber device, warranted service level agreements (SLA), node neighbor discovery and awareness, no need for a home

location register (HLR) or visitor location register (VLR), geo-location of devices, openness to web applications on the subscriber device, subscriber device unicast and multicast capabilities, increased radio saturation, graceful degradation, and the like.

[00193] In embodiments, methods and systems are provided herein for operating an all IP mobile ad hoc network with carrier grade network performance and improved spectrum utilization through IP transparent routing, media access control and physical layer convergence protocols including a plurality of wireless mobile nodes and a plurality of wireless communication links connecting the plurality of nodes. The methods and systems may include a range of features, including, for example, one or more of: (1) facilitating node level, network wide and interoperable time synchronization for packet level and frame level transmission/reception peer to peer, peer to network and network to peer; (2) supporting a variety of wireless access protocols using TDD or FDD transmission based on symmetrical waveforms optimized for peer to peer communications in a mobile ad-hoc network; (3) supporting a physical layer convergence protocol that allows for symmetrically optimized waveforms based on OFDM, OFDMA, SC-OFDMA, QAM, CDMA and TDMA protocols; (4) facilitating link-by-link autonomous data rate selection; (5) providing a slotted MAC protocol for peer to peer, peer to network and network to peer frame transmission/reception; (6) providing for autonomous network entry/exit for nodes entering or exiting the network, and transparently allowing new nodes to utilize ARP for end route translation, DHCP for authentication, authorization and IP address resolution; (7) providing peer to peer packet routing with facilities for packet segmentation and reassembly, Quality of Service based routing and traffic type based routing; (8) MAC layer and network layer fairness algorithms designed to optimize and prioritize traffic based on nodal queue build-up, traffic type latencies, bandwidth optimization and spectrum optimization; (9) providing unicast and multicast routing of packet data through the mobile ad hoc network; (10) facilitating peer-to-peer connections to selectively bypass network infrastructure; (11) providing for remote monitoring, control, and upgrade of the wireless mobile nodes; (12) providing location estimates of neighboring nodes to each node in the network; (13) facilitating adaptive control of transmission power of a node based on location of the node; (14) dynamically adapting packet routing according to network and spectrum conditions; (15) prioritizing delay sensitive traffic across the mobile ad hoc network; (16) providing multiple connections of the mobile ad hoc network to a fixed network; (17) enabling automatic re-transmission of loss-sensitive traffic; (18) providing secure connections and supporting existing IP security standards; (19) facilitating spectrum independence; and/or (20) Supporting multi-session support at individual node.

[00194] In embodiments, the present invention may include a plurality of other functions and capabilities in association with MBRI, such as prioritizing delay sensitive traffic across the network protocol through priority queuing and priority channel access by differentiating data traffic across the protocol stack, dynamically adapting bandwidth usage according to network and backhaul conditions through distributed decisions regarding local bandwidth usage by individual wireless nodes, dynamically assigning IP addresses

to new entry nodes or terminating IP addresses for exiting nodes according to network requests for service through distributed decisions regarding local resource usage by individual wireless nodes, and the like.

[00195] In embodiments the present invention may provide improved capabilities associated with MBRI associated with facilitating adaptive control of the transmission power of a node based on the location of a node in the mobile ad hoc network, mobile ad hoc network creation and self-forming networks made up of individual nodes based on their relative position with respect to each other in the mobile ad hoc network, mobile ad hoc self healing networks made up of individual nodes based on their relative position with respect to each other in the mobile ad hoc network, mobile ad hoc load leveling networks according to network requests for service and comprises making distributed decisions regarding local resource usage by individual wireless nodes, mobile ad hoc networks where the nodes and network are packet size indifferent and comprises making distributed decisions regarding local resource usage by individual wireless nodes, unicast routing in mobile ad networks according to network requests for service and comprises making distributed decisions regarding local resource usage by individual wireless nodes, mobile ad hoc networks that are Internet Protocol Plug Compatible, mobile ad hoc networks that are neighbor aware to requests for service and comprises making distributed decisions regarding local resource usage by individual wireless nodes, mobile ad hoc networks according that are geo location aware for network requests for geo location information, mobile ad hoc networks that are unconditionally open for Java Web applications, mobile ad hoc networks that are configured for private or public network usage, and the like.

[00196] In embodiments, the MBRI may distribute network, routing and switching intelligence to the subscriber device and to spanning network elements that enable subscriber devices to interconnect with the "wired" Internet. By doing this each subscriber device can autonomously determine its own path to transmitting/receiving information to/from other peer devices in the network and with the Internet. In addition, route diversity increases exponentially commensurate with the number of devices in a given geographic area thereby increasing Quality of Service, increasing bandwidth switching capability through improved spectrum reuse and increased spectrum tele-density. Furthermore, MBRI automatically load levels the access side traffic across all the available backhaul points of presence (which are also MBRI nodes that have fixed wired connections to the Internet). Fig. 39 provides one embodiment of a fully enabled IP router in a subscriber device and how it may be implemented within MBRI.

[00197] In embodiments, benefits of MBRI may include improved quality of service, better scalability for traffic carrying capacity, an ability to increase spectrum reuse for a given geography by an order of magnitude more than cellular systems used over the same geography, and the like. MBRI may allow each node to optimize the network resources and each other on a packet by packet basis for sending/receiving traffic from one device to another or to/from the wired Internet. The technology takes advantage of access side hopping/routing and backhaul hopping/routing to optimize packet forwarding.

[00198] In embodiments, the MBRI may scale, commercialize, and optimize both unlicensed and licensed spectrum band operations for the public communications marketplace including voice, video and data services through an all IP mobile ad-hoc routing network, where each node is a standalone router able to make unilateral routing decisions through unique mobile ad-hoc protocols that are equivalent and transparent to the standard IP protocols used in the public wired Internet.

[00199] In embodiments, the MBRI may have the capability to move routability into a mobile access network, in turn allowing intelligent routing, optionally including providing a network that is routable, such as IP-routable, down to the individual device in a mobile ad hoc network, without necessity of a base station to perform the routing. Thus, the methods and systems disclosed herein may allow peer-to-peer Internet communications in a mobile ad hoc network without the need for intervention by a base station or similar controller. In addition, the MBRI may allow disposing a MAC layer in a mobile subscriber device, mobile networks in which the subscriber device is both multicast and unicast, providing multi-session subscriber devices, and the like. Fig. 37 provides an embodiment of a multi-session enabled subscriber device and how it may be implemented in MBRI.

[00200] In embodiments, methods and systems disclosed herein also include providing a range of functions that have historically been provided as part of a base station in the handset or subscriber device in a mobile ad hoc network work, optionally including one or more of an air interface management facility, signaling intelligence, concentration logic, signal propagation algorithms, interference mitigation between devices, and the like. Methods and systems disclosed herein may include full radio resource management capabilities in a subscriber device, such as a handset, including management of the radio of the device itself, management of how the device cooperates with foreign devices, and handover and handoff by the subscriber device.

[00201] In embodiments, methods and systems disclosed herein may also include providing an architecture with fixed radios associated with mobile radios. The fixed radios may include various access points to nodes of an MBRI. Methods and systems disclosed herein include methods and systems for providing backhaul to the Internet from a mobile ad-hoc network, such as an MBRI. Backhaul may include a diversity of backhaul types, including connection to the Internet backbone, as well as optional interconnection into a FAP. Pre-deployment design for maximum bandwidth demand may identify where a FAP exists for backhaul and allocate MANET radios to these sites in a pattern that provides optimum backhaul capacity for all the MANET radios in the network. Other MANET radios that are not at a FAP may transmit their backhaul to those MANET radios that do have fiber and thus reduce the number of fibered points required to cover a region. In embodiments, FAPs may be successively activated as bandwidth demand grows in the network. This process of identifying where the FAPs are may require the development of specific data from multiple sources and the development of bandwidth planning in order to predict which FAPs are activated in which period. This may reduce the number of FAPs needed for a MANET network and thus reduce cost. It also may allow for the concentration of backhaul bandwidth and thus enable volume discounts on fiber backhaul. By bringing the radios to the FAPs, the time to deploy a network may be substantially reduced. In addition, it may provide a wider selection of Fiber Access Points to increase the flexibility of a MANET network design. Most wireless networks and network planning software programs design a network for coverage and rely on backhaul to be brought to every wireless site. This innovation reverses that process by the acquisition and unification of multiple data sources to identify FAPs prior to actual deployment and by software that enables systematic selection of the best FAPs for the network as demand grows. Benefits of the process may include network design for end state bandwidth capacity, network design for bringing MANET nodes to FAPS, data development to identify where FAPs are located, activation of pre-determined FAPs as bandwidth demand across the network grows, and the like.

[00202] In embodiments, backhaul-driven MANET network design may provide network design for improved end state capacity. Current network design software may be limited to executing algorithms that design a network for coverage, usually working out from a single fixed point and then locating new network nodes to provide contiguous network coverage. In embodiments of the present invention, MANET networks may enhance this software by first establishing where the network's forecast capacity would be concentrated and then selecting FAPs that correspond to this concentration of end state bandwidth demand. FAP data development may be provided through the purchase of multiple data sets that identify the location of fiber terminating equipment are combined and cross-checked against each other. Additional proprietary data may also be added, for instance from a fiber connectivity carrier or the municipality. Together, this data may provide a listing of all FAPs that could be used in the region. MANET network design may be undertaken using the FAPs as starting locations for MANET radios. Any gaps in coverage in the network may then be filled by deploying additional MANET radios that backhaul their traffic via a wireless ad hoc mesh. Fiber backhaul for the MANET radios located at FAPs may be activated as and when overall network traffic demand requires this additional backhaul. The overall result may be a network design optimized to the pre-existing FAPs and thus avoids the cost and time required to provide fiber backhaul to every MANET radio site. By successive activation of fiber backhaul so the cost of this fiber backhaul, transport may be deferred until the network bandwidth demand requires it.

[00203] In embodiments, methods and systems disclosed herein may include a range of performance improvement facilities, including, without limitation power control facilities, adaptive data rate facilities, cost-based routing algorithms, route diversity facilities, independence from a pre-set route list or need to retrieve a route list, warrantable service levels, neighbor discovery, awareness facilities, and the like, as shown in Fig. 38. In embodiments, power control facilities optionally may include adaptive power control of radio transmission power from a mobile device, such as for increasing radio saturation and for graceful degradation of network performance. Power control facilities, such as shown in Fig. 40, may provide for nearby devices whispering (w2, w5, w7, w8?) to each other at low power, optionally based on channel

conditions or other factors, so that they have minimal impact on the rest of the network. Power management in the MBRI system may be enabled through both a managed interface and from autonomous action at the node level. For instance, a node may individually sense power requirements to neighbor nodes through neighbor awareness, and be able to dynamically adjust power levels so that they are not to great, as to cause interference to other nodes in the neighborhood, or too low, as to reduce link quality. In another instance, power management may be provided in a more centralized manner, such as to declare certain links, services, data streams, and the like, certain power levels, such as for quality of service requirements or dedicated link assignments. In embodiments, the fixed MAPs and BAPs may also participate in power control algorithms.

[00204] In embodiments, ADR (adaptive data rate) facilities, such as shown in Fig. 41, may include methods and systems for varying data rates delivered to or from a device based on a variety of factors, including traffic type, density of subscriber devices in an area, spectral conditions in an environment, terms and conditions of a subscription plan, and others. MBRI may enable dynamic ADR facilities through link-by-link autonomous data rate selection, neighbor awareness, network management services, and the like. For instance, a node may detect that a type of data traffic is requesting routing on a particular link, and the node, enabled through the ability to select data rates for individual links, may be able to automatically adjust the data rate allocation provided to the link to meet the requirements of the new traffic type. Fig. 42 illustrates one method of how adaptive data rate may be utilized.

[00205] In embodiments, Cost-based routing algorithms may include algorithms that assign "costs" to links involved in a route, and with different links being assigned costs optionally based on a variety of factors, such as the number of hops involved in a series of links, the density or type of traffic being handled by a particular link, terms and conditions of service applicable to a particular link, quality of spectrum or channel conditions for a particular link, power required to communicate to a particular link, or the like, such as shown in Fig. 43. Costs of different available routes can then be compared with costs of different routes being calculated by considering overall cost of a plurality of links in a prospective route. Calculation of the cost may be based on a sum of costs, or based on a weighted average or other type of calculation. Calculation of cost can be subscriber-specific (or subscriber plan specific). For example, a subscriber plan might dictate finding "least cost" routes as to overall network performance (allowing the subscriber to have a less expensive subscription plan), or the subscriber might have a "high performance" plan that finds routes with the highest level of bandwidth or quality of service. Routing algorithms embodied in software on subscriber devices can thus take into account these various factors and route traffic in a way that accounts for the costs of routing, defined in whatever terms a network service provider prefers. Cost based routing may be enabled through MBRI capabilities, such as intelligent routing, neighbor awareness, peer-to-peer communications, link-by-link autonomous data rate selection, and the like. For instance, the cost of a route may be determined through both a node's ability to discern available routes through awareness of neighbor link availability and current traffic loading, but also on the ability of nodes in the network to alter their data rate per the changing routing

requirements of the network. For example, a high quality of service route through the network may be called for, such as to provide a data stream pipeline from a mobile network node to BAP connection point. The source node may be able to determine, through an awareness of network node availability and loading, a route that best provides the needs of the route. In addition, the source node, perhaps in conjunction with management facilities, may be able to alter power and data rate levels to improve the conditions under which the route costs are determined. In embodiments, MBRI may provide a dynamic and flexible way for optimal routes to be discovered and enhanced. Fig. 44 illustrates one embodiment of how least cost routing may be implemented within MBRI.

[00206] In embodiments, MBRI may provide for QoS for differentiated levels of service. There are multiple ways in which QoS is provided for differentiated levels of service for different traffic priorities, such as priority queuing, priority channel access, priority routing, and the like. Priority queuing may utilize the data queues within each node to create a system of "passing lanes" that can be used to give the traffic that is generated by some applications an advantage over others. Data queues may be organized by transmitted waveform mode and QoS setting. Priority channel access may use traffic priority settings to adjust the channel access schedule to give prioritized channel access to nodes transmitting higher priority data. A priority routing method is to route data along different paths according to priority level. High priority data may be routed along the most direct path, while lower priority data may be routed over multiple hops to balance the load level across the network. Multiple levels of priority queuing for user data within each waveform mode queue may provide a range of differentiated service levels. Additionally, a dedicated queue at the highest priority level may be reserved for routing protocol messages. This may help to make sure that data is following a suitable route through the network. Data packets may be queued on the basis of priority settings in a header. Within each sub-queue (such as a combination of waveform mode and QoS level), data may be served in a FIFO (first in, first out) manner. High priority data may be transmitted before lower priority data as shown in Fig. 45. Data packets may be en-queued according to selected waveform mode for the link corresponding to the next hop and QoS setting in the header. When a transmission opportunity is approaching, data may be selected to be de-queued for transmission. De-queuing may be based on QoS setting first, then waveform mode as shown in Fig. 46 for an example of strict priority de-queuing.

[00207] In embodiments, MBRI may enable QoS based routing, providing mobile nodes capability to route MANET traffic based on QoS information to optimize traffic, CPU load, mobile node's battery power usage, and the like. The mobile node's network layer may broadcast router control information to the MANET domain. This route control information has several components to it, including link cost, route cost, power cost, CPU cost, configurable cost, adaptive data rate (ADR) information, and the like. This information may be added to a given MANET routing protocols and broadcasted. Receiving nodes may create different routes to the destination based on different criteria such as power, link cost, and the like. Once a MANET routing protocol converges with this additional information, all nodes would have different

routing topologies based on these criteria, and then tagging the traffic to determine which criteria to use for routing the traffic. Host traffic may be tagged and assigned a set of QoS value based on programmable application awareness logic. This application awareness logic may essentially determine traffic requirements for a given data flow (e.g. VoIP call vs. mp3 download). Once traffic is tagged, relay nodes may use this information to route the traffic. Other examples of routing based on QoS may include relay nodes deciding to route based on power utilization (instead of link cost) to save battery power.

[00208] In embodiments, multiple queuing disciplines can be used, including strict priority, weighted round robin (WRR), and the like. Alternate methods of en-queuing and de-queuing, such as by next hop link instead of by mode may also be supported while maintaining the QoS sub-queues within each queue. The queue depths may be monitored to allow a node to indicate when it is experiencing congestion and needs more transmit slots to satisfy its offered load. The queue depths may be transformed into calculation of a "Node Weight" that is used to adjust transmit scheduling. The Channel Access module may be responsible for determining which node transmits during each time slot. When the node "wins" a time slot, it transmits. Channel access is partitioned into individual time slots. Without differentiated data priority levels, all nodes may have statistically equal opportunity to transmit during a given slot. When multiple levels of priority are enabled, a series of node weights corresponding to a combination of priority levels and data queue depth may be used to adjust the transmit schedule. This may allow nodes with higher node weights to win statistically more slots per second in order to meet their need for increased channel access and high priority transmission. Fig. 47 shows differing priority data inside the node queues inside two different nodes. Differentiated routing may send data along different paths across the network topology according to data priority. High priority data may be sent along the quickest, most direct route over the network, while lower priority data may be sent along a path that balances the data traffic across the network topology. An example is shown below in Fig. 48. The multiple levels of providing QoS prioritization are shown below in Fig. 49. High priority data packets within a node may be transmitted before lower priority data packets. A node with high priority data packets may be granted preferred channel access over a node containing lower priority data. Multiple routes between source and destination may be set up to allow high priority data to take the quickest, most direct path, while lower priority data may take a longer path in order to balance network load across the topology.

[00209] In embodiments, route diversity facilities may include software and technology on subscriber devices that enable selection of routes among a plurality of diverse routes, optionally including routing packets across diverse routes to ensure a very high or specified level of QoS. For example, if a subscriber plan calls for a particular level of quality of service, IP traffic packets to and from that subscriber device may be routed redundantly across various routes, ensuring that if there is failure of one route, packets can nevertheless be assembled for the intended traffic. Coupled with the other capabilities described herein (adaptive transmit power control and data rate based on channel conditions, for example), route diversity may allow a service provider to ensure high (or desired level) of quality of service; thus, a service provider may

warrant service levels, guaranteeing the delivery of service to a pre-committed service level in an entirely mobile network (such service level commitments being impractical in conventional cellular networks, where quality of service is highly dependent on density and traffic of mobile devices in proximity to a given base station). Route diversity may also include capabilities for SAR, such as using error correction techniques associated with packet segmentation and reassembly in the fixed Internet or other IP-based networks. In embodiments the MBRI, by having true IP-based routing, may allow independence from a pre-set route list and therefore independence of the need to retrieve a route list from a server or fixed infrastructure component, thereby simplifying routing as compared to conventional mobile networks. Neighbor discovery and awareness facilities may include software and components for identifying nearby MBRI-enabled subscriber devices and automatically establishing links with the other devices.

[00210] In embodiments, methods and systems may include facilities for registration of users, such as using DHCP for registration, optionally including registration independent of the need for HLR or VLR as required in mobile cellular networks. Management facilities may include management independent of cellular back office, such as for billing for data, authentication, provisioning, switching, and the like. In embodiments, a management path may be established for managing back office functions, distinct from the traffic path used to pass various types of traffic among subscriber devices. The management path may be implemented in various configurations, depending on the desires of the service provider or network operator. For example, a real-time continuous management path may be provided, in which the activities of individual subscriber devices are tracked, recorded, and managed at all times, including facilities for tracking the load of traffic handled to and/or from a subscriber device, the type of traffic, and even the content of the traffic (subject to regulatory and other privacy constraints). The real time management path may be provided as an IP-based management path, using all of the IP-routing capabilities described herein, and the management path may allow a service provider to interact with applications on the subscriber device, such as to deploy applications to a subscriber devices, enable or disable applications or capabilities on the subscriber devices (such as to allow higher performance capabilities, to alter service plans, or the like), to monitor traffic for purposes of administering service plans, and many other functions. Any of those activities may alternatively be provided in a batch-mode management path, with subscriber devices provided with applications for recording their activities and periodically reporting activity levels, traffic types and the like to a service provider or network operator. In another alternative embodiment, a subscriber-administered management path may be provided, in which a subscriber (such as an enterprise, educational institution, government entity, organization, or even a family or individual) may operate and manage subscriber devices without intervention of a conventional network operator. For example, a company could manage devices in a company headquarters, deploying applications, enabling or disabling capabilities, or the like, without the need to monitor traffic or usage, because the network bandwidth is provided entirely by the combination of the local swarm of IP-enabled subscriber devices and the enterprises' own local area network.

[00211] The existence of a subscriber-only management path may support, among other things, establishment of an entirely local IP-enabled network (a local Internet), consisting of a swarm of mobile devices in geographic proximity to each other, optionally extended or supported by local fixed assets such as local area networks. Such a network may allow internal traffic that is highly secure as compared to Internet or cellular traffic, in which traffic and content are transmitted, and often stored, on servers owned and operated by unknown entities distributed around the world. Such a local or geographically focused network swarm may also be provided by a service provider or network operator, using a more conventional management path, still offering an increased degree of security by virtue of its being optionally segregated from the Internet or cellular networks. A locally focused mobile swarm may also enable various value-added applications and capabilities, such as applications relating to local commerce, local news and entertainment content, local government, local public safety, local traffic, local weather, local operation of an enterprise, interpersonal communication with local friends, family and neighbors, and many others. The local swarm can enable an entire class of applications that can use very high bandwidth (e.g., at broadband video rates), that can be offered at low cost (due to low demands on network infrastructure for reasons described herein), that are highly secure (due to diminished use of unsecured network servers), and that are geographically aware (using geo-location facilities described herein). Fig. 50 provides an embodiment of local IP-based swarming, where content may be distributed within an immediate proximity swarm before requesting for external sources of the same.

[00212] In embodiments, methods and systems disclosed herein may allow effective equivalency between the MBRI core stack and the fixed Internet OSI stack. Thus, applications designed for the fixed Internet may be deployed on the MBRI, and vice versa, without requiring intervention, such as of a carrier or service provider. The MBRI core stack allows two different networked devices to communicate with each other regardless of the underlying architecture. In addition, the MBRI core stack provides a basis for understanding and designing a network architecture that is flexible, robust, and interoperable. The overall MBRI model consists of seven layers, the three layers of the MBRI stack, including the physical layer (layer 1), the MAC layer (layer *X),* and the router layer (layer 3), and the four higher layers of the fixed Internet OSI stack, including a transport layer (layer 4), a session layer (layer 5), a presentation layer (layer 6), and an application layer (layer 7). A sending or receiving device may implement one or more of the seven layers of the model. In embodiments, device A may be networked with device B through a transmission channel. The transmission channel may include one or more intermediate nodes between the connected devices A and B. In embodiments, the intermediate nodes may implement at least three layers of the model: the physical layer, the MAC layer, and the routing layer. In embodiments, the intermediate nodes connecting two devices A and B may process, transform, and modify the received data before retransmitting. In another embodiment, the intermediate node may retransmit the data between devices A and B without any modification or transformation. For example, the functionality of each of the layers may be pruned to meet specific

requirements without deviating from the scope of the invention. In embodiments, all functions specific to a particular layer may be implemented in software and/or hardware without deviating from the scope of the invention.

[00213] Fig. 51 provides a breakout of the MBRI core stack, including the routing layer, the MAC layer, and the physical layer. As shown in this embodiment, the MBRI routing layer may include the sub-layers IPv4/RFC 791, BGP4/RFC 4271, SLSR (scoped link state routing) and ROM (receiver oriented multicast). The MBRI MAC layer may include the sub-layers for encapsulation/RFC's 894/1042, MAC 802.3, ARP/RFC 826, DHCP, NDM (neighbor discovery management), ADR (adaptive data rate), and NAMA channel access. The MBRI physical layer may provide for the sub-layers SAR, LANTA network timing, and configurable waveform slot by slot; PLCP being replaced by the equivalent OFDMA waveform modes; and waveform discovery being replaced by OFDMA. In embodiments, the MBRI set of layers may provide a core stack that enables MBRI to facilitate the behavior and functionality of the fixed Internet in a MANET environment.

[00214] In embodiments, the physical layer may be associated with transmission of a bit stream over a channel. The physical layer may define the physical characteristics of the interface between a sending device and the transmission media. For example, the physical layer may delineate the characteristics of the interface between a receiving device and the transmission media. The MBRI may support segmentation and reassembly (SAR) of packets into physical timeslots in the physical payload, such as over the air payload, and therefore may be unique to MANET systems. In embodiments, most SAR functions in the stack may take place at the packet/MAC boundary. SAR may improve data delivery efficiency and allow packet lengths greater than single slot capacity. With respect to transmission, SAR may segment layer 2 data grams (essentially IP packets with an additional datalink header) to efficiently fit available payload capacity of a single time slot transmission. This may improve slot packing efficiency, where some of the SDUs may be segmented into fragments. The fully formed data link PDU may be sent to the physical layer controller for forwarding to the modem. With respect to interfaces, the physical layer controller may send fully formed slot payload ready for transmission and waveform mode definition, and data queues may pull data from a specified queue for segmentation. SAR may reassemble individual segments to form the original layer 2 data grams at the receiver node. The reassembly module may receive SAR SDUs (fragments) and reassemble them into data SDUs. The fragments may then be buffered and ordered according to SAR sequence numbers. When all the fragments that correspond to a data SDU are buffered, then the complete SDU may be sent to the L2 Forwarding switch to determine its next destination. When the reassembly process is started for any SDU, a configurable timer may be set. If this timer expires before reassembly is complete, then the reassembly process may be aborted in order to prevent the reassembly process from "hanging" when fragments are dropped or delayed. Un-segmented data and control SDUs may be passed directly through to the L2 Forwarding Switch. In embodiments, the SAR process may execute in a variety of ways, such as independently for each link in a multi-hop path through the wireless MANET, on the end-to-end route over the wireless portion of the network, and the like. In embodiments, there may be an SAR L2 Forwarding Switch that sends assembled data SDUs for further processing; a data link PDU De-capsulation that receives SAR SDUs, Data SDUs, and Control SDUs once data link PDU is broken into its constituent parts; a physical controller that receives demodulated data fragments for reassembly into original SDUs, and then IP packets; and the like.

[00215] The MBRI physical layer may provide for a local area node tracking algorithm (LANTA), a local node based timing algorithm that relies on distributed data across the MANET to derive actual network time (as opposed to a centralized time source for the standard Internet). In the MBRI MANET system, the system clocking may be a bit more complex than many systems in that the node must establish a network clock reference from the data received from other nodes. The local node may derive its clock offsets from its neighbors. Each node may estimate on receive the time offset and updates this estimate relative to the local clock on all observable links. Each node on transmit may send information to the receiver(s) its accumulated time shift since the last transmission so that this change since the last transmission can be subtracted from the local estimate at each receiver node. If a node has observed a packet from the AP, this node may reset its local reference to match the AP for network time and this change may get reflected in the next transmission to the other neighbor nodes. In embodiments, LANTA may interface with the other blocks in the physical modem to extract the time information from the received slots.

[00216] The MBRI physical layer may provide for a configurable waveform slot by slot, where each slot of every frame may be modulated independently of other slots in the frame depending upon the node destination and link characteristics for the end node. The modem at the receiver may detect the signal, demodulates a few bits of self-discovery data indicating which waveform mode was transmitted, and then demodulate the data payload sent during that time slot. To enable adaptive data rate (ADR) link adjustment across the MANET, the receiver may need to be able to decode and demodulate the transmitted data without knowing in advance which waveform mode was used to encode the data. Self-discovery bits may be encoded in every waveform burst so that once the signal is detected, these bits may be decoded to identify the signal processing needed to demodulate the transmitted waveform mode. This may occur independently on a slot by slot basis, and may be enabled by the independent slot configurability. In embodiments, this process may interface with the MACs physical controller to essentially receive "slot commands" indicating whether to transmit or receive and the associated frequency and bandwidth and waveform mode (on transmit).

[00217] The MBRI physical layer may provide for OFDMA / OFDMA waveform modes, where a family of waveform modes may be implemented to provide an adaptive modulation capability that balances waveform capacity and demodulation robustness. Each waveform mode may be parameterized by a combination of parameters, such as occupied bandwidth, error-correcting code rate, modulation technique,

and the like. In embodiments, the choice of these parameters may represent a trade-off between slot payload carrying capacity (i.e., data rate) and demodulation performance.

[00218] In embodiments, the physical layer may be associated with the MAC layer, where the MAC layer is provided to help impede the condition of collision of data (packets). The MBRI MAC layer may provide a high quality peer to peer packet transmission,/reception protocol for passing frames between nodes and for distinguishing between peer to peer, peer to network, and network to peer traffic. The MAC layer may also manage the radio resources of a single node and control sub-network layer convergence functions such as segmentation and reassembly, QoS, throughput fairness, adaptive data rate control and transmit power control. The MBRI MAC layer may utilize encapsulation / RFCs 894/1042, where channel access and segmentation, and transmission may be used to determine which packets to transmit over the air and how to break them up for over the air transmission. In embodiments, the standards may only be relevant at a nodal boundary between L3 and L2 and controlled by MTU size constraints at the layer boundary. A downward path (from L3) module may receive payload messages (packets) from the routing layer with a MANET Header already attached to them. This header may tell the data link about source, destination, and next hop route information as well as IP protocol type (e.g. TCP/UDP/ICMP), and the assigned QoS parameter for queue selection. An additional layer of forward error correction (FEC) may be applied to long IP packets (such as >1000 bytes) replacing the native cyclic redundancy check (CRC) in IP to provide improved performance over the wireless interface. This module may also be responsible for mapping the information in the MANET header into appropriate transmission modes and queues. There may be an upward path (to L3) module, which may remove the MANET Header and pass the packet to layer three. If the MANET Header indicates that the received SDU is a Control SDU received from the corresponding data link process in another node, the data link Control Message may be sent to the Neighbor Management and ADR module for interpretation. In addition, any FEC applied at the IP layer may be removed. There may be a number of interfaces, such as the L2/L3 API that may send and receive payload messages (packets) to/from the router layer with a MANET header already attached to them; an L2 Forwarding Switch that may receive data that is not eligible for L2 Forwarding, including payload data headed for L3; Data Queues that may en-queue the packets onto the message queues for transmission on the air interface based on the QoS level in the MANET Header and the ADR Mode on the link to the next hop; Queue Management that may provide the translation between next hop and proper mode queue; Neighbor Management and ADR that may forward data link control messages received from other nodes to the neighbor management and ADR module; and the like. Similarly, de-capsulation may be the reverse process of stripping off headers to recover the original IP packet after traversing the wireless network.

[00219] The MBRI MAC layer may utilize MAC 802.3, a standard function meaning that MBRI obeys the rules for MAC transport. That is, MBRI uses MTU sizes and buffering akin to the MAC standard. In embodiment, some MBRI functions may be different, for example, an MBRI state machines not retransmitting lost frames. MBRI may also utilize other standard stack functionality, such as ARP/RFC 826, DHCP, and the like.

[00220] The MBRI MAC layer may utilize neighbor discovery and management (NDM) protocol to develop and maintain a list of nearby nodes called "neighbors". NDM may discover and maintain the neighbor information and makes this information available for other processes (e.g., Channel Access, Routing, etc.) to make their decisions based on this information. Nodes are considered one-hop neighbors if they can communicate directly over the wireless link. Nodes are considered two-hop neighbors if they communicate over two hops across the wireless topology using exactly one relay node. The collection of one-hop neighbors may be called the "one-hop neighborhood", while the collection of all one-hop and two-hop nodes combined may be called the "two-hop neighborhood". In a distributed network topology, each node may have its own unique two-hop neighborhood. The two-hop neighborhoods of two nearby nodes may be often partially overlapping. Nodes may discover each other's presence and maintain timely knowledge of their link status by exchanging data link control messages (DCMs). DCMs may be sent using a pre-defined waveform mode (typically the most robust mode available) in order to form a richly connected neighborhood topology. The neighbor management portion of this module may be responsible for interpreting the received DCMs to form and update a neighbor table containing this link-state information. Conceptually, the neighbor table may contain a row of entries corresponding to each neighbor. A neighbor node may be added to the neighbor table when this module receives a DCM from the neighbor. A link quality measure may also be maintained for each neighbor, where the link quality may be incremented upon successful data reception from a node and decremented when the node was expecting a transmission from the neighbor but did not successfully receive one. In addition, nodes may be deleted when their DCMs are not received for some period of time, such as they are 'aged out' as their link quality measure drops to zero. A collection of network entry and formation protocols may control network formation, where a "network" in this context may be a collection of nodes that have discovered each other. Upon boot-up, a node may enter a listen-only mode for a short period of time to obtain time synchronization and begin forming its neighbor table. After some configurable period of time, the node may broadcast its DCM containing its one-hop neighbor table information. Other nodes receiving this information may add this node to their own neighbor tables. This updated information may then be reflected in the neighbor nodes' subsequent DCM transmissions received by the node entering the network. Once link quality measures reach a certain level, a "link" may be declared and the router notified, thus allowing the node to begin sending payload data over the network. In embodiments, there may be associated interfaces, such as Packet En(De)capsulation that may receive data link Control Message transmitted by a neighbor node; L2/L3 Link Manager Helper that may send an indication of neighbor link state change to notify router; Neighbor Table that may read Neighbor Table information and write Neighbor Table updates; Queue Management that receives an indication of queue depths by QoS level for determination of Node Weight for inclusion in transmitted DCMs; and the like.

[00221] The MBRI MAC layer may utilize adaptive data rate (ADR), a link by link matching of over the air capacity to the needs of capacity for packet forwarding. This function may not be needed in the Internet, since the underlying media does not change in capacity characteristics, unlike the spectrum between two nodes on a packet by packet basis. In ADR, once neighbors are discovered and links established may be made by using the lowest (lowest capacity, most robust) waveform mode. An ADR adjustment algorithm may be applied to increase the data rate on the link to the maximum rate that can be reliably sustained (i.e., low slot error rate) based on link conditions. The system may be able to adjust link data rate to maintain adequate demodulation performance in the presence of changing link conditions. When link conditions degrade below a certain threshold, the ADR algorithm may be able to rapidly decrease the link rate to a reliable mode to reduce the amount of data that is lost. When link conditions support higher data rates, the ADR algorithm may increase the link data rate to increase payload delivered by each slot. Otherwise, more slots may be needed to deliver the same amount of data, reducing the overall capacity carried by the network. The multiple possible combinations of waveform parameters may be organized into a one-dimensional ordered list of monotonically increasing data rate with correspondingly decreasing signal robustness. The ADR algorithm may "walk up and down" the list dynamically as a function of observed link performance. A combination of measurements characterizing link performance may be available. For each received time slot, the modem may return estimates of received signal strength (RSSI), Eb/No (SNR), and pre-FEC bit-error rate (BER) along with the slot payload data, transmitting node ID, and transmitted waveform mode. The data link control message may include the number of slots transmitted during each time period, such as 1 second intervals, for each waveform mode, allowing the receiving node to calculate the slot error rate for each waveform mode. These link observation statistics may be grouped by transmitting node and mode to adjust the receiving node's suggested waveform mode for each link. In embodiments, there may be associated interfaces, such as data link PDU de-capsulation that receives slot counts by neighbor node and ADR mode, neighbor table that reads neighbor table information and writes neighbor table updates, and the like.

[00222] The MBRI MAC layer may utilize queue serving, inbuilt ToS and QoS prioritization at a MAC Layer. This function may not be needed in the Internet, as they may not be resolved at the edge boundary because of MPLS types of algorithms, such as because the media is constant in its QoS. The queue management module may determine queue selection when packets are en-queued and de-queued and monitors queue utilization. Data packets may be en-queued according to ADR mode of the next hop and QoS setting in the MANET header. This module may forward the current link waveform mode from the neighbor table to the packet en(De)capsulation module to allow the data to be placed in the proper queue. When a transmit slot is approaching, data may be selected to be de-queued for transmission. De-queuing may be based on QoS setting first, then waveform. Multiple queuing disciplines may be supported, including strict priority and weighted round robin (WRR). Mode-based queuing may be used since the NAMA channel access protocol may schedule node transmissions without specifying the destination. In this way, a transmitting node may

send data to multiple neighbors using the same time slot. Queuing by waveform mode may allow the network to select the most efficient link rate that has data to send. The queue depths may be monitored to allow a node to indicate when it is experiencing congestion and needs more transmit slots to satisfy its offered load. The queue depths may be transformed into calculation of a "Node Weight" that may be used to adjust transmit scheduling in the two-hop neighborhood. In embodiments, there may be associated interfaces, such as packet en(de)capsulation that may send translation between next hop and waveform mode; data queues that may observe queue depths by mode and QoS level; Neighbor Management and ADR that may send node weight; neighbor table that may pull a waveform mode by one-hop neighbor; segmentation and transmission that may send de-queue selection; and the like.

[00223] The MBRI MAC layer may utilize node activated multiple access (NAMA) channel access, a protocol for the MBRI MAC layer that manages the slotted TDMA architecture that is the base control and data protocol between MANET nodes. The standard Internet has a very simple layer 2 state machine that relies on CSMA/CD or CSMA/CA at the physical layer to effect processing at the MAC level. However in an MBRI MANET there may be a need for a more feature rich MAC to take into account the variability and lack of uniform media quality at the physical layer (i.e. there may be a need to take into account the spectrum quality between nodes at any instant in time. In embodiments, NAMA may be the MBRI control and data protocol. The schedules for control slots and data slots may be computed in a statistically fair random manner based on two-hop neighborhood and time. The NAMA protocol may define the schedule. NAMA may run in a distributed fashion across the MANET topology to establish a coordinated collision-free schedule that manages the partially overlapping two-hop neighborhoods. Rather than compute the schedule explicitly like a WiMax base station would, each node may use a consistent data set (e.g., the two-hop neighborhood node ID, node weight, and time slot ID) to perform identical computations using a hashing function. The hash function may compute a "node priority" to each node for the time slot. The node with the highest priority in the two-hop neighborhood may then be elected the transmitter for that slot. In embodiments, all other nodes may be commanded to receive during that slot. A subset of the time slots may be designated as control slots, and a subset of the time slots may be designated as data slots. Nodes may use NAMA to compute the control slot schedule. In NAMA, all nodes may have statistically equal opportunity to win the slot for transmission. When the slot is won, the node may transmit its DCM and fill the remainder of the slot with payload data, space permitting. Control slots may be transmitted using the lowest (most robust) waveform mode so that all nodes (including nodes that are not yet neighbors) may have the opportunity to successfully receive the DCM and update their neighbor table. Each node may maintain a counter of the number of slots since its last transmitted a DCM. When this counter exceeds a configured value, the next slot a node wins for transmission may be treated as a control slot where a DCM may broadcast using the lowest waveform mode. The counter may then be reset. Data slots may be scheduled using "weighted NAMA" to compute the schedule. With weighted NAMA, the data slots may be divided into different weight levels for

the purposes of scheduling. Only nodes with node weights meeting or exceeding the weight level of the slot may participate in the schedule computation for that slot. This may allow nodes with higher node weights to win more slots per second in order to meet their need for increased channel access. In embodiments, there may be associated interfaces, such as a neighbor table that may pull a list of nodes and node weights in two-hop neighborhood, segmentation and transmission that may send an indication of upcoming transmit slot command, a physical controller that may send an indication of transmit or receive slot command to some number of slots in advance (e.g., two slots).

[00224] The MBRI MAC layer may utilize layer 2 forwarding (L2F), which may be responsible for packet forwarding per L2F table rules. If the received L2 SDU matches the rules in the L2F table, this module may send that packet to the next hop after modifying the PCOG MANET Header with next hop and TTL information. If instructed by the L2F table or no matches are found in the L2F table, this module may pass that packet towards the routing layer. In embodiments, there may be associated interfaces, such as an L2F table that may read table data to determine next hop for the packets received from reassembly module, data queues that may en-queues the messages to the message queues for transmission on the air interface after modifying the MANET Header to reflect the new next hop and TTL information, packet en(de)capsulation that may send a packet when a L2F table rule instructs this or no entry is found, reassembly that receives packet data after completion of the SAR process, and the like.

[00225] The MBRI MAC layer may utilize layer 2 / layer 3 link manager helper, a module that may convert one-hop link costs computed by ADR into L3 metrics and sends them to the Link Interface Manager in the routing layer. ADR link costs may be computed based on a combination of the waveform mode for the link, the size of the two-hop neighborhood, and the node weight distribution in the two-hop neighborhood. The L3 metrics may have a courser granularity (such as four or five different values) than the L2 costs, and they may not change as frequently in order to reduce downstream computation and overhead transmission impacts on SLSR. L2 metrics may reflect radio "reality" on a short-term basis, while L3 metrics may represent a more stable, coarser representation of link capacity to prevent excess routing protocol traffic. In embodiments, there may be associated interfaces, such as neighbor management and ADR that may receive an indication of major state change in neighbor table, a neighbor table that may pull one-hop Neighbor Table information, a layer 2 / layer 3 API that may send smoothed L3 link costs through API to router layer, and the like.

[00226] In embodiments, the MAC layer may be associated with the routing layer. In embodiments, the routing layer may enable logical addressing and routing. Logical addressing is a mechanism of adding an address for identifying the source and the destination when these are on different networks. The routing layer may provide for full transparency with the Internet through a border gateway protocol edge router, and make transparent all TCP/IP and UDP functions at the routing level via OSPF, open shortest path first protocol, an interior protocol for link state management, within a regional network. The

router may also be responsible for application awareness, multicast and unicast operations, multicast OSPF, IPv4 and IPv6 transparency, and the like. The MBRI routing layer may utilize standard routing functionality, such as IPV4/RFC 791, BGP4/RFC 4271, and the like. The MBRI routing layer may utilize scoped link state routing (SLSR) algorithms that may scope the amount of nodes and links evaluated for transport. In embodiments, the nearer the packet is to the end destination the more the routes may be pruned. The pruning may take into account link measures, which is not the case for standard Internet routing. That is, MBRI may map routes to the Internet routing only after evaluating and processing the availability within the MANET. The SLSR algorithm may be a unicast routing protocol used to determine routes within the wireless MANET portion of the network . The concept of multilevel "scoping" may be used to reduce routing update overhead in large networks. Each node may broadcast multiple types of SLSR control messages to provide link state updates, such as an intra-scope message, an inter-scope message, and the like. A maximum hop count or 'scope' may be specified over which routing protocol messages are exchanged. Multiple scope tiers may be maintained with different message exchange rates, where the most frequent, shortest distance messages may be called intra-scope messages, and less frequent, longer distance messages may be called inter-scope messages. These messages may be broadcast periodically with differing frequencies. In embodiments, a nominal update rate may be five seconds for intra-scope, and fifteen seconds for inter-scope. From state updates, nodes may construct the topology map of the entire network and compute efficient routes. SLSR may propagate link state updates as aggregates instead of flooding individually from each source. The result is that the route on which the packet travels may become progressively more accurate as the packet approaches its destination. As the network size grows large, multiple scopes with progressively increasing ranges (and decreasing update rates) may be used to keep routing overhead low. Since one-hop neighbor link state information is maintained by the data link, the "hello" packets typically sent by routers to establish one-hop neighbors may be suppressed to reduce routing overhead. Instead, the layer 2 link manager helper in the data link may forward this information to the link interface manager in layer 3. The link interface manager may continually forward this one-hop information to the SLSR process. In embodiments, SLSR may forward its MANET route information to the route table manager.

[00227] Finally, the MBRI routing layer may utilize receive oriented multicasting (ROM), a wireless routing protocol that may be optimized for determining the "spanning nodes" of a multicast tree prior to packet forwarding of a data stream that may require multicast where the tree can be updated on a packet by packet transmission. ROM may be the functional equivalent of SLSR for multicast routing, and in embodiments, ROM may have similar interfaces as SLSR. In embodiments, the MBRI stack may allow effective equivalency with the fixed Internet OSI stack. Thus, applications designed for the fixed Internet may be deployed on the MBRI, and vice versa, without requiring intervention, such as of a carrier or service provider. In addition, the MBRI stack may provide greater capabilities to a user of an MBRI enabled subscriber device, through the mobile environment that MBRI enables. In embodiments, methods and systems

may include openness to a wide range of applications, including capability, for example, to download an Internet application directly on the subscriber device. Methods and systems may also include facilities for geo-location, thereby enabling location with respect to a global position, including location of a mobile device within a swarm of mobile devices.

[00228] In embodiments, in contrast to conventional wireless and fixed wired access networks, methods and systems may be provided for a mobile broadband internet network solution where every subscriber device and infrastructure node has routing capabilities to allow for intelligent routing decisions enabling intra-network peer to peer communications. Traffic between nodes of the MBRI may not need to leave the mobile ad-hoc network for routing or switching purposes. Instead, because MBRI may be routing enabled, local traffic including required signaling may stay within the MBRI. In addition, because of its unique neighbor discovery management and Adaptive Data Rate and Power Management Capabilities the MBRI enables local intelligence to be shared across its member nodes leading to the creation and deployment of new classes of services and applications. Further, because of its mobile ad-hoc network characteristic the MBRI is independent of fixed traffic aggregation points such as base stations or cell towers, and instead can leverage multiple backhaul access points in a load leveling and self-healing manner. Because of the mobile ad-hoc network waveform characteristics and the mobile ad-hoc network architectural flexibility to deploy additional Backhaul Access Points or to upgrade existing mobile ad-hoc network access points with backhaul capability the MBRI assures broadband bandwidth to the individual SD/MAP nodes in excess of conventional 3G/4G networks. If combined with dynamic spectrum access technology the MBRI can coexist within existing defined spectrum with associated active network operations.

[00229] In embodiments, there may be distinct MBRI variants, having various sub-sets or supersets of the capabilities disclosed herein. For example, a basic MBRI may contain the mobile ad-hoc network protocol stack that brings Internet access and routing capability to the Subscriber Device (SD). Various enhanced versions of MBRI may include one or more of the enhancements described herein, such as individual selected media transport enhancements conceived to improve multimedia transport of the MBRI network. A more comprehensive, commercial grade MBRI may collect a plurality (or even all) of the enhancements, offering the full extent of benefits described herein. For example, a comprehensive MBRI may include a basic MBRI coupled with the cumulative conceived transport enhancements targeted at high quality service for multimedia, multi-session applications. A version of the MBRI using dynamic spectrum awareness may allow for management of traffic based on channel conditions, including enhancements to the mobile ad-hoc network protocol stack that allow for spectrum co-sharing between non-cooperative spectrum users or dissimilar spectrum technologies, and coordination between cooperative systems.

[00230] In embodiments, an MBRI may include ad-hoc network creation and self forming capabilities, self healing capabilities, and load leveling capabilities. An MBRI may be packet size indifferent, that is, it need not be constrained to particular packet sizes or types. The MBRI may use various routing

capabilities, such as unicast and/or multicast routing, routing enabled and peer-to-peer communication and the like. The MBRI, as noted above, may be Internet protocol plug compatible, allowing it to seamlessly integrate with fixed IP-routing networks. Subscriber devices in the MBRI may be neighbor aware. In embodiments subscriber devices may include geo-location capabilities. Geo location capabilities may include conventional facilities, such as GPS facilities located in subscriber devices. Geo location capabilities may also include enhanced geo location, such as locating a particular subscriber device within a swarm (such as based on the number of hops required to reach the device within the swarm from other subscriber devices of known location, based on the power levels received from a subscriber device by other nearby subscriber devices of known location, based on time-based techniques, or the like). By locating devices within a swarm, local, swarm-based applications may use the location of a subscriber device, such as for the various locally focused applications described above. For example, a commercial offer can be made to a subscriber device if the subscriber appears to be near a merchant, or the like. Subscriber devices may include radio resource management capabilities, including managing power levels, data rates, use of spectrum (optionally for channel or spectrum-aware radio resource usage with dynamic spectrum access networking (DYSAN)). Being IP-routable, MBRI devices may be unconditionally open for IP-based applications, such as web 2.0 applications, Java web applications, and the like, without requiring fixed Internet or cellular network infrastructure, such as specialized servers or device-specific application development. An MBRI may be provided in or associated with a private or public network, optionally separated from the Internet or integrated with the Internet. The MBRI may be provided with security features, applications and components used with the fixed Internet or cellular networks, including security at the routing layer and other layers of the MBRI stack. By being unconditionally open to applications, MBRI devices may be provided with security applications developed and used for any other IP-enabled device, such as anti-virus, firewall, anti-spam, unified threat management, device access security, network access control, application access control, device behavior profile monitoring, data leakage prevention, parental access control, software compliance detection, and other applications.

[00231] The MBRI may be spectrum independent; that is, it may be deployed at any spectrum location, even within small spectrum bands. With DYSAN capabilities the MBRI may offer enhanced usage of existing spectrum, such as by using available time-frequency rectangles within channels or bands not fully consumed by other usage of the same spectrum (such as by cellular networks). In embodiments, the combination of spectrum independence (e.g. the ability to operate at any frequency), and the capabilities of DYSAN (e.g. the ability to dynamically switch frequencies while transmitting between nodes), may allow MBRI to provide a high degree of frequency spectral reuse with a high level of throughput. A DYSAN enabled MBRI may be able to efficiently utilize a selected set of frequencies to operate with, allowing communications to both effectively utilize the spectrum as it becomes available, and change frequencies as the environment changes to the advantage or disadvantage of certain frequencies. In addition, the ability of

MBRI to operate at any frequency may allow local MBRI configurations to be operated at frequencies that are optimized for the area. In embodiments, MBRTs ability to operate on any frequency, coupled with MBRI's DYSAN capabilities, may provide MBRI with a robust operating frequency strategy that may be unique to MBRI.

[00232] The MBRI may be provided in a highly scalable configuration (e.g. leveraging incremental increases in spectral bandwidth that become available to a service provider/operator, leveraging incremental addition of fixed or mobile backhaul or connection points to fixed Internet and other networks, and leveraging addition of increased bandwidth due to increased peering (such as in whispering modes that don't degrade the network with new users in local swarms). In embodiments, for example, mobile access points can be added, such as to enhance bandwidth to a swarm at a concert or event, and the large number of peers at such an event may allow high bandwidth peering among them, thereby enabling broadband performance in usage environments that seriously degrade conventional cellular networks. The MBRI may be provided in a structured or unstructured network architecture, according to operator design, with varying management paths as described above. For example, a city park may be configured with fixed access points that help guarantee a complete coverage of the park grounds, even when there are few mobile device nodes present. In this instance, management paths may be provided from the fixed access points to the mobile device without the need for the presence of other mobile devices. Alternately, a park in the country may be supplied with a minimum set of fixed access points, thereby providing a more unstructured network access to mobile devices. In this instance, the area network may be designed to provide an extension of the fixed internet as a function of device density. Management paths may then be developed in an ad-hoc manner, as mobile device density and placement varies. In embodiments, the fixed access points placement and capabilities may be optimized based on the degree to which the network architecture is meant to be structured.

[00233] The MBRI may be provided with varying levels of spanning network capability, including mobile access points, backhaul access points, and other access points that optionally connect a swarm of subscriber devices to fixed Internet assets, as described in more detail below. For instance, a geographic area may be found to include areas of varying mobile device density, where areas of high density are separated by areas of low density. In this instance it may be desirable to span across the low density areas with access points in order to enable the greater benefits that may be provided by a larger area of interconnectivity. Alternately, it may be desirable to have a swarm of subscriber devices not connected, say to fixed Internet assets. This may be for the sake of security, such as in the case of an enterprise, or for the sake of flexibility, such as in the case of an impromptu network arrangement in a remote area where application services are locally provided, and no need for fixed Internet connectivity may exist. In embodiments, the ability to provide varying levels of spanning network capability may enable network designers to customize the capabilities of the network to the requirements of the network application.

[00234] The MBRI may use various physical layer wave form variants, including OFDMA wave forms, slotted wave forms, half duplex wave forms, wave forms synchronized by slot, , waveform variants (e.g. slotted/ half duplex, synchronization on each slot separately), multi-session, and the like.

[00235] In embodiments an enhanced MBRI may include adaptive data rate capabilities and may allow high quality of service, using flexible transport for both time sensitive and delay tolerant traffic. In embodiments, adaptive data rate capabilities may be device specific, application specific, time flexible or time dependent, adjustable as a function of available frequency spectrum, configurable by the individual or service provider as a function of service cost, and the like. Time sensitive traffic may include voice services, real-time streaming media services, real-time data collection, and the like, and may require that delivery of data be uninterrupted. Delay tolerant traffic on the other hand, may be data services that may not require that data is delivered in an uninterrupted manner, such as the download of an application from the network, the transfer of a data file between peers, access to a website, and the like. In embodiments, an enhanced MBRI may provide flexibility with respect to the needs of these various data services, while maintaining a high quality of service, through adaptive data rate capabilities. In embodiments, quality of service may be maintained through prioritized queuing and priority -based channel access that may explicitly provide the differential service level. Adaptive data rate may try to maximize the data rate on the link, though it may not be necessarily visible to the end-user experience. In embodiments, the amount of data the end-user receives may be based on both link rate and time slot scheduling. At a higher link rate, fewer time slots may be needed to send a constant amount of data, leaving more time slots available for the network to service other nodes.

[00236] In embodiments, MBRI routing may use sub-queues, traffic based scheduling, optimized short/medium/large packet support, and the like, to manage routing traffic. MBRI routing may perform routing traffic management in order to improve throughput, improve quality of service, avoid bottlenecks, and the like. For example, when a node experiences a high volume of data routing requests, the node may begin prioritizing traffic throughput, such as by time sensitivity, service agreed quality of service, message size, and the like. In addition, in order to better facilitate routing flexibility, the node may begin to vary the packet size, such as making them smaller. In this way, the node may be able to better interleave the data streams, and thus better meet their varying requirements. Alternately, packet sizes may be made larger in order to reduce the overhead associated with individual packets. In embodiments, the MBRI node may provide different strategies for different data stream combinations, such as one strategy for a highly diverse data traffic set, and another for a homogeneous data traffic set.

[00237] In embodiments, scoped link state routing (SLSR) link cost based routing and/or SLSR domain management may be utilized by MBRI nodes in order to improve routing efficiency, where mobile nodes may be provided a capability to determine an optimum path through mobile network by utilizing different types of cost/QoS information over any MANET routing protocol and by utilizing backhaul domain management for MBRI. Mobile nodes may use different information to calculate link cost, such as ADR, two

hop neighborhood size, link data rate, and the like. Mobile nodes may provide many parameters to minimize MANET routing algorithm cost, e.g. route/link cost, QoS, power level, etc. Other mobile nodes may see MANET routing information, along with these parameters, and determine the minimal cost. For instance, a mobile node that advertises it is a low power device may not be best choice for routing even though the device has better link/route cost. Mobile nodes may use the information provided by a MANET routing protocol, along with extra information, to determine optimum network routes. Mobile nodes may create multiple paths to their destination based on different criteria. MBRI may provide a mechanism to create MANET domains when additional backhaul access points are deployed. The MANET domain concept may be similar to the cellular "cell" concept. These MANET domains may limit the scope of MANET routing, thus partitioning the network for an optimum route towards the internet. Once MANET domains are created, they may provide a backhaul exit point for MANET traffic. MANET domains may work together with other MANET domains and MANET routing protocols. This may help provide alternate routes information in the case of a backhaul failure. MANET domains may be automatically created when backhaul access points are deployed, thus adding capacity without a site survey and re-provisioning of an existing system. Fig. 52 shows a MANET domain concept, where an arbitrary MANET cloud is formed around a BAP. As shown, MANET domains may intersect each other and BAPs may not need to be at the exact center of the BAP domain. Fig. 53 shows three mobile nodes (Nl, N2 andN3) and a BAP (N4) in BAP domain Dl. Mobile node N3 belongs to an overlapping BAP domain D2 and co-exists with other nodes N l and N2. All these nodes may advertise their link state (per MANET protocols) along with "extra" information such as cost, QoS, power level and BAP domains. Mobile nodes may use this information to create different topology based on different criteria. For example, some set of nodes may be used to determine a BAP's shortest path optimizing QoS, but a different set of nodes may be used to calculate the same BAP's shortest path using optimizing power usage. Mobile nodes would advertise the following properties on top of a MANET routing protocol. These nodes may use information when received from other nodes, such as cost (as provisioned), cost (as discovered), QoS (as provisioned), QoS (as discovered), power usage, hops (cost) to BAP, mobility (vehicular, pedestrian node or fixed), and the like. Fig. 54 shows determination of BAP shortest path using optimization of minimum delay versus power usage options. In embodiments, SLSR link cost based routing and/or SLSR domain management may better enable MBRI to provide efficient routing strategies for communications across the network.

[00238] In embodiments, multicasting within the MBRI network may be enabled through a node's IP routable capabilities. Multicast is the delivery of information to a group of destination nodes simultaneously using the most efficient strategy to deliver the messages over each link of the network only once, creating copies only when the links to the multiple destinations split. MBRI nodes, being IP routable, may have the capability to provide multicast transmissions across the network. In this way, the MBRI may

increase routing efficiency through the network by taking advantage of node distribution and density to transmit messages to a plurality of locations, while minimizing the need for duplicate transfers.

[00239] In embodiments, layer 2 forwarding (L2F) and layer 3 fast pipe may be associated with increasing the speed in communicating across the MBRI network, and may be protocols implemented inside the node. The data path through Layer 3 (L3) may be based on the concept of a L3 Fast Pipe as depicted in Fig. 62. The Application Awareness, QoS Translation, and L3 Fast Pipe modules may work together to handle bi-directional data flows between the wired interface and the data link. A list of data flows may be compiled and maintained. Each flow may be uniquely identified using the 4-way combination of source IP address, source port, destination IP address, and destination port. When data is presented to L3 over either the wired interface or the data link, these four parameters may be checked to determine whether an L3 Fast Pipe flow has been established. If it has been established, the data may be inserted into the L3 Fast Pipe with the parameters for the corresponding flow. The Ethernet header data may then replaced with a header that may contain the next hop information for the route and QoS level for the flow. When data packets with source and destination parameters that don't match an installed flow arrive at a Layer 3 interface, these modules may work together to install a new flow in the L3 Fast Pipe. An embodiment for the business logic for this process is shown in Fig. 70. The left side shows the logic for payload data received across the data link interface, and the right side shows the logic for payload data received across the wired interface. When data packets arrive at the data link interface, the Route Table Manager may be used to obtain the next hop identification for insertion into the PCOG MANET Header. Additionally, the flow may be installed into the L3 Fast Pipe. When data packets arrive at the host interface, an Application Awareness module may examine the terms of service (ToS) settings and packet statistics to identify a suitable QoS level for the flow. A ToS to QoS translation table may also be used to determine the QoS level through the MANET, and the Route Table Manager identifies the next hop. This information may be inserted into the PCOG MANET Header and the flow installed into the L3 Fast Pipe. When the next hop for the route changes, the L3 Fast Pipe may be quickly adjusted to point to the new next hop. Flows may be removed from the L3 Fast Pipe when data is not received for some period of time, such as 30 seconds, and may be configurable.

[00240] In embodiments, L2F may act as a sub-network protocol used by the MBRI nodes to circumvent routing operations taking place at layer 3 and thereby prevent timely and resource expensive routing functions from operating on incoming packets at a node. This may then provide header information that may be resolved at layer 2 to make smart routing decisions, thereby increasing the speed of decision making and increasing network throughput and efficiency. The mobile node's network layer sends router control information to the data link layer that helps prepare the layer two forwarding table. The mobile traffic may have a special fixed header, such as with source, destination, next hop routing information, and the like. Once a data link layer receives mobile traffic, it may examine the header, consult with the layer two forwarding table, and forward the traffic to next hop as determined by the layer two forwarding table. The

layer two forwarding table may instruct layer two to pass the packet up to the network layer for routing. In embodiments, the networking may layer prepare and sends layer two forwarding table information to data link layer based on various MANET routing protocols, such as shown in Fig. 72. The networking layer may apply a special header to traffic, such as including source, destination, next hop and related QoS related information, and the like, such as shown in Fig. 73. The data link layer may use the layer two forwarding table information to route the packets to a destination by using special header information as identified, such as illustrated in Fig. 71. In embodiments, this may reduce latency on multi-hop paths by keeping the data from going all the way up to the router at each hop.

[00241] In embodiments, MBRI may support SAR, a process used to fragment and reassemble packets so as to allow them to be transported across networks, such as asynchronous transfer mode (ATM) compatible networks. In SAR, an incoming packet from another protocol to be transmitted across the network is chopped up into segments that fit into fixed byte chunks carried as cell payloads. At the far end, these chunks are fitted back together to reconstitute the original packet. In embodiments, The SAR function may perform a large packet to small packet transformation and reassemble the packet at the next hop destination for efficiency at the data link layer. In embodiments, packet size may be determined dynamically in response to the real-time data-rate available over each individual data link. In a network running TDMA in the MBRI, transmissions may occur with fixed duration time bursts. The slot capacity may depend upon the modulation, coding, bandwidth, TDMA time slot duration, and the like. A depiction of TDMA time slots is provided at the top of Fig. 74, where capacity is filled with payload data. Typically, the IP packets that make up the payload data do not always fit evenly into the slot capacity. Rather than allow the remaining slot capacity to go unused, IP packets may be segmented into smaller pieces to fill the available slot capacity efficiently, such as show in Fig 28. The original IP packet is divided into multiple segments, and a SAR Header is added to tag each segment and enable reassembly at the receiver. The individual segments are transmitted using multiple TDMA time slots. Upon reception, the data from the individual TDMA time slots containing the SAR fragments is reassembled into the original IP packet as depicted in Fig. 75. The fragments may be buffered and ordered according to SAR sequence numbers contained in the SAR Header. Once all the fragments that correspond to a single IP packet are buffered, the complete IP packet is formed and sent up the protocol stack. When the reassembly process is started for any packet, a configurable timer may be set. If this timer expires before reassembly is complete, then the reassembly process may be aborted in order to prevent the reassembly process from "hanging" when fragments are dropped or delayed. Un-segmented IP packets may be passed directly up the protocol stack. In embodiments, the SAR process may be executed independently for each link over a multi-hop path through the wireless MANET or over the complete end-to-end route over the wireless portion of the network.

[00242] In embodiments, MBRI may support multi-channel MAC. In a network running TDMA in the MBRI, transmissions may typically occur using a single channel. The slot capacity depends on the modulation, coding, bandwidth, and TDMA time slot duration. A representation of the TDMA time slots are shown in Fig. 76. In a multi-channel environment, control-plane cooperation may enable neighboring nodes to notify transmitter-receiver pairs of channel conflicts and deaf terminals to prevent collisions and retransmissions. MBRI, though full OSI functionality, may provide the facility for multi-channel MAC in order to improve packet transfer throughout the MBRI network. Multimedia internet data can have widely varying characteristics and delivery requirements including data rate, latency, and jitter requirements. In some instantiations, the bandwidth may be divided into sub-channels. In others, the radio may be able to access multiple channels over a bandwidth that may be greater than the modem's single channel bandwidth. In both cases, a multi-channel MAC increases the number of transmission opportunities in the network for exchanging data. When multiple distinct RF channels are accessed and scheduled, the overall network capacity is increased beyond that achievable using a single channel. Fig. 77 shows both examples of using a multi-channel MAC. The multi-channel MAC may use knowledge of the distributed network topology and spectrum availability. One method for scheduling sub-channels is to first select which node in the topology is the receiving node, and then select the multiple transmitters for the different sub-channels. Similarly, multiple RF channels may be scheduled where the spectrum availability is used to determine number of channels to be scheduled simultaneously. The spectrum availability may be defined prior to network operation, or may be based on local sensing of the RF channel utilization. In embodiments, the transmit power of the individual nodes may be adjusted to minimize the variation of received power over the different sub-channels at the receiver. Another method for scheduling sub-channels may be to schedule transmissions based on pairs of nodes in the network topology and select sub-channels to avoid causing interference between the transmissions internal to the network. In embodiments, transmit power control may be used to manage interference levels.

[00243] In embodiments, MBRI may support adaptive power control, which may provide the ability to manage power based on network performance, spectrum reuse, emergency needs, spectrum conditions, environmental conditions, service level commitments, subscriber rate plan, traffic type, application type, and the like. In embodiments, adaptive power control may be used to support "whispering" as much as possible, such as to increase the number of parallel conversations to promote better spectrum reuse. The MBRI node may be able to adjust power based on an established need or changing conditions. For example, a user may subscribe to a high quality of service, and the user's device node may need to boost power in order to help guarantee the quality of the transmission to the next node. In a more general case, the node may find itself transmitting in an environment that requires more or less power to accommodate its links to adjacent nodes, where through adaptive power control the node may be able to dynamically adjust the power level based on changing environmental conditions. In embodiments, MBRI may also be able to adjust

power levels on certain frequencies, such as in association with DYSAN capabilities. In embodiments, the MBRI ability to support adaptive power control may contribute to longer battery operation of mobile nodes while extending the data transmission capabilities of the node within varying network and subscriber conditions.

[00244] In embodiments, MBRI may provide the necessary requirements for distributed data services, such as for storage, schema persistence, low latency data transfer, and the like. MBRI may enable a new category of wireless web and device applications by providing mechanisms that spread data across many nodes, exchange information to bind the data together as a whole, and respond quickly when the data is requested. Fig. 55 illustrates one embodiment of distributed data and applications within MBRI.

[00245] In embodiments, in MBRI a distributed data store may be created when users can save information on a network node (device) other than their own. These nodes are known as peers. Peers collaborate with another by allowing data to be stored on each other, and a peer-to-peer network may save data using this distributed mechanism. MBRI supports peer-to-peer network architecture because it is a routable IP network, providing multiple diverse paths for communication between nodes. A peer-to-peer network may assume diverse connections between nodes in a network and ad hoc connections between peers. The usefulness of peer-to-peer networks is well established, and such networks are commonly used for sharing content files containing location, audio, video, or even real time data such as telephony. The size of the data need not be large, nor need it persist for very long to nonetheless be useful to an application. In addition to data sharing, more complex applications may use distributed or federated databases, where each peer contains a small part of a database (such as a table or record, as appropriate for the form factor of the device), and also maintains logical pointers to data parts that exist on other devices. The pointers link together separate data parts to form a larger logical database, spread across the MBRI network. Such a solution may only be workable in a low-latency, high-bandwidth IP network, making MBRI a unique platform for this kind of scalable storage solution in the wireless arena..

[00246] In embodiments, MBRI may provide for schema persistence. A schema describes the logical structure or view of some data. When nodes exchange data, some common schema is at work, so that the data matches up. In the simplest view of distributed data, a Web application may execute locally on a node, and provides a description of the data it uses, with enough contextual information about what the data contains, so that another Web application on a different node can decode the description and also work with it. In a mobile network such as MBRI, peers may join and leave the network. Simple data schema solutions suffer from the problem of persistence, where a large distributed data store may lose an essential, small portion of the whole data view. To be persistent, data in the individual peers is replicated. To be readily available, small embedded distributed data services (or applications) may exchange information called hash maps, which are distributed metadata structures that permit reassembly in real time of the missing data.

[00247] In embodiments, MBRI may provide for low latency data transfer through data distribution. In hub-and-spoke wireless and wired topologies, the movement of data is constrained by available path bandwidth and number of paths from source to sink. In MBRI, bandwidth is a cumulative function of the number of available nodes through which data can be transferred. The low latency of MBRI makes distributed storage possible; data joins would otherwise be too slow to be of practical use. The MBRI topology and latency may enable resilient large file transfers, using techniques such as parity files. Large files may be split into multiple smaller ones; parity files may be generated that are then transferred along with the original data files. MBRI may provide routing mechanisms to optimize the transfer of these small files, which are then reassembled. If any of the data files were damaged or lost whilst being propagated, parity files are used to reconstruct the damaged or missing files. These techniques may be of particular benefit in secure or hostile environments.

[00248] In embodiments, MBRI has the essential characteristics for distributing, saving and moving data across a network. These characteristics include ad hoc nodes, low latency IP over diverse connections, multiple paths for increased bandwidth, and the like. MBRI may enable incremental scaling of data capacity, fault tolerance, high availability in a low-latency network, and the like, through distributed storage and processing. Depending on the form factor and processing capacity of the node, standard IP network storage services are possible, making MBRI a transparent substitute for some fixed networks.

[00249] In embodiments, MBRI may provide for local intelligence, such as caching, local content and services, and the like. In embodiments, local intelligence may provide for a number of different applications, but be based on MBRTs ability for nodes to have a local awareness. For instance, information from the local area may be circulated, such as within the local geographic area, within the local swarm of mobile nodes, associated with local access points, and the like. An application that has large data storage requirements, such as video or image applications, may store or cache data in surrounding nodes. A local application, such as in association with a local store, may provide content and services throughout the local network through storing the content and user service access interfaces on user device nodes. In embodiments, MBRI's ability to share and store information amongst nodes in the local area may provide a local intelligence that is unique to the capabilities of MBRI, and for which user's and services may benefit through shared resources. Fig. 56 and Fig. 57 illustrate an embodiment of how local mobile applications may be implemented within MBRI.

[00250] In embodiments, MBRI may provide support for distributed applications, non server based applications, and the like. MBRI, through local awareness capabilities and on-device storage capabilities, may enable the storage of applications, including applications that may be provided in a distributed manner, such as amongst a number of device nodes. MBRI nodes may then share data back and forth within the MBRI network. In embodiments, applications running on network nodes may provide application use within the MBRI network apart from any application support from the fixed Internet. For

example, an auction support application, set up and distributed to user device nodes in a remote location, may execute application functions within the MBRI network in a manner completely separate from any fixed internet access point. As such, the auction application may provide for a distributed or non-server based application that may provide an application environment that is unique to MBRI.

[00251] In embodiments, MBRI may provide for nodes to enter a sleep mode, where sleep mode may be a way to conserve battery power on the node. In embodiments, there may be multiple different kinds of sleep modes with different time scales, where, for instance, some may be as short as 500 microseconds and don't necessarily rely on detecting network activity.. Sleep mode may reduce functionality of the node, while maintaining an awareness of neighbor activity, such as detected neighbor traffic, request for routing, a neighbor leaving sleep mode, and the like. In this way, a node in sleep mode may exit sleep mode when it detects activity from a neighbor. In embodiments, the ability for a node to exit sleep mode upon detection of neighbor activity may allow for a number of nodes to be in sleep mode, and for them to reawaken sequentially or serially upon the initiation of network activity.

[00252] In embodiments, MBRI may support assured bandwidth / admission control, providing traffic admission control capability to the MBRI enabled network, where upon request a subscriber device may be provisioned with assured bandwidth for a session on the MBRI network. A subscriber device requiring guaranteed bandwidth for a specific session or all the session may request the desired bandwidth by sending a control message, such as to a MANET bandwidth manager via BAP. The BAP may allocate the bandwidth towards the core network and pass the request to the MANET bandwidth manager. The MANET bandwidth manager may authenticate the request against a subscriber's class of service and the bandwidth available, if needed it may contact the external bandwidth manager to assure external bandwidth towards the ISPs backbone to the internet. Once the request is verified and resources allocated, it may acknowledge the subscriber device with a specific QoS value. Now the subscriber device may use this special QoS value for the traffic, relay nodes may honor this QoS value to assure the bandwidth. The MANET side of the network has a reserved range of QoS values for assured bandwidth applications and each node in the network may honor these QoS values. Fig. 58 shows and example of two different traffic flows, one with bandwidth assured and the other one without. The relay nodes, MAP and BAPs may prioritize the bandwidth assured traffic. Fig. 59 shows assured bandwidth between two mobile nodes. In this example a relay node uses QoS values to discriminate between regular traffic and bandwidth assured traffic. Fig. 60 shows assured bandwidth between two different BAP domains. In this example data flow relay nodes assure bandwidth by honoring the special QoS values. In this scenario BAPs involved allocated bandwidth on the core network for this traffic. Fig. 61 shows an example control protocol for a subscriber device going through a bandwidth request.

[00253] In embodiments, MBRI may support MANET address resolution protocol (MARP), a mechanism that tracks the dynamic bindings between IP addresses and data link addresses in MANETs. Each

device in this type of network may have two addresses: an IP address and a data link address. In this instance, the IP addresses may be static, whereas the data link addresses may be assigned dynamically, and can change over time when devices move from one location to another. Whenever an IP datagram is to be sent by one device to another, it may be encapsulated with a data link header that specifies the current data link address that corresponds to the destination IP address. MARP helps to ensure that the correct destination data link addresses are available when IP data grams are forwarded in MANETs. In embodiments, the Internet protocol ARP (RFC 826) may provide an IP address to data link address binding service for broadcast LANs, such as the Ethernet. However, MANET technologies may not provide the broadcast data link service that ARP requires for correct operation, consequently, ARP may not be used by MANETs. MARP may provide ARP services for MANETs.

[00254] In embodiments, MARP may maintain dynamic databases of the bindings between data link and IP addresses. An authoritative, master database may be maintained on a server that is accessible by all devices via the MANET's data link unicast service. Entries from this database may be cached on each device for the purpose of assigning data link addresses when IP data grams are encapsulated in preparation for forwarding to their destinations. In embodiments, MARP may use an aging process that discards entries when they are not refreshed, where aging may prevent the retention of bindings from nodes that have lost network connectivity. The protocol may be invoked when certain events occur, such as a registration, where each time a device is assigned a data link address it registers its new binding by sending a message that contains the current binding to the master database (the master database time may stamp the binding and store it); resolution, where a device needs a binding that is not available in its local cache, it retrieves the current one from the authoritative cache, by sending a request and receiving a response (he up-to-date binding may then be time-stamped by the device and stored in its cache); aging, where each device, and the master database, ages out the entries in its cache by examining their time stamps and discarding any bindings that exceed a specified life time; and the like. MARP, when run on a device, may update its cached bindings by issuing proactive resolution requests before entries expire, and repeating its own registration before its entry in the master database expires. Aging may be necessary for the elimination of cache entries that refer to hosts that are no longer reachable. Registration may need to be repeated at a rate that exceeds the aging rate. In embodiments, MARP may replace the ARP protocol (RFC 826) that was designed to provide an address binding service for Ethernet LANs. MARP may operate on a data link that provides a basic unicast service, that supports dynamic IP address to data link address bindings thereby increasing scalability, that supports dynamic IP address to data link address bindings thereby increasing scalability.

[00255] In embodiments, MBRI may support traffic policing, where nodes on the network may monitor, adjust, and take action with respect to network traffic. Network traffic policing may be for the purposes of security, quality of service, maintenance, contract compliance, and the like. For instance, policing may occur within a single node at its ingress point to the MBRI. The device may police the amount

of traffic that is trying to enter the network. If the traffic exceeds the negotiated contract, the device may prevent some of the data from entering the network.

[00256] In embodiments, MBRI may provide traffic shaping on the network, such as per flow, per node, per MAP/BAP, and the like. In a similar fashion as for traffic policing, as described herein, traffic shaping may be realized through monitoring network activity, such as by an individual node, by neighboring nodes, throughout the network, and the like. For example, traffic shaping may be associated with the process of smoothing the burstiness in time of offered traffic so that a more uniform offered load is presented to the ingress point of the network. In embodiments, traffic in MBRI components may go through an L3 fast pipe, such as described herein, and shown in Fig. 62. In embodiments, host traffic may be inspected on two edges of the network, such as at the subscriber device and at the BAP. Based on subscriber class of service traffic type the L3 fast pipe may offer traffic shaping to optimize the network load. Traffic types (e.g. real time voice/ video or mp3 streaming etc.) may be used to calculate traffic priorities, and higher priority traffic (e.g. real time voice) may then take preference over non real time type traffic (e.g. mp3 download via FTP). Policy enforcement logic may be used to decide if a certain type of traffic is allowed via MBRI, such as a subscriber signing up for a WAP-only plan, and not being allowed an mp3 download via FTP. In addition, policy enforcement may also restrict bandwidth usage by a certain subscriber to optimize network load.

[00257] In embodiments, MBRI may provide automatic retransmission request (ARQ) functionality, where a node may receive a transmission from a node and request a retransmission because of a detected anomaly. For instance, the receiving node may detect a checksum error or the like, and as a result may request a retransmission from the sending node. In embodiments, automatic retransmission request functionality may improve transmission reliability and overall quality of service.

[00258] In embodiments, MBRI may provide for forward error correction (FEC) on long IP packets. FEC is a system of error control for data transmission, whereby the sender node adds redundant data to its messages, also known as an error correction code. This allows the receiving node to detect and correct errors (within some bound) without the need to ask the sender node for additional data. The advantage of forward error correction is that a back-channel is not required, or that retransmission of data can often be avoided, at the cost of higher bandwidth requirements on average. In embodiments, FEC may be applied in situations where retransmissions are relatively costly or impossible.

[00259] In embodiments, MBRI transmissions may occur in units of slots, where each slot may contain multiple data blocks that are forward error correction (FEC) encoded to provide robustness to bit errors. In multipath propagation, some bursts may contain residual errors for a slot error rate (SLER), such as on the order of 1-5%, even after the inner FEC is applied. In MBRI, IP packets may be often divided up into multiple segments for transmission over multiple TDMA time slots. Even when the packet is not divided across multiple time slots, the packet may be divided across multiple FEC blocks. If one segment (or inner FEC block) is lost due to burst errors, the entire IP packet may be lost. This results in the transport layer (e.g.,

TCP) experiencing a higher loss rate. The TCP protocol may react by reducing the offered load on the network and consequently the throughput experienced by the user. This problem may be solved by applying an additional layer of FEC (i.e., an outer code) to long IP packets (longer than 1000 Bytes) so that slots experiencing residual errors can be corrected to construct the full IP packet before being sent up the protocol stack for interpretation by TCP. For the purposes of illustration, the encoding process is shown for a single IP Packet in Fig. 63. The method may be applied to any length or grouping of payload data for transmission over a wireless link. In this example, first the IP packet is segmented. Dummy data may be appended to form an integer number of segments. Next, an outer FEC code is applied across the data segments - a Reed-Solomon (R-S) code is depicted in the figure, but the approach is general to accept any FEC code. Multiple R-S blocks are combined to form a coded representation of the original IP packet. This data is then encoded according to the defined waveform format that includes interleaving and FEC (an inner code) for transmission over a wireless link. The coded IP packets may be segmented prior to waveform encoding as part of a Segmentation & Reassembly (SAR) process for aligning data payload with TDMA slot payload. The receive process is shown in Fig. 64. The individual waveform FEC blocks contain some residual burst errors (indicated by a red 'X'). The bursty error bits are disbursed across the multiple blocks in the outer code. Each code block contains a small enough quantity of errored bits such that the data is recovered error-free. Reassembly (if applicable) is applied after successful data recovery to form the original IP Packet. As an extension, the individual blocks that comprise the coded data may be routed over different paths between a common source and destination in order to provide route diversity for performance improvements. Additionally, the code rate of the outer code may be dynamically adjusted to compensate for varying link burst error rate conditions. Fig. 65 provides one embodiment of how packet length dependent FEC may be implemented in MBRI.

[00260] In embodiments, MBRI may provide proactive router handoff capabilities in order to accommodate fast moving nodes. Consider the following example, without limitation, of a fast moving mobile node in the network shown in Fig. 66. Multiple fixed (MAPs and two BAPs are shown to form a spanning network to provide coverage in a region. Links between access points are indicated by the light blue solid lines. A fast moving mobile node (yellow circle) follows a trajectory indicated by the thin dotted line. Links to nearby access points are indicated by magenta solid lines. A route that connects the mobile to the fixed network is formed through a BAP (indicated by thick dashed line). Based on node location in the region, connectivity through one or the other of the BAPs is preferred (for network efficiency). As the node traverses the region where the network is deployed, links change. In the basic MBRI, routes reactively update to link state changes. This necessarily leads to a delay between when the links change and when the routes are updated. Fig. 67 shows the mobile node after it has crossed over into the area where the preferred routing is through BAP #2. However, due to the reactive routing updates, the route to/from the fixed network remains through BAP #1. Depending on node velocity and routing update rate, the links may change again before route updates are completed. This results in data from the fixed network traversing an inefficient path that is

always trying to "catch up" to the mobile node as it moves through the network. The impact is additional hopping leading to increased latency and decreased network capacity. The preferred route through BAP #2 is shown in Fig. 68. Rather than waiting for reactive routes to adjust, proactive routes are formed. The first step is to identify fast moving mobile nodes in the network that might require proactive routing updates. Identification can occur in a variety of ways to include Doppler estimates from the received signals, geo-location estimates of mobile node location, and interpretation of the rate of change of link state variables. The predictive routing algorithms may use knowledge of the location of fixed infrastructure (MAPs and BAPs) and the anticipated location of the fast moving mobile node to adjust routes based on the predicted link states / costs in the network. In this manner, the route may be updated before waiting for the link cost to reflect the change indicating that a route update is needed, and further waiting for the route to actually be updated. In embodiments, proactive router handoff may provide a way for MBRI to be extended to nodes in vehicles, and so, out onto a road network.

[00261] In embodiments, MBRI may provide for vehicular mobility-vector based routing, providing optimum routing of traffic to and from nodes moving at vehicular speeds for MBRI network, such as shown in Fig. 69. When mobile nodes travel at a faster speed than it takes MANET networks to converge, it may cause a mobile node to miss data as the data is routed via nodes that are no longer reachable. A node, in a vehicle may be able to determine a mobility-vector for the sake of establishing and/or maintaining routing within an MBRI network structure as the node moves. In embodiments, a node may be in a vehicle as a result of being mounted in the vehicle, carried into the vehicle by a user of a mobile device, temporarily mounted on the vehicle, and the like. The node in the vehicle may determine the vehicular mobility-vector in a plurality of ways, such as detecting and monitoring link parameters, including power level, data rate capabilities, and the like; through relative or absolute directionality associated with the motion of the vehicle or surrounding nodes; through information supplied by neighboring nodes; and the like. In embodiments MBRI may provide certain rules or capabilities associated with routing in association with nodes in rapid motion, such as vehicular mobile nodes may not participate in relay of traffic of stationary (or lower speed) nodes, minimize the ripple in topology caused by fast moving node; preferentially directing the communications of vehicular mobile nodes with AP as long as power requirements are met (i.e. it may not need high power to transmit); vehicular mobile nodes may hand off to an overlay cellular network if the only routing choice available is high power transmission; vehicular mobile nodes may attempt to relay thru other vehicular mobile nodes if the other mobile nodes are travelling in the same direction and towards AP; an edge router (ER) may calculate the speed and vector of the mobile node by using GPS and/or TDOA; ER anticipates a scoped region where a mobile node is for the return traffic; ER may send scoped multicast traffic to the nodes in that anticipated area where the vehicle is expected; nodes when discovering a vehicle in their area may relay that traffic to the vehicular mobile node; and the like. In embodiments, vehicular mobile-vectoring may enable an AP predicting the possible mobile node location based on mobility, GPS, speed, vector and other characteristics;

AP using scoped multicasting to send data to all the possible locations; Mobile nodes discriminating highly mobile nodes from routing calculations to avoid excessive route ripple; and the like. In embodiments, vehicular mobility-vector based routing may better enable MBRI to extend connectivity to nodes moving at vehicle speeds, and thus across a road system.

[00262] In embodiments, MBRI may provide a device to device environment where files and applications may be generated, shared, deployed, transferred, downloaded, distributed amongst a plurality of devices, and the like. For instance, MBRI may provide benefits associated with being Web 2.0 ready. Web 2.0 is a term describing the trend in the use of World Wide Web technology and web design that aims to enhance creativity, information sharing, collaboration among users, and the like. These concepts have led to the development and evolution of web-based communities and hosted services, such as social-networking sites, wikis, blogs, folksonomies, and the like. MBRI, representing a mobile extension of the Internet, may better enable these services. In addition, MBRI may provide aspects of a local distributed computing presence, which better enables these services at a local level. In embodiments, MBRI, through device node capabilities and MBRI neighbor node awareness capabilities, may provide the facility for these direct-to-device application deployments, distributed processing, application file sharing, and the like. In addition, MBRI nodes, having the capability to manage transfer and routing of this data along with throughput traffic, may be able to provide this peer to peer distributed processing and file sharing in a manner that does not degrade system performance. Because of MBRI's ability to control, manage, and shape data traffic amongst network nodes, these nodes may also be able provide direct device-to-device peering with symmetrical throughput, where traffic and data transfers are managed to maintain an even flow of data amongst the nodes of the MBRI network. Fig. 78 illustrates one embodiments of how Web 2.0 applications may be implemented within MBRI.

[00263] MBRI, being Web 2.0 ready, may provide for new end user applications, and entirely local mobile Internet applications, where applications may be created that are unique to the mobile Internet environment that MBRI creates. For instance, an instant picture sharing application could be created that takes advantage of many users taking pictures of an event or location at the same time. In this instance, MBRI may allow the real-time, or near real-time sharing and distribution of photos to the users within a swarm or local area. In embodiments, new end user applications may be created that are unique to MBRI, where users may be able to share, utilize, distribute data in ways only available to a mobile Internet environment, such as with MBRI's self managed node routing and neighbor awareness.

[00264] In embodiments, MBRI may provide broadband throughput data rates to mobile subscriber devices, such as enabled by high data rate backhaul access points to the fixed internet, and high data rate inter-node links. Broadband access for a user may be additionally enabled by high data rate MAP and CAP connections. In embodiments, quality of service may be better ensured through MBRI by way of multiple high data rate access points for any given local swarm of user nodes.

[00265] In embodiments, an end-user may participate in the deployment of a device onto the network, such as when the user enters the MBRI network, first connects to the MBRI network, and the like. That is, a user may want to, or have to, perform some act or function in order for their device to begin acting as a node on the network, and thereby be provided the services and access available from the Internet through MBRI. For example, the user may be charged a fee for access to the mobile Internet, and so the user may want a function that manually enables or disables their access. Alternatively, a user may have to provide some form of identification, whether manually or automatically, in order to gain access to the mobile network. In embodiments, this process may be provided in a transparent manner, where the user has previously set up a profile for the conditions under which they connect, and under these conditions, the user may be automatically connected.

[00266] In embodiments, a combination of enhancements and capabilities may be provided in a given configuration of the invention. For example, a more comprehensive, commercial-grade MBRI may include the totality of MBRI-Enhancements and MBRI Basic capabilities. In addition, any of the MBRI capabilities may be combined with dynamic spectrum access capabilities. In embodiments, combinations of enhancements and capabilities may be made available to service providers in the form of tools to manage operation and consumption of resources in a mobile Internet environment. For example, certain resources may be made to be restricted, such as bandwidth, application accessibility, multi-session capability, shared resource capabilities, quality of service level, and the like. In this way, service providers may be able to establish different costs for different access to resources, and control the use of resources in a given environment, network, device, and the like.

[00267] In embodiments, the design and deployment of field radio network infrastructure for outdoor and indoor environments may be a complex, costly, and time consuming process. Some of the design and deployment considerations that may need to be addressed for effective field radio network system design engineering and deployment planning to meet field system performance specifications may include physical factors such as geographic topology, area building infrastructure, line-of-site, available telecom infrastructure, radio frequency interference and propagation factors (e.g. foliage, occlusion), suitable radio installation site availability, network volume demand profile, outdoor and indoor coverage requirements, and the like. The MBRI system of the present invention may address these environmental conditions in a manner that may simplify the complexity and substantially lessen the cost and time required to design a radio network for the field, plan for its deployment and execute deployment where the MBRI technology platform is employed.

[00268] In embodiments, the MBRI system may enable network engineers and deployment managers to change the nature of the field network design, deployment planning and deployment process in a plurality of areas, including 1.) efficient use of real estate required for fixed radio installation, 2.) efficient connection to other wired telecom infrastructure required for connection to other networks, 3.) low cost and fast network design engineering and deployment planning, 4.) low cost, fast deployment and network turn-up,

5.) low cost and fast capacity expansion and network upgrade, 6.) seamless outdoor and indoor operation, 7.) network end-user deployment participation, and the like. In embodiments, this present invention may change the logic of field radio network design deployment and management from up-front complex, high-cost and time consuming network design and field based RF engineering and installation, to highly automated, low cost and rapid up-front network design and deployment planning with a rapid and low cost deployment and network installation process.

[00269] In embodiments, the present invention may provide for efficient use of existing real estate for fixed radio installation. Physical sites may be required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites in the relevant geography to accommodate sufficient fixed radio installation may be a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which may be inherent in the radio system design. The MBRI MAP and BAP access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options may allow an MBRI network to be deployable to a range of many more candidate real estate locations for fixed site installation in any given geography than other field deployed radio networks. Thus, an optimal subset from this larger set of candidate locations may be selected that may meet the lowest cost, easiest to install and also satisfy network radio propagation and performance requirements.

[00270] In embodiments, the present invention may provide for efficient connection to other wired telecom infrastructure required for connection to other networks, including field deployed radio networks, tower-based assets (e.g. backup batteries and antennas), and the like. Field deployed radio networks may require connection to other wired telecom infrastructure to effectuate traffic transfer with other networks such as the Internet, the PSTN, other wireless networks, and the like. The availability, location, complexity and cost associated with accessing and equipping the wired telecom infrastructure connection points, such as fiber, copper, coax of Telcos, MSOs, and the like, to accept connection to the field deployed radio network may be a significant factor affecting field radio network architecture design, deployment planning, deployment, and installation. The MBRI MAP and BAP access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options may allow an MBRI network to be deployable to a range of many more candidate real estate locations for fixed site installation in any given geography than other field deployed radio networks while also concurrently satisfying radio propagation and network performance requirements. Thus, the selection of optimal wired network connection points may be made easier in that the optimal, lowest cost, easiest to access and upgrade wired infrastructure connection points may be selected from among those available in any given geography. In embodiments, an MBRI field network design may start with the optimal selection of the required wired telecom infrastructure BAP connection points for the

specified network backhaul capacity in any given geography and then proceed to the selection of the remainder of optimal MAP points. This may is the reverse of how field radio network systems are designed today, where optimal radio propagation coverage is determined first and then the network backhaul is constructed to meet it at optimal RF based location selections, adding complexity, cost and time. The MBRI system flexibility may significantly increase the options for inexpensive fixed radio location design and deployment, thus allowing for optimal backhaul BAP location selection first and then solving for meeting propagation specifications by deploying the number of MAPs needed at the most efficient locations to do so.

[00271] In embodiments, the present invention may provide for low cost and fast network design engineering and deployment planning. The availability of information and data regarding the geographic topology, area building infrastructure, line-of-site, available telecom infrastructure, radio frequency interference and propagation (e.g. foliage, occlusion), and the like. may be available in a variety of data based information sources from municipalities and private enterprise sources. This data may be organized and structured in a manner that may be evaluated to solve the multidimensional network design problem for the geographic specific network architecture design that is optimized concurrently and equally for low cost deployment and ongoing operations, addressing these complex environmental factors with a flexible network technology, in addition to achieving economically efficient high-performance scale operation. In embodiments, the MBRI MAP and BAP access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options may allow an MBRI network to be deployable in any environment where complex radio engineering formerly performed in the field at high cost may now be replaced with automated desk-top MBRI designing capabilities where environmental factors affecting network performance may be addressed by incorporating additional meshed MAPs and BAPs as required to satisfy performance specifications while also meeting lowest cost deployment objectives. In embodiments, an automated design tool incorporating the technical design factors for the MBRI network technology interacting with the structured environmental factor data may be designed and operated. This tool capability when used in unison with the MBRI network technology may substantially lower the cost and time required for network architecture design in any given geography as well as the deployment planning program design.

[00272] In embodiments, the present invention may provide for low cost, fast deployment and network turn-up. The MBRI MAP and BAP access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes may enable a highly simplified, low labor intensive, low cast and rapid network deployment, installation and turn-up. In embodiments, fixed radio sites may be optimally selected to meet network propagation and performance requirements while concurrently being optimized for easy and low cost for site: acquisition, physical accessibility and preparation, rental and ongoing maintenance costs, and the like. A sufficient number of them may be chosen

in any given geography to better assure for required network geographic coverage propagation and performance; in essence, more low cost MAPs may be added as necessary to "fill-in" propagation "holes" and to "reach" difficult coverage areas as a trade-off for fewer more expensive radios located at more costly sites, requiring complex RF designs and labor intensive field based RF engineering.

[00273] In embodiments, the present invention may provide for low cost and fast capacity expansion and network upgrade. The MBRI MAP and BAP access side and backhaul side mesh routing capabilities, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes may enable a highly simplified, low labor intensive, low cast and rapid network capacity expansion and network up-grade. In embodiments, backhaul load balancing may be an automatic feature of the MANET, and scale proportionally in relation to the number of BAPs. A field radio network design, deployment and ongoing management plan may include provisions for planned and unplanned network capacity expansions. As with the nature of the MBRI network system initial design and deployment innovations, any network capacity expansion, either permanent or temporary, may be met at low cost and rapidly using the same logic and tools to additional optimally pre-selected fixed site locations. Further, since the fundamental MBRI technology design may be incorporated into software and small form factor physical units, technology up-grades to an existing operational MBRI network may be effectuated at low cost and rapidly via software downloads or low cost and low labor intensive field installation activity.

[00274] In embodiments, the present invention may provide for seamless outdoor and indoor operation, including broadband coverage. The MBRI indoor premises located CAP, indoor premises located MAP when operationally associated with the outdoor fixed radio MAP and BAP access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes may enable seamless indoor coverage as indoor located CAPs and MAPs that may reach and connect with outdoor located MAPs and may be employed for indoor network coverage and indoor device connectivity. As may be with the logic of outdoor network design and planning, indoor RF propagation coverage and capacity and network performance requirements may be efficiently achieved with optimal site selection for fixed radio installation using the same data bases, network design logic and associated design tools, and the like. In embodiments, indoor CAP and MAP, as associated with outdoor MAP and BAP, may provide similar connectivity and broadband coverage for users as they migrate between indoor and outdoor environments.

[00275] Fig. 79 illustrates one embodiment of seamless outdoor and indoor operation. In this instance, MBRI may be seen as deployed as a combination of outdoor (LF810, LF812, LF834) and in building (LF824, 826, 828, 830 832) MAP units along with BAP (LF822) so as to provide MBRI. In embodiments BAP (LF822) may provide access side and back haul side. In most installation back haul access (LF852) may be coupled to a suitable router or switch (LF820) which may allow broadband access to a high speed internet backhaul. In its absence BAP (LF822) may be equipped with suitable backhaul interface capable of direct connection to the internet. A combination of in building (LF802) and outdoor MAP units may provide users a seamless connectivity since outdoor units (LF810, LF812, LF834) can be advantageously deployed so as to provide interconnectivity within building (LF802) MAP and BAP units.

[00276] Fig. 80 illustrates a further embodiment of seamless outdoor and indoor operation. As shown, outdoor (LF810, LF812, LF834) MAP units may be deployed in a near proximity to a building (LF802) having its structural features removed (or washed out) to exemplify radio link connectivity between various MAP/BAP units. In some deployment scenarios it may be desirable to have outdoor units to be camouflaged or disguised as common street fixtures or so as to appear as a part of building architectural features. For example, a MAP (LF810) unit may be installed on top of light stand (LF804). In another instance a wall sconce light fixture (LF806) may be integrated with MAP (LF812), thus essentially camouflaging the MAP. In other circumstances MAP (LF834) may be mounted in a secured location, away from unauthorized access, in a ruggedized weather resistant enclosure. In building (LF824, 826, 828, 830 & 834) MAP units may be mounted in storage closets or on the back side of the ceiling tiles to reduce unauthorized access. Building installation may bring in additional complications since radio way propagation may be difficult to predict and full coverage may be difficult to attain. Node LF822 may be installed in near proximity of a stairwell. Stairwell along with ventilation shafts can provide suitable radio signal path to adjacent MAP units deployed on different floors. Appropriate signal strength and link quality may need to be attained between MAP/BAP units for satisfactory network performance. Fig. 81 provides an interconnection diagram for the Fig. 80 illustration.

[00277] In embodiments, the present invention may provide for network end-user deployment participation. The MBRI indoor premises located CAP, when operationally associated with the outdoor fixed radio MAP and BAP access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including ad-hoc, self-healing and self-forming attributes may enable end-user subscriber effectuated seamless indoor coverage as indoor located CAPs purchased (e.g. retail equipment purchase of service provider provided) by consumers and installed indoors by consumers as "plug and play," "always-on" customer premises located devices that may reach and connect with outdoor located MAPs and may be employed for indoor network coverage and indoor device connectivity.

[00278] In embodiments, the present invention may provide for integration and coexistence with existing network and communications infrastructure. MBRI, which may be considered a mobile Internet, may become a natural extension of the fixed Internet, integrating with the existing infrastructure through BAP, MAP, and CAP access points in a seamless manner. The MBRI may provide an efficient use of existing backbone communications infrastructure, such as fiber, wire, microwave, radio, cellular, and the like, where BAP, MAP, and CAP access points may connect through fixed Internet resources to utilize the existing infrastructure. In addition, MBRI may provide a seamless integration with Internet communications facilities, such as WiMax, Wi-Fi, home networks, home routers, fiber to home optical network terminals, wired Internet, public safety network, enterprise network, machine to machine networks, municipal networks, fixed wireless, and the like.

[00279] MBRI may also coexist and utilize other communications facilities, such as with the cellular spectrum, LTE, GSM, Cable (HFC), electrical, satellite, unlicensed bands, and the like. In embodiments, a carrier may utilize MBRI to improve or expand their service. For example, if a carrier decides to use MBRI as a means to provide high bandwidth data services and continue voice services via their existing network solution, that may free up bandwidth at the tower and eliminate infrastructure cost otherwise required for upgrades. In another example, if a carrier has significant backhaul capacity at a tower this may be reused to support a MBRI operation. Since MBRI allows for direct P2P communication only external traffic may require the backhaul bandwidth, thus allowing for a greater number of connections compared to cellular. In another example, the carrier may add DYSAN capability to the tower to enable MRBI to co-share the cellular spectrum. In embodiments, MBRI may provide interfaces with operation support systems (OSS), which may be computer systems used by telecommunications service providers, and may describe the network systems dealing with the telecom network itself, supporting processes such as maintaining network inventory, provisioning services, configuring network components, managing faults, and the like. The MBRI may additionally interface with other existing network facilities, such as network management systems, network operations centers, and the like.

[00280] In embodiments, the MBRI may provide services in an improved manner over services offered in a cellular regime, such as providing Internet equivalent routing to mobile devices outside the cellular regime, direct access to applications that would otherwise be included in a controlled environment, such as in the case of a 'walled garden', IP application deployment to mobile devices outside the cellular regime, and the like. Mobile devices operating within a cellular system are often restricted in their access to applications. MBRI may provide users with the benefits of more direct routing and connectivity with applications, and as such, may provide MBRI enabled users with greater freedom of use with respect to applications than is typically available through a cellular system.

[00281] In embodiments, the MBRI may provide for node to node communications that may improve the performance within the network, including the use of node weight metrics, dynamic sharing of communications, dynamic data link segmentation and reassembly, nested weighted round robin queuing, multi-metric based multicast and unicast routing, and the like.

[00282] In embodiments, MBRI may provide for a communications system that may increase the successful outcome of a fair coin flip using a node weight metric. Channel access in a wireless ad-hoc communications network may pose the challenge of fair access and efficient use of channel bandwidth. That is, desired properties of a channel access protocol may include fairness (e.g. each node has the

opportunity to transmit), and efficient use of channel bandwidth (e.g. bandwidth is utilized fully by the nodes with data to transmit). In embodiments, utilizing a 'node weight' may improve the efficiency and fairness of channel access. Node weight may include the notion of a metric that indicates the level of data activity at a given node. Each node in the network may compute its own node weight. A node may share this information with its one-hop neighbors (e.g. those that it can communicate with directly via wireless media). In turn, neighboring nodes may share node weight amongst the nodes within a two-hop neighborhood to enable distributed (vices centralized) scheduling. Node weight may be used to skew the distribution of channel access to those nodes with the most data to transmit (i.e. those with more 'weight'). By utilizing a 'fair coin flip' to ensure a degree of fairness coupled with node weight to allocate bandwidth appropriately MBRI may better assure an efficient use of the wireless channel.

[00283] In embodiments, MBRI may provide for dynamic sharing of a communication channel based on nodal transmit and receive requirements using a set of bandwidth metrics in a communication system. Channel access in a wireless ad-hoc communications network may pose the challenge of fair access and efficient use of channel bandwidth. That is, desired properties of a channel access protocol may include fairness (e.g. each node has the opportunity to transmit) and efficient use of channel bandwidth (e.g. bandwidth is utilized fully by the nodes with data to transmit). In embodiments, MBRI may utilize a 'bandwidth' facility for improving the efficiency and fairness of channel access. Bandwidth may include the notion of metrics that indicate the level of data activity at a given node. Each node in the network may compute its own bandwidth in and bandwidth out for each of its 1 hop neighbors (e.g. all of the nodes within direct communication range of a transmitter). In turn, neighboring nodes may share bandwidth in and bandwidth out amongst the nodes within a two-hop neighborhood to enable distributed (vices centralized) scheduling. Bandwidth may be used in the calculation to skew the distribution of channel access to those nodes with the most data to transmit (i.e. those with a higher bandwidth out). By utilizing bandwidth out and bandwidth in to compute node weight for use in a 'fair coin flip', MBRI may better ensure a degree of fairness and efficient use of the wireless channel.

[00284] In embodiments, MBRI may prioritize nested weighted round robin queuing. Prioritized nested weighted round robin queuing may be associated with a parameterized mechanism to provide nodal quality of service for class-based traffic types. In embodiments, weights may meter the traffic onto the communication channel by class with a preemptive priority class of service provided. In embodiments, other queuing disciplines may be used in the MBRI, such as strict priority, simple round robin, and the like.

[00285] In embodiments, MBRI may provide for multi-metric based multicast and unicast routing. Heuristics may be developed, utilizing information from both the data link and physical layers, to create minimum cost routes utilizing delay, reliability, data rate capability, and the like, as metrics for the SLSR algorithm. The SLSR algorithm may perform the calculation on the heuristics to determine the

minimum cost path. The creation of the heuristics may provide routes over the most reliable, least delay, and highest data rate links between any source and destination in a network. Additionally, tie breaking mechanisms for unicast routing may be added to eliminate the overload of the highest IP address mechanism.

[00286] Referring to Fig. 82, a mobile broadband routable internet may be beneficially applied in a variety of environments 8202, some of which are described herein, others of which will be understood, and all of which are within the scope of the present disclosure. Environments may be enabled on the mobile broadband routable internet by one or more enablers 8298 associated with the mobile broadband routable internet. The environments may include an academic campus 8204, public safety 8208, a city/metro area 8210, spectral condition 8212, avoiding obstacles (incl 3d) 8214, dense users 8218, an intense user 8220, an enterprise (bank, a mfg) 8222, municipal 8224, indoors 8228, an indoor/outdoor transition 8230, in home 8232, automotive 8234, events 8238, a sports arena/stadium 8240, a transportation environ/ ports 8242, an exhibit hall 8244, a theme park 8248, medical 8250, a hospital, a doctor's office 8252, a subway 8254, a train 8258, in tunnel 8260, an airplane 8262, a boat 8264, a highway 8268, sparse users 8270, rural 8272, military, and the like. Enablers associated with the mobile broadband routable internet may include routing prioritization, network support for peer-to-peer traffic, peer to peer connectivity within mobile broadband routable internet, facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-device application deployment (e.g., for web 2.0 apps), distributed data for web apps in the mobile broadband routable internet device, distributed applications, multicast routing , remote network monitoring, control, and upgrade , adaptive transmit power control , FEC on long ip packets, adaptive link data rate , DYSAN - spectrum aware, spectral reuse with high system level throughput, frequency agnostic operation (operation at any frequency), network geo-location , multimedia , time synchronization , seamless outdoor and indoor operation , seamless indoor/outdoor broadband coverage, efficient use of real estate required for fixed radio installation , efficient connection to other wired telecom infrastructure required for connection to other networks , multiple fixed network gateway interfaces , low cost and fast network design engineering and deployment planning , low cost, fast deployment and network turn-up , low cost and fast capacity expansion and network upgrade , efficient use of existing backbone communications infrastructure, network end-user deployment participation , base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, cost-based routing in a subscriber device, fully enabled ip router in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (VPN, etc), internet-equivalent routing to mobile devices outside cellular regime - no need for walled garden or operator control of application deployment), ip application deployment to mobile devices outside cellular regime, mobile internet-style network , entirely local mobile internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local ip-based swarming, and the like.

[00287] In embodiments, an enhancement may be prioritization of medically-relevant, delay sensitive traffic across the network protocol through priority queuing and priority channel access by differentiating data traffic across the protocol stack. For example, the field of telemedicine relies heavily on reliable and fast trafficking of data, such as during a remotely-assisted surgery where the surgeon is in one location while the subject is in another location. In such a case, traffic across the network protocol originating from either end of the surgeon-subject connection is extremely delay sensitive. Prioritization of this traffic is critical. The prioritization of medically-relevant, delay-sensitive traffic, such as the traffic described herein, may be done by granting prioritized channel access to nodes with delay-sensitive data and sending the delay sensitive data before sending delay tolerant data from the same node. Prioritization may enable the provision of service level performance agreements related to the medically-relevant traffic.

[00288] In embodiments, an enhancement may be network support for peer-to-peer traffic on an academic campus. For example, academic campus' may be heavily populated with mobile subscriber devices for a majority of the day with many of these subscribers engaging in peer-to-peer traffic, such as for example, sharing videos, music, academic subject matter, and the like. Providing network support for peer-to-peer traffic on an academic campus without forcing routing through the fixed network may decrease the amount of wireless network capacity required to deliver service to mobile subscribers on the academic campus. This may allow the network to offer more service on the academic campus with the same amount of capacity.

[00289] In embodiments, in contrast to conventional wireless and fixed wired access networks, methods and systems may be provided for a mobile broadband internet network solution in a sports arena/ stadium where every subscriber device and infrastructure node has routing capabilities to allow for intelligent routing decisions enabling intra-network peer to peer communications in the sports arena/ stadium. Traffic between nodes of the mobile broadband routable internet may not need to leave the mobile ad-hoc network established in the sports arena/ stadium for routing or switching purposes. Instead, because mobile broadband routable internet may be routing enabled, local traffic, including required signaling, traffic may stay within the mobile broadband routable internet. For example, local traffic related to an ongoing sports contest, such as statistics for a player or team, advertisements related to concessions or souvenirs, replays, and the like, may be routed within the mobile broadband routable internet. In addition, because of its unique neighbor discovery management and Adaptive Data Rate and Power Management Capabilities, the mobile broadband routable internet enables local intelligence to be shared across its member nodes leading to the creation and deployment of new classes of services and applications.

[00290] In an embodiment, a mobile broadband internet network solution may facilitate file sharing, user-generated and peer-to-peer applications in a home-based environment without degrading system performance. Methods and systems may include openness to a wide range of applications, including

capability, for example, to download an Internet application directly on the subscriber device in the home-based environment. For example, mobile subscriber device connectivity in residential homes is often poor. However, forming links among other subscriber devices in or near the home augments wireless coverage, thus, system performance may be maintained downloading and using applications.

[00291] In an embodiment, a mobile broadband internet network solution may facilitate direct-to-device application deployment, such as for Web 2.0 applications, applications related to events, and the like. Application deployment methods, such as FTP or other file transfer methods may typically be used for application deployment, but the mobile broadband routable internet enables application deployment from any source along a mobile ad-hoc network, thus enabling direct-to-device application deployment, such as for event-related applications. For example, a band may offer an application related to a concert to concertgoers, and may protect their content from unauthorized re-distribution by bypassing the PC and downloading the application directly to secure and authenticated devices.

[00292] In an embodiment, a mobile broadband internet network solution may facilitate distributed data for web applications in a mobile broadband routable internet device operated at a doctor's office. The exchange of data structures between web applications and the application server may be facilitated by the mobile broadband routable internet where the network is augmented with subscriber nodes. Data management over a mobile broadband routable internet may be more robust than over a fixed network because of the capabilities of the mobile broadband routable internet described herein. For example, a doctor running an electronic medical records management application on a mobile device may require use of distributed data, such as data related to insurance coverage, diagnosis aids, and the like. Facilitating the utilization of distributed data by an application on the doctor's device may be critical in, for example, rapidly assessing a diagnostic situation.

[00293] In an embodiment, a mobile broadband internet network solution may facilitate multicast routing at a theme park. With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. Multicast routing addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them. In this embodiment, multicast routing may improve efficiency of network capacity at a theme park by avoiding multiple transmissions of common data along a common path. This may allow the network to offer more service at the theme park with the same capacity. For example, if a theme park wants to send streaming media to all visitors, multicast routing over the mobile broadband routable internet will enable the theme park to send out only a single copy.

[00294] In an embodiment, a mobile broadband internet network solution may facilitate adaptive transmit power control for an environment comprising a density of users. Adaptive transmit power control may reduce the area where the node causes interference to other nodes, allowing more efficient re-use of RF spectrum across network topology. This may support scalability to node densities required for carrier

networks. For example, in a densely populated area where node interference may be more of an issue, re-use of the RF spectrum becomes especially attractive. The adaptive transmit power control facility may be adapted to adjust transmission power of a mobile device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device, an application requirement of the device, and the like.

[00295] In an embodiment, a mobile broadband internet network solution may facilitate adaptive transmit power control for a hospital environment. Adaptive transmit power control may reduce the area where the node causes interference to other nodes, allowing more efficient re-use of RF spectrum across network topology. This may support scalability to node densities required for carrier networks. For example, in a hospital area where many machines and pieces of hospital equipment operate on a radio frequency, node interference may be more of an issue. Thus, re-use of the RF spectrum becomes especially attractive.

[00296] In an embodiment, a mobile broadband internet network solution may facilitate an adaptive link data rate for an intense user. In this embodiment, providing an adaptive link data rate may enable the network to simultaneously deliver capacity and coverage based on individual link conditions. For example, an intense user located in an area where only a low data rate is supported may be linked along the mobile ad-hoc network to a mobile node located in an area that supports a high data rate. A facility for enabling adaptation of the data rate provided for links among devices within the network may base the adaptation on at least one of the density of devices in the network, the condition of neighboring devices in the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition, an application requirement, and the like.

[00297] In an embodiment, a mobile broadband internet network solution may facilitate an adaptive link data rate for a rail or train environment. In this embodiment, providing an adaptive link data rate may enable the network to simultaneously deliver capacity and coverage based on individual link conditions. For example, a user riding a train where only a low data rate is supported may be linked along the mobile ad-hoc network to a mobile node located in an area that supports a high data rate.

[00298] In an embodiment, dynamic spectrum access, as a part of a mobile broadband routable internet may provide spectrum used to communicate wirelessly between nodes changes in a non-pre-determined manner in response to changing network and spectrum conditions, such as in a city or metropolitan area. In embodiments, the time scale of dynamics may be typically less than can be supported by engineering analysis, network re-planning, optimization, and the like. Dynamic spectrum access may be able to avoid interference to/from geographically proximate spectrum users, such as is typical in a city or metropolitan area, internal or external to their own wireless network. Dynamic spectrum access may also be able to access and utilize spectrum otherwise unavailable for wireless network use. In embodiments, local spectrum decisions may be coordinated and/or communicated using a fixed or logical control channel in an

over-the-air wireless network. DYSAN may comprise determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination.

[00299] A wireless network in a city or metropolitan area may use dynamic spectrum access that provides a dynamic allocation of wireless spectrum to network nodes. The spectrum may be used to communicate wirelessly between nodes in a non-pre-determined manner in response to changing network and spectrum conditions. Dynamic spectrum access technology may use the methodology of coordination of a collection of wireless nodes to adjust their use of the available RF spectrum. In embodiments, the spectrum may be allocated in response to manual or automated decisions. The spectrum may be allocated in a centralized manner (e.g., network partitioning) or in a distributed manner between individual nodes. The spectrum may be allocated dynamically such that interference to/from geographically proximate spectrum users, such as users in a city or metropolitan area, internal or external to the wireless network may be avoided. The local spectrum decisions may be coordinated/communicated using a fixed or logical control channel in the over-the-air wireless network. This may increase the performance of wireless networks by intelligently distributing segments of available radio frequency spectrum to wireless nodes. Dynamic spectrum access may provide an improvement to wireless communications and spectrum management in terms of spectrum access, capacity, planning requirements, ease of use, reliability, avoiding congestion, and the like.

[00300] In this embodiment, a mobile ad-hoc wireless network in a city or metropolitan area may be used in conjunction with dynamic spectrum access technology to provide carrier grade quality of service. A collection of wireless nodes in a mobile ad-hoc network may dynamically adapt spectrum usage according to network and spectrum conditions. Individual nodes in the mobile ad-hoc wireless network may make distributed decisions regarding local spectrum usage. In embodiments, quality of service for a mobile ad-hoc wireless network in a city or metropolitan area may be measured in terms of the amount of data which the network may successfully transfer from one place to another in a given period of time, and DYSAN may provide this through greater utilization of the available spectrum in a city or metropolitan area. In embodiments, the dynamic spectrum access technology may provide a plurality of network services and attributes such as, coordinated and uncoordinated distributed frequency assignment, fixed or dynamic network coordination control channel, assisted spectrum awareness (knowledge of available spectrum), tunable aggressiveness for co-existence with uncoordinated external networks, policy-driven for time-of-day frequency and geography, partitioning with coordinated external networks, integrated and/or external RF sensor, and the like.

[00301] In an embodiment, dynamic spectrum access, as a part of a mobile broadband routable internet may provide spectrum used to communicate wirelessly between nodes changes in a non-pre-determined manner in response to changing network and spectrum conditions, such as to avoid obstacles, including 3-dimensional obstacles. In embodiments, the time scale of dynamics may be typically less than can be supported by engineering analysis, network re-planning, optimization, and the like. Dynamic spectrum

access may be able to avoid interference to/from geographically proximate spectrum users internal or external to their own wireless network. Dynamic spectrum access may also be able to access and utilize spectrum otherwise unavailable for wireless network use. In embodiments, local spectrum decisions may be coordinated and/or communicated using a fixed or logical control channel in an over-the-air wireless network.

[00302] A wireless network located in the vicinity of an obstacle, such as a 3-dimensional obstacle, may use dynamic spectrum access that provides a dynamic allocation of wireless spectrum to network nodes. The spectrum may be used to communicate wirelessly between nodes in a non-pre-determined manner in response to changing network and spectrum conditions. Dynamic spectrum access technology may use the methodology of coordination of a collection of wireless nodes to adjust their use of the available RF spectrum. In embodiments, the spectrum may be allocated in response to manual or automated decisions. The spectrum may be allocated in a centralized manner (e.g., network partitioning) or in a distributed manner between individual nodes. The spectrum may be allocated dynamically such that interference to/from geographically proximate spectrum users internal or external to the wireless network may be avoided. The local spectrum decisions may be coordinated/communicated using a fixed or logical control channel in the over-the-air wireless network. This may increase the performance of wireless networks by intelligently distributing segments of available radio frequency spectrum to wireless nodes. Dynamic spectrum access may provide an improvement to wireless communications and spectrum management in terms of spectrum access, capacity, planning requirements, ease of use, reliability, avoiding congestion, and the like.

[00303] In this embodiment, a mobile ad-hoc wireless network may be used in conjunction with dynamic spectrum access technology to provide carrier grade quality of service, even in the presence of obstacles, such as 3-dimensional obstacles. A collection of wireless nodes in a mobile ad-hoc network may dynamically adapt spectrum usage according to network and spectrum conditions. Individual nodes in the mobile ad-hoc wireless network may make distributed decisions regarding local spectrum usage. In embodiments, quality of service for a mobile ad-hoc wireless network where there are obstacles, such as 3-dimensional obstacles, may be measured in terms of the amount of data which the network may successfully transfer from one place to another in a given period of time, and DYSAN may provide this through greater utilization of the available spectrum. In embodiments, the dynamic spectrum access technology may provide a plurality of network services and attributes such as, coordinated and uncoordinated distributed frequency assignment, fixed or dynamic network coordination control channel, assisted spectrum awareness (knowledge of available spectrum), tunable aggressiveness for co-existence with uncoordinated external networks, policy-driven for time-of-day frequency and geography, partitioning with coordinated external networks, integrated and/or external RF sensor, and the like.

[00304] In an embodiment, a mobile broadband internet network solution may facilitate spectral reuse with high system level throughput in an environment with certain spectral conditions. Spectral reuse

involves limiting the geographic area within a sector over which a signal is transmitted so that the same frequency channels may be used again in another sector, such as in an area where the spectrum is crowded. This approach results in a multiplication of the effective capacity of spectrum in a given area. This capability for flexible deployment provides a fully scalable wireless ad-hoc network and substantially reduces the adjacent node interference. The mobile broadband routable internet may enable communicating among the plurality of devices over a radio communication spectrum and reusing portions of the spectrum for communication based on availability of time frequency rectangles within portions of the spectrum.

[00305] In an embodiment, a mobile broadband internet network solution may facilitate spectral reuse with high system level throughput in a boating environment. As a boat travels through areas, the mobile ad-hoc network it is associated with may change. Spectra reuse may allow mobile devices in use on a boat to continue operating on a certain frequency and to not interfere with adjacent mobile nodes as the boat travels.

[00306] In an embodiment, a mobile broadband internet network solution may facilitate network geo-location in a transportation environment, such as at a port. In this embodiment, providing geo-location of network nodes in a transportation environment to the neighboring nodes may facilitate public safety and may enable location-based services. For example, estimating the position of a node at an unknown location, such as an RF-tagged container at a port, may involve receiving a location estimate from at least one neighboring node, measuring a geo-observable from at least one neighboring node, estimating the position of the network node, determining if the location estimate is accurate, and sending the location estimate to neighboring nodes.

[00307] In an embodiment, a mobile broadband internet network solution may facilitate network geo-location in a boating environment. In this embodiment, providing geo-location of network nodes in a boating environment to the boat's neighboring nodes may facilitate public safety and may enable location-based services. For example, estimating the position of a node at an unknown location, such as a an RF distress beacon on a boat lost at sea, may involve receiving a location estimate from at least one neighboring node, measuring a geo-observable from at least one neighboring node, estimating the position of the network node, determining if the location estimate is accurate, and sending the location estimate to neighboring nodes, such as to a rescue boat.

[00308] In an embodiment, a mobile broadband internet network solution may facilitate network geo-location in a highway environment. In this embodiment, providing geo-location of network nodes in a highway environment to the neighboring nodes may facilitate public safety and may enable location-based services. For example, estimating the position of a node at an unknown location, such as a wireless device carried in the automobile of a person being sought, may involve receiving a location estimate from at least one neighboring node, measuring a geo-observable from at least one neighboring node, estimating the position of the network node, determining if the location estimate is accurate, and sending the location estimate to neighboring nodes, such as to public safety officers.

[00309] In an embodiment, a mobile broadband internet network solution may facilitate a multimedia capability at an exhibit hall. Increased slot rate in communication in a mobile ad-hoc wireless network may facilitate better accommodating carrier grade service delivery of multimedia content in a mobile ad-hoc network in an exhibit hall. In embodiments, slot time is defined as the duration of a single opportunity that may be used for transmission. In an embodiment, an increased slot rate may be used to transmit data in a mobile ad-hoc wireless network. In an example, the slot rate used may be 1000-2000 slots/sec. An increased slot rate may allow more distinct opportunities for multiple nodes to access the channel. An increased slot rate may also reduce the delay between the opportunities available for the mobile nodes. An increased slot rate means a reduced slot time. A reduced slot time results in more number of devices sharing the network. The reduced slot time also reduces jitter in the network. For example, a video may be streamed to all visitors to an exhibit hall where the mobile ad-hoc network used to stream the video has an increased slot rate to accommodate the number of people in the hall attempting to access the video.

[00310] Continuing with multimedia capabilities as a mobile broadband routable internet enhancement, a hybrid frame structure may be used for transmitting data in a mobile ad-hoc wireless network in an exhibit hall. The optimal use of frame structure in data transmission in a wireless ad-hoc network may affect the performance of the network. In an embodiment, a hybrid frame structure with variable slot duration and sub-channelization of bandwidth may be used. In an embodiment, the hybrid frame structure may have a combination of short and long slots (i.e., multiple time duration slot sizes) to simultaneously provide sufficient performance for both delay-sensitive (e.g., VoIP) and high capacity (e.g., broadband data) applications that may be in use in the exhibit hall. The slot capacity may be roughly proportional to slot duration, though slot overhead may be reduced for longer slots. This may result in increased slot efficiency for longer slots. The combination of short and long slots in a hybrid frame may provide sufficient opportunities to service multimedia traffic with heterogeneous service requirements using a common radio. In another embodiment, the hybrid frame structure may have a combination of wide and narrow slots (i.e., multiple bandwidth slot sizes) to provide increased transmit opportunities to improve service delivery for delay-sensitive (e.g., VoIP) traffic. In this example, subdividing the channel access bandwidth to allow multiple users to simultaneously transmit in the same overall channel bandwidth may provide more total transmit opportunities in the exhibit hall. In an example, if dynamic TDMA-based data transmission is used, channel access opportunities for multimedia traffic with heterogeneous delivery requirements may be provided in the exhibit hall.

[00311] In an embodiment, a mobile broadband internet network solution may facilitate time synchronization in a municipal environment. The access points in a mobile ad-hoc network in a municipal environment may have knowledge of network timing to insignificant levels compared to the timing needs. A method for enabling timing synchronization may include communicating a sense of network timing at all the nodes with sufficient accuracy to enable reliable communications. The network timing may include slot

timing and carrier frequency timing. In an aspect of the present invention, it may be assumed that each node may be designed so that the slot timing and the carrier frequency is derived from the same local reference. In an example, frequency error in the slot timing may be directly proportional to the carrier frequency error. The carrier frequency may be an integer multiple of slot rate. In an example, the slot rate may be IkHz. Certain user nodes may use certain access points for obtaining timing information for synchronization. Other user nodes may use an indirect approach by obtaining the timing information derived from the user nodes using access points for synchronization. In an embodiment, the timing information may be obtained by comparing the incoming packet timing relative to the local timing reference. In this embodiment, the relative timing of all of the neighbor nodes may be tracked and the local node timing is set to match the mean of these tracked times. The tracking may be accomplished using a Kalman filter with two states. In an example, the two states may be the time offset of the slot and the incoming carrier frequency (the number of states may be increased and the delay as an additional state may be introduced later). This method may be used by each node to synchronize to the network time and estimate the error in this local timing reference.

[00312] Continuing with time synchronization as a mobile broadband routable internet enhancement, a topology for evaluating an algorithm that may be applied to a municipal environment, where the algorithm estimates the relative time of each node, corrects for time offsets and estimates the delays of each link in the network. Time synchronization among nodes of the network may be provided by communicating a representation of network timing at all the nodes with sufficient accuracy to enable reliable communications

[00313] In an embodiment, a mobile broadband internet network solution may facilitate seamless indoor and outdoor operation for an indoor environment and the indoor to outdoor transition. The mobile broadband routable internet indoor premises located CAP [Customer Access Point], indoor premises located MAP [Mesh Access Point] when operationally associated with the outdoor fixed radio MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes enable seamless indoor coverage as indoor located CAPs and MAPs that can reach and connect with outdoor located MAPs and can be employed for indoor network coverage and indoor device connectivity, as well as during the transition from indoors to outdoors. As is with the logic of outdoor network design and planning, indoor RF propagation coverage and capacity and network performance requirements can be efficiently achieved with optimal site selection for fixed radio installation using the same data bases, network design logic and associated design tools.

[00314] In an embodiment, a mobile broadband internet network solution may facilitate seamless indoor and outdoor operation for an automotive environment. The mobile broadband routable internet indoor premises located CAP [Customer Access Point], indoor premises located MAP [Mesh Access Point] when operationally associated with the outdoor fixed radio MAP [Mesh Access Point] and BAP [Backhaul Access

Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes enable seamless indoor coverage as indoor located CAPs and MAPs that can reach and connect with outdoor located MAPs and can be employed for automotive environment network coverage and automotive environment device connectivity. As is with the logic of outdoor network design and planning, automotive environment RF propagation coverage and capacity and network performance requirements may be efficiently achieved with optimal site selection for fixed radio installation using the same data bases, network design logic and associated design tools.

[00315] In an embodiment, a mobile broadband internet network solution may facilitate efficient use of real estate in a subway required for fixed radio installation. As in any field deployed radio network system, physical sites are required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites in a subway to accommodate sufficient fixed radio installation is a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which is inherent in the radio system design. The mobile broadband routable internet MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options allow a mobile broadband routable internet network to be deployable to a range of many more candidate real estate locations for fixed site installation in a subway than other field deployed radio networks. Thus, an optimal subset from this larger set of candidate locations can be selected that can meet the lowest cost, easiest to install and also satisfy network radio propagation and performance requirements. For example, providing wireless network coverage in a subway station may be as simple as establishing a mobile broadband routable internet in the subway station.

[00316] In an embodiment, a mobile broadband internet network solution may facilitate efficient use of real estate in a tunnel required for fixed radio installation. As in any field deployed radio network system, physical sites are required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites in a tunnel to accommodate sufficient fixed radio installation is a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which is inherent in the radio system design. The mobile broadband routable internet MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options allow a mobile broadband routable internet network to be deployable to a range of many more candidate real estate locations for fixed site installation in a tunnel than other field deployed radio networks. Thus, an optimal subset from this larger set of candidate locations can be selected that can meet the lowest

cost, easiest to install and also satisfy network radio propagation and performance requirements. For example, providing wireless network coverage in a tunnel may be as simple as establishing a mobile broadband routable internet in the tunnel.

[00317] In an embodiment, a mobile broadband internet network solution may facilitate efficient use of real estate in a rural area required for fixed radio installation. As in any field deployed radio network system, physical sites are required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites in a rural area to accommodate sufficient fixed radio installation is a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which is inherent in the radio system design. The mobile broadband routable internet MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options allow a mobile broadband routable internet network to be deployable to a range of many more candidate real estate locations for fixed site installation in a rural area than other field deployed radio networks. Thus, an optimal subset from this larger set of candidate locations can be selected that can meet the lowest cost, easiest to install and also satisfy network radio propagation and performance requirements. For example, providing wireless network coverage in a rural area may be as simple as establishing a mobile broadband routable internet in the rural area, where the distances between fixed site installations may be relatively large.

[00318] In an embodiment, a mobile broadband internet network solution may facilitate efficient connection to other wired telecommunications infrastructures required for connection to other networks, such as in an environment where users are sparse. The mobile broadband routable internet may facilitate the connection by providing an IP-compatible plug connection to at least one wired infrastructure type. Where field deployed radio networks require connection to other wired telecommunications infrastructure to effectuate traffic transfer with other networks such as the Internet, the PSTN, other wireless networks, and the like, the availability, location, complexity and cost associated with accessing and equipping the wired telecommunications infrastructure connection points, such as with fiber, copper, coaxial connections of Telcos, MSOs, and the like, to accept connection to the field deployed radio network may be a significant factor affecting field radio network architecture design, deployment planning, deployment and installation, especially in an environment where there are few users utilizing the network. The mobile broadband routable internet MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options facilitate a mobile broadband routable internet network to be deployable to a range of many more candidate real estate locations for fixed site installation in any given geography, such as in a geography comprising sparse users, than other field deployed radio networks while also concurrently satisfying radio propagation and network performance requirements. Thus, the selection of optimal wired network connection points is made easier in that the optimal, lowest cost, easiest to access and upgrade wired infrastructure connection points can be selected from among those available in any given geography. An mobile broadband routable internet field network design can start with the optimal selection of the required wired telecom infrastructure BAP connection points for the specified network backhaul capacity in any given geography and then proceed to the selection of the remainder of optimal MAP points. This is the reverse of how field radio network systems are designed today, where optimal radio propagation coverage may be determined first and then the network backhaul is constructed to meet it at optimal RF based location selections, adding complexity, cost and time. In contrast, the mobile broadband routable internet system flexibility may dramatically increase the options for inexpensive fixed radio location design and deployment, thus allowing for optimal backhaul BAP location selection first and then solving for meeting propagation specifications by deploying the number of MAPs needed at the most efficient locations to do so.

[00319] The deployment and operation of an MBRI network system in each of the following defined physical environment types, or in physical environments where any number of the defined physical environment types may coexist, is novel as the mobile broadband routable internet system deployment design attributes enables a mobile broadband routable internet network system to be uniquely effective and efficient for both deployment and ongoing operation in any combination of the physical environmental conditions defined.

[00320] Environment types may include Earth Topology Environment Types such as: Flat terrains where there are no of very few physical obstructions to radio propagation; hilly terrains where there is moderate earthen based physical obstruction to radio propagation; and mountainous terrains where there is sever earthen based physical obstruction to radio propagation.

[00321] Environment types may include Man-made Infrastructure Environment Types which may include: mobile broadband routable internet enabled network system deployment and operation in metropolitan environments; mobile broadband routable internet enabled network system deployment and operation in suburban environments; mobile broadband routable internet enabled network system deployment and operation in rural environments; locations where skyscraper and dense metro business district where buildings and other infrastructure obstruct radio propagation and sever multi-path effects are encountered; dense mixed business residential metro locations where buildings and other infrastructure moderately obstruct radio propagation and moderate multi-path effects are experienced; dense residential only metro locations where buildings and other infrastructure introduce some radio propagation obstruction and multi-path effects; suburban locations where mixed business and residential buildings and infrastructure introduce some radio propagation obstruction and multi-path effects; and suburban residential only locations where buildings and other infrastructure introduce some radio propagation obstruction and multi-path effects.

[00322] Environment types may include Telecom Infrastructure Environment Types which may include: metro area locations where there is a large amount of wired [copper, coax, fiber, etc.] telecom connectivity infrastructure available [from telcos, MSOs, municipalities, etc] for interconnection with a mobile broadband routable internet deployed network system; metro area locations where there is limited amount of wired [copper, coax, fiber, etc.] telecom connectivity infrastructure available [from telcos, MSOs, municipalities, etc] for interconnection with a mobile broadband routable internet deployed network system; suburban area locations where there is a large amount of wired [copper, coax, fiber, etc.] telecom connectivity infrastructure available [from telcos, MSOs, municipalities, etc] for interconnection with a mobile broadband routable internet deployed network system; and suburban area locations where there is a limited amount of wired [copper, coax, fiber, etc.] telecom connectivity infrastructure available [from telcos, MSOs, municipalities, etc] for interconnection with a mobile broadband routable internet deployed network system.

[00323] Environment types may include Radio Frequency [RF] Interference Environment Types which may include: metro or suburban area locations where there is a large amount of man-made and natural RF interference; metro or suburban area locations where there is a moderate amount of man-made and natural RF interference; and metro or suburban area locations where there is a limited amount of man-made and natural RF interference.

[00324] Environment types may include mobile broadband routable internet MAP and BAP "Hang Point" Environment Types which may include: metro or suburban area locations where there is a large amount of man-made and natural infrastructure available as "hang points" supporting the deployment and installation of mobile broadband routable internet enabled MAP and BAP radio infrastructure units; metro or suburban area locations where there is a moderate amount of man-made and natural infrastructure available as "hang points" supporting the deployment and installation of mobile broadband routable internet enabled MAP and BAP radio infrastructure units; and metro or suburban area locations where there is a limited amount of man-made and natural infrastructure available as "hang points" supporting the deployment and installation of mobile broadband routable internet enabled MAP and BAP radio infrastructure units.

[00325] Environment types may include "Outside/Inside" Environment Types which may include: metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices in outdoor areas; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices in outdoor and indoor areas seamlessly; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices in indoor areas; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside residences; metro or

suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside enterprise offices; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside arenas; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside stadiums; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside race tracks; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside exhibit halls; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices at theme parks; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside hospitals; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside schools; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside trains, subways and rail transit systems; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside tunnels; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside boats; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside automobiles; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside airplanes; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices along highways; and metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to mobile broadband routable internet enabled mobile devices inside and outside at campus locations.

[00326] Environment types may include Demand Environment Types which may include: metro or suburban area locations where the mobile broadband routable internet enabled network system is employed

to provide radio connectivity to many mobile broadband routable internet enabled mobile devices operating concurrently with high device and system data rate throughput; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to few mobile broadband routable internet enabled mobile devices operating concurrently with high device and system data rate throughput; metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to few mobile broadband routable internet enabled mobile devices operating concurrently with low device and system data rate throughput; and metro or suburban area locations where the mobile broadband routable internet enabled network system is employed to provide radio connectivity to many mobile broadband routable internet enabled mobile devices operating concurrently with low device and system data rate throughput.

[00327] Within the mobile broadband routable internet, multiple fixed-network gateway interfaces (such as and without limitation backhaul access points) may connect the mobile ad hoc network to the fixed network. The mobile broadband routable internet may be directed at an academic campus environment. For example and without limitation, a crew team on an academic campus may utilize the mobile ad hoc network by installing mobile devices in their sculls. As the sculls travel along a river, the mobile devices may connect to a series of fixed-network gateway interfaces along the river. Communications from mobile devices may relate to information such as scull position, strokes per minute, and so on. The communications may be directed at a computer on the fixed network that analyzes and/or stores the information. It will be understood that the mobile broadband routable internet may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00328] An automated network design tool may facilitate low cost and fast network design engineering and deployment planning of fixed infrastructure elements of a mobile broadband routable internet. The design and planning may be directed at a city/metro area. There may be highways within the city/metro area. For example and without limitation, the design and planning may be directed at deploying fixed infrastructure elements along the highways. It will be understood that uses of the automated network design tool may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00329] In some embodiments, a mobile broadband routable internet may be deployed quickly, at low cost, and with fast network turn-up within an environment of spectral conditions and sparse users. For example and without limitation, rapid deployment may include dropping access points from an airplane, manually emplacing access points, embedding the access points in manned or unmanned aerial vehicles that fly substantially overhead the geography, embedding the access points in robots or the like that deploy themselves or are remotely guided into the geography, and so on. Alternatively or additionally, the sparse users' mobile devices may include the ability to communicate with a low earth orbit satellite communications network or the like. Providing such mobile devices to the sparse users may provide quick, low cost

deployment of the mobile broadband routable internet with fast network turn-up. It will be understood that the MBIR may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00330] In some embodiments, a mobile broadband routable internet may be quickly expanded, at low cost, by adding small form factor nodes. Such a mobile broadband routable internet may be used to avoid obstacles. For example and without limitation, in a rural environment obstacles such as irrigation pipes may be obscured (e.g. by tall grass or the like). An operator of a vehicle (e.g. an off-road motorcycle or the like) may have a mobile device in his helmet that can alert him to the location of the irrigation pipes as he drives up on it. A small form factor node may include a geophysical sensor that measures soil moisture. The small form factor node may be installed near an irrigation pipe. The mobile device in the helmet, which may issue an aural proximity alert to the helmet's wearer, may detect communications from the small form factor node then issue the alert. It will be understood that the mobile broadband routable internet may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00331] In some embodiments, a mobile broadband routable internet may make efficient use of existing backbone communications infrastructure. The mobile broadband routable internet may be directed at environments having dense concentrations of users. For example and without limitation, a communications provider may install a backhaul access point that is connected to the existing backbone communications infrastructure. The users may have mobile devices that communicate with other devices via the existing backbone infrastructure by transmitting and receiving signals to/from the backhaul access point. It will be understood that the mobile broadband routable internet may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00332] In some embodiments, a mobile broadband routable internet may be used in an environment of network end-user deployment participation. In some embodiments, the end-users may be so-called intense users that make intensive and/or extensive use of the mobile broadband routable internet. For example and without limitation, the users may install user deployable access points in or around their homes, thus providing wireless broadband Internet to all nodes within communications range of the access point. It will be understood the mobile broadband routable internet may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00333] In some embodiments, a service provider tool may be provided, the service provider tool for managing consumption of at least one device on the ad hoc network of the mobile broadband routable internet in an indoor environment, or any other environment that will be understood. All such environments are within the scope of the present disclosure.

[00334] In some embodiments, full radio resource management functions may be provided in a subscriber's mobile device. The full radio resource management functions may be directed at situations in which the mobile device is transitioning between an indoor environment and an outdoor environment. For

example and without limitation, the mobile device's radio resource may be tuned in one way to accommodate communications in the indoor environment and another way to accommodate communications in the outdoor environment. It will be understood that the full radio resource management functions may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00335] In some embodiments, multi-session functions may be provided in at least one of a plurality of devices of a mobile broadband routable internet. Such devices may communicate via multiple sessions. The multi-session functions may be directed at an in-home market. For example and without limitation, a number of devices provided for use in a home may utilize one session to communicate amongst themselves and another session to communicate with a personal digital assistant used by a homeowner. Communication amongst the devices may be directed at coordinating actions of the devices (e.g. two air conditioners communicate to avoid turning on simultaneously, creating a load that may trip a circuit breaker). Communication with the personal digital assistant may enable a user to view and change the devices' operational states (e.g. on, off, and so on). It will be understood that multi-session functions may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00336] In some embodiments, cost-based routing functions may form and reform links and routes through the mobile broadband routable internet. The cost-based routing functions may be directed at an automotive market. For example and without limitation, in order to prove improved safety automobiles may communicate with one another as nodes in the mobile broadband routable internet. Communications between the automobiles may include vehicle position, velocity, route of travel, and so on. The cost of communications may relate to the urgency with which the communication must occur in order to help avert an accident, traffic, and so on. The routing of communications through the mobile broadband routable internet may be based upon such a cost. It will be understood that cost-base routing functions may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00337] In some embodiments, IP router functions may be provided in a subscriber's mobile device. The IP router functions in the subscriber's mobile devices may be directed at an event environment. For example and without limitation, an event organizer may communicate live video and related data feeds to mobile devices of event participants. The video and feeds may be routed between the mobile devices so that substantially all of the mobile devices can receive them. It will be understood that the IP router functions provided in a subscriber's mobile device could be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00338] In some embodiments, at least one of a plurality of mobile devices in a mobile broadband routable internet may include media access control layer capabilities. The media access control layer capabilities may be directed at a sports arena/stadium environment. Such an environment may contain digital displays (i.e. mobile devices) that receive real-time video or the like. MAC-based filters in the mobile devices may restrict incoming communications to only those communications originating from approved

MAC addresses. It will be understood that media access control layer capabilities may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00339] In some embodiments, route diversity may be provided to support a mobile broadband routable internet network in a transportation/port environment. Route diversity may be based at least on a number of network devices in a geographic area, which provide a diverse selection of routes through which packet communication may travel. For example and without limitation, network devices may become operational or disabled at any time, and countermeasures may be directed against the mobile broadband routable internet network and the network devices during an attack within a transportation/port environment. The route diversity may enable communications to flow through newly operational network devices, around disabled network devices, and in ways that are directed at defeating countermeasures as will be understood by those of ordinary skill in the art. It will be understood that route diversity within a mobile broadband routable internet network may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00340] In some embodiments, layer 2 forwarding may be provided within a mobile broadband routable internet in an exhibit hall environment. For example and without limitation, operators of an exhibit hall environment may contain devices that utilize the layer 2 forwarding to form a virtual private network for secure communications relating to exhibit hall operations. It will be understood that such a mobile broadband routable internet may be directed at use in a variety of environments. All such environments are within the scope of the present disclosure.

[00341] In some embodiments, a node in a mobile broadband routable internet may also communicate with a cellular network through at least one fixed infrastructure element (e.g. a cell tower or the like) while the mobile broadband routable internet is provided outside the cellular network. In such embodiments the node may communicate both through the cellular network and a mobile ad hoc network. The mobile broadband routable internet having the node may be directed at a theme park environment. For example and without limitation, the node may provide communications to operations personnel within the theme park environment via the mobile ad hoc network while also allowing the personnel to make telephone calls via the cellular network. It will be understood that the mobile broadband routable internet having the node may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00342] In some embodiments, IP application deployment may be provided to a device in a mobile broadband routable internet network. The IP application deployment may enabled by data packets that are routed through the mobile ad hoc network. The data packets may be IP packets or the like, and thus the mobile broadband routable internet may provide a mobile Internet-style network. The IP application deployment may be directed at a medical environment. For example and without limitation, medical first responders may have mobile devices that communicate with the mobile broadband routable internet network.

From time to time, software upgrades may be available for the mobile devices. These software upgrades, which may be updates to software for medical first responders, may be provided via the IP application deployment. Generally, the mobile Internet-style network may be directed at a medical environment in which medical devices, mobile devices, or the like communicate via a mobile Internet-style network. It will be understood that IP application deployment and mobile Internet-style networks may be directed at a variety of other environments. All such environments are within the scope of the present disclosure.

[00343] In some embodiments, data packets may be routed through the mobile ad hoc network of a mobile broadband routable internet absent communications with fixed infrastructure elements of the mobile broadband routable internet. Such routing of data packets may be applied within a doctor's office environment. For example and without limitation, a number of devices within a doctor's office may communicate directly with one another absent communications with fixed infrastructure elements. Some of the devices may be imaging devices and other of the devices may display devices, and the communications may convey image data from the imaging devices to the display devices. It will be understood that a variety of environments may benefit from the routing of data packets through the mobile ad hoc network of a mobile broadband routable internet absent communications with fixed infrastructure elements. All such environments are within the scope of the present disclosure.

[00344] In some embodiments, during normal operations the mobile broadband routable internet may provide broadband communications of at least 768 kbit/sec between nodes. In some embodiments, the broadband communications may be available when the nodes are in motion at vehicular speeds. The broadband data communications may be directed at a subway or train environment. For example and without limitation, backhaul access points may be installed within subway or train tunnels to provide broadband communications to the public Internet from within the tunnels. It will be understood that broadband communications may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00345] In some embodiments, communication via the mobile ad hoc network of a mobile broadband routable internet may be directed at a convention market. For example and without limitation, digital displays installed in trade-show booths may utilize the communication to provide timely convention information to trade-show attendees. It will be understood that the communications may be directed at a variety of environments. All such environments are within the scope of the present disclosure.

[00346] In some embodiments, swarm intelligence may determine at least part of at least some routes through a mobile broadband routable internet in an airplane environment. For example and without limitation, passengers in an airplane may use a mobile device to place a phone call. The mobile device may communicate VoIP data packets via the mobile broadband routable internet to another mobile device phone. As nodes or devices join, leave, and move about the mobile broadband routable internet any and all routes through the mobile broadband routable internet may change, become more or less available, and so on. Routes used by the VoIP data packets may follow at least some of the routes determined by the swarm intelligence. It will be understood that swarm intelligence may determine at least part of at least some routes in a mobile broadband routable internet within a variety of environments. All such environments are within the scope of the present disclosure.

[00347] Referring to Fig. 83, a mobile broadband routable internet may be beneficially applied in a variety of markets, some of which are described herein, others of which will be understood, and all of which are within the scope of the present disclosure. Markets 8302 may be enabled on the mobile broadband routable internet by one or more enablers 8298 associated with the mobile broadband routable internet. The markets may include public safety 8302, enterprise 8304, emergency response 8308, consumer 8310, home 8312, state 8314, municipal 8318, conference rooms/convention/tradeshows 8320, traffic management 8322, traffic light 8324, parking meter apps 8328, federal 8330, non-governmental organizations 8323, military 8334, and the like. Enablers associated with the mobile broadband routable internet may include routing prioritization, network support for peer-to-peer traffic, peer to peer connectivity within mobile broadband routable internet, facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-device application deployment (e.g., for web 2.0 apps), distributed data for web apps in the mobile broadband routable internet device, distributed applications, multicast routing , remote network monitoring, control, and upgrade , adaptive transmit power control , FEC on long ip packets, adaptive link data rate , DYSAN - spectrum aware, spectral reuse with high system level throughput, frequency agnostic operation (operation at any frequency), network geo-location , multimedia , time synchronization , seamless outdoor and indoor operation , seamless indoor/outdoor broadband coverage, efficient use of real estate required for fixed radio installation , efficient connection to other wired telecom infrastructure required for connection to other networks , multiple fixed network gateway interfaces , low cost and fast network design engineering and deployment planning , low cost, fast deployment and network turn-up , low cost and fast capacity expansion and network upgrade , efficient use of existing backbone communications infrastructure, network end-user deployment participation , base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, cost-based routing in a subscriber device, fully enabled ip router in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (VPN, etc), internet-equivalent routing to mobile devices outside cellular regime - no need for walled garden or operator control of application deployment), ip application deployment to mobile devices outside cellular regime, mobile internet-style network , entirely local mobile internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local ip-based swarming, and the like.

[00348] In embodiments, an enhancement may be prioritization of public safety-relevant, delay sensitive traffic across the network protocol through priority queuing and priority channel access by differentiating data traffic across the protocol stack. For example, the field of public safety relies heavily on reliable and fast trafficking of data, such as during an investigation, an alert, and the like. In such a case, traffic across the network protocol originating from either end of the public safety dispatcher-officer network is extremely delay sensitive. Prioritization of this traffic is critical. The prioritization of public safety-relevant, delay-sensitive traffic, such as the traffic described herein, may be done by granting prioritized channel access to nodes with delay-sensitive data and sending the delay sensitive data before sending delay tolerant data from the same node. Prioritization may enable the provision of service level performance agreements related to the public safety-relevant traffic.

[00349] In embodiments, an enhancement may be network support for peer-to-peer traffic for a non-governmental organization (NGO). For example, non-governmental organizations often do work in developing countries where infrastructure may be minimal, but mobile subscriber devices may be relatively plentiful. Forming a mobile broadband routable internet amongst these subscriber devices may facilitate the NGO' s ability to engage in peer-to-peer traffic, such as for example, sharing videos, music, developmental subject matter, and the like. Providing network support for peer-to-peer traffic for an NGO without forcing routing through the fixed network may decrease the amount of wireless network capacity required to deliver service to mobile subscribers in the NGO. This may allow the network to offer more service to the NGO with the same amount of capacity.

[00350] In an embodiment, a mobile broadband internet network solution may facilitate direct-to-device application deployment, such as for Web 2.0 applications, in conference rooms, convention halls, trade shows, and the like. Application deployment methods, such as FTP or other file transfer methods may typically be used for application deployment, but the mobile broadband routable internet enables application deployment from any source along a mobile ad-hoc network, thus enabling direct-to-device application deployment, such as for applications specific to a conference rooms, a convention hall, a trade show, and the like. For example, a speaker at a conference may offer an application related to a new mobile programming interface to audience members for immediate download during the speech. By establishing a mobile broadband routable internet in the conference room, the speaker may bypass the PC and facilitate downloading the application directly to devices on the mobile broadband routable internet.

[00351] In an embodiment, a mobile broadband internet network solution may facilitate distributed data for enterprise web applications in a mobile broadband routable internet device within the enterprise environment. The exchange of data structures between web applications and the application server may be facilitated by the mobile broadband routable internet where the network is augmented with subscriber nodes. Data management over a mobile broadband routable internet may be more robust than over a fixed network because of the capabilities of the mobile broadband routable internet described herein. For example,

a company running an enterprise time management application on a mobile device may require use of distributed data, such as data related to client projects, billing rates, and the like. Facilitating the utilization of distributed data by an application on the doctor's may be critical in, for example, rapidly assessing a diagnostic situation.

[00352] In an embodiment, a mobile broadband internet network solution may facilitate multicast routing for traffic management. With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. Multicast routing addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them. In this embodiment, multicast routing may improve efficiency of network capacity for traffic management by avoiding multiple transmissions of common data along a common path. This may allow the network to offer more service related to traffic management with the same capacity. For example, if a central traffic control office wants to send accident alert data to only those traffic officers on duty, multicast routing over the mobile broadband routable internet will enable the traffic control office to send out only a single copy.

[00353] In embodiments, a mobile broadband internet network solution may facilitate remote home network monitoring, control, and upgrade. In this embodiment, remote monitoring of network elements may enable proactive and reactive network maintenance. Remote control may enable reduced cost network upgrades and tuning. Remote upgrade may dramatically reduce labor content of network-wide upgrade. For example, a home-based user need only to be connected to the mobile broadband routable internet in order to receive network upgrades rather than having to connect to a PC or bring a device in to a store.

[00354] In an embodiment, a mobile broadband internet network solution may facilitate adaptive transmit power control for traffic lights. Adaptive transmit power control may reduce the area where the node causes interference to other nodes, allowing more efficient re-use of RF spectrum across network topology. This may support scalability to node densities required for carrier networks. For example, a traffic light may operate in an area densely packed with other devices operating on a radio frequency and node interference may be an issue in communicating with the traffic light. Thus, re-use of the RF spectrum becomes especially attractive if, say, a user needed to communicate with the traffic light in order to modify its timing.

[00355] In an embodiment, a mobile broadband internet network solution may facilitate an adaptive link data rate for parking meter applications. In this embodiment, providing an adaptive link data rate may enable the network to simultaneously deliver capacity and coverage based on individual link conditions. For example, a parking meter located in an area where only a low data rate is supported may be linked along the mobile ad-hoc network to a mobile node located in an area that supports a high data rate. A facility for enabling adaptation of the data rate provided for links among devices within the network may base the adaptation on at least one of the density of devices in the network, the condition of neighboring devices in

the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition, an application requirement, and the like.

[00356] In an embodiment, dynamic spectrum access, as a part of a mobile broadband routable internet may provide spectrum used to communicate wirelessly between nodes changes in a non-pre-determined manner in response to changing network and spectrum conditions, such as in a municipal area. In embodiments, the time scale of dynamics may be typically less than can be supported by engineering analysis, network re-planning, optimization, and the like. Dynamic spectrum access may be able to avoid interference to/from geographically proximate spectrum users, such as is typical in a municipal area, internal or external to their own wireless network. Dynamic spectrum access may also be able to access and utilize spectrum otherwise unavailable for wireless network use. In embodiments, local spectrum decisions may be coordinated and/or communicated using a fixed or logical control channel in an over-the-air wireless network. DYSAN may comprise determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination.

[00357] A wireless network in a municipal area may use dynamic spectrum access that provides a dynamic allocation of wireless spectrum to network nodes. The spectrum may be used to communicate wirelessly between nodes in a non-pre-determined manner in response to changing network and spectrum conditions. Dynamic spectrum access technology may use the methodology of coordination of a collection of wireless nodes to adjust their use of the available RF spectrum. In embodiments, the spectrum may be allocated in response to manual or automated decisions. The spectrum may be allocated in a centralized manner (e.g., network partitioning) or in a distributed manner between individual nodes. The spectrum may be allocated dynamically such that interference to/from geographically proximate spectrum users, such as users in a municipal area, internal or external to the wireless network may be avoided. The local spectrum decisions may be coordinated/communicated using a fixed or logical control channel in the over-the-air wireless network. This may increase the performance of wireless networks by intelligently distributing segments of available radio frequency spectrum to wireless nodes. Dynamic spectrum access may provide an improvement to wireless communications and spectrum management in terms of spectrum access, capacity, planning requirements, ease of use, reliability, avoiding congestion, and the like.

[00358] In this embodiment, a mobile ad-hoc wireless network in a municipal area may be used in conjunction with dynamic spectrum access technology to provide carrier grade quality of service. A collection of wireless nodes in a mobile ad-hoc network may dynamically adapt spectrum usage according to network and spectrum conditions. Individual nodes in the mobile ad-hoc wireless network may make distributed decisions regarding local spectrum usage. In embodiments, quality of service for a mobile ad-hoc wireless network in a municipal area may be measured in terms of the amount of data which the network may successfully transfer from one place to another in a given period of time, and DYSAN may provide this through greater utilization of the available spectrum in a municipal area. In embodiments, the dynamic

spectrum access technology may provide a plurality of network services and attributes such as, coordinated and uncoordinated distributed frequency assignment, fixed or dynamic network coordination control channel, assisted spectrum awareness (knowledge of available spectrum), tunable aggressiveness for co-existence with uncoordinated external networks, policy-driven for time-of-day frequency and geography, partitioning with coordinated external networks, integrated and/or external RF sensor, and the like.

[00359] In an embodiment, a mobile broadband internet network solution may facilitate spectral reuse with high system level throughput for federal use. Spectral reuse involves limiting the geographic area within a sector over which a signal is transmitted so that the same frequency channels may be used again in another sector, such as in an area where the spectrum is crowded. This approach results in a multiplication of the effective capacity of spectrum in a given area. This capability for flexible deployment provides a fully scalable wireless ad-hoc network and substantially reduces the adjacent node interference. The mobile broadband routable internet may enable communicating among the plurality of devices over a radio communication spectrum and reusing portions of the spectrum for communication based on availability of time frequency rectangles within portions of the spectrum. For example, the federal government may be able to preserve certain frequencies of the spectrum, such as for emergency and military use, by implementing spectral reuse over a mobile broadband routable internet for the existing RF frequencies currently in use.

[00360] In an embodiment, a mobile broadband internet network solution may facilitate frequency agnostic operation for military use. For example, a military application in a somewhat remote environment may benefit from establishment of a mobile broadband routable internet to augment wireless coverage, but the application may require a secure frequency. The ability for the mobile broadband routable internet to operate on any frequency may facilitate the military implementation of a secure mobile broadband routable internet in an remote environment.

[00361] In an embodiment, a mobile broadband internet network solution may facilitate network geo-location for emergency response. In this embodiment, providing geo-location of network nodes to the neighboring nodes may facilitate emergency response and may enable location-based services. For example, estimating the position of a node at an unknown location, such as a wireless device carried in the automobile of a person being sought, may involve receiving a location estimate from at least one neighboring node, measuring a geo-observable from at least one neighboring node, estimating the position of the network node, determining if the location estimate is accurate, and sending the location estimate to neighboring nodes, such as to police officers seeking the motorist.

[00362] In an embodiment, a mobile broadband internet network solution may facilitate a multimedia capability for a consumer market. Increased slot rate in communication in a mobile ad-hoc wireless network may facilitate better accommodating carrier grade service delivery of multimedia content in a consumer-based mobile ad-hoc network. In embodiments, slot time is defined as the duration of a single opportunity that may be used for transmission. In an embodiment, an increased slot rate may be used to

transmit data in a mobile ad-hoc wireless network. In an example, the slot rate used may be 1000-2000 slots/sec. An increased slot rate may allow more distinct opportunities for multiple nodes to access the channel. An increased slot rate may also reduce the delay between the opportunities available for the mobile nodes. An increased slot rate means a reduced slot time. A reduced slot time results in more number of devices sharing the network. The reduced slot time also reduces jitter in the network. For example, a video may be streamed to all consumers indicating an interest in Major League baseball. The mobile ad-hoc network used to stream the video may have an increased slot rate to accommodate the number of people attempting to access the video.

[00363] Continuing with multimedia capabilities as a mobile broadband routable internet enhancement, a hybrid frame structure may be used for transmitting data in a consumer-based mobile ad-hoc wireless network. The optimal use of frame structure in data transmission in a wireless ad-hoc network may affect the performance of the network. In an embodiment, a hybrid frame structure with variable slot duration and sub-channelization of bandwidth may be used. In an embodiment, the hybrid frame structure may have a combination of short and long slots (i.e., multiple time duration slot sizes) to simultaneously provide sufficient performance for both delay-sensitive (e.g., VoIP) and high capacity (e.g., broadband data) applications that may be in use in various consumer applications. The slot capacity may be roughly proportional to slot duration, though slot overhead may be reduced for longer slots. This may result in increased slot efficiency for longer slots. The combination of short and long slots in a hybrid frame may provide sufficient opportunities to service multimedia traffic with heterogeneous service requirements using a common radio. In another embodiment, the hybrid frame structure may have a combination of wide and narrow slots (i.e., multiple bandwidth slot sizes) to provide increased transmit opportunities to improve service delivery for delay-sensitive (e.g., VoIP) traffic. In this example, subdividing the channel access bandwidth to allow multiple users to simultaneously transmit in the same overall channel bandwidth may provide more total transmit opportunities for the consumer application. In an example, if dynamic TDMA-based data transmission is used, channel access opportunities for multimedia traffic with heterogeneous delivery requirements may be provided for the consumer-based application.

[00364] In an embodiment, a mobile broadband internet network solution may facilitate seamless indoor and outdoor operation for emergency response. The mobile broadband routable internet indoor premises located CAP [Customer Access Point], indoor premises located MAP [Mesh Access Point] when operationally associated with the outdoor fixed radio MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes enable seamless indoor coverage as indoor located CAPs and MAPs that can reach and connect with outdoor located MAPs and can be employed for indoor network coverage and indoor device connectivity, as well as during the transition from indoors to outdoors and for use outdoors. As

is with the logic of outdoor network design and planning, indoor RF propagation coverage and capacity and network performance requirements may be efficiently achieved with optimal site selection for fixed radio installation using the same data bases, network design logic, associated design tools, and the like. For example, an emergency response situation may require responders to move from an outdoor to an indoor situation over the course of the response and the responder may need to be continuously receiving data from the network. The mobile broadband routable internet facilitates a seamless transition from the outdoor environment to the indoor environment for the emergency responder.

[00365] In an embodiment, a mobile broadband internet network solution may facilitate efficient use of state-controlled real estate required for fixed radio installation. As in any field deployed radio network system, physical sites are required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites to accommodate sufficient fixed radio installation may be a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which is inherent in the radio system design. The mobile broadband routable internet MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options allow a mobile broadband routable internet network to be deployable to a range of many more candidate real estate locations for fixed site installation than other field deployed radio networks. For example, a state-wide deployment of MAPs and BAPs in public areas may be facilitated by selecting an optimal subset from a larger set of candidate locations that may meet the lowest cost, be easiest to install, and also satisfy network radio propagation and performance requirements. The ability to select have more flexibility on selection of real estate may facilitate more rapid approval for installation by the state.

[00366] In an embodiment, a municipal mobile broadband internet network solution may facilitate efficient connection to other wired telecommunications infrastructures required for connection to other networks. The municipal mobile broadband routable internet may facilitate the connection by providing an IP-compatible plug connection to at least one wired infrastructure type. Where field deployed radio networks require connection to other wired telecommunications infrastructure to effectuate traffic transfer with other networks such as the Internet, the PSTN, other wireless networks, and the like, the availability, location, complexity and cost associated with accessing and equipping the wired telecommunications infrastructure connection points, such as with fiber, copper, coaxial connections of Telcos, MSOs, and the like, to accept connection to the field deployed radio network may be a significant factor affecting field radio network architecture design, deployment planning, deployment and installation, especially in an environment where there are few users utilizing the network. The municipal mobile broadband routable internet MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors,

antennae options and powering options facilitate a mobile broadband routable internet network to be deployable to a range of many more candidate real estate locations for fixed site installation in any given geography, such as in a geography comprising sparse users, than other field deployed radio networks while also concurrently satisfying radio propagation and network performance requirements. Thus, the selection of optimal wired network connection points may be made easier in that the optimal, lowest cost, easiest to access and upgrade wired infrastructure connection points may be selected from among those available in any given municipal geography. A municipal mobile broadband routable internet field network design may start with the optimal selection of the required wired telecom infrastructure BAP connection points for the specified network backhaul capacity in the municipal area and then proceed to the selection of the remainder of optimal MAP points. This is the reverse of how field radio network systems are designed today, where optimal radio propagation coverage may be determined first and then the network backhaul is constructed to meet it at optimal RF based location selections, adding complexity, cost and time. In contrast, the mobile broadband routable internet system flexibility may dramatically increase the options for inexpensive fixed radio location design and deployment, thus allowing for optimal backhaul BAP location selection first and then solving for meeting propagation specifications by deploying the number of MAPs needed at the most efficient locations in the municipal area to do so.

[00367] The deployment and operation of a mobile broadband routable internet network system in each of the following defined market types, or in markets where any number of the defined market types may coexist, is novel as the mobile broadband routable internet system design enables a mobile broadband routable internet network system to be uniquely effective and efficient in meeting the needs for each defined market and any combination the defined markets.

[00368] Market Types may include Consumer Market Types which may include: consumer individuals, needs and applications; consumer individuals anywhere; consumer individuals at home; consumer individuals at work; consumer individuals at school; consumer individuals at home, work, and school; consumer individuals and families for communicating, entertainment and leisure; consumer families anywhere.

[00369] Market Types may include Public Safety Market Types which may include police department needs and applications; fire department, needs and applications; fire rescue, needs and applications; first responder, needs and applications; emergency medical service [EMS], needs and applications; municipality based public safety, needs and applications; county-wide based public safety, needs and applications; state-wide based public safety, needs and applications; federal based homeland defense and public safety needs and applications; city administration, needs and applications; municipal parking management applications; municipal traffic management applications; municipal meter reading applications.

[00370] Market Types may include Business Market Types which may include large enterprise markets, needs and applications; small and medium businesses, needs and applications; work-at-home businesses, needs and applications; individual business market segments, needs and applications:

[00371] Market Types may be SIC Codes Based which may include: Automotive; Finance; Aerospace; Electronic Manufacturers; Textile Manufacturers; Retailers; Pharmaceutical Manufacturers; Computer Manufacturers; Petroleum Refiners; Shipping ; Utility Companies.

[00372] Within the mobile broadband routable internet, multiple fixed-network gateway interfaces (such as and without limitation backhaul access points) may connect the mobile ad hoc network to the fixed network. The mobile broadband routable internet may be directed at a public safety market. For example and without limitation, law enforcement personnel may carry communications devices that utilize the mobile ad hoc network to form a virtual private network for secure communications relating to law enforcement operations. It will be understood that such a mobile broadband routable internet may be directed at use in a variety of markets. All such markets are within the scope of the present disclosure.

[00373] An automated network design tool may facilitate low cost and fast network design engineering and deployment planning of fixed infrastructure elements of a mobile broadband routable internet. The design and planning may be directed at an enterprise market. For example and without limitation, a health care enterprise may manage medical records and related information, which may be distributed to nodes of the mobile broadband routable internet according to strict access control rules. The design and planning may include consideration for encryption and authentication requirements, as well as taking into account transmission limits on radiofrequency transmission within certain medical environments of the enterprise. These limits may exist to ensure the proper functioning of health care equipment within a hospital medical environment of the enterprise. It will be understood that uses of the automated network design tool may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00374] In some embodiments, a mobile broadband routable internet may be deployed quickly, at low cost, and with fast network turn-up by deploying a plurality mesh access points to provide network coverage in a geography. The mobile broadband routable internet may be directed at an emergency response market. For example and without limitation, an emergency response agency such as FEMA may rapidly deploy mesh access points to provide network coverage in a disaster area. Rapid deployment may include dropping access points from an airplane, manually emplacing access points, embedding the access points in manned or unmanned aerial vehicles that fly substantially overhead the geography, embedding the access points in robots or the like that deploy themselves or are remotely guided into the geography, and so on. It will be understood that deploying a plurality of mesh access points to provide network coverage in a geography may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00375] In some embodiments, a mobile broadband routable internet may be quickly expanded, at low cost, by adding small form factor nodes. The mobile broadband routable internet may be directed at a consumer market. For example and without limitation, a consumer may wish to have mobile broadband routable internet access within his apartment. The consumer may purchase a small form factor node and then connect the node to a local area network in his apartment. The small form factor node may include a backhaul access points, thus providing the consumer with a mobile broadband routable internet-to-internet bridge within his apartment. Such an installation may expand the mobile broadband routable internet by expanding the geography within which mobile broadband routable internet-to-internet connectivity is available. It will be understood that such an expansion of the mobile broadband routable internet may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00376] In some embodiments, a mobile broadband routable internet may make efficient use of existing backbone communications infrastructure. The mobile broadband routable internet may be directed at a home market. For example and without limitation, a homeowner may have a number of mobile broadband routable internet-enabled devices in his home. Within communications range of these devices, a communications provider may install a backhaul access point that is connected to existing backbone communications infrastructure. The mobile broadband routable internet-devices may communicate with other devices via the existing backbone communications infrastructure by transmitting and receiving signals to/from the backhaul access point. Other examples of the mobile broadband routable internet making efficient use of existing backbone communications infrastructure will be appreciated. It will be understood that the mobile broadband routable internet's making efficient use of existing backbone communications infrastructure may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00377] In some embodiments, a user deployable access point may connect to the mobile broadband routable internet network. The mobile broadband routable internet may be directed at a state market. For example and without limitation, a state may decide to extend broadband access to all citizens of the state. Citizens of the state may install the user deployable access point in or around their homes, thus providing wireless broadband Internet to all nodes within communications range of the access point. A state subsidy or mandate may ensure an adequate density of access points to provide wireless broadband Internet to substantially all citizens in their homes. It will be understood that the user deployable access point may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00378] In some embodiments, a base station controller function may be provided in at least one subscriber's mobile device. The base station controller function may be directed at a municipal market. For example and without limitation, the subscriber's mobile device may include base station and may be communications system installed in a police cruiser. The base station may function in one mode during normal operations (i.e. routine patrol) and another mode during special operations (i.e. response to a 911 call).

The base station controller function may switch the base station between the two modes in response to activation/deactivation of the cruiser's emergency lights. It will be understood that the base station controller function in the subscriber's mobile device may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00379] In some embodiments, a service provider tool may be provided, the service provider tool for managing consumption of at least one device on the ad hoc network of the mobile broadband routable internet. The tool may be directed at a convention market. For example and without limitation, the service provider tool may enable a service provider to allow increased network resource consumption for a device used in the geography of a convention. This may allow increased or enhanced connectivity between participants at the convention. It will be understood that the service provider tool may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00380] In some embodiments, full radio resource management functions may be provided in a subscriber's mobile device. The full radio resource management functions may be directed at a traffic management market. For example and without limitation, the subscriber's mobile device may be a traffic light and the full radio resource management functions may adapt the mobile device so that it utilizes spectrum that is momentarily not utilized by other mobile devices. Communications between such traffic lights may enable synchronization of traffic lights within a geography without disrupting communications of other devices. In some embodiments, swarm intelligence may determine at least part of at least some routes through a mobile broadband routable internet. It will be understood that the full radio resource management functions may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00381] In some embodiments, multi-session functions may be provided in at least one of a plurality of devices of a mobile broadband routable internet. Such devices may communicate via multiple sessions. The multi-session functions may be directed at a traffic light market. For example and without limitation, a traffic light may communicate low-priority synchronization messages on a low-priority session while communicating high-priority emergency messages on a high-priority session. The emergency messages may be transmitted using a protocol that automatically retries delivery of dropped packets (e.g. TCP) while the synchronization messages may be transmitted using a protocol that does not retry delivery of dropped packets (e.g. UDP). It will be understood that the multi-session functions may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00382] In some embodiments, cost-based routing functions may form and reform links and routes through the mobile broadband routable internet. The cost-based routing functions may be directed at a parking meter market. For example and without limitation, in order to provider longer battery life, parking meters that communicate via the mobile broadband routable internet may contain the cost-based routing functions. Such parking meters may be configured to choose low-cost communicating reports of revenue collected or other usage statistics. Such communications may be addressed to an accounting system via the

mobile broadband routable internet. It will be understood that cost-based routing functions may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00383] In some embodiments, a IP router functions may be provided in a subscriber's mobile device. The IP router functions in the subscriber's mobile devices may be directed at a federal market. For example and without limitation, the device may include a surveillance camera that is part of an ad hoc network of federal surveillance cameras. Each of the cameras may transmit data packets containing video data through the ad hoc network, eventually reaching a backhaul access point from which the data packets travel through a fixed network to a central operations center or the like. In order to route the data from the cameras, one or more of the surveillance cameras may use a built-in IP router function that routes the data as appropriate. It will be understood that the IP router functions provided in a subscriber's mobile device could be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00384] In some embodiments, at least one of a plurality of mobile devices in a mobile broadband routable internet may include media access control layer capabilities. The media access control layer capabilities may enable a non-governmental organization (NGO) market. Such a market may involve the use of mobile devices in public relations, consulting, project management, and so on. MAC-based filters may limit communications between the mobile devices of an NGO so that only mobile devices having approved MAC addresses may communicate. It will be understood that media access control layer capabilities may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00385] In some embodiments, route diversity may be provided within a mobile broadband routable internet network to facilitate assurance of packet communication. Route diversity may be based at least on a number of network devices in a geographic area, which provide a diverse selection of routes through which packet communication may travel. The route diversity may be directed at a military market. For example and without limitation, during military operations network devices may become operational or disabled at any time, and countermeasures may be directed against the mobile broadband routable internet network and the network devices. The route diversity may enable communications to flow through newly operational network devices, around disabled network devices, and in ways that are directed at defeating countermeasures as will be understood by those of ordinary skill in the art. It will be understood that route diversity within a mobile broadband routable internet network may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00386] In some embodiments, layer 2 forwarding may be provided within a mobile broadband routable internet, and a device may communicate via said forwarding. Layer 2 forwarding may be directed at a public safety market. For example and without limitation, law enforcement personnel may carry communications devices that utilize the layer 2 forwarding to form a virtual private network for secure communications relating to law enforcement operations. It will be understood that such a mobile broadband

routable internet may be directed at use in a variety of markets. All such markets are within the scope of the present disclosure.

[00387] In some embodiments, a node in a mobile broadband routable internet may also communicate with a cellular network through at least one fixed infrastructure element (e.g. a cell tower or the like) while the mobile broadband routable internet is provided outside the cellular network. In such embodiments the node may communicate both through the cellular network and a mobile ad hoc network. The mobile broadband routable internet having the node may be directed at an enterprise market. It will be understood that the mobile broadband routable internet having the node may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00388] In some embodiments, IP application deployment may be provided to a device in a mobile broadband routable internet network. The IP application deployment may be directed at an emergency response market. For example and without limitation, emergency responders may have mobile devices that communicate with the mobile broadband routable internet network. From time to time, software upgrades may be available for the mobile devices. These software upgrades, which may be updates to software for emergency responders, may be provided via the IP application deployment. It will be understood that IP application deployment may be directed at a variety of other markets. All such markets are within the scope of the present disclosure.

[00389] In some embodiments, data packets may be routed through the mobile ad hoc network of a mobile broadband routable internet. The data packets may be IP packets or the like, and thus the mobile broadband routable internet may provide a mobile Internet-style network. The mobile broadband routable internet may be directed at a consumer market. For example and without limitation, a consumer may have a number of devices in his home (e.g. telephone, computer, television, and so on) that communicate via the Internet-style network. When the telephone rings, it may communicate the number to the television so that the television can display the number. The television may communicate via the Internet-style network to a remote server that provides additional information relating to the phone number (e.g. reverse number lookup and the like). It will be understood that the Internet-style network may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00390] In some embodiments, data packets may be routed through the mobile ad hoc network of a mobile broadband routable internet absent communications with fixed infrastructure elements of the mobile broadband routable internet. Such routing of data packets may be directed at a home market. For example and without limitation, a number of devices within a home may communicate directly with one another absent communications with fixed infrastructure elements. Some of the devices may be light switches and others of the devices may be light controllers. When a person toggles a light switch, the light switch may communicate to a light controller via the mobile broadband routable internet and without communicating via fixed infrastructure elements. The communication may include a command to turn a light on or off. It will be

understood that a variety of markets may benefit from the routing of data packets through the mobile ad hoc network of a mobile broadband routable internet absent communications with fixed infrastructure elements. All such markets are within the scope of the present disclosure.

[00391] In some embodiments, during normal operations the mobile broadband routable internet may provide broadband communications of at least 768 kbit/sec between nodes. In some embodiments, the broadband communications may be available when the nodes are in motion at vehicular speeds. The broadband data communications may be directed at a state market. For example and without limitation, a state may install appropriate access points within automotive and train tunnels to provide broadband communications within all transportation tunnels operated by the state. It will be understood that broadband communications may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00392] In some embodiments, communication via the mobile ad hoc network of a mobile broadband routable internet may be directed at a convention market. For example and without limitation, digital displays installed in trade-show booths may utilize the communication to provide timely convention information to trade-show attendees. It will be understood that the communications may be directed at a variety of markets. All such markets are within the scope of the present disclosure.

[00393] Referring to Fig. 84, a mobile broadband routable internet may be beneficially applied to a variety of management systems, some of which are described herein, others of which will be understood, and all of which are within the scope of the present disclosure. Management systems 8402 may be enabled on the mobile broadband routable internet by one or more enablers 8298 associated with the mobile broadband routable internet. The management systems may include operation support systems (oss) 8404, trouble ticketing systems 8408, deep pack inspection systems 8410, billing systems 8412, accounting systems 8414, supply chain management system 8418, it management systems 8420, point of sale systems 8422, inventory systems 8424, and the like. Enablers associated with the mobile broadband routable internet may include routing prioritization, network support for peer-to-peer traffic, peer to peer connectivity within mobile broadband routable internet, facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-device application deployment (e.g., for web 2.0 apps), distributed data for web apps in the mobile broadband routable internet device, distributed applications, multicast routing , remote network monitoring, control, and upgrade , adaptive transmit power control , FEC on long ip packets, adaptive link data rate , DYSAN - spectrum aware, spectral reuse with high system level throughput, frequency agnostic operation (operation at any frequency), network geo-location , multimedia , time synchronization , seamless outdoor and indoor operation , seamless indoor/outdoor broadband coverage, efficient use of real estate required for fixed radio installation , efficient connection to other wired telecom infrastructure required for connection to other networks , multiple fixed network gateway interfaces , low cost and fast network design engineering and deployment planning , low cost, fast deployment and network turn-up , low cost and fast capacity expansion and network upgrade , efficient use of existing backbone communications infrastructure, network end-user deployment participation , base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, cost-based routing in a subscriber device, fully enabled ip router in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (VPN, etc), internet-equivalent routing to mobile devices outside cellular regime - no need for walled garden or operator control of application deployment), ip application deployment to mobile devices outside cellular regime, mobile internet-style network , entirely local mobile internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local ip-based swarming, and the like.

[00394] In embodiments, an enhancement may be prioritization of delay sensitive traffic in a point-of-sale (POS) system across the network protocol. Prioritization may occur through priority queuing and priority channel access by differentiating data traffic across the protocol stack. For example, POS systems rely on fast trafficking of data, such as during a credit card checkout at an open-air festival, handheld checkout at a busy electronics store, and the like. In such a case, traffic across the network protocol originating from either end of the POS system - credit card approval facility is extremely delay sensitive. Prioritization of this traffic is critical. The prioritization of POS, delay-sensitive traffic, such as the traffic described herein, may be done by granting prioritized channel access to nodes with delay-sensitive data and sending the delay sensitive data before sending delay tolerant data from the same node. Prioritization may enable the provision of service level performance agreements related to the POS system.

[00395] In embodiments, an enhancement may be network support for peer-to-peer traffic for an inventory system. For example, certain inventory systems may utilize wireless devices spread out over a large warehouse facility. Forming an MBRI amongst these devices may facilitate the device's ability to engage in peer-to-peer traffic, such as for example, to share inventory data, replenishment data, and the like. Providing network support for peer-to-peer traffic for an inventory system without forcing routing through the fixed network may decrease the amount of wireless network capacity required to deliver service to devices in the inventory system. This may allow the network to offer more service to the inventory system with the same amount of capacity.

[00396] In embodiments, in contrast to conventional wireless and fixed wired access networks, methods and systems may be provided for a mobile broadband internet network solution for an inventory system where every device in the system and infrastructure node has routing capabilities to allow for intelligent routing decisions enabling intra-network peer to peer communications. Traffic between nodes of the MBRI may not need to leave the mobile ad-hoc network established for the inventory system for routing or switching purposes. Instead, because MBRI may be routing enabled, local traffic, including required

signaling, traffic may stay within the MBRI. For example, local traffic related to inventory, such as inventory of an item in an online retailer's various national warehouses, and the like, may be routed within the MBRI. In addition, because of its unique neighbor discovery management and Adaptive Data Rate and Power Management Capabilities, the MBRI enables local intelligence to be shared across its member nodes leading to the creation and deployment of new classes of services and applications.

[00397] In an embodiment, a mobile broadband internet network solution may facilitate direct-to-device application deployment, such as for Web 2.0 applications, for IT management systems. Application deployment methods, such as FTP or other file transfer methods may typically be used by IT management systems for application deployment, but the MBRI enables application deployment from any source along a mobile ad-hoc network, thus enabling direct-to-device application deployment, such as for applications specific to the IT system being managed. For example, an IT manager may wish to deploy an application for enterprise mobile devices. By establishing an MBRI in association with the IT management system, the IT manager may bypass the need to plug the enterprise mobile device into a PC and facilitate downloading the application directly to devices on the MBRI.

[00398] In an embodiment, a mobile broadband internet network solution may facilitate distributed data for web applications in an MBRI device within an inventory system. The exchange of data structures between web applications and the application server may be facilitated by the MBRI where the network is augmented with device nodes. Data management over an MBRI may be more robust than over a fixed network because of the capabilities of the MBRI described herein. For example, running an inventory management application on a mobile device may require use of distributed data, such as data related to pending orders, backorders, current inventory, and the like. Facilitating the utilization of distributed data by an application on a mobile device of the inventory system MBRI may be critical in, for example, rapidly assessing the need for additional inventory.

[00399] In an embodiment, a mobile broadband internet network solution may facilitate distributed applications in a POS system. A distributed application may be an application made up of distinct components in separate runtime environments. The runtime environments may be on different platforms connected via a MBRI. Application components may be distributed among a plurality of mobile broadband routable internet devices. For example, each MBRI device in a POS system may run a program to track inventory data. A central server may accumulate data from all of the distributed applications to generate a total picture of inventory for regions, products, stores, periods of time, and the like.

[00400] In an embodiment, a mobile broadband internet network solution may facilitate multicast routing for trouble ticketing systems. With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. Multicast routing addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them. In this embodiment, multicast routing may improve efficiency

of network capacity for trouble ticketing systems by avoiding multiple transmissions of common data along a common path. This may allow the network to offer more service related to trouble ticketing with the same capacity. For example, if a trouble ticketing system wants to send out an open ticket alert to only those technicians on duty, multicast routing over the MBRI will enable the trouble ticketing system to send out only a single copy.

[00401] In an embodiment, a mobile broadband internet network solution may facilitate multicast routing for accounting systems. With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. Multicast routing addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them. In this embodiment, multicast routing may improve efficiency of network capacity for accounting systems by avoiding multiple transmissions of common data along a common path. This may allow the network to offer more service related to accounting with the same capacity. For example, if an accounting system wants to send out a billing alert to only those clients with a current bill, multicast routing over the MBRI will enable the accounting system to send out only a single copy.

[00402] In embodiments, a mobile broadband internet network solution may facilitate remote network monitoring, control, and upgrade for operation support systems (oss). In this embodiment, remote monitoring of network elements may enable proactive and reactive network maintenance. Remote control may enable reduced cost network upgrades and tuning. Remote upgrade may dramatically reduce labor content of network-wide upgrade. For example, an oss need only to deploy an operational upgrade over an MBRI rather than having to connect the target mobile device to a PC or bring the device in to a store.

[00403] In an embodiment, a mobile broadband internet network solution may facilitate adaptive transmit power control for a point of sale system. Adaptive transmit power control may reduce the area where the node causes interference to other nodes, allowing more efficient re-use of RF spectrum across network topology. This may support scalability to node densities required for carrier networks. For example, a POS may operate in an area densely packed with other devices operating on a radio frequency and node interference may be an issue in communicating with the POS system. Thus, re-use of the RF spectrum becomes especially attractive if, say, a POS needed to communicate with the POS system in order to modify its firmware, upload sales data, and the like.

[00404] In an embodiment, a mobile broadband internet network solution may facilitate an adaptive link data rate for billing systems. In this embodiment, providing an adaptive link data rate may enable the network to simultaneously deliver capacity and coverage based on individual link conditions. For example, a billing system located in an area where only a low data rate is supported may be linked along the mobile ad-hoc network to a mobile node located in an area that supports a high data rate. A facility for enabling adaptation of the data rate provided for links among devices within the network may base the

adaptation on at least one of the density of devices in the network, the condition of neighboring devices in the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition, an application requirement, and the like.

[00405] In an embodiment, a mobile broadband internet network solution may facilitate network geo-location for inventory systems. In this embodiment, providing geo-location of network nodes to the neighboring nodes may facilitate inventory accounting and may enable location-based services. For example, estimating the position of a node at an unknown location, such as a shipment of inventory, may involve receiving a location estimate from at least one neighboring node, measuring a geo-observable from at least one neighboring node, estimating the position of the network node, determining if the location estimate is accurate, and sending the location estimate to neighboring nodes, such as to a warehouse expecting the shipment.

[00406] In an embodiment, a mobile broadband internet network solution may facilitate time synchronization for deep pack inspection (DPI) systems. DPI has the potential of inspecting and prioritizing every single packet in up to a million simultaneous real-time connections while maintaining high network speeds. DPI has the potential to scan for viruses, collect information for law enforcement analysis, and to selectively deny service. DPI may relate to network neutrality because of its capability of selectively allowing content and giving priority to selective content. DPI has the capability of collecting an enormous amount of user data, which could be stored, analyzed and sold. The access points in a mobile ad-hoc network of a deep pack inspection system may have knowledge of network timing to insignificant levels compared to the timing needs. A method for enabling timing synchronization may include communicating a sense of network timing at all the nodes with sufficient accuracy to enable reliable communications. The network timing may include slot timing and carrier frequency timing. In an aspect of the present invention, it may be assumed that each node may be designed so that the slot timing and the carrier frequency is derived from the same local reference. In an example, frequency error in the slot timing may be directly proportional to the carrier frequency error. The carrier frequency may be an integer multiple of slot rate. In an example, the slot rate may be IkHz. Certain user nodes may use certain access points for obtaining timing information for synchronization. Other user nodes may use an indirect approach by obtaining the timing information derived from the user nodes using access points for synchronization. In an embodiment, the timing information may be obtained by comparing the incoming packet timing relative to the local timing reference. In this embodiment, the relative timing of all of the neighbor nodes may be tracked and the local node timing is set to match the mean of these tracked times. The tracking may be accomplished using a Kalman filter with two states. In an example, the two states may be the time offset of the slot and the incoming carrier frequency (the number of states may be increased and the delay as an additional state may be introduced later). This method may be used by each node to synchronize to the network time and estimate the error in this local timing

reference. For example, DPI may be facilitated by time synchronization methods, such as after the DPI prioritizes a packet, it may be sent along a link not experiencing a delay in time synchronicity.

[00407] Continuing with time synchronization as an MBRI enhancement, a topology for evaluating an algorithm that may be applied to a deep pack inspection system, where the algorithm estimates the relative time of each node, corrects for time offsets and estimates the delays of each link in the network. Time synchronization among nodes of the network may be provided by communicating a representation of network timing at all the nodes with sufficient accuracy to enable reliable communications

[00408] In an embodiment, a mobile broadband internet network solution may facilitate seamless indoor and outdoor operation for a supply chain management system. The MBRI indoor premises located CAP [Customer Access Point], indoor premises located MAP [Mesh Access Point] when operationally associated with the outdoor fixed radio MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes enable seamless indoor coverage as indoor located CAPs and MAPs that can reach and connect with outdoor located MAPs and can be employed for indoor network coverage and indoor device connectivity, as well as during the transition from indoors to outdoors and for use outdoors. As is with the logic of outdoor network design and planning, indoor RF propagation coverage and capacity and network performance requirements may be efficiently achieved with optimal site selection for fixed radio installation using the same data bases, network design logic, associated design tools, and the like. For example, a supply chain management system may track a resource beginning with the ecological and biological regulation of natural resources, followed by the human extraction of raw material and followed by several production links before reaching the end consumer. Managing such a diverse supply chain, such as a paper production facility where supply begins outdoors with trees in a forest, a truck ride for the trees to a mill, and ends up at an indoor processing facility, requires that the network be available at both the outdoor segments of the supply chain but also the indoor components. The MBRI facilitates a seamless transition from the outdoor environment to the indoor environment for the supply chain management system.

[00409] In an embodiment, a mobile broadband internet network solution may facilitate efficient use of real estate required for fixed radio installation for a POS system. As in any field deployed radio network system, physical sites are required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites to accommodate sufficient fixed radio installation may be a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which may be inherent in the radio system design. The MBRI MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options

may allow an MBRI network to be deployable to a range of many more candidate real estate locations for fixed site installation than other field deployed radio networks. For example, a deployment of MAPs and BAPs in public areas, such as for a mall-wide POS system, may be facilitated by selecting an optimal subset from a larger set of candidate locations that may meet the lowest cost, be easiest to install, and also satisfy network radio propagation and performance requirements.

[00410] A mobile broadband routable internet may be beneficially applied to a variety of management systems, some of which are described herein, others of which will be understood, and all of which are within the scope of the present disclosure. Management systems may be enabled on the mobile broadband routable internet by one or more enablers associated with the mobile broadband routable internet. The management systems may include operation support systems (oss), trouble ticketing systems, deep pack inspection systems, billing systems, accounting systems, supply chain management systems, it management systems, point of sale systems, inventory systems, and the like. Enablers associated with the mobile broadband routable internet may include routing prioritization, network support for peer-to-peer traffic, peer to peer connectivity within mobile broadband routable internet, facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-device application deployment (e.g., for web 2.0 apps), distributed data for web apps in the mobile broadband routable internet device, distributed applications, multicast routing , remote network monitoring, control, and upgrade , adaptive transmit power control , FEC on long ip packets, adaptive link data rate , DYSAN - spectrum aware, spectral reuse with high system level throughput, frequency agnostic operation (operation at any frequency), network geo-location , multimedia , time synchronization , seamless outdoor and indoor operation , seamless indoor/outdoor broadband coverage, efficient use of real estate required for fixed radio installation , efficient connection to other wired telecom infrastructure required for connection to other networks , multiple fixed network gateway interfaces , low cost and fast network design engineering and deployment planning , low cost, fast deployment and network turn-up , low cost and fast capacity expansion and network upgrade , efficient use of existing backbone communications infrastructure, network end-user deployment participation , base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, cost-based routing in a subscriber device, fully enabled ip router in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (VPN, etc), internet-equivalent routing to mobile devices outside cellular regime - no need for walled garden or operator control of application deployment), ip application deployment to mobile devices outside cellular regime, mobile internet- style network , entirely local mobile internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local ip-based swarming, and the like.

[00411] In embodiments, an enhancement may be prioritization of delay sensitive traffic in a point-of-sale (POS) system across the network protocol. Prioritization may occur through priority queuing and priority channel access by differentiating data traffic across the protocol stack. For example, POS systems rely on fast trafficking of data, such as during a credit card checkout at an open-air festival, handheld checkout at a busy electronics store, and the like. In such a case, traffic across the network protocol originating from either end of the POS system - credit card approval facility is extremely delay sensitive. Prioritization of this traffic is critical. The prioritization of POS, delay-sensitive traffic, such as the traffic described herein, may be done by granting prioritized channel access to nodes with delay-sensitive data and sending the delay sensitive data before sending delay tolerant data from the same node. Prioritization may enable the provision of service level performance agreements related to the POS system.

[00412] In embodiments, an enhancement may be network support for peer-to-peer traffic for an inventory system. For example, certain inventory systems may utilize wireless devices spread out over a large warehouse facility. Forming an MBRI amongst these devices may facilitate the device's ability to engage in peer-to-peer traffic, such as for example, to share inventory data, replenishment data, and the like. Providing network support for peer-to-peer traffic for an inventory system without forcing routing through the fixed network may decrease the amount of wireless network capacity required to deliver service to devices in the inventory system. This may allow the network to offer more service to the inventory system with the same amount of capacity.

[00413] In embodiments, in contrast to conventional wireless and fixed wired access networks, methods and systems may be provided for a mobile broadband internet network solution for an inventory system where every device in the system and infrastructure node has routing capabilities to allow for intelligent routing decisions enabling intra-network peer to peer communications. Traffic between nodes of the MBRI may not need to leave the mobile ad-hoc network established for the inventory system for routing or switching purposes. Instead, because MBRI may be routing enabled, local traffic, including required signaling, traffic may stay within the MBRI. For example, local traffic related to inventory, such as inventory of an item in an online retailer's various national warehouses, and the like, may be routed within the MBRI. In addition, because of its unique neighbor discovery management and Adaptive Data Rate and Power Management Capabilities, the MBRI enables local intelligence to be shared across its member nodes leading to the creation and deployment of new classes of services and applications.

[00414] In an embodiment, a mobile broadband internet network solution may facilitate direct-to-device application deployment, such as for Web 2.0 applications, for IT management systems. Application deployment methods, such as FTP or other file transfer methods may typically be used by IT management systems for application deployment, but the MBRI enables application deployment from any source along a mobile ad-hoc network, thus enabling direct-to-device application deployment, such as for applications specific to the IT system being managed. For example, an IT manager may wish to deploy an application for

enterprise mobile devices. By establishing an MBRI in association with the IT management system, the IT manager may bypass the need to plug the enterprise mobile device into a PC and facilitate downloading the application directly to devices on the MBRI.

[00415] In an embodiment, a mobile broadband internet network solution may facilitate distributed data for web applications in an MBRI device within an inventory system. The exchange of data structures between web applications and the application server may be facilitated by the MBRI where the network is augmented with device nodes. Data management over an MBRI may be more robust than over a fixed network because of the capabilities of the MBRI described herein. For example, running an inventory management application on a mobile device may require use of distributed data, such as data related to pending orders, backorders, current inventory, and the like. Facilitating the utilization of distributed data by an application on a mobile device of the inventory system MBRI may be critical in, for example, rapidly assessing the need for additional inventory.

[00416] In an embodiment, a mobile broadband internet network solution may facilitate distributed applications in a POS system. A distributed application may be an application made up of distinct components in separate runtime environments. The runtime environments may be on different platforms connected via a MBRI. Application components may be distributed among a plurality of mobile broadband routable internet devices. For example, each MBRI device in a POS system may run a program to track inventory data. A central server may accumulate data from all of the distributed applications to generate a total picture of inventory for regions, products, stores, periods of time, and the like.

[00417] In an embodiment, a mobile broadband internet network solution may facilitate multicast routing for trouble ticketing systems. With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. Multicast routing addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them. In this embodiment, multicast routing may improve efficiency of network capacity for trouble ticketing systems by avoiding multiple transmissions of common data along a common path. This may allow the network to offer more service related to trouble ticketing with the same capacity. For example, if a trouble ticketing system wants to send out an open ticket alert to only those technicians on duty, multicast routing over the MBRI will enable the trouble ticketing system to send out only a single copy.

[00418] In an embodiment, a mobile broadband internet network solution may facilitate multicast routing for accounting systems. With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. Multicast routing addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them. In this embodiment, multicast routing may improve efficiency of network capacity for accounting systems by avoiding multiple transmissions of common data along a

common path. This may allow the network to offer more service related to accounting with the same capacity. For example, if an accounting system wants to send out a billing alert to only those clients with a current bill, multicast routing over the MBRI will enable the accounting system to send out only a single copy.

[00419] In embodiments, a mobile broadband internet network solution may facilitate remote network monitoring, control, and upgrade for operation support systems (oss). In this embodiment, remote monitoring of network elements may enable proactive and reactive network maintenance. Remote control may enable reduced cost network upgrades and tuning. Remote upgrade may dramatically reduce labor content of network-wide upgrade. For example, an oss need only to deploy an operational upgrade over an MBRI rather than having to connect the target mobile device to a PC or bring the device in to a store.

[00420] In an embodiment, a mobile broadband internet network solution may facilitate adaptive transmit power control for a point of sale system. Adaptive transmit power control may reduce the area where the node causes interference to other nodes, allowing more efficient re-use of RF spectrum across network topology. This may support scalability to node densities required for carrier networks. For example, a POS may operate in an area densely packed with other devices operating on a radio frequency and node interference may be an issue in communicating with the POS system. Thus, re-use of the RF spectrum becomes especially attractive if, say, a POS needed to communicate with the POS system in order to modify its firmware, upload sales data, and the like.

[00421] In an embodiment, a mobile broadband internet network solution may facilitate an adaptive link data rate for billing systems. In this embodiment, providing an adaptive link data rate may enable the network to simultaneously deliver capacity and coverage based on individual link conditions. For example, a billing system located in an area where only a low data rate is supported may be linked along the mobile ad-hoc network to a mobile node located in an area that supports a high data rate. A facility for enabling adaptation of the data rate provided for links among devices within the network may base the adaptation on at least one of the density of devices in the network, the condition of neighboring devices in the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition, an application requirement, and the like.

[00422] In an embodiment, a mobile broadband internet network solution may facilitate network geo-location for inventory systems. In this embodiment, providing geo-location of network nodes to the neighboring nodes may facilitate inventory accounting and may enable location-based services. For example, estimating the position of a node at an unknown location, such as a shipment of inventory, may involve receiving a location estimate from at least one neighboring node, measuring a geo-observable from at least one neighboring node, estimating the position of the network node, determining if the location estimate is accurate, and sending the location estimate to neighboring nodes, such as to a warehouse expecting the shipment.

[00423] In an embodiment, a mobile broadband internet network solution may facilitate time synchronization for deep pack inspection (DPI) systems. DPI has the potential of inspecting and prioritizing every single packet in up to a million simultaneous real-time connections while maintaining high network speeds. DPI has the potential to scan for viruses, collect information for law enforcement analysis, and to selectively deny service. DPI may relate to network neutrality because of its capability of selectively allowing content and giving priority to selective content. DPI has the capability of collecting an enormous amount of user data, which could be stored, analyzed and sold. The access points in a mobile ad-hoc network of a deep pack inspection system may have knowledge of network timing to insignificant levels compared to the timing needs. A method for enabling timing synchronization may include communicating a sense of network timing at all the nodes with sufficient accuracy to enable reliable communications. The network timing may include slot timing and carrier frequency timing. In an aspect of the present invention, it may be assumed that each node may be designed so that the slot timing and the carrier frequency is derived from the same local reference. In an example, frequency error in the slot timing may be directly proportional to the carrier frequency error. The carrier frequency may be an integer multiple of slot rate. In an example, the slot rate may be IkHz. Certain user nodes may use certain access points for obtaining timing information for synchronization. Other user nodes may use an indirect approach by obtaining the timing information derived from the user nodes using access points for synchronization. In an embodiment, the timing information may be obtained by comparing the incoming packet timing relative to the local timing reference. In this embodiment, the relative timing of all of the neighbor nodes may be tracked and the local node timing is set to match the mean of these tracked times. The tracking may be accomplished using a Kalman filter with two states. In an example, the two states may be the time offset of the slot and the incoming carrier frequency (the number of states may be increased and the delay as an additional state may be introduced later). This method may be used by each node to synchronize to the network time and estimate the error in this local timing reference. For example, DPI may be facilitated by time synchronization methods, such as after the DPI prioritizes a packet, it may be sent along a link not experiencing a delay in time synchronicity.

[00424] Continuing with time synchronization as an MBRI enhancement, a topology for evaluating an algorithm that may be applied to a deep pack inspection system, where the algorithm estimates the relative time of each node, corrects for time offsets and estimates the delays of each link in the network. Time synchronization among nodes of the network may be provided by communicating a representation of network timing at all the nodes with sufficient accuracy to enable reliable communications

[00425] In an embodiment, a mobile broadband internet network solution may facilitate seamless indoor and outdoor operation for a supply chain management system. The MBRI indoor premises located CAP [Customer Access Point], indoor premises located MAP [Mesh Access Point] when operationally associated with the outdoor fixed radio MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing

capabilities, size, weight, form-factors, antennae options and powering, including its ad-hoc, self-healing and self-forming attributes enable seamless indoor coverage as indoor located CAPs and MAPs that can reach and connect with outdoor located MAPs and can be employed for indoor network coverage and indoor device connectivity, as well as during the transition from indoors to outdoors and for use outdoors. As is with the logic of outdoor network design and planning, indoor RF propagation coverage and capacity and network performance requirements may be efficiently achieved with optimal site selection for fixed radio installation using the same data bases, network design logic, associated design tools, and the like. For example, a supply chain management system may track a resource beginning with the ecological and biological regulation of natural resources, followed by the human extraction of raw material and followed by several production links before reaching the end consumer. Managing such a diverse supply chain, such as a paper production facility where supply begins outdoors with trees in a forest, a truck ride for the trees to a mill, and ends up at an indoor processing facility, requires that the network be available at both the outdoor segments of the supply chain but also the indoor components. The MBRI facilitates a seamless transition from the outdoor environment to the indoor environment for the supply chain management system.

[00426] In an embodiment, a mobile broadband internet network solution may facilitate efficient use of real estate required for fixed radio installation for a POS system. As in any field deployed radio network system, physical sites are required to deploy fixed radios that connect to end-user devices and backhaul traffic to and from end-user devices and other networks. The availability of suitable real estate sites to accommodate sufficient fixed radio installation may be a function of radio size, weight, power requirements, the inter-radio networking scheme including, radiated power, propagation and routing, and the like, all of which may be inherent in the radio system design. The MBRI MAP [Mesh Access Point] and BAP [Backhaul Access Point] access side and backhaul side mesh routing capabilities, backhaul load balancing, RF propagation and routing capabilities, size, weight, form-factors, antennae options and powering options may allow an MBRI network to be deployable to a range of many more candidate real estate locations for fixed site installation than other field deployed radio networks. For example, a deployment of MAPs and BAPs in public areas, such as for a mall-wide POS system, may be facilitated by selecting an optimal subset from a larger set of candidate locations that may meet the lowest cost, be easiest to install, and also satisfy network radio propagation and performance requirements.

[00427] Referring to Fig. 85, mobile broadband routable internet capabilities may enable the use of web based applications 8502, such as searching 8504, swarm based searching 8508, e-commerce 8510, social networking 8512, local searching 8514, distributed computing 8518, video sharing 8520, video conferencing 8522, webinar 8524, navigation 8528, presence 8530, video 8532, music 8534, auctions 8538, local advertisements 8540, surveillance 8542, entertainment 8544, news 8548, books 8550, image searching 8552, traffic 8554, travel , travel booking 8558, action replay 8560, ticketing 8562, and the like. In embodiments, mobile broadband routable internet capabilities that may enable web based applications may include prioritization, network support for peer-to-peer traffic, peer-to-peer connectivity within mobile broadband routable internet, facilitating file sharing and user generated peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-de vice application deployment (e.g., for web 2.0 applications), distributed data for web applications in the mobile broadband routable internet device, distributed applications, multicast routing, removal of network monitoring control and upgrade, adaptive transmit power control, FEC on long IP packets, adaptive link data rate, DYSAN spectrum awareness, spectral reuse with high system level throughput, frequency agnostic operation (e.g., capability to operate at any frequency), network geo-location, multimedia, time synchronization, seamless outdoor and indoor operation, seamless indoor and outdoor broadband coverage, efficient use of real estate required for fixed radio installation, efficient connection to other wired telecom infrastructure required for connection to other networks, multiple fixed network gateway interfaces, low cost and fast network design engineering and deployment planning, low cost fast deployment and network turn-up, low cost and fast capacity expansion and network upgrade, efficient use of existing backbone communications infrastructure, network end-user deployment participation, base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile Internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, least-cost routing in a subscriber device, fully enabled IP routing in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (e.g. VPN, and the like), Internet-equivalent routing to mobile devices outside a cellular regime (such as no need for a walled garden or operator control of application deployment), IP application deployment to mobile devices outside a cellular regime, mobile Internet-style network, entirely local mobile Internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local IP-based swarming, and the like. In embodiments, mobile broadband routable internet may provide for the enablement of web based applications that improve a user's capabilities in a mobile communications environment.

[00428] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with prioritization, where priority may be provided between different types of communications, such as time-sensitive applications vs. non-time-sensitive communications. For example, video conferencing may be a time-sensitive application where mobile broadband routable internet network nodes and access points would provide prioritization in order to help guarantee any quality of service requirements for that user link. For instance, an enterprise user may have subscribed to a video conferencing service with a high quality of service. The high quality of service may be required in order to maintain a smooth rendition of the video conference to users, such as providing video with no delay, interruptions, gaps, jitter, and the like. In order to do this, mobile broadband routable internet network nodes may need to recognize the video conference routed stream of data as being time-sensitive, and provide it with priority over data streams that are not time-sensitive, or have a lower quality of service requirement. An example of a

lower quality of service requirement may be a live cam at a resort that is being fed over the Internet as part of their web page. In this instance, a high quality of service may not be required, and so the resort may not wish to expend financial resorces on the higher quality of service. And example of a non-time-sensitive service may be the normal routing of data across the network, such as application data, which may require prompt delivery, but not at the time resolution requirements of a video conference. So, when a node receives requests for routing the high quality of service video stream at the same time as a low quality of service data stream or non-time-sensitive data, the node may provide prioritization, and route the high quality of service data stream first. In embodiments, prioritization may help provide a high quality of service for mobile broadband routable internet, which may contribute to mobile broadband routable internet carrier-grade performance.

[00429] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with network support for peer-to-peer connectivity within mobile broadband routable internet, where nodes within the mobile broadband routable internet network act as peers that are able to communicate with each other in an equitable fashion, such as all nodes being equally able to initiate communications, control routing, receive communications, process data, and the like. For example, social networking services focus on building online communities of people who share interests and activities, or who are interested in exploring the interests and activities of others. Most social network services are web based and provide a variety of ways for users to interact, such as e-mail and instant messaging services. The ability of mobile broadband routable internet to support peer-to-peer traffic may enable new ways for individuals to interact within a social networking environment. For instance, suppose groups of teenagers are at a concert, and they decide they want to meet new people with similar interests, such as indicated or guided through the use of a social network application. Through the peer-to-peer capabilities of mobile broadband routable internet, these teenagers may be able to establish direct communications with each other through some locally enabled social networking application, such as an application being present on the teenager's devices or distributed amongst all their devices. In this way, the teenagers may not need to directly access server services on the fixed internet, and allow a more dynamic version of social network that may be unique to mobile broadband routable internet.

[00430] Continuing with the example of teenagers at a concert, mobile broadband routable internet may be able to utilize mobile broadband routable internet's ability to provide network support for peer-to-peer traffic as the teenagers perform swarm based searches for information about the concert, such as for individuals at the concert, information about the band, music from the band, entertainment venues for after the concert, and the like. Swarm based searching may involve individuals searching for information within their local swarm, and under the conditions at a concert, the swarm may be large, and the searching may be creating peer-to-peer traffic on a level that requires the nodes to effectively route the incoming traffic through the mobile broadband routable internet network. For instance, multiple searches may be simultaneously multicasting across the local swarm, and the searching may only be made effective through the mobile

broadband routable internet's ability to provide network support for peer-to-peer traffic. In embodiments, without this support, these searches, under these conditions, may congest the network, such as beyond practical use.

[00431] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with direct device-to-device peering with symmetrical throughput, where at the physical layer traffic may be allowed to transit in both directions with equal throughput capabilities. This may be especially important when a user application is interactive, as with on-line entertainment such as an interactive Internet game. For example, in an on-line game a user may be very conscious of any delays that may occur between the user executing some action, and the action being reflected in the game play. This user interaction may require a symmetrical throughput capability in the network links. If one transmission direction or the other becomes slow, this may tend to increase the overall latency in the round trip communication. Through direct device-to-device peering with symmetrical throughput, mobile broadband routable internet may provide for a more homogeneous response time in link-to-link communications throughout the mobile broadband routable internet network, and thus may help eliminate any directional specific delays that might otherwise occur.

[00432] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with distributed applications, where application functions, such as processing, storage, databases, applications, and the like, are provided in a distributed manner across a networked environment. For instance, in embodiments, mobile broadband routable internet may provide for support of distributed computing. Distributed computing may take many different forms, such as distributing parallel processing tasks to a plurality of networked processing nodes, distributing storage of data during processing, distributing user interfaces, and the like. For example, searching the web may be a task that requires processing time that could be shortened if the application where distributed amongst a number of distributed processing mobile broadband routable internet nodes. In this case, an application associated with the execution of a search may be distributed and made quicker. In a more specific example, say the search was for airline flight availability. This is a task that may require the searching of a number of different databases. Through distributed applications support, mobile broadband routable internet may enable this search to be performed in a distributed manner, and thus reduce the time required. In embodiments, mobile broadband routable internet may enable the capability of distributed applications through peer-to-peer interactions, neighbor awareness, intelligent routing, and the like. In embodiments, the ability for mobile broadband routable internet to provide for an intelligent peer-to-peer environment, may provide for increased enablement of distributed applications.

[00433] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with remote network monitoring, control, and upgrade. mobile broadband routable internet may be able provide network elements, such as user device nodes, with monitoring and

control of performance, version, network connections, traffic, application use, and the like. As a result of this monitoring and control, mobile broadband routable internet may be able to provide upgrades to the system to accommodate changing conditions, environments, nodes, and the like, and thus provide a constantly updated system that provides a better optimized performance. For example, a user may be attempting a video connection through the mobile broadband routable internet network, and the user device node may be first connected into the network and evaluated for updates and compatibility. As a result, the user device node may be updated prior to communications on the network. In addition, a user device node may initiate the video connection, and the mobile broadband routable internet system may detect a sub-optimal performance associated with the device, such as due to capabilities that may be updated or upgraded, and as such, the mobile broadband routable internet system may provide for upgrades to enhance the user device's capability to operate through the mobile broadband routable internet system. In embodiments, the mobile broadband routable internet system may be able to provide improved capabilities to a user wishing to utilize a video web application, through remote network monitoring, control, and upgrades.

[00434] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with adaptive transmit power control, where power from a transmitting node may be dynamically adjusted to help optimize performance associated with the node, link, surrounding nodes, and the like. For instance, a transmitting node may increase transmit power to improve the quality of a link, decrease power to reduce interference with neighbor nodes, and the like. As an example, you may imagine a group of students gathered around in a group and sharing music through their mobile broadband routable internet enabled device nodes. In this instance, each member of the group may be transmitting to another member of the group, and so there may be a great deal of transmitting being performed across a short distance between a plurality of nodes. If these nodes didn't sense the proximity of their neighbors, the nodes might transmit at a power level that could cause interference and possible disruption to the other nodes. Through adaptive transmit power control, the nodes may adjust their power level to be appropriate to the communications they are performing, and thus decrease localized interference. Further, should one of the users suddenly initiate a communication to some distance, and so require greater power, the node may be able to adjust the power level for that communication, and then drop back down once the communication has been completed. In embodiments, adaptive power control may allow a mobile broadband routable internet node to adapt to changing communication's conditions, and thus improve the overall performance of the mobile broadband routable internet network.

[00435] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with forward error correction (FEC). FEC is a system of error control for data transmission, whereby the sender adds redundant data to its messages, also known as an error correction code. This allows the receiver to detect and correct errors (within some bound) without the need to ask the sender for additional data. The advantage of forward error correction is that a back-channel is not required, or

that retransmission of data can often be avoided, at the cost of higher bandwidth requirements on average. FEC is therefore applied in situations where retransmissions are relatively costly or impossible. For example, a mobile broadband routable internet network may be experiencing a peak of communications traffic, where retransmissions would only make conditions worse. In this case, the ability for mobile broadband routable internet to support FEC may reduce or eliminate the need for retransmission, and thereby increase the available bandwidth of the mobile broadband routable internet network.

[00436] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with adaptive link data rate, where a mobile broadband routable internet transmitting node may change the link data rates as communications conditions change, such as changes in the environment, data volume, quality of service requirements, and the like. For instance, a user device node may be interfacing with a news service, where the data provided by the news service may vary depending on the format of the content. For example, the format may be low data volumes associated with a text story, and as such, the link rates may be required to be quite low in order to provide a quality communications link with low latency. However, the user may then click on a video link associated with the news service, where suddenly the data rate requirements become very high. Rather than provide the node with a constant link data rate, which may be too low or too high, mobile broadband routable internet may provide for adaptive link data rate, where the link may be adjusted to be appropriate to the requirements of the current link. In this way, mobile broadband routable internet may be able to dynamically allocate data rate resources amongst the nodes and links in order to better maintain high performance across the network. In embodiments, mobile broadband routable internet may implement adaptive data rate facilities in conjunction with adaptive transmit power control in order to better control the communications resources associated with the network.

[00437] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with DYSAN, where node to node links may be provided with the ability to dynamically change link frequencies to accommodate changes in radio spectral performance in the local area. Changes in radio spectral performance may be due to changes in the weather, the physical structures near the transmitting and/or receiving node, changes in location, and the like. For example, a user device node may be mobile in a vehicle performing a navigation application. This navigation application may require a constant data link for some functionality, such as real-time navigation, transmission of updates, location determination, and the like. However, the vehicle is likely to be changing locations, and the radio spectral conditions may vary as the location changes. This may be particularly the case for driving in a city. Through DYSAN, mobile broadband routable internet may be able to dynamically change the operating frequency of the link in order to accommodate the changes in the radio spectrum response in the immediate area. For instance, the operating frequency being used may suddenly be absorbed or reflected by a structure, such as a building, as the vehicle traverses a road network through a mobile broadband routable internet network. As this change in spectrum response occurs, the vehicle's transmitting node may utilize DYSAN to dynamically switch

between frequencies in order to maintain the integrity of the communications link. In embodiments, mobile broadband routable internet's use of DYSAN may provide a more robust network of communication links for the implementation of web based applications.

[00438] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with spectral reuse with high system level throughput, which may be related to DYSAN as described herein. The ability of mobile broadband routable internet to provide for spectrum reuse may provide for a greater utilization of available frequencies and bandwidth as they become available or needed. For example, an enterprise may decide to provide a webinar as a cost effective way for them to teach prospective clients about their product. This webinar, utilizing mobile broadband routable internet, may have some mobile component to it, such as clients using the product in the field as a part of the presentation. However a webinar, likely to be a live dialog between representatives of the enterprise and the client participants, may require a high quality of service. And wherein a high quality of service may entail a number of different aspects associated with providing that service, one may be the need to be flexible to the use and reuse of spectral bands in order to help guarantee a high system level of throughput. For instance, as clients in the field move about, spectrum usage may have to change in order to adjust to changing communications conditions such as for foliage, structures, weather, RF interference, and the like. In embodiments, mobile broadband routable internet may provide for a greater quality of service through the use of spectral reuse.

[00439] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with being frequency agnostic in its operation, that is, mobile broadband routable internet may be able to operate at a plurality of frequencies. For example, mobile broadband routable internet may be used in mobile surveillance web applications, where certain frequencies may already be used or allocated to other uses or applications. mobile broadband routable internet may provide the flexibility to operate at different frequencies, and so for a given application, such as the example of a mobile surveillance web application, mobile broadband routable internet may be adjusted to operate in a selected band. In addition, through capabilities such as DYSAN, mobile broadband routable internet may be able to switch between these selected bands and other bands, such as bands that are operating at another portion of the network, or at an access point. In embodiments, mobile broadband routable internet's ability to operate at any frequency may provide mobile broadband routable internet greater flexibility in accommodating the needs of unique applications.

[00440] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with geo-location, such as an application that locates the position of a node to other nodes, the location of all nodes in a swarm, the tracking of a node within the swarm, the location of one node relative to the location of another node, and the like. For example, air travelers often find themselves changing travel plans while on a trip, and having to change their flight reservations. With mobile broadband routable internet's ability to determine the location of a node, a travel or booking application may

be able to greatly narrow the choices that are to be presented to the traveler associated with such rebooking. For instance, if the traveler is in the airport, the travel application can immediately provide only those airline resources available at that airport. This may greatly decrease the time required for the traveler to locate the information that they seek within the application. Alternately, if a traveler is located in a city associated with multiple airports, such as New York City, and the traveler is not located near any particular one, the travel application may know to provide the traveler with information associated with all the airports. In embodiments, the travel or booking application may be able to provide the traveler a plurality of services associated with geo-location, such as locating another traveler, locating a ticketing kiosk, locating a gate, and the like. In embodiments, the ability for mobile broadband routable internet to provide network geo-location may provide a useful enhancement to the mobile user device within a mobile broadband routable internet networked environment.

[00441] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with multimedia, such as playback or real-time presentation of shows, concerts, games, sports, and the like. Multimedia applications may provide streaming media to mobile broadband routable internet enabled nodes through such capabilities as adaptive link data, DYSAN, adaptive power transmission, neighbor awareness, intelligent routing, and the like. In embodiments, mobile broadband routable internet may also provide some multimedia application capabilities through data storage, both at the individual node level as well as across the local swarm of nodes. Through data storage, mobile broadband routable internet may be enable to implement delayed playback, or replay of some action. For instance, a user watching a multimedia streaming sports event on their mobile device node, may be able replay the action previously seen, such as through the device node keeping a certain amount of most recent streamed data in local (e.g. on the individual node) or distributed storage (e.g. across a number of local nodes) for replay. In embodiments, multimedia web applications may enable mobile users improved capabilities through mobile broadband routable internet functionality.

[00442] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with time synchronization, where the time and timing of events are in sync across the network, such as across the local swarm, relative to one another node, in synchronization with the wired Internet, and the like. For instance, time synchronization is essential for many web applications that rely on the time or relative time as associated with user events. And so the ability for the mobile broadband routable internet network to maintain time synchronicity across all the nodes in the mobile broadband routable internet network may provide an important element in the success of such an application. For example, consider a group of individuals playing an interactive on-line game across the mobile broadband routable internet network. The actions of all members of the game may need to be accurately time stamped in order for the game to assign relative time behavior and response to individual game players within the action of the game. In embodiments, each node must therefore have the ability to provide time tags that are the same

for all nodes, thus the need for time synchronization across the entire network. In embodiments, time synchronization may provide time coherence to the mobile broadband routable internet, such that applications can rely on time tags provided to be consistent and reliable.

[00443] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with seamless indoor and outdoor operation, where the transition of the network between indoor and outdoor environments may be made through access points. For instance, a user that begins to access the mobile broadband routable internet network indoors, and then walk outside, may experience a seamless transition, and thus not experience any disruption during the transition. A user may for example access the morning traffic conditions on their mobile device node while inside their home, and then walk outside to their car to begin their commute. The user may do this in order to initiate the traffic application inside the house while their hands are free, and then carry the device out to the car to continue to monitor traffic during their commute. In embodiments, in order to implement this, mobile broadband routable internet access points may be placed both inside and outside, where the two access points may be wired together, and possibly connected to the wired internet. In embodiments, the mobile broadband routable internet's continuous connectivity across indoor and outdoor environments may help to provide the mobile broadband routable internet as a truly mobile extension of the Internet.

[00444] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with seamless indoor and outdoor broadband coverage, where the transition of connectivity from indoor to outdoor environments may include the continuous supply of broadband coverage. Again, as with the general case of seamless indoor and outdoor operation, the seamless transition of broadband coverage inside to broadband coverage outside may be provided through access points both inside and outside. For example, a user may be searching for images that are typically large files, such that in the absence of a broadband link may download too slowly to be practical. Here, the access points provided inside and outside may be provided as broadband access points, along with any other fixed nodes meant to extend either the network inside or outside. In this manner, the user accessing large image files as a result of searching may be provided a seamless broadband connection, and thus not experience any disruption associated with transitioning between inside and outside environments.

[00445] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with efficient use of real estate required for fixed radio installation, such as buildings, traffic control instillations, telephone and power line distribution structures, and the like. The use of existing real estate may provide a convenient way for installation of fixed radio access points in order to provide spanning and connectivity connection points for use in establishing the MRBI network and connection to the fixed Internet and other telecommunication facilities. As an example, consider a ticketing facility, such as one that normally involves lines to a window where the ticket provider, through a wired connection to the ticketing application on the Internet, sells people tickets by hand. However, many people

coming in for tickets may have mobile devices that are nodes on the mobile broadband routable internet, and so by installing an access point in the room of the existing ticketing facility, those mobile broadband routable internet users may be enabled for purchasing tickets through the mobile broadband routable internet connection. In embodiments, there is a great variety of examples of how existing real estate may be used to provide fixed radio access points for mobile broadband routable internet web applications, involving connections both inside and outside existing structures.

[00446] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with the efficient connection to other wired telecommunications infrastructure required for connection to other networks. These connections, for instance, may be provided through BAP access points. For example, a mobile broadband routable internet swarm may be connected together through links from node to node, such as from mobile nodes to mobile nodes, mobile nodes to fixed nodes, and the like. The connection from the local area mobile broadband routable internet swarm may then be connected to other wired telecommunications infrastructure through BAP connection points, where the BAP connects to wired connections such as a LAN, WAN, fiber connection point, through a microwave facility, through a cellular facility, and the like. In an example, a user may be performing a local search for a restaurant in town, and is operating within a mobile broadband routable internet swarm. Information about the restaurant may not however to be found within the local swarm, and requires connection to the fixed Internet. The mobile broadband routable internet may provide such a connection through the BAP, where the mobile broadband routable internet connection may be connected to the fixed Internet, such as through a fiber connection point. This connection may be provided in a seamlessly and efficient manner such that the user may never have to know anything of the structure of the mobile broadband routable internet, the BAP, the fixed Internet, the fiber connection, or any other component or facility associated with the connection between the mobile broadband routable internet user and the search tools and results out on the fixed Internet. In embodiments, the efficient connection of mobile broadband routable internet to the wired telecommunications infrastructure may help enable the mobile broadband routable internet to be a true extension of the wired internet.

[00447] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with multiple fixed network gateway interfaces, where a gateway may be a node on a network that serves as an entrance to another network. Applications that may benefit from having multiple gateway interfaces may include security applications requiring redundancy, high quality of service type applications that may allow for switching gateways in the event of high traffic, applications that may require connection to different networks, and the like. For example, a surveillance application may have the requirement for maintaining constant coverage of a security environment, where automatic monitoring and reporting are utilized. In this instance, the only way to cover the loss of a network, such as at the gateway itself, may be to have an entirely separate gateway interface to an entirely separate network. In embodiments,

the mobile broadband routable internet's ability to maintain connection to multiple gateway interfaces may provide greater reliability to the network.

[00448] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with low cost, fast network design engineering, deployment planning, and turn-up. For example, a news organization may have a situation that demands a mobile video conference in the field, and needs to set up a mobile broadband routable internet network quickly and at low cost. The mobile broadband routable internet, where nodes may come fully configured for operation, may provide require only hardware configuration and installation of access points to connect the mobile broadband routable internet network to other telecommunications networks required for the video conference connection, and software management configuration, such as through the access point and/or in association with a management facility on the network. In embodiments, the ability for mobile broadband routable internet to be quickly designed and deployed at low cost may allow new mobile broadband routable internet network to respond flexibly to changing needs and demands of developers. In embodiments, mobile broadband routable internet may also provide fast network turn-up, such as being able to get the system going quickly after installation. For example, the news organization may be able to rapidly establish operability once the fixed access points are established.

[00449] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with low cost and fast capacity expansion and network upgrade. For example, consider a downtown shopping district where the mobile broadband routable internet network is being used to deliver local advertisements to mobile broadband routable internet users that are passing by. It may be the case that as the main shopping areas meet success through mobile broadband routable internet enabled local advertisements, that stores off from the main shopping areas may what mobile broadband routable internet brought into their area. mobile broadband routable internet may be expanded to cover the new areas at a low cost, such as because that primarily what needs to be done for expansion of the mobile broadband routable internet network may be the addition of spanning access nodes, and possibly additional BAP connection points. Other than that, the mobile broadband routable internet user nodes may provide the rest. In addition, the entire mobile broadband routable internet may be easily upgraded, to say a higher bandwidth capability, by upgrading the capacity of the access points. The rest of the network will upgrade as a function of continuous user device node upgrades, and as such, the entire mobile broadband routable internet network may be undergoing constant upgrade.

[00450] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with efficient use of existing backbone communications infrastructure, such as cellular facilities, microwave facilities, fiber trunks, and the like. Connection to existing backbone communications infrastructure may provide a mobile broadband routable internet network with greater connectivity the international fixed Internet, and as such, may provide the mobile broadband routable internet

user with that access. For example, a mobile broadband routable internet user may perform a search, such as an academic search, which may require searches across the international research community. By connecting the mobile broadband routable internet network to the existing communications infrastructure, it may better enable the search to proceed with both greater speed and comprehensiveness.

[00451] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with network end-user deployment participation, such as a mobile broadband routable internet user taking action as part of entering the network, to allow another user to enter the network, to enable the expansion of the mobile broadband routable internet network, and the like. For example, a parent may have a service agreement that allows control over certain accesses of a child's mobile broadband routable internet enabled device, such as connectivity to social networking sites. For instance, a parent may be punishing a child, and the punishment includes being denied social networking access. In this way, the parent is participating in the deployment of certain mobile broadband routable internet network resources to the child's device. In embodiments, the parent may have control of the child's mobile broadband routable internet access in part or in whole with regard to use of the mobile broadband routable internet when the child enters a mobile broadband routable internet enabled vicinity, such as control of functions, control of geographic regions, time of day control, and the like.

[00452] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with base station controller functions being enabled in a subscriber device. With controller functions enabled in a subscriber device, a user may be substantially better enabled to directly execute Internet functionality. For instance, consider two mobile broadband routable internet enabled device users standing next to one another discussing an audio book that the one has but the other does not. The two users may also have an embedded application associated with the download and use of the audio books. As such, and with the mobile broadband routable internet user devices having base station controller functions enabled in the devices, the users may be able to freely exchange the audio book from one user to the other 'across the Internet' without the need to have ever been connected to any other communications infrastructure at all. In embodiments, having base station functionality in the subscriber device may allow mobile broadband routable internet greater autonomy from other communications infrastructure.

[00453] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with service provider tools to manage consumption in a mobile Internet, such as the control of resources including power, data rate, bandwidth, access, and the like. Service providers may have certain resource allocations associated with a user's contract, and as such, the service provider may have the ability to monitor and manage the consumption of those resources. For example, a user's service provider agreement may specify only a certain amount of bandwidth allocated for the streaming of media, such as video. In this regard, if a service provider detects that the user is exceeding their allocation, then the service provider may have management tools to manage the consumption of that resource, such as reducing

the throughput through the network, through the device, at a mobile broadband routable internet access point, and the like.

[00454] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with full radio resource management as enabled in a subscriber device, including the subscriber device acting unilaterally, the subscriber device cooperating with other nodes, interference mitigation, handover / handoff functionality, backhaul capabilities such as access to the public Internet, IP-RAN capabilities, and the like. Through integrated radio resource management mobile broadband routable internet may be able to provide user services that enable a user device node to act as an independent network entity, capable of initiating interactions with other nodes, and working with other nodes independently from network infrastructure. For example, a user may wish to share a video with another user through their mobile broadband routable internet enabled device nodes. mobile broadband routable internet may enable the user with the video to initiate an interaction with the other user's device, and this interaction may be carried out independent of network infrastructure, perhaps even separate from other mobile broadband routable internet enabled devices. In embodiments, the integrated radio resource management into a mobile broadband routable internet subscriber device may significantly increase the autonomous nature of the mobile broadband routable internet system.

[00455] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with a multi-session enabled subscriber device, where multi-session may refer to the subscriber device having the capability to carry out multiple communication sessions with another node, multiple communication sessions with a plurality of other nodes, multiple application processing sessions within the device node, multiple routing sessions with other nodes, and the like. For instance, a user may be at a sporting event where there are many mobile broadband routable internet device users, and the user wants to perform a search within the swarm to collect information pertaining to the sporting event, such as for instance, how many people are at the event from the user's home town. The user may then initiate the search within the swarm. However, this type of search may require the user device to collect and handle data from multiple sources at once, through multiple sessions, as swarm-based search results are returned. In embodiments, the ability of mobile broadband routable internet to handle multiple sessions may significantly increase the throughput and processing abilities associated with mobile broadband routable internet nodes, where otherwise the nodes may become bottlenecks within the network data flow.

[00456] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with least-cost routing in a subscriber device, where least cost may refer to the shortest path through the network, the most efficient path through the network, the path through the network that requires the least resources, the path through the network with the fewest hops, the path through the network with the highest speed broadband, and the like. The ability of mobile broadband routable internet nodes to participate in least-cost routing determination may significantly increase the mobile broadband

routable internet network's ability to provide appropriate routing services within the network structure, such as routing services to meet quality of service provider agreements. For example, a user may have a service agreement that specifies a high broadband quality of service, so that the user may not only watch streaming video from sporting events on their mobile device, but also enabled to provide action replay services. For such a service, the network may route the user's data stream through a least-cost network path that provides the user with the best broadband path through the network. In embodiments, a mobile broadband routable internet subscriber device that provides for least-cost routing may not only provide mobile broadband routable internet with enhanced abilities to route traffic efficiently, but also to provide individual users with improved service provider agreement compliance.

[00457] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with a subscriber device being a fully enabled IP router. That is, the mobile broadband routable internet subscriber may provide Internet routing capabilities such that the mobile broadband routable internet network acts as a seamless extension of the fixed Internet. For example, a mobile broadband routable internet user may be able to initiate a local search in a manner that may be completely transparent to the fixed Internet, such as in the case where the local search is associated with applications located on the fixed Internet. The local search may be executed across the fixed Internet and the mobile broadband routable internet without regard to boundaries in protocol that might otherwise be experienced if the mobile broadband routable internet didn't fully enable IP routing. In embodiments, the ability of mobile broadband routable internet subscriber devices to fully provide IP routing may enable mobile broadband routable internet to better emulate a true extension of the fixed Internet.

[00458] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with providing a MAC layer in a subscriber device, where the MAC layer provides addressing and channel access control mechanisms that make it possible for several terminals or network nodes to communicate within a multipoint network. The MAC layer may emulate a full-duplex logical communication channel in a multipoint network. This channel may provide unicast, multicast, or broadcast communication service. The ability of a mobile broadband routable internet subscriber device to include MAC layer functionality may enable the mobile broadband routable internet network of nodes to act in an interconnected and cooperative manner. For example, consider a group of mobile broadband routable internet subscriber nodes set up to perform a distributed computing function, where processes from one node are completed and would need to be immediately communicated to another node, and where this process of continuous communications would be necessary as a part of the distributed computing. The existence of the MAC layer within the subscriber units may make distributed computing feasible within the boundaries of a mobile network. In embodiments, the ability for a subscriber node to provide MAC functionality may better enable mobile broadband routable internet to communicate in a fashion similar to the fixed Internet.

[00459] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with route diversity, where route diversity may provide greater routing flexibility within the mobile broadband routable internet network. For example, an enterprise may decide to run a webinar in association with product training, where the product training is to be flexible to those customers that will be participating from a mobile broadband routable internet enabled platform. As such, it may be important that these mobile customers be provided a reliable high quality of service communications link. mobile broadband routable internet, through the ability to provide a diversity of routes through the mobile broadband routable internet network, may be able to provide this service. For instance, should traffic begin to threaten link latency for the link currently in use by the webinar, mobile broadband routable internet may be able to choose a different route from the diversity of routes available through the network. This dynamic way to change from route to route as conditions change may provide the mobile broadband routable internet communications with a higher degree of reliability and quality of service.

[00460] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with layer 2 forwarding L2F, where L2F may be used to establish a secure tunnel across the mobile broadband routable internet network infrastructure. This tunnel may create a virtual point-to-point connection between one node and another, between the user device and the enterprise customer's network, and the like. One embodiment of L2F may be a virtual private network, where there may are may not be security boundaries placed to isolate the tunnel from other network activity. For example, a user may set up a secure tunnel for a ticketing service, where the activity associated with the link needs to remain isolated and secure from the rest of the network. For instance, the ticketing link may be carrying financial transactions, purchased tickets, personal information, and the like. In this instance it may be essential for the link to remain private in order for this service to be executed across the mobile broadband routable internet network. In embodiments, the ability for mobile broadband routable internet to provide L2F facilities may provide the mobile broadband routable internet with the necessary degree of link privacy to ensure the reliable use of secure application links across the network.

[00461] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with internet equivalent routing to mobile devices outside a cellular regime. As a result, for instance, there may be no need for a 'walled garden' or operator control of an application deployment. For example, travel booking and rebooking is a typical activity for a traveler on the road, and services provided for booking may be typically accessed in association with a service provider. Through mobile broadband routable internet these services may be available more directly to the user. For instance, the user's mobile broadband routable internet enabled device node may also include a cell phone. The traveler, equipped with their mobile broadband routable internet enabled phone, may now go onto the Internet through the mobile broadband routable internet and access those travel booking services directly, rather than indirectly through the service provider. In embodiments, mobile broadband routable internet may provide

quicker and more direct access to Internet applications than might otherwise be available indirectly through a service provider.

[00462] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with IP application deployment to a mobile device outside the cellular regime. That is, mobile broadband routable internet may make it easier to deploy IP applications to a mobile device, because the mobile broadband routable internet mobile device may be essentially on the Internet. For example, a mobile device that is only connected to the Internet through a cellular facility may be limited in its ability to download applications, such as due to slow speed, restricted downloading, constrained user interface, and the like. However, with a mobile broadband routable internet enabled mobile device the user may be able to access and download an application directly from the Internet. For instance, a news service may be a typical application service provided through a cellular facility, and access to the news service may be configured to require minimized computer resources through the service provider. This may be due in part to the general device constraints that the service provider is trying to accommodate. However, the mobile broadband routable internet user may access any Internet application they choose, and so may maintain control over what applications work well for their particular device constraints. In embodiments, the deployment of IP applications may be significantly more direct for mobile broadband routable internet devices than for devices constrained to downloading through a cellular regime.

[00463] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with a mobile Internet-style network. For example, in a mobile Internet-style network there may be a greater sense for the presence of nodes in the network, such as through neighbor awareness and intelligent routing. For example, in a cellular network or on the fixed Internet, user devices may not be used in the routing of data, and so there may be little need for other networked devices to sense the presence of other nodes on the network. However, mobile broadband routable internet enabled nodes may all be a part of the network, with neighboring nodes sensing the presence of neighboring nodes and using them for routing. In this way, web applications may take advantage of this sense of presence, and provide functions and services that would not be capable through other network types. For example, social networking applications, geo-location applications, and the like, may benefit from the network sensing their presence. In embodiments, a mobile Internet-style network, such as mobile broadband routable internet, may provide for a new dimension in web applications that may not be available through the cellular or fixed Internet networks.

[00464] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with broadband throughput data rates to mobile subscriber devices, such as the ability of a mobile broadband routable internet node to handle the routing of a broadband data stream through the node, handle the receiving and buffering of a broadband data stream into the node, the retransmission of a broadband data stream from the node, and the like. For instance, mobile broadband

routable internet nodes may be aided in their ability to handle the throughput of broadband through the use of level 2 forwarding (L2F), which may involve reducing latency on multi-hop paths by keeping the data from going all the way up to the router at each hop. In this way, a node may be able to pass the data in a bent-pipe manner, and so reduce the latency associated with the hop. For example, consider a user of mobile broadband routable internet executing an image search, and where the large image files have to make their way across the mobile broadband routable internet network, through what could be a number of hops, and over to the user. The ability of mobile broadband routable internet to handle the throughput of high data rates, such as through L2F, may enable mobile broadband routable internet to provide users with a high quality of service with low latency while executing broadband applications such as an image search across the mobile broadband routable internet network.

[00465] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with mobile broadband throughput at vehicular speed, such as a car containing an integral mobile broadband routable internet node, a mobile mobile broadband routable internet user carrying and operating their mobile broadband routable internet device in the vehicle while driving, and the like. For example, a user may be browsing for points of interest photos and video tours in association with a navigation application through the mobile broadband routable internet network, and then jump in a car as a passenger and keep browsing while the car is moving. The mobile broadband routable internet may be able to maintain the necessary broadband connectivity with the user in a non-disruptive manner by continuously sensing broadband capable neighbor nodes along the roadway, such as in other vehicles, as access points associated with the road network, in other pedestrian nodes, and the like. In embodiments, the ability for mobile broadband routable internet nodes to maintain broadband connectivity while traveling at vehicular speeds may be partially enabled through mobile broadband routable internet's ability to sense the presence of other nodes within its vicinity, and constantly adapting power and data rates to accommodate changing communication conditions.

[00466] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with a basic mobile broadband routable internet level of support. For example, the basic mobile broadband routable internet may provide a fully IP enabled MANET environment, where users are able to access the Internet from a mobile device, where their device node may act as a true extension of the fixed Internet, but perhaps without some of the enhanced capabilities that otherwise might be available for improved performance. In embodiments, a user with basic mobile broadband routable internet capabilities may be able to access web applications as if they were on the Internet. For example, a user may decide to browse for audio books through their mobile broadband routable internet enabled device, and though basic mobile broadband routable internet capabilities, be able to browse, sample, purchase, and download an audio book as if they were using a fixed Internet computing facility.

[00467] In embodiments, mobile broadband routable internet may provide improved capabilities with web applications associated with local IP-based swarming, such as an application that operates in a local swarm of users independent from other communications infrastructure, an application that provides enhanced features in the presence of a local swarm of users, takes advantage of conditions associated with a local swarming environment, and the like. For instance, the sharing of music between friends may occur anywhere, whether there is a local access point or not, and so a web application that provides sharing services amongst a swarm of local users may be beneficial. Such an application, through IP-based swarming, may allow for instance the sensing of 'open' music on a user device, where all the users in the swarm may play the music on their own device without downloading it, thus providing a sharing facility that may not violate the music's protections. In embodiments, mobile broadband routable internet may provide significant advantages to web applications that take advantage of the characteristics of local IP-based swarming.

[00468] In embodiments, mobile broadband routable internet may provide improved capabilities associated with web applications associated with e-commerce, such as goods and services, advertising, networking, recommendation services, research, navigation, pricing research, affiliates, and the like. With regard to e-commerce, mobile broadband routable internet may enable a plurality of web application facilities, such as associated with being web application ready, providing an open application deployment, support of thin client capabilities, support of fat client capabilities, downloading and execution of applets, use of servlets, providing caching, providing filing services, support of name server functions, support of open architecture, support of geo-location services, relative position determination though swarming, support of local intelligence servers, advertising to users, distributed databases, local databases, localized applications, and the like.

[00469] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with direct-to-device application deployment, where the mobile broadband routable internet enabled user may be able to support the download of web 2.0 type developed applications directly through client access, install wizards, server interfaces, support of Java Virtual Machines, and other object paradigms for web 2.0. Web 2.0 is a term describing the trend in the use of World Wide Web technology and web design that aims to enhance creativity, information sharing, collaboration among users, and the like. These concepts have led to the development and evolution of web-based communities and hosted services, such as social-networking sites, wikis, blogs, folksonomies, and the like. mobile broadband routable internet, representing a mobile extension of the Internet, may better enable these services. In addition, mobile broadband routable internet may provide aspects of a local distributed computing presence, which better enables these services at a local level. For example, e-commerce provides individuals with the ability to purchase, and sell products across the internet. Many of these services are interactive with the user, such as with e-bay. Continuing with this instance, mobile broadband routable internet, providing local distributed computing, may enable web application at the current service level as well as at a local level. That is, an

individual may have access to a localized e-bay type service. Suppose a user is interested in selling a camera on e-bay. An mobile broadband routable internet enabled user may be able to specify, or have automatically specified, a locality associated with the product. A buyer may now be able to go onto the e-bay site and sort by locality, or specify only products within a certain locality. In this way, buyers and sellers may be brought together in a local environment, where the buyer is now able to go look at the product, and pick up the product without incurring a shipping cost. In embodiments, the present invention may provide an improved facility for goods and services, where mobile broadband routable internet may provide greater mobility and interconnectivity with the Internet, localized access to goods and services, distributed access to goods and services through other users, and the like.

[00470] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with direct device-to-device application deployment, such as being able to support web 2.0 applications. For example, local advertising provided over the Internet may be a key component in effective growth and targeting of e-commerce. Web advertising developers may tend to use the latest web applications in order to better secure an edge in the very competitive advertising market place. As such, web advertising developers may utilize the direct-to-device application deployment to keep their advertising products competitive with the latest application developments. In addition, mobile broadband routable internet may provide support for the plurality of client and open source technologies, and thus better enable advertisements to reach mobile broadband routable internet users. In addition, new applications may be easily deployed to the mobile broadband routable internet user, either from the application source, from local sources, from other mobile broadband routable internet user devices, and the like. For example, an advertisement, in the form of a coupon, may be distributed by a local store to mobile broadband routable internet users in the local area. An advertisement distribution facility, perhaps at the local store itself, may connect and forward the advertisement to a mobile broadband routable internet user that enters the locality of the store. If the user's mobile broadband routable internet device may not presently support the application that advertisement requires, such as for display, interaction, voice, music, and the like, mobile broadband routable internet may enable the deployment of the application directly to the user's device. Further, when a second user moves into the locality, the advertisement and associated application may be deployed to this second user from the first user, or directly from the advertisement distribution facility. In embodiments, mobile broadband routable internet may provide an improved facility for the deployment of e-commerce related products and applications, including by direct interaction though the network, from other mobile broadband routable internet users, from local deployment points, and the like.

[00471] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with thin client functionality, such as support for "screen scraping" protocols as in Citrix, thin protocols as in Java beans transparently for access to remote servers, and the like. A thin client (sometimes also called a lean or slim client) is a client computer or client software in client-server

architecture networks which depends primarily on a central server for processing activities, and mainly focuses on conveying input and output between the user and the remote server. mobile broadband routable internet may enable a mobile device to act as a thin client and thereby provide access to a greater number of applications, and a greater computing capability than may otherwise be available to the device. For example, mobile broadband routable internet may utilize a thin client like service, such as provided by Akamai, which transparently mirrors content (usually media objects such as audio, graphics, animation, video, and the like) stored on customer servers. In embodiments, through mobile broadband routable internet's ability to enable thin client functionality, mobile broadband routable internet may be able to provide access to applications beyond the native capabilities of the device.

[00472] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with thick client functionality, such as support for turnkey applications incorporating local caching, local database access, remote database access (e.g. SQL), embedded data type definitions, native process functions using local memory resources and CPU resources, and the like. A fat client, or rich client, is a computer (client) in client-server architecture networks which typically provides rich functionality independently of the central server, where the rich functionality typically refers to the large size of applications residing on the client machine. mobile broadband routable internet may support full applications operating on mobile broadband routable internet enabled devices, thus providing mobile Internet enabled devices, with full application functionality. For example, a user may be using a mobile broadband routable internet enabled device with interactive navigation application software. In this instance, a user may begin using the navigation functionality while in connectivity with the mobile broadband routable internet network, where the thick client on-device navigation software is monitoring the device's location, the user is specifying navigation requests, and the navigation software is providing directions associated with the request. Now suppose the user leaves all mobile broadband routable internet connectivity. Because the application is running as a fat client, the application may continue to provide navigation services, and keep the user on course, even though interactivity for other Internet dependent applications may be suspended. When the device re-enters mobile broadband routable internet connectivity, all Internet dependent functionality returns to the device, and the fat client navigation application may continue unfettered. In embodiments, mobile broadband routable internet may provide improved capabilities with respect to mobile application capabilities due to mobile broadband routable internet's ability to support fat client functionality.

[00473] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support for downloading of applets (i.e. skinny helper functions and code for server based applications or remote access). An applet is a software component that runs in the context of another program, such as a web browser. Applets encompass a large variety of functions, including Java applets, Flash movies, media players, browser games, 3D imaging, and the like. An applet usually performs a very narrow function that has no independent use, and it executes only on the "client" platform environment

of a system. mobile broadband routable internet may allow for the downloading of applets that enhance the Internet experience for mobile users, where applets may be downloaded across the network from the applet's primary source, from a local site for storing applets, from another mobile broadband routable internet device, and the like. For example, suppose a user is vacationing in Rome, and is in Saint Peter's Square trying to determine were to visit next. Suppose the square is full of people, and that the square is mobile broadband routable internet enabled. The user may then go on the Internet where they may find a site offering guided tours of various facilities within the Vatican. However, the virtual tour requires an imaging applet to be downloaded. The mobile broadband routable internet may allow the downloading of the virtual tour along with the associated applet from a Internet server associated with travel in the Vatican. In addition, because mobile broadband routable internet may provide distributed interconnection amongst the nearby nodes of the mobile broadband routable internet network, and it is likely that other visitors have also previously downloaded the virtual guided tour and associated applet, the user may be able to download the virtual tour and applet from a nearby node or user device. In embodiments, the mobile broadband routable internet's ability to support the download of applets may provide the user with an enhanced Internet experience.

[00474] In embodiments, mobile broadband routable internet may provide e-commerce web applications benefits associated with support for downloading of servlets, local server functionality, including caching, database, CPU and memory intensive resource access for remote application support, and the like. The servlet API allows a software developer to add dynamic content to a web server. The generated content may be HTML, XML, and the like. Servlets are similar to dynamic Web content technologies such as PHP, CGI and ASP.NET. However, servlets can maintain state across many server transactions by using HTTP cookies, session variables or URL rewriting. The mobile broadband routable internet support of servlets may allow the mobile broadband routable internet node to act as a network entity to remote applications and peers, and so, provide an enhanced network capability to users. For example, an advertiser may want to provide ads and coupons for products and services in a mobile environment, such as at a sporting event, a shopping area, a park, and the like. In order to provide this, the advertiser may need to utilize a server at a mobile broadband routable internet node, and as such, they may find the need to download servlets to their mobile mobile broadband routable internet server node. In embodiments, with the capability to download servlets, the mobile broadband routable internet environment may be able to substantially increase the computing resources available to users and goods and service providers in a mobile environment.

[00475] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, including the ability to store significant amounts of data, pages, variables, constants and other data items for the node for inter-nodal, intra nodal and application specific purposes; providing peer-to-peer distributed and node provided applications; and the like. For example, users may have the option to share images, information, reviews, menus, and the like, for an area of interest, such as

a downtown historical area, a national park, a sporting event, and the like. Users may provide a shared folder on their mobile broadband routable internet device, where the contents of the shared folder may be transferred to other user nodes, stored on other user nodes, transferred to a fixed Internet location, and the like. The shared folder may accumulate files from other users, or be a part of a distributed mobile storage database, accessible to other users on the network. The data may accumulate in a user's cache, and be drawn from by other users. In embodiments, the facility for the mobile broadband routable internet to support file sharing may provide a way for large amounts of data to be stored or transferred throughout the mobile broadband routable internet that are much larger than otherwise may be available from a single device, and may be done so through mobile broadband routable internet without degrading the system performance of the network or the device.

[00476] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with distributed data for web applications in the mobile broadband routable internet device, such as support for filing services, support of local database functionality, query and response applications support for locally stored data, and the like. Continuing with the example of the shared folder in support of caching, mobile broadband routable internet support of filing services may allow users or user's devices to query other nodes for distributed information. For example, shared photographs from another user may be made available, and when queried, may be transferred to the user's device. In embodiments, a group of nodes may provide shared filing services such that the total amount of data stored is much larger than otherwise may be available from a single device.

[00477] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support for name server functions, including the ability to extend network interoperability through local Dynamic Host Configuration Protocol (DHCP), authentication, authorization, accounting, and the like functions, including NAT network address translations (NAT) in support of IPv4 and IPv6. DHCP is a protocol for assigning dynamic IP addresses to devices on a network. With dynamic addressing, a device can have a different IP address every time it connects to the network. In some systems, the device's IP address may even change while it is still connected. DHCP may also supports a mix of static and dynamic IP addresses, where dynamic addressing may simplify network administration because the software keeps track of IP addresses rather than requiring an administrator to manage the task. This may enable a new device to be added to a network without the need for manually assigning a unique IP address. mobile broadband routable internet support of DHCP may enable better management of client nodes connecting to the network as part of an e-commerce. For example, a mobile broadband routable internet node may be associated with a DHCP server, and that server may then perform the name server functions for that portion of the mobile broadband routable internet network, assigning IP addresses to devices coming on the network and requesting goods and services.

[00478] In embodiments, mobile broadband routable internet may provide e-commerce web applications benefits associated with support for network geo-location associated with geographical information systems (GIS), including GIS coordinates driven by global positioning system (GPS) technology and algorithms. For example, a mobile client in a mobile broadband routable internet network may be in a new region of the country, and as such, their client GPS navigational system may need updating. In this example, the client may first determine the location of the client, perhaps either directly through a GPS sensor readings or through the mobile broadband routable internet network, and then to obtain the updates through the network. In another embodiment, the mobile broadband routable internet network may provide GIS information from local sources, and the GIS information may be propagated through the network, such as constantly from node to node, where any new node entering into the mobile broadband routable internet network may be provided the GIS information. In embodiments, mobile broadband routable internet may provide the user with enhanced e-commerce capabilities associated with GIS, where the GIS may enable the user the ability to enter a mobile broadband routable internet network, have GIS information updated or enhanced with local e-commerce information, and provide to the user updated and locally relevant e-commerce information that improves the user's e-commerce experience, especially at the local level.

[00479] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support for network geo-location for determination of swarm relative position, such as partial GPS information allowing a node to track its relative position with respect to known GPS coordinates, such as to mesh access points (MAP), backhaul access points (BAP), and the like. In addition, a node's relative position may also be determined with respect to neighboring nodes in the same cloud. For example, a user node may be provided with absolute or relative position coordinates associated with local BAP and MAP points, along with GIS algorithms that allow the user to determine their absolute or relative position. In embodiments, this information may be continuously updated to the user's device to enable the user's device to constantly determine the user's location, either in absolute position, such as to a map of the region, or in relative position, such as to other nodes, user devices, points of interest, points of destination, and the like. In embodiments, the user may be provided relative position capabilities through the use of mobile broadband routable internet that provide the user with improved e-commerce capabilities relative to local commerce sites. For instance, the user may be able to determine their current position relative to an enterprise associated with an e-commerce site, receiving advertisements that are associated with local stores, provided with recent favorite purchases in the local area, and the like. In embodiments, the ability for mobile broadband routable internet to support swarm relative positioning may provide the user with enhancements beyond the capabilities of the fixed internet or other mobile internet services.

[00480] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support of local intelligence server functionality, such as a node acting as its own server for user based applications. For example, a node may provide for server support of a local e-

commerce user service, such as purchases, advertisements, auctions, research, travel, information, network behavior, navigation, pricing, and the like. For example, a node may provide local travel information, where other users may be provided current travel information associated with their current location. A user may be able to access services and information associated their current location associated with travel, such as local events, weather, shops, restaurants, interactive travel support, games, a interactive history of the area, and the like. In embodiments, the mobile broadband routable internet may provide the user with improved access to e-commerce products and services through local intelligence server functionality through server nodes on the mobile broadband routable internet network.

[00481] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support of advertisements targeted to a user's behavior based on user profile settings, based on most recent web accesses, based on most recent web transactions, and the like. For example, a user may provide user profile settings associated with e-commerce on their device, where the user chooses to share this information with other nodes in the mobile broadband routable internet network. This information may then be used by e-commerce sites to deliver advertisements to the user aimed at matching the user's habits, needs, interests, and the like. For instance, a user of a mobile broadband routable internet node device may be a teenage girl, and has listed the type of clothing they like amongst their e-commerce interests, or provided a sharing setting associated with their buying habits. This information may then be disseminated across the mobile broadband routable internet network, where it finds its way to an advertisement related node. Advertisements may then be delivered to the user's node device, such as including coupons for a local store. In this way, the mobile broadband routable internet may provide an enhanced environment for targeting a population, such as a local population, for advertisements based on user's behavior.

[00482] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support of distributed databases, including using inter-node and peer to network transparency functions to distribute data. In addition, mobile broadband routable internet may also use virtual directory structures and lightweight directory protocols to "fetch" data from other peers or the network. For example, a distributed database may created for the purpose of rating and recommending local restaurants, where individuals enter a rating or recommendation into their mobile broadband routable internet device such that the information is enabled to be a part of a restaurant rating database. The recommendations may then be distributed across the mobile broadband routable internet network, where data may be organized in a virtual directory across the network, and accessible to any new node entering into the network. In embodiments, the mobile broadband routable internet may provide an improved facility for storing information associated with e-commerce, where the information may be stored in association with the distributed nodes in the mobile broadband routable internet network.

[00483] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support of a local database, where the local database could be distributed, stored in an e-commerce associated location, and the like. For instance, the local database could be located at a local store, where the store owner and / or users contribute to the database across the mobile broadband routable internet network. In embodiments, the owner could create an interactive database of products that are rated based on sales. In addition, users could enter the database, and rate the products based on whether they like the product, think the product is priced well, and the like. In embodiments, the mobile broadband routable internet may improve the local e-commerce user experience through the use of locally available databases.

[00484] In embodiments, mobile broadband routable internet may provide e-commerce web application benefits associated with support of entirely local mobile Internet applications, including user based application access and storage, such as downloadable over local interfaces such as Bluetooth, USB, WiFi based connections, local nodes providing applications for use in the local swarm, distributed applications across a local swarm, an application associated with a local access point, an e-commerce application located and operating in a local area, and the like. For example, a mobile broadband routable internet network may be established for an auction, where the organizer of the auction has provided an auction application for download for user interaction. mobile broadband routable internet node device users may then come to the auction location and download the application, where the user may now be able to interact with the auction organizers as well as the other users as a part of the auction. In embodiments, mobile broadband routable internet may provide a more dynamic user environment though enabling the potential for adding local applications as needed by users and e-commerce service providers.

[00485] In embodiments, e-commerce web applications may be enhanced through the use of mobile broadband routable internet, including e-commerce goods and services, such as associated with apparel, audio and video, automotive, babies, baby and wedding registry, beauty, bed and bath, books, cameras and photos, cell phones and services, computer and video games, computers, digital books, DVDs, educational, electronics, e-wallet, electronic key and micro payments, financial services, friends and favorites, furniture and decor, gourmet food, health and personal care, home and garden, images, information, jewelry and watches, kitchen and house wares, local e-commerce, local e-bay, magazine subscriptions, maps, movie show times, music musical instruments, office products, outdoor living, pet supplies, pharmaceuticals, real estate, secure payment, shoes, software, sports and outdoors, tools and hardware, toys and games, travel video weather, wish lists, yellow pages, and the like. Through advertising, including in association with an advertisement aggregator, ads site, attention brokering, bid to advertise, communication with end users, coupons, dynamic ad insertion, editorial and ad relationship, permission-based advertisements, promotions, spam and email, classified ads such as real estate vehicles, used goods, new goods, services, and the like. Through network services, such as provide with Akamai, BitTorrent, peer to peer, and the like. Through

recommendations and research services, including buying-based behavior, click-based behavior, collaborative filtering, customer reviews, editorial reviews, machine learning, reputation measures, and the like. Through metadata, including in association with navigation, navigation based on past behavior, buyer behavior, and the like. Through pricing and research, including in association with agents, auctions, catalog aggregator, pricing comparison engine, ratings, reverse actions, shopping bots, and the like. In embodiments, mobile broadband routable internet may provide a plurality of benefits to web application e-commerce.

[00486] Referring to Fig. 86, a mobile broadband routable internet may be beneficially used with a variety of mobile applications, some of which are described herein, others of which will be understood, and all of which are within the scope of the present disclosure. Mobile applications 8202 may be enabled on the mobile broadband routable internet by one or more enablers associated with the mobile broadband routable internet. The mobile applications 8602 may include distributed computing (local cache) 8604, web services deployed with MANET 8608, local ip-based swarming 8610, point to point communications 8612, location based services 8614, soft/smart phone package 8618, video apps 8620, music apps 8622, gaming apps 8624, VoIP 8628, loc app deployment (region based) 8630, entertainment 8632, television 8634, personal access network (pan) 8638, desktop collaboration 8640, video calling 8642, video conferencing 8644, enterprise apps 8648, privacy/security (VPN / firewall) 8650, machine to machine apps 8652, private mobile internet 8654, surveillance 8658, traffic management 8660, parking 8662, theme parks 8664, QoS in unlicensed apps 8668, and the like. Enablers associated with the mobile broadband routable internet may include routing prioritization, network support for peer-to-peer traffic, peer to peer connectivity within mobile broadband routable internet, facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-device application deployment (e.g., for web 2.0 apps), distributed data for web apps in the mobile broadband routable internet device, distributed applications, multicast routing , remote network monitoring, control, and upgrade , adaptive transmit power control , FEC on long ip packets, adaptive link data rate , DYSAN - spectrum aware, spectral reuse with high system level throughput, frequency agnostic operation (operation at any frequency), network geo-location , multimedia , time synchronization , seamless outdoor and indoor operation , seamless indoor/outdoor broadband coverage, efficient use of real estate required for fixed radio installation , efficient connection to other wired telecom infrastructure required for connection to other networks , multiple fixed network gateway interfaces , low cost and fast network design engineering and deployment planning , low cost, fast deployment and network turn-up , low cost and fast capacity expansion and network upgrade , efficient use of existing backbone communications infrastructure, network end-user deployment participation , base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, cost-based routing in a subscriber device, fully enabled ip router in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (VPN, etc), internet-equivalent routing to mobile devices outside cellular regime - no need for walled garden or operator control of application deployment), ip application deployment to mobile devices outside cellular regime, mobile internet-style network , entirely local mobile internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local ip-based swarming, and the like.

[00487] Below are representative embodiments of mobile applications enabled on the mobile broadband routable internet.

[00488] Mobile television, such as IP-based television may be enabled by routing prioritization on a mobile broadband routable internet. IP-based television may include streaming video and/or content that may benefit from prioritized routing over the mobile broadband routable internet. IP-based routing of television content may include transmission of the content through a plurality of mobile broadband routable internet nodes to reach a user device displaying the television content. To provide a smooth, pleasing display of television content on a mobile device in the mobile broadband routable internet, routing prioritization may allow the nodes participating in the routing of the television content to have require little or no buffering of the content. Without prioritized routing, content may need to be buffered at one or more of the nodes to ensure smooth delivery and display of the television content. Routing prioritization may facilitate reducing or eliminating the buffering in the user device that displays the television content to the user. Alternatively, television may be available at differentiated levels of performance on the mobile broadband routable internet. Free or advertisement based television may be utilized non-prioritized routing and fee-based or subscription-based television may utilize prioritized routing to ensure high quality television display on devices of the mobile broadband routable internet.

[00489] Mobile applications, such as machine-to-machine applications may be enabled by the mobile broadband routable internet support for peer-to-peer traffic. At least the routable nature of the mobile broadband routable internet allows communication among machines (e.g. mobile devices, servers, non-mobile devices, and the like) independently of fixed infrastructure elements. By adding peer-to-peer traffic support, machine-to-machine applications, such as file sharing, distributed databases, and the like may be available on the mobile broadband routable internet even without any fixed infrastructure elements.

[00490] Mobile applications, such as a private mobile internet may be enabled by peer-to-peer connectivity associated with the mobile broadband routable internet. Peer-to-peer connectivity may be used to configure a private mobile internet by making the peer-to-peer connections private. Alternatively, by establishing a private mobile internet on the mobile broadband routable internet, peer-to-peer connections accessible through the private mobile internet are also private. Peer-to-peer connectivity over the routing nodes of the mobile broadband routable internet may be implemented as a virtualized network that may be encoded similarly to a virtual private network so that even though the member of the private mobile network access the private mobile network through nodes of the mobile broadband routable internet that are not included in the private mobile network, the content and existence of the private mobile network remains private. Peer-to-peer connectivity within the mobile broadband routable internet may be configured similarly and therefore may facilitate private connection between and among members of a private mobile internet.

[00491] Mobile applications, such as video applications may be enabled by facilitating file sharing, user generated applications, peer-to-peer applications, and the like on the mobile broadband routable internet without degrading network system performance. Mobile video applications generally require substantial amounts of network bandwidth to deliver high quality, high fidelity video. It is common to find small form factor mobile devices, such as cellular phones that include digital cameras to capture images and video. Therefore, video content may be readily generated by nodes in the mobile broadband routable internet. Additionally, video content, especially feature length or high definition content may require a large amount of memory for storage. The file sharing and user and peer-to-peer application sharing enablers of the mobile broadband routable internet facilitate mobile video applications on the mobile broadband routable internet by distributing video content memory storage across a plurality of devices (e.g. mobile devices, fixed devices, fixed infrastructure elements, servers, and the like). As an example, mobile video applications operating within the mobile broadband routable internet may access video content using file sharing in a distributed file sharing configuration. Additionally, user generate video content, which may be bundled into a user generated mobile application that includes functionality associated with the video content (e.g. a video player, interactive user interface, forwarding features, blogging interfaces, and the like) can be readily shared among the mobile devices in the mobile broadband routable internet without having to access or interact with fixed infrastructure elements of the mobile broadband routable internet. Sharing of video files, user generated applications, and peer-to-peer applications may also facilitate mobile video applications in the mobile broadband routable internet operating without degrading network system performance through the sophisticated routing capabilities of the mobile broadband routable internet.

[00492] Mobile applications, such as point-to-point communication may be enabled on a mobile broadband routable internet through direct device-to-device peering with symmetrical throughput. Although routes taken to communicate between devices in the mobile broadband routable internet may be highly dynamic, the routes may be selcted and adjusted dynamically to provide symmetrical throughput between any two nodes or points in the mobile broadband routable internet. In an example, if a first device communicates with a second device that has indicated a request for symmetrical communication, the routing of data will be configured and/or dynamically reconfigured by the first and second devices and any nodes (e.g. devices) providing the connection between the first and second devices to ensure symmetrical throughput. To ensure symmetrical throughput, nodes along the transmission route may select prioritized routing, normal routing, delayed routing, and the like to ensure the throughput is symmetrically balanced between the first and second devices.

[00493] Mobile applications, such as web services that are deployed with MANET may be enabled by direct-to-device application deployment (e.g. web 2.0 applications) using a mobile broadband routable internet. Web services (sometimes called application services) are services (usually including some combination of programming and data, but possibly including human resources as well) that may be available from a business's web server for web users and/or web-connected programs. Web service creation and availability present a major internet trend. Generally users can access web services by going to a central server. Some services can communicate with other services through middleware. Also web services are also increasingly enabled by the use of XML as a means of standardizing data formats and exchanging data and as the core language of the Web Services Description Language (WSDL). Access to web services, publishing and deploying web services, and sharing user created web services may be facilitated by direct-to-device application deployment. A user may request that a web service be deployed on his/her mobile device. Direct-to-device application deployment allows the web service provider to deploy the requested web service directly to the user's mobile device without having to clear any security protocol associated with a communication service provider, such as a cellular service provider. In this way, web service applications that may normally execute on the server may now execute on any of the mobile devices having received the direct deployment of the web service. This may facilitate distributing the computing load for and accessibility to the web service.

[00494] Mobile applications, such as distributed computing and personal area networking may be enabled by distributed data for web-type applications distributed across two or more mobile broadband routable internet devices. Distributed computing may take advantage of distributed data by allocating computing functions to devices based on accessibility of the distributed data. In an example, if data in a matrix is available on two devices in the mobile broadband routable internet, processing the matrix may be distributed to devices in proximity to the devices holding the matrix data. Personal area networking, which may include, among other embodiments a proximity based network may take advantage of the distributed data capabilities of the mobile broadband routable internet to allow a user to seamlessly access data on any device that is participating in the personal area network.

[00495] Mobile applications, such as local applications may be distributed across a local region of mobile broadband routable internet devices. Applications may be localized to a region and may be distributed across a plurality of devices in the region. By distributing the local application across devices in the region, routing delays associated with communicating among the distributed applications executing on devices in the region may be reduced or minimized. Also, the localization of the application may include determining the region for distribution. In an example, application localization may be based on one of a network geo-location and a device home region setting so that only devices within the geo-location and/or having a local home region setting would receive the distributed application. Additionally, application

distribution may benefit processing load leveling by distributing application execution across a plurality of mobile broadband routable internet devices.

[00496] Mobile applications, such as soft/smart phone applications, enterprise applications, and the like may be enabled by multicast routing capabilities of the mobile broadband routable internet. Multicast routing allows a single source to identify a plurality of destination nodes or no specific destination node to receive a transmission. In this way, all devices that detect the multicast routing transmission may receive the transmission independently of any other device that is receiving the transmission. The mobile broadband routable internet may provide multicast routing by ensuring that the transmission is routed to every node, such as if no destination node is specified, or all specified destination nodes. Therefore, as an example, upgrading a mobile application such as a smart phone application or an enterprise application to which mobile devices on the mobile broadband routable internet are communicating, may be enabled. Enterprise applications may use multicast routing to provide network related updates such as to notify mobile nodes of a planned maintenance activity. Mobile enterprise applications may also benefit from multicast routing to distribute daily updates of information such as inventory, orders, and the like that the mobile users may prefer to access locally to preserve security of the information. Soft/smart phone mobile applications may utilize multicast routing to deliver contact information during a meeting. In an example, a salesman may visit a prospective client and may multicast his contact information to be available to every person in the company or at least a portion of the people, such as the attendees of the meeting.

[00497] Mobile applications, such as traffic management may be enabled on the mobile broadband routable internet through remote network monitoring, control, and upgrade. Remote monitoring of vehicular traffic is essential to properly managing the vehicular traffic. The mobile broadband routable internet may facilitate remote monitoring through connection of network devices in vehicles, pedestrians, bicyclists, traffic lights, toll booths, and the like. Data collected through remote monitoring may be analyzed to determine at least one preferred or alternate traffic pattern and remote upgrade may be used to adjust timing of traffic lights and other traffic management features. Even devices that are not directly connected to the mobile broadband routable internet may take advantage of remote upgrade by adapting an upgrade signal originating in the mobile broadband routable internet to contact a device outside the mobile broadband routable internet (e.g. a cellular phone network).

[00498] Mobile applications, such as music applications may be enabled by adaptive transmit power control on the mobile broadband routable internet. Mobile music applications may take advantage of the adaptive transmit power control during music searching. The mobile music application may intentionally select a lower transmit power for a search request to preserve power for music playback. If the lower power search request is unsuccessful, a higher power search request may be executed. In this way, the music application may attempt to rely on neighboring nodes to propagate the request throughout the network. Alternatively, the application may adjust transmit power based on signal strength of neighboring devices.

Adaptive transmit power control may also be useful to music applications in that during playback, transmit power may be reduced to ensure battery power is reserved for playback time so that it is not diminished by high power music searching.

[00499] Mobile applications, such as video conferencing and the like may be enabled on a mobile broadband routable internet by forward error correction (FEC) on long IP packets. As the video conferencing IP connection is routed over the mobile broadband routable internet, portions of the video conference content may be embodied in long IP packets. In an example, video conference may include live video, live audio, data (e.g. image data), and the like. Packaging audio into long packets may reduce the number of packets required for the audio. However, as the long audio packets are transmitted through the ad hoc wireless network nodes of the mobile broadband routable internet, audio quality may be compromised if the content is not properly error corrected and FEC represents a key error correction method enabled in the mobile broadband routable internet.

[00500] Mobile applications, such as video calling and the like may be enabled by adaptive data link rate capabilities of the mobile broadband routable internet. A video calling mobile application may include routing video, audio, and control content between two video capable devices of the mobile broadband routable internet. The adaptive data link rate capabilities of the mobile broadband routable internet may facilitate selecting routing based on link data rate so that video and audio quality are maintained even when a link data rate changes. Alternatively, a data link rate may be adjusted, such as it may be increased, to ensure that video data arrives at a destination in time to maintain smooth video display. Video calling may use compression techniques that transmit information about the differences in sequentially captured image frames. Consequently, if the video content does not change from frame to frame, such as if the camera is pointing at an empty room or a static scene, the data link used for transmitting the video may be adapted to use a lower data rate because the amount of data being sent may be substantially reduced.

[00501] Mobile applications, such as parking related applications including searching for parking, reserving parking, seeking the reserved parking, paying for parking, and the like may be enabled by dynamic spectrum analysis (DYSAN) capabilities of the mobile broadband routable internet. Mobile parking applications may include vehicle operation in urban areas that include large objects that impact the availability of wireless communication spectrum. As a vehicle enters a tunnel, turns down a busy city street, enters a parking facility, and the like the available spectrum changes rapidly. Such rapid changes are readily accommodated by the DYSAN features of the mobile broadband routable internet and therefore can enable all aspects of mobile parking applications. In an example, a mobile device in a vehicle is communicating with other devices in the mobile broadband routable internet to ascertain parking status near a destination in a distant city. Upon entering the parking facility the vehicle-based mobile broadband routable internet device will be subjected to the impact of structural features on communication as well as a high density of vehicles that may include devices communicating over the mobile broadband routable internet. The spectrum for

wireless communication may change dynamically based on the vehicle movement relative to the structural features and the activity from the dense concentration of devices. The DYSAN features of the mobile broadband routable internet may facilitate highly efficient and dynamic use of the available spectrum to ensure high quality connection to the vehicle-based mobile device over the mobile broadband routable internet.

[00502] An aspect of the mobile broadband routable internet that may be related to DYSAN is support of spectral reuse while maintaining a high system level throughput. This potentially related capability may enable offering quality of service guarantees for mobile applications on the mobile broadband routable internet. By supporting spectral reuse, as portions of the wireless communication spectrum become available or are determined to offer sufficient signal quality, the mobile broadband routable internet may use the portion of the spectrum, thereby ensuring that any available spectrum is utilized if there is demand for it. Also, because the mobile broadband routable internet may measure spectrum quality and availability, mobile applications may be able to offer quality of service guarantees that are based on up to date spectrum availability and quality.

[00503] Another aspect of the mobile broadband routable internet related to wireless operation may include operation of the mobile broadband routable internet at any frequency. This frequency agnostic feature of the mobile broadband routable internet may enable mobile applications such as voice over IP. In an example, a voice over IP mobile application may operate to provide voice communication between two devices connected to the mobile broadband routable internet. The voice over IP application can operate independently of any wireless radio frequency constraints that may be imposed by regulatory bodies, interference from other radio sources (e.g. transformers, broadcast towers, other radio towers, and the like), and the like. By being frequency agnostic, the mobile broadband routable internet is not restricted to certain frequencies of the wireless communication spectrum. In an example, a direct-connect voice over ip mobile application may be operated at a spectrum that is different than existing radio, cellular, and other communication without risk of interference with or from the existing radio communication sources.

[00504] Mobile applications, such as location based applications may be enabled by network geo-location features of the mobile broadband routable internet. The unique device based routing and network topology sensing capability of the mobile broadband routable internet facilitates geo-location by being able to detect a device within a swarm of devices. When one or more devices in the swarm is a fixed infrastructure device (e.g. a tower or other fixed radio device), the geo-location of the selected device may be determined as well. In this way, device geo-location may be detected and provided to mobile applications such as location based applications. In an example, a device of a user searching for a tailor may be geo-located to be close to W12th and 47th street in New York City. A location based search application may use the device location to identify and present information about tailors near to the location.

[00505] Mobile applications, such as gaming and entertainment may be enabled by multimedia capabilities and features of the mobile broadband routable internet. The multimedia capabilities may be provided on the mobile broadband routable internet through a hybrid frame structure that includes variable slot duration and sub-channelization of bandwidth. Mobile gaming applications may include a large amount of local graphics manipulation to provide a pleasing visual gaming display. However, the information that is communicated among devices participating in the gaming may be rather small in size and duration. However, the information may require high bandwidth to ensure rapid communication of the information so that actions in one of the gaming devices may impact the other gaming devices in near real-time. By providing a hybrid frame structure that supports variable slot duration, short signals among gaming devices may be accommodated at very high speed without utilizing a large amount of communication spectrum. When considering entertainment, the variable slot duration and sub-channelization that may be included in the multimedia features of the mobile broadband routable internet may enable entertainment by utilizing slot duration based on content demand. In an example, transmitting a short signal, such as in gaming or to transmit a user selection in a video game may only require a short duration slot. However, transmitting a portion of a frame of video data may involve larger or longer content that may best be transmitted with a long duration slot. At least as described herein, by providing variable slot duration capabilities the mobile broadband routable internet may offer key features that enable gaming, entertainment, and the like.

[00506] Mobile applications, such as desktop collaboration may be effectively enabled by time synchronization features of the mobile broadband routable internet. To allow simultaneous display of a shared virtual drawing board among a plurality of mobile devices, time synchronization of information exchange may be beneficial. Without the coordination of communication among devices that time synchronization provides, updates to users may occur at different times so that a first user may see an update to the virtual shared drawing board before another user. Without synchronization, active updates of the virtual shared drawing board would become out of phase, potentially causing the collaboration session to be ineffective. Time synchronization may also benefit desktop collaboration that includes multiple channels of communication. In an example, desktop collaboration among several devices over the mobile broadband routable internet may include a shared drawing board, a document viewing window, and voice over ip for discussing the shared board and document. By time synchronizing communication associated with the multiple channels of communication, the mobile broadband routable internet may facilitate coordinating the voice over ip and the visual transmissions so that they are arrive at each device with a proper phase relationship.

[00507] Mobile applications, such as mobile device use at a theme park may be enabled by seamless outdoor and indoor operation of the mobile broadband routable internet. Theme parks generally include outdoor and indoor activity and amusements. Some of the amusements may be limited to just indoor or just outdoor, however even indoor amusements are generally advertised to outdoor theme park visitors (e.g.

signs or other display). By offering seamless outdoor and indoor operation, an outdoor visitor may receive information about an indoor amusement through the mobile broadband routable internet. An indoor mesh access point (MAP) or customer access point (CAP) associated with the indoor amusement may transmit information about the indoor amusement to all outdoor users by first communicating to an outdoor devices such as a fixed infrastructure device outside the indoor amusement. Also, a visitor may use the transmitted indoor amusement information to find the amusement while making a voice over ip phone call with instructions to a companion to join him. Upon entering the amusement, the visitor's device may be detected as being indoors so information related to fees, payment, seating, etc may be provided to the visitor while his voice over ip call continues uninterrupted due to the seamless outdoor and indoor operation of the mobile broadband routable internet.

[00508] Additionally, services such as high speed vehicle-based broadband can be enabled through the mobile broadband routable internet. As a vehicle operates at high speed, such as when traveling into and out of tunnels, a broadband connection to a device in or associated with the vehicle can be seamlessly maintained during the transitions. This seamless broadband session may be based on the deployment of MAPs so that a MAP inside the tunnel can communicate with a MAP or a fixed infrastructure element outside the tunnel.

[00509] Network security such as virus detection, firewall use, and the like are often found as part of an networked infrastructure. The seamless indoor/outdoor broadband capabilities of the mobile broadband routable internet enable network security independent of location and independent of outdoor/indoor transition. Therefore network security, such as a firewall can be fully functional for indoor use, outdoor use, transitional use, and the like.

[00510] Mobile applications, such as security or surveillance may be enabled on the mobile broadband routable internet by efficient use of real estate required for fixed radio installations. Because fixed radio installations associated with the mobile broadband routable internet may be as simple as placing a mobile type device at a planned location, a video surveillance or security camera can be readily equipped with a fixed radio and installed in a location that is most beneficial for the security or surveillance purpose. A casino that has a large plurality of surveillance cameras and recording capability may benefit from deploying mobile broadband routable internet radio enabled surveillance cameras. These adapted cameras could serve a dual purpose including surveillance and mobile broadband routable internet-based wireless communication. The high flexibility and dynamic routing nature of the mobile broadband routable internet devices may facilitate using the mobile device capability associated with the cameras as access points for casino visitor mobile devices.

[00511] Mobile applications, such as local IP-based swarming may benefit from and may be enabled by the efficient connection to other wired telecom infrastructure as may be required to connect the mobile broadband routable internet to other networks. Every mobile device of the mobile broadband routable

internet may be a routable node and therefore may facilitate connection to other wired telecom infrastructure. In an example of efficient connection to other wired telecom infrastructure enabling local IP-based swarming, a device may include mobile broadband routable internet connectivity and other network (e.g. cellular) connectivity. The device with the cellular connection may act as a gateway between the mobile broadband routable internet and the cellular network. Other devices local to the device may use IP-based swarming methods to determine routing paths among the devices to enable access to the cellular network through the device.

[00512] Within the MBRI, multiple fixed-network gateway interfaces (such as and without limitation backhaul access points) may connect the mobile ad hoc network to the fixed network. Some embodiments may provide a distributed computing mobile application that communicates between a mobile device and a device on a fixed network. For example and without limitation, such a mobile application may enable nodes on the MBRI to function as members of a compute cloud. In some embodiments, owners or operators of the mobile device and/or the fixed device may receive compensation for participating in the compute cloud. For example, the owners or operators may receive cash compensation; increased access to computing, storage, network, or other computing resources; public recognition; frequent flier miles; or any and all other forms of reward. In some embodiments the device on the fixed network may be a personal computer, another compute cloud, a computing grid, or any and all other form of computing infrastructure. In any case, the distributed computing mobile application may enable the mobile device and/or the device on the fixed network to access the memory, processor, storage, or any and all other function or service of the other. In embodiments a plurality of mobile devices and/or devices on the fixed network may be present. Communications between the mobile devices and the devices on the fixed network may include IP packets that are routed through the MBRI as described herein and elsewhere. It will be understood that a variety of mobile applications may communicate between a mobile device and a device on a fixed network. All such mobile applications are within the scope of the present disclosure.

[00513] An automated network design tool may facilitate low cost and fast network design engineering and deployment planning of fixed infrastructure elements of a MANET. Some embodiments may deploy a web service via the MANET, the web service configured to use a network designed by the design tool. For example and without limitation, MANET provider in San Francisco may wish to seed the city with fixed infrastructure elements (such as mesh access points, backhaul access points, and the like) in order to provide a baseline level of MANET coverage within the city. The MANET provider may use the design tool to engineer and plan deployment of the fixed infrastructure elements. Once the fixed infrastructure elements have been deployed, the web service may be deployed. In this example, the web service may be aware of the fixed infrastructure elements may, based upon a triangulation or other such calculation comparing the relative signal strengths or latencies between a mobile device and the fixed infrastructure elements, estimate the mobile device's location. When the web service is a mobile mapping application, the location may be

displayed on a map on the mobile device. The web service may mash-up or aggregate information relating to the location from a variety of web services (e.g. web sites, blog feeds, twitter streams, and so on) and communicate such information to the mobile device for display in association with the location. It will be understood that a variety of mobile applications may be configured to use the network designed by the design tool. All such mobile applications are within the scope of the present disclosure.

[00514] In some embodiments, an MBRI may be deployed quickly, at low cost, and with fast network turn-up by deploying a plurality mesh access points to provide network coverage in a geography. Some embodiments may further include a local IP-based swarming application that communicates at least in part via the mesh access points. Communicating with the mesh access points may, at least in part, allow the swarming application to route and forward IP packets through the MBRI. For example and without limitation, the MBRI may include a plurality of mobile devices and mesh access points. Some of the mobile devices may not be in direct communication with one another due to power constraints on radio transmissions, poor signal-to-noise radio of transmissions, extended distances between the mobile devices, radio obstructions between the mobile devices, multi-path effects caused by urban terrain, any and all combinations of the foregoing, and so on. In some such cases, a number of mobile devices that are not in direct communication with one another may be in direct communication with a common mesh access point. The local IP-based swarming application may discover this and route traffic between the mobile devices via one hop through the mesh access point. A variety of other such examples will be appreciated. It will understood that a variety of mobile applications may be associated with the MBRI' s ability to be deployed quickly, at low cost, and with fast network turn-up. All such mobile applications are within the scope of the present disclosure.

[00515] In some embodiments, an MBRI may be quickly expanded, at low cost, by adding small form factor nodes. These nodes, which may be described in greater detail herein and elsewhere, may include mesh access points, backhaul access points, or the like. In any case a mobile application employing point-to-point communications may communicate via the small form factor nodes. The mobile application may require a user to have line-of-sight between his mobile device and the small form factor node, or to at least to have an antenna of his mobile device properly oriented with respect to the small form factor node. It will be understood that a variety of mobile applications using point-to-point communications are possible. All such mobile applications are within the scope of the present disclosure.

[00516] In some embodiments, an MBRI may make efficient use of existing backbone communications infrastructure. Such embodiments may route communications between a mobile device and a device on a remote network so as to substantially favor routes through the mobile, broadband, routable Internet that have fewer hops between the mobile device and a backhaul access point. A mobile application providing location-based services may utilize such communications. For example and without limitation, the mobile application may provide a user with information about the neighborhood in which he is walking. The mobile application may first communicate geographical coordinates of the user's mobile device to a server on

a fixed network, the communication traveling through the MBRI via a relatively small number of hops to the backhaul access point bridging the MBRI to the fixed network. The server may respond to the geographical coordinates by transmitting information related to the coordinates back to the mobile device, the communication traveling through the fixed network to the backhaul access point and then through the MBRI via a relatively small number of hops to the mobile device. It will be understood that a variety of mobile applications providing location-based services are possible. All such applications are within the scope of the present disclosure.

[00517] In some embodiments, a user deployable access point may connect to the MBRI network. A mobile application may utilize said access point. An example of such a mobile application may be a soft/smart phone package in which the access point is embodied. When the user powers on the soft/smart phone, it may perform as an access point within the MBRI. It will be understood that a variety of mobile applications utilizing the user deployable access point are possible. All such mobile applications are within the scope of the present disclosure.

[00518] In some embodiments, a base station controller function may be provided in at least one subscriber's mobile device. A mobile application may utilize at least one of the controller functions. For example and without limitation, a video mobile application may utilize a controller function that configures an air interface of the base station to provide adequate bandwidth and suitable signal-to-noise ratio for communication of a substantially real-time video stream between the mobile device and the base station. In some embodiments, a previous configuration of the air interface or base station may be restored by the mobile application after transmission of the video stream has concluded. It will be understood that a variety of mobile applications that employ at least one of the base station controller function are possible. All such mobile applications are within the scope of the present disclosure.

[00519] In some embodiments, a service provider tool may be provided, the service provider tool for manage consumption of at least one device on the ad hoc network of the MBRI. The tool may be deployed on at least one of the plurality of mobile devices of the MBRI and may use at least one management path for reporting usage of the at least one device. A mobile application may report its computing/network resource utilization (i.e. usage) by using the path. For example and without limitation, a music mobile application may download or stream content from sources that are within and/or reachable via the MBRI. Such downloading or streaming may consume network resources, such as and without limitation network bandwidth. The music mobile application may report such consumption of network resources over the path. In some embodiments, the path may include a limited bandwidth, un-metered backchannel or the like between the mobile device running the music mobile application and a management server or the like. It will be understood that a variety of mobile applications that employ the path are possible. All such mobile applications are within the scope of the present disclosure.

[00520] In some embodiments, full radio resource management functions may be provided in a subscriber's mobile device. These management functions may enable a mobile application, which may operate responsively to a state of a managed radio resource. For example and without limitation, a gaming mobile application may allow a plurality of users to participate in a multi-player game, but only when the users' mobile devices have their radio resources switched into an appropriate state. The gaming mobile application may detect the state and may provide the multi-player game when the appropriate state is detected. It will be understood that a variety of mobile applications that operate responsively to a state of a managed radio resource are possible. All such mobile applications are within the scope of the present disclosure.

[00521] In some embodiments, multi-session functions may be provided in at least one of a plurality of devices of an MBRI. In such embodiments, a mobile application may communicate via multiple sessions. For example and without limitation, a VoIP mobile application may use one session for transmitting substantially real-time data that encodes voices waveforms while using a second session for transmitting lower priority signaling data. The one session may be configured to transmit data with low latency, low jitter, or the like, even if delivering such quality of service requires that greater resource utilization costs per bit will be incurred as compared with a lower quality of service configuration. The second session, on the other hand, may be configured with a lower quality of service configuration that requires, on average, that fewer resources per bit be consumed. The second channel may provide lower quality of services levels (e.g. greater latency, greater jitter, and so on) than the one channel, which may be acceptable given the nature of the data being transmitted over the second channel. It will be understood that a variety of mobile applications that communicate via multiple channels are possible. All such mobile applications are within the scope of the present disclosure.

[00522] In some embodiments, cost-based routing functions may form and reform links and routes through the MBRI. A mobile application may use the cost-based routing functions to deliver a desired balance of cost and quality of service. For example and without limitation, a mobile application may include installing itself on mobile devices within a particular region of the MBRI. The mobile application may determine which mobile devices are within the region my limiting installation to those mobile devices that can be reached through the MBRI while incurring up to but not more than a given cost. The cost may be measured in terms if Jules-per-bit, hops-per-packet or time-to-live, or the like. The desired balance of cost and quality of service may relate to the number of Jules consumed MBRI-wide to install the application (e.g. more Jules equals higher cost) and the number of mobile devices on which the application is installed (e.g. more mobile devices results in higher quality of service). It will be understood that a variety of applications that use cost-based routing functions to deliver a desired balance of cost and quality of service are possible. All such mobile applications are within the scope of the present disclosure.

[00523] In some embodiments, a IP router functions may be provided in a subscriber's mobile device. A mobile application may use the IP router functions to communicate via the ad hoc network. For

example and without limitation, an entertainment mobile application may receive communications containing multimedia content or the like. These communications may reach a mobile device running the mobile application via the MBRI. The communications may traverse any number of intermediate mobile devices through the MBRI in order to reach the mobile device running the mobile application. The IP router functions within the intermediate mobile devices may route such communications through the MBRI, thus enabling such communication via the ad hoc network. It will be understood that a variety of mobile applications that use the IP router functions to communicate via the ad hoc network are possible. All such mobile applications are within the scope of the present disclosure.

[00524] In some embodiments, at least one of a plurality of mobile devices in an MBRI may include media access control layer capabilities. A mobile application may use the MAC layer capabilities to communicate via the ad hoc network. For example and without limitation, a television mobile application may receive multicast or broadcast signals from a television source, which may be a mobile device on the MBRI or a fixed network connected to the MBRI. The television mobile application may only receive data packets having a MAC address of the television source. Although this may not guarantee that the data packets are in fact from the television source (in some embodiments, the MAC address may be spoofed), it will limit the number of packets that an instance of the television mobile application needs to consider when listening to multicast or broadcast packets. It will be understood that a variety of mobile applications that use the Mac layer capabilities to communicate via the ad hoc network are possible. All such applications are within the scope of the present disclosure.

[00525] In some embodiments, route diversity may be provided within an MBRI network to facilitate assurance of packet communication. Route diversity may be based at least on a number of network devices in a geographic area, which provide a diverse selection of routes through which packet communication may travel. A mobile application may use route diversity to communicate via the ad hoc network of an MBRI. For example and without limitation, a personal area network may be a mobile application that uses route diversity. The personal area network may connect a variety of devices that are within close proximity of one another, such as and without limitation carried on one's person. At least one of the variety of devices may be connected to the MBRI. Route diversity may help ensure that the MBRI-connected device remains in communication with the MBRI, even has environmental or other factors that may affect connectivity change. The variety of devices may communicate with other devices in the MBRI through the MBRI-connected device. Thus, some or all of the devices may serve as a personal-area-network-to-MBRI bridge. It will be understood that a variety of mobile applications using route diversity to communicate via the ad hoc network are possible. All such applications are within the scope of the present disclosure.

[00526] In some embodiments, layer 2 forwarding may be provided within an MBRI, and a mobile application may communicate via said forwarding. For example and without limitation, a desktop

collaboration mobile application may enable a plurality of users to share a single desktop interface. The desktop interface may appear on each of the users' mobile devices and interactions with the desktop on one device may suitably affect the desktop as it appears on the other devices. The instances of this mobile application may communicate with one another via a virtual private network, which may employ the layer 2 forwarding. It will be understood that a variety of mobile applications that communicate via layer 2 forwarding are possible. All such mobile applications are within the scope of the present disclosure.

[00527] In some embodiments, a node in an MBRI may also communicate with a cellular network through at least one fixed infrastructure element (e.g. a cell tower or the like) while the MBRI is provided outside the cellular network. In such embodiments a mobile application may communicate both through the cellular network and the MBRI' s mobile ad hoc network. For example and without limitation, a video calling mobile application may provide three-way video calling between mobile devices on the MBRI and the cellular network. The mobile device of a first caller on the MBRI may connected to the mobile device of a second caller that is communicating via the MBRI and the fixed infrastructure element. The mobile device of a third caller on the cellular network may communicate with the mobile device of the second caller via the fixed infrastructure element. During the three-way call, the second device may more or less simultaneously communicate with the MBRI and the fixed infrastructure element to enable the call, that is to enable the transmission of video-and-voice data end-to-end between the first caller's mobile device and the third caller's mobile device. It will be understood that a variety of mobile applications that communicate through the cellular network and the mobile ad hoc network are possible. All such applications are within the scope of the present disclosure.

[00528] In some embodiments, IP application deployment may be provided to a device in an MBRI network. In addition to communicating with the MBRI, the device may also communicate with a cellular network through at least one of the fixed infrastructure elements of the MBRI. The application deployed over IP may be deployed over the MBRI (i.e. outside of the cellular network). For example and without limitation, a video conferencing mobile application may be deployed over IP to a device in the MBRI network. It will be understood that a variety of mobile applications may be deployed over IP to a device in the MBRI network, the device also communicating with the cellular network. All such applications are within the scope of the present disclosure.

[00529] In some embodiments, data packets may be routed through the mobile ad hoc network of an MBRI. The data packets may be IP packets or the like, and thus the MBRI may provide a mobile Internet-style network. Mobile applications may communicate via the data packets. For example and without limitation, an enterprise mobile application on a mobile device operatively coupled to the MBRI may communicate data packets encoding information relating to an enterprise. Such information may without limitation include calendar events, notes, email messages or the like, photographs, video, any and all combinations of the foregoing, and so on. The communication of data packets may be between multiple

instances of the enterprise application running on multiple mobile devices operatively coupled to the MBRI; between a mobile device and a device on a fixed network, the fixed network operatively coupled to the MBRI by a backhaul link or the like; and so on. It will be understood that a variety of mobile applications may communicate via the data packets. All such applications are within the scope of the present disclosure.

[00530] In some embodiments, data packets may be routed through the mobile ad hoc network of an MBRI absent communications with fixed infrastructure elements of the MBRI. Mobile applications may communicate via data packets so routed. For example and without limitation, a privacy/security mobile application may receive the data packets; inspect them according to a policy (e.g. a firewall policy, a security policy, or the like); and then allow or deny the packets passage through the privacy/security mobile application to another application, network interface, or the like. It will be understood that a variety of mobile applications may communicate via data packets routed through the mobile ad hoc network absent communications with fixed infrastructure elements. All such applications are within the scope of the present disclosure.

[00531] In some embodiments, during normal operations the MBRI may provide broadband communications of at least 768 kbit/sec between nodes. Mobile applications may communicate via the broadband communications. For example and without limitation, machine-to-machine mobile applications may communicate via the broadband connections to keep in sync distributed databases, distributed shared memory, or the like. It will be understood that a variety of mobile applications may communicate via the broadband communications. All such applications are within the scope of the present disclosure.

[00532] In some embodiments, the MBRI may provide communications to nodes having a throughput of at least 768 kbit/sec when the nodes are in motion at vehicular speeds. Mobile applications may use such communications. For example and without limitation, a private mobile internet application may allow a restricted group of mobile devices in cars to communicate without exposing the content of such communications to eavesdroppers or other mobile devices. In some embodiments, the cars may be law enforcement vehicles and the communications may relate to coordinating the efforts of law enforcers. It will be understood that a variety of mobile applications may use communications as described in this paragraph. All such applications are within the scope of the present disclosure.

[00533] In some embodiments, a mobile application may communicate via the mobile ad hoc network of an MBRI. For example and without limitation, a surveillance mobile application may communicate video, audio, alarms, or the like via the mobile ad hoc network. The communications may be transmitted and/or received by mobile devices operatively coupled to the mobile ad hoc network. It will be understood that a variety of mobile applications may communicate via the mobile ad hoc network. All such applications are within the scope of the present disclosure.

[00534] In some embodiments, swarm intelligence may determine at least part of at least some routes through an MBRI. A mobile application may communicate via the MBRI. For example and without

limitation, a traffic management mobile application may monitor network traffic on the MBRI to observe any affect of the routes chosen by the swarm intelligence. A user may access the traffic management mobile application to enable, disable, or otherwise modify the swarm intelligence's behavior. Alternatively or additionally, the traffic management mobile application may provide reports showing performance characteristics (e.g. latency, number of hops, packet lass, and so on) of routes selected by the swarm intelligence as compared with routes selected by other routing protocols or methods. It will be understood that a variety of mobile applications may communicate via an MBRI in which swarm intelligence determines at least port of at least some routes. All such applications are within the scope of the present disclosure.

[00535] Within the MBRI, multiple fixed-network gateway interfaces (such as and without limitation backhaul access points) may connect the mobile ad hoc network to the fixed network. A mobile application may communicate between a mobile device and a device on the fixed network. For example and without limitation, a parking mobile application may operate on a mobile device used by parking enforcement personnel. The parking mobile application may communicate via the MBRI to a central parking enforcement application running on a computer connected to the fixed network. As the personnel create a new parking ticket on the mobile device, communications between the mobile device and the computer may serve to update a central database containing information relating to issued tickets. It will be understood that a variety of mobile applications may communicate between a mobile device and a device on a fixed network. All such mobile applications are within the scope of the present disclosure.

[00536] An automated network design tool may facilitate low cost and fast network design engineering and deployment planning of fixed infrastructure elements of a MANET.

[00537] Some embodiments may deploy a theme park mobile application via the MANET. For example and without limitation, the theme park mobile application may operate on a mobile device held by a theme park patron. The mobile device and mobile application may together provide the patron with ability to jump substantially to the head of a line (e.g. the mobile device may display a message that indicates to a park attendant that the patron may jump the line). In order to operate, the mobile device may require connectivity to the MANET so that it can communicate with and coordinate with other mobile devices to provide for a desired distribution over time of line-jumping patrons at any particular park attraction. The automated network design tool may be employed to design and plan the deployment of fixed infrastructure elements of the MANET throughout the park, thus ensuring that adequate MANET coverage exists throughout the park. It will be understood that a variety of mobile applications may be configured to use the network designed by the design tool. All such mobile applications are within the scope of the present disclosure.

[00538] In some embodiments, an MBRI may be deployed quickly, at low cost, and with fast network turn-up by deploying a plurality mesh access points to provide network coverage in a geography. Mobile applications may be configured to communicate at least in part via the mesh access points. Such mobile applications may include an unregistered mobile application receiving a certain QoS provided by the

MBRI with mesh access points. For example and without limitation, an application may operate as an unregistered application until a user possessing a registration key registers it. While operating as an unregistered mobile application, the application may receive the certain QoS from the MBRI. Once registered, however, the application may receive a different and more desirable QoS from the MBRI. In some embodiments, a provider of the MBRI (or any other entity) may receive compensation for issuing the registration key to the user. It will understood that a variety of mobile applications may be associated with the MBRI's ability to be deployed quickly, at low cost, and with fast network turn-up. All such mobile applications are within the scope of the present disclosure.

[00539] Referring to Fig. 87, a mobile broadband routable internet may be beneficially used with a variety of devices, some of which are described herein, others of which will be understood, and all of which are within the scope of the present disclosure. Devices 8702 may be enabled on the mobile broadband routable internet by one or more enablers associated with the mobile broadband routable internet. The devices 8702 may include smart phone/PDAs 8704, PCMCIA cards 8708, cell phones 8710, computers 8712, servers 8714, networks 8718, appliances 8720, net connected devices (home/enterprise) 8722, portable e-books 8724, sensors 8728, surveillance cameras 8730, navigation devices 8732, traffic lights 8734, parking facilities 8738, parking meters 8740, RFID scanners 8742, utility meters 8744, health/medical devices 8748, entertainment systems 8750, and the like. Further examples of devices may include appliances which may include: refrigerators which may include: bottom-mount freezer, top-mount freezer, reversible door, French door, side-by-side, built-in, counter-depth, freezer-less, compact, through-the-door services, frost-free refrigeration, and other cooling or freezing appliances; ranges which may include: cook-top and wall oven, freestanding ranges, gas ranges, duel-fuel ranges, electric ranges (including open-coil burners, smooth top burners, and halogen burners, bridge elements, high-, medium- and low-power burners), convection ranges, tri-vection ranges, commercial-style ranges, and other cooking or heating type appliances; dishwashers which may include: built-in, portable, drawer, ultra-compact, dish-drawer, and other hard material type washing appliances; clothes washers which may include: top-loader, front-loader, combination washer-dryer, and other soft material type washers; dryers which may include: electric dryers, gas dryers, and other types of drying or water removal appliances; microwaves which may include: compact, full-size, mid-size, convection, browning capabilities, and other non-thermal food or matter heating appliances; televisions which may include: CRT tubes, LCDs, plasma, DLP, LCoS rear-projection, SDTV, EDTV, HDTV, and other display devices; surveillance cameras which may include: CCDs, color, black and white, fixed focal length, variable focal length, pan tilt zoom (PTZ), infrared, dome, mini-dome, bullet cameras, wireless, vandal-resistant, spy cameras, board cameras, mini-board cameras, IP cameras, motion-activated, body-worn cameras, with built-in DVR, and other types of image acquisition devices; navigation devices; RFID scanners which may include: antenna, multiple antenna, fixed, handheld, vehicle-mounted, wireless sensors, animal tracking devices, automated vehicle identification systems, host based card readers, card access systems, license plate inventory and recognition systems, and other radio frequency identification type sensors; utility meters which may include: usage meters, demand meters, variable rate meters, multiple tariff meters, time-of-use meters, measured in watts, kilowatts, joules, or mega joules, and other types of utility type meters for water, electricity, gas, oil, and the like. These and other devices as may be selected based on the above exemplary list of devices are included herein.

[00540] Enablers associated with the mobile broadband routable internet may include routing prioritization, network support for peer-to-peer traffic, peer to peer connectivity within mobile broadband routable internet, facilitating file sharing, user-generated and peer-to-peer applications without degrading system performance, direct device-to-device peering with symmetrical throughput, direct-to-device application deployment (e.g., for web 2.0 apps), distributed data for web apps in the mobile broadband routable internet device, distributed applications, multicast routing , remote network monitoring, control, and upgrade , adaptive transmit power control , FEC on long ip packets, adaptive link data rate , DYSAN - spectrum aware, spectral reuse with high system level throughput, frequency agnostic operation (operation at any frequency), network geo-location , multimedia , time synchronization , seamless outdoor and indoor operation , seamless indoor/outdoor broadband coverage, efficient use of real estate required for fixed radio installation , efficient connection to other wired telecom infrastructure required for connection to other networks , multiple fixed network gateway interfaces , low cost and fast network design engineering and deployment planning , low cost, fast deployment and network turn-up , low cost and fast capacity expansion and network upgrade , efficient use of existing backbone communications infrastructure, network end-user deployment participation , base station controller functions enabled subscriber device, service provider tools to manage consumption in a mobile internet, full radio resource management enabled subscriber device, multi-session enabled subscriber device, cost-based routing in a subscriber device, fully enabled ip router in subscriber device, MAC layer in subscriber device, route diversity, layer 2 forwarding (VPN, etc), internet-equivalent routing to mobile devices outside cellular regime - no need for walled garden or operator control of application deployment), ip application deployment to mobile devices outside cellular regime, mobile internet-style network , entirely local mobile internet applications, broadband throughput data rates to mobile subscriber devices, broadband throughput at vehicular speed mobility, mobile broadband routable internet basic, local ip-based swarming, and the like.

[00541] Below are representative embodiments of devices enabled on the mobile broadband routable internet.

[00542] Devices that may be associated with the mobile broadband routable internet may include traffic signals that may be enabled by routing prioritization of the mobile broadband routable internet. Traffic management through computer automated control of traffic signals can improve traffic flow in congested roadways. It can also adjust traffic in a emergency to facilitate passage of emergency response vehicles. Traffic management systems may include communicating with devices in or associated with vehicles, fixed

beacon systems, emergency response systems, planning systems, traffic analysis systems, weather systems, and the like. When an urgent communication, such as an emergency response signal is present, its routing may preferably be prioritized over other traffic management communication. The mobile broadband routable internet routing prioritization capabilities may allow the urgent communication, which may be encoded as IP data packets coded for priority transmission, to receive priority routing so that the communication will be transmitted through the routable nodes of the mobile broadband routable internet before other communication. In this way, when an emergency response vehicle is about to enter a potentially congested road system, an emergency response communication may be prioritized so that it reaches traffic light control facilities urgently so that traffic along the emergency response vehicle route may be controlled accordingly to allow unimpeded passage.

[00543] Devices that may be associated with the mobile broadband routable internet may include appliances that may be enabled by support for peer-to-peer traffic of the mobile broadband routable internet. Appliances, such as home appliances may be computer controlled and may use the mobile broadband routable internet to communicate with each other, with power metering and control circuits, with home computers, home owner devices, and the like. In an example, a user may be returning home from shopping at a grocery store and the user's mobile device may have received a list of all purchased items from the point of sale system at the grocery store. The user's refrigerator may have established a peer-to-peer connection with the user's device and may use the connection to monitor for updates to the list of purchased items. The refrigerator controller may adjust the settings of the refrigerator based on the updates to the list. In this example the support for peer-to-peer traffic in the mobile broadband routable internet may facilitate automated control of appliances. In another example, a frost-free freezer includes a heating element to keep the interior of the freezer from collecting frost. The freezer controller may exchange peer-to-peer traffic with a electrical service panel that may identify times of peak loading of the electrical power grid. The freezer controller may use the information exchanged in the peer-to-peer traffic to schedule frost-free operation during non-peak times.

[00544] Peer-to-peer connectivity with the mobile broadband routable internet may enable devices, such as servers. Servers may include compute servers, web servers, data servers, video servers, audio servers, shared servers, virtual servers, server hosting facilities, and the like. Access to data, information, video, audio, and the like on servers may be achieved through peer-to-peer connectivity. The mobile broadband routable internet may facilitate this connectivity so that mobile devices on the mobile broadband routable internet may use peer-to-peer connection with the servers. In an example, a mobile device may be part of a peer-to-peer network using the peer-to-peer features of the mobile broadband routable internet. A server may include information that the user of the device may wish to access. By establishing peer-to-peer connectivity between the server and the user device, such as through the peer-to-peer network associated with the device,the user may access the server data in a peer-to-peer mode. Peer-to-peer

connectivity has many well known advantages that can be made available to servers, devices, and the like that are connected to the mobile broadband routable internet.

[00545] Devices that may be associated with the mobile broadband routable internet may include health and/or medical devices that may be enabled by device-to-device peering with symmetrical throughput of the mobile broadband routable internet. Health / medical devices may include a personal electrocardiogram (ECG) monitor, a home defibrillator, a CAT scan, a MRI scan, a PET scan, a heart monitor, a BP monitor, an x-ray, a surgical robot, a glucose monitor, a diagnostic device, a therapeutic device, an administrative device, and any other medical or health device. By peering two devices and providing symmetrical throughput between the peered devices, the mobile broadband routable internet may facilitate critical information exchange needed for some medical procedures. In an example, robot assisted surgery may benefit from peered symmetrical throughput that ensures interaction with other devices, such as a controller, sensors, and the like is properly configured for safe operation of the device.

[00546] Devices that may be associated with the mobile broadband routable internet may include smart phones and/or PDAs that may be enabled by direct-to-device application deployment (e.g. for web 2.0 applications) features provided by the mobile broadband routable internet. Smart phones which may be capable of executing software applications including, without limitation, scheduling (calendar), email, and the like may receive direct application deployment through the mobile broadband routable internet. In an example, a smart phone may be one of the plurality mobile devices that make up the mobile broadband routable internet. The device may communicate through the mobile broadband routable internet with a web service that supports download of applications. Because the smart phone is a IP addressable device in the mobile broadband routable internet, the web service may deploy one or more applications, such as applications that the user of the smart phone has requested, directly to the smart phone. One reason why the web server may download directly to the smart phone is because the communication between the smart phone and the web server is not required to pass through any management network, such as a cellular provider service. In the example, the application may provide phone number lookup capabilities to the smart phone and auto dial capabilities that would allow the smart phone to lookup a traditional land-line phone number over the mobile broadband routable internet and then automatically dial over the cellular network to call the number.

[00547] Devices that may be associated with the mobile broadband routable internet may include PCMCIA cards that may facilitate distributing data for web applications associated with the mobile broadband routable internet. PCMCIA cards may include various types of memory, dedicated functions such as communication ports, general functions such as process accelerators, and the like. PCMCIA cards may facilitate distributed data in the mobile broadband routable internet by providing data storage at one or more of the nodes in the mobile broadband routable internet. Some PCMCIA card features may also be enabled by distributed data for web applications over the mobile broadband routable internet. By providing high density

storage at a plurality of the devices that make up the mobile broadband routable internet, PCMCIA memory devices may be used to support distributed data. In an example a web application, such as an application that monitors electronic auctions may store information associated with user bids (e.g. current bid, maximum bid, bid increment, end time of the auction, and the like) on the user's mobile device in a PCMCIA storage device. Alternatively, the information may be stored on another device. Multiple copies of the information may be available and may be synchronized so that even if the user's device is off-line, the web application may still have access to the user's information to provide bid monitoring and automatic bidding. However, not all of this information need be stored on the user's mobile device. Instead, a portion, such as the auction end time may be stored on another device. The web application may store and access the information on devices in the mobile broadband routable internet so that the information is always available and readily updated.

[00548] For intelligent PCMCIA cards, such as specialty function cards, the distributed data capabilities of the mobile broadband routable internet may enable certain features of the PCMCIA cards. In an example, a PCMCIA card may provide data flow processing capabilities, such as virus detection, for a node in the mobile broadband routable internet. As data is distributed to a portion of the PCMCIA memory, the data may be processed by the PCMCIA data flow processor to check for viruses in the data. Alternatively, the PCMCIA card processor may be enabled to perform virus cleaning of the data that is distributed to the PCMCIA card.

[00549] Devices that may be associated with the mobile broadband routable internet may include one or more networks of devices that may be enabled by distributed applications associated with the mobile broadband routable internet. Applications that are deployed as distributed applications on nodes of the mobile broadband routable internet may function in a coordinated fashion to establish a form of network. The distributed applications may provide node discovery and recovery capabilities so that mobile broadband routable internet nodes that appear to be no longer connected to the network may be discovered and potentially recovered to be part of the network. Distributing such an application may be important because device discovery may be based at least in part on local and direct connection between a discovering device and a discovered device.

[00550] Devices that may be associated with the mobile broadband routable internet may include entertainment devices that may be enabled by multicast routing features of the mobile broadband routable internet. Multicast routing allows a single source to identify a plurality of destination nodes or no specific destination node to receive a transmission. In this way, all devices that detect the multicast routing transmission may receive the transmission independently of any other device that is receiving the transmission. The mobile broadband routable internet may provide multicast routing by ensuring that the transmission is routed to every node, such as if no destination node is specified, or to all specified destination nodes. Therefore, as an example, an entertainment device, such as a video game for networked multi-user game a means for play may take advantage of the multicast routing capabilities of the mobile broadband

routable internet to distribute background scenes, update leader boards, distribute new game features, and the like. In another example, game play start and/or stop may be signaled to every entertainment device through the use of multicast routing.

[00551] Devices that may be associated with the mobile broadband routable internet may include computers that may participate in remote network monitoring, control, and upgrade of the mobile broadband routable internet. Devices, such as computers that are connected to the mobile broadband routable internet may include remote services that facilitate network monitoring, control, and upgrade. A computer connected to the mobile broadband routable internet may be remotely monitored by another computer or device over the mobile broadband routable internet. In contrast to networks that do not provide IP routing to the individual device, the mobile broadband routable internet allows any device on the network to remotely communicate with any other device on the network. Remote communication may include monitoring the device over the network, controlling the device remotely, and remotely upgrading aspects of the device such as software, configuration, features, applications, and the like. In an example, an enterprise may use the mobile broadband routable internet to connect computers associated with the enterprise (e.g. an accounting computer, an engineering computer, a manufacturing computer, and information technology management computer, portable computers, mobile computers, and the like). In the example, the enterprise computers may or may not be co-located. Further in the example, the information technology management computer may remotely monitor application status on any or all of the other enterprise computers by accessing the other enterprise computers over the mobile broadband routable internet. As needed, the information technology computer may provide a remote update or upgrade of application software to one or more of the other enterprise computers by transmitting (e.g. using the multicast capabilities of the mobile broadband routable internet) application upgrade information to each of the other enterprise computers.

[00552] Devices that may be associated with the mobile broadband routable internet may include RFID sensors (e.g. scanners) that may be enabled by adaptive transmit power control that facilitates adapting transmission power of the device. The transmission power of the device may be adapted based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device, an application requirement of the device, and the like. Application of RFID scanners may benefit from the adaptive transmit power control features of the mobile broadband routable internet. In an environment that includes a large number of RFID scanners, such as in a high volume package handling environment, mobile broadband routable internet connected RFID scanners may adapt transmit power based on the operational mode of the scanner. If the scanner does not have any RFID scanned data to transmit, the transmission power may be reduced, thereby reducing or eliminating potential high power signal transmission interference. Also as packages in the high volume handling environment pass near

the scanner, the scanner may increase its transmission power to ensure that a transmission of a scanned RFID properly reaches a destination device in the mobile broadband routable internet.

[00553] Devices that may be associated with the mobile broadband routable internet may include portable digital books (e.g. e-books) that may benefit from forward error correction on long IP packets features of the mobile broadband routable internet. E books may offer preview capability that may allow a user of the e-book to download for review a portion of an e-book. It may be convenient for a host, such as a web server providing the preview content to send is as long IP packets. By applying forward error correction (FEC) to the long IP packets, the packets can be transmitted through several routing nodes and errors accumulated along the way may be corrected through FEC. Forwarding error correction may be usefully applied to medium length and short IP packets, however the overhead of FEC for these types of packets may not be as efficient as other correction methods. However, by offering FEC on long IP packets as part of the routing and data packet handling protocol enacted by the mobile devices in the mobile broadband routable internet, routing errors associated with transmitting long IP packets can be corrected.

[00554] Devices that may be associated with the mobile broadband routable internet may include utility meters that may benefit from adaptive link data rate features of the mobile broadband routable internet. Adapting a data link rate associated with a device may be based on at least one of the density of devices in the network, the condition of neighboring devices in the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition, an application requirement, and the like. A utility meter may communicate over the mobile broadband routable internet to utility connected devices being served by the utility meter. When a served device is operating in a lower power consumption mode, such as when a computer operates in stand by mode, the utility meter may reduce the transmit link data rate so the device in the standby or lower power mode does not have to increase power consumption to receive a communication. In that some devices served by the utility meter may be operating in low power mode and others may be operating in normal or high power mode, the mobile broadband routable internet transmit facility on the utility meter may dynamically adjust the transmit link data rate based on the status of the transmission destination.

[00555] Devices that may be associated with the mobile broadband routable internet may include navigation devices that may benefit from dynamic spectrum access capabilities within the network that facilitate determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination. Navigation devices are generally in motion during use. Navigation devices may move through a wide range of environments that may impact transmit and receive signal quality. The spectrum access capabilities of the mobile broadband routable internet may enable a navigation device to receive and send information over the mobile broadband routable internet independent of the changing signal quality conditions. As portions of the wireless communication spectrum degrade or improve based at least on the changing environment, a navigation system that communicates over the mobile

broadband routable internet take advantage of the mobile broadband routable internet dynamic spectrum access capabilities by determining communication spectrum quality and adjusting a wireless radio operation in response to the determined spectrum quality changes.

[00556] Devices that may be associated with the mobile broadband routable internet may include cellular phones. Cellular phones may be enabled on the mobile broadband routable internet by spectral reuse of the wireless communication spectrum which may result in high system level throughput. Cellular phones may be enabled through spectral reuse by providing access to the communication spectrum for alternate uses such as cellular communication. In an example, cellular phone communication may be converted to IP packets and transmitted over any time frequency rectangles within portions of the spectrum that come available after another device no longer uses the time frequency rectangles.

[00557] Devices, such as sensors may be enabled on the mobile broadband routable internet through frequency independent operation of the network. Sensors may be deployed in a wide range of environments and applications. The conditions related to wireless communication associated with each environment may result in no one frequency or range of frequencies being available in all environments. Sensors, such as wireless sensors, that communicate at a fixed frequency or in a fixed range of frequencies may not be useful in all sensor applications. This may limit a sensor's usefulness to a small range of applications. A sensor configured to use the mobile broadband routable internet could communicate with other devices on the mobile broadband routable internet independently of frequency. Therefore mobile broadband routable internet enabled sensors can be deployed in any application environment.

[00558] Devices, such as vehicle parking related devices that facilitate searching for parking, reserving parking, finding the reserved parking, paying for parking, and the like may be enabled on the mobile broadband routable internet through network geo-location. Devices associated with vehicle parking may include devices in urban areas have high demand for parking. A user of the mobile broadband routable internet may be operating a vehicle in an urban area and may desire to find nearby parking. A parking search device may use the mobile broadband routable internet to determine the user's current location through the geo-location detection capabilities of the network. Based on the detected location, choices of parking options may be delivered to the user device over the mobile broadband routable internet. The unique device based routing and network topology sensing capability of the mobile broadband routable internet facilitates geo-location by being able to detect a device within a swarm of devices. When the geo-location of one or more devices in the swarm is known, or a fixed infrastructure device (e.g. a fixed radio device associated with a parking facility) is proximate to the swarm in which the device is located, the geo-location of the selected device may be determined.

[00559] Devices, such as net connected devices for home and/or office may be enabled on the mobile broadband routable internet through multimedia capabilities of the mobile broadband routable internet. The multimedia capabilities may be provided on the mobile broadband routable internet through a hybrid

frame structure that includes variable slot duration and sub-channelization of bandwidth. Home and/or office net connected devices may include media devices such as television, music players, appliance control, temperature control, automatic lighting, and the like. Multimedia capabilities of the mobile broadband routable internet may facilitate connecting devices with very diverse communication requirements to one network. While a television may require large amounts of communication bandwidth and may include several video channels and audio channels (e.g. two or more channels may be used for stereo sound), automatic lighting may have very low communication bandwidth demand. Automatic lighting may require very small but intense communication to perform lighting related functions such as on, off, dim, and the like. The mobile broadband routable internet may enable both a television and automatic lighting by providing long duration communication slots to the television communication and short duration communication slots for communicating with an automated lighting fixture.

[00560] Devices, such as medical / health devices may be enabled on the mobile broadband routable internet through time synchronization of network devices and communication. Medical / health devices may include automatic dosing devices that need to provide controlled medicine doses at precise times. Other devices may precisely measure medicine delivery. Accurate time synchronization among these devices may ensure that medicine is delivered precisely at the precise time. Time synchronization may also facilitate adding a new medical / health device to the mobile broadband routable internet by providing the new device a representation of network timing with sufficient accuracy to enable reliable communications. The device may use the network timing information to determine neighboring devices and accurately determine communication times to some other mobile broadband routable internet connected devices. Time synchronization may also enable automated switch-off from one medical device to another. By using the representation of network timing, a digital x-ray device may optimally allocate buffer memory to ensure no loss of data during image capture while ensuring the most rapid transfer of the image data from the x-ray to a data storage or image viewing device.

[00561] Devices, such as surveillance cameras may be enabled on the mobile broadband routable internet through the seamless indoor and outdoor operation of the network. Surveillance cameras may be placed at entrances and exits of a facility such as to aid in securing the safety of the facility and the occupants. Secure access to a facility may include an electronic key card or security device that the user submits to examination to gain access to the facility. By combining surveillance cameras and security key card / devices with the mobile broadband routable internet, users may be detected by a surveillance camera outside a facility, verified for entry through validation of the electronic security card/device, detected by the surveillance camera inside the facility, and confirmed by the seamless connection of the security card /device upon entry to the facility with the mobile broadband routable internet operating within the facility.

[00562] Devices, such as parking meters may be enabled on the mobile broadband routable internet through efficient connection to other wired telecom infrastructure as may be required for connection

to other networks. A network of parking meters in a city may be connected to the mobile broadband routable internet to provide information about parking meter status and fee payment for enforcement. The parking meters may also be connected to the mobile broadband routable internet to provide a user who has parked his car in the parking space associated with the parking meter with updates on time left, automated fee payment capabilities, and the like To the extent that parking meters are plentiful, generally deployed in busy areas, and comprise a fixed infrastructure, a parking meter that is configured to communicate over the mobile broadband routable internet may also act as a fixed infrastructure facility, such as a backhaul access point (BAP). In this way, this dual purpose device may provide BAP capabilities as well as mesh access point (MAP) features for other devices connected to the mobile broadband routable internet.

[00563] Devices may be enabled by a variety of elements, features, capabilities, and technologies associated with the mobile broadband routable internet, all of which are included in mobile broadband routable internet enablers. The mobile broadband routable internet enablers may include any of the following.

[00564] OFDMA may include orthogonal frequency division multiple access protocol. PHY convergence may include a physical layer sub-convergence protocol that hides the internal complexities of the native waveform from the formal layer interfaces above the MAC layer or for applications and services using the PHY layer via an upper layer API - Application Programming Interface. SAR may include segmentation and reassembly - a protocol that breaks up PDU (packet data units) into sub fragments where each sub-fragment is transmitted from one node to another in strict sequence based on available frame space in the slotted TDMA framing protocol used by mobile broadband routable internet (NAMA protocol). LANTA may include time synchronization for MANET without requiring GPS and atomic clock reference sources for self timing (e.g. a distributed protocol that calculates its GPS position with respect to known GPS sources by exchanging time/position relative information with its neighbors and peers). Channel access may include access to radio resources and transmit/receive slot information in a slotted TDMA (NAMA) frame. Queue serving may include quality of service information used to traverse queues prioritized by priority, payload type, latency and size information with weighting technology to prevent information aging and stale delivery. ADR may include adaptive data rate algorithms used to find the highest output and best quality route for information transport on a packet by packet basis between peers in the mobile broadband routable internet network. NDM may include neighbor discovery mgmt. a sub protocol for new peers entering into the network or accessing a new MAP or BAP. ROM may include receiver oriented multicast a protocol for multicast transport based on available spanning information using receiver data such as signal strengths and signal stability. SLSR may include scoped link state routing protocol used by the mobile broadband routable internet MANET to make routing decisions transparent with respect to BGP4 (IPv4 and IPv6) edge protocols and OPSF (open shortest path first) protocols used by the Internet. SLSR uses the 1 and 2 hop neighbor information to make route information for packets traversing the MANET more accurate the closer the packets get to the wired Internet. DySAN TDD may include dynamic spectrum awareness for time division

duplex systems such as WiMax. DySAN FDD may include dynamic spectrum awareness for frequency division duplex systems such as LTE. OSS may include operation support system interfaces that support remote fault, configuration, billing, performance monitoring and security monitoring of the mobile broadband routable internet network, equipment and devices. RF front end may include a small bandwidth, known center frequency, and analog radio frequency transceiver. Wide band RF front end may include a wide band RF front end that is tunable across a very broad frequency range (but the operating range may still be relatively small, such as 20 Mhz). Adaptive power control may include an ability to adapt the transmit power to the known RF conditions such that the least amount of power is used on a frame by frame basis to transmit information to MANET peers.

[00565] Within the MBRI, multiple fixed-network gateway interfaces (such as and without limitation backhaul access points) may connect the mobile ad hoc network to the fixed network. A device may communicate with a mobile device and a device on the fixed network. For example and without limitation, a smart phone or PDA may communicate with both the mobile device and the device on the fixed network via the TCP/IP protocol as supported by the MBRI. Packets addressed to the device on the fixed network may be routed through the MBRI to at least one of the fixed-network gateway interfaces and from there be routed by the fixed network to the device. It will be understood that a variety of devices may communicate with a mobile device and a device on the fixed network. All such devices are within the scope of the present disclosure.

[00566] An automated network design tool may facilitate low cost and fast network design engineering and deployment planning of fixed infrastructure elements of an MBRI.

[00567] The design and planning may call for deploying devices, such as and without limitation PCMCIA cards, to be included in machines that communicate via the MBRI. For example and without limitation, the deployment planning may include plans to install a mesh access point on a college campus and then install PCMCIA cards in laptop computers used at the collect campus. Together, the mesh access point and the PCMCIA cards may use and/or provide all or part of the MBRI. It will be understood that a variety of devices may be configured to use the network designed by the by the design tool. All such devices are within the scope of the present disclosure.

[00568] In some embodiments, an MBRI may be deployed quickly, at low cost, and with fast network turn-up by deploying a plurality mesh access points to provide network coverage in a geography. A device may communicate at least in part via the mesh access points. For example and without limitation, a suitable cell phone may communicate via the MBRI with other mobile devices. Some of the mobile devices may not be in direct communication with cell phone due to power constraints on radio transmissions, poor signal-to-noise radio of transmissions, extended distances between the mobile devices, radio obstructions between the mobile devices, multi-path effects caused by urban terrain, any and all combinations of the foregoing, and so on. In some such cases, those mobile devices not in direct communication with the cell

phone may be in direct communication with a mesh access point that is in communication with the cell phone. Alternatively, the mesh access point may be in communication with one or a series of other mesh access points, at least one of which is in communication with the cell phone. In any case, routing of packets in the MBRI (as described herein and elsewhere) may dictate that communications between the cell phone and the other mobile devices involves the cell phone communicating with at least one of the mesh access points. It will be understood that a variety of devices may communicate at least in part via the mesh access points. All such devices are within the scope of the present disclosure.

[00569] In some embodiments, an MBRI may be quickly expanded, at low cost, by adding small form factor nodes. These nodes, which may be described in greater detail herein and elsewhere, may include mesh access points, backhaul access points, or the like. A device may communicate at least in part via the small form factor nodes. For example and without limitation, a computer that is the device may communicate with other devices via the MBRI, as described elsewhere herein. It will be appreciated that such communications may involve data packets traversing one or more access points, any and all of which may be the small form factor nodes. It will be understood that a variety of devices may communicate at least in part via the small form factor nodes. All such devices are within the scope of the present disclosure.

[00570] In some embodiments, an MBRI may make efficient use of existing backbone communications infrastructure. Such embodiments may route communications between a mobile device and a device on a remote network so as to substantially favor routes through the mobile, broadband, routable Internet that have fewer hops between the mobile device and a backhaul access point. For example and without limitation, a server may be the mobile device or the device on the remote network. As the server communicates, its communications may be routed as just described in this paragraph. It will be understood that a variety of devices may use said communications. All such devices are within the scope of the present disclosure.

[00571] In some embodiments, a user deployable access point may connect to the MBRI network. A device may utilize said access point. For example and without limitation the device may include a fixed network that utilizes the access point as a bridge between itself and the MBRI. Here, the access point may be a backhaul access point, which is described in detail herein and elsewhere. Other examples of devices that could use the access point include PDAs, sensors, computers, and so on. It will be understood that a variety of devices may use the access point. All such devices are within the scope of the present disclosure.

[00572] In some embodiments, a base station controller function may be provided in at least one subscriber's mobile device. For example and without limitation, the mobile device may be a network appliance (e.g. file server, print server, or the like), a household appliance (e.g. toaster, refrigerator, or the like), or any other kind of appliance. In any case, a user of the mobile device may use the base station controller function to control a base station that is integral to the mobile device. It will be understood that a

variety of devices may include and employ at least one base station controller function. All such devices are within the scope of the present disclosure.

[00573] In some embodiments, a service provider tool may be provided, the service provider tool for manage consumption of at least one device on the ad hoc network of the MBRI. The tool may be deployed on at least one of the plurality of mobile devices of the MBRI and may use at least one management path for reporting usage of the at least one device. A device may use the management path to report usage of the device. For example and without limitation, the device may include a network-connected device in a home or office. Each web site visited by a user of the device may include logged and reported via the management path to a remote computer. In this way, remote monitoring of a user's web site visits may be achieved. A variety of other measurements of usage of the device will be appreciated, and all such usages are within the scope of the present disclosure. Moreover, it will be understood that a variety of devices that use the management path to report usage of the device are possible. All such devices are within the scope of the present disclosure.

[00574] In some embodiments, full radio resource management functions may be provided in a subscriber's mobile device. The mobile device may operate responsively to a state of a managed radio resource. For example and without limitation, the mobile device may be a portable book or so-called e-book. The portable book may be capable of downloading content via the MBRI, but only when the radio is switched into an appropriate state (e.g. an on/active state). The portable book may detect when the radio is switched into the appropriate state and may download the content while the radio is in the appropriate state. A variety of radio resource management functions will be appreciated, and all such management functions are within the scope of the present disclosure. Moreover, it will be understood that a variety of devices are possible. All such devices are within the scope of the present disclosure.

[00575] In some embodiments, multi-session functions may be provided in at least one of a plurality of devices of an MBRI. Such devices may then communicate via multiple sessions. For example and without limitation, such devices may include sensors, which may communicate routine information in one session and high-priority alerts in another session. The session handing the high-priority alerts may be configured to retransmit the alert until receiving confirmation that the alert was delivered to an intended recipient. The session handling the routine information, however, may be configured to deliver the routine information using a best-effort delivery mechanism that does not guarantee and/or confirm delivery to an intended recipient. It will be understood that a variety of devices communicating via multiple sessions are possible. All such devices are within the scope of the present disclosure.

[00576] In some embodiments, cost-based routing functions may form and reform links and routes through the MBRI. A device may use the cost-based routing functions to deliver a desired balance of cost and quality of service. For example and without limitation, a personal area network may encompass a device that communicates with other devices or nodes via the MBRI. Devices of the personal area network

may include any and all electronic devices carried on one's person and communicating with other devices of the personal area network. Such devices may include a storage device, a computing device, a heads-up display or the like, a keypad-based input device, and so on. In any case, each of the devices of the personal area network may be relatively small and powered by a batteries enclosed therein. In order to provide longer battery life, the devices may be configured to transmit using a relatively small number of Joules-per-bit. When the devices of the personal area network are in communication with the MBRI, the desired balance of cost and quality of service may relate to the number of Joules consumed by the devices, on the one hand, and the effective data rate between the personal area network and the MBRI on the other hand. It will be understood that a variety of devices may use the cost-based routing functions to deliver a desired balance of cost and quality of service. All such devices are within the scope of the present disclosure.

[00577] In some embodiments, a IP router functions may be provided in a subscriber's mobile device. A device may use the IP router function to communicate via the ad hoc network of the MBRI. For example and without limitation, the device may include a surveillance camera that is part of an ad hoc network of surveillance cameras. Each of the cameras may transmit data packets containing video data through the ad hoc network, eventually reaching a backhaul access point from which the data packets travel through a fixed network to a central operations center or the like. In order to route the data from the cameras, one or more of the surveillance cameras may use a built-in IP router function that routes the data as appropriate. It will be understood that a variety of devices may use the IP router function to communicate via the ad hoc network of the MBRI. All such devices are within the scope of the present disclosure.

[00578] In some embodiments, at least one of a plurality of mobile devices in an MBRI may include media access control layer capabilities. A device may use the MAC layer to communicate via the ad hoc network of an MBRI. For example and without limitation, the device may include a navigation device, which may receive multicast or broadcast data packets from a source of road traffic data. The device may only receive data packets having a MAC address of the source. Although this may not guarantee that the data packets are in fact from the source (in some embodiments, the MAC address may be spoofed), it will limit the number of packets that the device needs to consider when listening to multicast or broadcast packets. It will be understood that a variety of devices that use the MAC layer capabilities to communicate via the ad hoc network are possible. All such devices are within the scope of the present disclosure.

[00579] In some embodiments, route diversity may be provided within an MBRI network to facilitate assurance of packet communication. Route diversity may be based at least on a number of network devices in a geographic area, which provide a diverse selection of routes through which packet communication may travel. A device may use route diversity to communicate via the ad hoc network of an MBRI. For example and without limitation, the device may include traffic lights and a plurality of such devices may in communication with one another via the MBRI. This communication may enable the traffic lights to stay synchronized so that, for example, some traffic may be allowed to travel across a city at the

city's speed limit and without encountering a red light. Due to vagaries of the MBRI (e.g. nodes joining and leaving, intermittent multi-path or other deleterious environmental effects, and so on), the route diversity may enable the traffic lights to stay synchronized even as particular routes through the MBRI change, become available, become unavailable, and so on. It will be understood that a variety of devices may use the route diversity to communicate via the ad hoc network. All such devices are within the scope of the present disclosure.

[00580] In some embodiments, layer 2 forwarding may be provided within an MBRI, and a device may communicate via said forwarding. For example and without limitation, a parking access device may enable a user to open a garage door to a parking garage. A controller of the garage door and the parking access device may communicate via a virtual private network that is enabled by the layer 2 forwarding. Access to the virtual private network may be controlled, thus preventing an unauthorized parking access device or other mobile device from communicating with the controller of the garage door. It will be understood that a variety of devices may communicated via the layer 2 forwarding. All such devices are within the scope of the present disclosure.

[00581] In some embodiments, a node in an MBRI may also communicate with a cellular network through at least one fixed infrastructure element (e.g. a cell tower or the like) while the MBRI is provided outside the cellular network. In such embodiments the node (i.e. a device) may communicate both through the cellular network and a mobile ad hoc network. For example and without limitation, the device may be a parking meter that communicates via the MBRI to handheld nodes of traffic enforcement personnel in order to alert that personnel that the parking meter has expired. The parking meter may also communicate through the cellular network to a central computer to report revenue gathered or other usage statistics. It will be understood that a variety of devices that communicate through the cellular network and the mobile ad hoc network are possible. All such devices are within the scope of the present disclosure.

[00582] In some embodiments, IP application deployment may be provided to a device in an MBRI network. In addition to communicating with the MBRI, the device may also communicate with a cellular network through at least one of the fixed infrastructure elements of the MBRI. For example and without limitation, the device may be an RFID scanner for tracking merchandise in a warehouse. As items are moved in and out of the warehouse, the RFID scanner may detect the items movement and report the movement over the cellular network to a central accounting system. From time to time, application software within the RFID scanner may be updated via IP application deployment over the MBRI. Such updates may patch the application software to fix bugs, enhance features, or the like. It will be understood that a variety of devices may be deployed over IP to a device in the MBRI network, the device also communicating with the cellular network. All such devices are within the scope of the present disclosure.

[00583] In some embodiments, data packets may be routed through the mobile ad hoc network of an MBRI. The data packets may be IP packets or the like, and thus the MBRI may provide a mobile Internet-

style network. A device may communicate via the packets. For example and without limitation, the device may be a utility meter that communicates a metered value to a utility's accounting system via the MBRI. It will be understood that a variety of devices that communicate via the packets are possible. All such devices are within the scope of the present disclosure.

[00584] In some embodiments, data packets may be routed through the mobile ad hoc network of an MBRI absent communications with fixed infrastructure elements of the MBRI. Thus, a device may communicate solely within the mobile ad hoc network. For example and without limitation, a health/medical device may be used in a hospital setting in which cellular-type communications could cause harmful interference with other devices. The device may communicate solely via low-power communications with proximate mobile devices in an MBRI and thus may not cause such harmful interference. It will be understood that a variety of devices may communicate via packets routed through the mobile ad hoc network absent communications with fixed infrastructure elements. All such devices are within the scope of the present disclosure.

[00585] In some embodiments, during normal operations the MBRI may provide broadband communications of at least 768 kbit/sec between nodes. A device may communicate via the broadband communications. For example and without limitation, a device may include an entertainment system providing on-demand movies for viewing. The movies may be downloaded on-demand via broadband communications of sufficient bandwidth to support on-demand viewing. It will be understood that a variety of devices may communicate via broadband communications. All such devices are within the scope of the present disclosure.

[00586] In some embodiments, the MBRI may provide communications to nodes having a throughput of at least 768 kbit/sec when the nodes are in motion at vehicular speeds. A device may use such communications. For example and without limitation, the device may include a smart phone/PDA used by a passenger in a car for video conferencing with users of other devices in the MBRI. The video conferencing may use the communications. It will be understood that a variety of devices may use communications having a throughput of at least 768 bkit/sec when at least one of the devices is in motion at vehicular speeds. All such devices are within the scope of the present disclosure.

[00587] In some embodiments, a device may communicate via the mobile ad hoc network of an MBRI. For example and without limitation, the device may include a PCMCIA card. Communications from the PCMCIA card may be transmitted and/or received by other mobile ad hoc devices that are operatively coupled to the mobile ad hoc network. It will be understood that a variety of devices may communicate via the mobile ad hoc network. All such devices are within the scope of the present disclosure.

[00588] In some embodiments, swarm intelligence may determine at least part of at least some routes through an MBRI. A device may communicate via the MBRI. The device may include a cell phone. For example and without limitation, to enable a phone call the cell phone may transmit VoIP data packets via the MBRI to another cell phone. As nodes or devices join, leave, and move about the MBRI any and all routes through the MBRI may change, become more or less available, and so on. Routes used by the VoIP data packets may follow at least some of the routes determined by the swarm intelligence. It will be understood that a variety of devices may communicate via an MBRI in which swarm intelligence determines at least part of the at least some of the routes. All such devices are within the scope of the present disclosure.

[00589] Those with ordinary skill in the art will appreciate that the elements in the figures are illustrated for simplicity and clarity and are not necessarily drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated, relative to other elements, in order to improve the understanding of the present invention.

[00590] The elements depicted in flow charts and block diagrams throughout the figures imply logical boundaries between the elements. However, according to software or hardware engineering practices, the depicted elements and the functions thereof may be implemented as parts of a monolithic software structure, as standalone software modules, or as modules that employ external routines, code, services, and so forth, or any combination of these, and all such implementations are within the scope of the present disclosure. Thus, while the foregoing drawings and description set forth functional aspects of the disclosed systems, no particular arrangement of software for implementing these functional aspects should be inferred from these descriptions unless explicitly stated or otherwise clear from the context.

[00591] Similarly, it will be appreciated that the various steps identified and described above may be varied, and that the order of steps may be adapted to particular applications of the techniques disclosed herein. All such variations and modifications are intended to fall within the scope of this disclosure. As such, the depiction and/or description of an order for various steps should not be understood to require a particular order of execution for those steps, unless required by a particular application, or explicitly stated or otherwise clear from the context.

[00592] The methods or processes described above, and steps thereof, may be realized in hardware, software, or any combination of these suitable for a particular application. The hardware may include a general-purpose computer and/or dedicated computing device. The processes may be realized in one or more microprocessors, microcontrollers, embedded microcontrollers, programmable digital signal processors or other programmable device, along with internal and/or external memory. The processes may also, or instead, be embodied in an application specific integrated circuit, a programmable gate array, programmable array logic, or any other device or combination of devices that may be configured to process electronic signals. It will further be appreciated that one or more of the processes may be realized as computer executable code created using a structured programming language such as C, an object oriented programming language such as C++, or any other high-level or low-level programming language (including assembly languages, hardware description languages, and database programming languages and technologies) that may

be stored, compiled or interpreted to run on one of the above devices, as well as heterogeneous combinations of processors, processor architectures, or combinations of different hardware and software.

[00593] Thus, in one aspect, each method described above and combinations thereof may be embodied in computer executable code that, when executing on one or more computing devices, performs the steps thereof. In another aspect, the methods may be embodied in systems that perform the steps thereof, and may be distributed across devices in a number of ways, or all of the functionality may be integrated into a dedicated, standalone device or other hardware. In another aspect, means for performing the steps associated with the processes described above may include any of the hardware and/or software described above. All such permutations and combinations are intended to fall within the scope of the present disclosure.

[00594] While the invention has been disclosed in connection with the preferred embodiments shown and described in detail, various modifications and improvements thereon will become readily apparent to those skilled in the art. Accordingly, the spirit and scope of the present invention is not to be limited by the foregoing examples, but is to be understood in the broadest sense allowable by law.

[00595] All documents referenced herein are hereby incorporated by reference.

CLAIMS

What is claimed is:

1. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in an environment, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing geo-location coding of device nodes in the network, wherein geo-location is based at least in part on a network location of a device node relative to other devices in the network; and

facilitating at least one location-based service by using geo-location of device nodes in the environment.

2. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in an environment, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing fixed radio installations that facilitate connection of the plurality of mobile devices, wherein the fixed radio installations are based at least in part on meeting a criteria associated with network radio propagation and performance; and

facilitating the use of the fixed radio installation for backhaul communication in the environment.

3. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

providing multiple fixed-network gateway interfaces connecting the mobile ad hoc network to a fixed network.

4. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

providing an automated network design tool to facilitate low cost and fast network design engineering and deployment planning of the fixed infrastructure elements of the network.

5. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

providing small form factor nodes that allow for low cost and fast capacity expansion and network upgrade.

6. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

routing data packets through the mobile ad hoc network.

7. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements.

8. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation.

9. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing support for peer-to-peer traffic within the network.

10. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet for a market, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing an adaptive transmit power control facility for a device within a market-based network, the adaptive transmit power control facility adapted to adjust transmission power of the device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device and an application requirement of the device.

11. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing dynamic spectrum access capabilities within the network by determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination; and

enhancing use of spectral bandwidth by a market using the dynamic spectrum access capabilities.

12. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet in the environment, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing multimedia support within the network through a hybrid frame structure that includes variable slot duration and sub-channelization of bandwidth; and facilitating market-related multimedia services using the multimedia support.

13. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements.

14. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation, wherein the method is directed at a traffic management method.

15. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds, wherein the method is directed at a traffic management method.

16. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation, wherein the method is directed at a traffic control lighting method.

17. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds, wherein the method is directed at a traffic control lighting method.

18. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation, wherein the method is directed at a parking meter method.

19. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds, wherein the method is directed at a parking meter method.

20. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing support for peer-to-peer traffic within the network.

21. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and providing a facility for distributing data among a plurality of mobile broadband routable internet devices.

22. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing a facility for distributing application components among a plurality of mobile broadband routable internet devices.

23. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing remote monitoring through the network.

24. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing remote control over the network.

25. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

establishing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing remote upgrade of at least one of software and services associated with the network.

26. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; and

routing data packets through the mobile ad hoc network.

27. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

applying swarm intelligence to determine at least some parts of at least some routes through the mobile, broadband, routable internet; and

providing a swarm based search web application that communicates via the mobile ad hoc network.

28. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing direct device-to-device peering with symmetrical throughput between at least two nodes of the mobile broadband routable internet; and

providing a search web application co-operating on the at least two nodes, wherein a search web application utilizes the symmetrical throughput between the at least two nodes.

29. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

facilitating direct-to-device application deployment over the mobile broadband routable internet; and

providing an e-commerce web application that is deployed directly to a device in the mobile broadband routable internet using direct-to-device application deployment.

30. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

providing the routable internet to a node in the network, wherein the node also communicates with a cellular network through at least one of the fixed infrastructure elements and the routable internet is provided outside the cellular network; and

providing a search web application that communicates both through the cellular network and the mobile ad hoc network.

31. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as sending and receiving nodes in a mobile ad hoc network and in which packets are IP routable to the individual devices independent of fixed infrastructure elements;

providing routing priority within the network, wherein the routing priority is provided by granting channel access to a node for which prioritized routing is identified and sending delay-sensitive data from the node before sending delay-tolerant data from the node; and

providing a voice over IP mobile application that uses the routing priority to manage routing of data within the mobile, broadband, routable internet.

32. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing direct device-to-device peering with symmetrical throughput between at least two nodes of the mobile broadband routable internet; and

providing a video conferencing mobile application co-operating on the at least two nodes, wherein the mobile application utilizes the symmetrical throughput between the at least two nodes.

33. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing multicast routing within the network by allowing a data object to be transmitted by a device to a plurality of destinations over a plurality of routes; and

providing a video conferencing mobile application that uses the multicast routing to at least distribute application-related updates.

34. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing an adaptive transmit power control facility for a device within the network, the adaptive transmit power control facility adapted to adjust transmission power of the device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device and an application requirement of the device; and

providing a point to point communication mobile application that uses adaptive transmit power control to adapt the transmit power associated with the application based on at least a density of devices.

35. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing forwarding error correction on at least long IP packets; and

providing a surveillance mobile application that is enabled at least in part by utilizing forwarding error correction on the mobile broadband routable internet.

36. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing dynamic spectrum access capabilities within the network by determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination; and

providing a distributed computing mobile application that uses the dynamic spectrum access capabilities to provide enhanced use of spectral bandwidth.

37. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; applying swarm intelligence to determine at least some parts of at least some routes through the mobile, broadband, routable internet; and providing a local IP-based swarming mobile application that communicates via the mobile ad hoc network.

38. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

providing the routable internet to a node in the network, wherein the node also communicates with a cellular network through at least one of the fixed infrastructure elements and the routable internet is provided outside the cellular network.

39. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements; and

providing a web service deployed with MANET mobile application that communicates solely within the mobile ad hoc network.

40. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

routing data packets through the mobile ad hoc network absent communications with the fixed infrastructure elements; and

providing a locally deployed mobile application that communicates solely within the mobile ad hoc network.

41. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing peer to peer connectivity within the mobile broadband routable internet; and

providing a device associated with the network that uses the peer to peer connectivity to facilitate mobile, fixed-infrastructure-independent, peer-to-peer application connection among at least a subset of the plurality of mobile devices.

42. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing file sharing over the mobile broadband routable internet; and

providing a device associated with the network that supports file sharing without degrading system performance.

43. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing user-generated applications over the mobile broadband routable internet; and

providing a device associated with the network that receives a deployment of a user-generated application.

44. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing peer-to-peer applications over the mobile broadband routable internet; and

providing a device associated with the network facilitates uses peer-to-peer application execution without degrading performance of the mobile broadband routable internet.

45. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

providing direct device-to-device peering with symmetrical throughput between at least two nodes of the mobile broadband routable internet, and wherein at least one of the two nodes is a device associated with the mobile broadband routable internet.

46. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; providing an adaptive transmit power control facility for a device within the network, the adaptive transmit power control facility adapted to adjust transmission power of the device based on at least one of the density of proximate devices in the network, the condition of a neighboring device on the network, a channel condition of the network, a service level condition, a network performance condition, an environmental condition of the device and an application requirement of the device; and

providing a device that uses adaptive transmit power control to adapt the transmit power of the device based on at least a density of devices.

47. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing dynamic spectrum access capabilities within the network by determining communication spectrum quality and adjusting use of time frequency rectangles within the communication spectrum based on the determination; and

providing a device that uses the dynamic spectrum access capabilities to provide enhanced use of spectral bandwidth.

48. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

communicating among the plurality of devices over a radio communication spectrum and reusing portions of the spectrum for communication based on availability of time frequency rectangles within portions of the spectrum; and

providing a device that reuses spectrum allocated for at least one other device.

49. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements; and

communicating wirelessly among at least a portion of the plurality of mobile devices, wherein the at least a portion of the plurality of mobile devices communicate independent of which radio frequency is used for the wireless communication; wherein a device communicates over the mobile broadband routable internet independent of the radio frequency.

50. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to the individual device independent of fixed infrastructure elements;

providing an IP-compatible plug connection to at least one wired infrastructure type; and providing a device that uses the connection.

51. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing small form factor nodes that allow for low cost and fast capacity expansion and network upgrade; and

providing a device that communicates at least in part via the small form factor nodes.

52. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing at least one base station controller function in at least one subscriber device, the base station controller function including at least one of an air interface management function, a signaling function, a concentration logic function, and a signal propagation function; and

providing a device employing the at least one base station controller function.

53. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing full radio resource management functions in at least one device, the radio resource management functions including at least one of radio management, handover, handoff, and foreign device cooperation functions, wherein the at least one device is a subscriber device, and wherein the at least one device operates responsively to a state of a managed radio resource.

54. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements; providing IP router functions at individual mobile devices of the network, wherein the individual mobile devices are subscriber devices; and providing a device that uses the IP router functions to communicate via the ad hoc network.

55. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

providing the routable internet to a node in the network, wherein the node also communicates with a cellular network through at least one of the fixed infrastructure elements and the routable internet is provided outside the cellular network; and

providing a device that communicates both through the cellular network and the mobile ad hoc network.

56. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

providing IP application deployment to a device in the network, wherein the device also communicates with a cellular network through at least one of the fixed infrastructure elements and the IP application is deployed outside the cellular network; and

providing a device that receives applications deployed over IP and that communicates via the cellular network.

57. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/sec during normal operation; and

providing a device that uses the communications.

58. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements, communications to the nodes having a throughput of at least 768 kbit/set when the nodes are in motion at vehicular speeds; and

providing a device that uses the communications.

59. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

applying swarm intelligence to determine at least some parts of at least some routes through the mobile, broadband, routable internet; and

providing a device that communicates via the mobile ad hoc network.

60. A computer program product embodied in a computer readable medium that, when executing on one or more computers, operates a mobile ad hoc network by performing the steps of:

providing a mobile, broadband, routable internet, in which a plurality of mobile devices interact as nodes in a mobile ad hoc network and in which packets are IP routable to each of the devices independent of fixed infrastructure elements;

allowing layer 2 forwarding among at least some of the plurality of mobile devices; and

providing a device that communicates via the layer 2 forwarding, wherein the device facilitates parking.

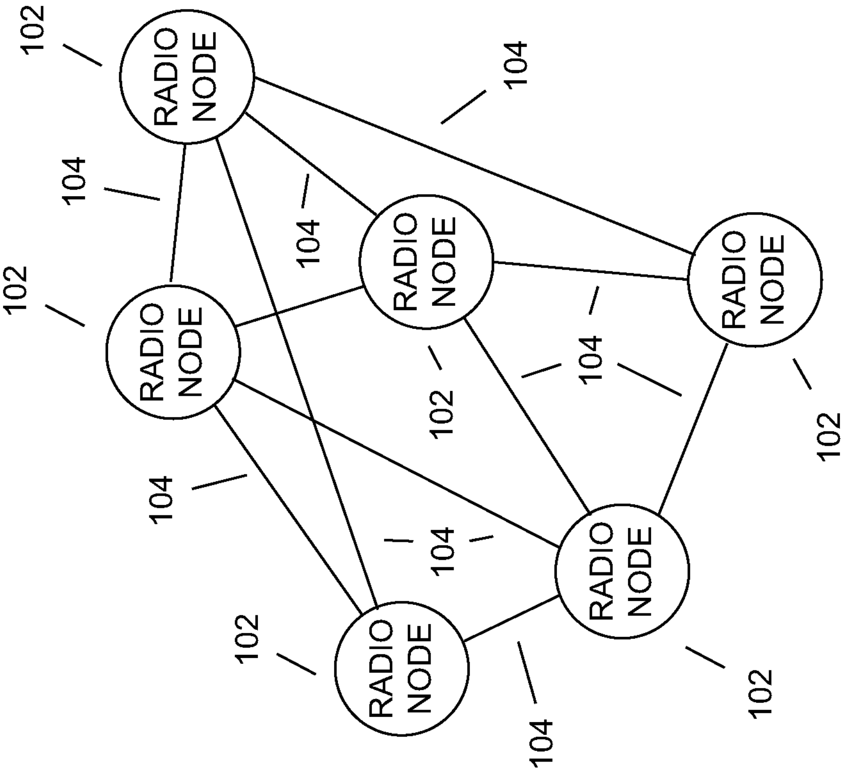


FIG. 1B

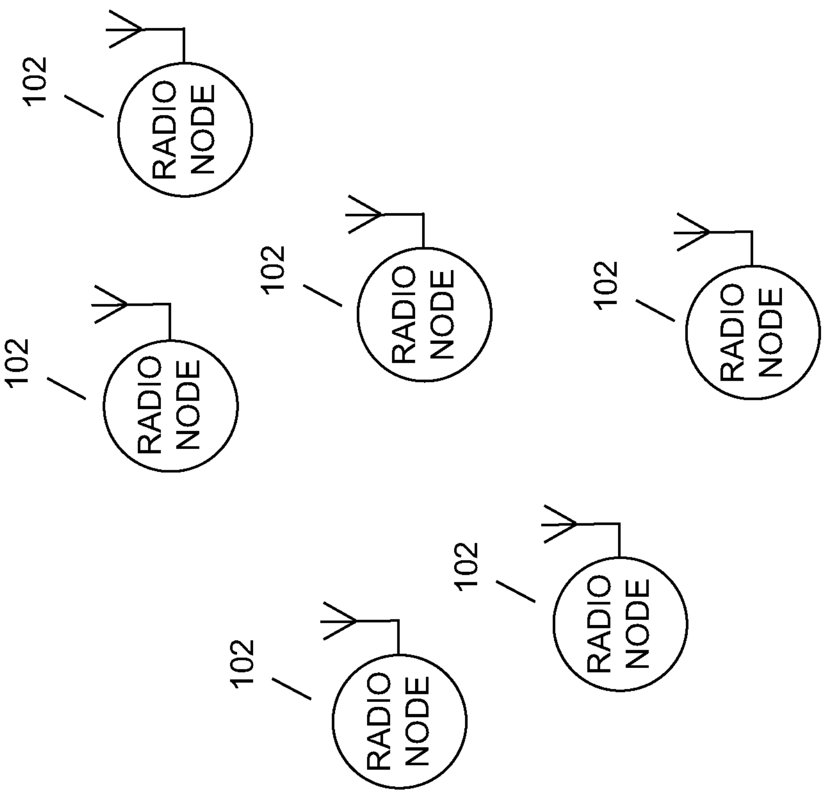


FIG. 1A

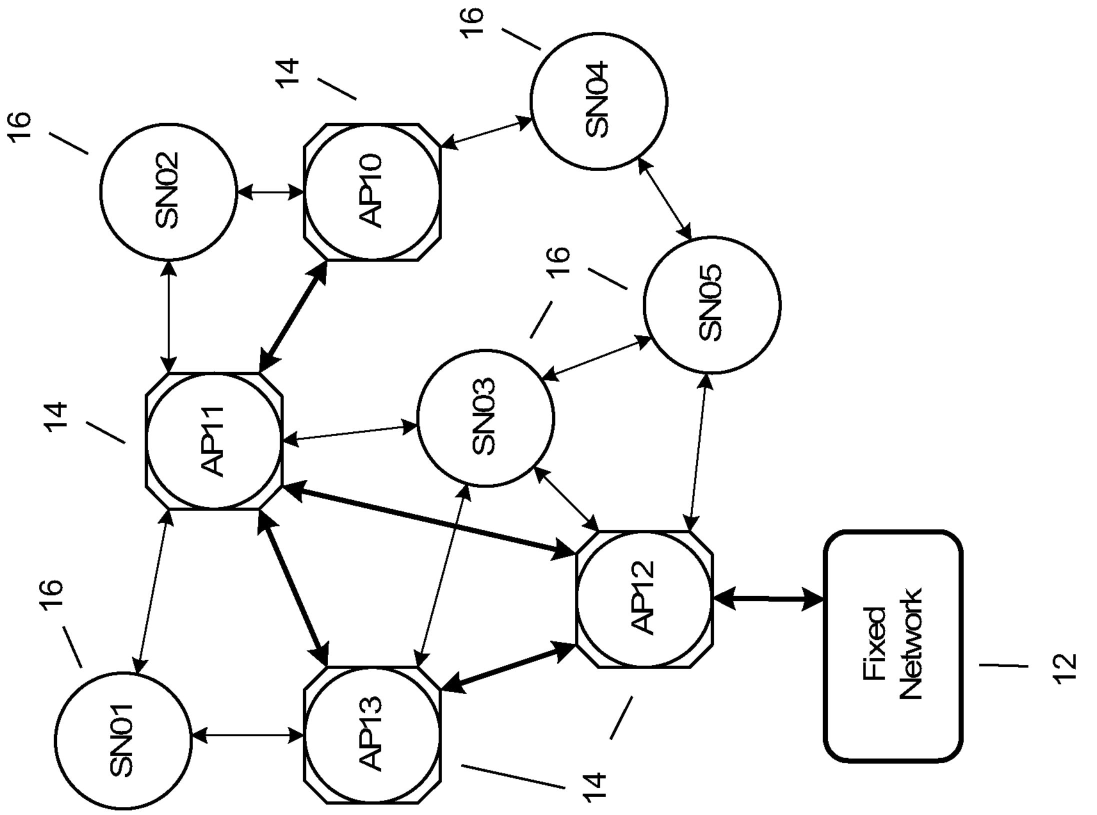

SN01
SN02
SN03
SN04
SN05
AP10
AP11
AP12
AP13
Fixed Network
12
14
14
14
14
14
16
16
16
16
16

FIG. 2B

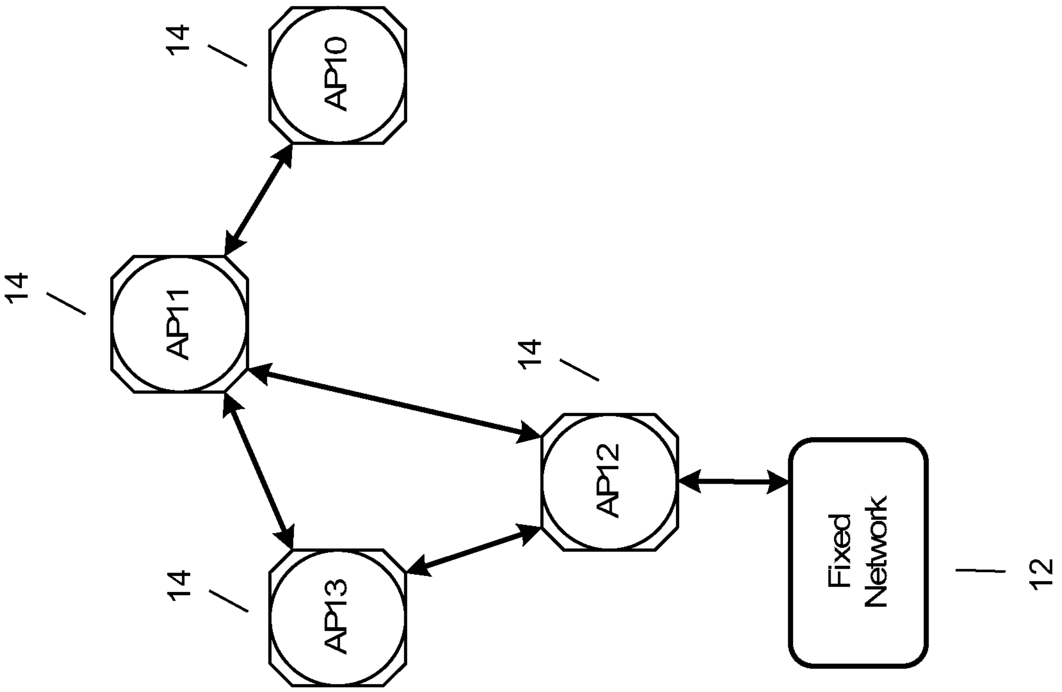
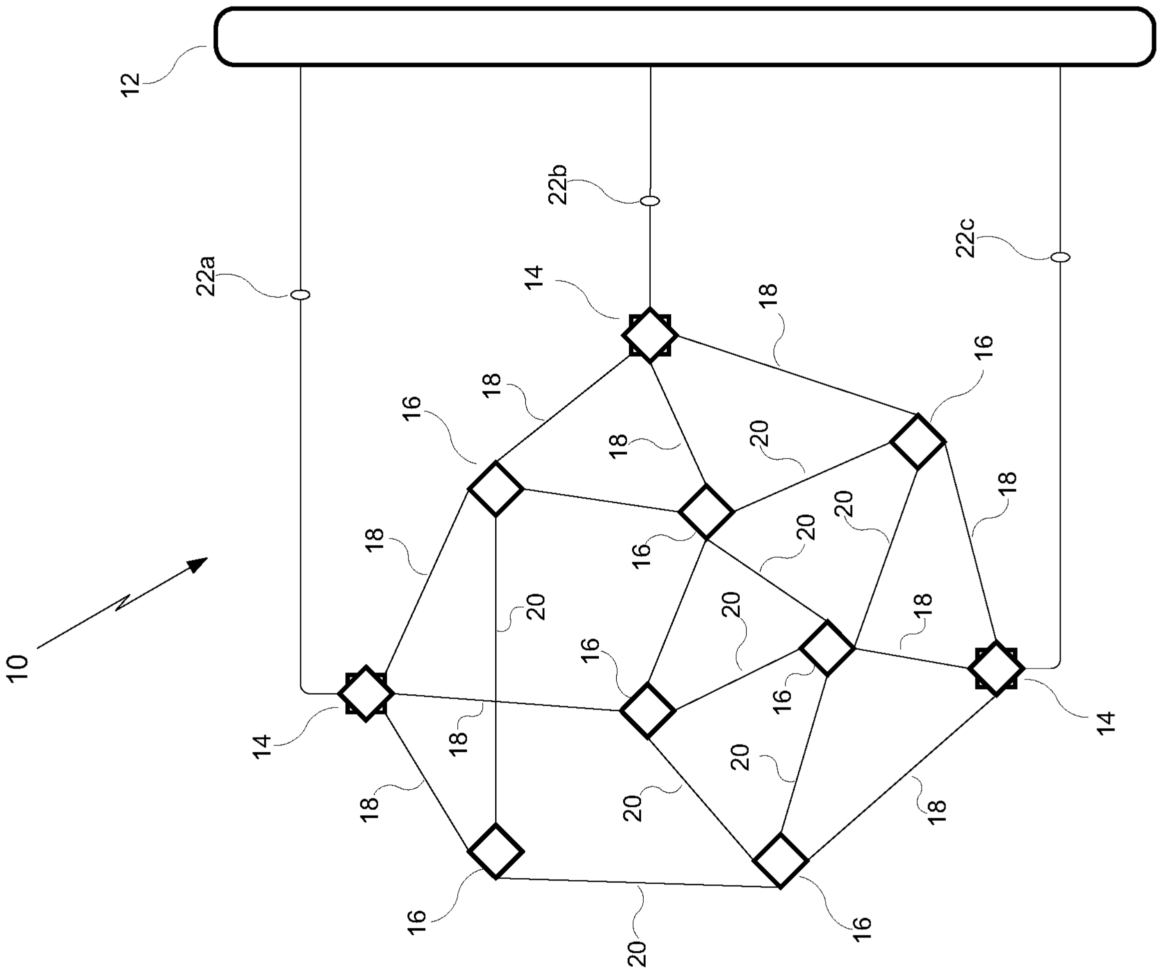

AP10
AP11
AP12
AP13
Fixed Network
12
14
14
14
14

FIG. 2A


12
22a
22b
22c
14
14
14
16
16
16
16
16
16
16
18
18
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20
10

FIG. 3

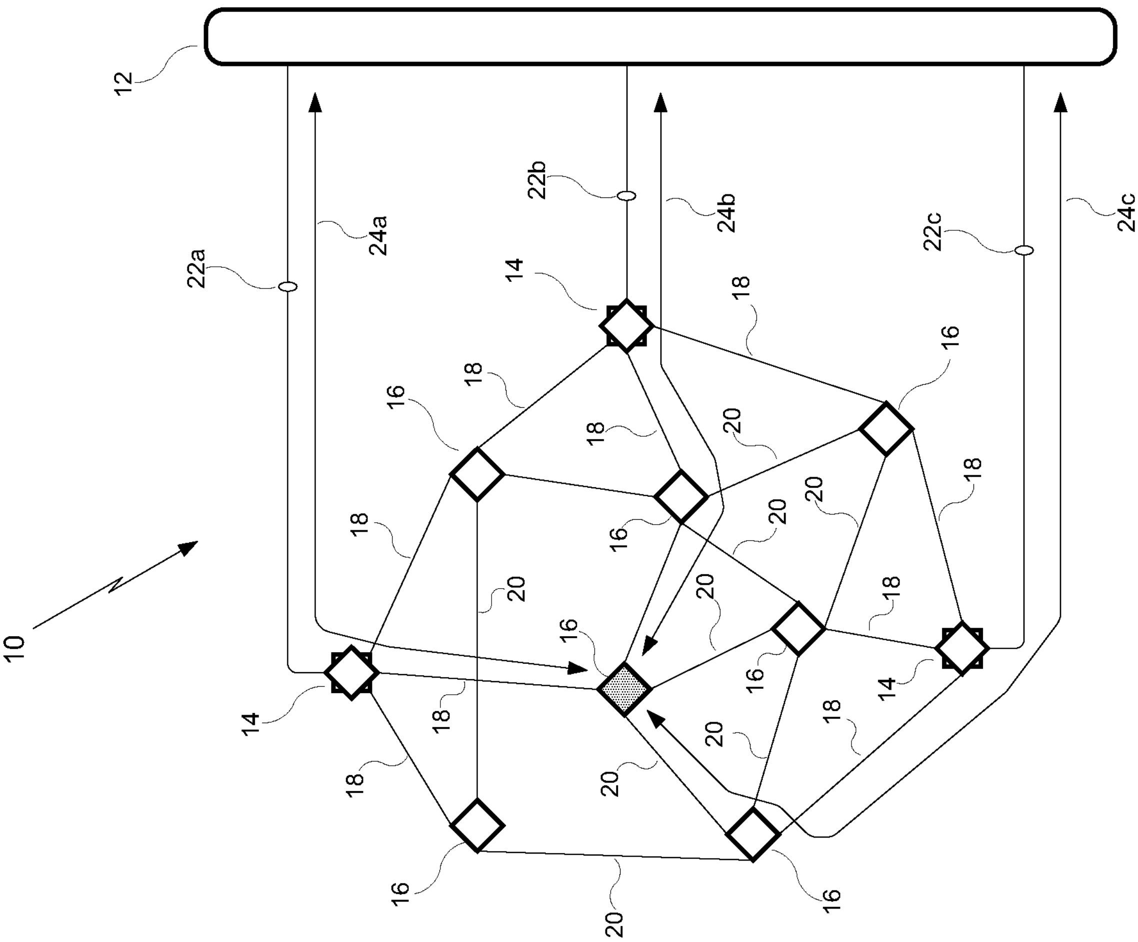


FIG. 4

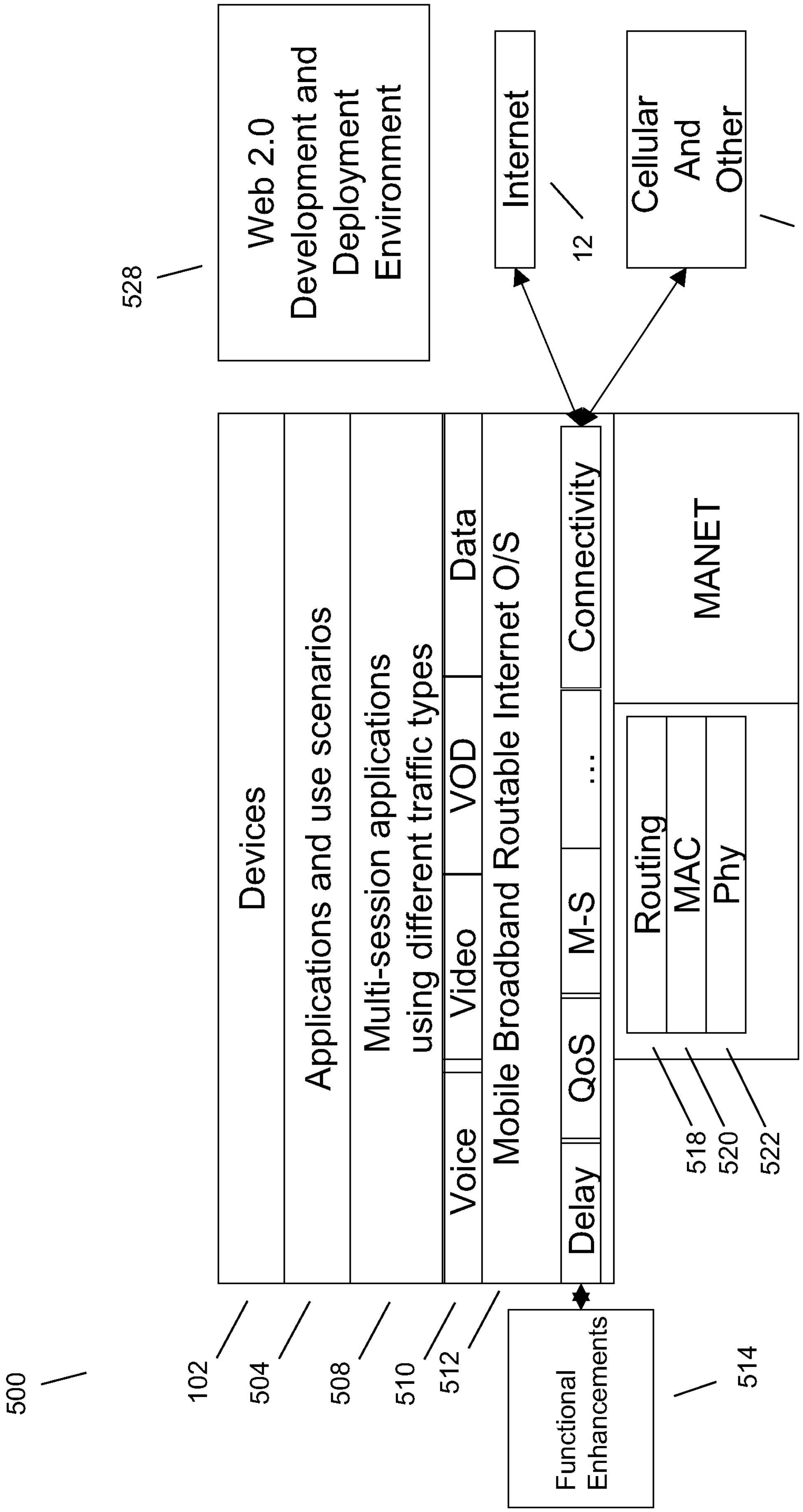

500
102
504
508
510
512
Devices
Applications and use scenarios
Multi-session applications using different traffic types
Voice
Video
VOD
Data
Mobile Broadband Routable Internet O/S
Delay
QoS
M-S
...
Connectivity
Functional Enhancements
514
Routing
MAC
Phy
518
520
522
MANET
524
528
Web 2.0 Development and Deployment Environment
Internet
12
Cellular And Other
12

FIG. 5

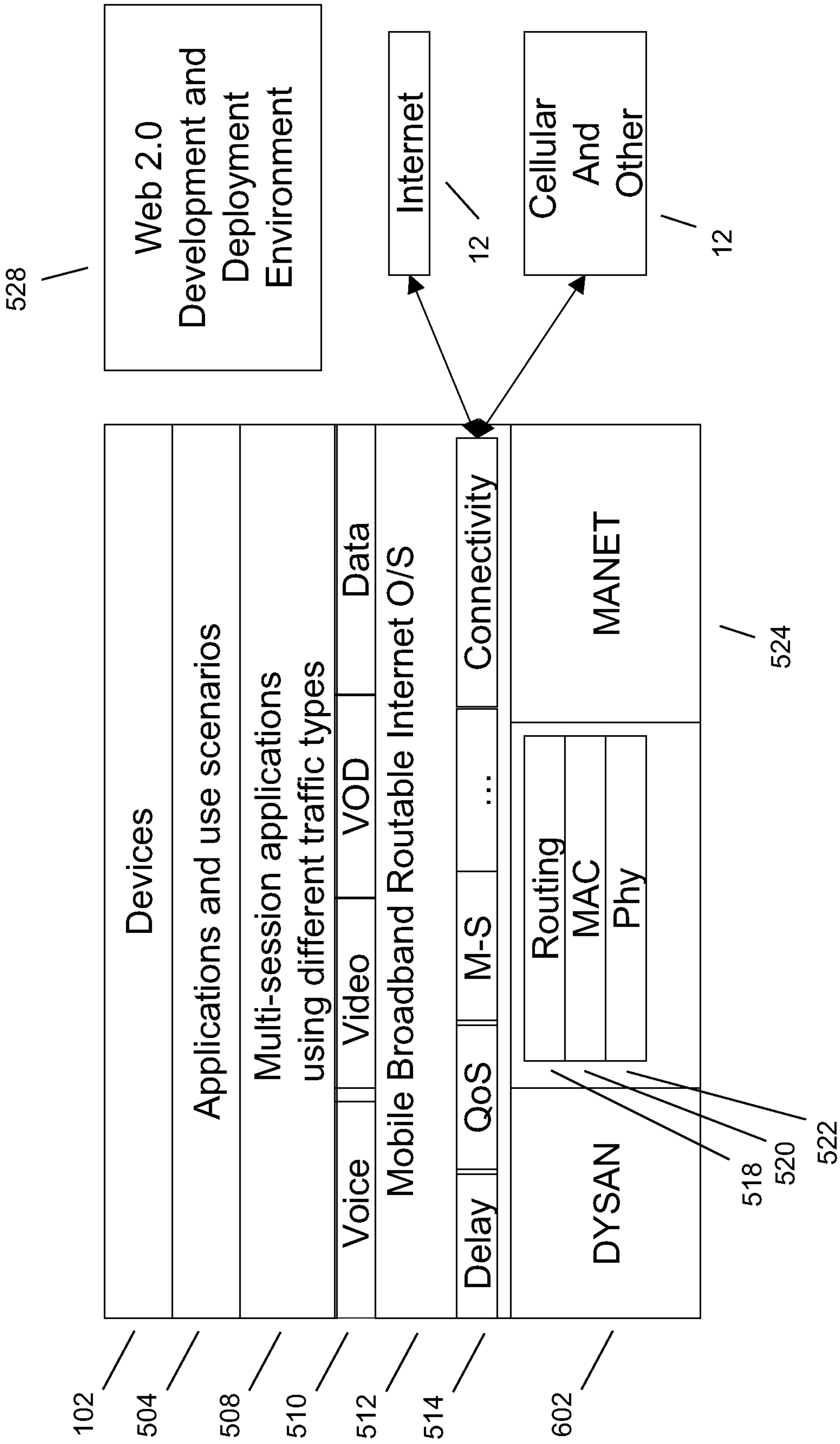

528
Web 2.0 Development and Deployment Environment
Internet
12
Cellular And Other
12
Devices
Applications and use scenarios
Multi-session applications using different traffic types
Voice
Video
VOD
Data
Mobile Broadband Routable Internet O/S
Delay
QoS
M-S
...
Connectivity
DYSAN
Routing
MAC
Phy
MANET
518
520
522
524
102
504
508
510
512
514
602

FIG. 6

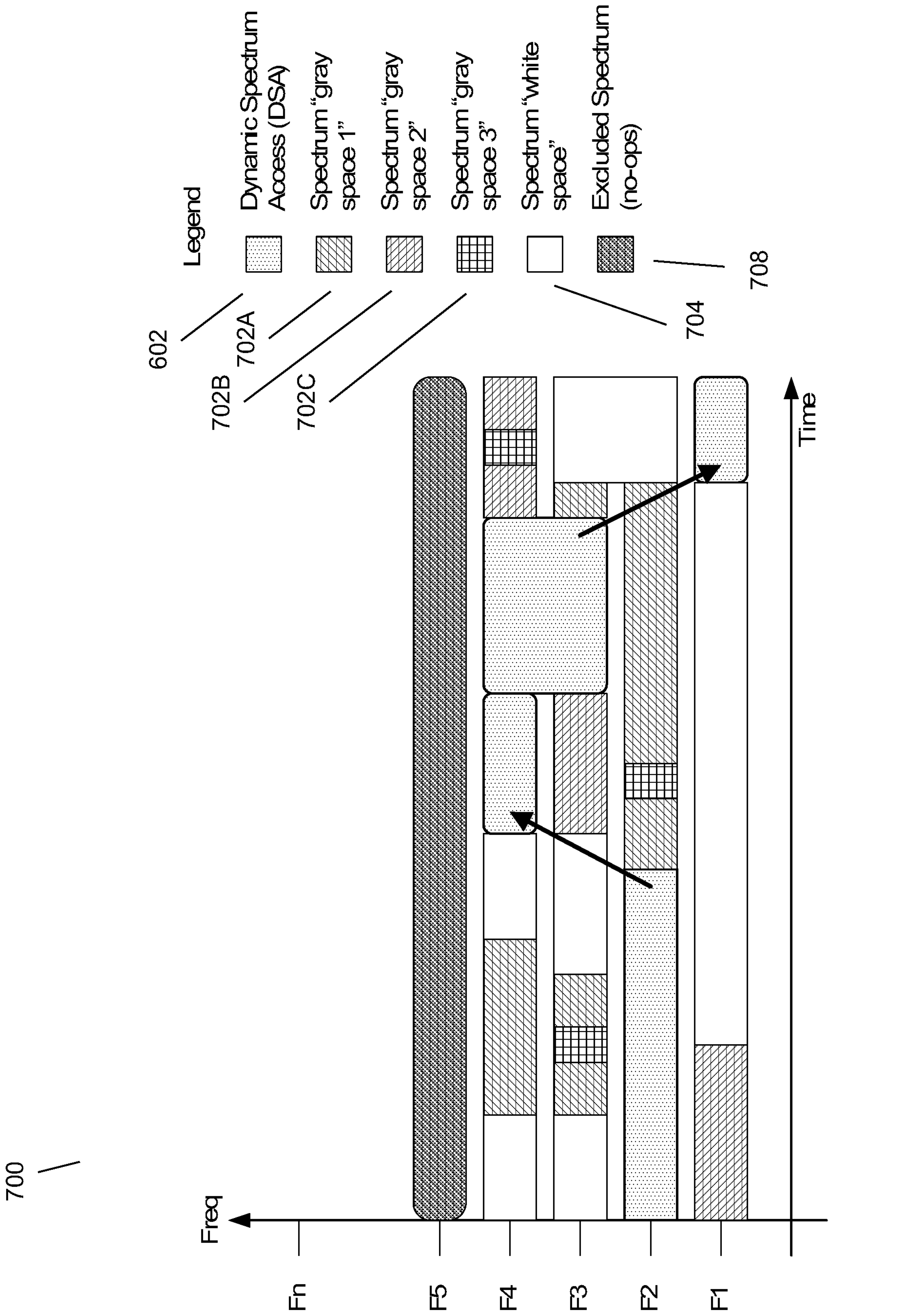

700
Legend
Dynamic Spectrum Access (DSA)
Spectrum "gray space 1"
Spectrum "gray space 2"
Spectrum "gray space 3"
Spectrum "white space"
Excluded Spectrum (no-ops)
602
702A
702B
702C
704
708
Freq
Time
Fn
F5
F4
F3
F2
F1

FIG. 7

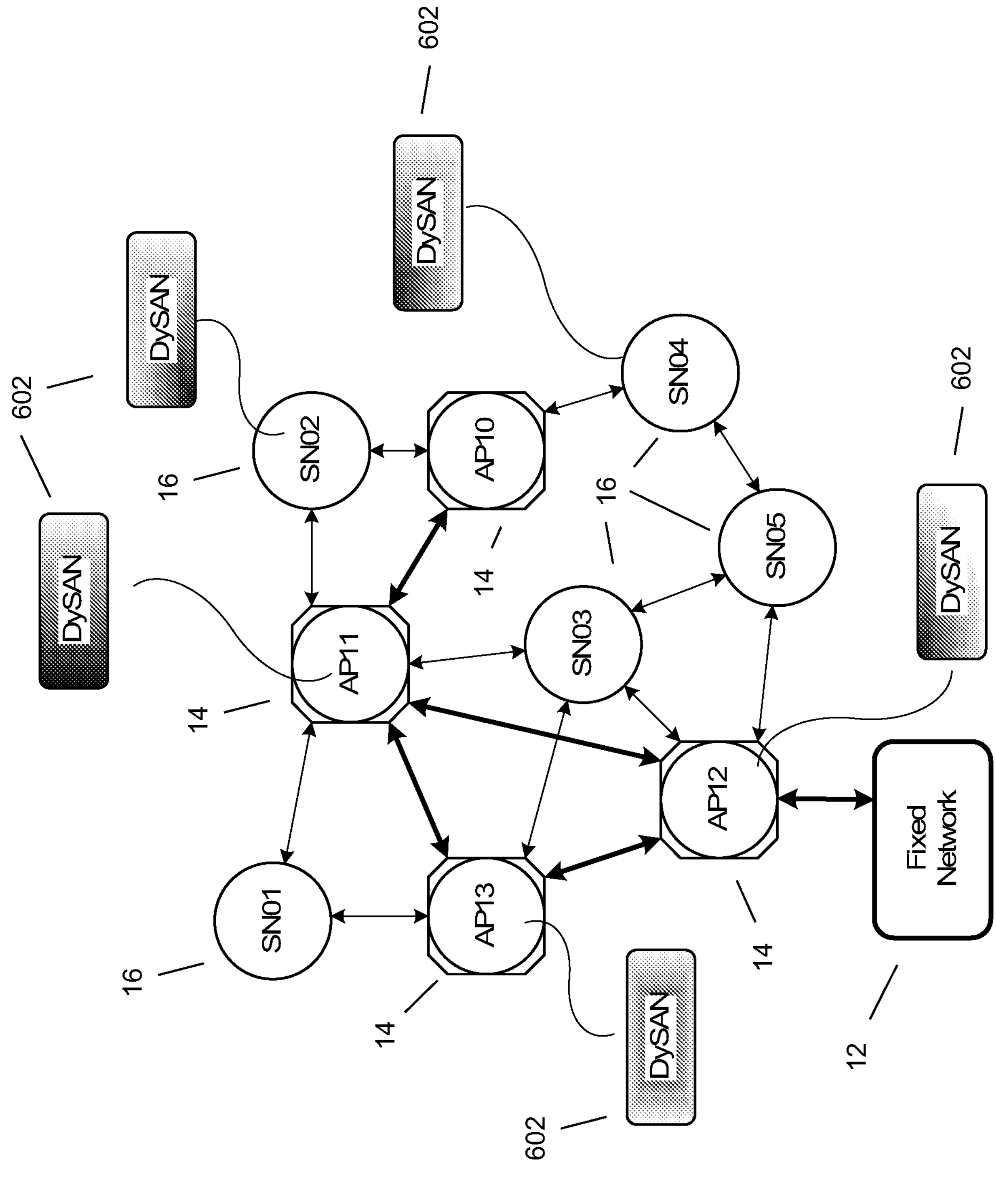

602
DySAN
602
DySAN
602
DySAN
SN02
AP10
SN04
16
16
14
AP11
SN03
SN05
602
DySAN
14
AP12
Fixed Network
SN01
AP13
16
14
14
DySAN
602
12

FIG. 8

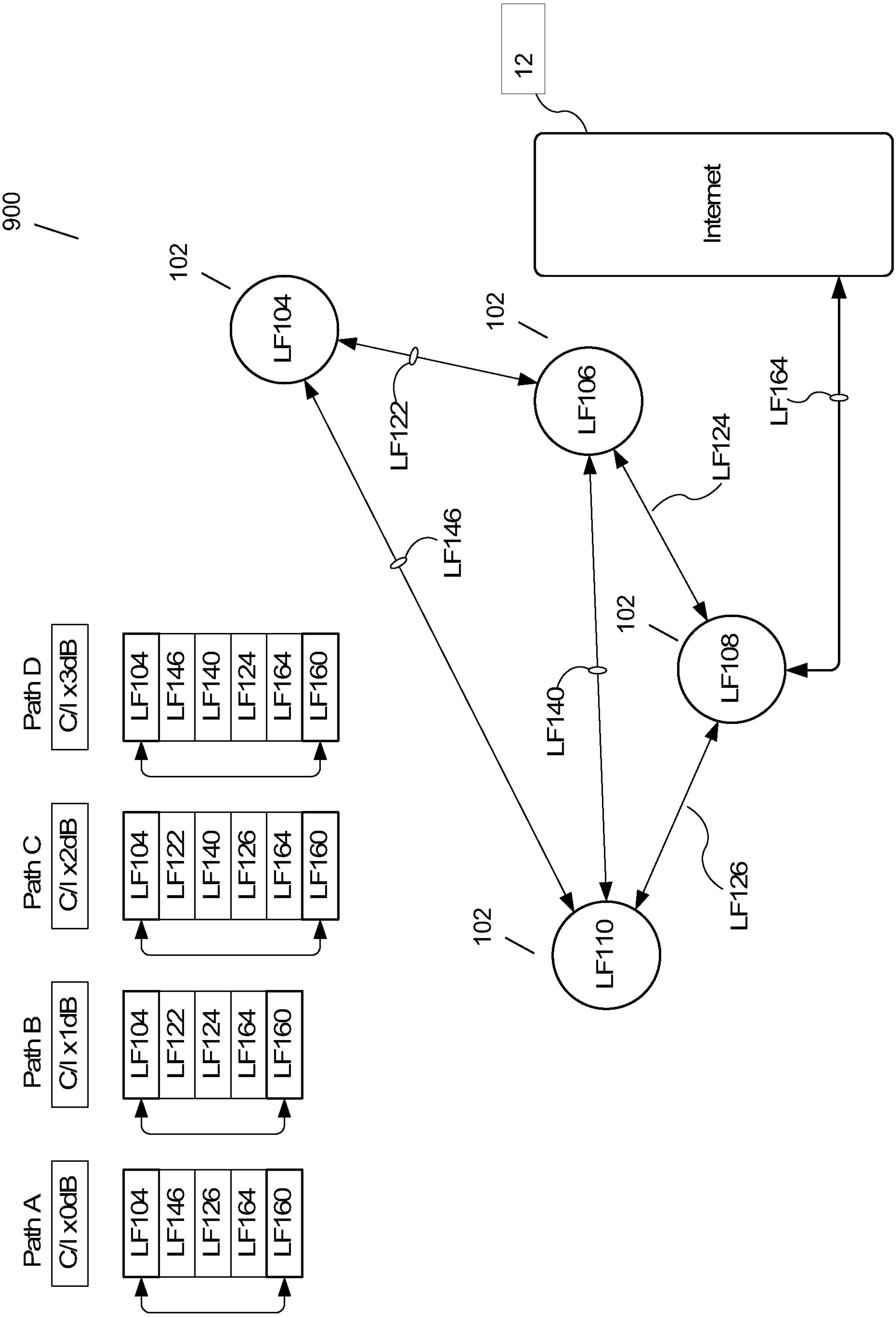

900
Path A
C/I x0dB
LF104
LF146
LF126
LF164
LF160
Path B
C/I x1dB
LF104
LF122
LF124
LF164
LF160
Path C
C/I x2dB
LF104
LF122
LF140
LF126
LF164
LF160
Path D
C/I x3dB
LF104
LF146
LF140
LF124
LF164
LF160
102
LF104
102
LF106
102
LF108
102
LF110
LF122
LF146
LF124
LF140
LF126
LF164
Internet
12

FIG. 9

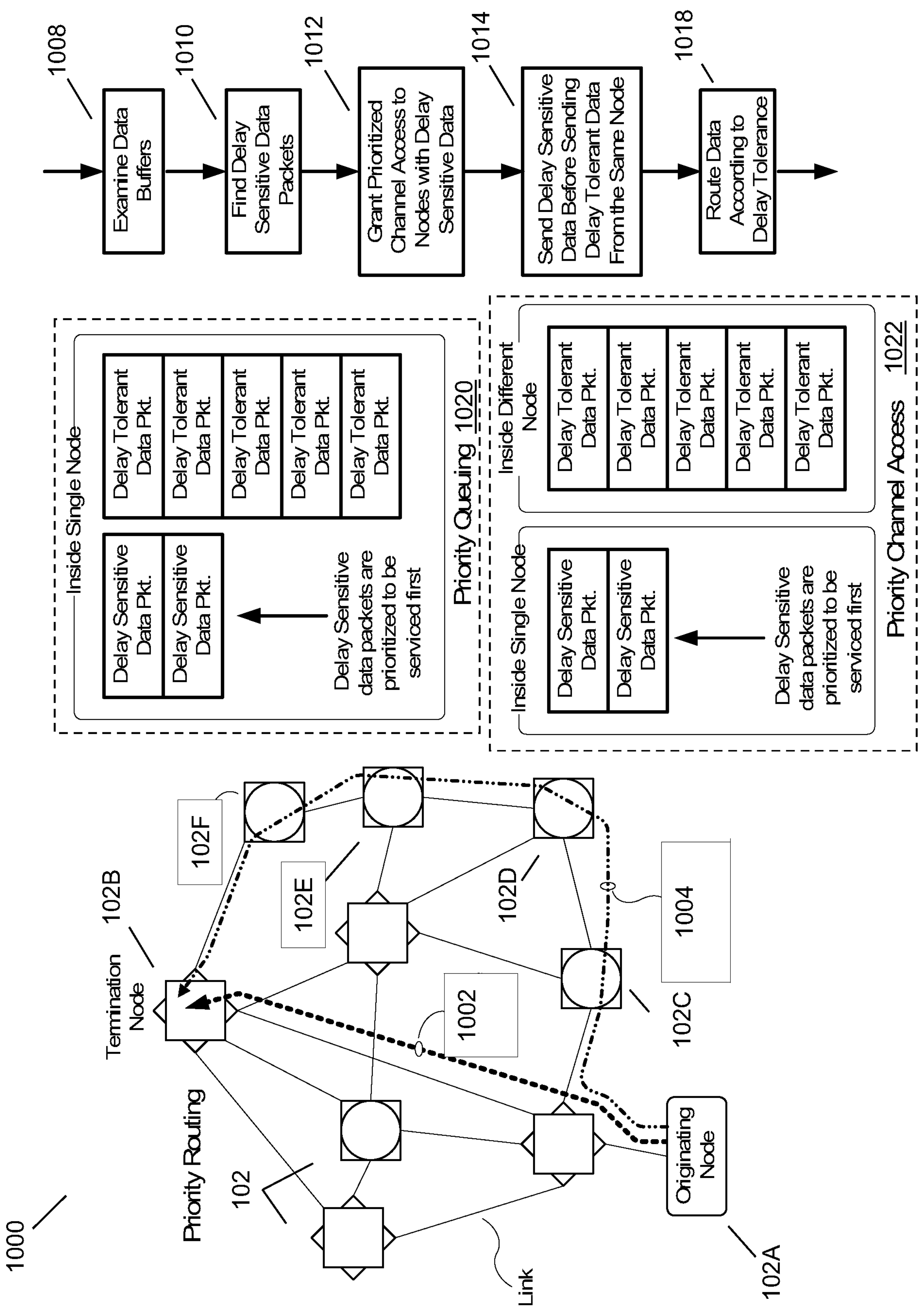

1000
Priority Routing
102
Link
Termination Node
102B
102F
102E
102D
102C
1002
1004
Originating Node
102A
Inside Single Node
Delay Sensitive Data Pkt.
Delay Sensitive Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Sensitive data packets are prioritized to be serviced first
Priority Queuing 1020
Inside Single Node
Delay Sensitive Data Pkt.
Delay Sensitive Data Pkt.
Delay Sensitive data packets are prioritized to be serviced first
Inside Different Node
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Delay Tolerant Data Pkt.
Priority Channel Access 1022
1008
Examine Data Buffers
1010
Find Delay Sensitive Data Packets
1012
Grant Prioritized Channel Access to Nodes with Delay Sensitive Data
1014
Send Delay Sensitive Data Before Sending Delay Tolerant Data From the Same Node
1018
Route Data According to Delay Tolerance

FIG. 10

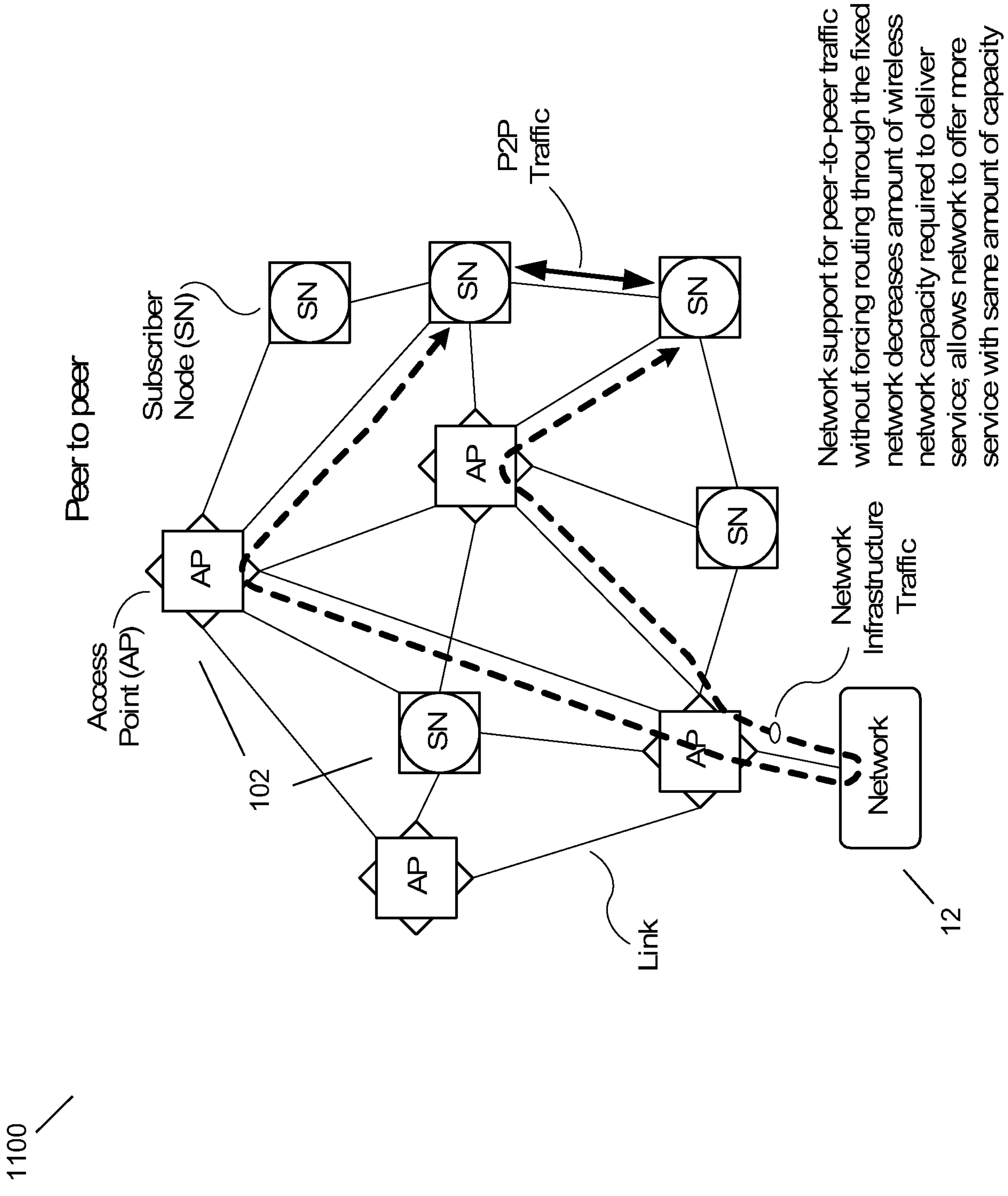

1100
Peer to peer
Access Point (AP)
Subscriber Node (SN)
P2P Traffic
AP
AP
AP
AP
SN
SN
SN
SN
SN
102
Link
Network
12
Network Infrastructure Traffic
Network support for peer-to-peer traffic without forcing routing through the fixed network decreases amount of wireless network capacity required to deliver service; allows network to offer more service with same amount of capacity

FIG. 11

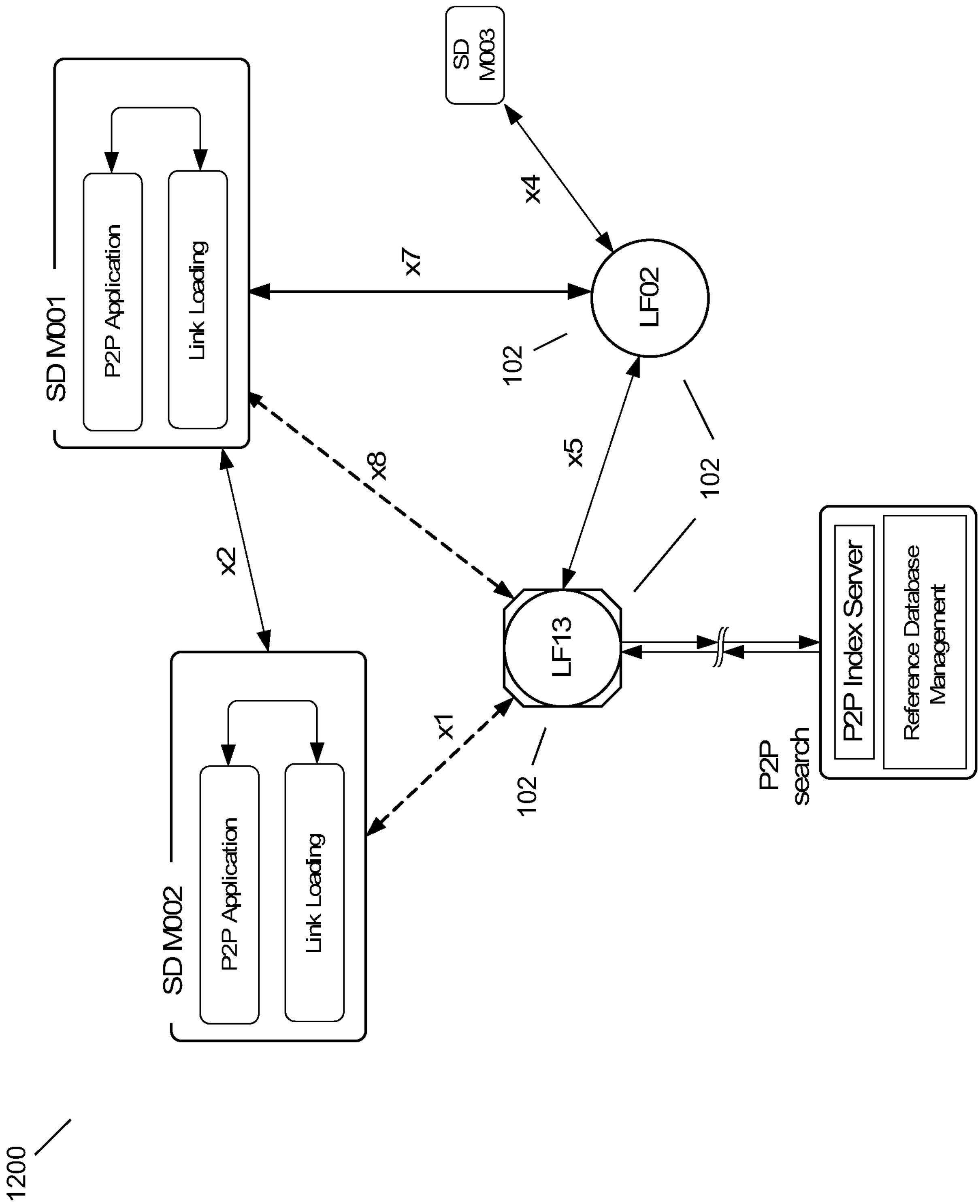

1200
SD M001
P2P Application
Link Loading
SD M002
P2P Application
Link Loading
SD M003
LF02
LF13
x1
x2
x4
x5
x7
x8
102
102
102
102
P2P Index Server
Reference Database Management
P2P search

FIG. 12

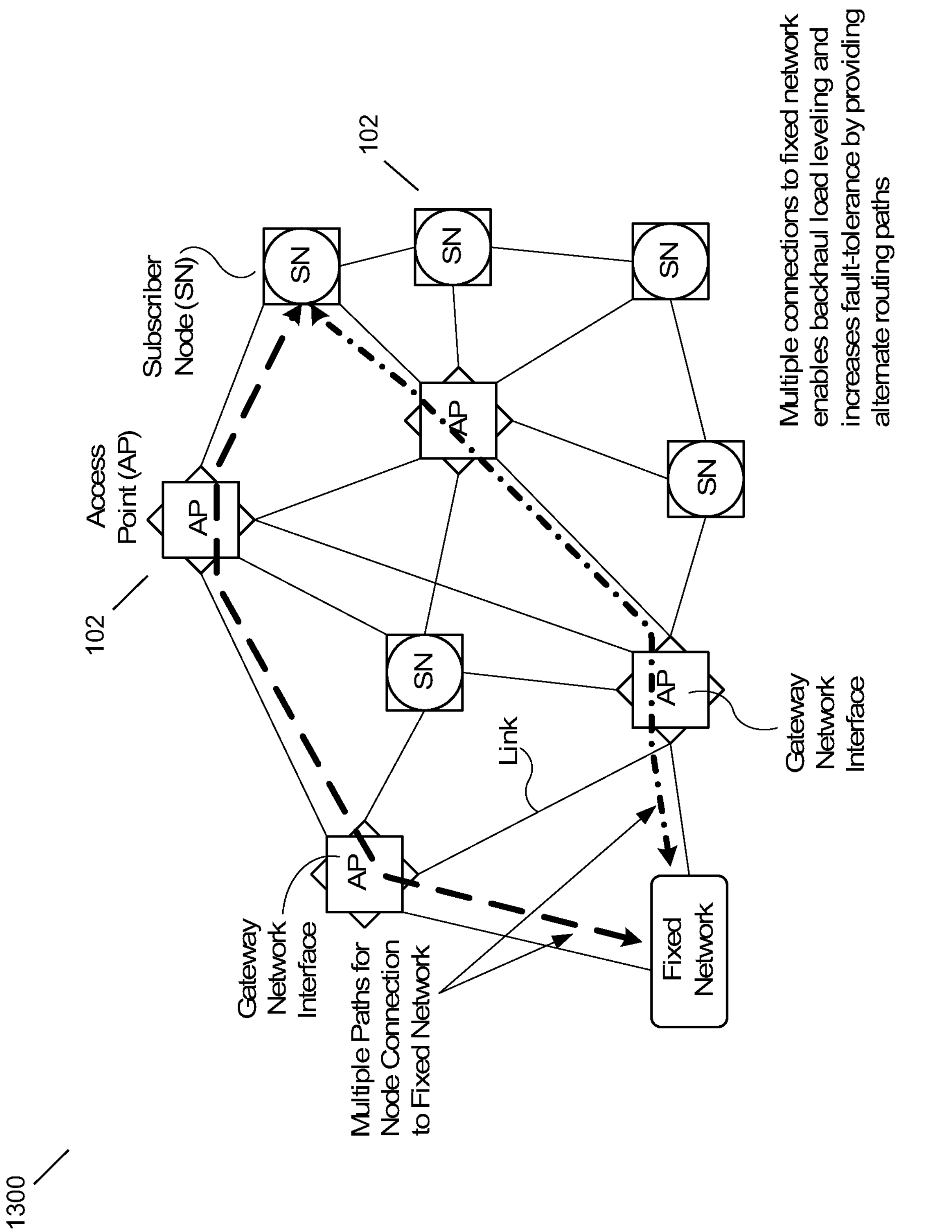

1300
102
Access Point (AP)
AP
Subscriber Node (SN)
SN
102
SN
SN
AP
SN
SN
AP
Gateway Network Interface
Link
AP
Gateway Network Interface
Multiple Paths for Node Connection to Fixed Network
Fixed Network
Multiple connections to fixed network enables backhaul load leveling and increases fault-tolerance by providing alternate routing paths

FIG. 13

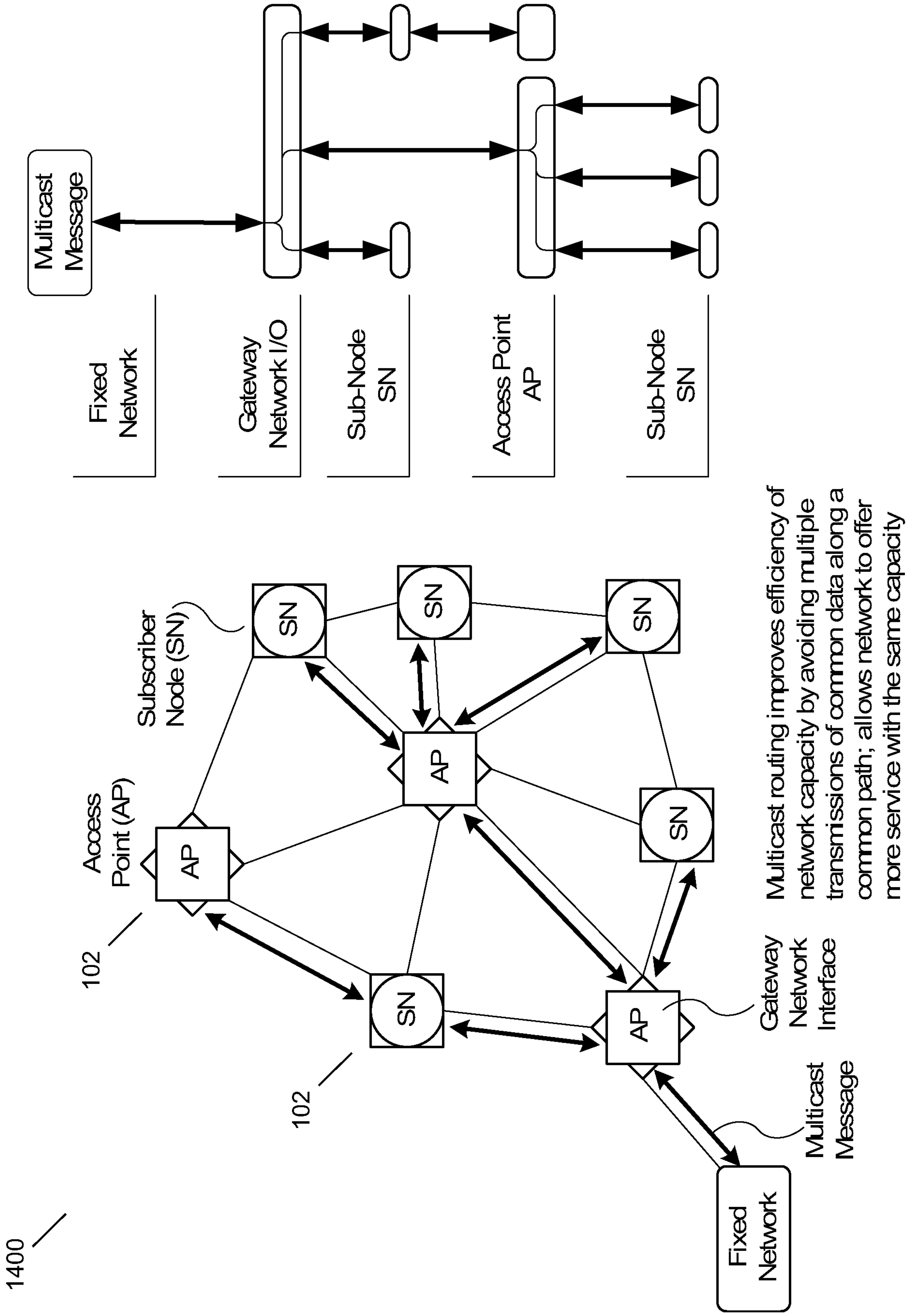

1400
Fixed Network
Multicast Message
102
102
Access Point (AP)
Subscriber Node (SN)
AP
AP
AP
SN
SN
SN
SN
SN
Gateway Network Interface
Multicast routing improves efficiency of network capacity by avoiding multiple transmissions of common data along a common path; allows network to offer more service with the same capacity
Fixed Network
Gateway Network I/O
Sub-Node SN
Access Point AP
Sub-Node SN
Multicast Message

FIG. 14

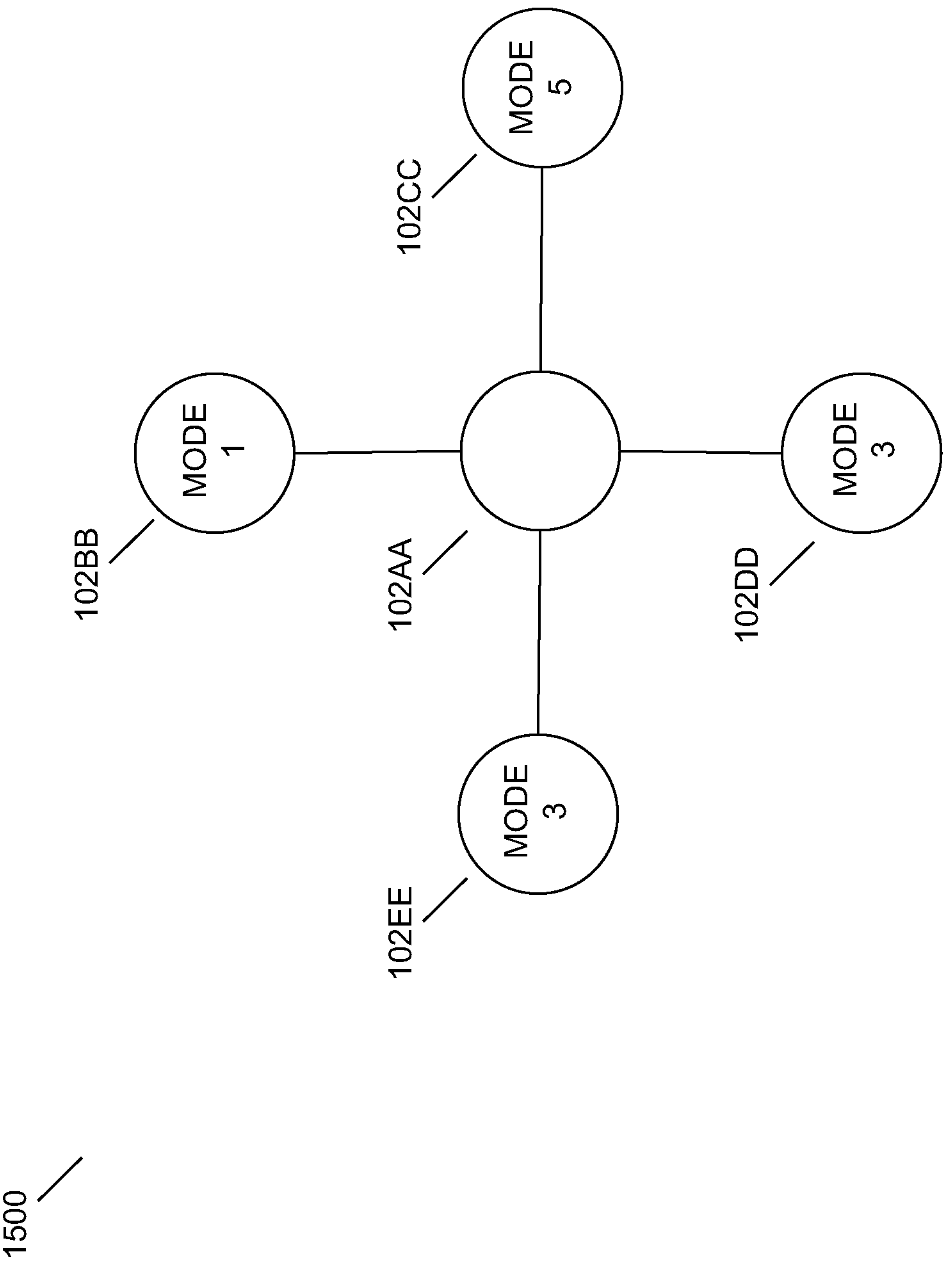


FIG. 15

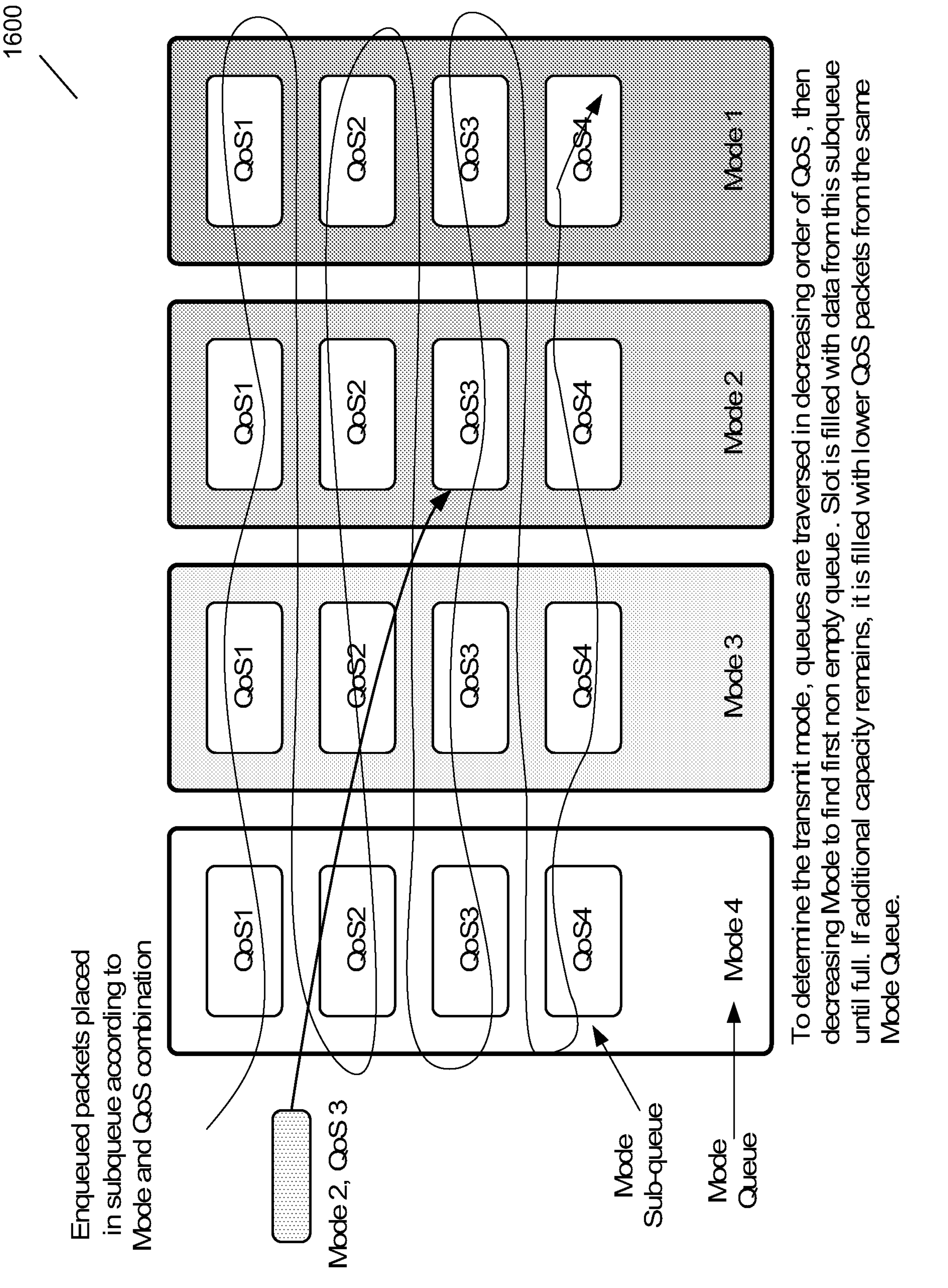

1600
Enqueued packets placed in subqueue according to Mode and QoS combination
Mode 2, QoS 3
Mode Sub-queue
Mode Queue
QoS1
QoS2
QoS3
QoS4
Mode 4
Mode 3
Mode 2
Mode 1
To determine the transmit mode, queues are traversed in decreasing order of QoS, then decreasing Mode to find first non empty queue. Slot is filled with data from this subqueue until full. If additional capacity remains, it is filled with lower QoS packets from the same Mode Queue.

FIG. 16

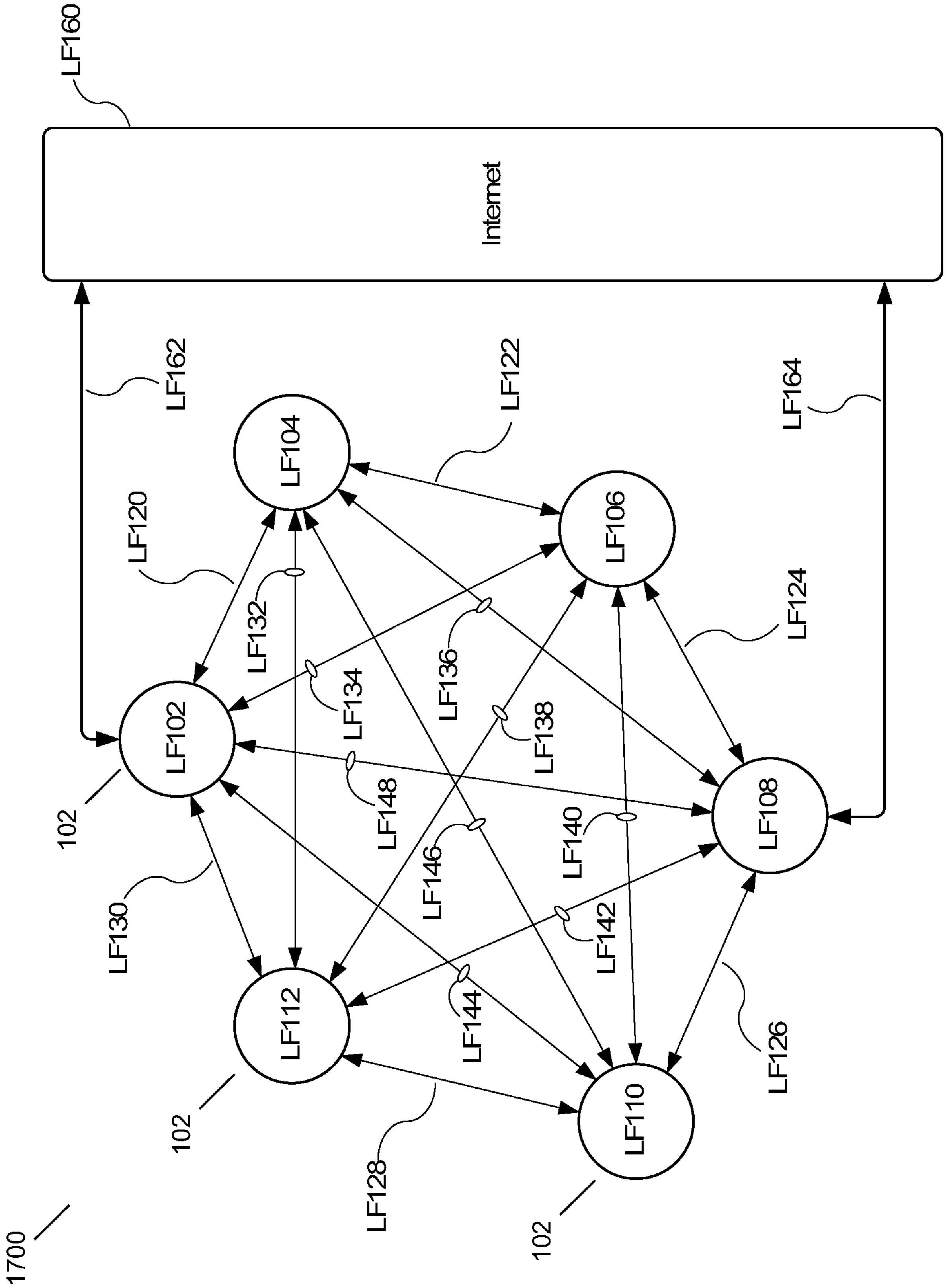

LF160
Internet
LF162
LF164
LF122
LF104
LF106
LF120
LF124
LF132
LF136
LF134
LF102
LF138
LF148
LF108
LF140
LF146
102
LF130
LF142
LF112
LF144
LF126
LF110
102
LF128
102
1700

FIG. 17

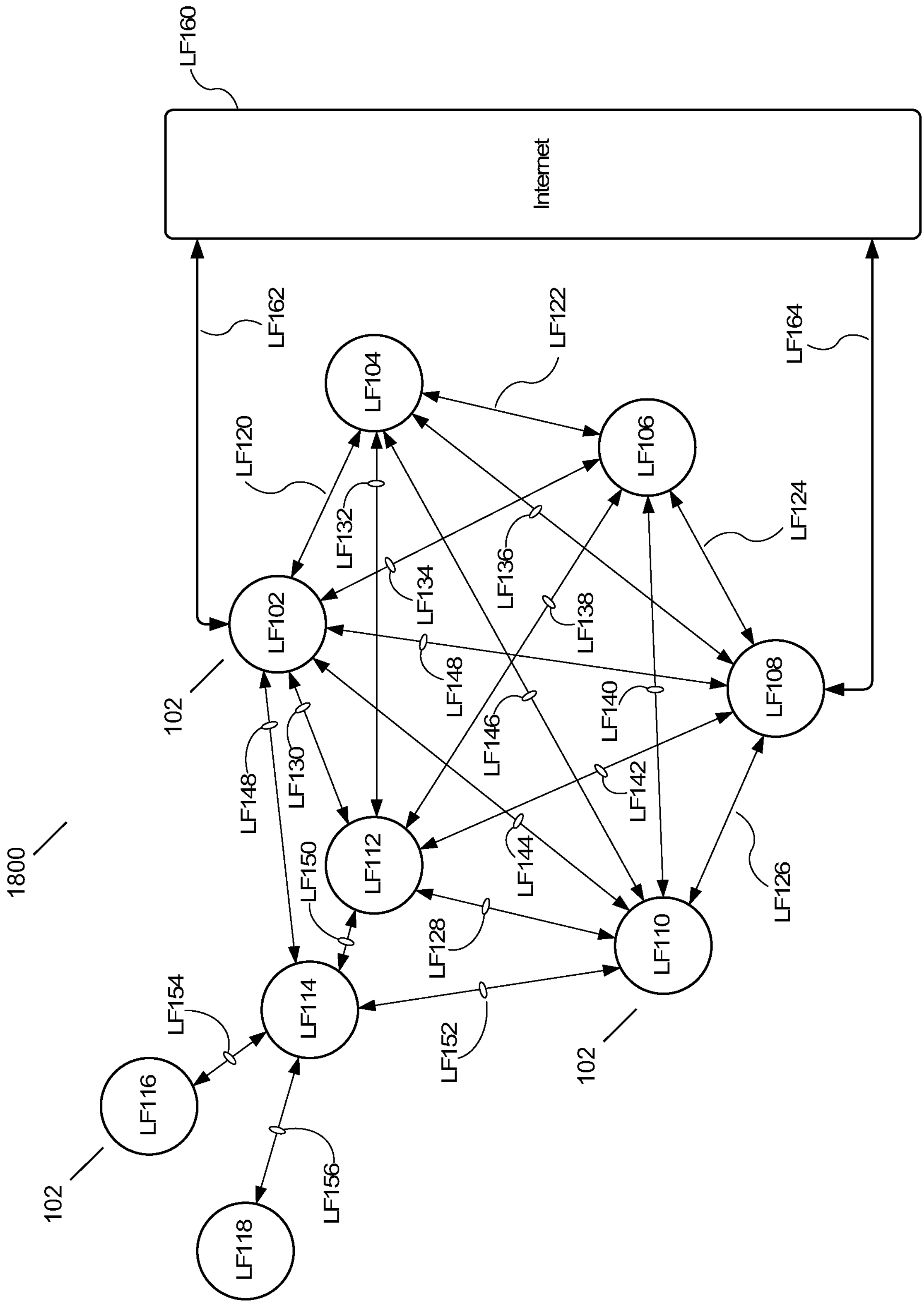

1800
LF160
Internet
LF162
LF164
LF102
LF104
LF106
LF108
LF110
LF112
LF114
LF116
LF118
LF120
LF122
LF124
LF126
LF128
LF130
LF132
LF134
LF136
LF138
LF140
LF142
LF144
LF146
LF148
LF148
LF150
LF152
LF154
LF156
102
102
102

FIG. 18

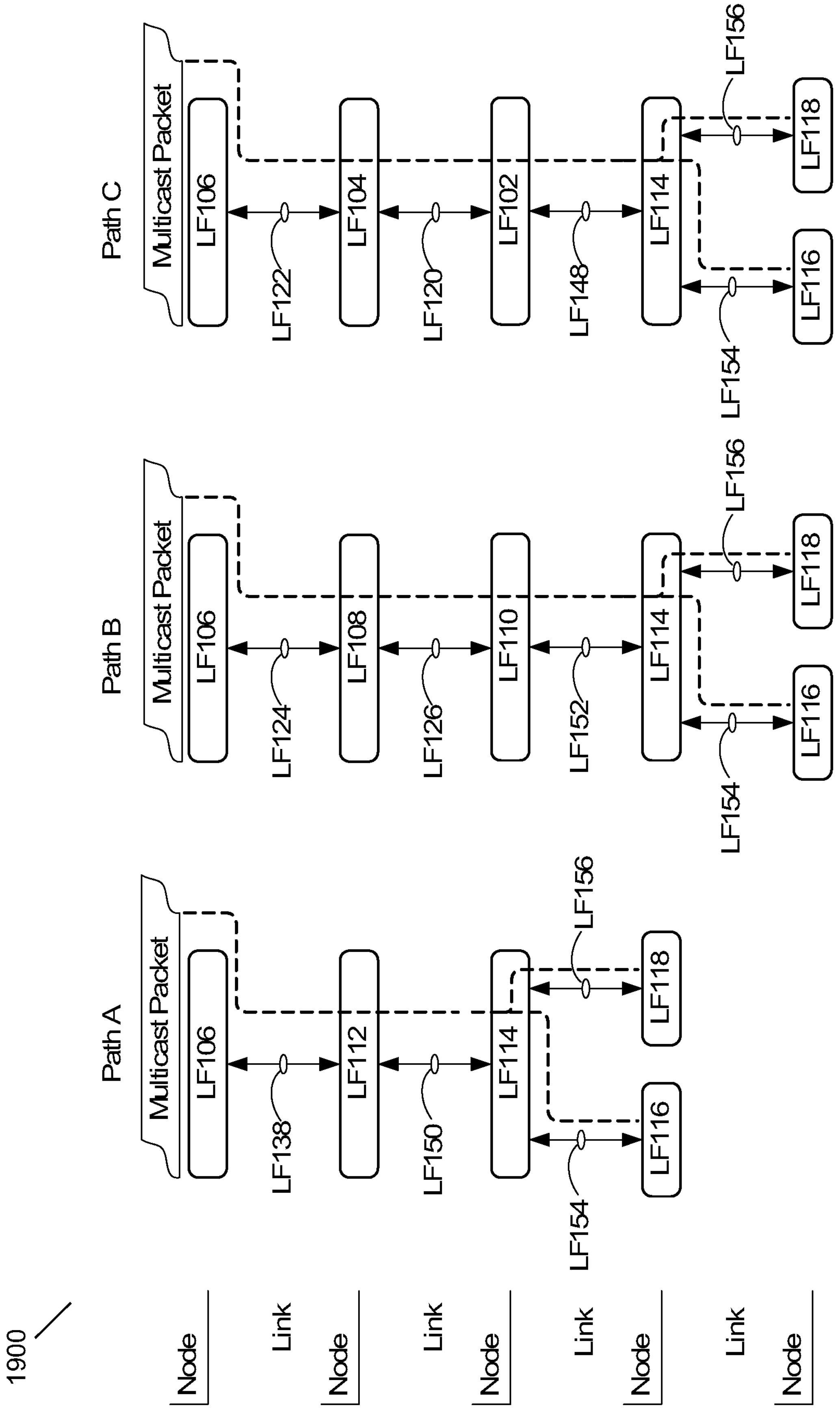

1900
Node
Link
Node
Link
Node
Link
Node
Link
Node
Path A
Multicast Packet
LF106
LF138
LF112
LF150
LF114
LF154
LF156
LF116
LF118
Path B
Multicast Packet
LF106
LF124
LF108
LF126
LF110
LF152
LF114
LF154
LF156
LF116
LF118
Path C
Multicast Packet
LF106
LF122
LF104
LF120
LF102
LF148
LF114
LF154
LF156
LF116
LF118

FIG. 19

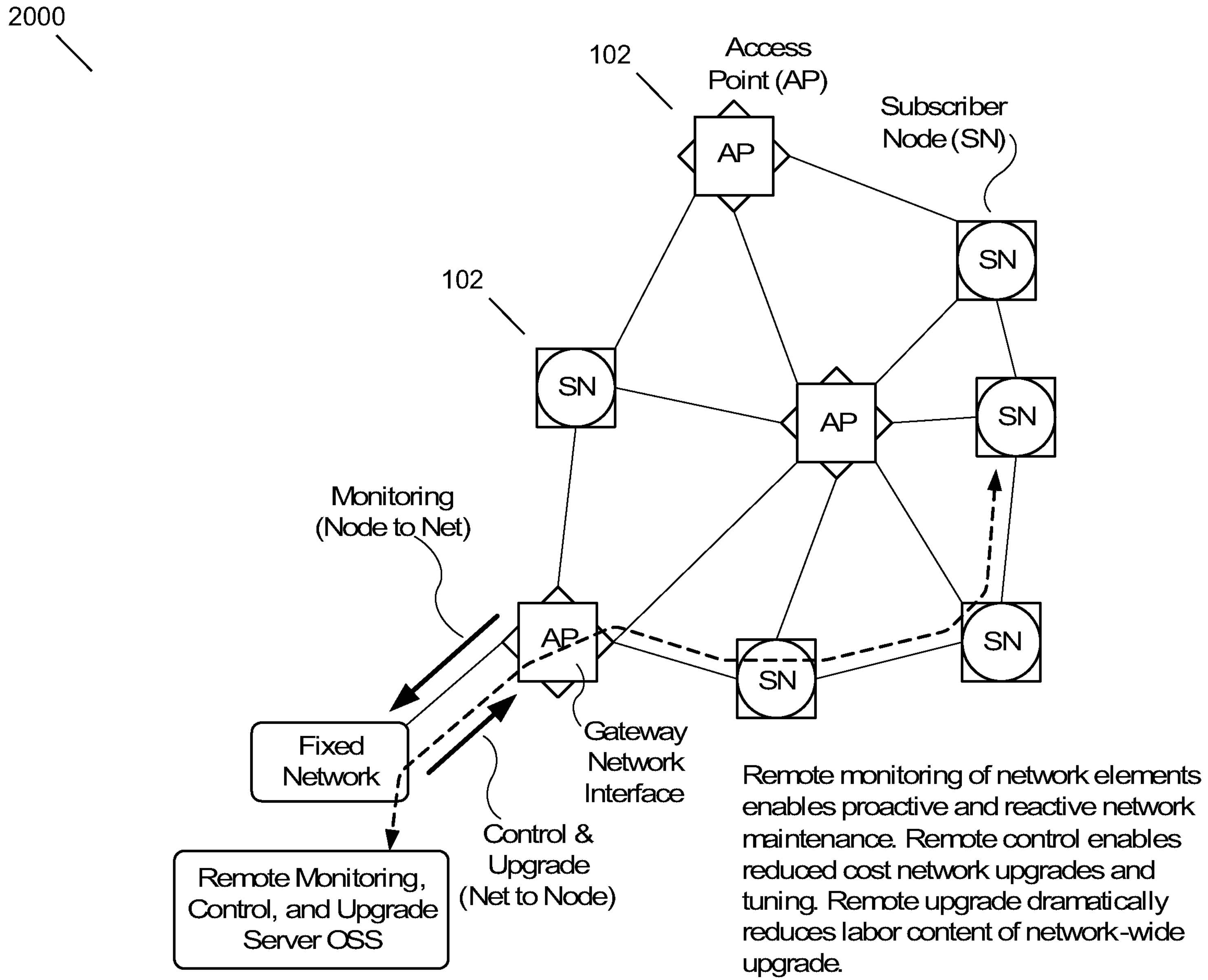

2000
102
Access Point (AP)
Subscriber Node (SN)
AP
SN
102
Monitoring (Node to Net)
Fixed Network
Gateway Network Interface
Control & Upgrade (Net to Node)
Remote Monitoring, Control, and Upgrade Server OSS
Remote monitoring of network elements enables proactive and reactive network maintenance. Remote control enables reduced cost network upgrades and tuning. Remote upgrade dramatically reduces labor content of network-wide upgrade.

FIG. 20

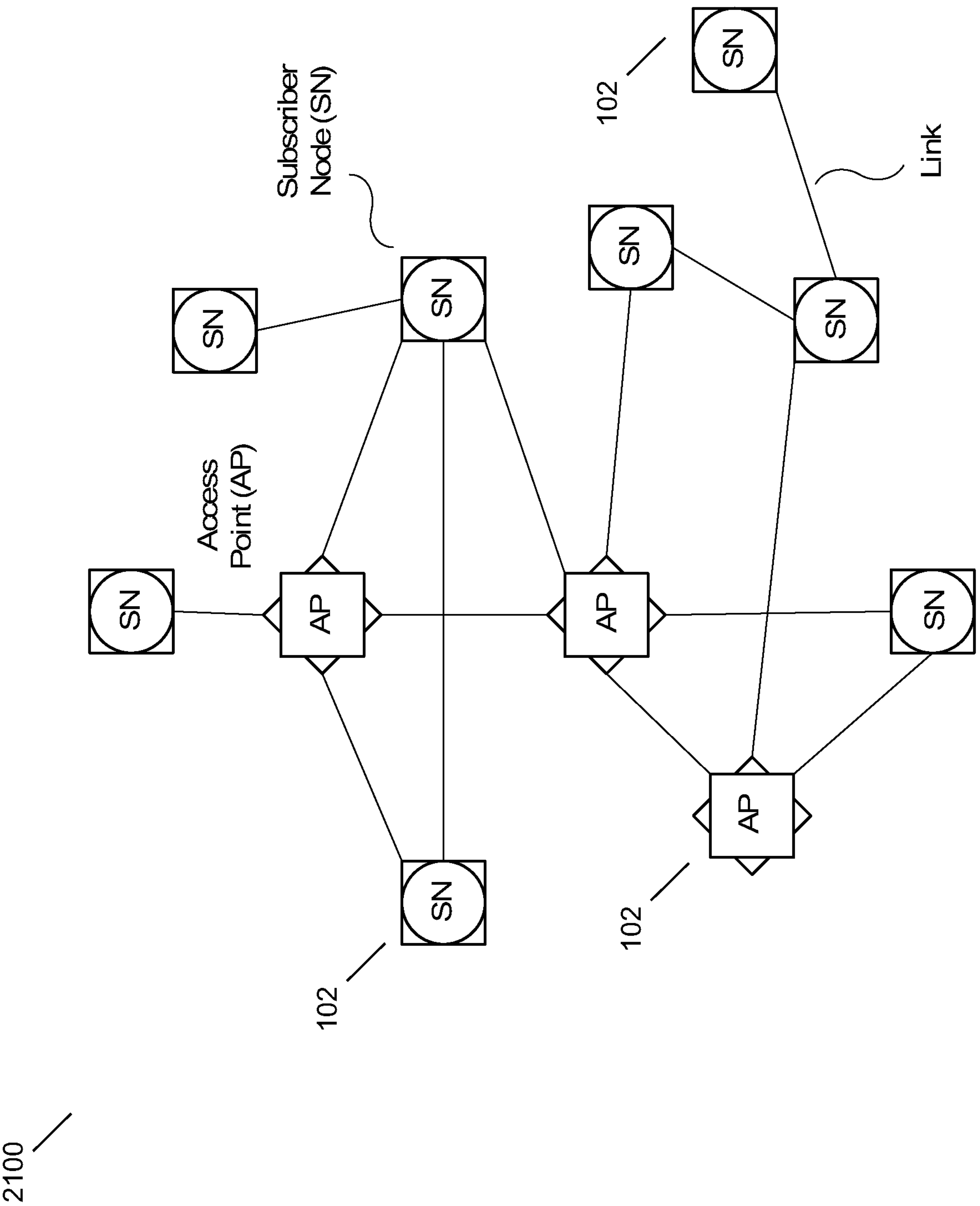


FIG. 21

2200

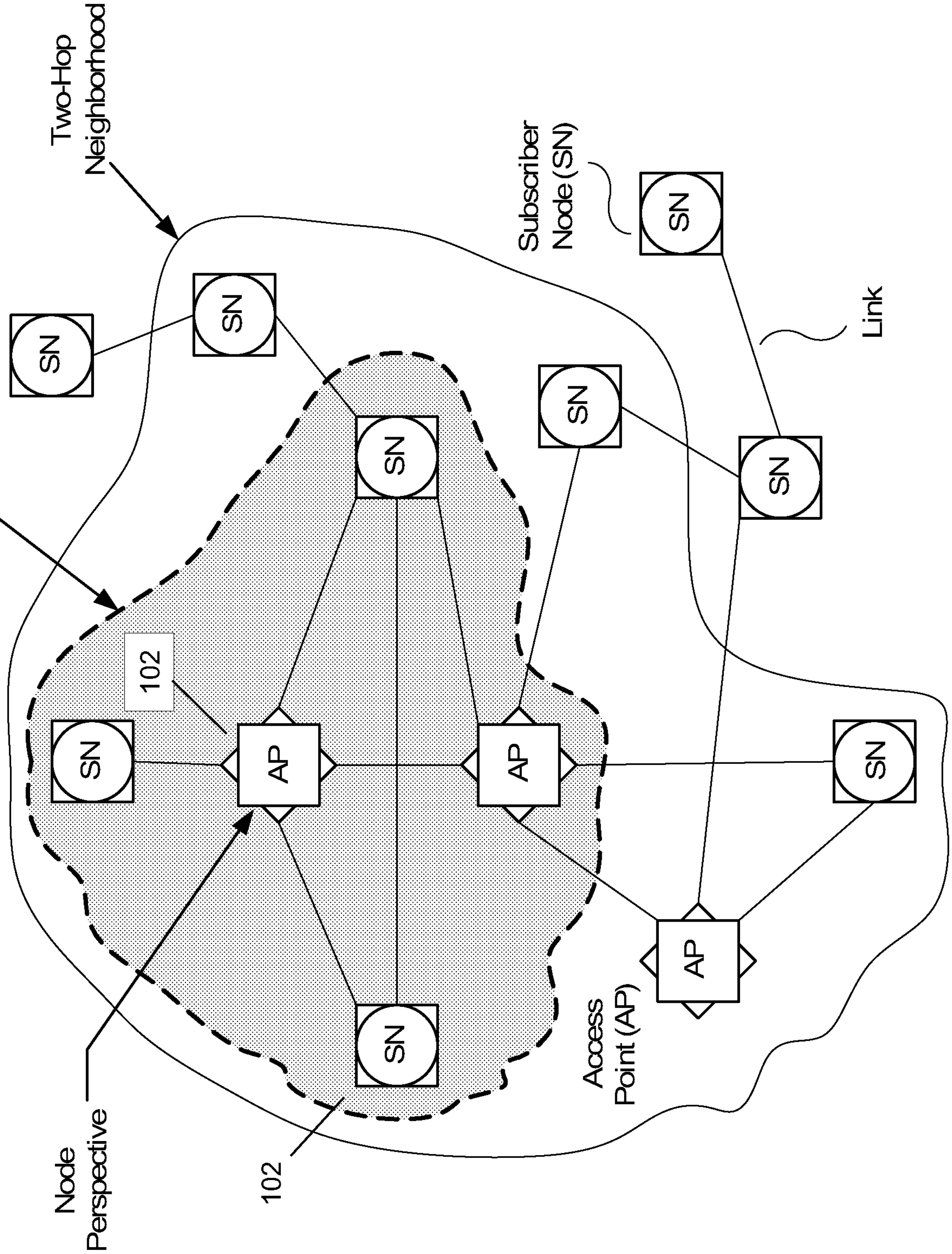

Two-Hop Neighborhood
One-Hop Neighborhood
Subscriber Node (SN)
Link
SN
AP
102
Node Perspective
Access Point (AP)

FIG. 22

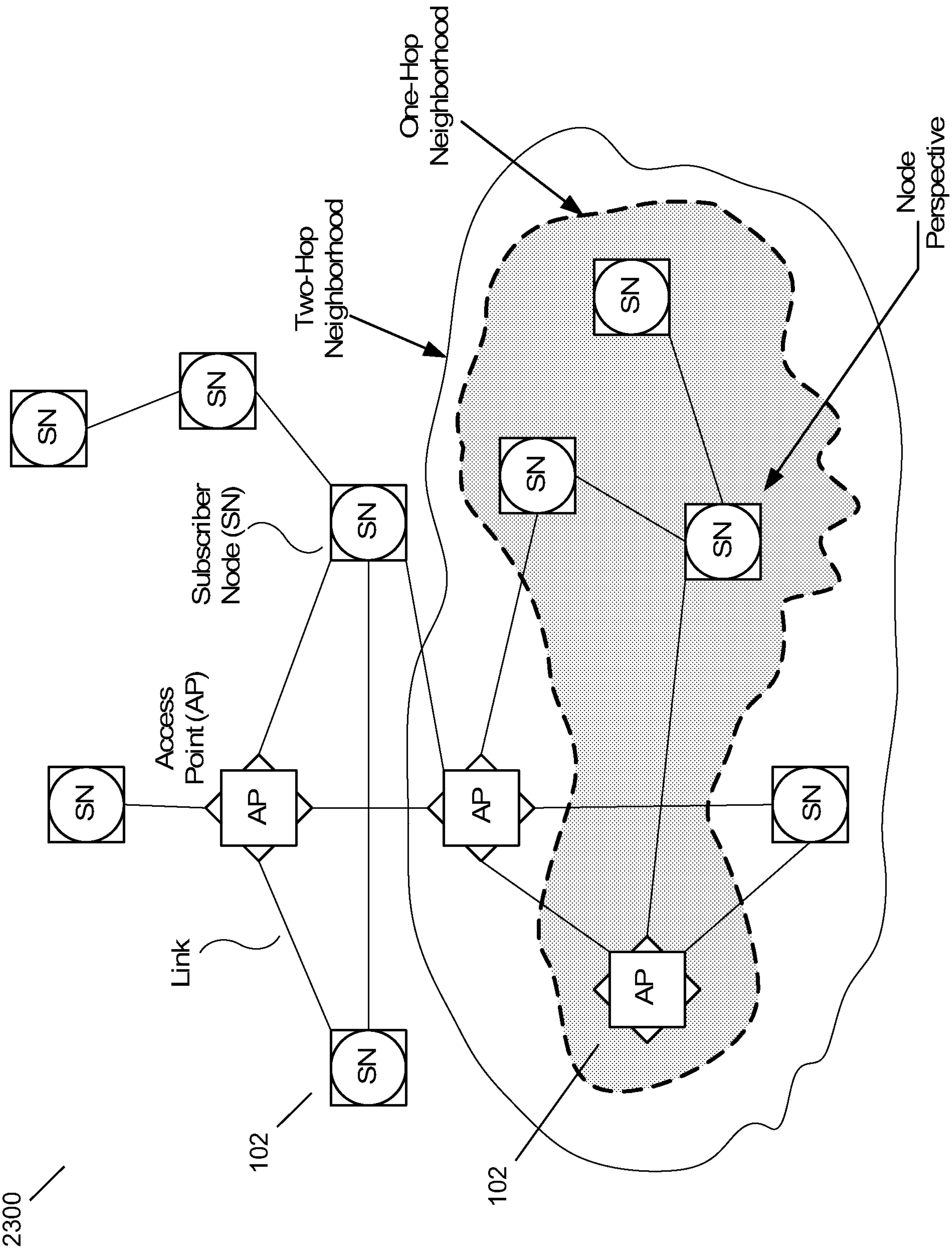

2300
102
102
Link
Access Point (AP)
Subscriber Node (SN)
Two-Hop Neighborhood
One-Hop Neighborhood
Node Perspective
SN
AP

FIG. 23

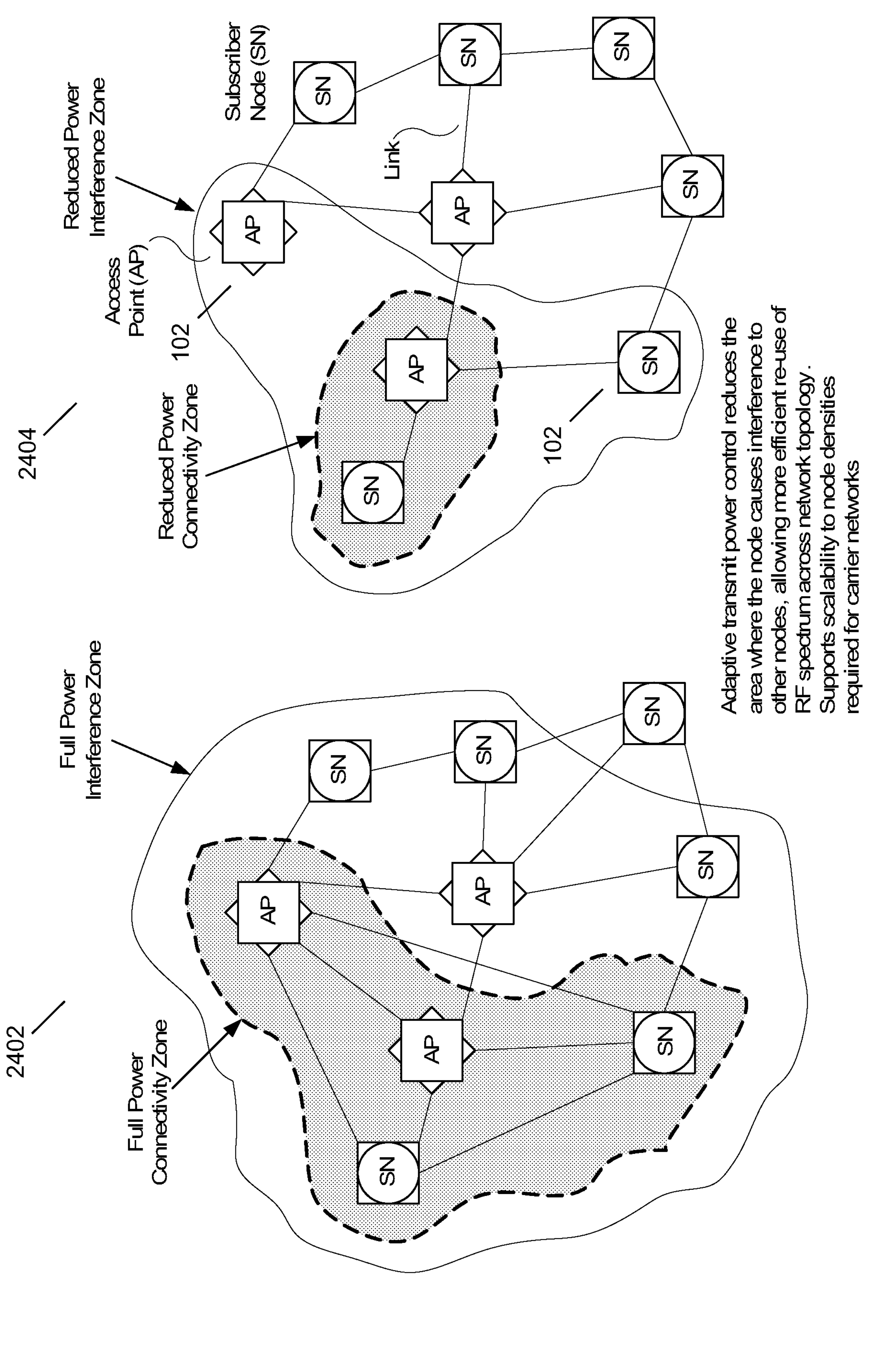

2402
2404
Full Power Interference Zone
Full Power Connectivity Zone
Reduced Power Interference Zone
Reduced Power Connectivity Zone
Access Point (AP)
Subscriber Node (SN)
Link
102
102
AP
SN
Adaptive transmit power control reduces the area where the node causes interference to other nodes, allowing more efficient re-use of RF spectrum across network topology.
Supports scalability to node densities required for carrier networks

FIG. 24

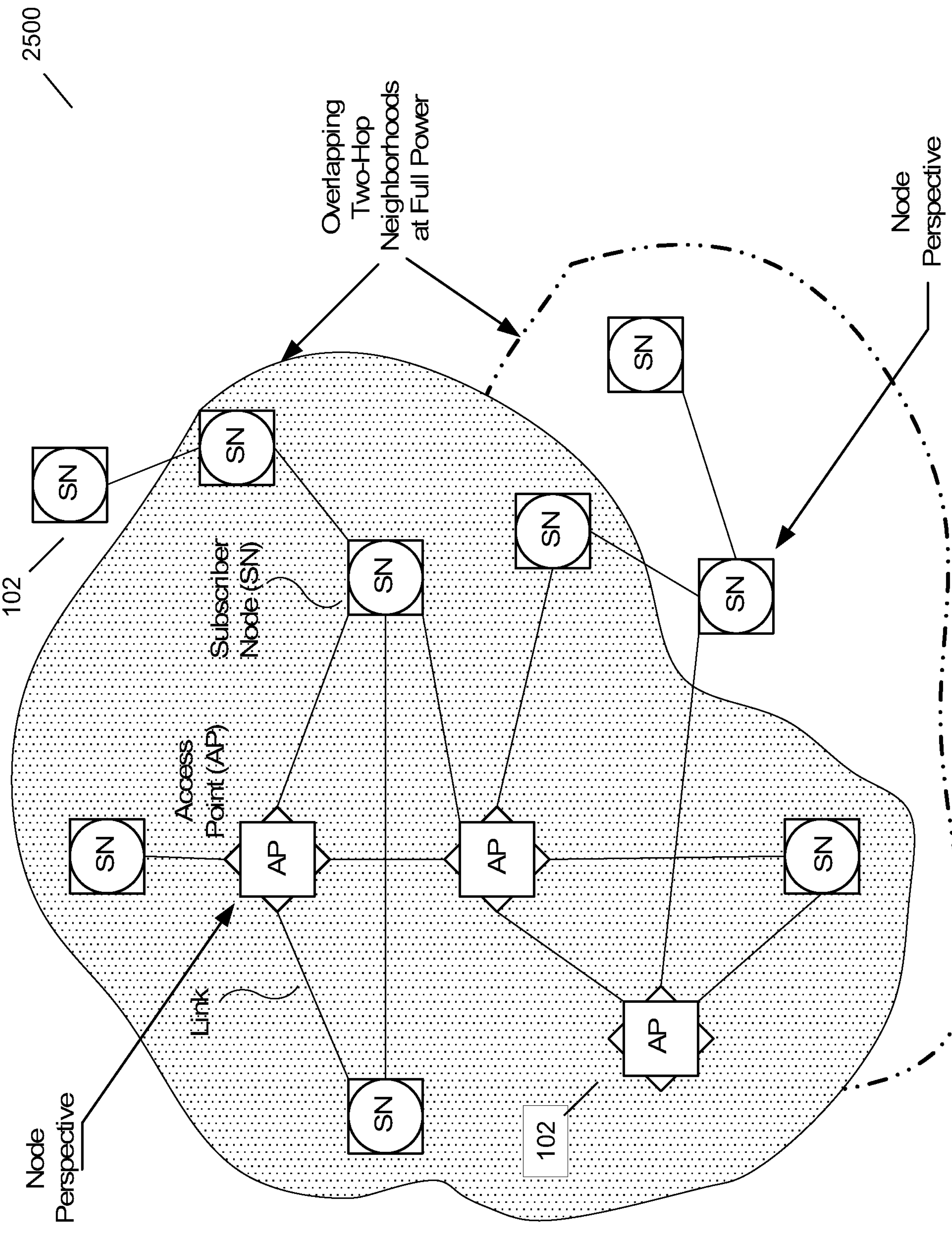

2500
Overlapping Two-Hop Neighborhoods at Full Power
Node Perspective
Node Perspective
102
102
Subscriber Node (SN)
Access Point (AP)
Link
SN
AP

FIG. 25

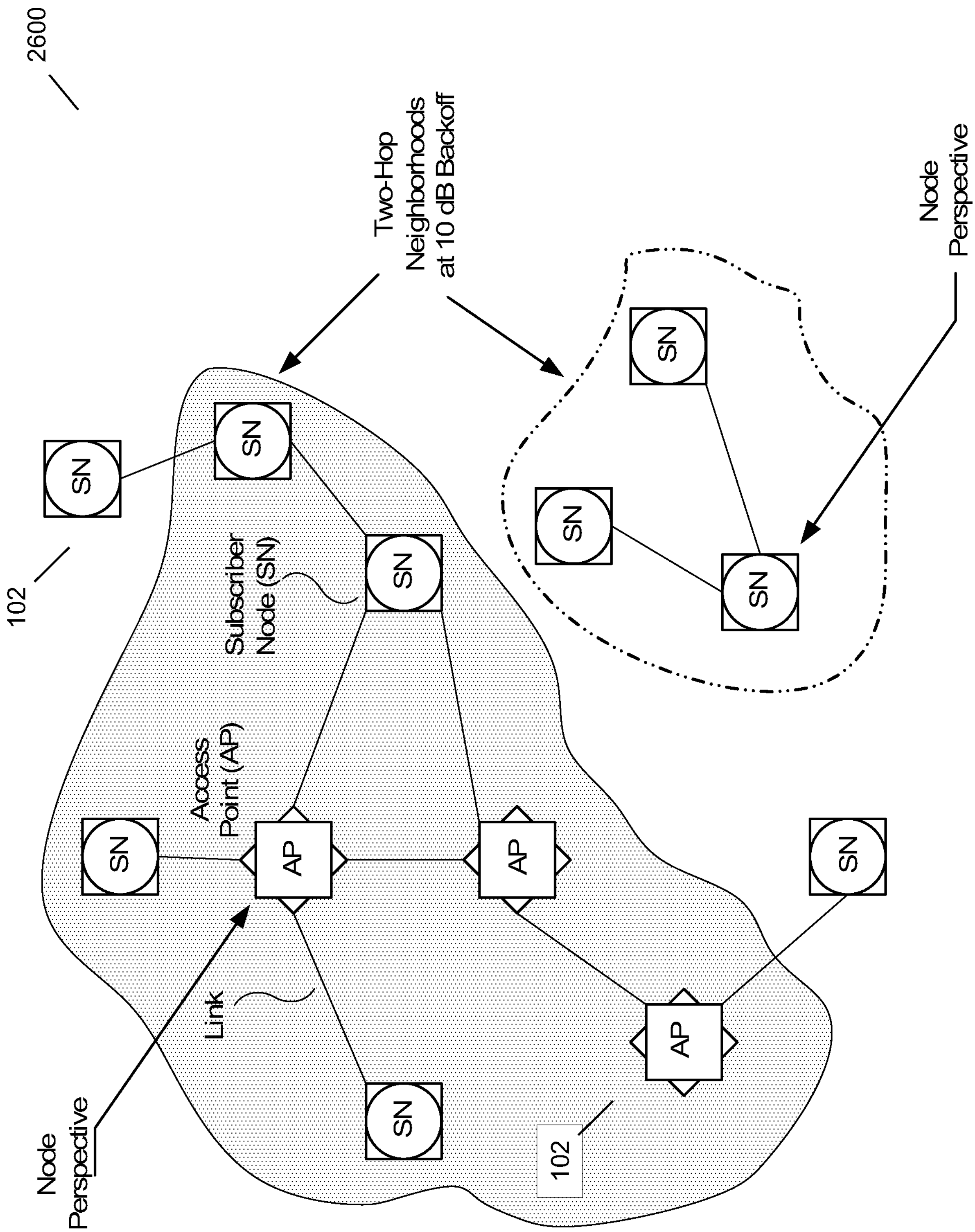

2600
Two-Hop Neighborhoods at 10 dB Backoff
Node Perspective
SN
SN
SN
SN
102
Subscriber Node (SN)
SN
SN
Access Point (AP)
SN
AP
AP
SN
Link
Node Perspective
AP
SN
102

FIG. 26

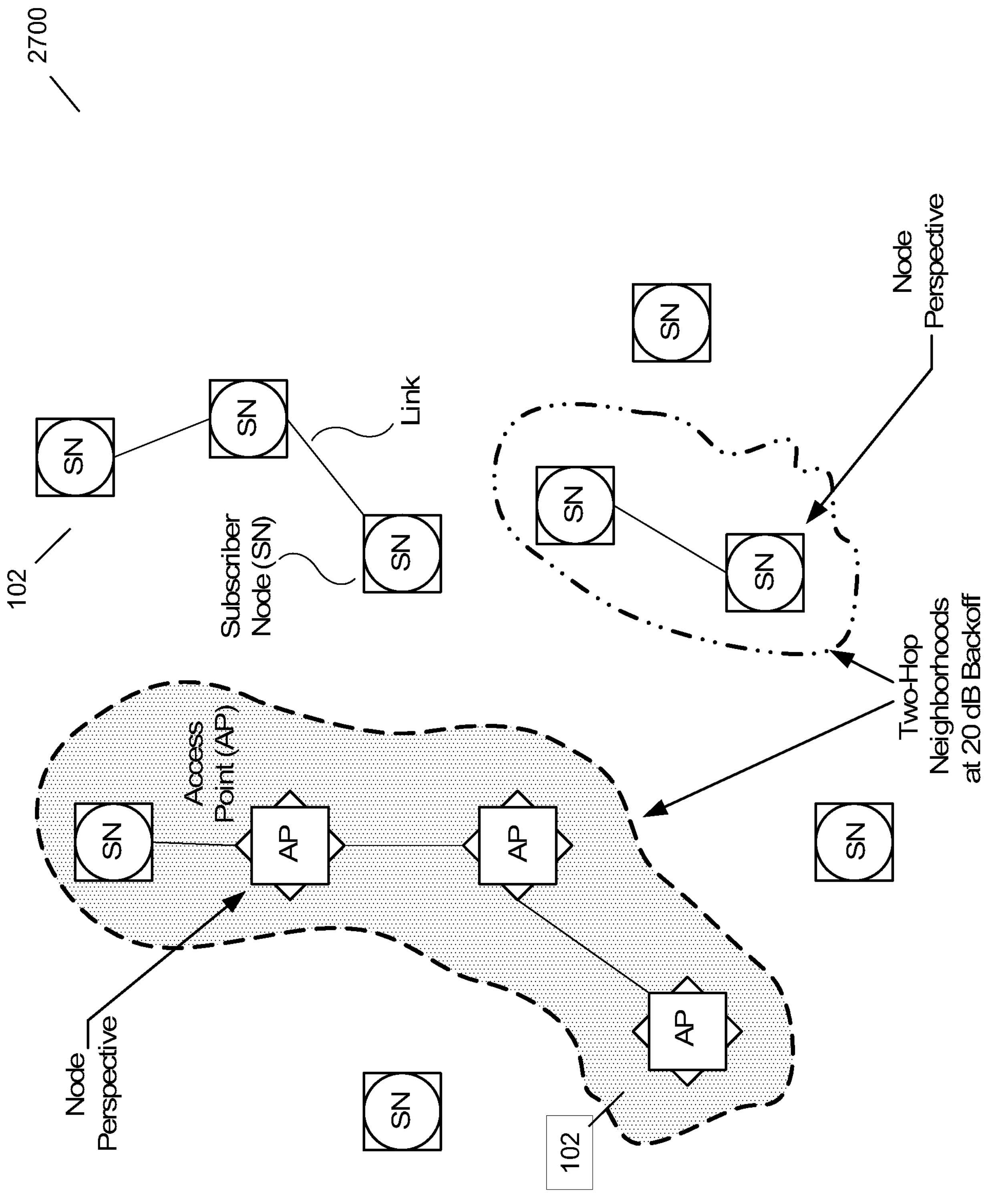

2700
102
SN
Link
Subscriber Node (SN)
Node Perspective
Access Point (AP)
AP
Two-Hop Neighborhoods at 20 dB Backoff
102

FIG. 27

2800

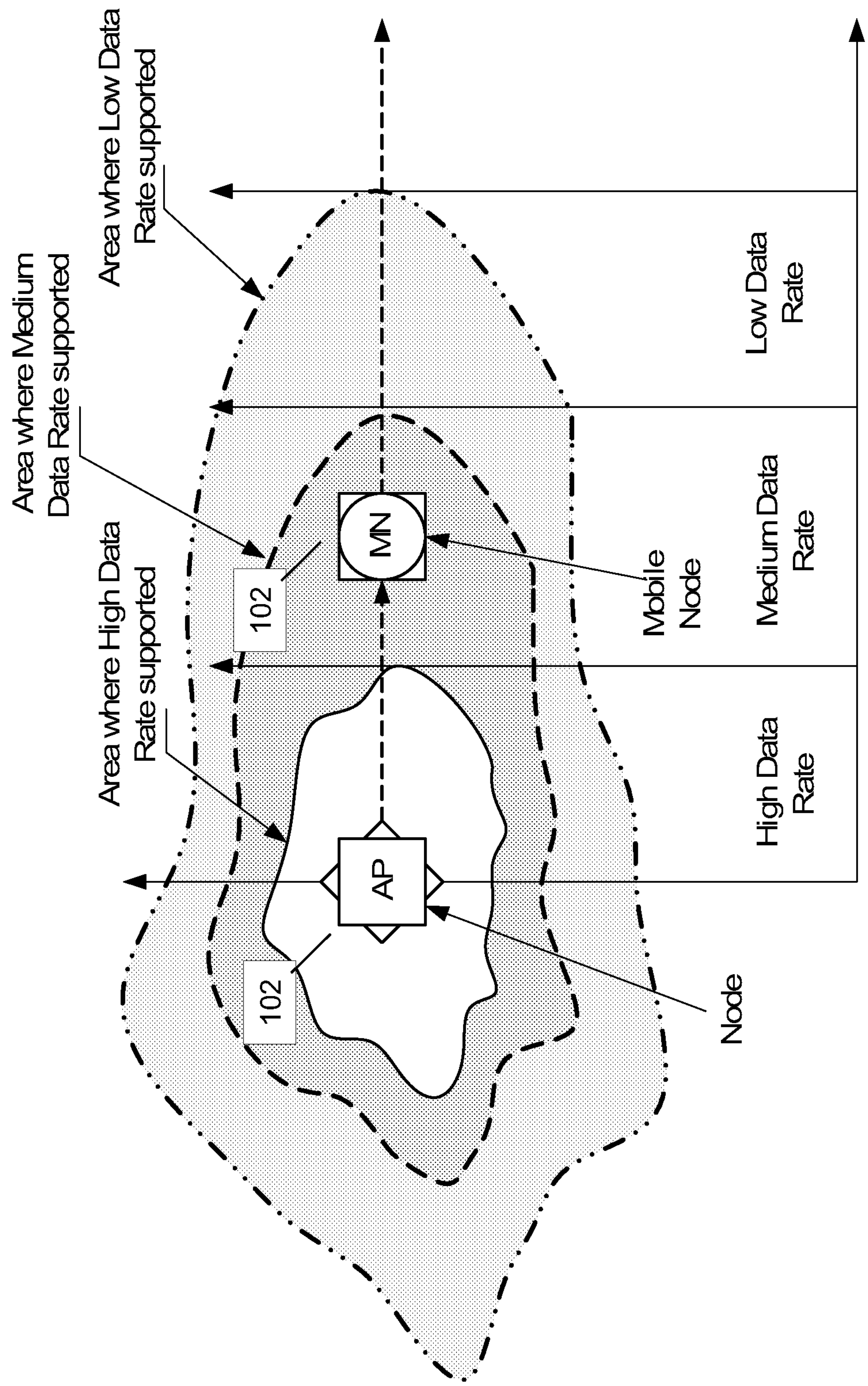

Area where Low Data Rate supported
Area where Medium Data Rate supported
Area where High Data Rate supported
102
MN
102
AP
Mobile Node
Node
Low Data Rate
Medium Data Rate
High Data Rate

FIG. 28

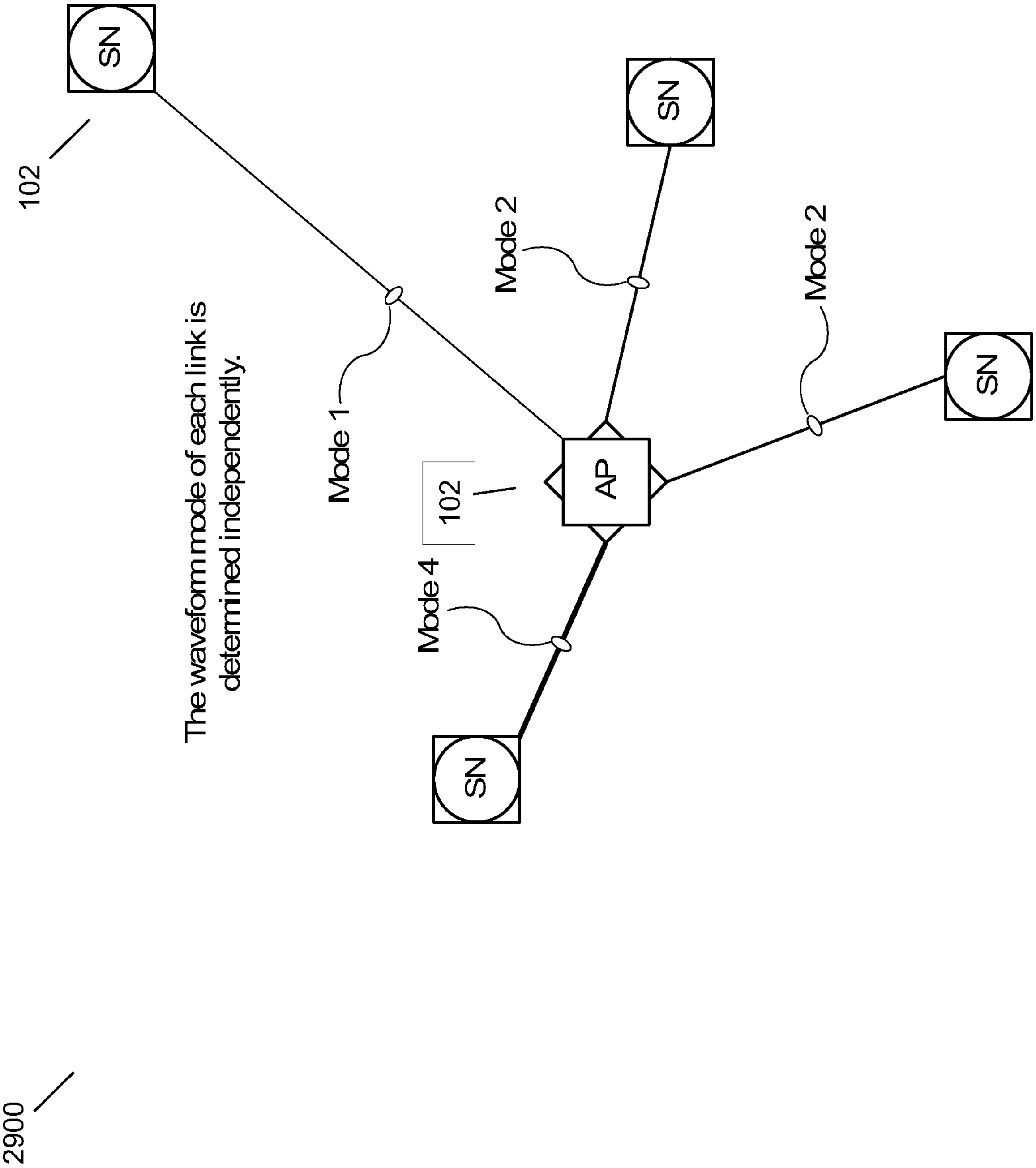

2900
102
SN
SN
SN
SN
AP
102
Mode 1
Mode 2
Mode 2
Mode 4
The waveform mode of each link is determined independently.

FIG. 29

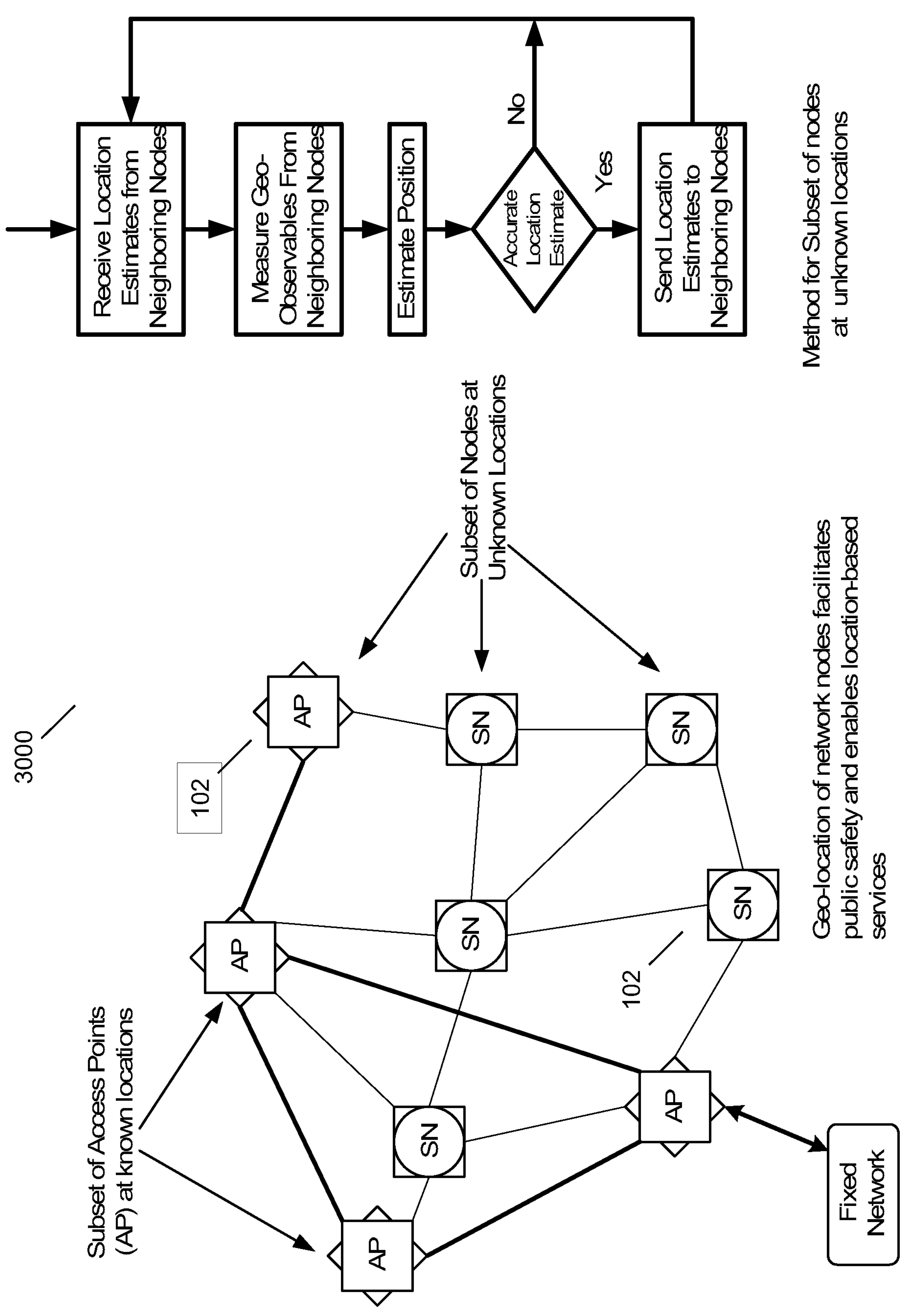

Receive Location Estimates from Neighboring Nodes
Measure Geo-Observables From Neighboring Nodes
Estimate Position
Accurate Location Estimate
No
Yes
Send Location Estimates to Neighboring Nodes
Method for Subset of nodes at unknown locations
3000
Subset of Nodes at Unknown Locations
102
AP
SN
102
Subset of Access Points (AP) at known locations
Geo-location of network nodes facilitates public safety and enables location-based services
Fixed Network

FIG. 30

3100

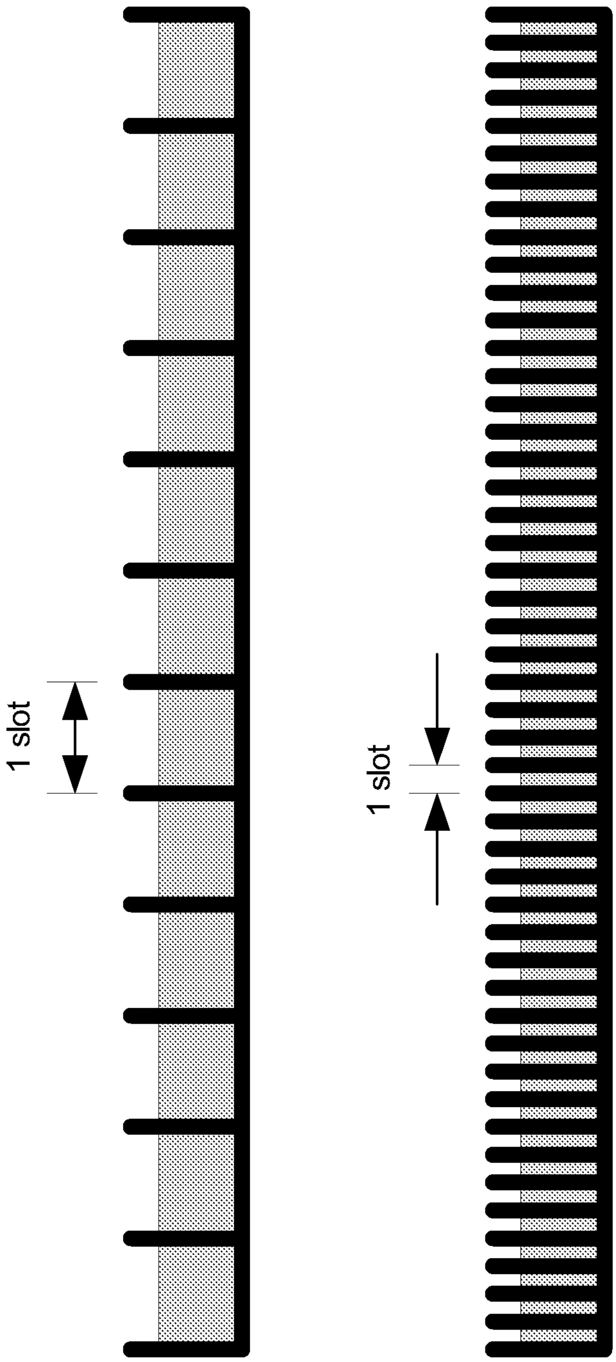


FIG. 31

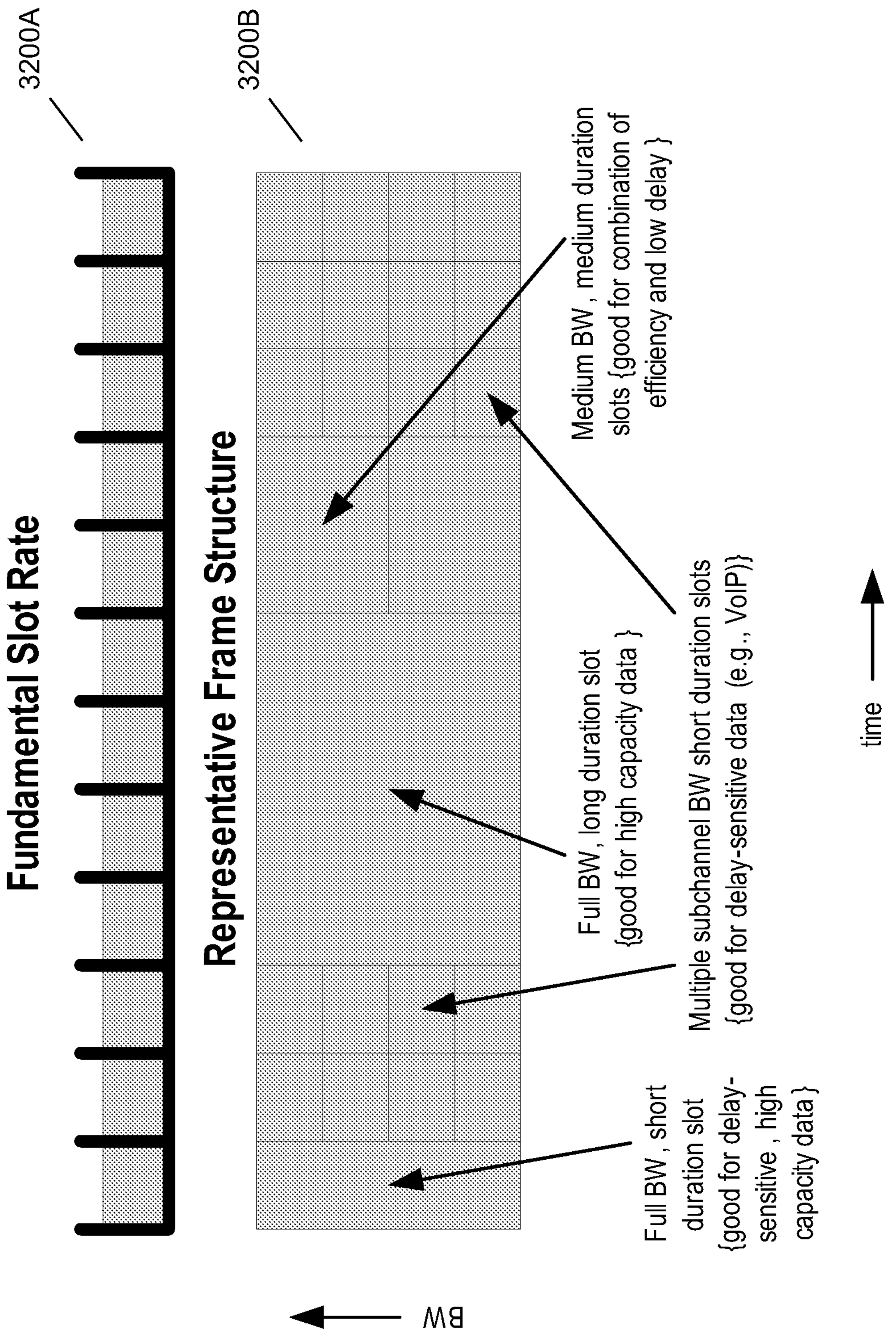

3200A
3200B
Fundamental Slot Rate
Representative Frame Structure
Medium BW , medium duration slots {good for combination of efficiency and low delay }
Full BW , long duration slot {good for high capacity data }
Multiple subchannel BW short duration slots {good for delay-sensitive data (e.g., VoIP)}
Full BW , short duration slot {good for delay-sensitive , high capacity data }
time
BW

FIG. 32

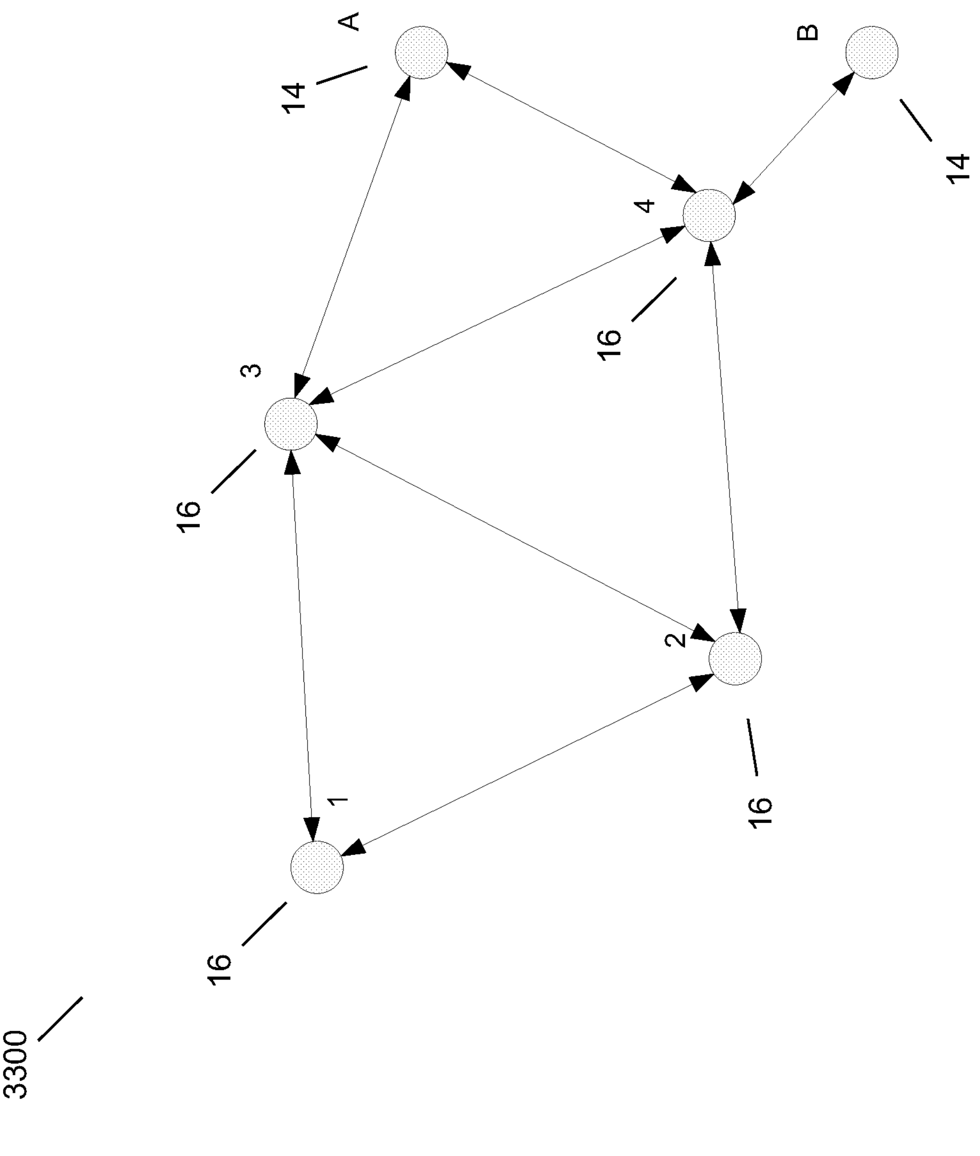


FIG. 33

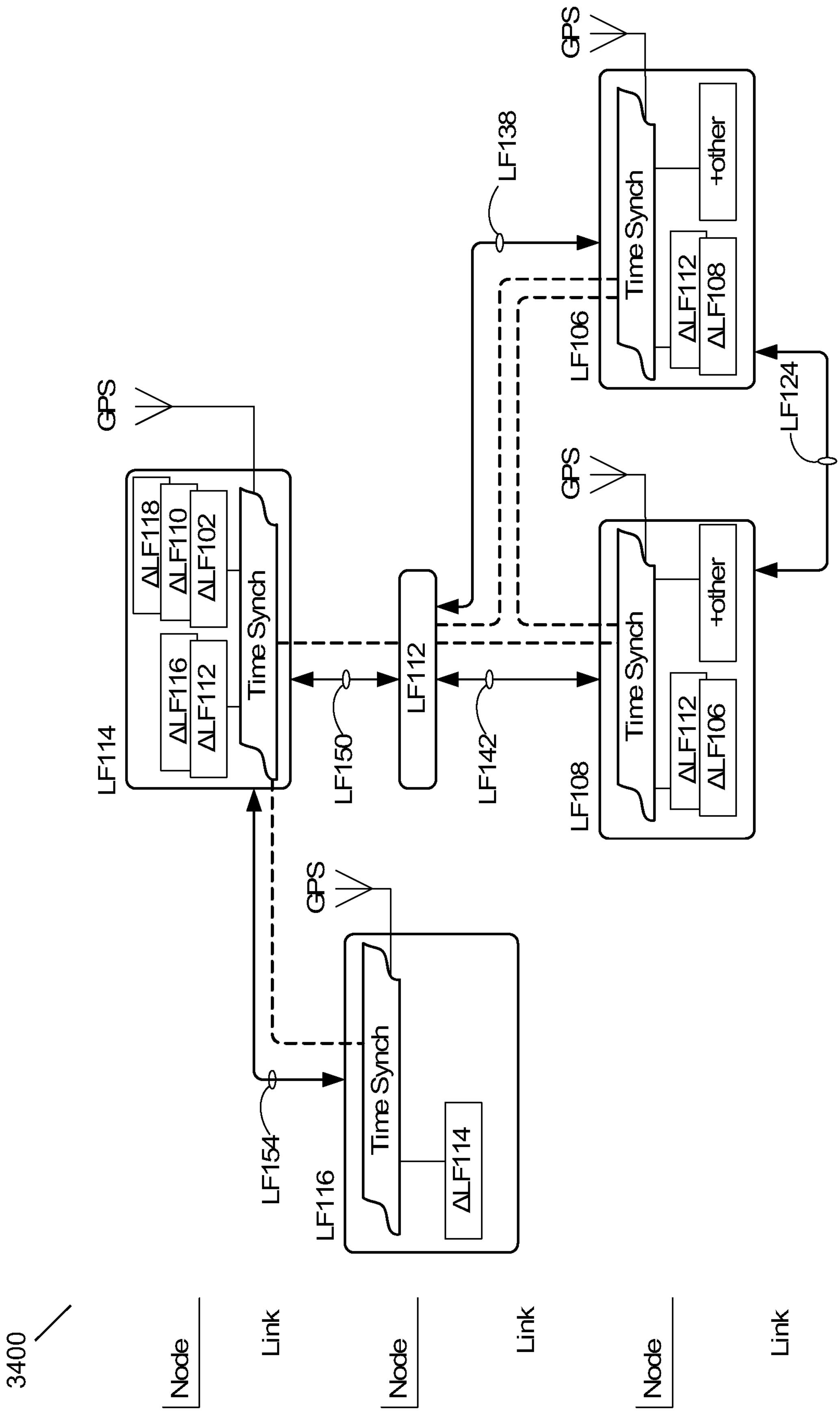

3400
Node
Link
Node
Link
Node
Link
LF116
Time Synch
ΔLF114
GPS
LF154
LF114
ΔLF116
ΔLF112
ΔLF118
ΔLF110
ΔLF102
Time Synch
GPS
LF150
LF112
LF142
LF108
Time Synch
ΔLF112
ΔLF106
+other
GPS
LF124
LF138
LF106
Time Synch
ΔLF112
ΔLF108
+other
GPS

FIG. 34

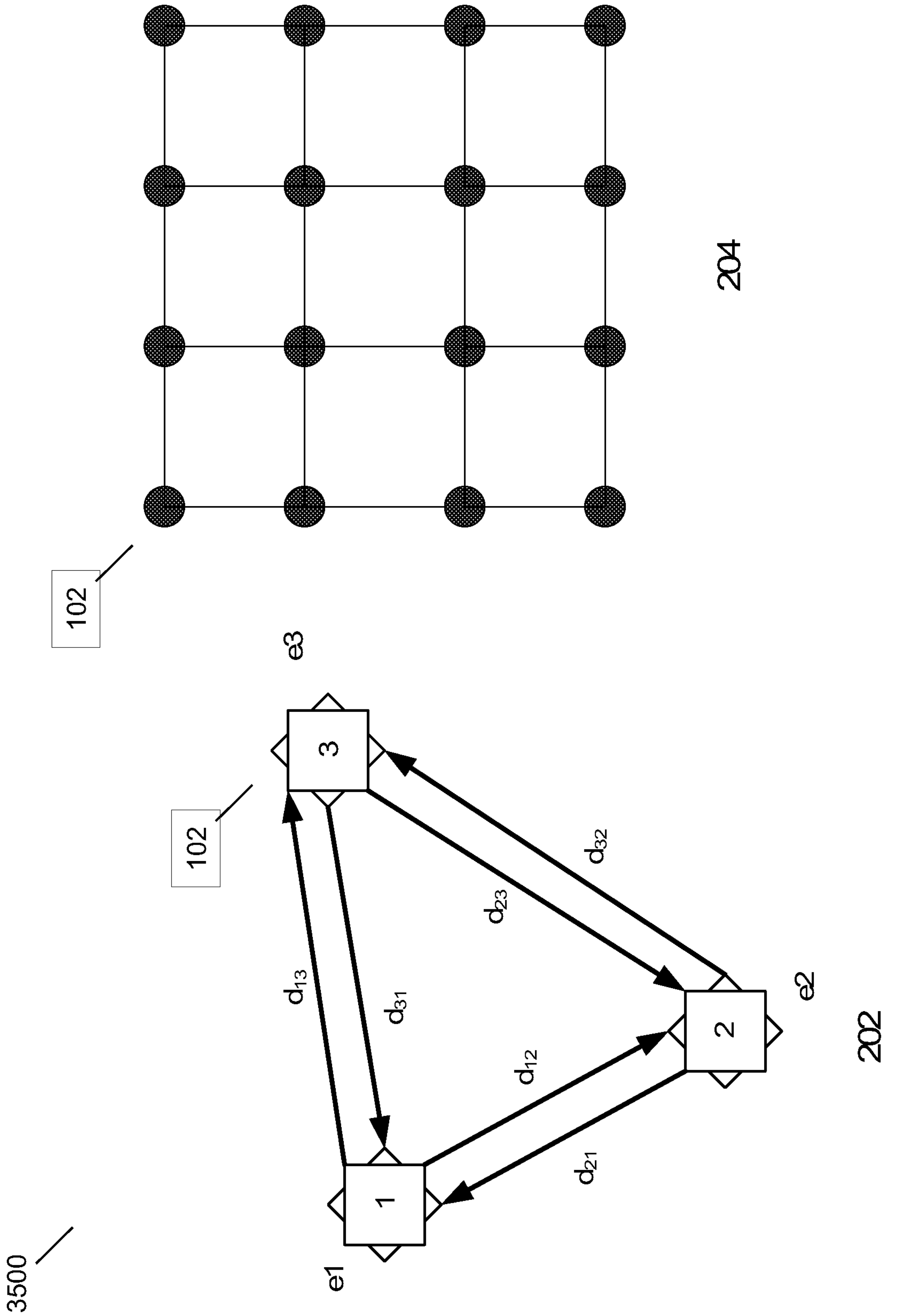


FIG. 35

3500A

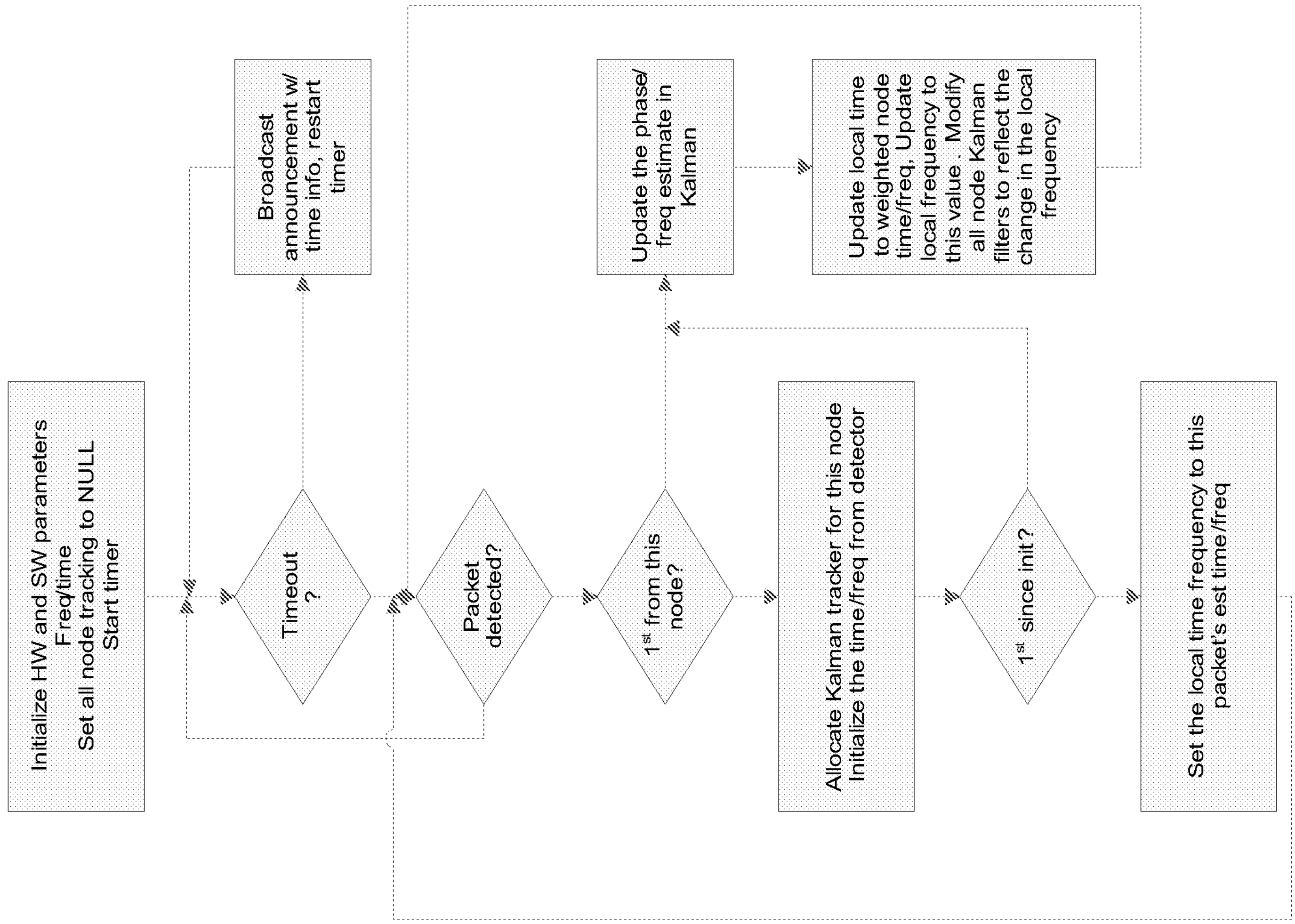


FIG. 35A

3500B

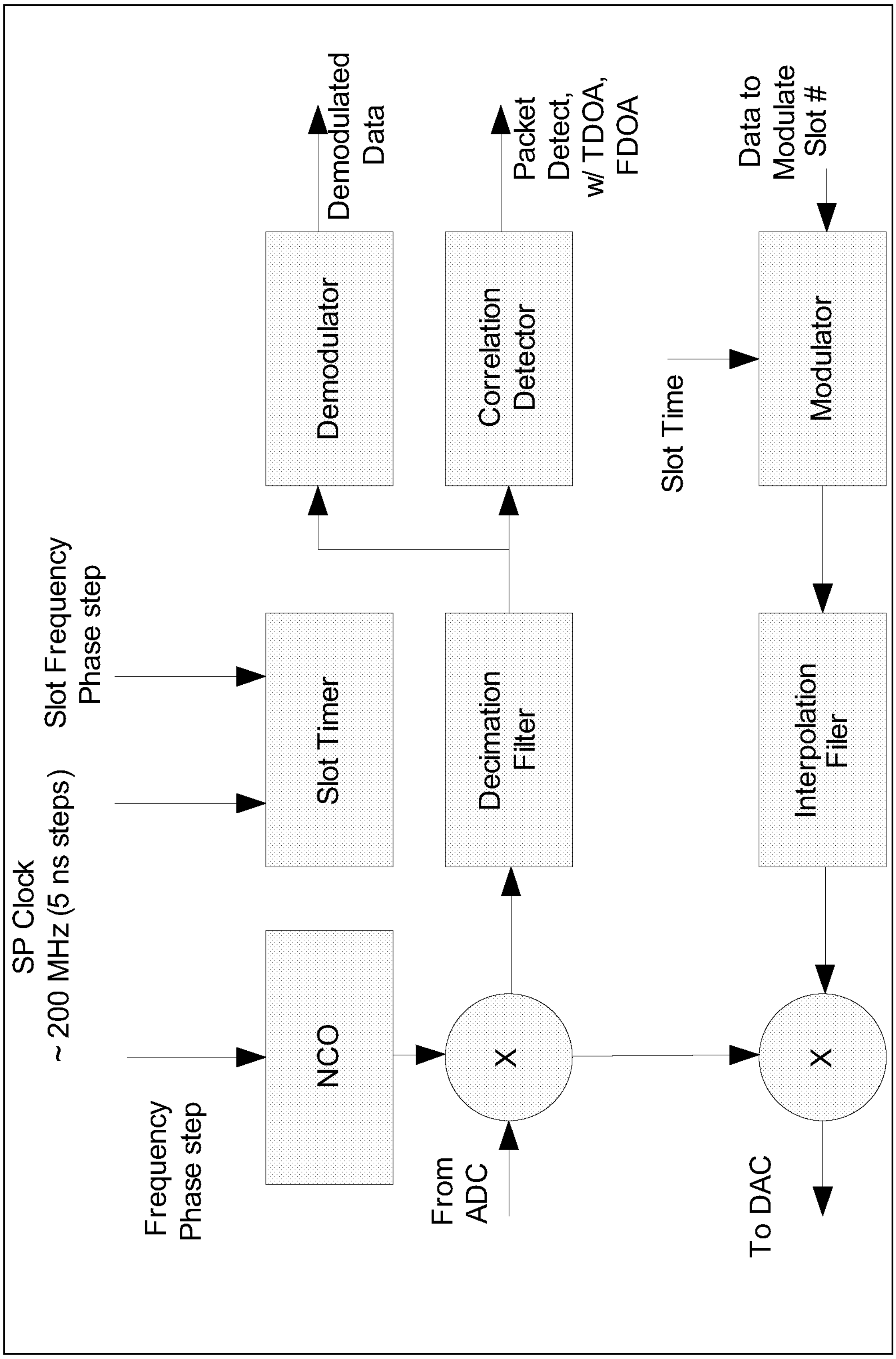
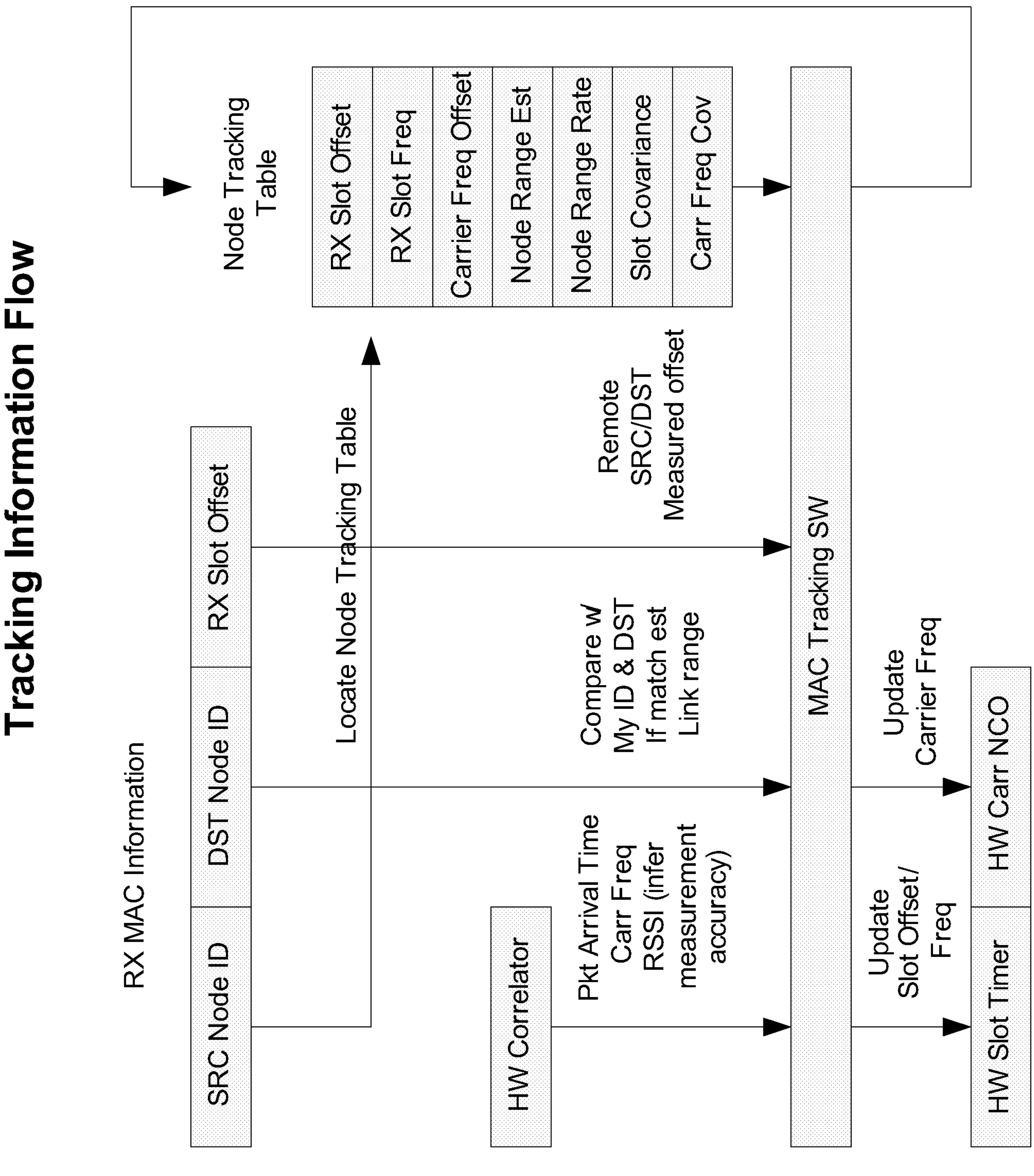


FIG. 35B



3500C

FIG. 35C

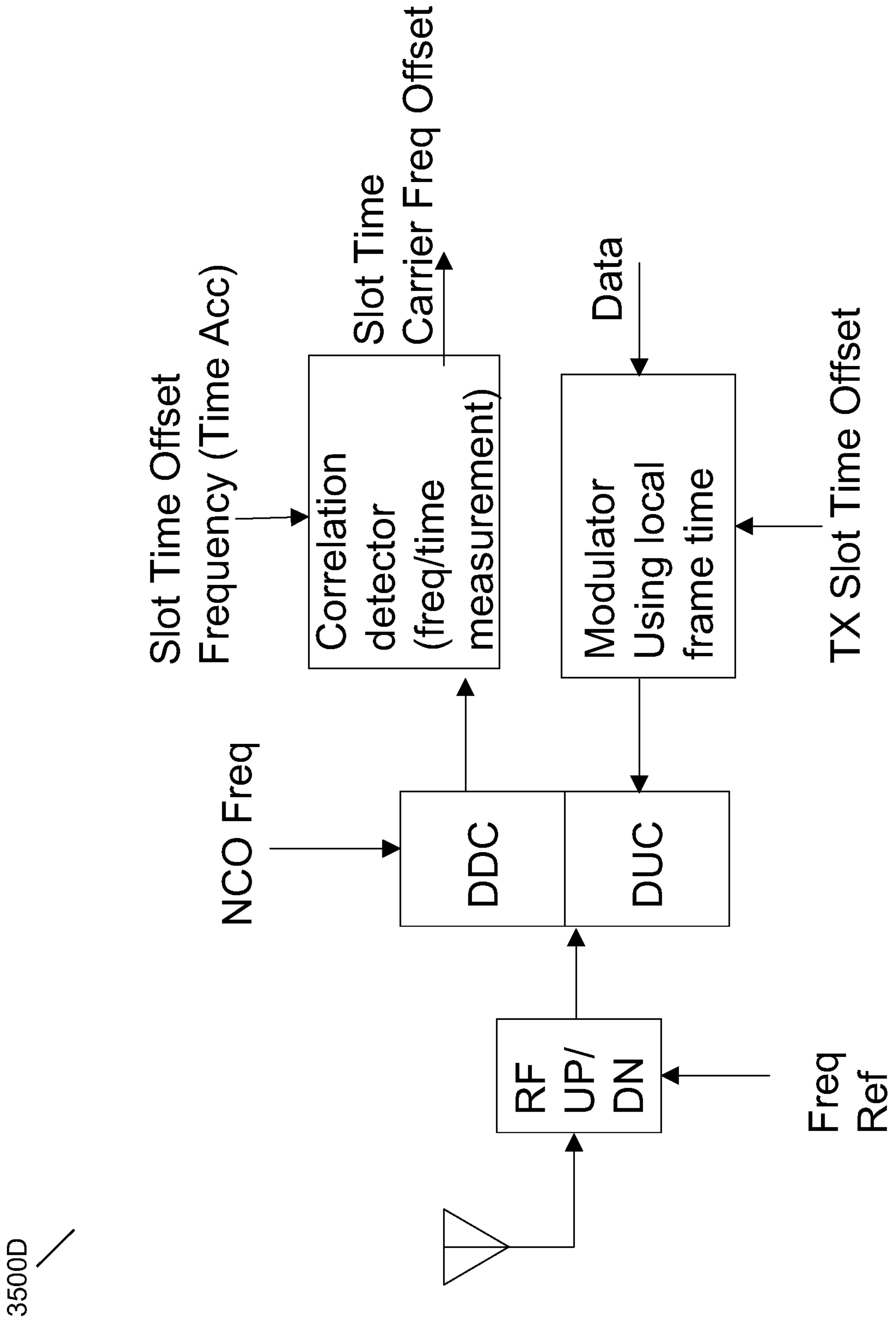

3500D
Slot Time Offset
Frequency (Time Acc)
Correlation detector (freq/time measurement)
Slot Time
Carrier Freq Offset
NCO Freq
DDC
DUC
Data
Modulator Using local frame time
TX Slot Time Offset
RF UP/ DN
Freq Ref

FIG. 35D

3500E

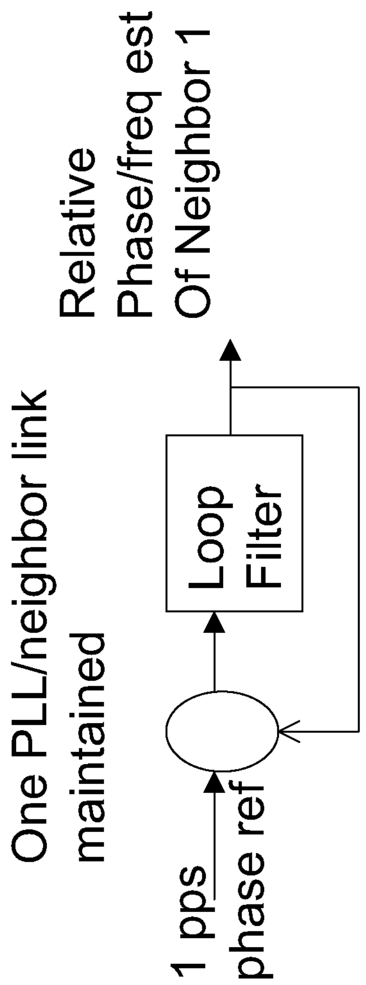


FIG. 35E

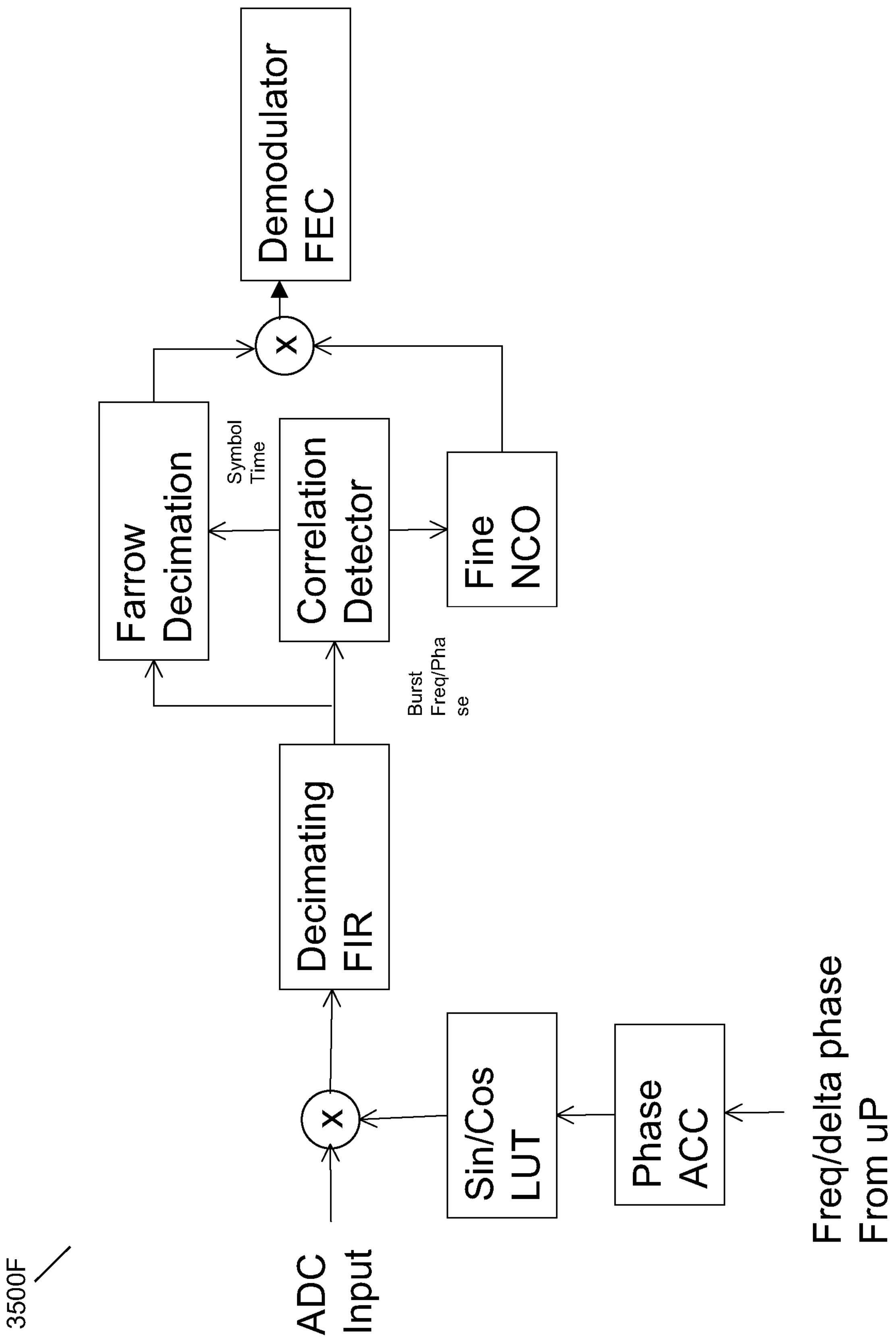

3500F
ADC Input
Decimating FIR
Sin/Cos LUT
Phase ACC
Freq/delta phase From uP
Burst Freq/Phase
Farrow Decimation
Correlation Detector
Symbol Time
Fine NCO
X
X
Demodulator FEC

FIG. 35F

3500G

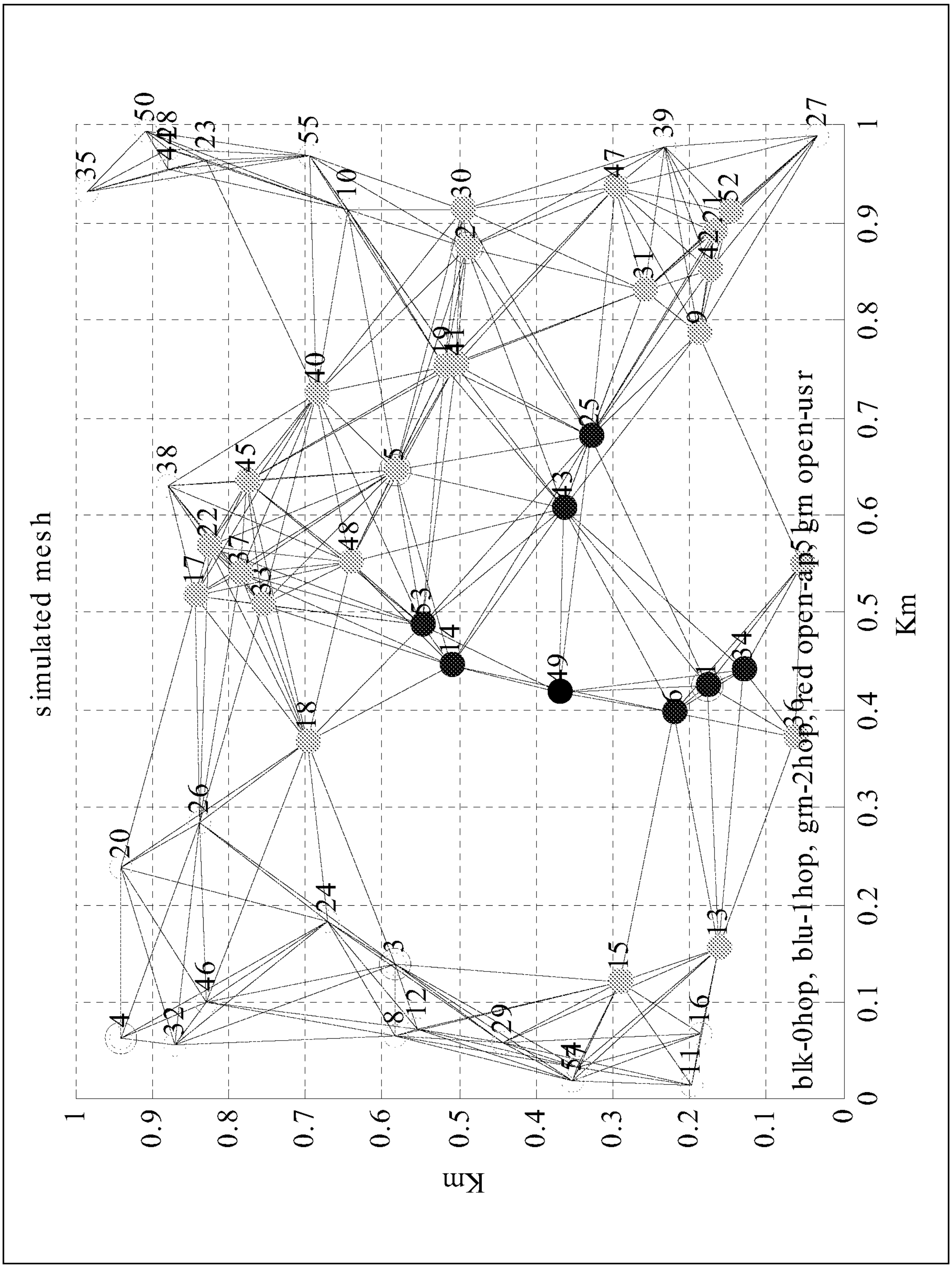


FIG. 35G

3500H

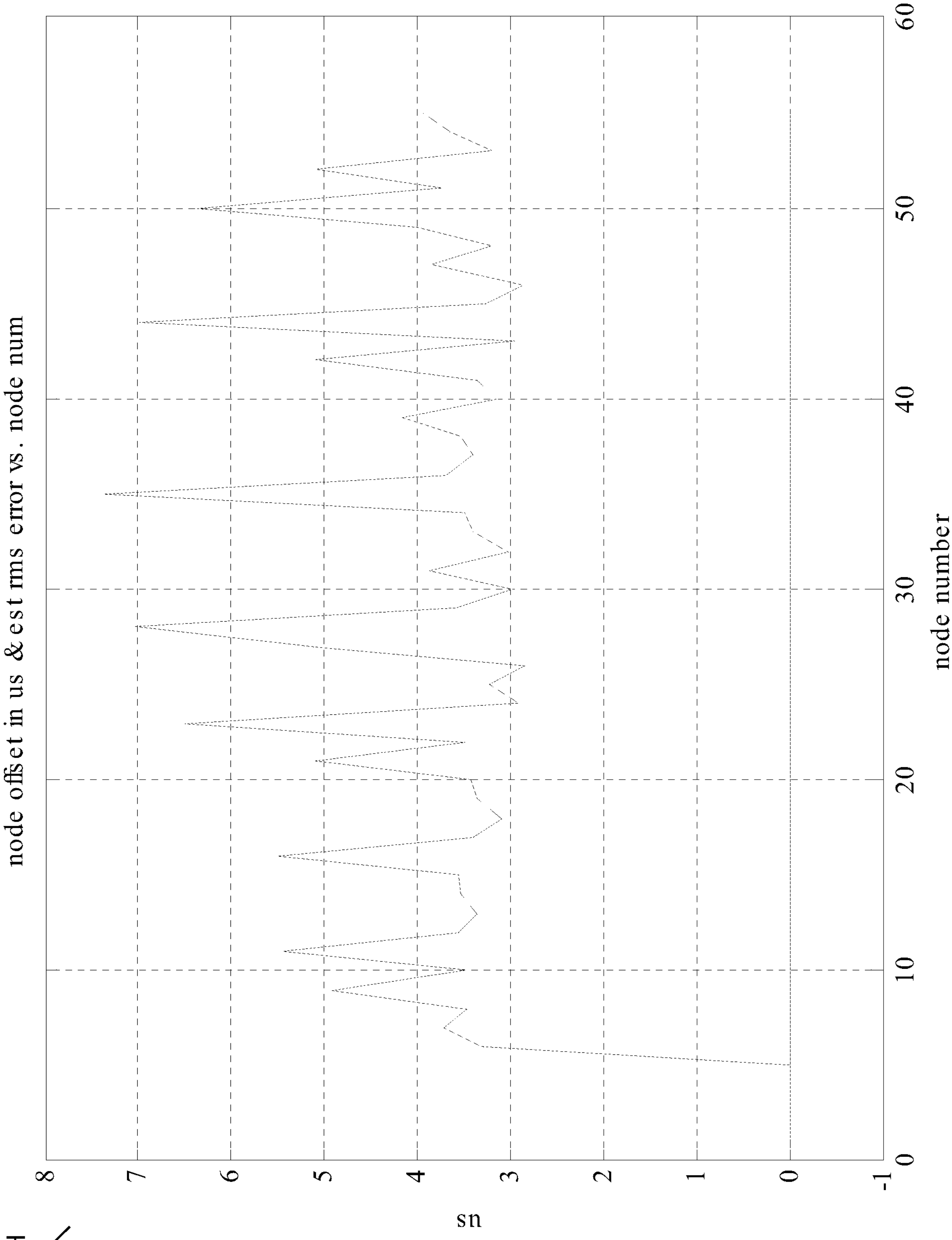


FIG. 35H

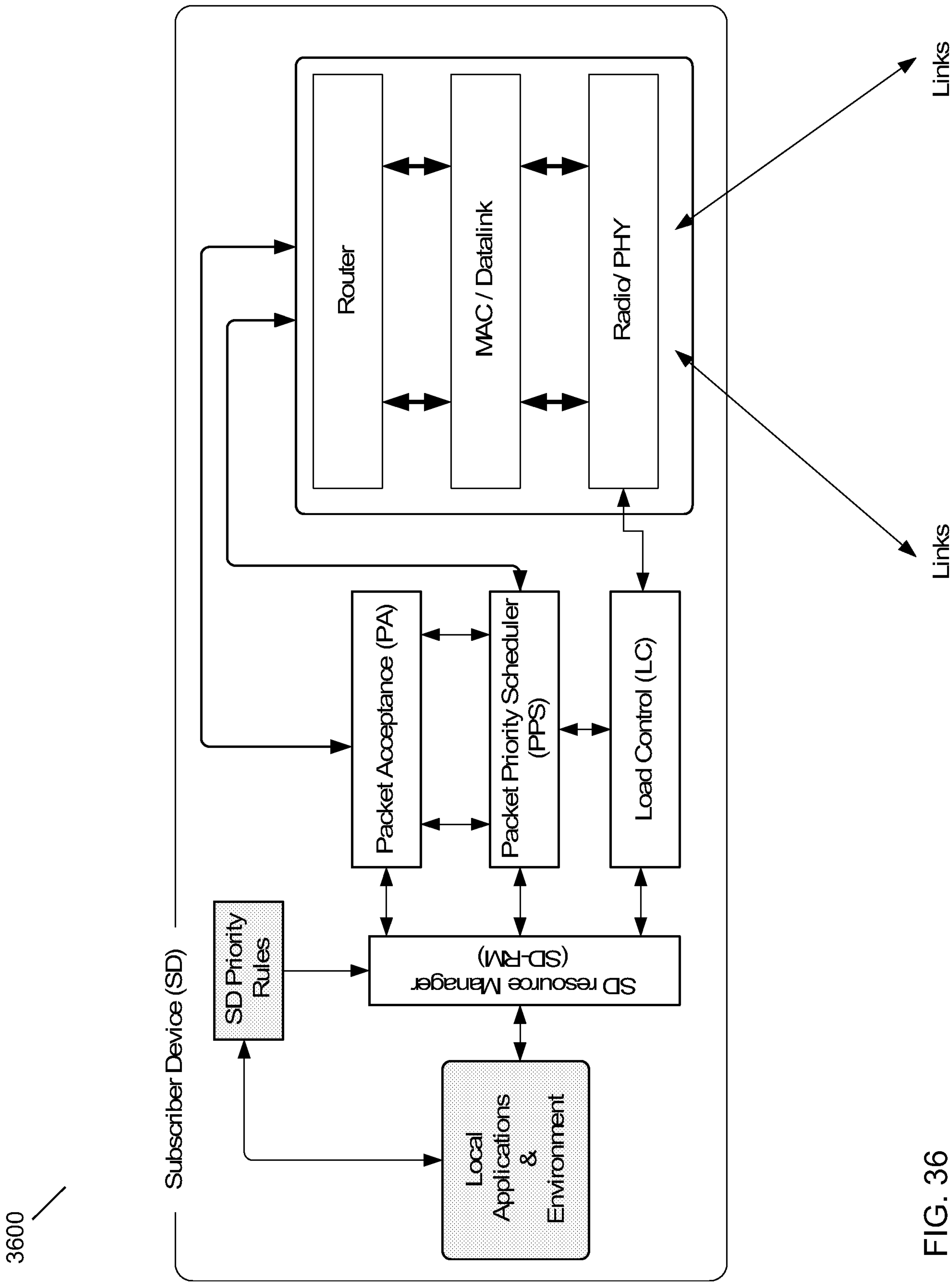

3600
Subscriber Device (SD)
Router
MAC / Datalink
Radio/ PHY
Links
Links
Packet Acceptance (PA)
Packet Priority Scheduler (PPS)
Load Control (LC)
SD Priority Rules
SD resource Manager (SD-RM)
Local Applications & Environment

FIG. 36

3700

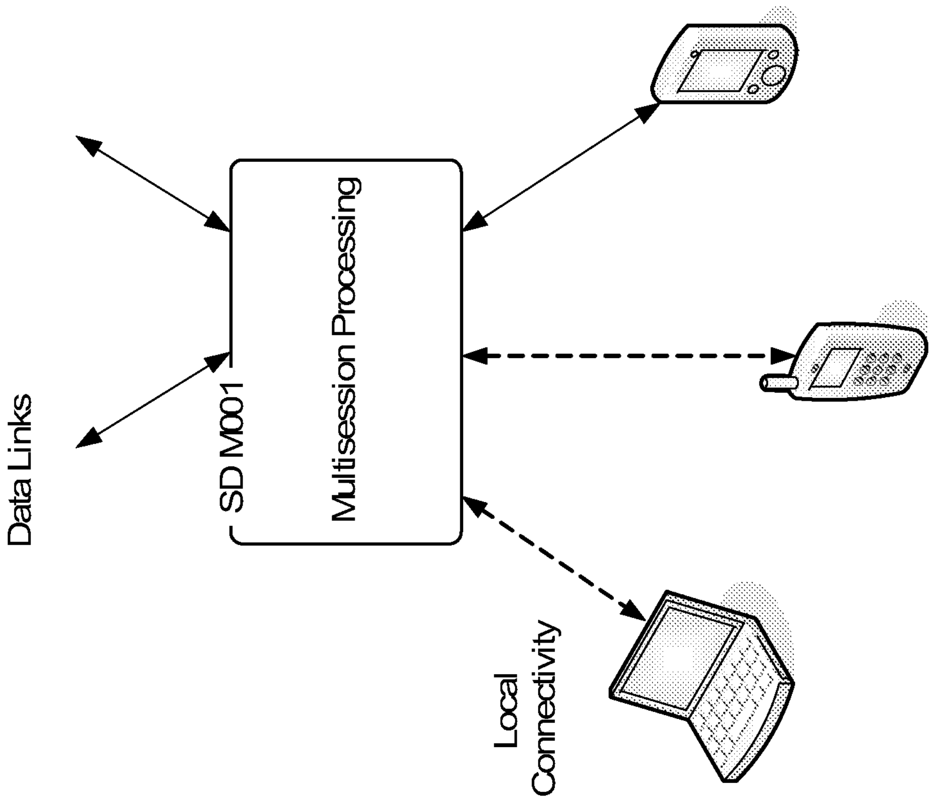

Data Links
SD M001
Multisession Processing
Local Connectivity

FIG. 37

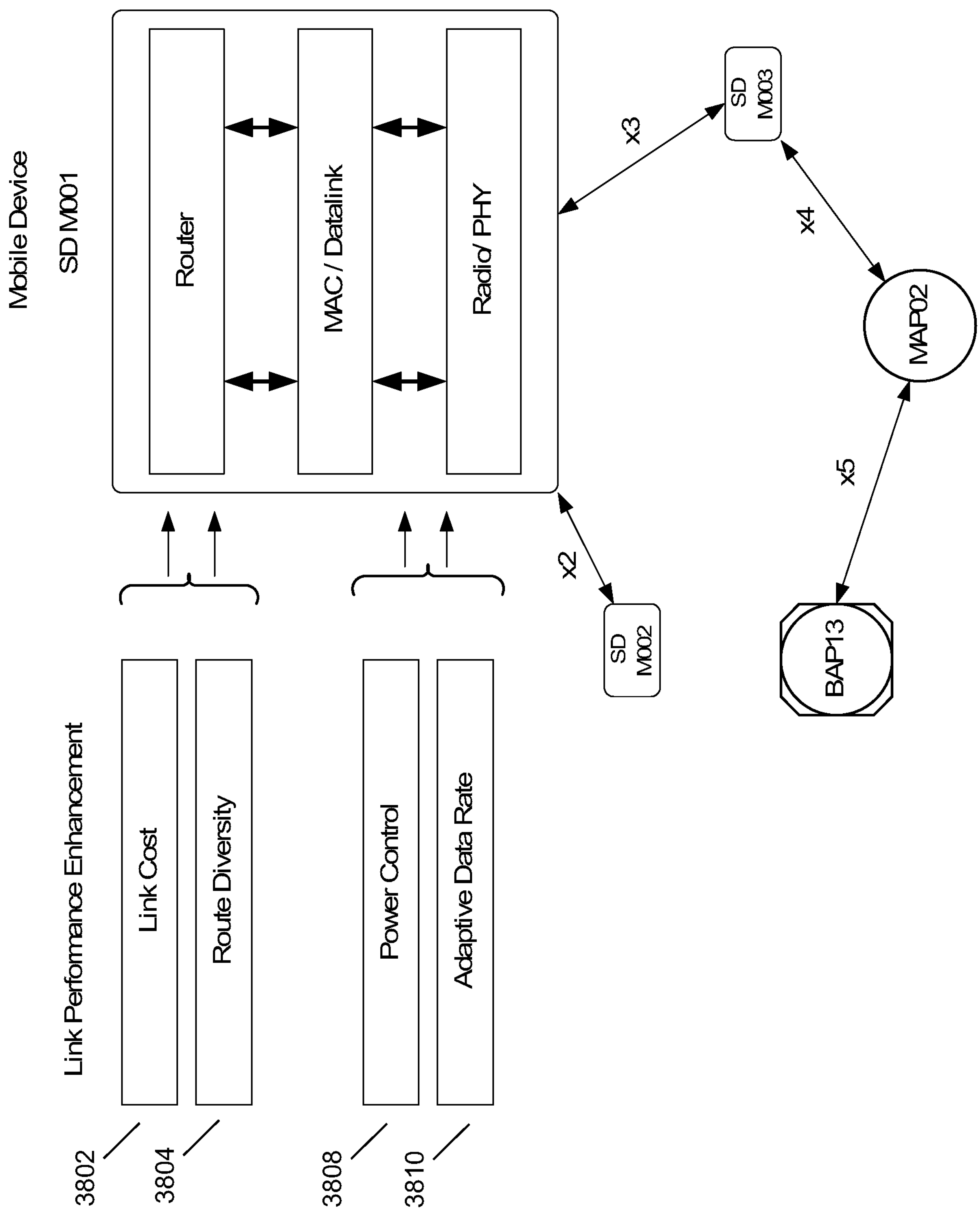

Mobile Device
SD M001
Router
MAC / Datalink
Radio/ PHY
x3
SD
M003
x4
MAP02
x5
BAP13
x2
SD
M002
Link Performance Enhancement
Link Cost
Route Diversity
Power Control
Adaptive Data Rate
3802
3804
3808
3810

FIG. 38

3900

Contents of a Mobile Subscriber Device Routing Tables

	Network ID	Least Cost Route	Next Hop
SD id# M002	SD_xx2	x2	SD M002
SD id# M003	SD_xx3	x3	SD M003
••• •••	••• •••	••• •••	••• •••
MAP id# LF02	MAP_xx2	x3+x4	SD M003
BAP id# LF13	BAP_x13	x3+x4+x5	SD M003

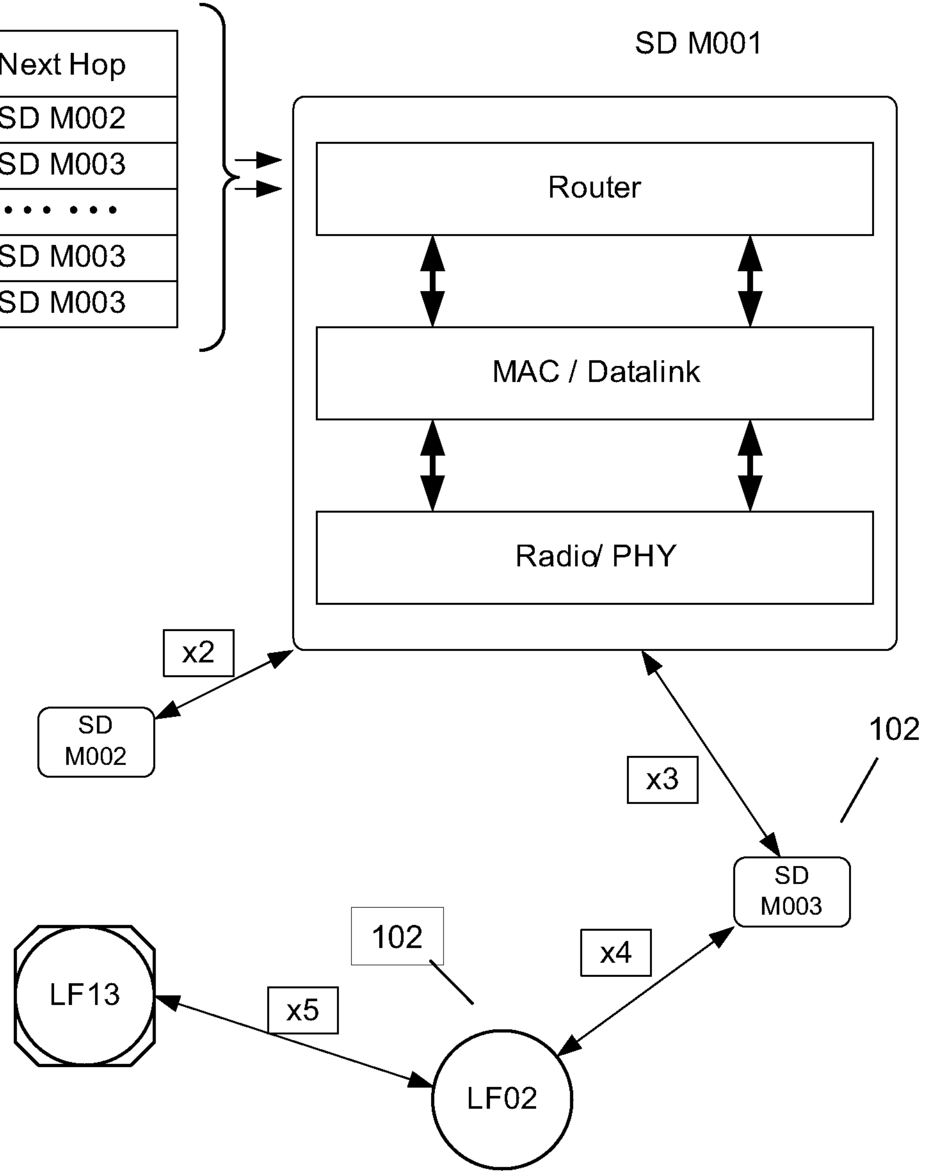


FIG. 39

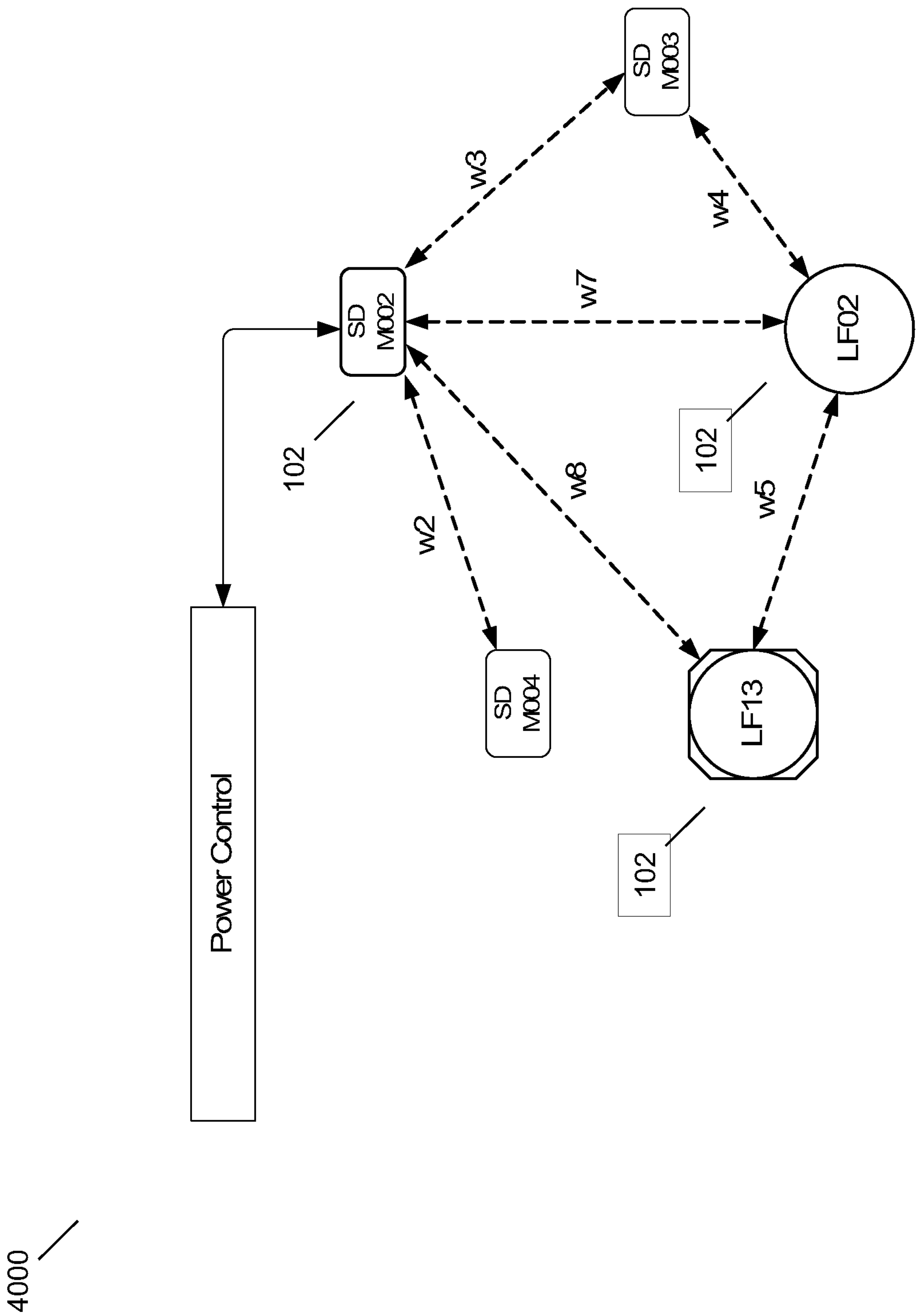

4000
Power Control
SD
M002
SD
M003
SD
M004
LF02
LF13
w2
w3
w4
w5
w7
w8
102
102
102

FIG. 40

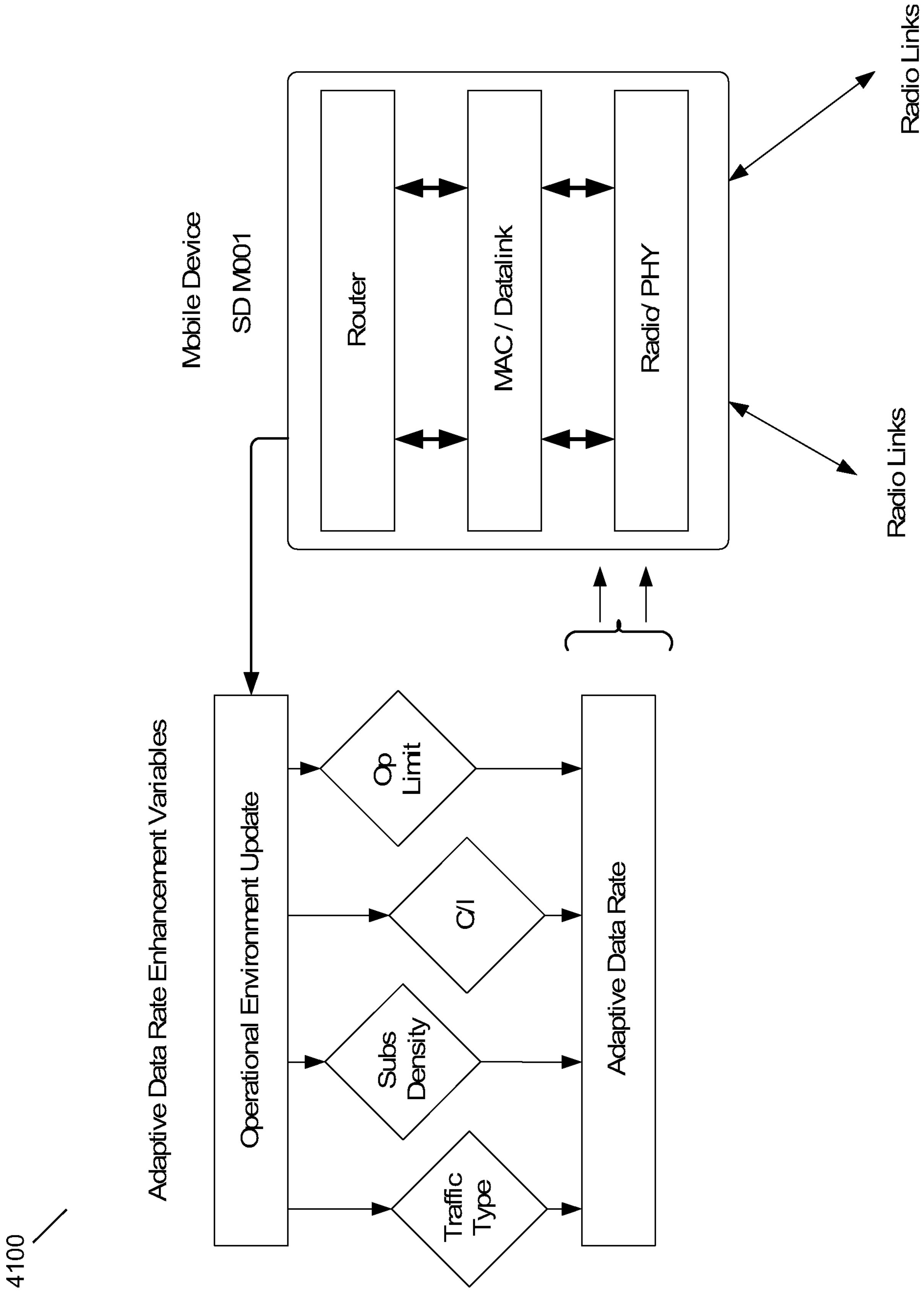

4100
Adaptive Data Rate Enhancement Variables
Operational Environment Update
Op Limit
C/I
Subs Density
Traffic Type
Adaptive Data Rate
Mobile Device
SD M001
Router
MAC / Datalink
Radio/ PHY
Radio Links
Radio Links

FIG. 41

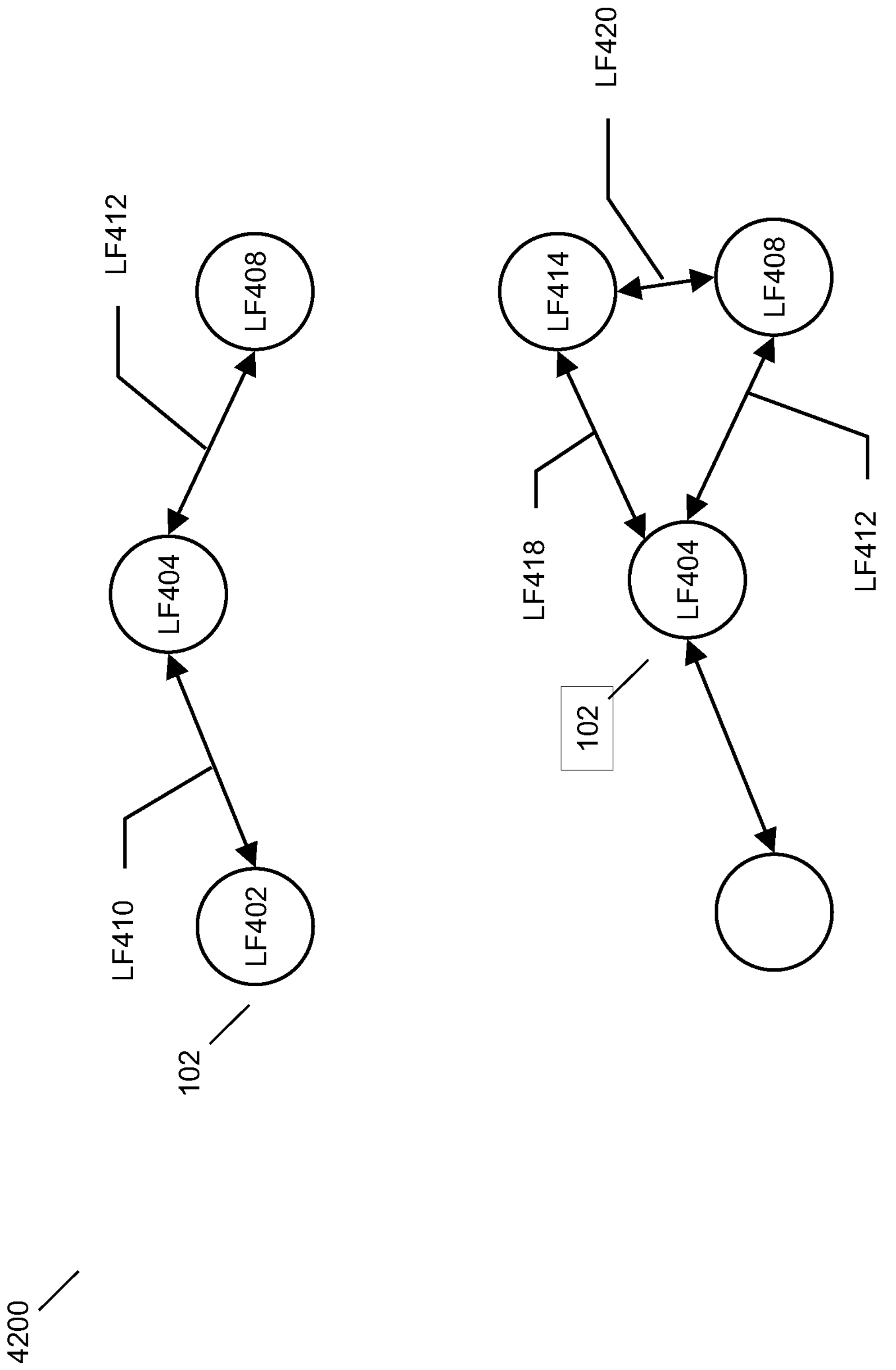

4200
102
LF410
LF402
LF404
LF412
LF408
102
LF418
LF404
LF412
LF414
LF408
LF420

FIG. 42

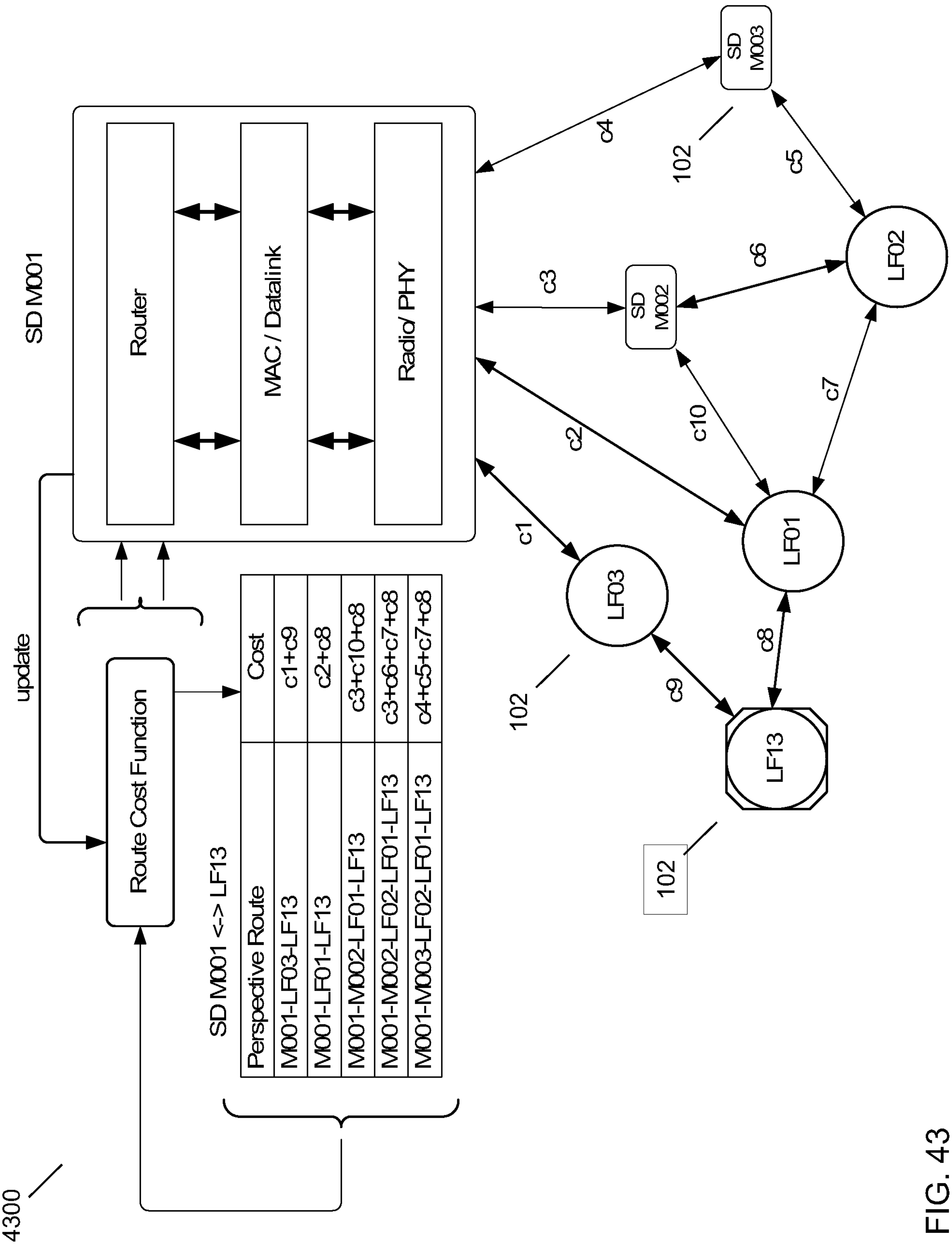
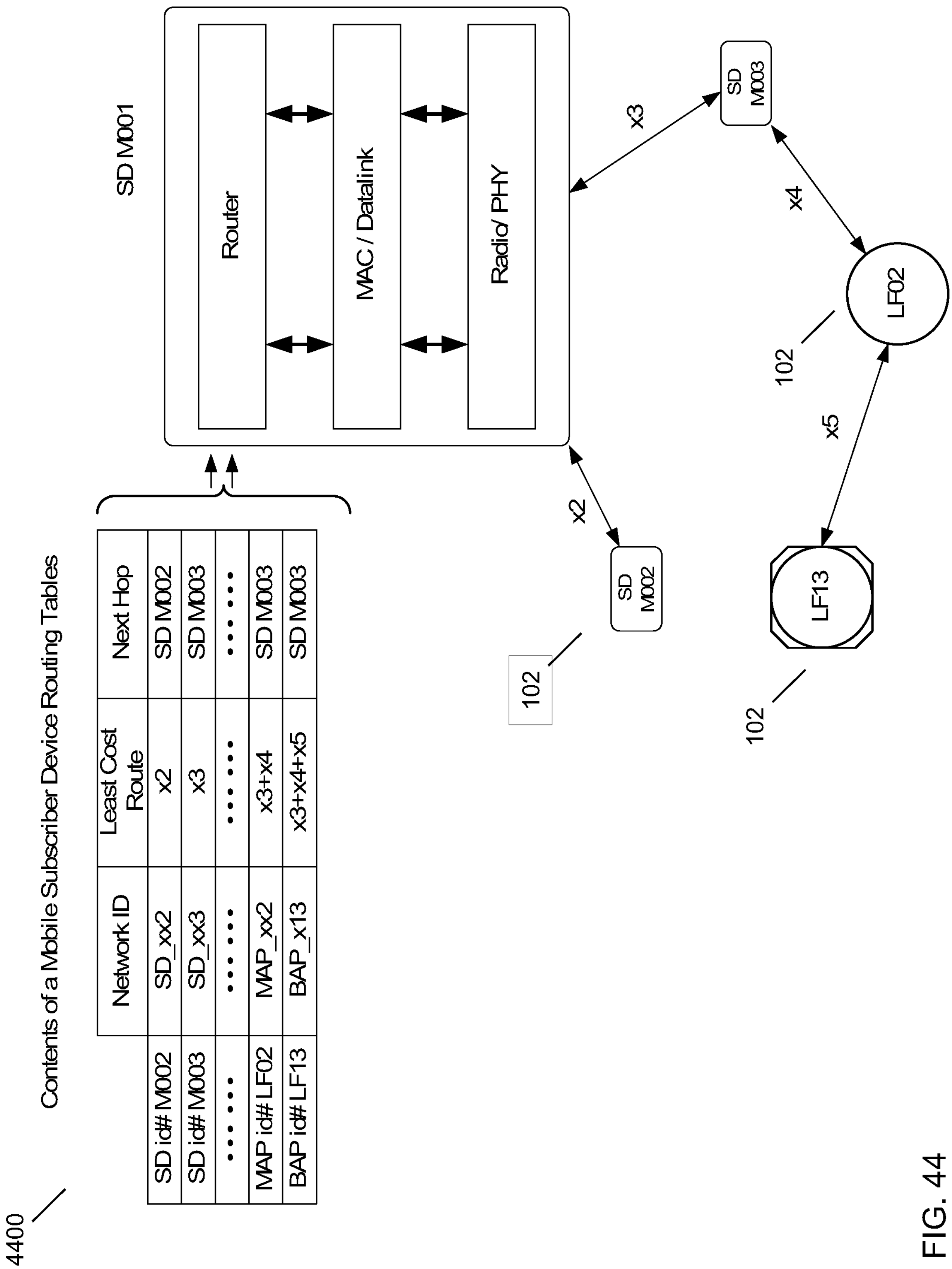

4300
SD M001
Router
MAC / Datalink
Radio/ PHY
update
Route Cost Function
SD M001 <-> LF13
Perspective Route
Cost
M001-LF03-LF13
c1+c9
M001-LF01-LF13
c2+c8
M001-M002-LF01-LF13
c3+c10+c8
M001-M002-LF02-LF01-LF13
c3+c6+c7+c8
M001-M003-LF02-LF01-LF13
c4+c5+c7+c8
c1
c2
c3
c4
c5
c6
c7
c8
c9
c10
SD M002
SD M003
LF01
LF02
LF03
LF13
102
102
102

FIG. 43



	Network ID	Least Cost Route	Next Hop
SD id# M002	SD_xx2	x2	SD M002
SD id# M003	SD_xx3	x3	SD M003
•••••••	•••••••	•••••••	•••••••
MAP id# LF02	MAP_xx2	x3+x4	SD M003
BAP id# LF13	BAP_x13	x3+x4+x5	SD M003

FIG. 44

4500

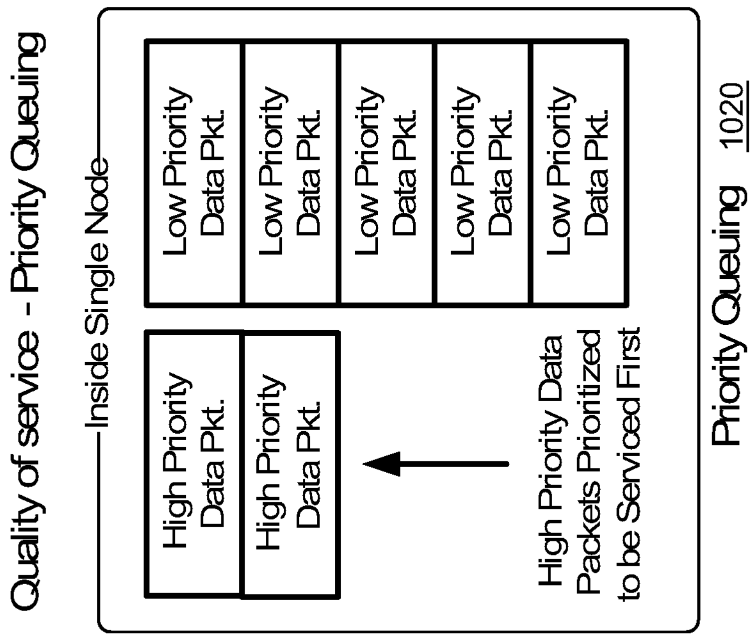

Quality of service - Priority Queuing
Inside Single Node
High Priority Data Pkt.
High Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
High Priority Data Packets Prioritized to be Serviced First
Priority Queuing 1020

FIG. 45

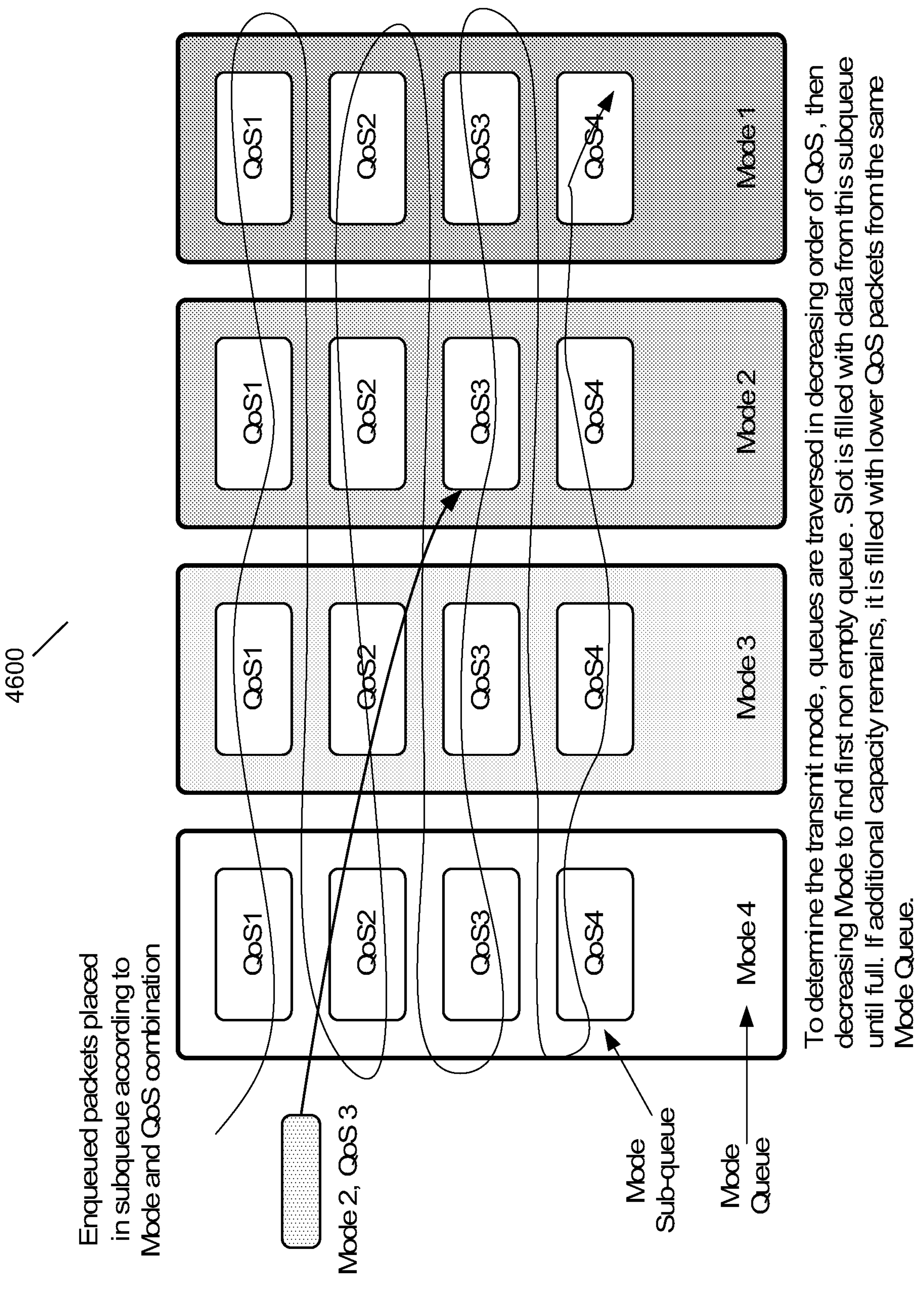

4600
Enqueued packets placed in subqueue according to Mode and QoS combination
Mode 2, QoS 3
Mode Sub-queue
Mode Queue
QoS1
QoS2
QoS3
QoS4
Mode 4
QoS1
QoS2
QoS3
QoS4
Mode 3
QoS1
QoS2
QoS3
QoS4
Mode 2
QoS1
QoS2
QoS3
QoS4
Mode 1
To determine the transmit mode, queues are traversed in decreasing order of QoS, then decreasing Mode to find first non empty queue. Slot is filled with data from this subqueue until full. If additional capacity remains, it is filled with lower QoS packets from the same Mode Queue.

FIG. 46

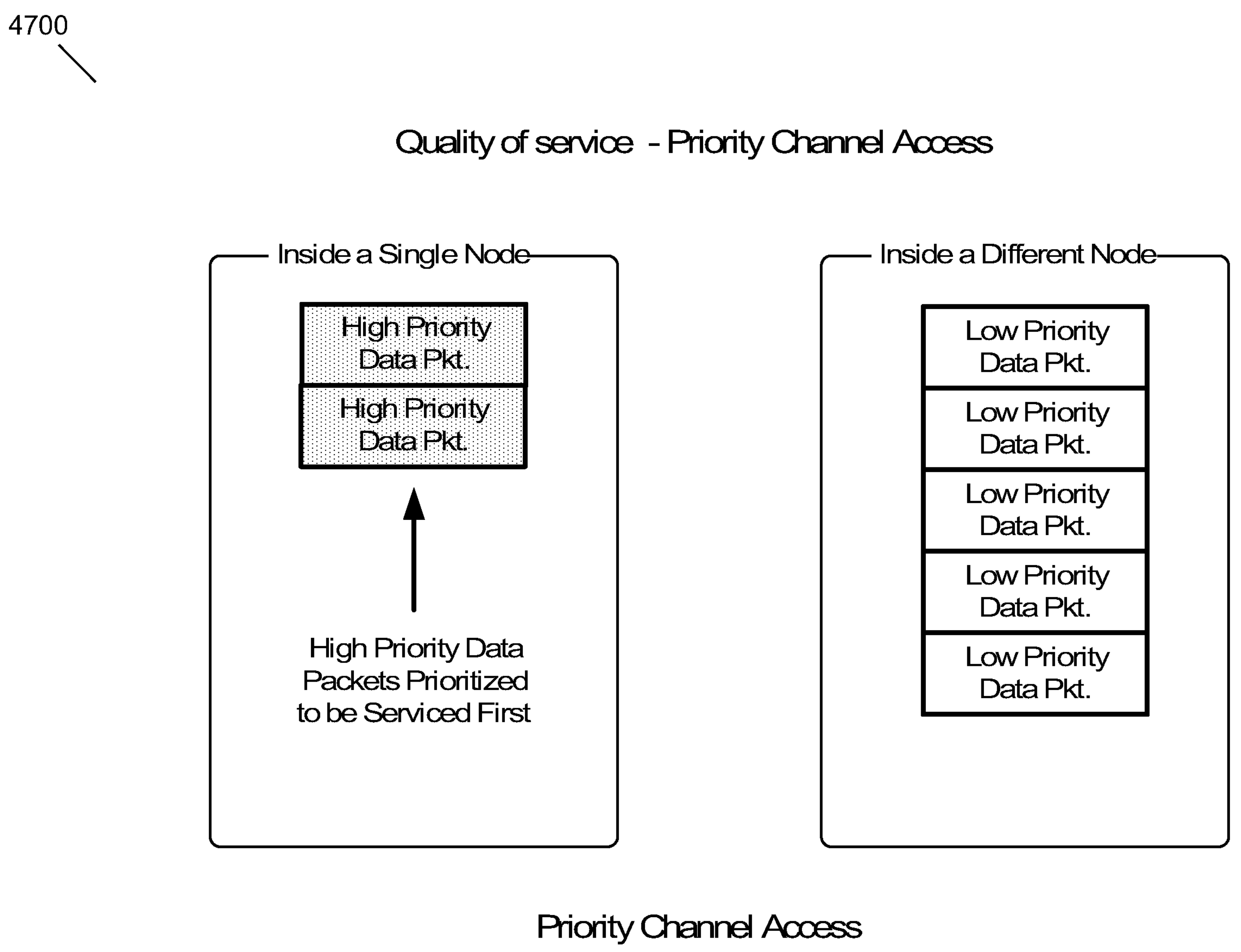

4700
Quality of service - Priority Channel Access
Inside a Single Node
High Priority Data Pkt.
High Priority Data Pkt.
High Priority Data Packets Prioritized to be Serviced First
Inside a Different Node
Low Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
Low Priority Data Pkt.
Priority Channel Access

FIG. 47

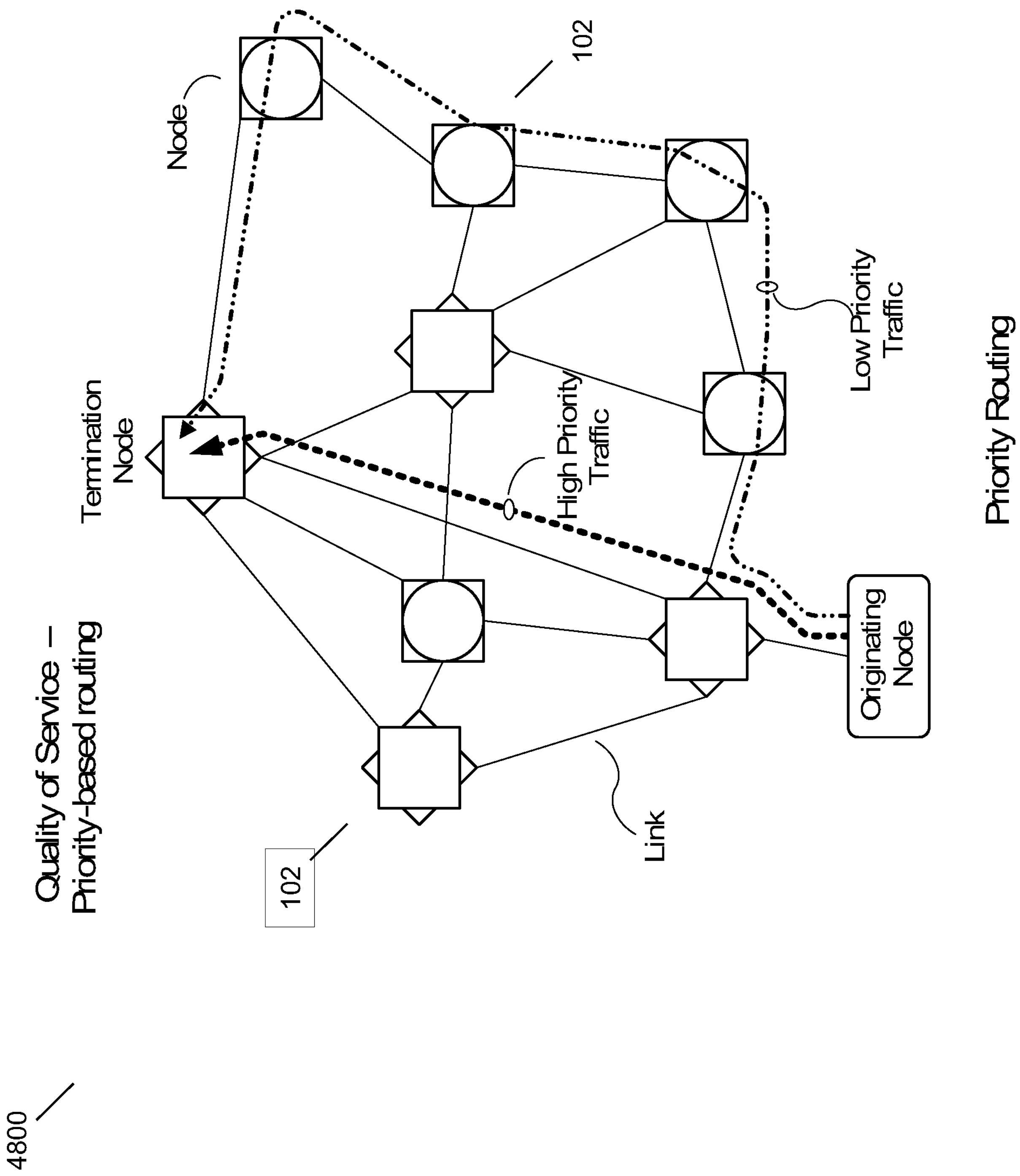

4800
Quality of Service –
Priority-based routing
102
Link
Originating
Node
Termination
Node
Node
102
High Priority
Traffic
Low Priority
Traffic
Priority Routing

FIG. 48

4900

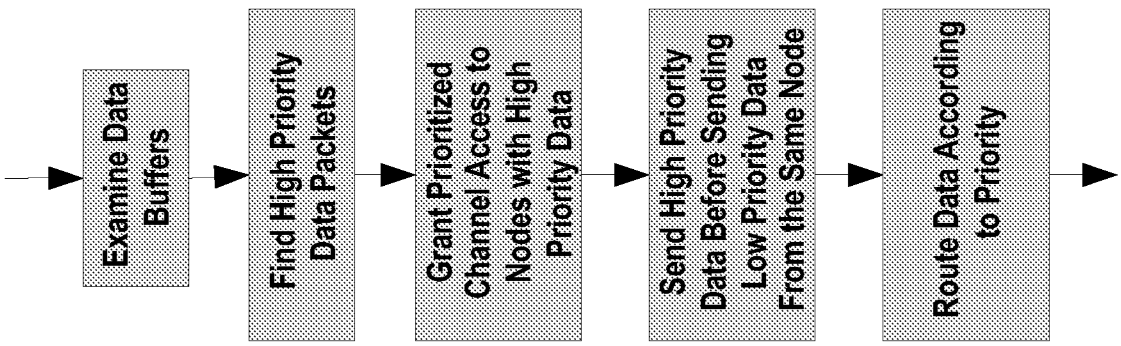

Examine Data Buffers
Find High Priority Data Packets
Grant Prioritized Channel Access to Nodes with High Priority Data
Send High Priority Data Before Sending Low Priority Data From the Same Node
Route Data According to Priority

FIG. 49

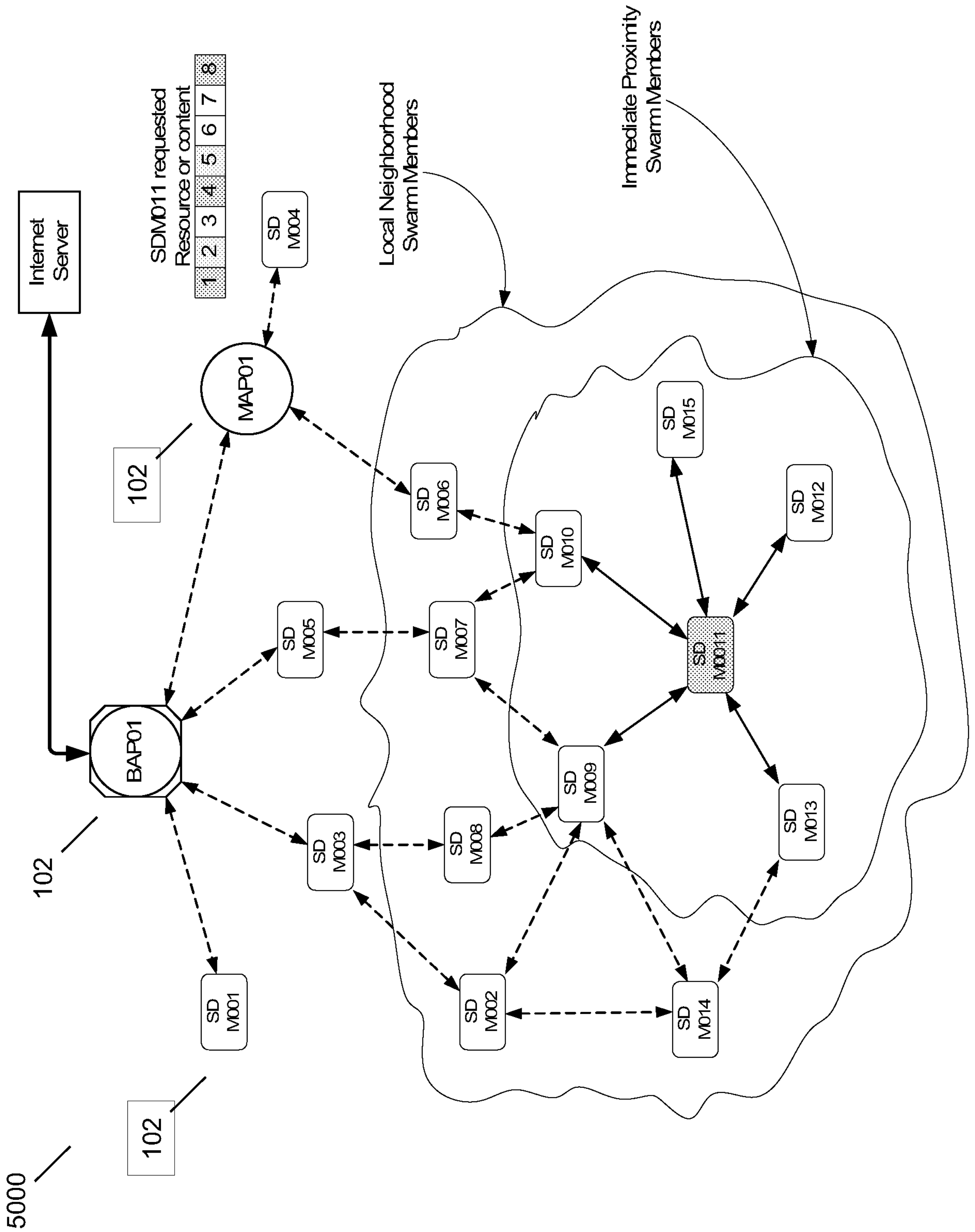
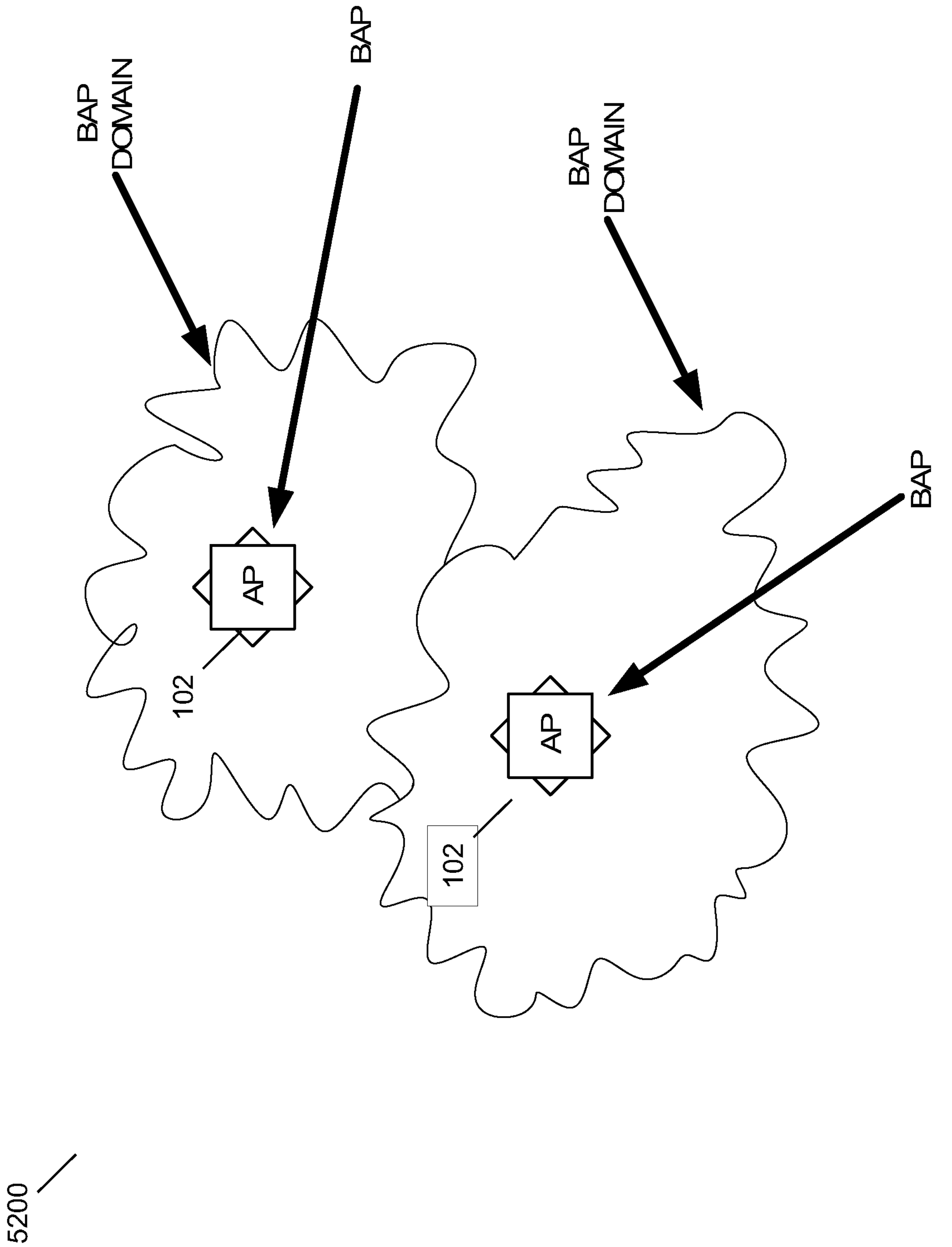

5000
102
102
102
Internet Server
SDM011 requested Resource or content
1 2 3 4 5 6 7 8
BAP01
MAP01
SD M001
SD M002
SD M003
SD M004
SD M005
SD M006
SD M007
SD M008
SD M009
SD M010
SD M0011
SD M012
SD M013
SD M014
SD M015
Local Neighborhood Swarm Members
Immediate Proximity Swarm Members

FIG. 50

5100

518	Router Layer	IPv4/RFC 791
		BGP4/RFC 4271
		SLSR – Scoped Link State Routing
		ROM – Receiver Oriented Multicast
520	MAC Layer	Encapsulation / RFC's 894/1042
		MAC 802.3
		NDM Neighbor Discovery Managment
		ADR – Adaptive Data Rate
		Queue Serving
		ARP/RFC 826
		DHCP
		NAMA Channel Access
522	Physical Layer	SAR – Segmentation & Reassembly
		LANTA – Network Timing
		Configurable waveform slot by slot
		OFDMA Waveform modes
		OFDMA

FIG. 51



SLSR link cost based routing – domain concept

FIG. 52

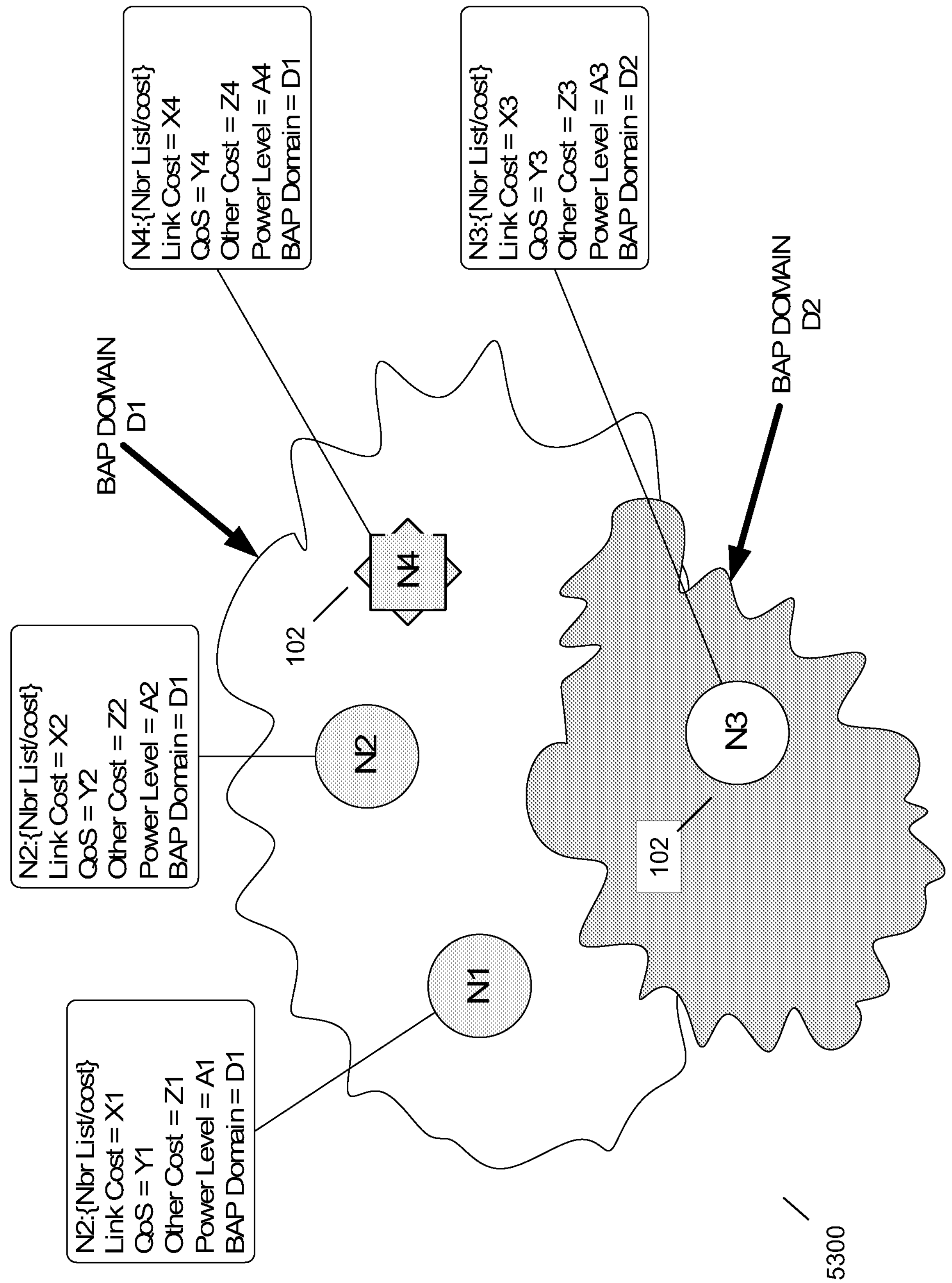


FIG. 53 SLSR link cost based routing – Protocol with extra information

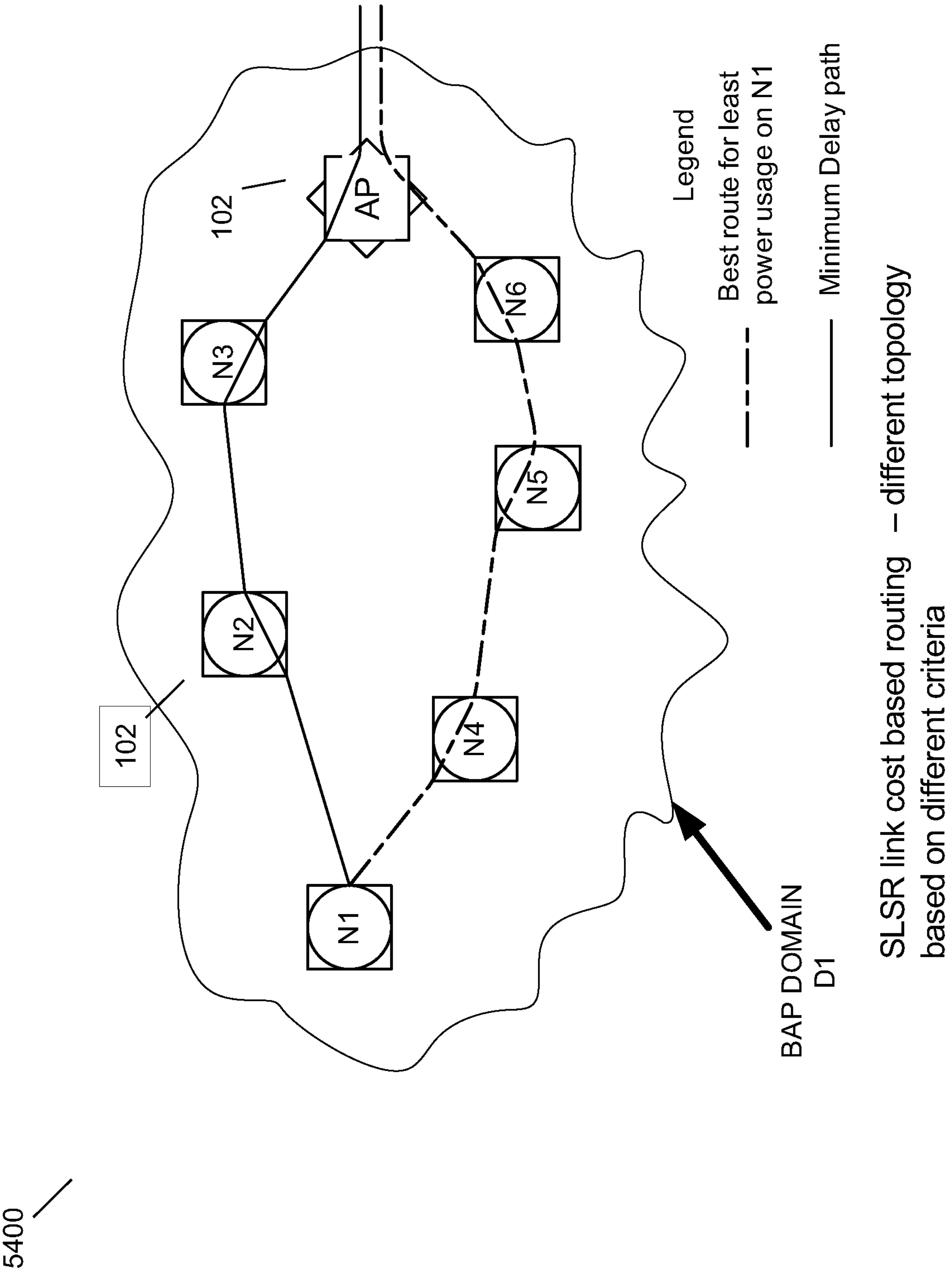

5400
102
102
AP
N1
N2
N3
N4
N5
N6
BAP DOMAIN
D1
Legend
Best route for least
power usage on N1
Minimum Delay path
SLSR link cost based routing – different topology
based on different criteria

FIG. 54

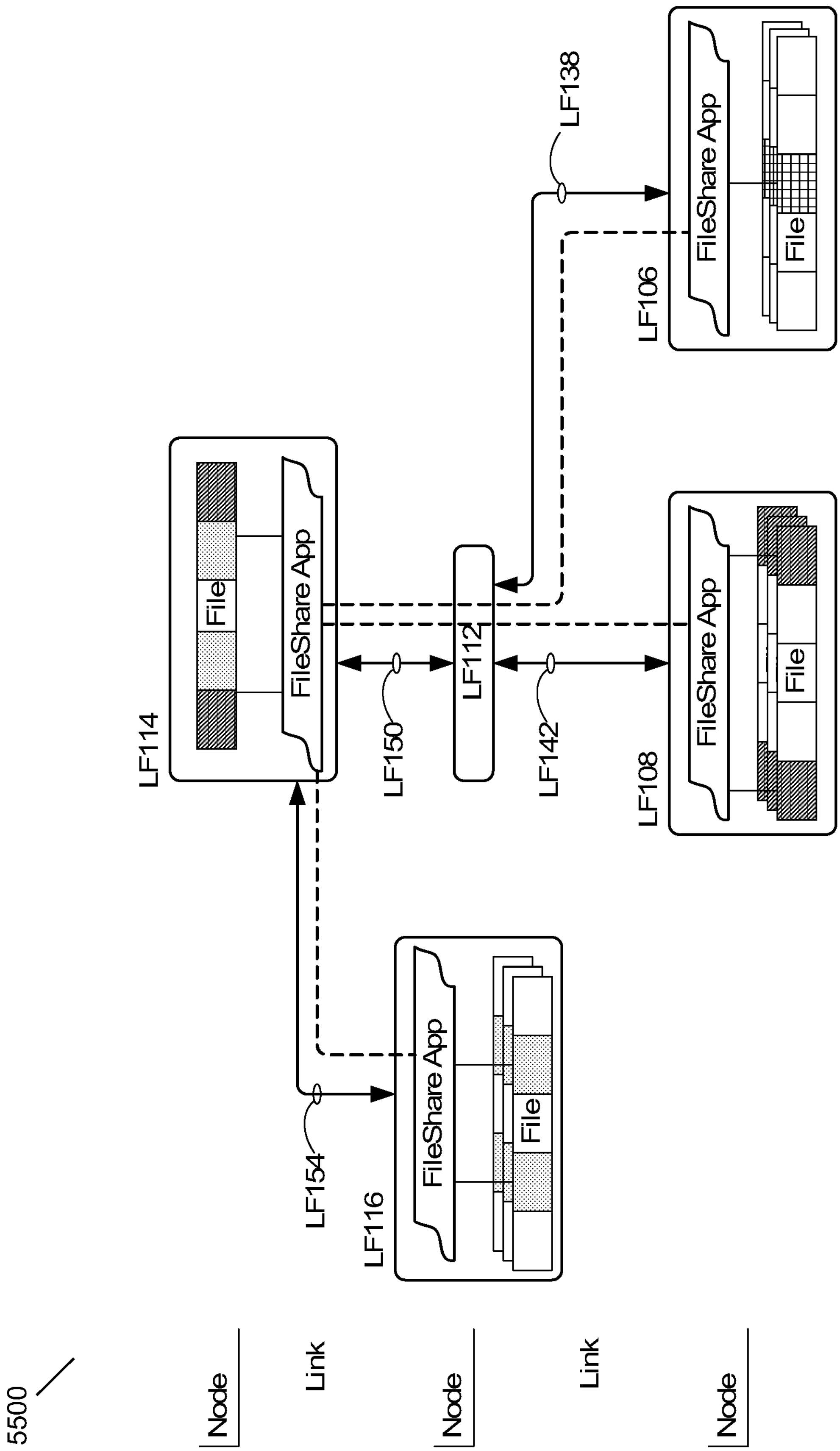

5500
Node
Link
Node
Link
Node
LF114
File
FileShare App
LF150
LF112
LF142
LF108
FileShare App
File
LF138
LF106
FileShare App
File
LF154
LF116
FileShare App
File

FIG. 55

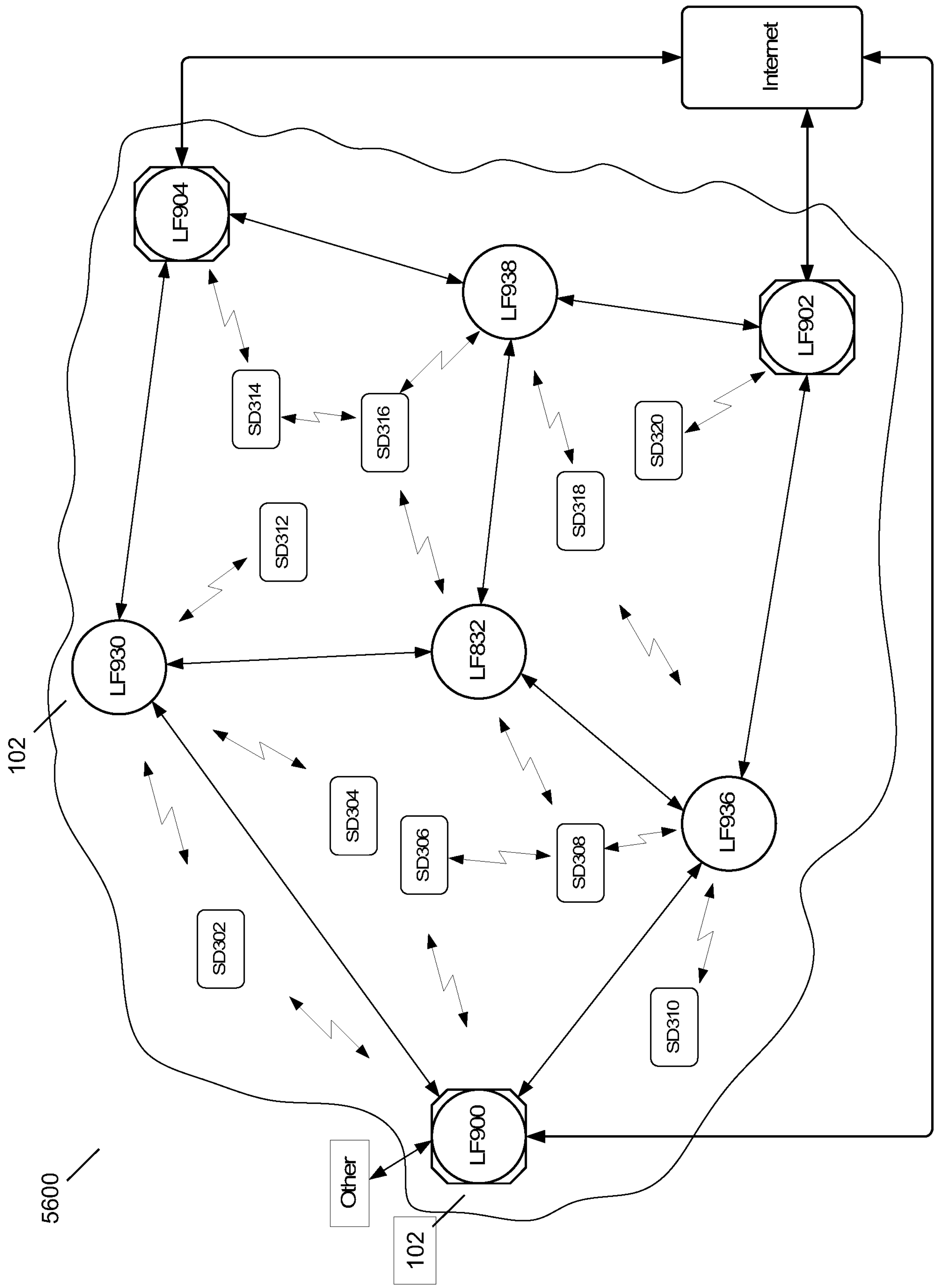

Internet
LF904
LF938
LF902
SD314
SD316
SD320
SD318
SD312
LF930
LF832
102
SD304
SD306
SD308
LF936
SD302
SD310
LF900
Other
102
5600

FIG. 56

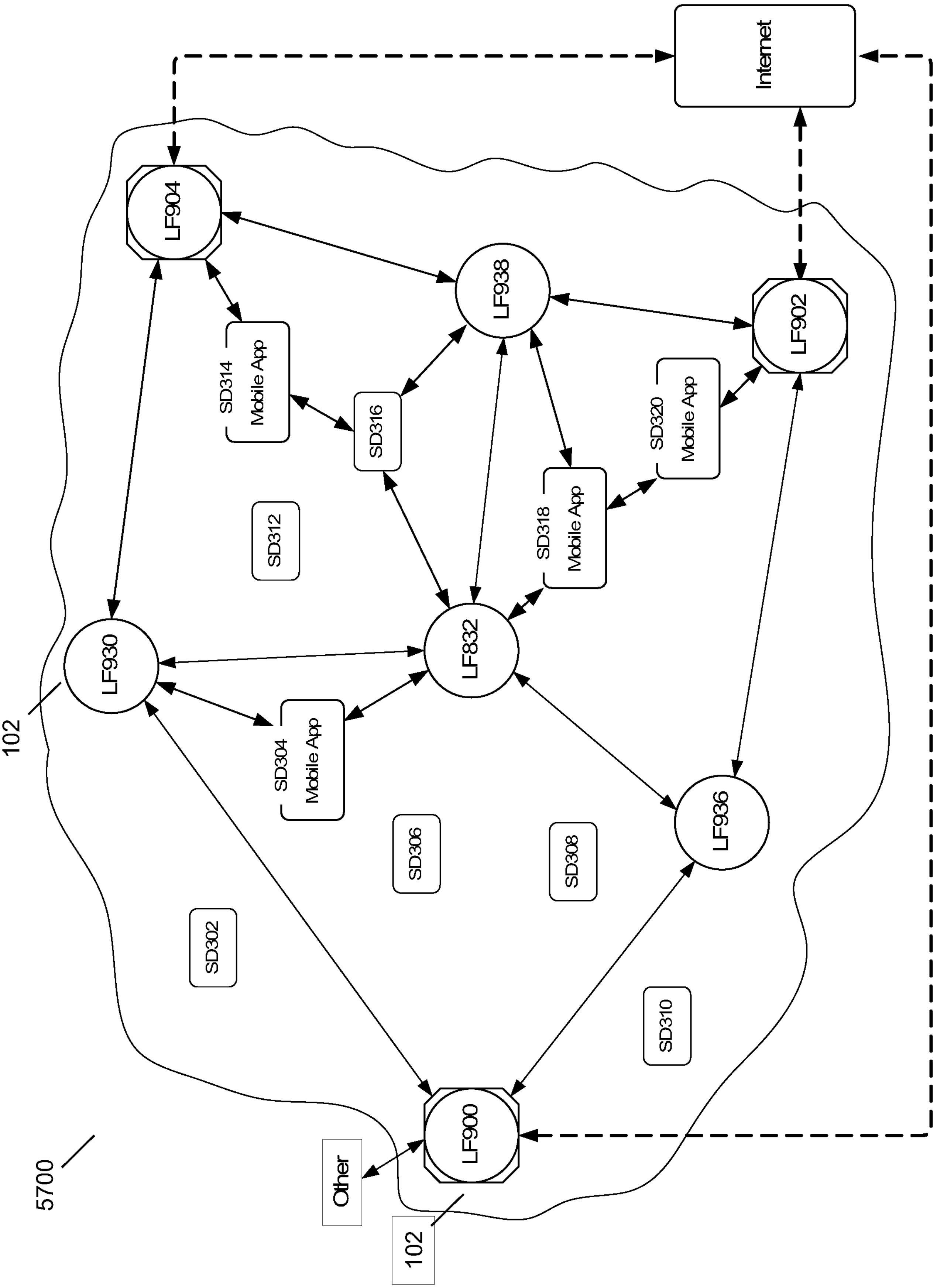

5700
102
Internet
LF904
LF938
LF902
SD314
Mobile App
SD316
SD320
Mobile App
SD312
SD318
Mobile App
LF930
LF832
SD304
Mobile App
LF936
SD306
SD308
SD302
SD310
LF900
Other
102

FIG. 57

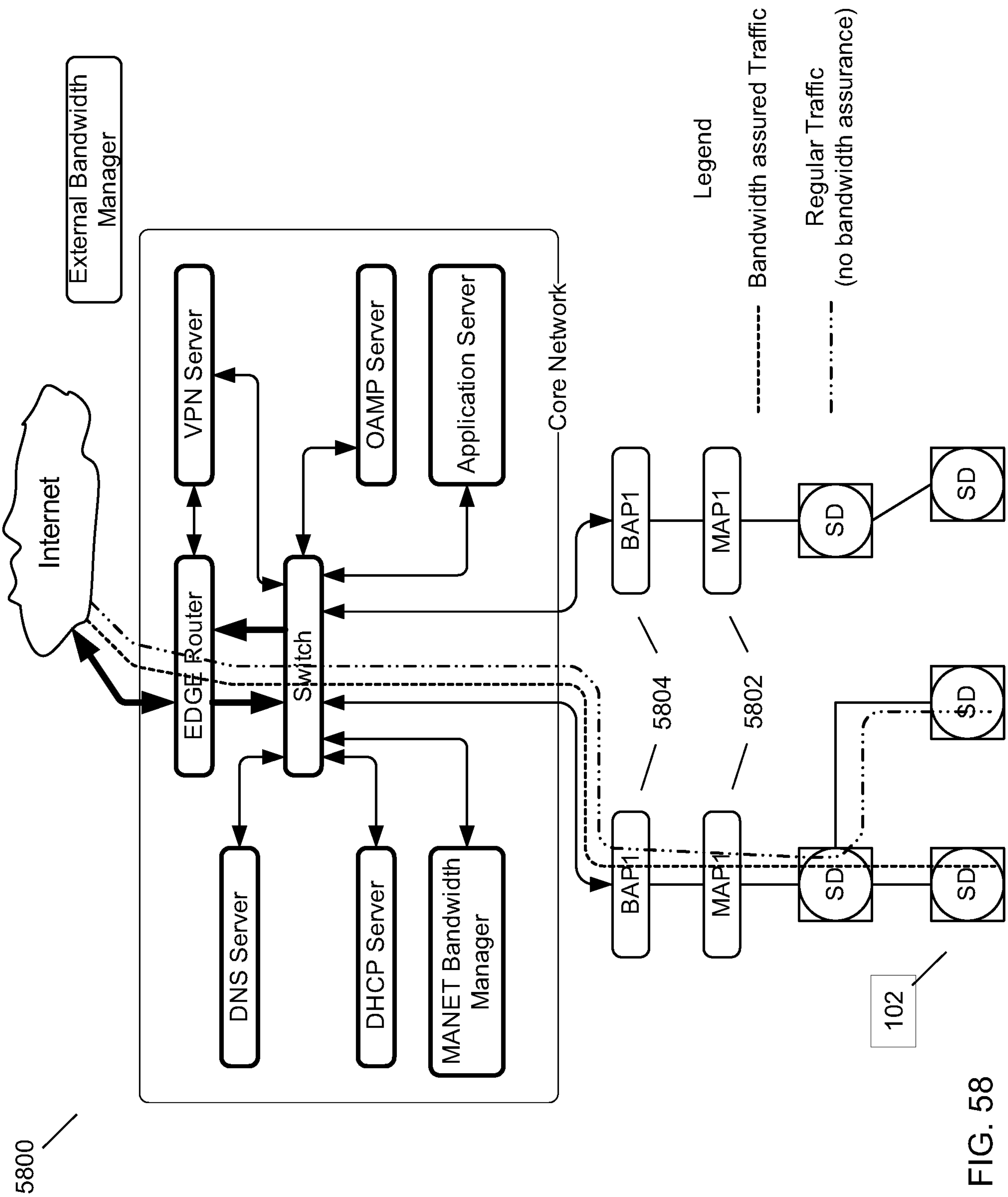

5800
External Bandwidth Manager
Internet
EDGE Router
Switch
VPN Server
OAMP Server
Application Server
DNS Server
DHCP Server
MANET Bandwidth Manager
Core Network
BAP1
MAP1
BAP1
MAP1
5804
5802
SD
SD
SD
SD
SD
SD
102
Legend
Bandwidth assured Traffic
Regular Traffic
(no bandwidth assurance)

FIG. 58

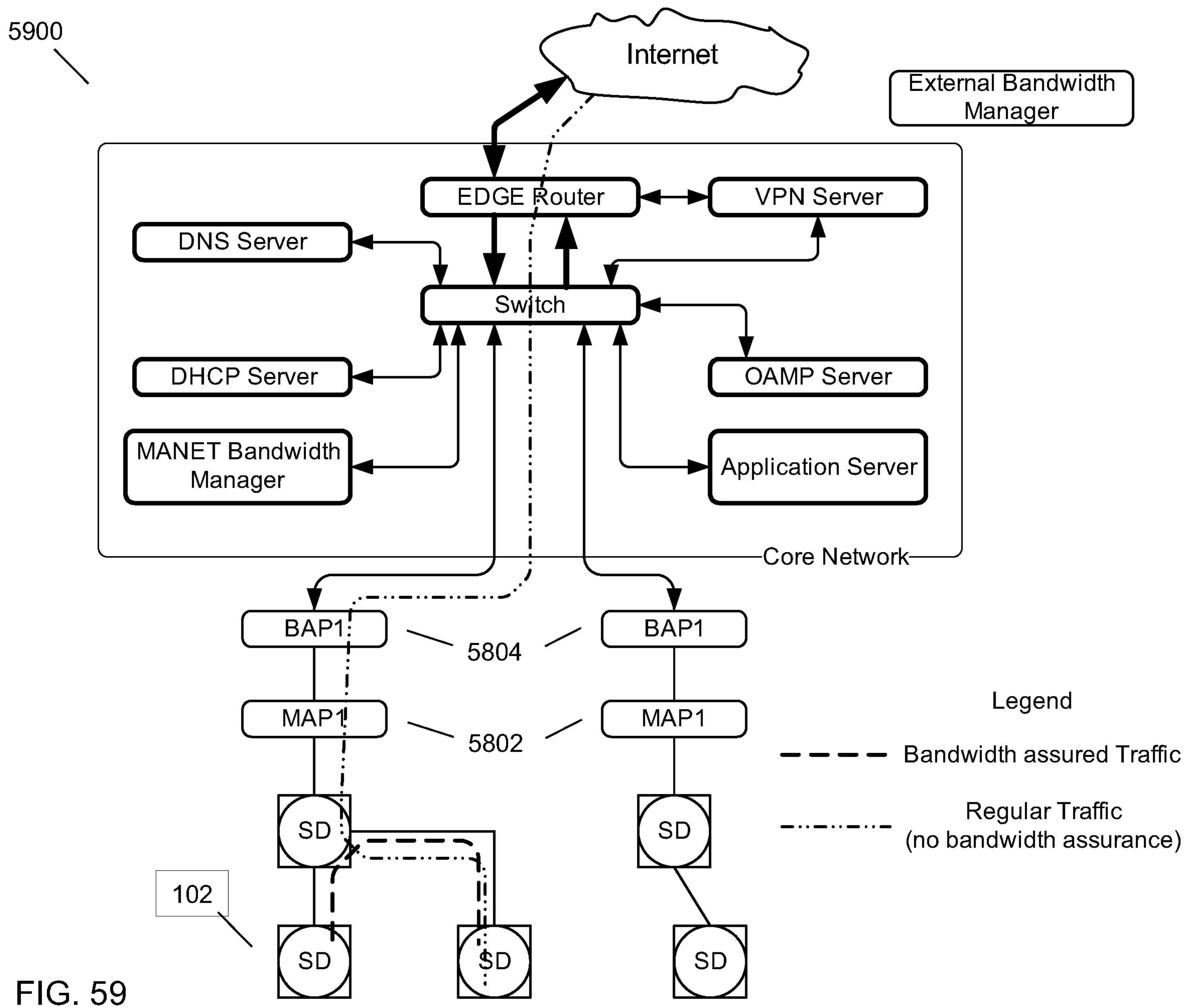
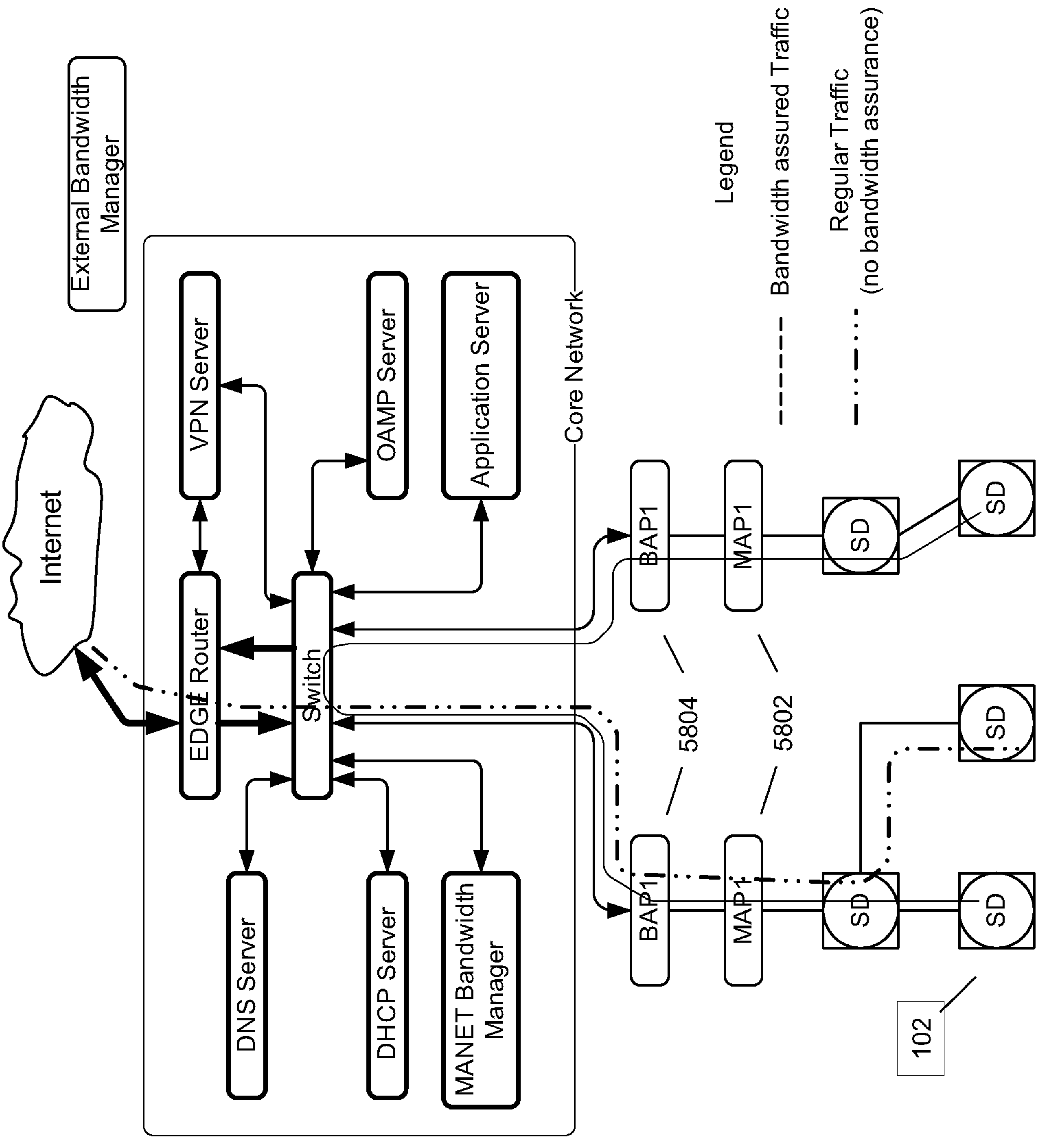

5900
Internet
External Bandwidth Manager
EDGE Router
VPN Server
DNS Server
Switch
DHCP Server
OAMP Server
MANET Bandwidth Manager
Application Server
Core Network
BAP1
BAP1
5804
MAP1
MAP1
5802
Legend
Bandwidth assured Traffic
Regular Traffic
(no bandwidth assurance)
SD
SD
102
SD
SD
SD
SD

FIG. 59



Internet
External Bandwidth Manager
VPN Server
OAMP Server
Application Server
EDGE Router
Switch
DNS Server
DHCP Server
MANET Bandwidth Manager
Core Network
BAP1
MAP1
SD
5804
5802
102
Legend
Bandwidth assured Traffic
Regular Traffic (no bandwidth assurance)

6000

FIG. 60

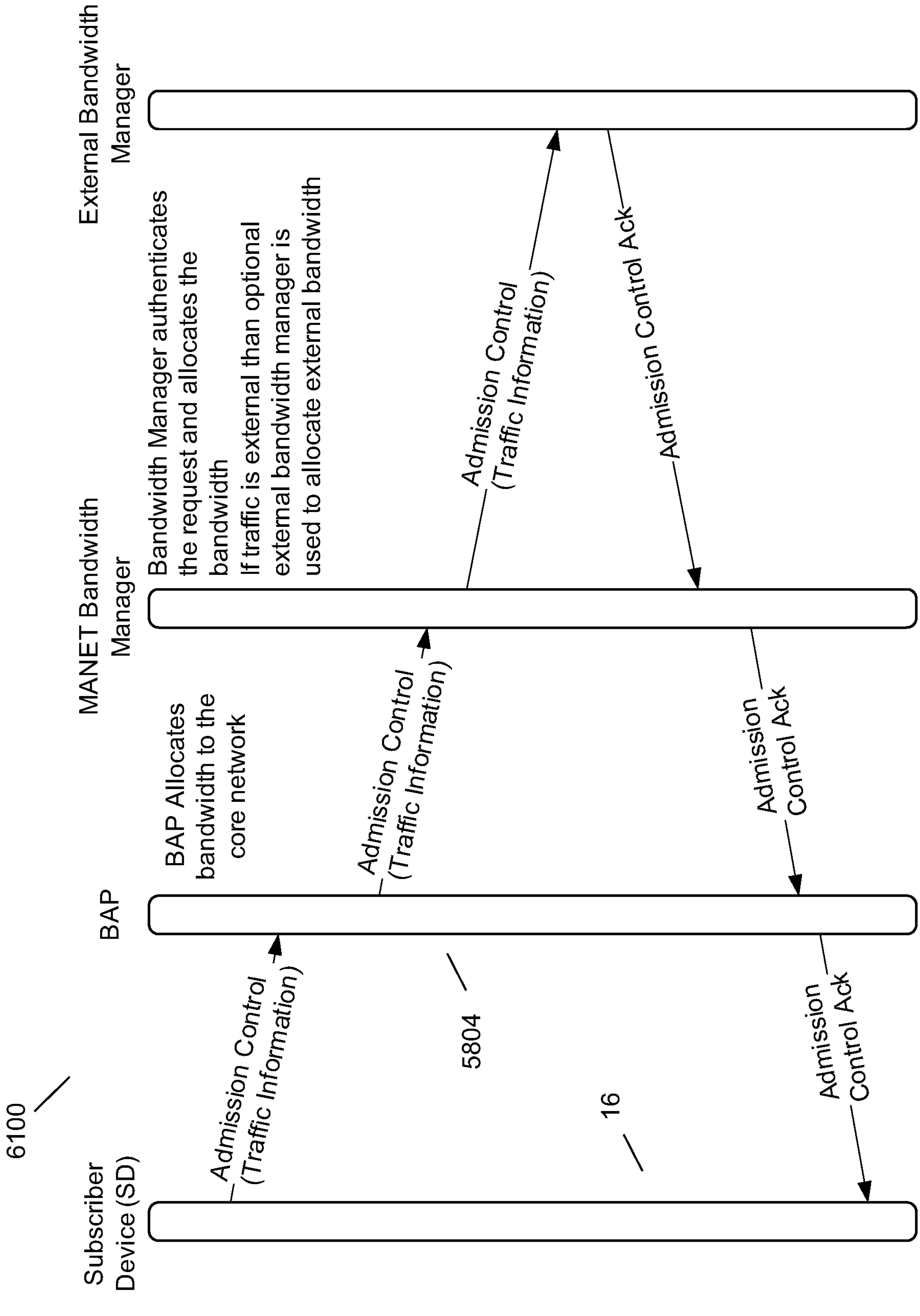

6100
Subscriber Device (SD)
BAP
MANET Bandwidth Manager
External Bandwidth Manager
Admission Control (Traffic Information)
BAP Allocates bandwidth to the core network
Admission Control (Traffic Information)
Bandwidth Manager authenticates the request and allocates the bandwidth
If traffic is external than optional external bandwidth manager is used to allocate external bandwidth
Admission Control (Traffic Information)
Admission Control Ack
Admission Control Ack
Admission Control Ack
5804
16

FIG. 61

6200

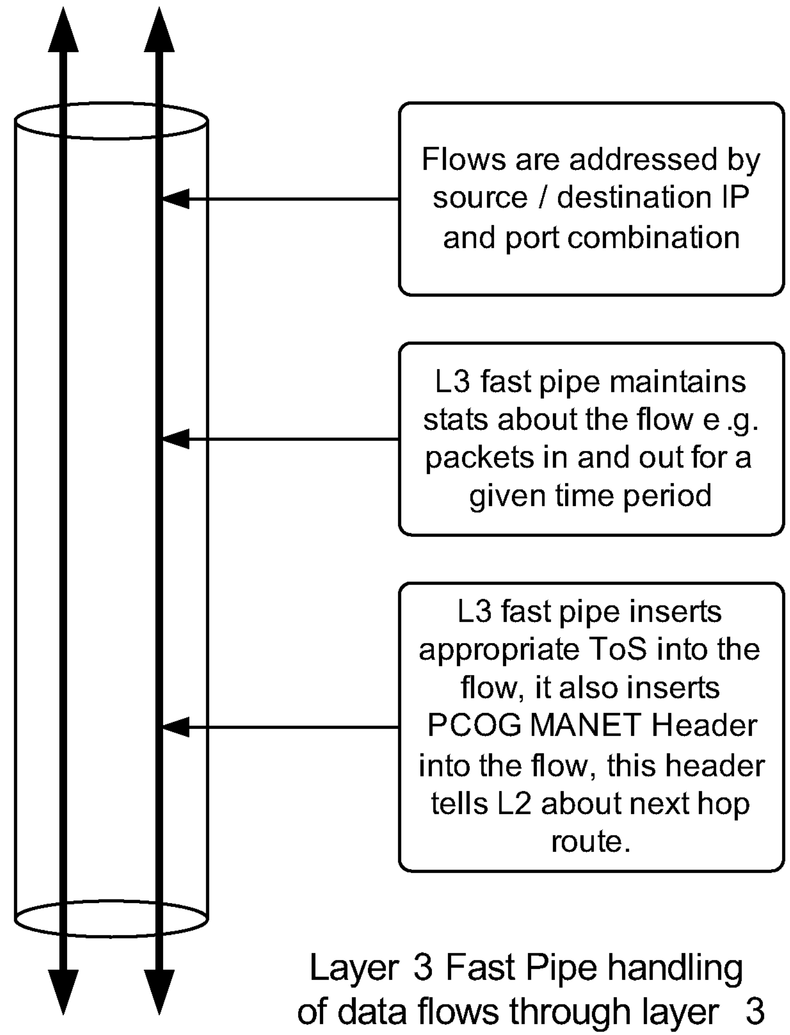

Flows are addressed by source / destination IP and port combination
L3 fast pipe maintains stats about the flow e.g. packets in and out for a given time period
L3 fast pipe inserts appropriate ToS into the flow, it also inserts PCOG MANET Header into the flow, this header tells L2 about next hop route.
Layer 3 Fast Pipe handling of data flows through layer 3

FIG. 62

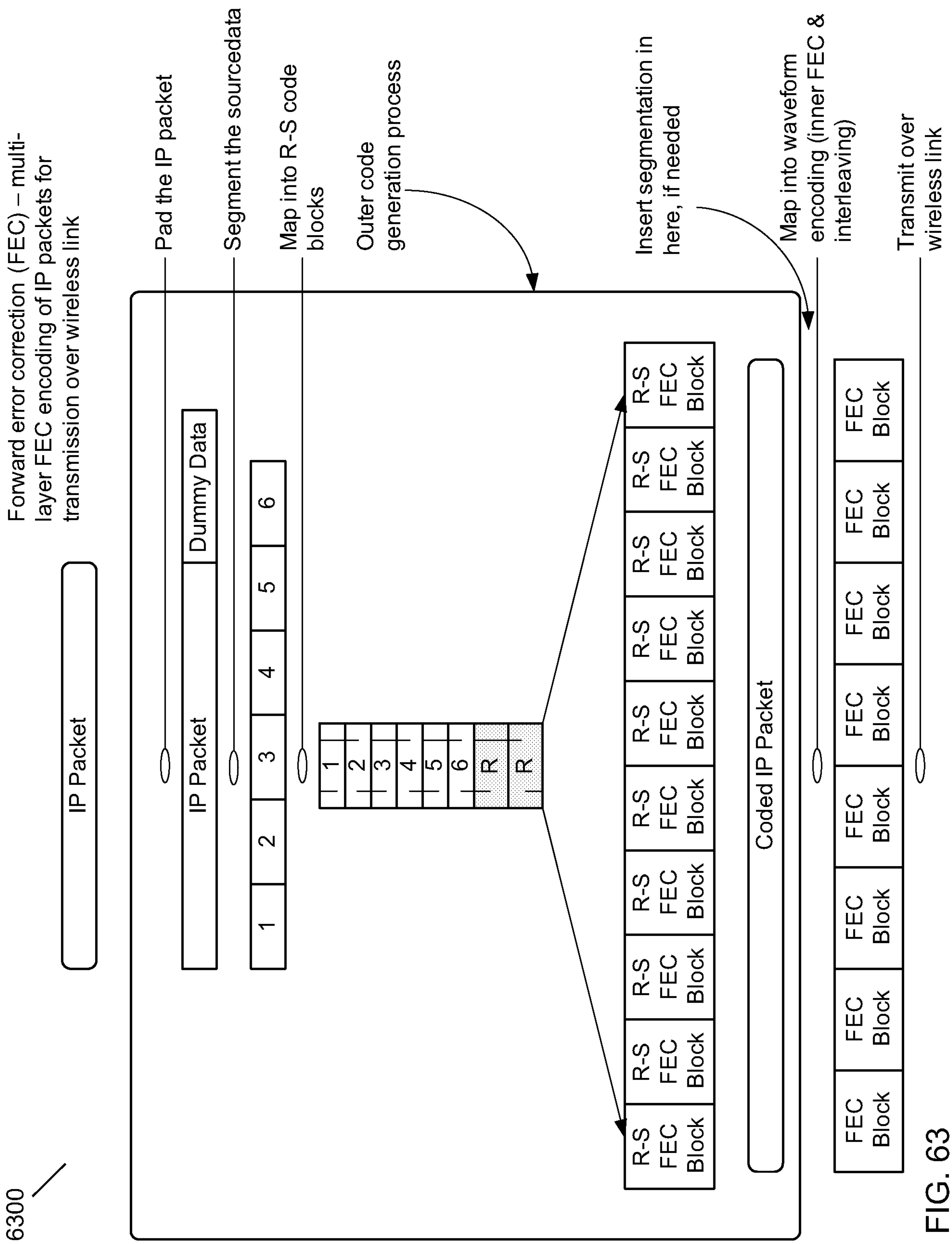

6300
Forward error correction (FEC) – multi-layer FEC encoding of IP packets for transmission over wireless link
IP Packet
Pad the IP packet
IP Packet
Dummy Data
Segment the sourcedata
1
2
3
4
5
6
Map into R-S code blocks
1
2
3
4
5
6
R
R
Outer code generation process
R-S FEC Block
Insert segmentation in here, if needed
Coded IP Packet
Map into waveform encoding (inner FEC & interleaving)
FEC Block
Transmit over wireless link

FIG. 63

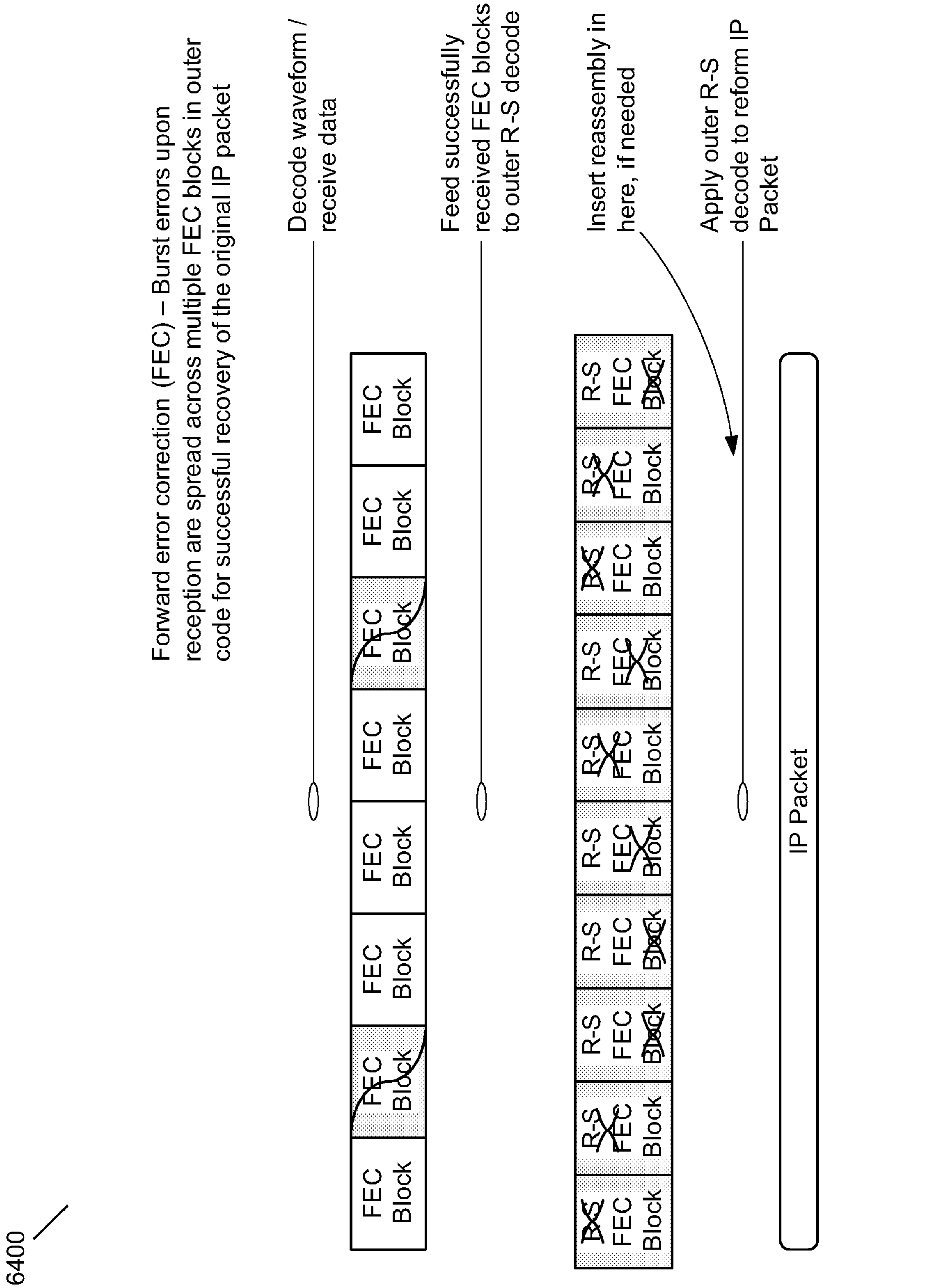

6400
Forward error correction (FEC) – Burst errors upon reception are spread across multiple FEC blocks in outer code for successful recovery of the original IP packet
Decode waveform / receive data
Feed successfully received FEC blocks to outer R-S decode
Insert reassembly in here, if needed
Apply outer R-S decode to reform IP Packet
FEC Block
R-S FEC Block
IP Packet

FIG. 64

6500

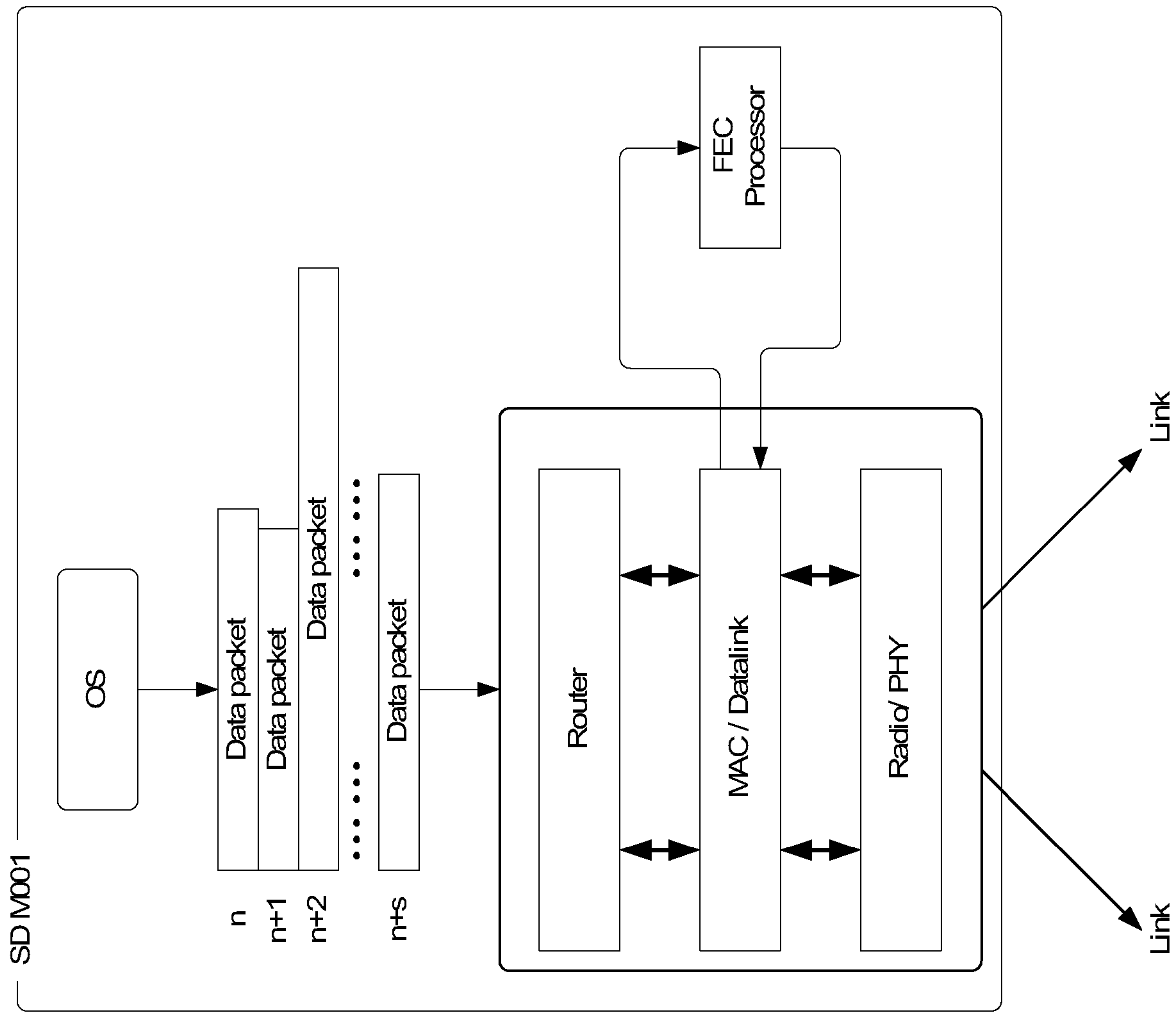

SD M001
OS
Data packet
Data packet
Data packet
Data packet
n
n+1
n+2
n+s
FEC Processor
Router
MAC / Datalink
Radio/ PHY
Link
Link

FIG. 65

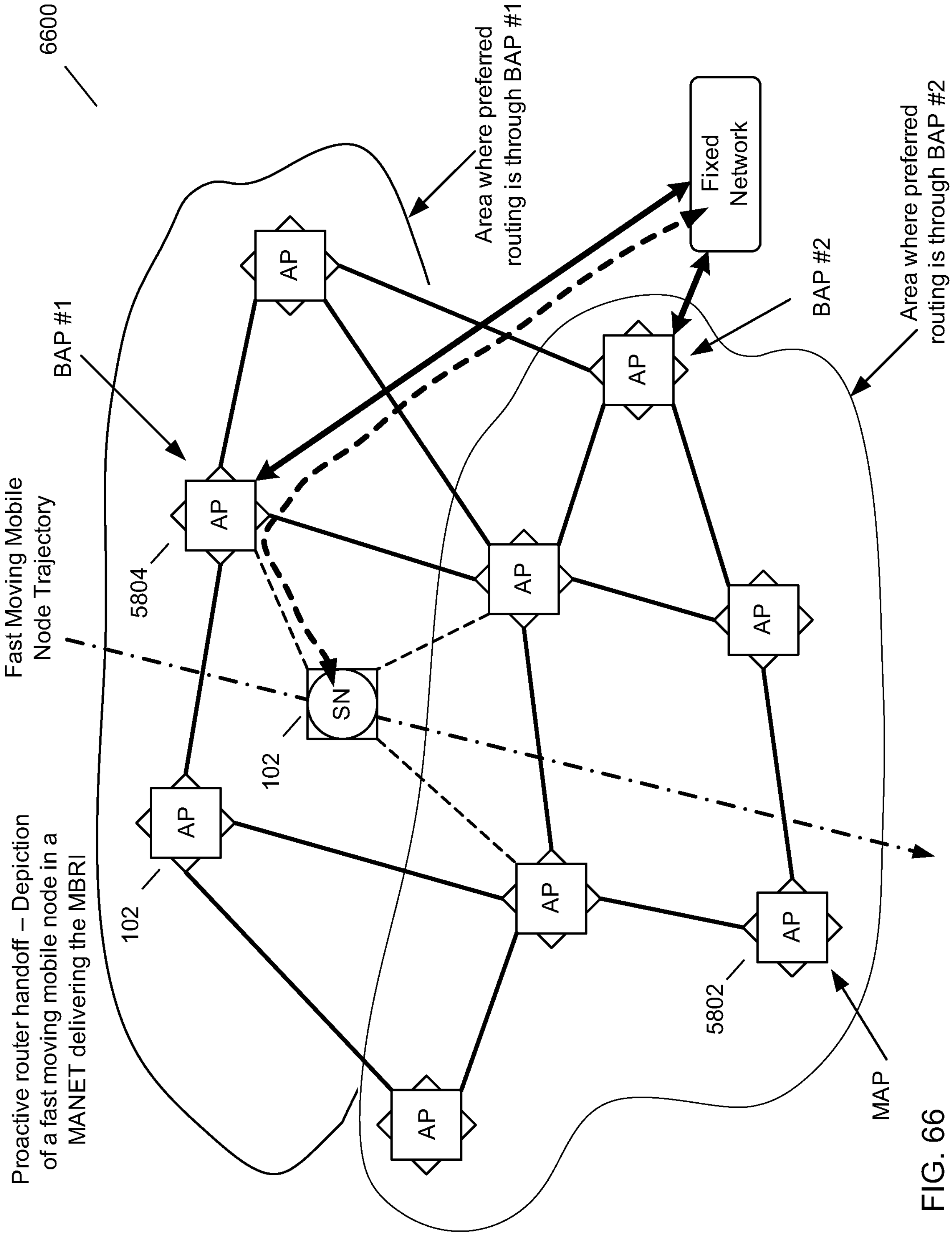

6600
Proactive router handoff – Depiction of a fast moving mobile node in a MANET delivering the MBRI
Fast Moving Mobile Node Trajectory
BAP #1
5804
AP
AP
AP
AP
AP
AP
AP
AP
AP
SN
102
102
Area where preferred routing is through BAP #1
Fixed Network
BAP #2
Area where preferred routing is through BAP #2
5802
MAP

FIG. 66

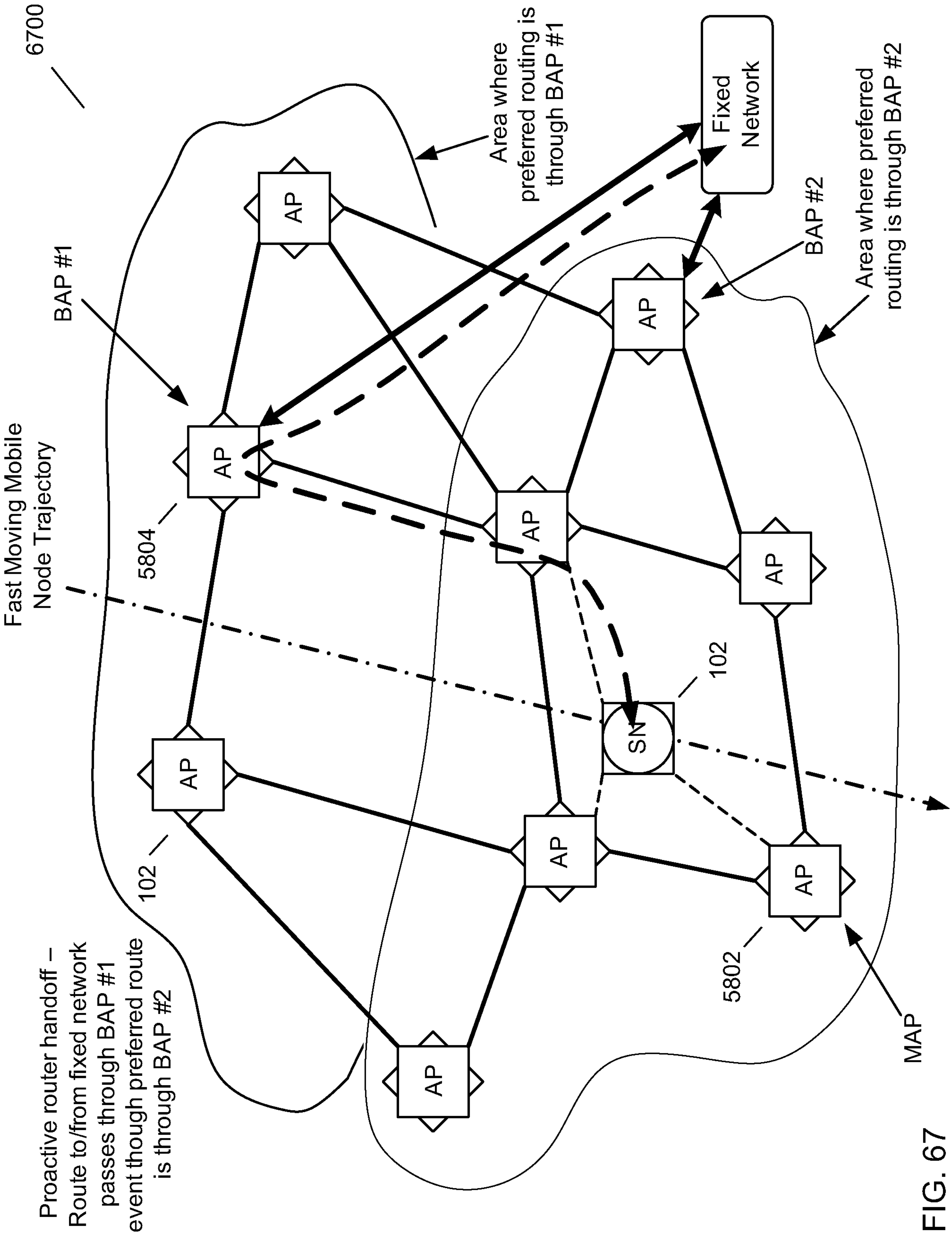

6700
Area where preferred routing is through BAP #1
Fixed Network
BAP #1
BAP #2
Area where preferred routing is through BAP #2
Fast Moving Mobile Node Trajectory
AP
AP
AP
AP
AP
AP
AP
AP
AP
SN
5804
102
102
5802
MAP
Proactive router handoff – Route to/from fixed network passes through BAP #1 event though preferred route is through BAP #2

FIG. 67

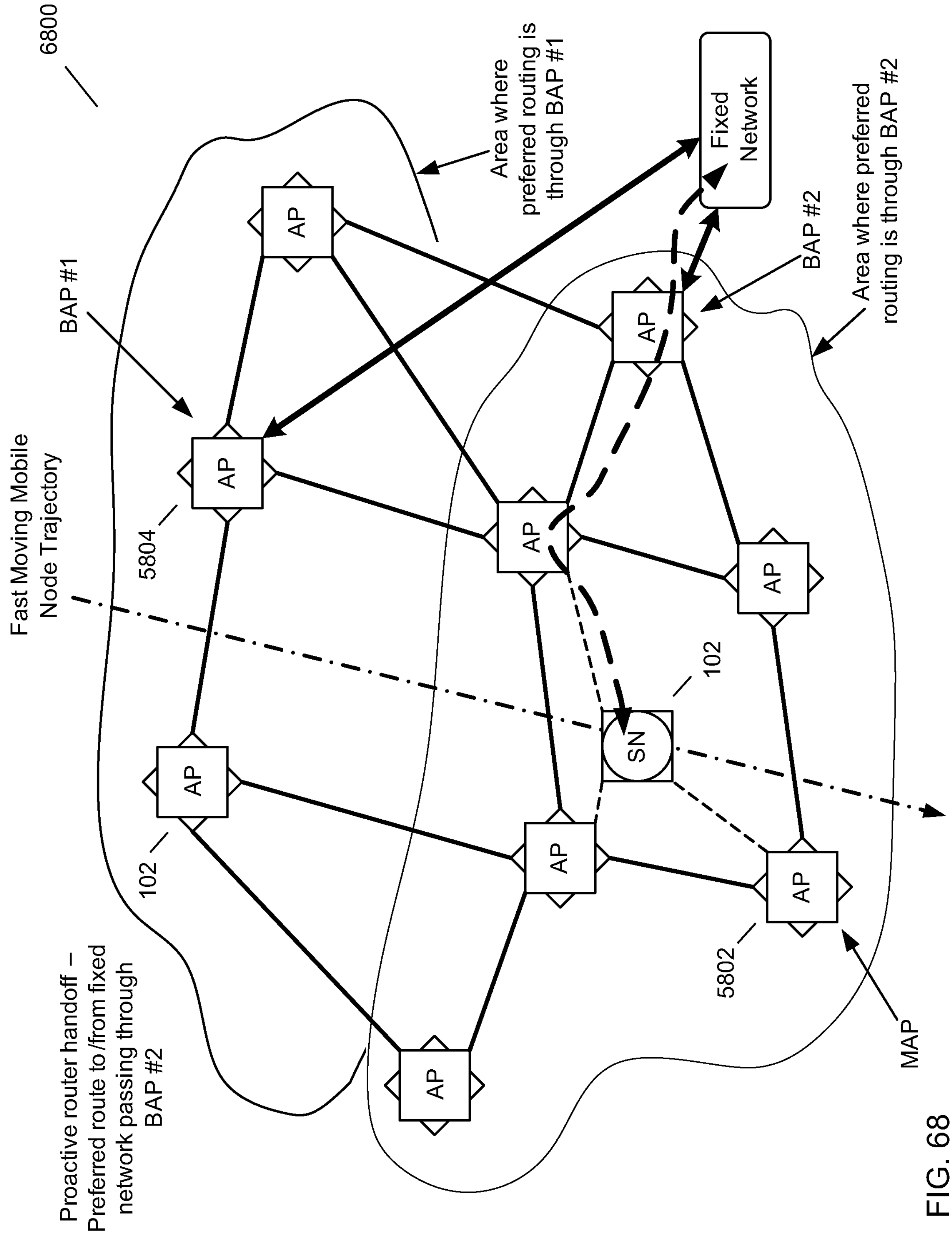

6800
Area where preferred routing is through BAP #1
Fixed Network
BAP #1
BAP #2
Area where preferred routing is through BAP #2
Fast Moving Mobile Node Trajectory
AP
SN
5804
102
102
5802
MAP
Proactive router handoff – Preferred route to /from fixed network passing through BAP #2

FIG. 68

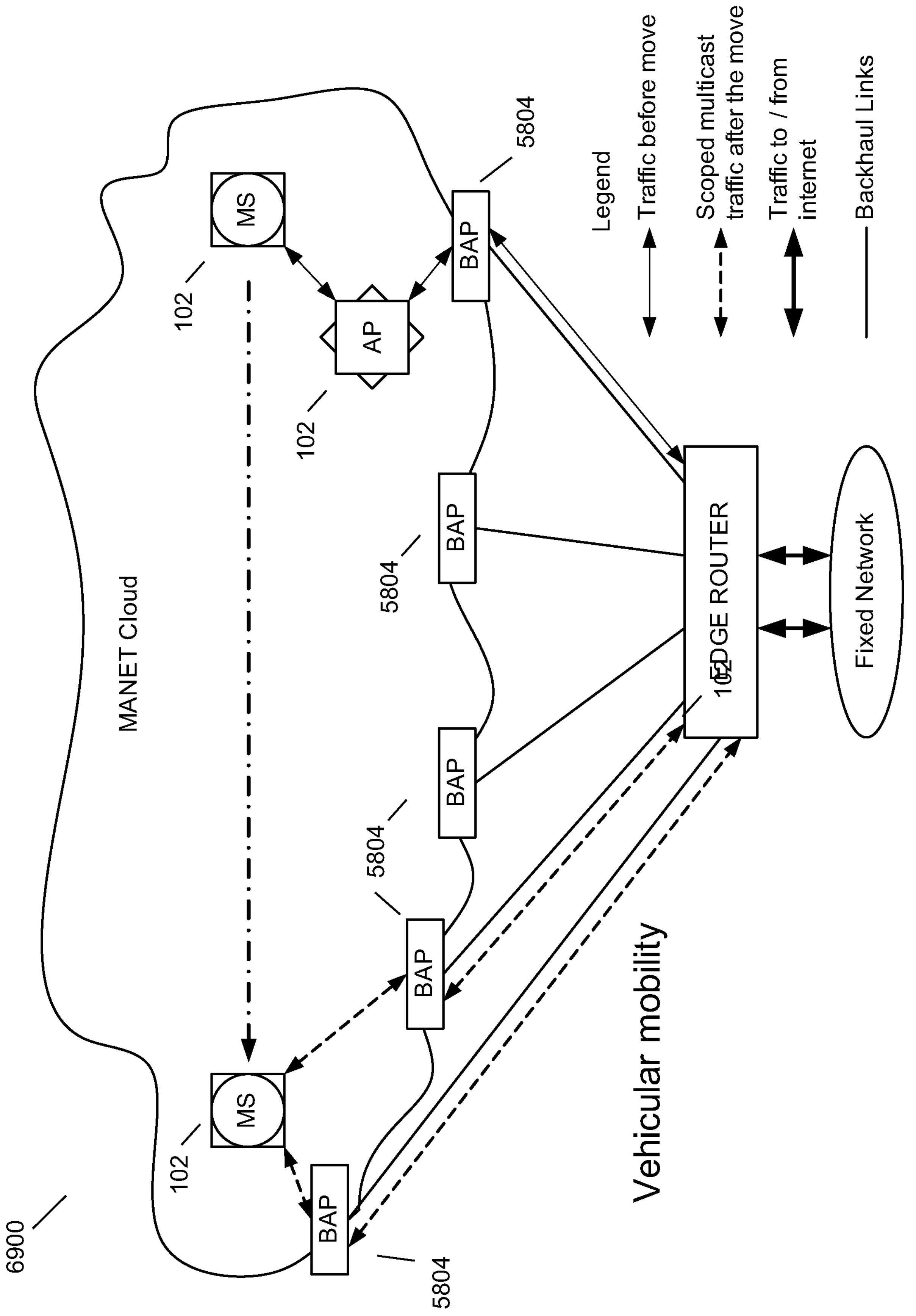

6900
MANET Cloud
MS
102
AP
102
BAP
5804
BAP
5804
BAP
5804
BAP
5804
MS
102
BAP
5804
EDGE ROUTER
102
Fixed Network
Vehicular mobility
Legend
Traffic before move
Scoped multicast traffic after the move
Traffic to / from internet
Backhaul Links

FIG. 69

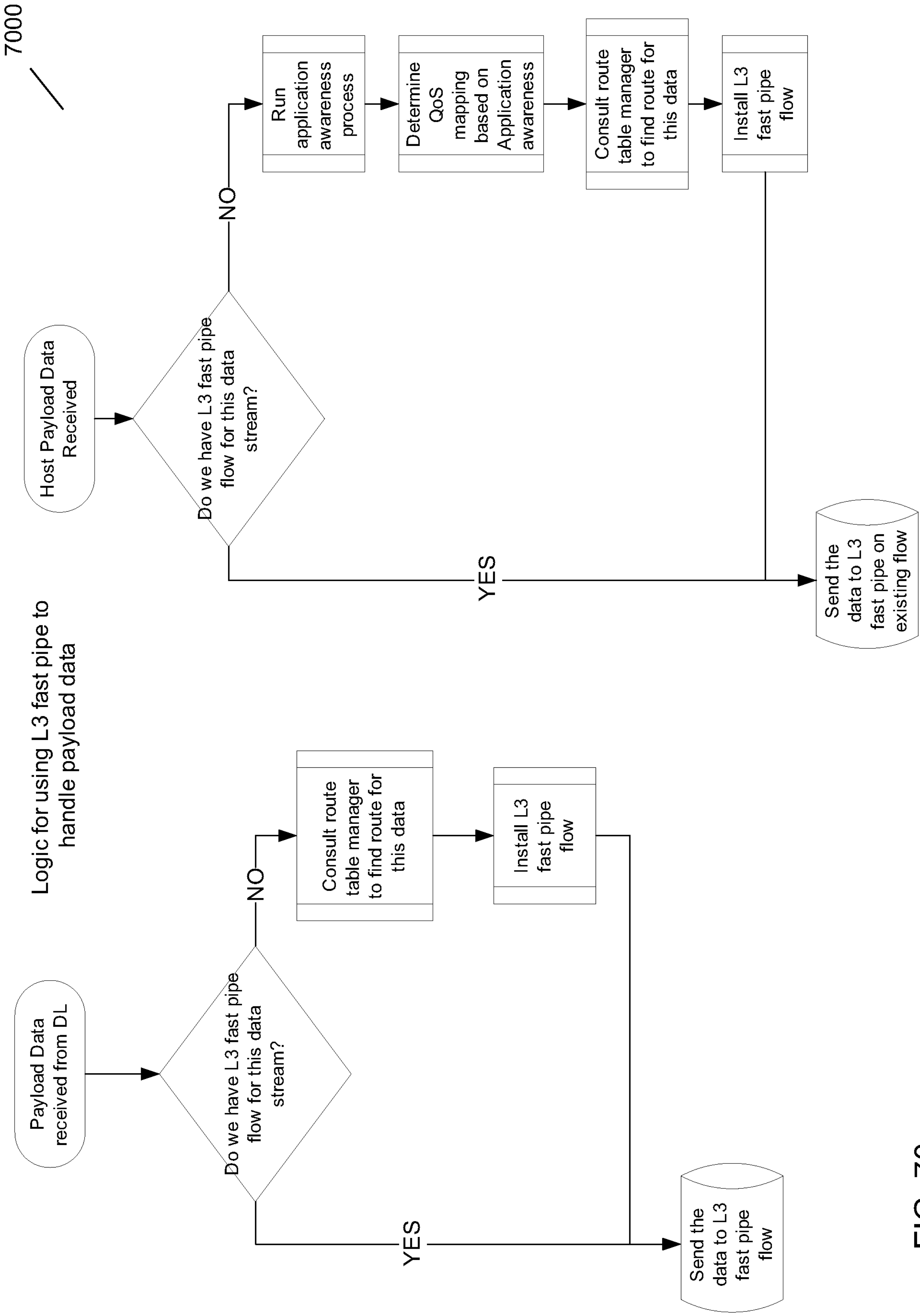

7000
Logic for using L3 fast pipe to handle payload data
Payload Data received from DL
Do we have L3 fast pipe flow for this data stream?
NO
YES
Consult route table manager to find route for this data
Install L3 fast pipe flow
Send the data to L3 fast pipe flow
Host Payload Data Received
Do we have L3 fast pipe flow for this data stream?
NO
YES
Run application awareness process
Determine QoS mapping based on Application awareness
Consult route table manager to find route for this data
Install L3 fast pipe flow
Send the data to L3 fast pipe on existing flow

FIG. 70

7100

L2 Forwarding table format

Destination MAC	Next Hop
My MACs	Router Layer
MACa	MACx
Default Installed	MAC default Route
Anything Else	Go to Router layer

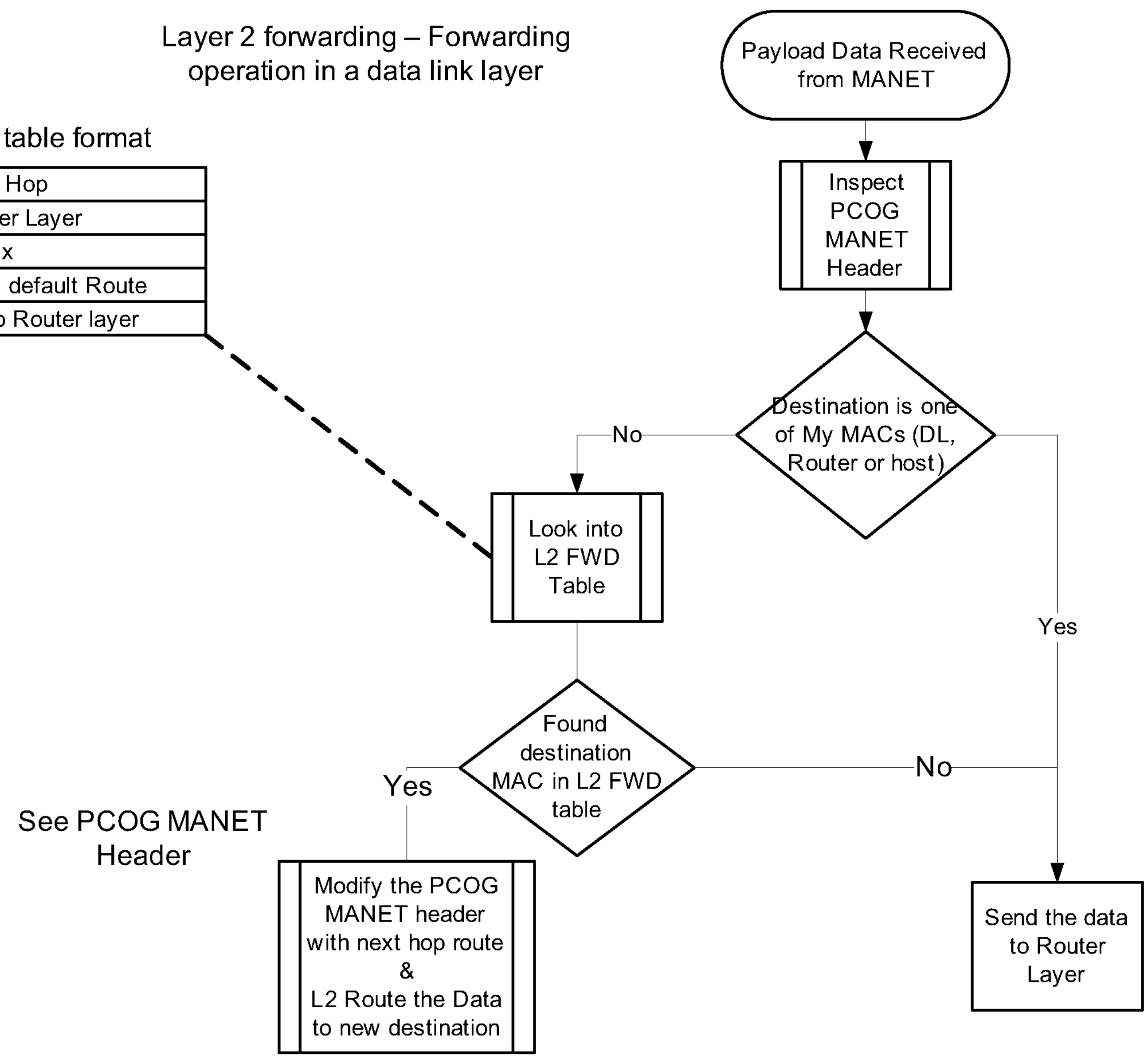


FIG. 71

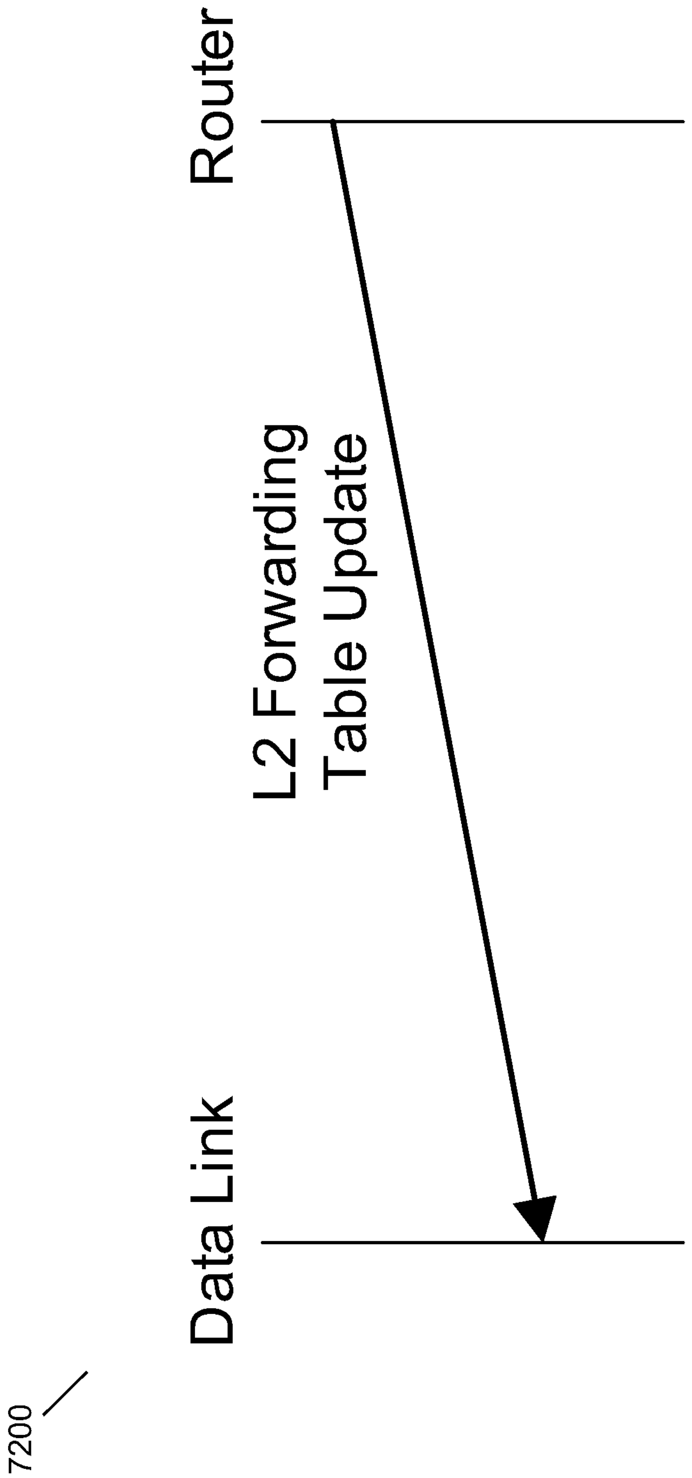


FIG. 72

7300

Layer 2 forwarding – Header table

Field Name	Data Type	# of Bytes	Description
Destination NodeId	NODE_ID	5	Node Id of Destination for this datagram
Next Hop NodeId	NODE_ID	5	Node Id of the next hop node for this datagram
Source NodeId	NODE_ID	5	Node Id of the source node for this datagram
QoS	Byte	1	QoS parameter for this datagram. This QoS is derived from TOS
TTL	Byte	1	Time to live
Payload Type	Byte	1	Payload Type •UDP •TCP •Broadcast •…
Spare	Byte[]	2	Make it align to 4 byte boundary

FIG. 73

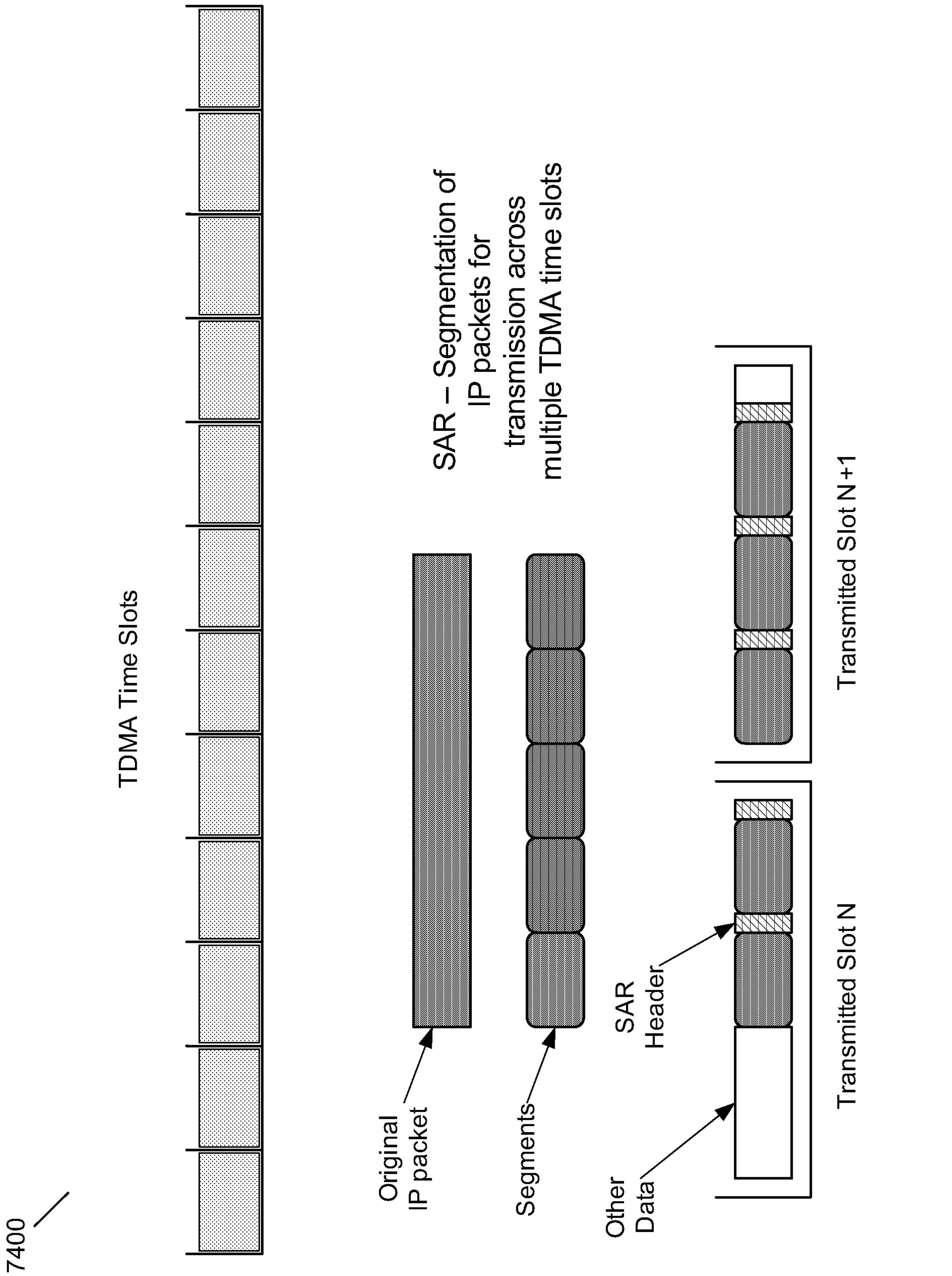

7400
TDMA Time Slots
SAR – Segmentation of IP packets for transmission across multiple TDMA time slots
Original IP packet
Segments
SAR Header
Other Data
Transmitted Slot N
Transmitted Slot N+1

FIG. 74

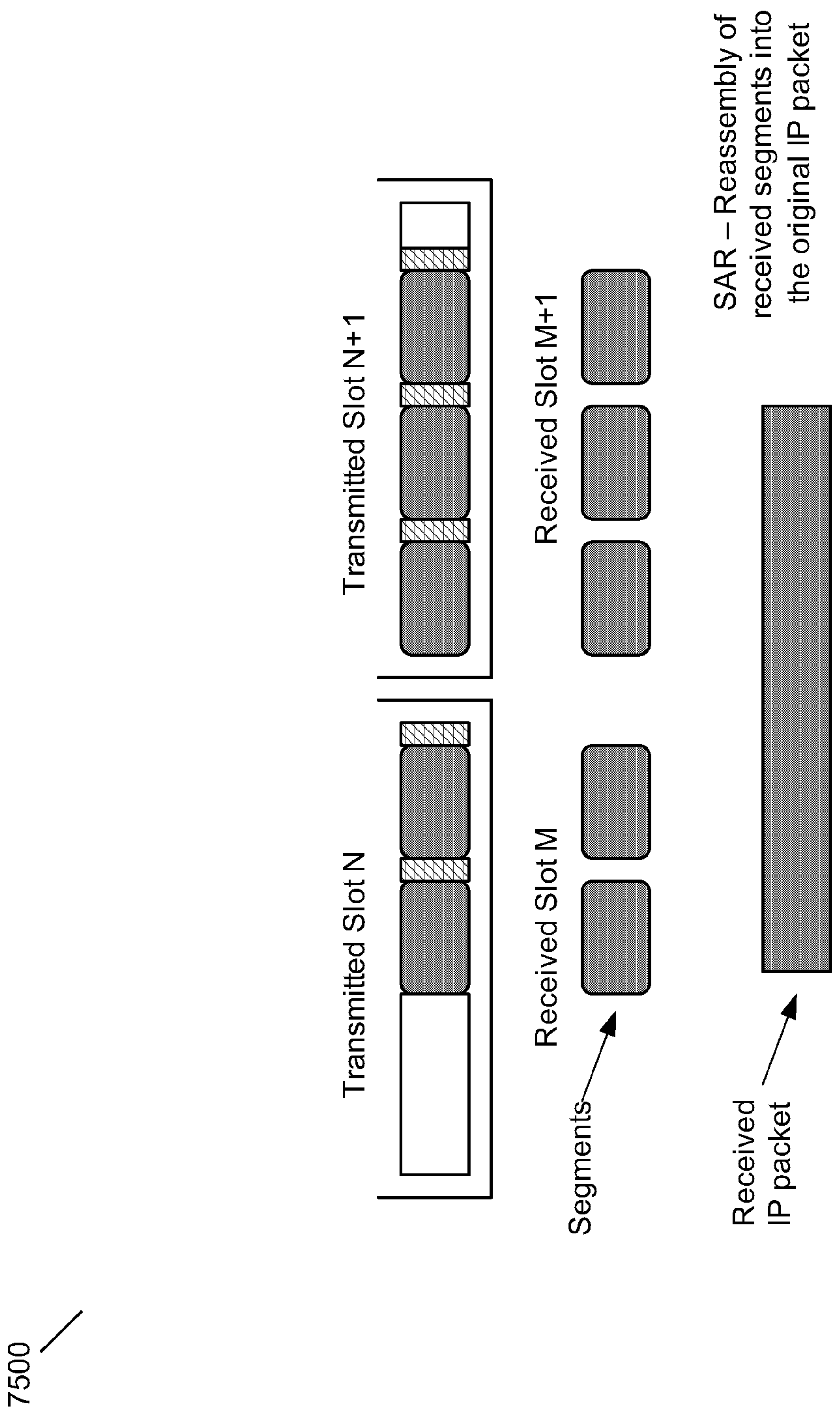

7500
Transmitted Slot N
Transmitted Slot N+1
Received Slot M
Received Slot M+1
Segments
Received IP packet
SAR – Reassembly of received segments into the original IP packet

FIG. 75

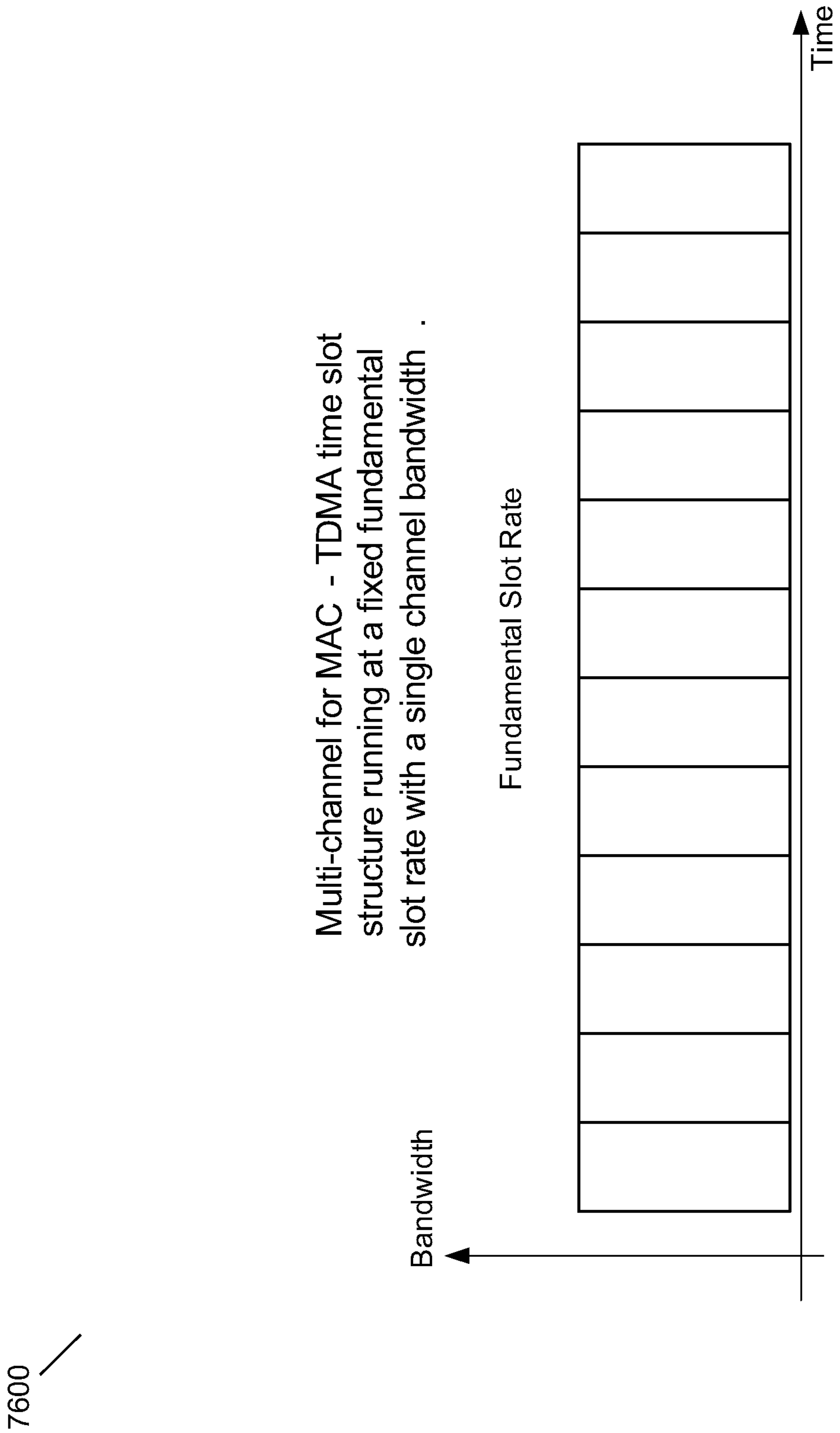

7600
Multi-channel for MAC - TDMA time slot structure running at a fixed fundamental slot rate with a single channel bandwidth .
Fundamental Slot Rate
Bandwidth
Time

FIG. 76

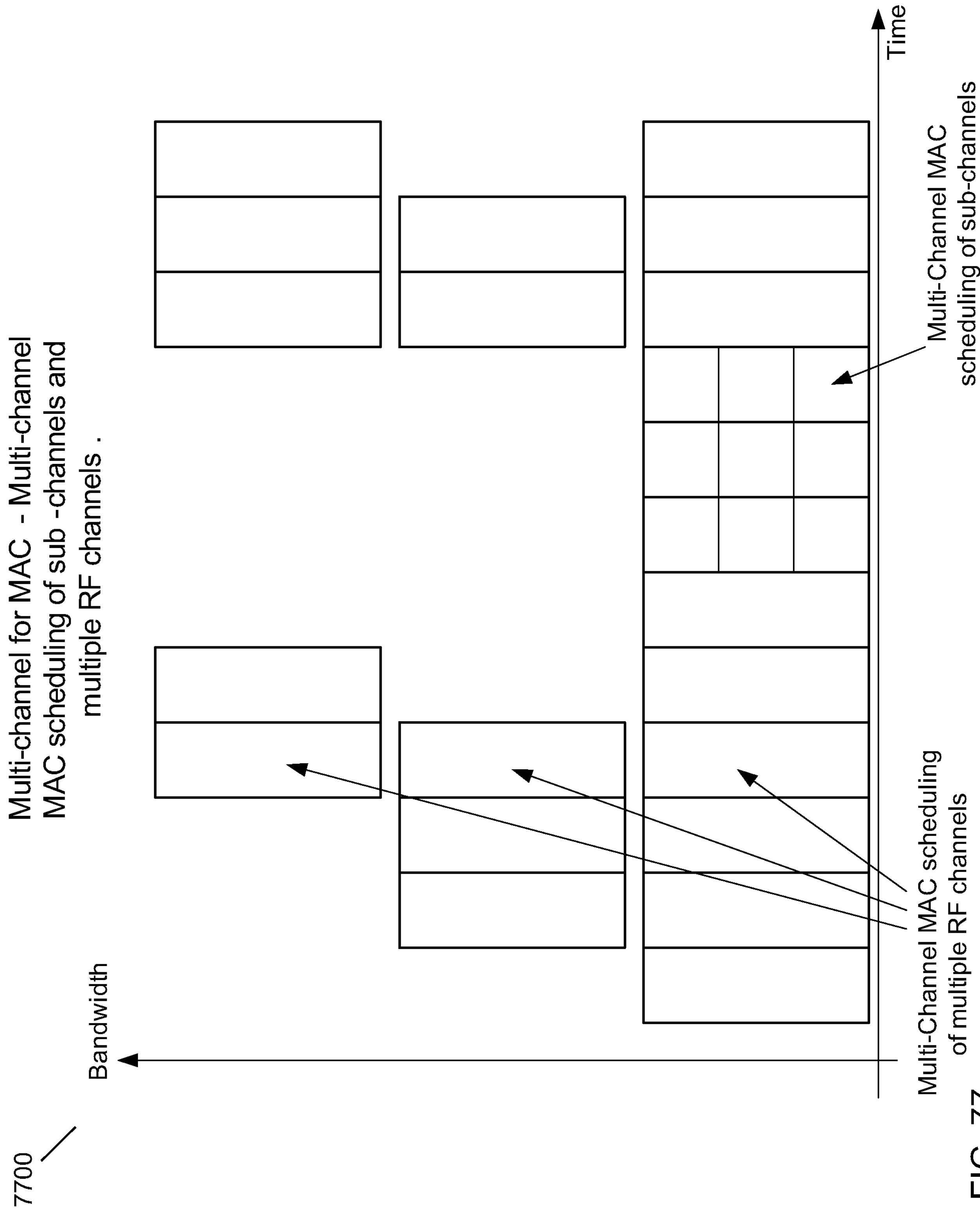

7700
Multi-channel for MAC - Multi-channel MAC scheduling of sub -chanels and multiple RF channels .
Bandwidth
Time
Multi-Channel MAC scheduling of sub-channels
Multi-Channel MAC scheduling of multiple RF channels

FIG. 77

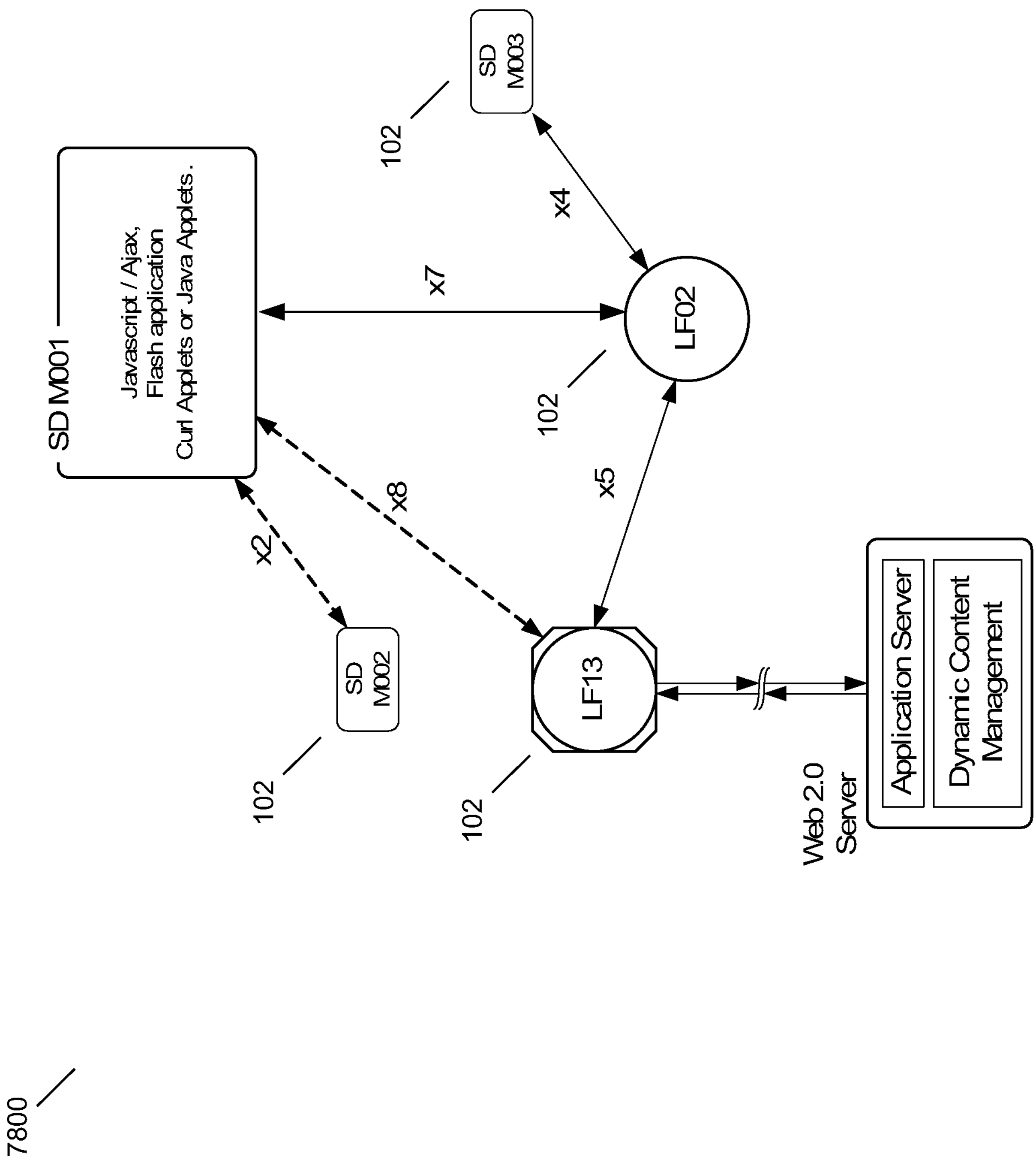

7800
SD M001
Javascript / Ajax,
Flash application
Curl Applets or Java Applets .
SD
M002
SD
M003
LF02
LF13
102
102
102
102
102
x2
x4
x5
x7
x8
Web 2.0
Server
Application Server
Dynamic Content
Management

FIG. 78

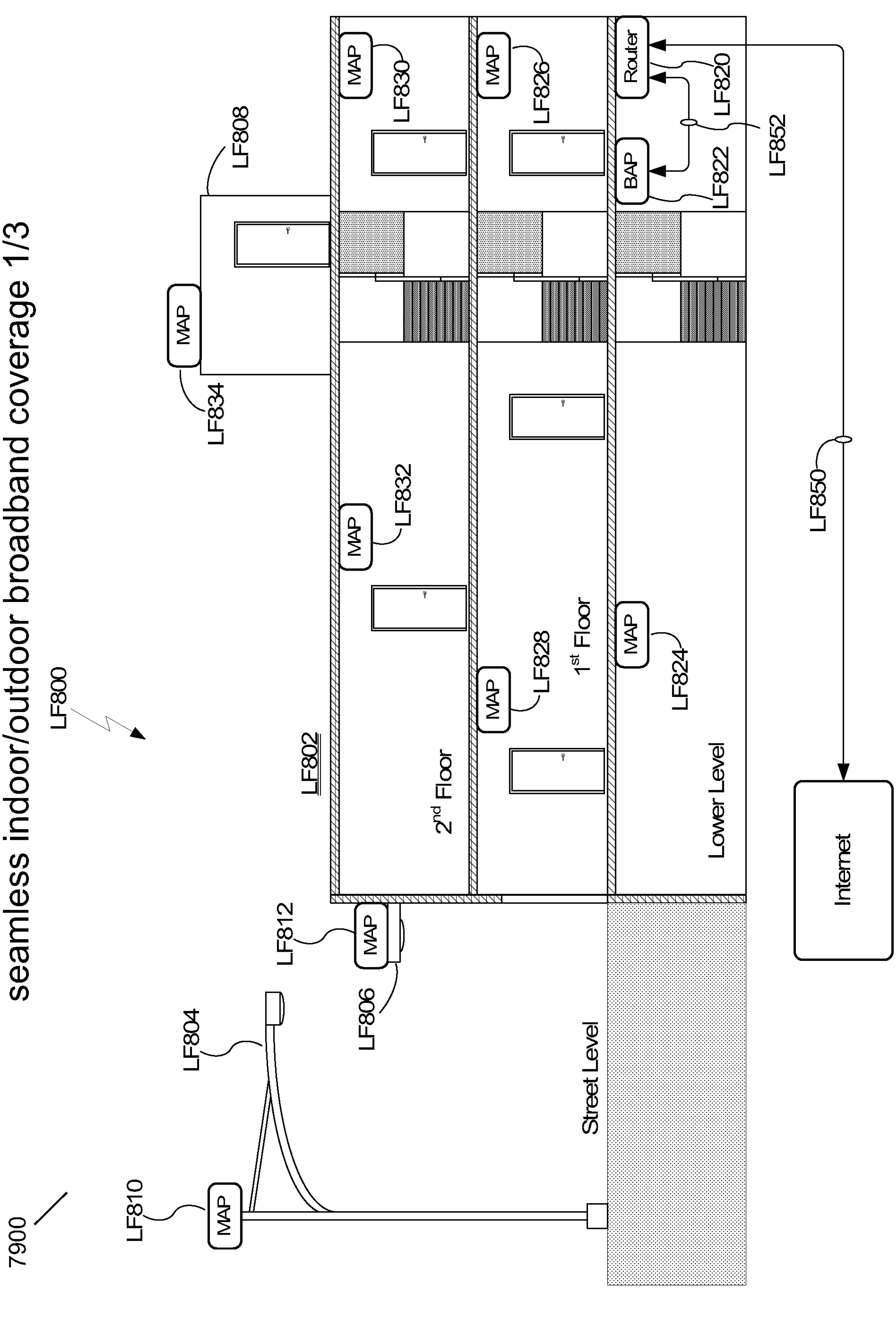

seamless indoor/outdoor broadband coverage 1/3
7900
LF800
LF802
LF804
LF806
LF808
LF810
LF812
LF820
LF822
LF824
LF826
LF828
LF830
LF832
LF834
LF850
LF852
MAP
BAP
Router
Internet
2nd Floor
1st Floor
Lower Level
Street Level

FIG. 79

seamless indoor/outdoor broadband coverage 2/3

8000

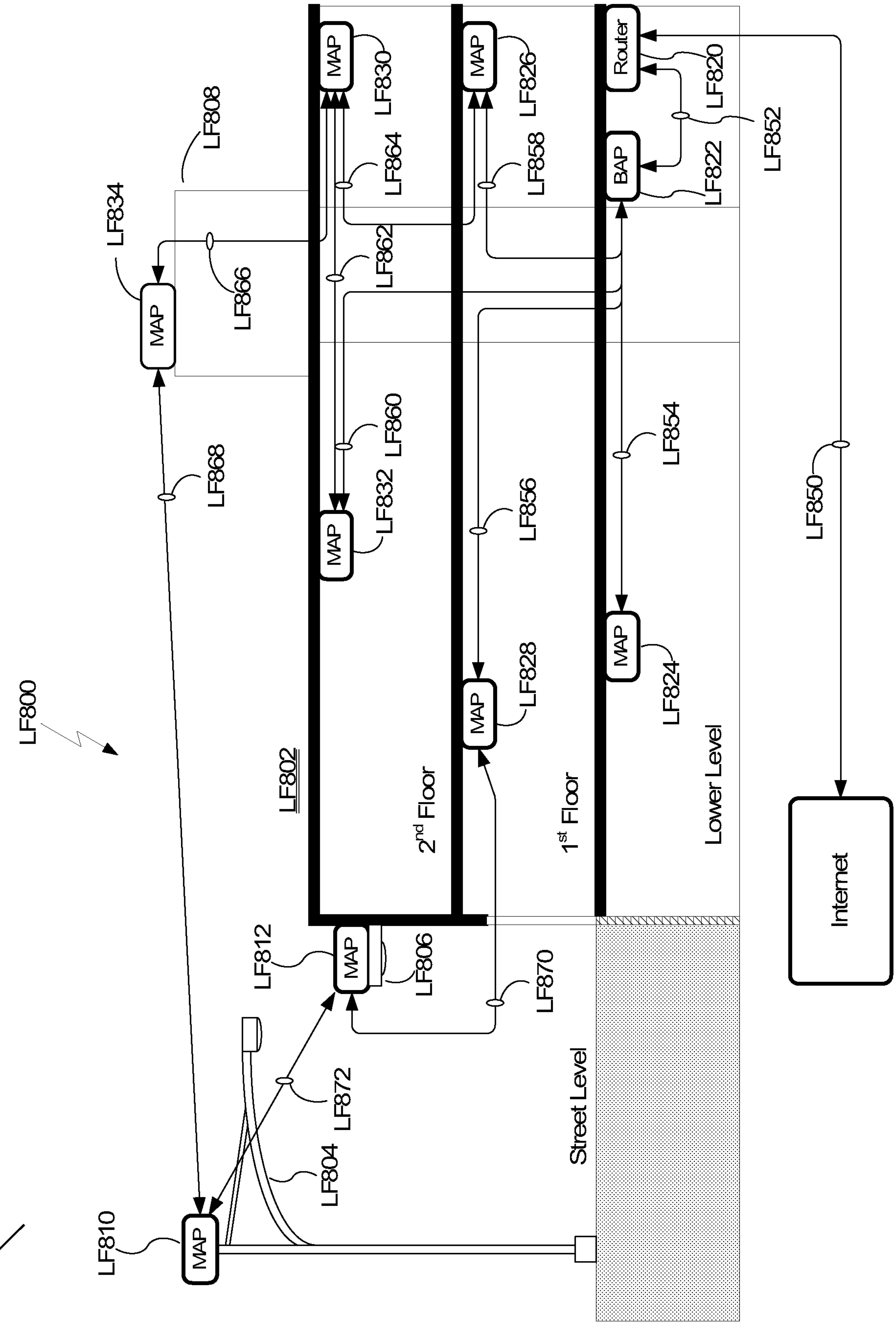


FIG. 80

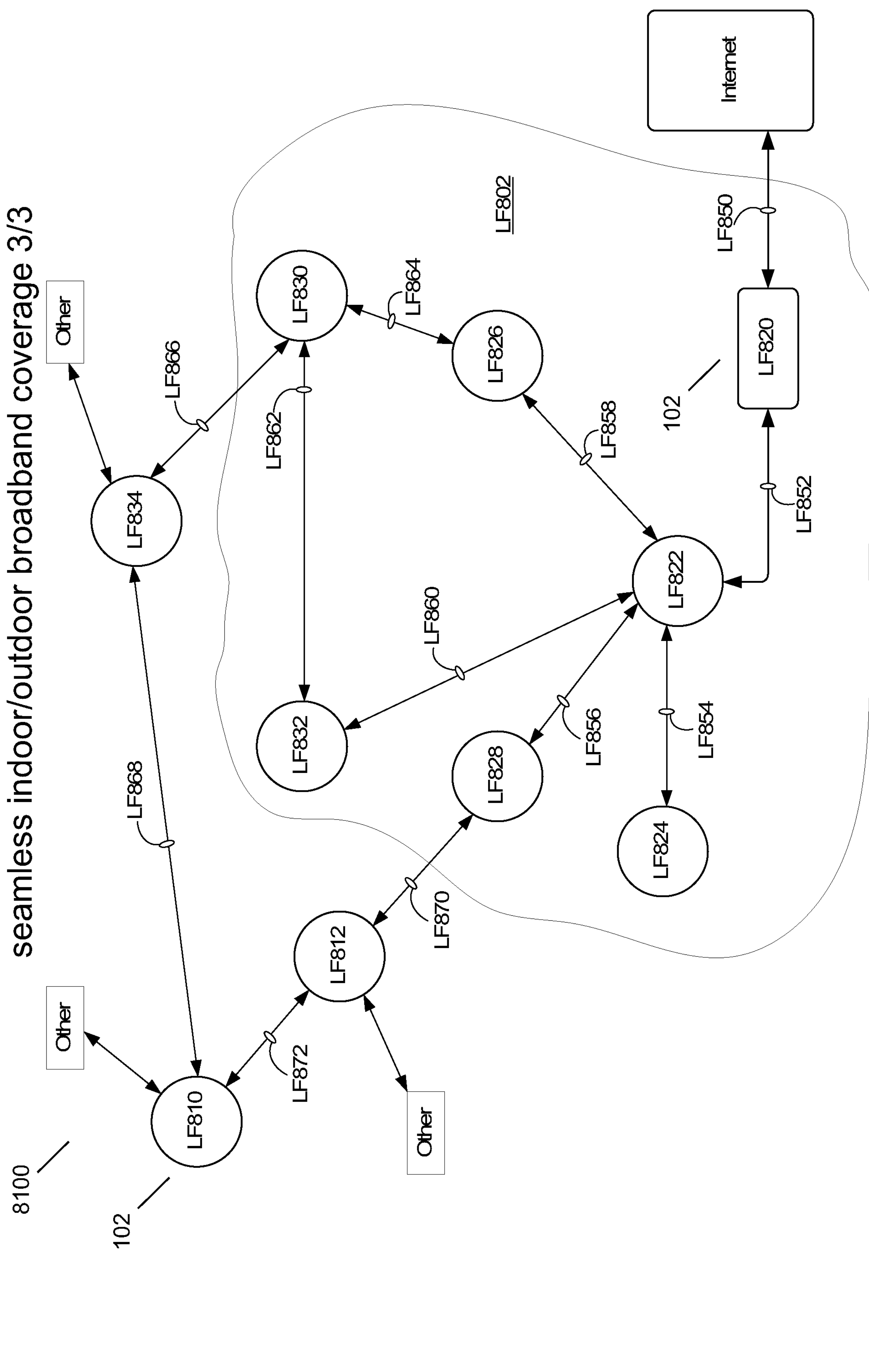

seamless indoor/outdoor broadband coverage 3/3
8100
102
LF810
Other
LF872
LF812
Other
LF868
LF870
LF834
Other
LF866
LF828
LF856
LF832
LF860
LF862
LF830
LF864
LF826
LF858
LF824
LF854
LF822
LF852
LF802
102
LF820
LF850
Internet

FIG. 81

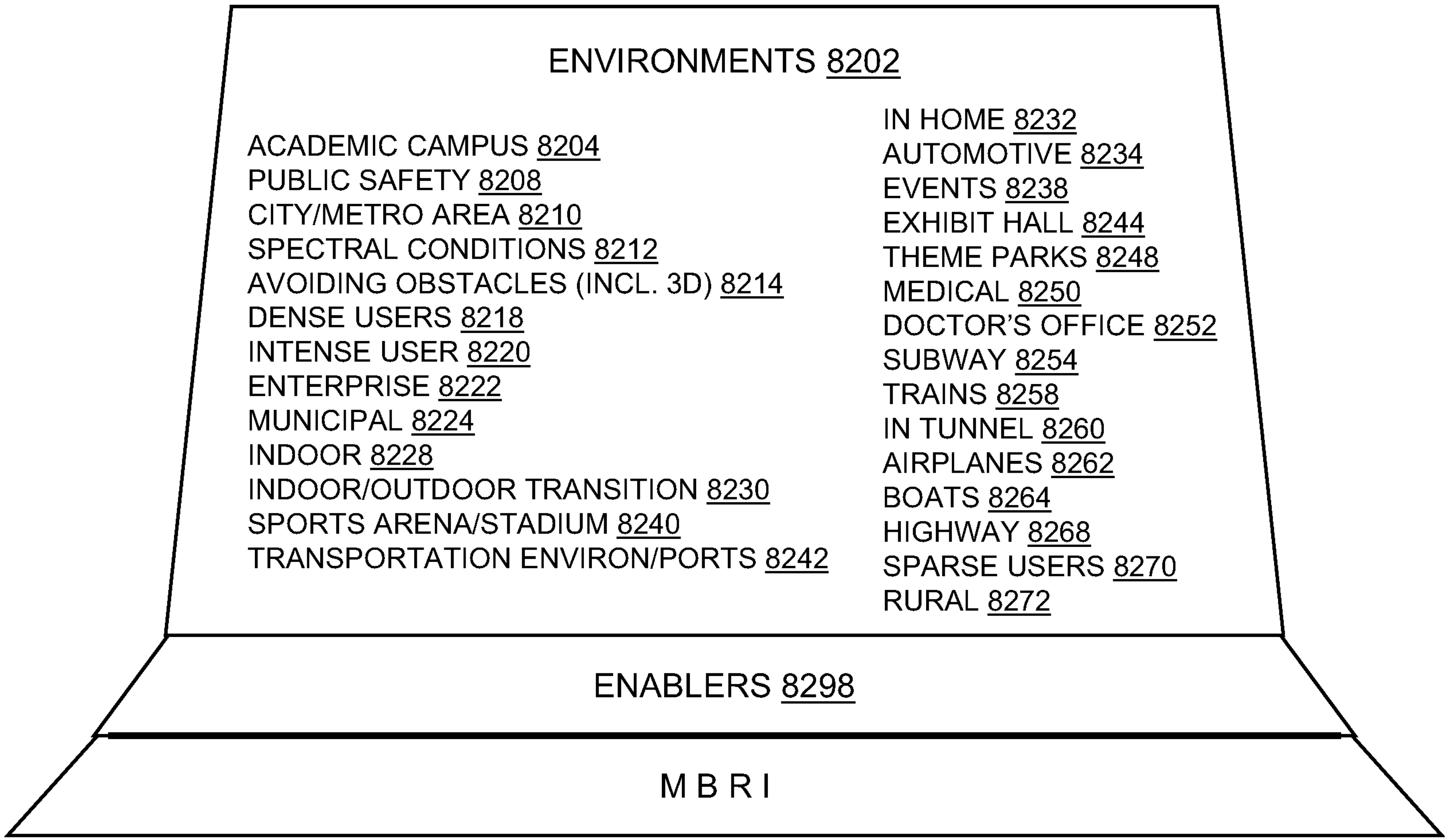

ENVIRONMENTS 8202
ACADEMIC CAMPUS 8204
PUBLIC SAFETY 8208
CITY/METRO AREA 8210
SPECTRAL CONDITIONS 8212
AVOIDING OBSTACLES (INCL. 3D) 8214
DENSE USERS 8218
INTENSE USER 8220
ENTERPRISE 8222
MUNICIPAL 8224
INDOOR 8228
INDOOR/OUTDOOR TRANSITION 8230
SPORTS ARENA/STADIUM 8240
TRANSPORTATION ENVIRON/PORTS 8242
IN HOME 8232
AUTOMOTIVE 8234
EVENTS 8238
EXHIBIT HALL 8244
THEME PARKS 8248
MEDICAL 8250
DOCTOR'S OFFICE 8252
SUBWAY 8254
TRAINS 8258
IN TUNNEL 8260
AIRPLANES 8262
BOATS 8264
HIGHWAY 8268
SPARSE USERS 8270
RURAL 8272
ENABLERS 8298
M B R I

Fig. 82

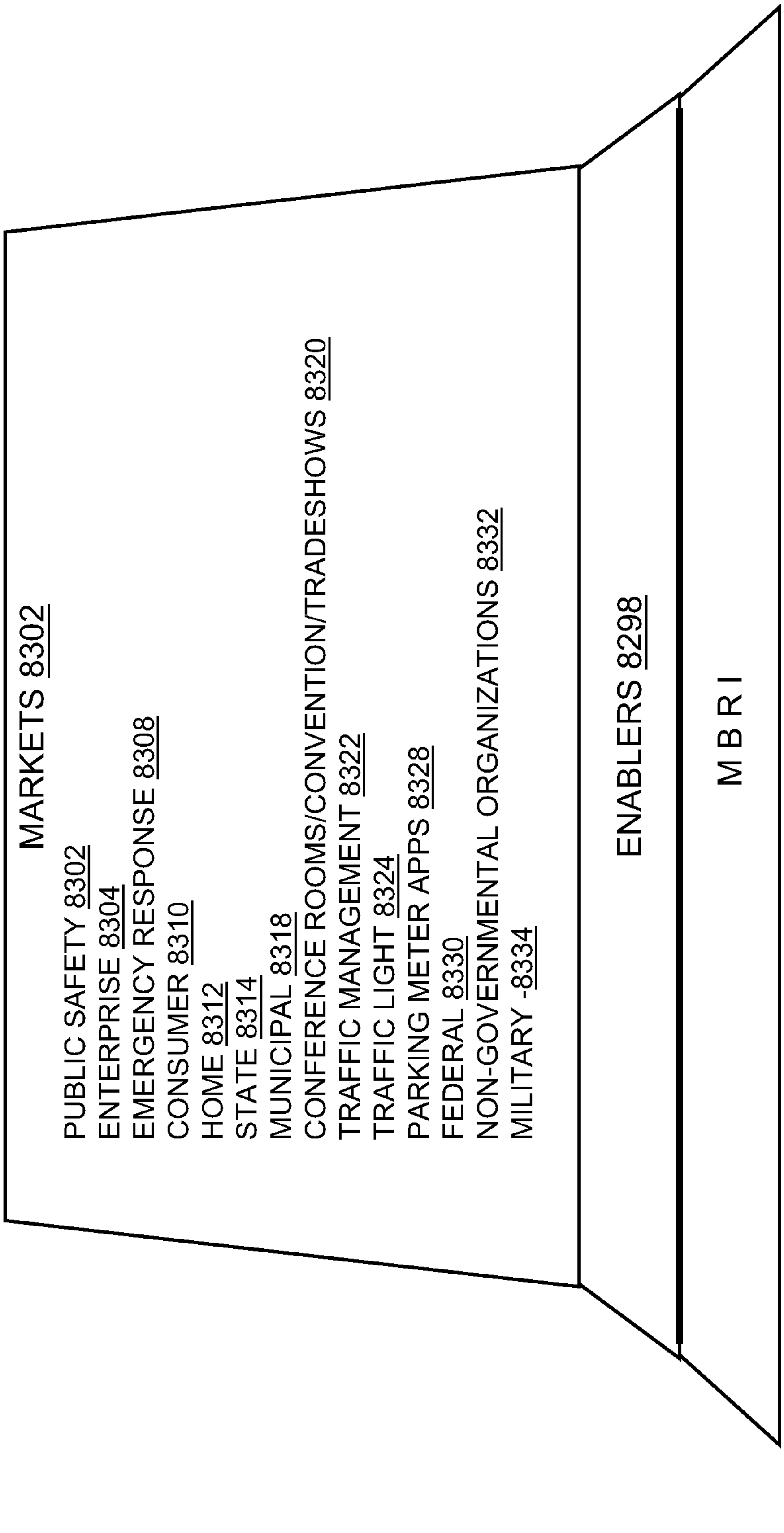

MARKETS 8302
PUBLIC SAFETY 8302
ENTERPRISE 8304
EMERGENCY RESPONSE 8308
CONSUMER 8310
HOME 8312
STATE 8314
MUNICIPAL 8318
CONFERENCE ROOMS/CONVENTION/TRADESHOWS 8320
TRAFFIC MANAGEMENT 8322
TRAFFIC LIGHT 8324
PARKING METER APPS 8328
FEDERAL 8330
NON-GOVERNMENTAL ORGANIZATIONS 8332
MILITARY -8334
ENABLERS 8298
M B R I

Fig. 83

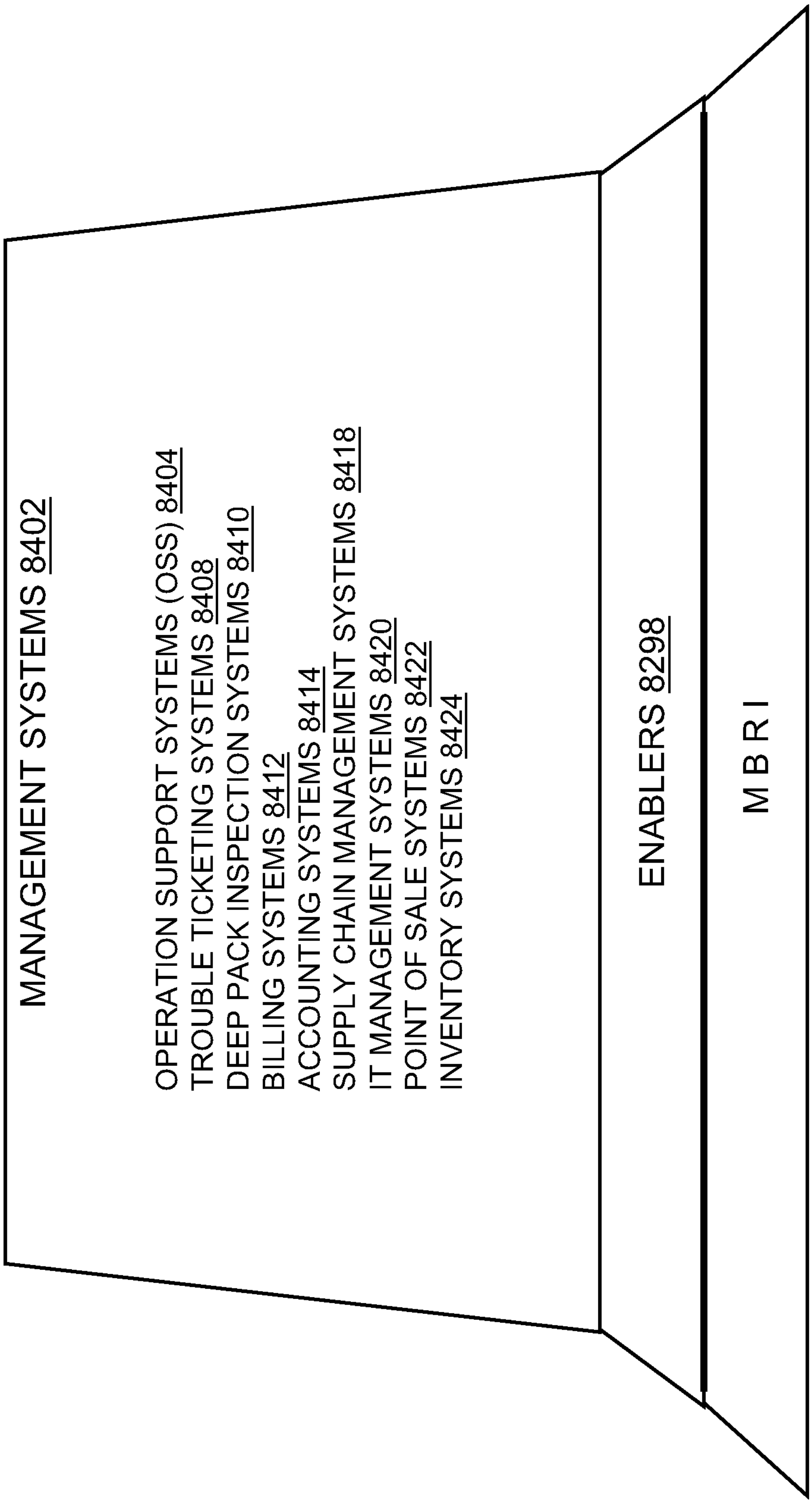

MANAGEMENT SYSTEMS 8402
OPERATION SUPPORT SYSTEMS (OSS) 8404
TROUBLE TICKETING SYSTEMS 8408
DEEP PACK INSPECTION SYSTEMS 8410
BILLING SYSTEMS 8412
ACCOUNTING SYSTEMS 8414
SUPPLY CHAIN MANAGEMENT SYSTEMS 8418
IT MANAGEMENT SYSTEMS 8420
POINT OF SALE SYSTEMS 8422
INVENTORY SYSTEMS 8424
ENABLERS 8298
M B R I

Fig. 84

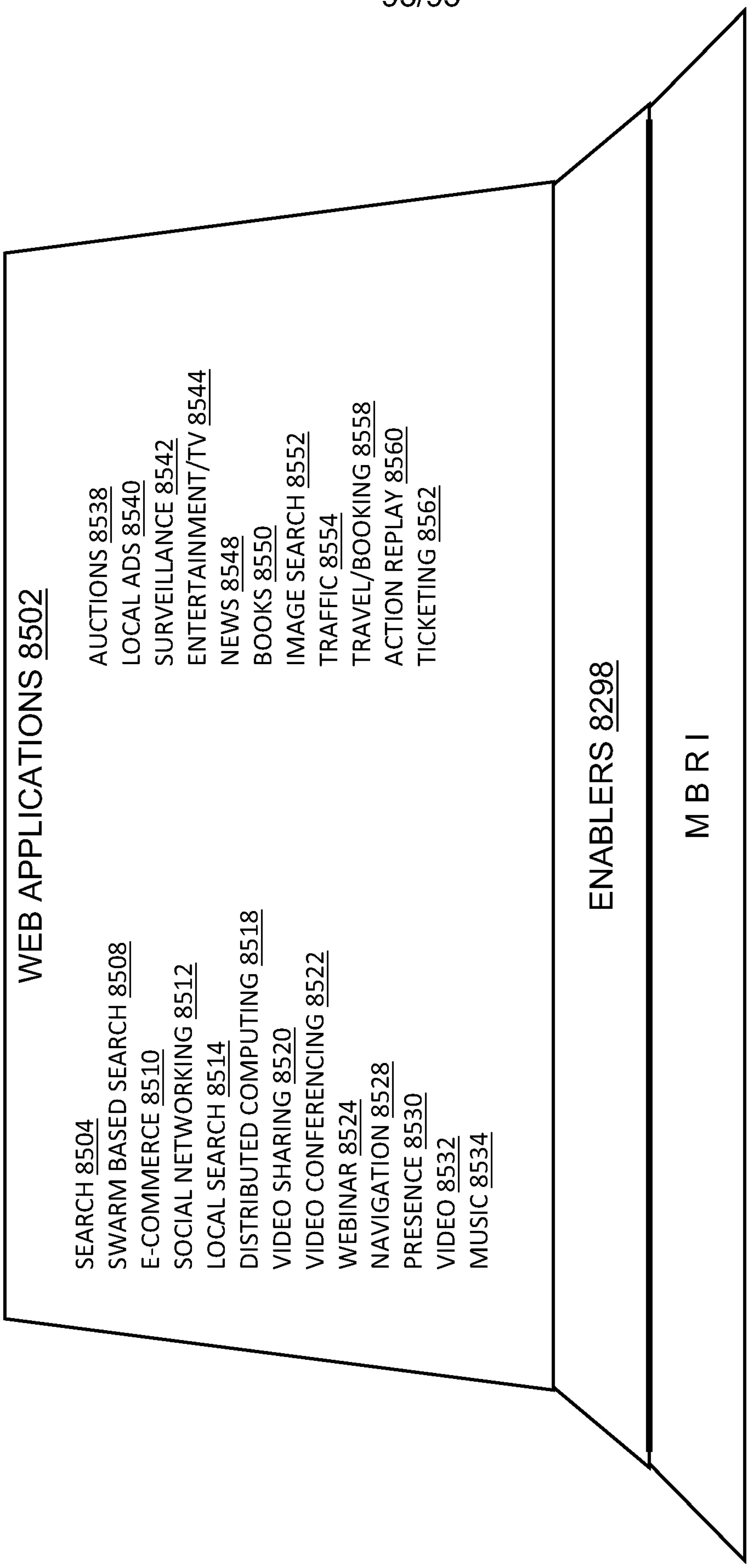
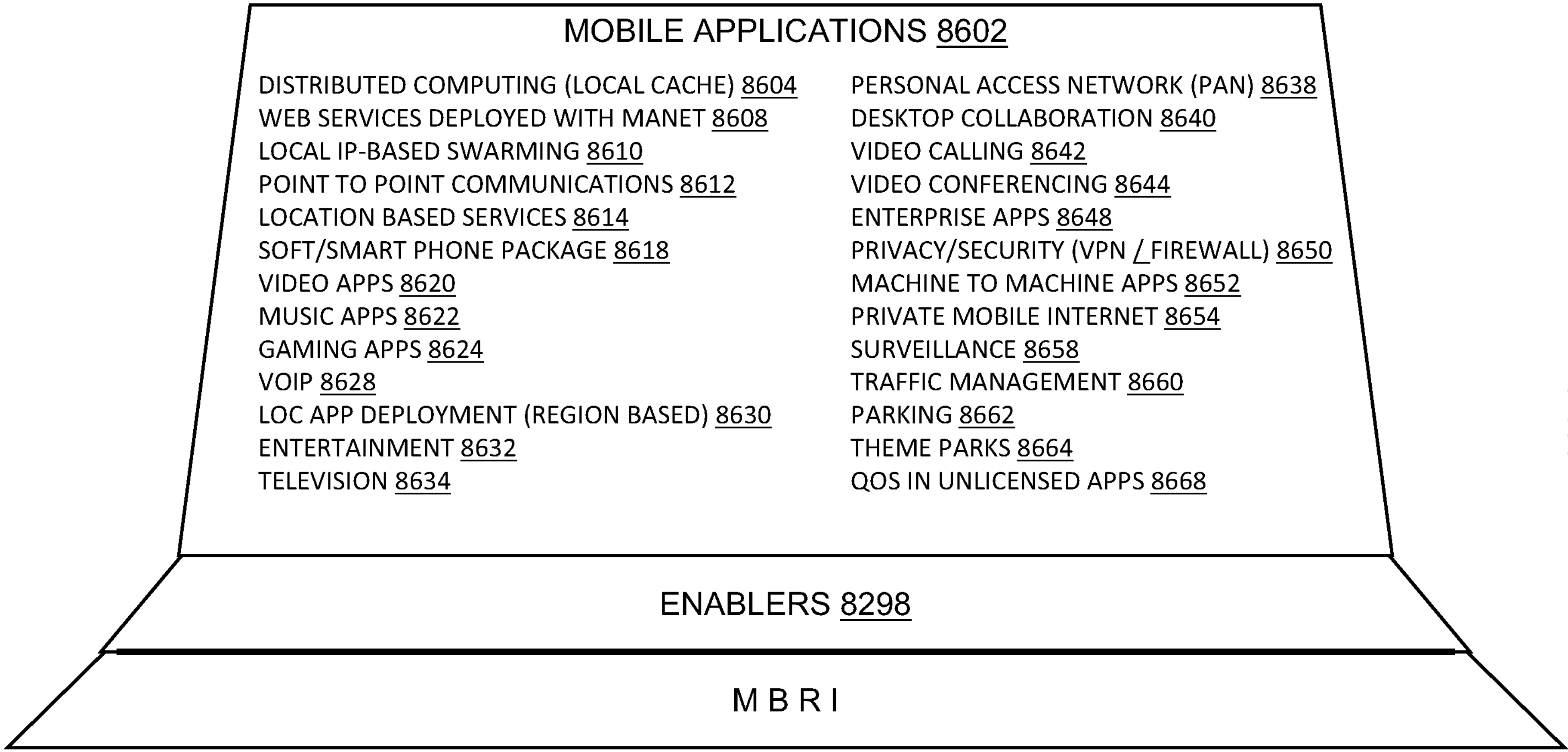

WEB APPLICATIONS 8502
SEARCH 8504
SWARM BASED SEARCH 8508
E-COMMERCE 8510
SOCIAL NETWORKING 8512
LOCAL SEARCH 8514
DISTRIBUTED COMPUTING 8518
VIDEO SHARING 8520
VIDEO CONFERENCING 8522
WEBINAR 8524
NAVIGATION 8528
PRESENCE 8530
VIDEO 8532
MUSIC 8534
AUCTIONS 8538
LOCAL ADS 8540
SURVEILLANCE 8542
ENTERTAINMENT/TV 8544
NEWS 8548
BOOKS 8550
IMAGE SEARCH 8552
TRAFFIC 8554
TRAVEL/BOOKING 8558
ACTION REPLAY 8560
TICKETING 8562
ENABLERS 8298
M B R I

Fig. 85


MOBILE APPLICATIONS 8602
DISTRIBUTED COMPUTING (LOCAL CACHE) 8604
WEB SERVICES DEPLOYED WITH MANET 8608
LOCAL IP-BASED SWARMING 8610
POINT TO POINT COMMUNICATIONS 8612
LOCATION BASED SERVICES 8614
SOFT/SMART PHONE PACKAGE 8618
VIDEO APPS 8620
MUSIC APPS 8622
GAMING APPS 8624
VOIP 8628
LOC APP DEPLOYMENT (REGION BASED) 8630
ENTERTAINMENT 8632
TELEVISION 8634
PERSONAL ACCESS NETWORK (PAN) 8638
DESKTOP COLLABORATION 8640
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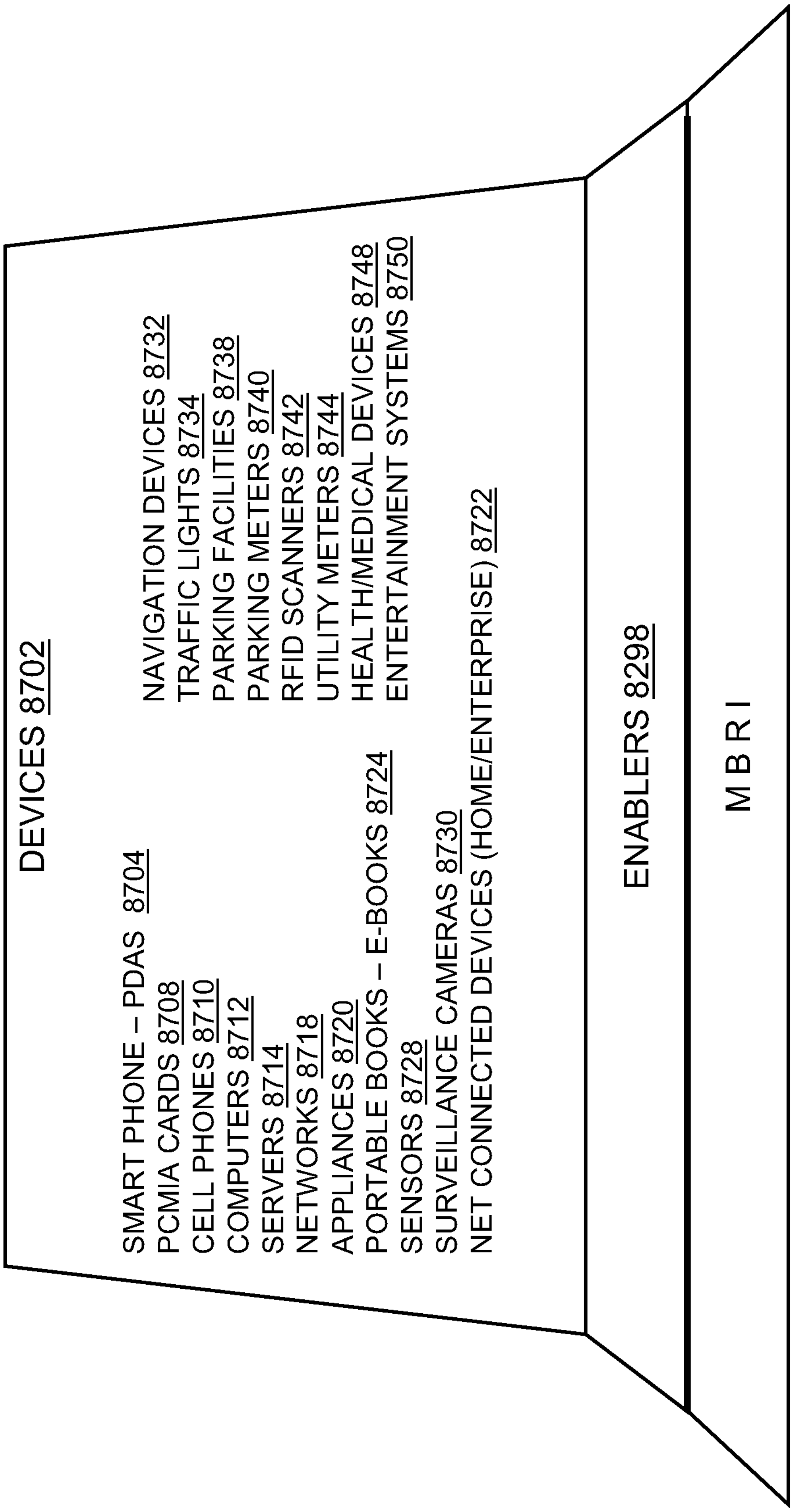
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Fig. 87