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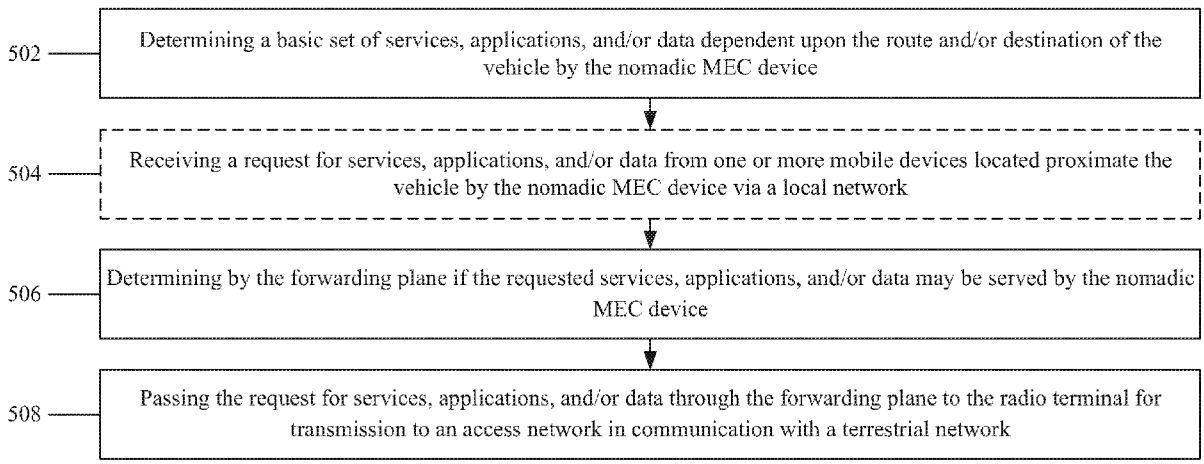


FIG. 5

(57) Abstract: An apparatus, method, and computer program products are provided in reference to a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route. The apparatus may obtain services, applications, or data from a terrestrial networking entity prior to travel along the route. The apparatus may cause a location of the vehicle to be reported during travel along the route, and in response to the location of the vehicle, may receive an update to the services, applications, or data during travel along the route. The apparatus may further provide access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

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NOMADIC MULTI-ACCESS DEVICE CONFIGURED TO BE CARRIED BY A VEHICLE AND TO OBTAIN UPDATES OF SERVICES, APPLICATIONS OR DATA BASED ON THE LOCATION OF THE VEHICLE

TECHNOLOGICAL FIELD

[0001] An example embodiment relates generally to multi-access edge computing ("MEC") and, more particularly, to obtaining and updating services, applications, and/or data by a MEC device on a vehicle traveling along a route.

BACKGROUND

[0002] Communication networks are often used in conjunction with various vehicles, such as railway systems, as a means to provide passengers with access to services, applications, and data while traveling to their destination. Particularly, these vehicles may allow passengers to connect to an external network by accessing a network hosted by the vehicle. However, current railway communications systems, for example the Global System for Mobile Communications – Railway ("GSM-R"), present challenges relating to the accommodation of spectrum and bandwidth offered by emerging broadband services. In particular, the European telecommunications standards institute ("ETSI") industry specification group ("ISG") indicates that current GSM-R communication solutions are not expected to meet the requirements set by forthcoming broadband traffic.

[0003] With reference to FIG. 1a, a conventional GSM-R system is illustrated. This example GSM-R system includes one or more mobile devices 10 disposed on a train in communication with a core network 40 via a radio base station 20 and a radio network controller 30. The current GSM-R system shown in FIG. 1a may have radio base stations 20 located along the train's route in communication with a core network 40 to facilitate direct communication of the mobile devices 10 with a core network 40. Additionally, with reference to FIG. 1b, conventional GSM-R systems may utilize a Wi-Fi or wireless local area network ("WLAN") hosted by the train. In such networks, the mobile devices 50 may connect to a satellite or mobile radio network 90 via connection with a WLAN 60 hosted by the train. A wireless access point ("WAP") 70 and radio terminal 80 may facilitate this connection. However, these conventional networks illustrated in FIGS. 1a and 1b fail to meet the requirements set forth by forthcoming broadband traffic as defined by the ETSI. By way of example, a passenger traveling in a train car utilizing conventional communication networks, as seen in FIGS. 1a and 1b, may be connected to a local

Wi-Fi network hosted by the train. However, the passenger may receive varying levels of service along the route, and may experience disruptions in service caused by weak or non-existent radio or satellite coverage when the train passes through a tunnel or is blocked by elevated terrain.

BRIEF SUMMARY

[0004] An apparatus, method, and computer program product are provided according to an example embodiment in order to provide services, applications, or data to mobile devices on a vehicle traveling along a route. An example of the disclosure may provide an apparatus embodied by a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route. The apparatus includes at least one processor and at least one memory including computer program code with the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to obtain services, applications, or data from a terrestrial networking entity prior to travel along the route. The apparatus is also caused to report a location of the vehicle during travel along the route. In response to the location of the vehicle, the apparatus is caused to receive an update to the services, applications, or data during travel along the route, and is caused to provide access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

[0005] In one embodiment, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to obtain the services, applications, or data from the terrestrial networking entity via a wireless local area network prior to travel along the route. In another embodiment, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to receive the update to the services, applications, or data during travel along the route via a satellite network or mobile radio network.

[0006] In some embodiments, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to obtain services, applications, or data from the terrestrial networking entity by causing a request for the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial

networking entity. In an alternative embodiment, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to obtain services, applications, or data from the terrestrial networking entity by causing a request for the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

[0007] In some embodiments, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to request an update to the services, applications, or data during travel along the route based on a request by the one or more passengers of the vehicle. In some further embodiments, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to provide advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route. The apparatus of any of the above embodiments may, with the at least one memory and the computer program code, be further configured to, with the at least one processor, cause the apparatus to maintain a connection between the apparatus and a satellite network, a mobile radio network, and a wireless local area network, and provide an option to the one or more passengers of the vehicle to select which connection to utilize.

[0008] In conjunction with a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route, a method is provided in accordance with another embodiment with the method including obtaining services, applications, or data from a terrestrial networking entity prior to travel along the route. The method includes causing a location of the vehicle to be reported during travel along the route. In response to the location of the vehicle, the method includes receiving an update to the services, applications, or data during travel along the route, and providing access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

[0009] In one embodiment, the method includes obtaining services, applications or data comprising obtaining the services, applications, or data from the terrestrial networking entity via a wireless local area network prior to travel along the route. In another embodiment, the method includes receiving an updated comprises receiving the update to the services, applications, or data during travel along the route via a satellite network or mobile radio network. In a further

embodiment, obtaining the services, applications, or data from the terrestrial networking entity includes requesting the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity. In other embodiments, obtaining the services, applications, or data from the terrestrial networking entity includes requesting the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

[0010] In some embodiments, requesting an update to the services, applications, or data during travel along the route includes requesting an update based on a request by the one or more passengers of the vehicle. In some still further embodiments, the method includes providing advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route. The method of any of the above embodiments may include maintaining a connection between the nomadic multi-access computing device and a satellite network, a mobile radio network, and a wireless local area network, and providing an option to the one or more passengers of the vehicle to select which connection to utilize.

[0011] In a further embodiment, a computer program product is provided that may be embodied by or otherwise utilized in conjunction with a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route. The computer program product comprises at least one non-transitory computer-readable storage medium having computer-executable program code stored therein with the computer-executable program code comprising program code instructions configured to obtain services, applications, or data from a terrestrial networking entity prior to travel along the route. The computer executable program code portions also include program code configured to cause a location of the vehicle to be reported during travel along the route. In response to the location of the vehicle, the computer executable program code portions also include program code configured to receive an update to the services, applications, or data during travel along the route, and provide access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

[0012] In one embodiment, the program code instructions are configured to obtain the services, applications, or data from the terrestrial networking entity comprise program code instructions configured to obtain the services, applications or data via a wireless local area

network prior to travel along the route. In another embodiment, the program code instructions are configured to cause the apparatus to receive the update to the services, applications, or data during travel along the route comprise the program code instructions configured to receive the updated via a satellite network or mobile radio network.

[0013] In one embodiment, the program code instructions are configured to obtain services, applications, or data from the terrestrial networking entity comprise program code instructions configured to cause a request for the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity. In an alternative embodiment, the program code instructions are configured to obtain services, applications, or data from the terrestrial networking entity comprise program code instructions configured to cause a request for the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

[0014] In some further embodiments, the program code instructions are configured to request an update to the services, applications, or data during travel along the route comprise program code instructions configured to request the update based on a request by the one or more passengers of the vehicle. In some embodiments, the computer-executable program code further comprise program code instructions configured to provide advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route. The computer program product of any of the above embodiment may comprise program code instructions configured to maintain a connection between the apparatus and a satellite network, a mobile radio network, and a wireless local area network, and provide an option to the one or more passengers of the vehicle to select which connection to utilize.

[0015] In yet another example embodiment, an apparatus is provided that may be embodied by or otherwise utilized in conjunction with a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route. The apparatus includes means for obtaining services, applications, or data from a terrestrial networking entity prior to travel along the route. The apparatus also includes means for causing a location of the vehicle to be reported during travel along the route. The apparatus further includes means for, in response to the location of the vehicle, receiving an update to the services, applications, or data during

travel along the route, and means for providing access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

[0016] The apparatus of an example embodiment further includes means for obtaining the services, applications, or data from the terrestrial networking entity comprise means for obtaining the services, applications or data via a wireless local area network prior to travel along the route. In some embodiments, the means for receiving the update to the services, applications, or data during travel along the route includes means for receiving the update via a satellite network or mobile radio network.

[0017] In other embodiments, the means for obtaining services, applications, or data from the terrestrial networking entity includes means for causing a request for the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity. In some further embodiments, the means for obtaining services, applications, or data from the terrestrial networking entity includes means for causing a request for the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

[0018] In some still further embodiments, the means for requesting an update to the services, applications, or data during travel along the route includes means for requesting the updated based on a request by the one or more passengers of the vehicle. The apparatus of an example embodiment further includes means for providing advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route. The apparatus of any of the above described embodiments may further include means for maintaining a connection between the apparatus and a satellite network, a mobile radio network, and a wireless local area network, and providing an option to the one or more passengers of the vehicle to select which connection to utilize.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0019] Having thus described certain embodiments of the disclosure in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

[0020] FIG. 1a shows an example block diagram of a GSM-R system;

[0021] FIG. 1b shows an example block diagram of a Wi-Fi train communication system;

[0022] FIG. 1c shows an example block diagram of a nomadic network that may be specifically configured, according to an example embodiment of the present disclosure;

[0023] FIG. 2 shows an example block diagram of a terrestrial network, according to an example embodiment of the present disclosure;

[0024] FIG. 3 shows a block diagram of an apparatus that may be specifically configured in accordance with an example embodiment of the present disclosure;

[0025] FIG. 4 shows a flowchart illustrating operations performed, such as by the apparatus of FIGS. 1c and/or 2, in accordance with an example embodiment of the present disclosure;

[0026] FIG. 5 shows a flowchart illustrating operations performed, such as by the apparatus of FIGS. 1c and/or 2, in accordance with an example embodiment of the present disclosure; and

[0027] FIG. 6 shows a flowchart illustrating operations performed, such as by the apparatus of FIGS. 1c and/or 2, in accordance with an example embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[0028] Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. As used herein, the description may refer to an "apparatus." However, elements of the apparatus described herein may be equally applicable to the claimed method and computer program product. In any embodiment of the present disclosure, a "vehicle" may refer to any object used for transporting people or goods. This disclosure may refer to a train or railway system as the applicable vehicle. However, any form of transportation may equally use the apparatuses, methods, and computer products disclosed herein. Thus, use of any such terms should not be taken to limit the spirit and scope of embodiments of the present invention.

Definition of Terms

[0029] Certain terms used in connection with embodiments described herein are defined below.

[0030] As used herein, the terms "data," "content," "services," "information," and similar terms may be used interchangeably to refer to information capable of being transmitted, received, and/or stored in accordance with embodiments of the present invention. Thus, use of any such terms should not be taken to limit the spirit and scope of embodiments of the present invention. Further, where a computing device/server is described herein to receive data from another computing device/server, it will be appreciated that the data may be received directly from the another computing device, or may be received indirectly via one or more intermediary computing devices, such as, for example, one or more servers, relays, routers, network access points, base stations, hosts, and/or the like, sometimes referred to herein as a "network." Similarly, where a computing device/server is described herein to send data to another computing device/server, it will be appreciated that the data may be sent directly to the another computing device or may be sent indirectly via one or more intermediary computing devices, such as, for example, one or more servers, relays, routers, network access points, base stations, hosts, and/or the like.

[0031] As used herein, the terms "application," "mobile application," "mobile app," and "software application" refer to computer-executable application software programmed to or capable of running on a processing unit of a server, computing device mobile device, or the like. Example software applications may include word processors, email, calendars, shared workspaces, issue tracking, software development tools, enterprise wiki collaboration, project management, code hosting, service desks, status monitoring pages, internet browsers, collaborative spaces, text/voice/video chat, sign on identity, bug reporting, and the like.

[0032] As used herein, the term "user profile," "passenger profile," and "profile" refer to a collection of preferences, settings, configurations, mobile device identifiers, data, and information associated with a specific passenger or mobile device. A passenger profile refers therefore to the explicit digital representation of a passenger's identity and other data or information associated with the passenger. A passenger profile configured in accordance with the present disclosure is accessible by one or more of the software applications that are supported by the mobile device or server, and, thus, may include application-specific preferences, settings, configurations, data, and information. In some embodiments, a passenger profile can be used to

store a description of characteristics of the passenger and/or of the mobile device, as well as credentials and preferences of the passenger.

[0033] As used herein, the terms "mobile computing device" and "mobile device" (which may be used interchangeably) refer to computer hardware and/or software that is configured to access a service made available by a server and, among various other functions, is configured to communicate or otherwise request data from the server. Example mobile devices may include a smartphone, a tablet computer, a laptop computer, a wearable device, and the like. In other embodiments, a mobile device may include a "smart device" that is equipped with chip of other electronic device that is configured to communicate with the server via Bluetooth, near field communication (NFC), Wi-Fi, third generation (3G), fourth generation (4G), fifth generation (5G), radio frequency identification (RFID) protocols, and the like. In one example, a mobile device may include an object that is equipped with a Wi-Fi radio that is configured to communicate with a Wi-Fi access point that is communicably connected with a server.

[0034] As defined herein, a "computer-readable storage medium," which refers to a non-transitory physical storage medium (e.g., volatile or non-volatile memory device), can be differentiated from a "computer-readable transmission medium," which refers to an electromagnetic signal.

[0035] Additionally, as used herein, the term 'circuitry' refers to (a) hardware-only circuit implementations (e.g., implementations in analog circuitry and/or digital circuitry); (b) combinations of circuits and computer program product(s) comprising software and/or firmware instructions stored on one or more computer readable memories that work together to cause an apparatus to perform one or more functions described herein; and (c) circuits, such as, for example, a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term herein, including in any claims. As a further example, as used herein, the term 'circuitry' also includes an implementation comprising one or more processors and/or portion(s) thereof and accompanying software and/or firmware. As another example, the term 'circuitry' as used herein also includes, for example, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, other network device, and/or other computing device.

An Example System Architecture

[0036] A nomadic multi-access edge computing device, method and computer program product are provided to apply a multi-access or mobile edge computing to a moving object. However, multi-access edge computing ("MEC'), also known as mobile-edge computing, provides for content to be rapidly processed at the edge of a mobile network. As such, application developers, content providers and others can enjoy cloud-computing capabilities with ultra-low latency and high bandwidth as well as real time access to radio network information that may be leveraged by various MEC applications. MEC may be utilized by a variety of applications including video analytic applications, location service applications, Internet of Things (IoT) applications, augmented reality applications, optimized local content distribution applications and data caching applications. A nomadic MEC device, as described herein, may provide lower latency, dynamic service/application offering, and higher performance to a nomadic environment. Additionally, the utilization of a nomadic MEC device may provide a reduced need for data transmission during a vehicle's travel along a route by downloading services, applications, and/or data prior to the commencement of the vehicle's route. Further, at least certain embodiments described herein may be configured for use with the next generation of Global System for Mobile Communications – Railway ("GSM-R").

[0037] With reference to FIG. 1c, an example nomadic networking entity in the form of a nomadic network 100 is illustrated in communication with an access network 114 and terrestrial network 200. The nomadic network 100 may comprise a nomadic multi-access edge computing ("MEC") device 102, such as a MEC server as shown in FIG. 1c, one or more mobile devices 104, a local network 106, a wireless access point ("WAP") 108, and a radio terminal 112. The nomadic MEC device 102 may, in some embodiments, comprise a forwarding plane 110, one or more applications ("Appl") 120, and a multi-access edge ("ME") platform 118. The example nomadic network 100 may be disposed on and carried by a vehicle (*e.g.*, railway system, train, or the like) associated with a route such that the MEC server is nomadic.

[0038] The nomadic MEC device 102 may include circuitry, networked processors, or the like (*e.g.*, as seen in FIG. 3) configured to perform some or all of processes described herein, and may be any suitable network server and/or other type of processing device. In some embodiments, nomadic MEC device 102 may function as a "cloud" with respect to the nomadic network 100. In that sense, the nomadic MEC device 102 may include several servers

performing interconnected and/or distributed functions. To avoid unnecessarily overcomplicating the disclosure, the nomadic MEC device 102 is shown and described herein as a single server. In some embodiments, the nomadic MEC device 102 may further define one or more applications 120 and a ME platform 118 hosted and/or stored by the nomadic MEC device 102. As described below in detail, the one or more applications 120 and the ME platform 118 may correspond to services, applications, and/or data requested by one or more mobile devices 104 communicably connected with the nomadic MEC device 102. Although described herein as a "server," the present disclosure contemplates that the nomadic MEC device 102 may be broadly encompassed by any computing device.

[0039] The nomadic network 100 may be configured in some embodiments, as seen in FIG. 1c, such that the one or more mobile devices 104 disposed on the vehicle may be communicably connected with the nomadic MEC device 102 via a local network 106 and a WAP 108. The local network 106 may include one or more wired and/or wireless communication networks including, for example, a wired or wireless local area network (LAN), personal area network (PAN), metropolitan area network (MAN), wide area network (WAN), or the like, as well as any hardware, software and/or firmware for implementing the one or more networks (*e.g.*, network routers, switches, hubs, etc.). For example, the local network 106 may include a cellular telephone, mobile broadband, long term evolution (LTE), a global system for mobile communications (GSM)/enhanced data GSM environment (EDGE), a universal mobile telecommunications system (UMTS)/a high-speed packet access (HSPA), Institute of Electrical and Electronics Engineers (IEEE) 802.11, IEEE 802.16, IEEE 802.20, Wi-Fi, dial-up, and/or a world interoperability for microwave access (WiMAX) network. Furthermore, the local network 106 may include a public network, such as the Internet, a private network, such as an intranet, or combinations thereof, and may utilize a variety of networking protocols now available or later developed including, but not limited to transmission control protocol (TCP)/internet protocol (IP) based networking protocols. Although described herein as a single local network (*e.g.*, local network 106 in FIG. 1c), the present disclosure contemplates that various network beacons may be disposed on a vehicle. By way of example, a train car may have a plurality of Wi-Fi access beacons located throughout the train car to facilitate connection to a Wi-Fi network hosted by the train car.

[0040] The WAP 108 may be configured to receive wireless signals transmitted by the one or more mobile devices 104 via the local network 106 and convert the wireless signals to electrical signals for transmitting and/or processing by the nomadic MEC device 102. By way of example, a mobile device traveling in a train car may connect to a Wi-Fi network hosted by the train (*e.g.*, by the nomadic network 100) such that the mobile device may request services, applications, and/or data from an external network (*e.g.*, terrestrial network 200 and core network 214 in FIG. 2). In some embodiments (not shown), the one or more mobile devices 104 may also be directly communicably connected with an access network such as access network 114. As is discussed in detail hereinafter, a mobile device 104 may be a cellular device connected to a cellular network and may receive services, applications, and/or data directly from the cellular network as well as from the nomadic network 102. In some embodiments, the mobile device may be provided options (*e.g.*, in the form of a menu or the like). In such an embodiment, a passenger may select to either utilize the nomadic network described herein or to use a conventional access network (*e.g.*, a mobile cellular network, satellite network, or the like). Additionally, the provided options may include conditions associated with each option (*e.g.*, estimated download time, costs/charges, or the like). In some embodiments, the WAP 108 may be configured to maintain a connection between the nomadic MEC device 102 and a satellite network, a mobile radio network, and a wireless local area network, and provide an option to the one or more passengers of the vehicle to select which connection to utilize.

[0041] In some embodiments, each mobile device 104 may be associated with a passenger and/or passenger profile. Although described in reference to a single mobile device 104, the present disclosure contemplates that any number of mobile devices may be associated with various other passengers and/or passenger profiles. Additionally, the present disclosure contemplates that the nomadic MEC device 102 may be communicably connected to any number of mobile devices 104 located within or proximate the vehicle.

[0042] In some embodiments, the nomadic network 100 may utilize a radio terminal 112 for connecting the nomadic network 100 to a terrestrial network 200, via an access network 114. The radio terminal 112 may be configured to convert signals received from the nomadic MEC device 102 to appropriate signals for transmission to the access network 114. As will be discussed in detail hereinafter, the access network used by the nomadic network 100, via the radio terminal 112, may depend upon the location of the vehicle (*e.g.*, prior to travel along the

route or during travel along the route). By way of example, if the vehicle is located at a station, such as a train station, prior to travel along a route, the nomadic network 100 may utilize a WLAN, mobile radio network, or satellite network access network for connecting with the terrestrial network 200. However, if the vehicle is traveling along its route, the radio terminal 112 may utilize an alternative access network. By way of a more particular example, if a train has arrived at a stop along its associated route, the train may utilize a Wi-Fi access network to request or otherwise receive services, applications, or data via a WLAN offered by the station. However, if the train is located between stops, the train may utilize a satellite access network or mobile radio network such that the nomadic network may connect to a terrestrial network. As such, various types of access networks, such as 3GPP and non-3GPP access technologies, including an evolved UMTS, terrestrial radio access network (E-UTRAN), evolved node B (eNB), a HSPA network, a GSM/EDGE radio access network (GERAN), a wireless local area network (WLAN) or a WiMAX network, may be utilized to access the terrestrial network 200.

[0043] In some embodiments, the nomadic network 100 may, at various points in time, be in communication with one or more of a plurality of access networks associated with various stations located along the route associated with the vehicle. By way of example, the route of a railway system may include various terminals or stops along the route where passengers may enter or exit the train car. In some embodiments, each of these stations may offer various access networks 114.

[0044] In some embodiments, the nomadic MEC device 102 may include a forwarding plane 110. In such an embodiment, the forwarding plane 110 may be communicably connected with the wireless access point 108 and the radio terminal 112. The forwarding plane 110 may be configured to monitor a data flow transmitted between the wireless access point 108 and the radio terminal 112. By way of example, the forwarding plane 110 may receive data (*e.g.*, a request for services, applications, and/or data) from the one or more mobile devices 104 and may determine that the nomadic MEC device 102 cannot serve or otherwise fulfil the request. Similarly, the forwarding plane 100 may receive data requested by the nomadic network 100 from a terrestrial network (*e.g.*, terrestrial network 200 in FIG. 2), and may similarly determine that the nomadic MEC device may not serve the data, applications, and/or data.

[0045] With reference to FIG. 2, an example terrestrial networking entity in the form of a terrestrial network 200 is illustrated in communication with an access network 114 and a core

network 214. The terrestrial network 200 may comprise a terrestrial MEC device 202, such as a MEC server, an access network 114, a core network gateway 210, and a multi-access edge orchestrator ("MEO") 212. The terrestrial MEC device 202, similar to the nomadic MEC device 102 in FIG. 1c, may, in some embodiments, comprise a forwarding plane 204, one or more applications 206, and a multi-access edge ("ME") platform 208.

[0046] The terrestrial MEC device 202 may include circuitry, networked processors, or the like (*e.g.*, as seen in FIG. 3) configured to perform some or all of processes described herein, and may be any suitable network server and/or other type of processing device. In some embodiments, terrestrial MEC device 202 may function as a "cloud" with respect to the terrestrial network 200. In that sense, the terrestrial MEC device 202 may include several servers performing interconnected and/or distributed functions. To avoid unnecessarily overcomplicating the disclosure, the terrestrial MEC device 202 is shown and described herein as a single server. In some embodiments, the terrestrial MEC device 202 may further define one or more applications 206 and a ME platform 208 hosted and/or stored by the terrestrial MEC device 202. As described below in detail, the one or more applications 206 and the ME platform 208 may correspond to services, applications, and/or data requested by one or more mobile devices (*e.g.*, mobile devices 104 in FIG. 1c) communicably connected with the terrestrial MEC device 202 via the nomadic network 100.

[0047] The terrestrial network 200 may also comprise a core network gateway 210 communicably connected with the terrestrial MEC device 202, the core network 214, and the MEO 212. The core network gateway 210 may be configured to communicably connect the terrestrial network 200 with a core network 214. A core network 214 may comprise the highly functional communication facilities that interconnect primary nodes of access networks. The core network may further be configured to route or exchange data among various sub-networks. The core network 214 may be any suitable core network structure such as an evolved packet core (EPC) network, a general packet radio system (GPRS) core network, or the like. The core network gateway 210 may further be configured to receive a request for services, applications, and/or data from the terrestrial MEC device 202 and route the request to the core network 214 or the MEO 212.

[0048] The terrestrial network 200 may also comprise a MEO 212 (*e.g.*, a network management entity). The MEO 212 may be communicably connected to a core network 214 via

a core network gateway 210 and may also be communicably connected with the terrestrial MEC device 202. The MEO 212 may operate to manage and control requests for services, applications, and/or data by the terrestrial MEC device 202, and, by the connection between the nomadic network 100 and the terrestrial network 200, further manage and control requests for services, applications, and/or data by the nomadic MEC device 102 in FIG. 1c. In some embodiments, the MEO 212 may receive services, applications, and/or data from a core network 214 via the core network gateway 210, and may manage the routing and distribution of said services, applications, and/or data to the terrestrial network 200 and the nomadic network 100.

[0049] In some embodiments, the terrestrial MEC device 202 may detect a request from the nomadic network 100 in FIG. 1c and may forward the request to the MEO 212. The MEO 212 may route a response from the terrestrial network 200 to the nomadic multi-access edge computing device 102 via the terrestrial multi-access edge computing device 202. In other embodiments, the terrestrial MEC device 202 may detect a request from the nomadic network 100, and may route the request to the MEO 212 via the core network gateway 210 such that the terrestrial MEC device 202 operates to pass the request transparently therethrough.

[0050] In some embodiments, similar to the nomadic MEC device in FIG. 1c, the terrestrial MEC device 202 may include a forwarding plane 204. In such an embodiment, the forwarding plane 204 may be communicably connected with the access network 114 and the core network gateway 210. The forwarding plane 204 may be configured to monitor a data flow transmitted between the access network 114 and the core network gateway 210. By way of example, the forwarding plane 110 may receive data (*e.g.*, a request for services, applications, and/or data) from the access network 114 (*e.g.*, via a request made by the nomadic network 100 in communication with the terrestrial network 200 by the access network 114) and may determine that the terrestrial MEC device 202 cannot serve or otherwise fulfil the request.

[0051] Regardless of the type of device that embodies the nomadic MEC device 102 or terrestrial MEC device 202, the nomadic MEC device 102 and/or terrestrial MEC device 202 may include or be associated with an apparatus 300 as shown in FIG. 3. In this regard, the apparatus 300 may include or otherwise be in communication with a processor 302, a memory device 304, a communication interface 306, and/or a user interface 308. As such, in some embodiments, although devices or elements are shown as being in communication with each other, hereinafter such devices or elements should be considered to be capable of being

embodied within the same device or element and thus, devices or elements shown in communication should be understood to alternatively be portions of the same device or element.

[0052] In some embodiments, the processor 302 (and/or co-processors or any other processing circuitry assisting or otherwise associated with the processor) may be in communication with the memory device 304 via a bus for passing information among components of the apparatus. The memory device may include, for example, one or more volatile and/or non-volatile memories. In other words, for example, the memory device may be an electronic storage device (e.g., a computer readable storage medium) comprising gates configured to store data (e.g., bits) that may be retrievable by a machine (e.g., a computing device like the processor). The memory device 304 may be configured to store information, data, content, applications, instructions, or the like for enabling the apparatus 300 to carry out various functions in accordance with an example embodiment of the present invention. In this regard, the memory device 304 may store the applications 120, 206 in FIGs. 1c and 2. For example, the memory device 304 could be configured to buffer input data for processing by the processor 302. Additionally or alternatively, the memory device 304 could be configured to store instructions for execution by the processor 302.

[0053] As noted above, the apparatus 300 may be embodied by a nomadic MEC device 102 configured to be utilized in an example embodiment of the present invention. However, in some embodiments, the apparatus may be embodied as a chip or chip set. In other words, the apparatus 300 may comprise one or more physical packages (e.g., chips) including materials, components and/or wires on a structural assembly (e.g., a baseboard). The structural assembly may provide physical strength, conservation of size, and/or limitation of electrical interaction for component circuitry included thereon. The apparatus 300 may therefore, in some cases, be configured to implement an embodiment of the present invention on a single chip or as a single "system on a chip." As such, in some cases, a chip or chipset may constitute means for performing one or more operations for providing the functionalities described herein.

[0054] The processor 302 may be embodied in a number of different ways. For example, the processor 302 may be embodied as one or more of various hardware processing means such as a coprocessor, a microprocessor, a controller, a digital signal processor (DSP), a processing element with or without an accompanying DSP, or various other processing circuitry including integrated circuits such as, for example, an ASIC (application specific integrated circuit), an

FPGA (field programmable gate array), a microcontroller unit (MCU), a hardware accelerator, a special-purpose computer chip, or the like. As such, in some embodiments, the processor 302 may include one or more processing cores configured to perform independently. A multi-core processor may enable multiprocessing within a single physical package. Additionally or alternatively, the processor 302 may include one or more processors configured in tandem via the bus to enable independent execution of instructions, pipelining and/or multithreading.

[0055] In an example embodiment, the processor 302 may be configured to execute instructions stored in the memory device 304 or otherwise accessible to the processor 302. Alternatively or additionally, the processor 302 may be configured to execute hard coded functionality. As such, whether configured by hardware or software methods, or by a combination thereof, the processor 302 may represent an entity (e.g., physically embodied in circuitry) capable of performing operations according to an embodiment of the present invention while configured accordingly. Thus, for example, when the processor 302 is embodied as an ASIC, FPGA or the like, the processor 302 may be specifically configured hardware for conducting the operations described herein. Alternatively, as another example, when the processor 302 is embodied as an executor of software instructions, the instructions may specifically configure the processor 302 to perform the algorithms and/or operations described herein when the instructions are executed. However, in some cases, the processor 302 may be a processor 302 of a specific device (e.g., a nomadic MEC device, such as the ME platform 118, 208 and/or the forwarding plane 110, 204 as shown in FIGs. 1c and 2) configured to be employed by an embodiment of the present invention by further configuration of the processor 302 by instructions for performing the algorithms and/or operations described herein. The processor 302 may include, among other things, a clock, an arithmetic logic unit (ALU) and logic gates configured to support operation of the processor.

[0056] Meanwhile, the communication interface 306 may be any means such as a device or circuitry embodied in either hardware or a combination of hardware and software that is configured to receive and/or transmit data between computing devices and/or servers (*e.g.*, the nomadic MEC device 102 in FIG. 1c and the terrestrial MEC device 202 in FIG. 2 and, more particularly, the forwarding plane 110, 204). In this regard, the communication interface 306 may include, for example, an antenna (or multiple antennas) and supporting hardware and/or software for enabling communications wirelessly. Additionally or alternatively, the

communication interface may include the circuitry for interacting with the antenna(s) to cause transmission of signals via the antenna(s) or to handle receipt of signals received via the antenna(s). For example, the communication interface 306 may be configured to communicate wirelessly with the one or more mobile devices, such as via Wi-Fi, Bluetooth or other wireless communications techniques. In some instances, the communication interface may alternatively or also support wired communication. As such, for example, the communication interface 306 may include a communication modem and/or other hardware/software for supporting communication via cable, digital subscriber line (DSL), universal serial bus (USB) or other mechanisms. For example, the communication interface 306 may be configured to communicate via wired communication with other components of the computing device or sever.

[0057] In some embodiments, the apparatus 300 may optionally include a user interface 308 in communication with the processor 302, such as by the user interface circuitry, to receive an indication of a user input and/or to provide an audible, visual, mechanical, or other output to a user. As such, the user interface 308 may include, for example, a keyboard, a mouse, a joystick, a display, a touch screen display, a microphone, a speaker, and/or other input/output mechanisms. The user interface may also be in communication with the memory 304 and/or the communication interface 306, such as via a bus.

[0058] The method, apparatus 300, and computer program product of an example embodiment will now be described in conjunction with the operations illustrated in FIGS. 4-6. With reference to FIG. 4, a flowchart is provided that illustrates a method for a nomadic MEC network 400 for use with some embodiments, described herein. The method for a nomadic MEC network 400 may include obtaining services, applications, or data by a nomadic multi-access edge computing device disposed on and carried by a vehicle along a route, prior to travel along the route at Block 402. As described in more detail with reference to FIG. 3, the apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may include means, such as the processor 302, the communications interface 306 or the like, for transmitting a request for a services, applications, and/or data. By way of example, the request at Block 402 may occur when a train is located at a terminal prior to beginning a route. The nomadic MEC device 102 onboard the train may identify one or more mobile devices located proximate the train (*e.g.*, in a train car), and may determine a basic set of services, applications, and/or data associated with the one or more mobile devices for which a request is transmitted.

[0059] In some embodiments, the one or more mobile devices (*e.g.*, mobile device(s) 104 in FIG. 1c) may provide initial requests for services, applications, and/or data to the nomadic network (*e.g.*, nomadic network 100 in FIG. 1c) prior to the vehicle commencing its route such that the request at Block 402 includes the services, applications and/or data that were the subject of the initial request by the mobile device(s). In some further embodiments, the method 400 at Block 402 may consider data associated with a passenger profile. The passenger profile may be associated with a mobile device and may include biographic data (*e.g.*, gender, age, ethnicity, employment, home address, user liked and/or disliked services, or the like), destination information (*e.g.*, stops along the vehicle's route), and services and/or applications subscribed to or otherwise ordered by the passenger (*e.g.*, via their mobile device or the like). As such, the request at Block 402 may include services, applications and/or data that are determined, such as by processor 302, based upon the passenger profile and in which there is a reasonable likelihood that the passenger will utilize or otherwise have interest. In some embodiments, the nomadic network 100 may receive passenger profiles or other associated passenger data from ticket purchasing. By way of example, a passenger on a railway system may purchase a ticket with a particular destination and a request for Wi-Fi access. The request for these services, applications, and/or data may be included in the obtaining services, applications, or data by a nomadic multi-access edge computing device disposed on and carried by a vehicle along a route, prior to travel along the route at Block 402. Additionally, the present disclosure contemplates that the nomadic MEC device 102 may request all basic services, applications, and/or data at Block 402 prior to commencing its route, or may request any subset of these services, applications, and/or data.

[0060] Once the vehicle obtains services, applications, or data by a nomadic multi-access edge computing device disposed on and carried by a vehicle along a route, prior to travel along the route at Block 402, the apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may include means, such as the processor 302, the communications interface 306 or the like, for reporting a location of the vehicle during travel along the route to a terrestrial network 200 by a nomadic network 100 disposed on a vehicle at Block 404. The nomadic network 100 may receive a request for services, applications, and/or data from one or more mobile devices 104 proximate the vehicle as described above, or the nomadic MEC device 102 may determine that services, applications, and/or data are necessary for the nomadic network 100, and may report a

location of the vehicle to the radio terminal 112 for further transmission, via an access network 114, to a terrestrial network 200 at Block 404.

[0061] The apparatus 300 (*e.g.*, nomadic MEC device 102 and radio terminal 112 in FIG. 1c) may include means such as the processor 302, the communications interface 306 or the like, for determining if the vehicle is located within a coverage region defined by a station or stop along the route at Block 406. In some embodiments, the nomadic network 100, via the nomadic MEC device 102, may periodically transmit the location of the vehicle along route to the terrestrial network 200 via an access network 114. As discussed below, the access network selected by the nomadic network 100 may be determined by the location of the vehicle relative to stations along the route (*e.g.*, a proximity to a terminal or stop along the route). In some embodiments, the nomadic MEC device 102 may determine that the vehicle, and the associated nomadic network 100, is located within a coverage region defined by a station by determining the availability of access networks associated with the terrestrial network 200. By way of example, a train traveling along a route outside of a coverage region (*e.g.*, between stations) may not receive access to a Wi-Fi network (*e.g.*, access network) hosted by a station. Once the train is located within the coverage region (*e.g.*, stopped at a station), the nomadic MEC device 102 may determine that the train is located within a coverage region due to the availability of the Wi-Fi network.

[0062] If the vehicle is determined to be located within a coverage region defined by a station at Block 406, the apparatus 300 (*e.g.*, nomadic MEC device 102 and radio terminal 112 in FIG. 1c) may include means such as the processor 302, the communications interface 306 or the like, for connecting the nomadic MEC device 102 with the terrestrial network 200 via a first set of access networks at Block 408. The first set of access networks may include wireless local area networks, fixed networks, mobile/cellular radio networks, satellite networks, and the like. The present disclosure contemplates that when the vehicle is located within a coverage region defined by a station, any and all access networks may be utilized to connect the nomadic network 100 with the terrestrial network 200. By way of example, when the train is located at a terminal, the nomadic network 100 may connect with the terrestrial network 200 via a Wi-Fi network (*e.g.*, only available within the coverage region) or via a satellite network (*e.g.*, available both within and outside of the coverage region).

[0063] If the vehicle is determined to be located outside of a coverage region defined by a station at Block 406, the apparatus 300 (*e.g.*, nomadic MEC device 102 and radio terminal 112 in FIG. 1c) may include means, such as the processor 302, the communications interface 306 or the like, for connecting the nomadic MEC device 102 with the terrestrial network 200 via a second set of access networks at Block 410. The second set of access networks may include mobile/cellular radio networks, satellite networks, and the like. Although the first and second sets of access networks may include some of the same access networks, the access networks utilized when outside of a coverage region defined by a station are different in one embodiment than the access network utilized while within the coverage region of the station. The present disclosure contemplates that when the vehicle is located outside of a coverage region defined by a station, access networks which are only available to the nomadic network 100 may be utilized to connect the nomadic network 100 with the terrestrial network 200. By way of example, when the train is traveling between terminals, the nomadic network 100 may connect with the terrestrial network 200 via a satellite network or mobile/cellular radio network. The present disclosure further contemplates that the nomadic network 100 may connect with the terrestrial network 200 via any access network (*e.g.*, second set of access networks) configured to connect a nomadic computing device/server to a terrestrial network or core network.

[0064] Once the nomadic network 100 is connected with the terrestrial network 200 via an access network at Blocks 408, 410, the apparatus 300 (*e.g.*, nomadic MEC device 102 and terrestrial MEC device 202 in FIGS. 1c-2) may include means, such as the processor 302, the communications interface 306 or the like, for receiving an update to the services, applications, or data during travel along the route at Block 412. As described in more detail with reference to FIG. 6, the terrestrial network 200 may receive a request for services, applications, and/or data from the nomadic network 100 via an access network 114. The terrestrial network may determine the appropriate services, applications, and/or data required to satisfy the request of the nomadic network 100 at Block 412. By way of example, the terrestrial network 200, via the terrestrial MEC device 202 in conjunction with the MEO 212, may determine whether to activate possible service and/or application update operations at Block 412. Additionally, the determination may consider the location of the vehicle along the route, the proximity of the vehicle with a station located along the route, the size of the services, applications, and/or data

requested, the available bitrate or bandwidth offered by the terrestrial network, the velocity of the vehicle, and any potential network coverage issues (*e.g.*, tunnels, mountains, or the like).

[0065] Once the nomadic network 100, in response to the location of the vehicle, receives an update to the services, applications, or data during travel along the route at Block 412, the apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may include means, such as the processor 302, the communications interface 306 or the like, for providing access to one or more passengers of the vehicle to the services, applications, or data during travel along the route at Block 414. The nomadic network 100 communicably connected with the terrestrial network 200 may download the services, applications, and/or data transmitted by the terrestrial network 200 via the access network 114. The nomadic network 100 may, via the nomadic MEC device 102, enable an access to or route the downloaded services, applications, and/or data to the one or more mobile devices proximate the vehicle via the local network 106. In some embodiments, the nomadic MEC device 102, such as the processor 302, the communication interface 306 or the like, may be configured to maintain a connection to and between a satellite network, a mobile radio network, and a wireless local area network, and provide an option to the one or more passengers (*e.g.*, mobile devices 104) of the vehicle to select which connection to utilize.

[0066] As described above, the nomadic MEC device of an example embodiment therefore facilitates the efficient and timely provision of services, applications or data to passengers in a vehicle that moves along a route. In this regard, the nomadic MEC device is configured to communicate with networks offboard the vehicle to obtain the services, applications or data and the networks with which the nomadic MEC device communicates may change during the time span from prior to the vehicle traveling along its route, while the vehicle is traveling along its route and upon completion of the route. Additionally, the nomadic MEC device may, in some embodiments, identify the services, applications or data to be obtained based on information provided by or associated with the passenger(s), such as via passenger profile. Thus, the passenger experience may be enhanced, while the network utilization is correspondingly improved.

[0067] With reference to FIG. 5, a flowchart is provided that illustrates a communication method for receiving a basic data set 500 for use with some embodiments described herein, such as in instances prior to the vehicle's travel along the route. The apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may include means, such as the processor 302 or the like, for

determining a basic set of services, applications, and/or data dependent upon the route and/or destination of the vehicle by the nomadic MEC device 102 at Block 502. The nomadic MEC device 102, such as the processor 302, may consider various characteristics associated with the vehicle and the vehicle's associated route in order to determine services, applications, and/or data to request from the terrestrial network 200. By way of example, the determination may consider the length of the vehicle's route, the number and location of stations located along the route, the size of the services, applications, and/or data requested, the number of mobile devices communicably connected with the nomadic MEC device, the velocity of the vehicle, and any potential network coverage issues (*e.g.*, tunnels, mountains, or the like) along the route. In some embodiments, this determination and request of a basic set of services, applications, and/or data dependent upon the route and/or destination of the vehicle at Block 502 may be made without receiving a request for services, applications, or data from one or more mobile devices. By way of example, the nomadic MEC device 102 may request a basic set of services, applications, and/or data based only upon the route of the vehicle, without considering requests from one or more mobile devices.

[0068] In some embodiments, upon determining a basic set of services, applications, and/or data dependent upon the route and/or destination of the vehicle by the nomadic MEC device at Block 502, the apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may include means, such as the processor 302, the communications interface 306 or the like, for receiving a request for services, applications, and/or data from one or more mobile devices 104 located proximate the vehicle by the nomadic MEC device 102 via a local network 106 at Block 504. By way of example, one or more mobile devices 104 located proximate the vehicle (*e.g.*, passengers on the train) may request, prior to the vehicle traveling along its route, particular services, applications, and/or data to be supplied by the nomadic network 100. In addition to the basic set of services, applications, and/or data determined at Block 502, the nomadic MEC device may also receive the requests from the one or more mobile devices 104 via a local network 106 and WAP 108. By way of example, one or more mobile devices 104 may request particular services, applications, or data in addition to the basic set of services, applications, or data determined at Block 502.

[0069] Upon receiving a request for services, applications, and/or data from one or more mobile devices 104 located proximate the vehicle by the nomadic MEC device 102 via a local network 106 at Block 504, the apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may

include means, such as the processor 302, the communications interface 306 or the like, for determining by the forwarding plane if the requested services, applications, and/or data may be served by the nomadic MEC device 102 at Block 506. As discussed above with reference to FIG.1c, the forwarding plane 110 may be configured to monitor a data flow transmitted between the wireless access point 108 and the radio terminal 112. By way of example, the forwarding plane 110 may receive data (*e.g.*, a request for services, applications, and/or data) from the one or more mobile devices 104 and may determine that the nomadic MEC device 102 cannot serve or otherwise fulfil the request (*e.g.*, due to low bandwidth, memory storage concerns, or the like).

[0070] Upon determining by the forwarding plane 110 that the requested services, applications, and/or data may be served by the nomadic MEC device at Block 506, the apparatus 300 (*e.g.*, nomadic MEC device 102 in FIG. 1c) may include means, such as the processor 302, the communications interface 306 or the like, for passing the request for services, applications, and/or data through the forwarding plane 110 to the radio terminal 112 for transmission to an access network 114 in communication with the terrestrial network 200 at Block 508. As described above with reference to the architecture of the nomadic network 100, the forwarding plane 110 may operate to pass a request from the nomadic MEC device 102 to the terrestrial network 200 via an access network 114.

[0071] With reference to FIG. 6, a flowchart is provided that illustrates a communication method for routing a request through a terrestrial network 600 for use with some embodiments described herein. The apparatus 300 (*e.g.*, terrestrial MEC device 202 and access network 114 in FIG. 2) may include means, such as the processor 302, the communications interface 306 or the like, for receiving a request for services, applications, and/or data from the nomadic network 100 via the radio terminal 112 in communication with an access network 114 at Block 602. As discussed above with reference to FIG. 4, the nomadic network 100 may report its location to the terrestrial network 200 via an access network 114. The nomadic network 100 may connect with the access network 114 via a set of access networks dependent upon the access networks available to the nomadic network 100. Similarly, upon receiving a request for services, applications, and/or data from the nomadic network 100 via the radio terminal 112 in communication with an access network 114 at Block 602, the apparatus 300 (*e.g.*, terrestrial MEC device 202 in FIG. 2) may include means, such as the processor 302, the communications

interface 306 or the like, for detecting the request for services, applications, and/or data by a terrestrial MEC device 202 at Block 604.

[0072] In some embodiments, the communication method for routing a request through a terrestrial network 600 may receive the request for services, applications, and/or data at the terrestrial MEC device 202 and may route (*e.g.*, forward) the request to the MEO 212 at Block 606. In such an embodiment, the terrestrial MEC device 202 may function similar to the nomadic MEC device 102 described above, where the forwarding plane 204 may be configured to monitor a data flow transmitted between the access network 114 and the core network gateway 210. By way of example, the processor 302 and/or communication interface 306, such as may embody the forwarding plane 204, may receive data (*e.g.*, a request for services, applications, and/or data) from the access network 114, and may determine that the terrestrial MEC device 202 cannot serve or otherwise fulfil the request (*e.g.*, due to low bandwidth, memory storage concerns, or the like).

[0073] In other embodiments such as in instances in which the terrestrial network does not have a terrestrial MEC device or in which the terrestrial MEC device is configured to act transparently to allow the request to pass therethrough, the communication method for routing a request through a terrestrial network 600 may receive the request for services, applications, and/or data at the terrestrial MEC device 202 and may route (*e.g.*, forward) the request to the MEO 212 via a core network gateway 210 at Block 608. In such an embodiment, the terrestrial MEC device, such as the processor 302, the communication interface 306 or the like, may operate to route the request for services, applications, and/or data transparently through the terrestrial MEC device 202. By way of example, the terrestrial MEC device 202 may allow the received request to pass to the core network gateway 210 without modification by the terrestrial MEC device 202. Further the core network may function to fulfil the request by transmitting the requested services, applications, and/or data to the MEO 212. The MEO 212 may then operate to determine an appropriate set of services, applications, and/or data for transmitting to the nomadic network 100.

[0074] Upon routing the request for services, applications, and/or data from the terrestrial MEC device 202 at Blocks 606, 608, the apparatus 300 (*e.g.*, MEO 212 in FIG. 2) may include means such as the processor 302, the communications interface 306 or the like, for determining by the MEO 212 an appropriate set of services, applications, and/or data for transmitting to the

nomadic network 100 at Block 610. By way of example, the terrestrial network 200, via the MEO 212, may determine whether to activate possible service and/or application update operations. Additionally, the determination at the MEO 212 may consider the location of the vehicle along the route, the proximity of the vehicle to a station located along the route, the size of the services, applications, and/or data requested, the available bitrate or bandwidth offered by the terrestrial network, the velocity of the vehicle, and any potential network coverage issues (*e.g.*, tunnels, mountains, or the like).

[0075] In some embodiments, the communication method for routing a request through a terrestrial network 600 may further include means, such as the processor 302 or the like, for considering by the MEO 212 passenger profiles and data associated with the one or more mobile devices 104 located proximate the vehicle at Block 612. By way of example, the one or more mobile devices 104 communicably connected to the terrestrial network 200 via the nomadic network 100, may be associated with one or more passenger profiles. As discussed above with reference to FIG. 4, each passenger profile may be associated with a mobile device and may include biographic data (*e.g.*, gender, age, ethnicity, employment, home address, user liked and/or disliked services, or the like), destination information (*e.g.*, stop along vehicle route), and services and/or applications subscribed to or otherwise ordered by the passenger (*e.g.*, via their mobile device or the like). In some embodiments, the nomadic network 100 may receive passenger profiles or other associated passenger data from ticket purchasing. The MEO 212, such as by the processor 302, may apply a categorization or classification to a passenger profile based upon the destination of the passenger, the current location of the vehicle, the remaining duration to the destination of the passenger, ticketing information, and/or information provided by the passenger in order to determine the application, services or other data to be downloaded and provided or otherwise made available to a passenger, such as by downloading services and/or applications to which a passenger subscribes or has ordered and/or downloading services and/or applications in which the processor 302 determines the passenger may have interest based upon the passenger profile, the passenger's historical download or access patterns or the like. In some embodiments, the MEO 212, such as by the processor 302, may utilize the passenger related categorization or passenger profile data for advertising directly to current passengers, or for future advertising campaigns, thereby providing more targeted advertising based upon the passenger profile data.

[0076] In some embodiments, the MEO 212, such as by the processor 302, may identify a passenger and associated mobile device belonging to a certain category or classification or passenger profile, communicably connected with a local network hosted by the vehicle (*e.g.*, local network 106 in FIG. 1c) by identifying an access code or password given to the passenger and subsequently utilized by the passenger when connecting to the local network. In such an embodiment, the access code or password may be related or otherwise tied to a ticket purchased by the passenger. For example, the access code or password, in some embodiments, may correspond to a ticket number or code listed on the ticket.

[0077] Upon considering passenger profiles and data associated with the one or more mobile devices located proximate the vehicle, the apparatus 300 (*e.g.*, MEO 212 in FIG. 2) may include means, such as the processor 302, the communications interface 306 or the like, for the transmitting via the terrestrial MEC 202 and the access network 114 the appropriate set of services, applications, and/or data from the terrestrial network 200 to the nomadic network 100 at Block 616. The terrestrial network 200 may be communicably connected with the nomadic network 100 such that the appropriate set of services, applications, and/or data may transmitted by the terrestrial network 200 via the access network 114.

[0078] As described above, Figures 4-6 illustrate flowcharts of an apparatus 300, method, and computer program product according to example embodiments of the disclosure. It will be understood that each block of the flowcharts, and combinations of blocks in the flowcharts, may be implemented by various means, such as hardware, firmware, processor, circuitry, and/or other devices associated with execution of software including one or more computer program instructions. For example, one or more of the procedures described above may be embodied by computer program instructions. In this regard, the computer program instructions which embody the procedures described above may be stored by a memory 304 of an apparatus 300 employing an embodiment of the present invention and executed by a processor 302 of the apparatus. As will be appreciated, any such computer program instructions may be loaded onto a computer or other programmable apparatus (e.g., hardware) to produce a machine, such that the resulting computer or other programmable apparatus implements the functions specified in the flowchart blocks. These computer program instructions may also be stored in a computer-readable memory that may direct a computer or other programmable apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of

manufacture the execution of which implements the function specified in the flowchart blocks. The computer program instructions may also be loaded onto a computer or other programmable apparatus to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus provide operations for implementing the functions specified in the flowchart blocks.

[0079] Accordingly, blocks of the flowcharts support combinations of means for performing the specified functions and combinations of operations for performing the specified functions for performing the specified functions. It will also be understood that one or more blocks of the flowcharts, and combinations of blocks in the flowcharts, can be implemented by special purpose hardware-based computer systems which perform the specified functions, or combinations of special purpose hardware and computer instructions.

[0080] In some embodiments, certain ones of the operations above may be modified or further amplified. Furthermore, in some embodiments, additional optional operations may be included. Modifications, additions, or amplifications to the operations above may be performed in any order and in any combination.

[0081] Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe example embodiments in the context of certain example combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

THAT WHICH IS CLAIMED:

1. An apparatus embodied by a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route, the apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to:

obtain services, applications, or data from a terrestrial networking entity prior to travel along the route;

cause a location of the vehicle to be reported during travel along the route;

in response to the location of the vehicle, receive an update to the services, applications, or data during travel along the route; and

provide access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

2. An apparatus according to Claim 1, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to obtain the services, applications, or data from the terrestrial networking entity via a wireless local area network prior to travel along the route.

3. An apparatus according to Claims 1 or 2, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to receive the update to the services, applications, or data during travel along the route via a satellite network or mobile radio network.

4. An apparatus according to any one of Claims 1 to 3, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to obtain services, applications, or data from the terrestrial networking entity by causing a request for the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity.

5. An apparatus according to any one of Claims 1 to 3, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to obtain services, applications, or data from the terrestrial networking entity by causing a request for the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

6. An apparatus according to any one of Claims 1 to 5, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to request an update to the services, applications, or data during travel along the route based on a request by the one or more passengers of the vehicle.

7. An apparatus according to any one of Claims 1 to 6, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to provide advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route.

8. An apparatus according to any one of Claims 1 to 7, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to maintain a connection between the apparatus and a satellite network, a mobile radio network, and a wireless local area network, and provide an option to the one or more passengers of the vehicle to select which connection to utilize.

9. A method for a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route, the method comprising:

obtaining services, applications, or data from a terrestrial networking entity prior to travel along the route;

causing a location of the vehicle to be reported during travel along the route;

in response to the location of the vehicle, receiving an update to the services, applications, or data during travel along the route; and

providing access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

10. A method according to Claim 9, wherein obtaining services, applications or data comprising obtaining the services, applications, or data from the terrestrial networking entity via a wireless local area network prior to travel along the route.

11. A method according to Claims 9 or 10, wherein receiving an update comprises receiving the update to the services, applications, or data during travel along the route via a satellite network or mobile radio network.

12. A method according to any one of Claims 9 to 11, wherein obtaining the services, applications, or data from the terrestrial networking entity comprises requesting the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity.

13. A method according to any one of Claims 9 to 11, wherein obtaining the services, applications, or data from the terrestrial networking entity comprises requesting the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

14. A method according to any one of Claims 9 to 13, wherein requesting an update to the services, applications, or data during travel along the route comprises requesting an update based on a request by the one or more passengers of the vehicle.

15. A method according to any one of Claims 9 to 14, further comprising providing advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route.

16. A method according to any one of Claims 9 to 15, further comprising maintaining a connection between the nomadic multi-access computing device and a satellite network, a mobile radio network, and a wireless local area network, and providing an option to the one or more passengers of the vehicle to select which connection to utilize.

17. A computer program product embodied by a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route, the computer program product comprising at least one non-transitory computer-readable storage medium having computer-executable program code stored therein, the computer-executable program code comprising program code instructions configured to:

obtain services, applications, or data from a terrestrial networking entity prior to travel along the route;

cause a location of the vehicle to be reported during travel along the route;

in response to the location of the vehicle, receive an update to the services, applications, or data during travel along the route; and

provide access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

18. A computer program product according to Claim 17, wherein the program code instructions configured to obtain the services, applications, or data from the terrestrial networking entity comprise program code instructions configured to obtain the services, applications or data via a wireless local area network prior to travel along the route.

19. A computer program product according to Claims 17 or 18, wherein the program code instructions configured to cause the apparatus to receive the update to the services, applications, or data during travel along the route comprise the program code instructions configured to receive the update via a satellite network or mobile radio network.

20. A computer program product according to any one of Claims 17 to 19, wherein the program code instructions configured to obtain services, applications, or data from the terrestrial networking entity comprise program code instructions configured to cause a request for the

services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity.

21. A computer program product according to any one of Claims 17 to 19, wherein the program code instructions configured to obtain services, applications, or data from the terrestrial networking entity comprise program code instructions configured to cause a request for the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

22. A computer program product according to any one of Claims 17 to 21, wherein the program code instructions configured to request an update to the services, applications, or data during travel along the route comprise program code instructions configured to request the update based on a request by the one or more passengers of the vehicle.

23. A computer program product according to any one of Claims 17 to 22, wherein the computer-executable program code further comprise program code instructions configured to provide advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route.

24. A computer program product according to any one of Claims 17 to 23, wherein the computer-executable program code further comprise program code instructions configured to maintain a connection between the apparatus and a satellite network, a mobile radio network, and a wireless local area network, and provide an option to the one or more passengers of the vehicle to select which connection to utilize.

25. An apparatus embodied by a nomadic multi-access edge computing device configured to be disposed on and carried by a vehicle along a route, the apparatus comprising at least:

means for obtaining services, applications, or data from a terrestrial networking entity prior to travel along the route;

means for causing a location of the vehicle to be reported during travel along the route;

means for, in response to the location of the vehicle, receiving an update to the services, applications, or data during travel along the route; and

means for providing access to one or more passengers of the vehicle to the services, applications, or data during travel along the route.

26. An apparatus according to Claim 25, wherein the means for obtaining the services, applications, or data from the terrestrial networking entity comprise means for obtaining the services, applications or data via a wireless local area network prior to travel along the route.

27. An apparatus according to Claims 25 or 26, wherein the means for receiving the update to the services, applications, or data during travel along the route comprise means for receiving the update via a satellite network or mobile radio network.

28. An apparatus according to any one of Claims 25 to 27, wherein the means for obtaining services, applications, or data from the terrestrial networking entity comprise means for causing a request for the services, applications, or data to be transmitted by a terrestrial MEC device with an indication of an identity of the vehicle and the route to a multi-access edge orchestrator defined by the terrestrial networking entity.

29. An apparatus according to any one of Claims 25 to 27, wherein the means for obtaining services, applications, or data from the terrestrial networking entity comprise means for causing a request for the services, applications, or data to be transmitted with an indication of an identity of the vehicle and the route to a core network gateway for forwarding to a multi-access edge orchestrator defined by the terrestrial networking entity.

30. An apparatus according to any one of Claims 25 to 29, wherein the means for requesting an update to the services, applications, or data during travel along the route comprise means for requesting the update based on a request by the one or more passengers of the vehicle.

31. An apparatus according to any one of Claims 25 to 30, further comprising means for providing advertising material to the one or more passengers of the vehicle based upon passenger data or the location of the vehicle along the route.

32. An apparatus according to any one of Claims 25-31, further comprising means for maintaining a connection between the apparatus and a satellite network, a mobile radio network, and a wireless local area network, and providing an option to the one or more passengers of the vehicle to select which connection to utilize.

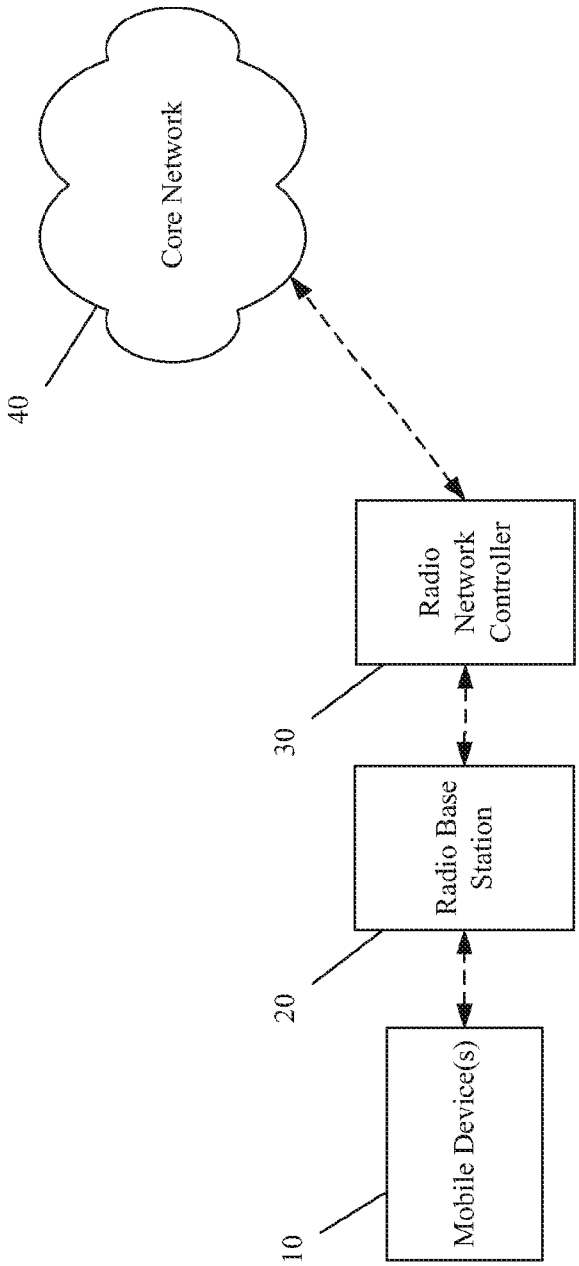


FIG. 1a
Prior Art

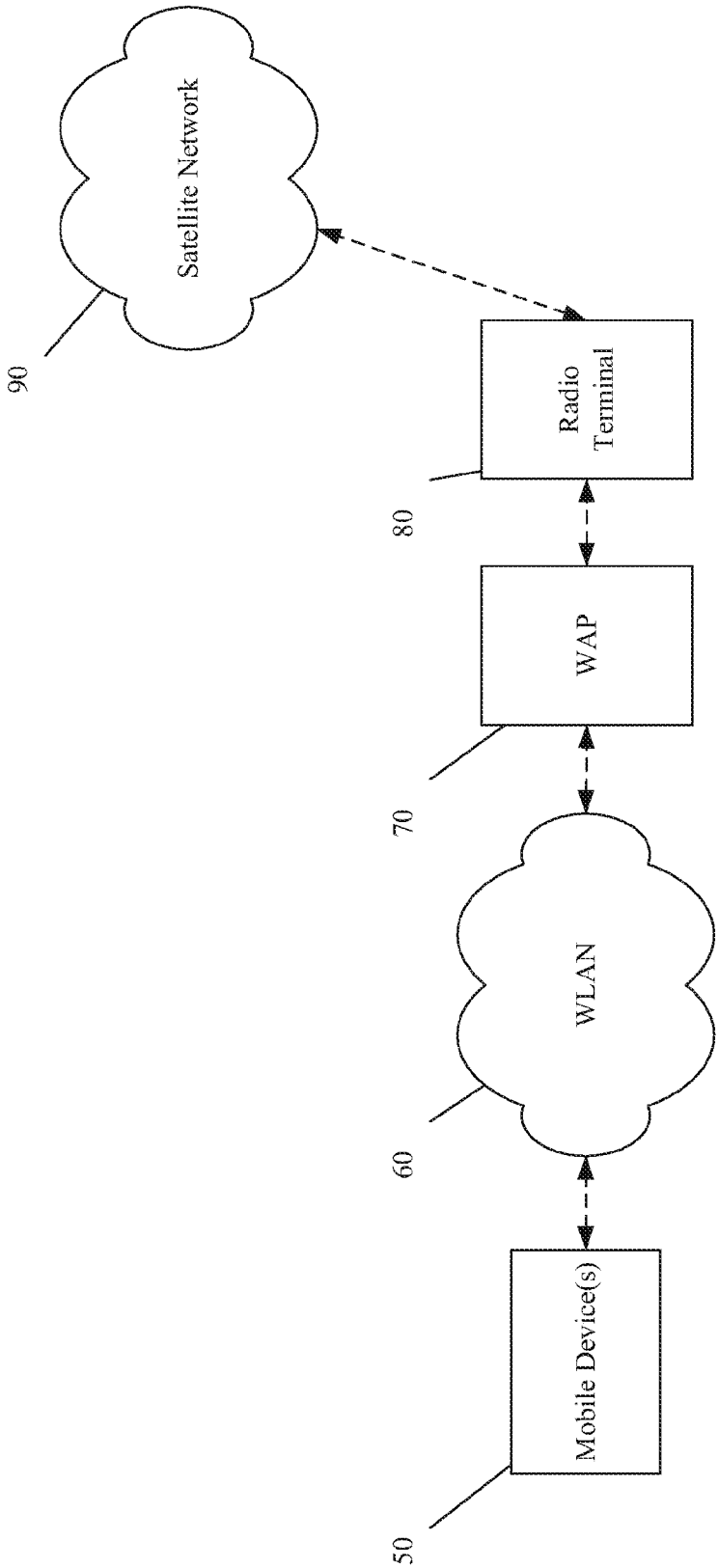


FIG. 1b
Prior Art

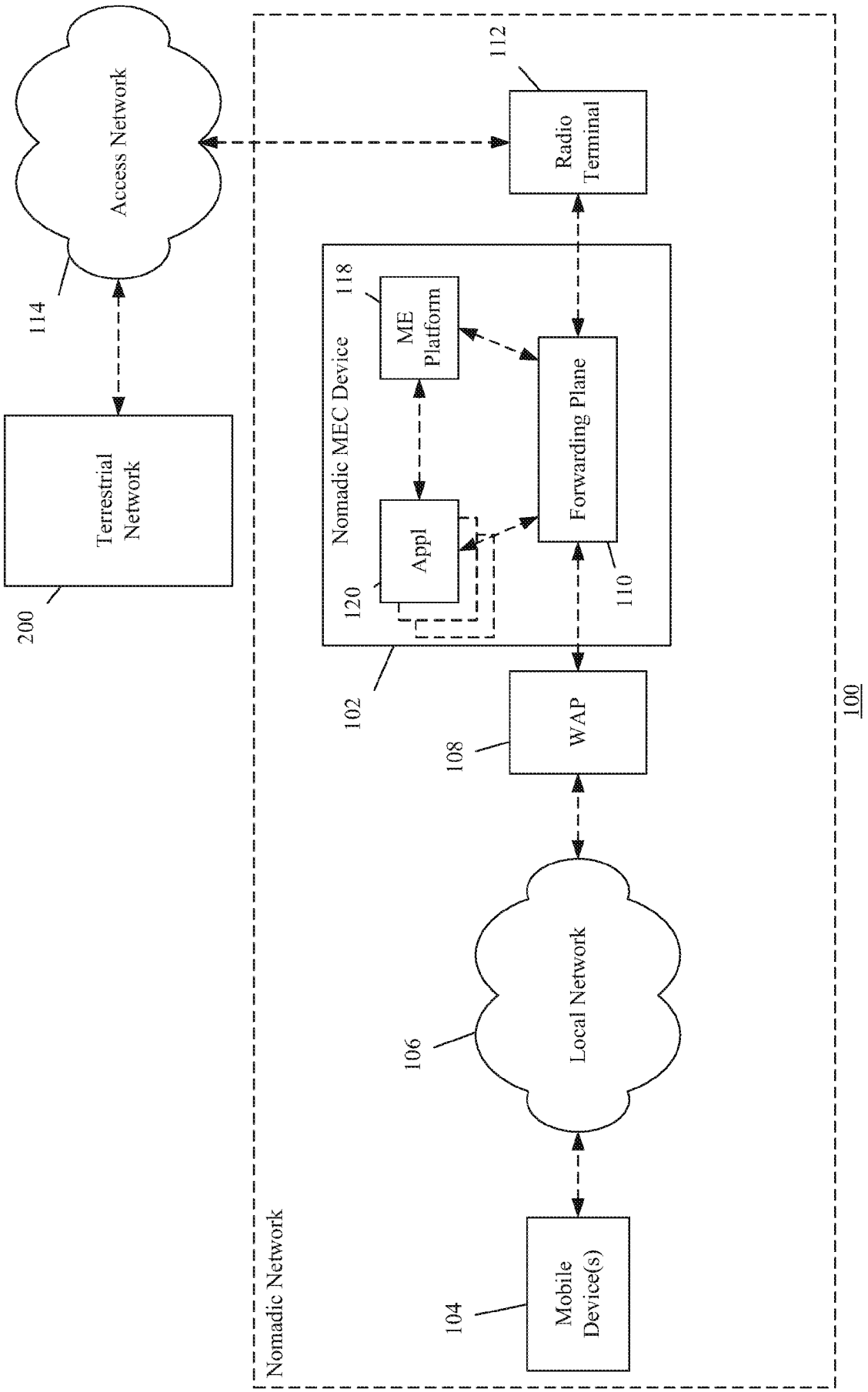

Access Network
114
Terrestrial Network
200
Nomadic Network
Radio Terminal
112
Nomadic MEC Device
118
ME Platform
Forwarding Plane
Appl
120
110
102
WAP
108
Local Network
106
Mobile Device(s)
104
100

FIG. 1c

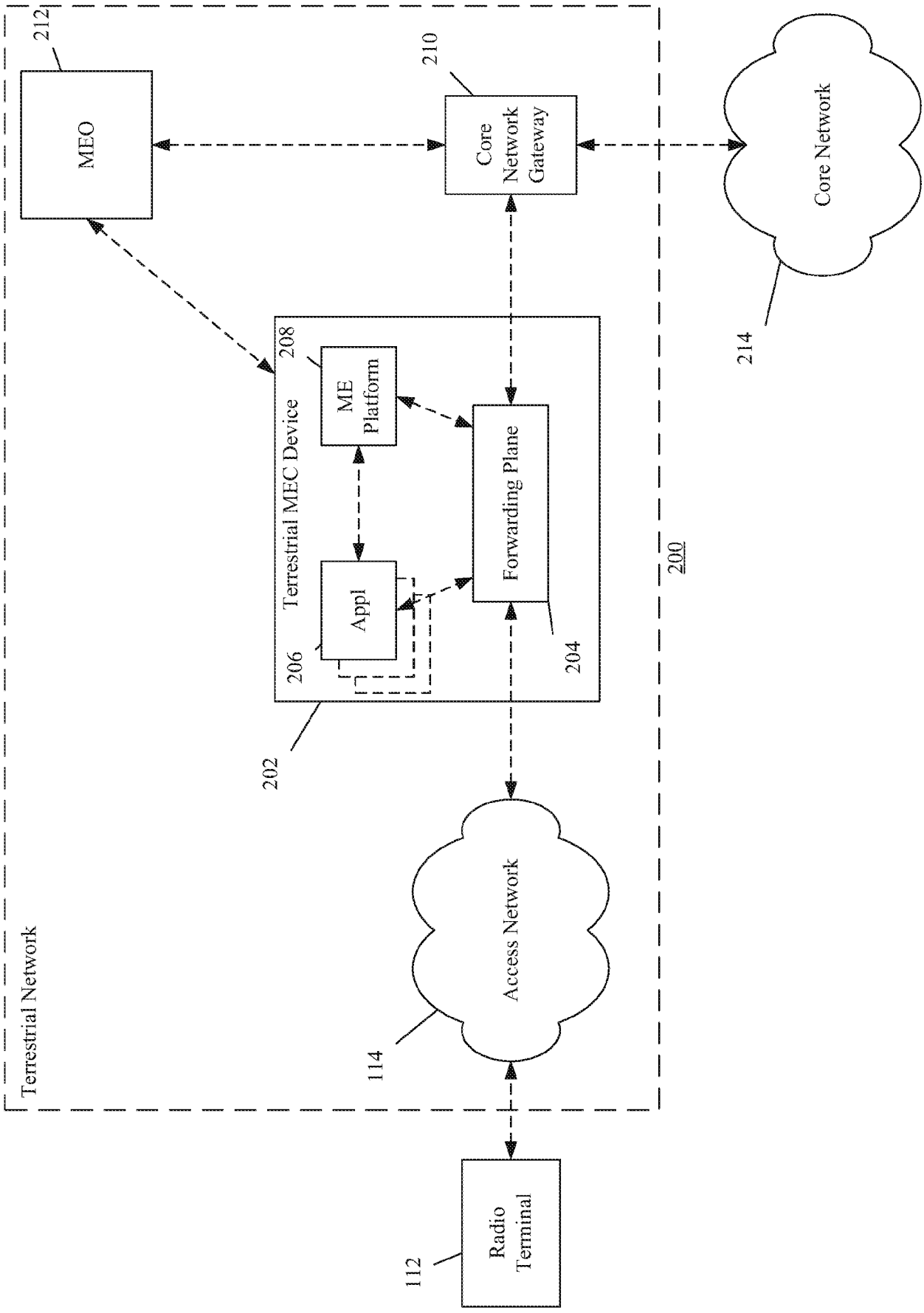

Terrestrial Network
212
MEO
210
Core Network Gateway
Core Network
214
208
ME Platform
Terrestrial MEC Device
Forwarding Plane
206
Appl
204
202
200
Access Network
114
Radio Terminal
112

FIG. 2

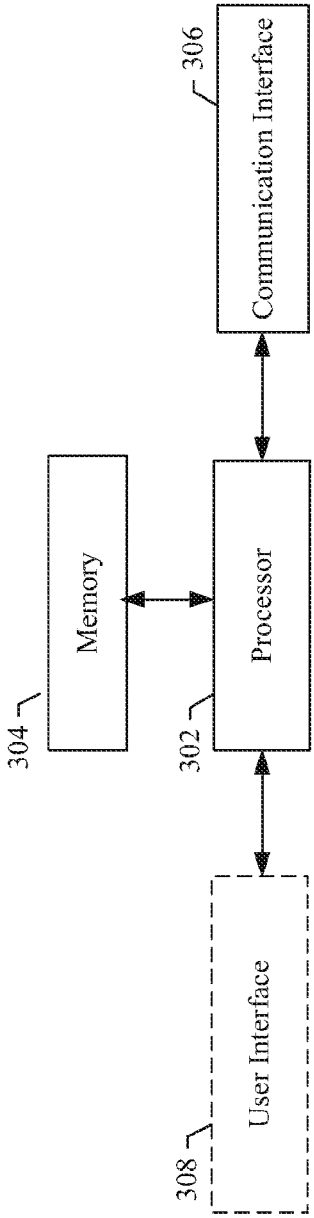

306
Communication Interface
Memory
Processor
300
304
302
User Interface
308

FIG. 3

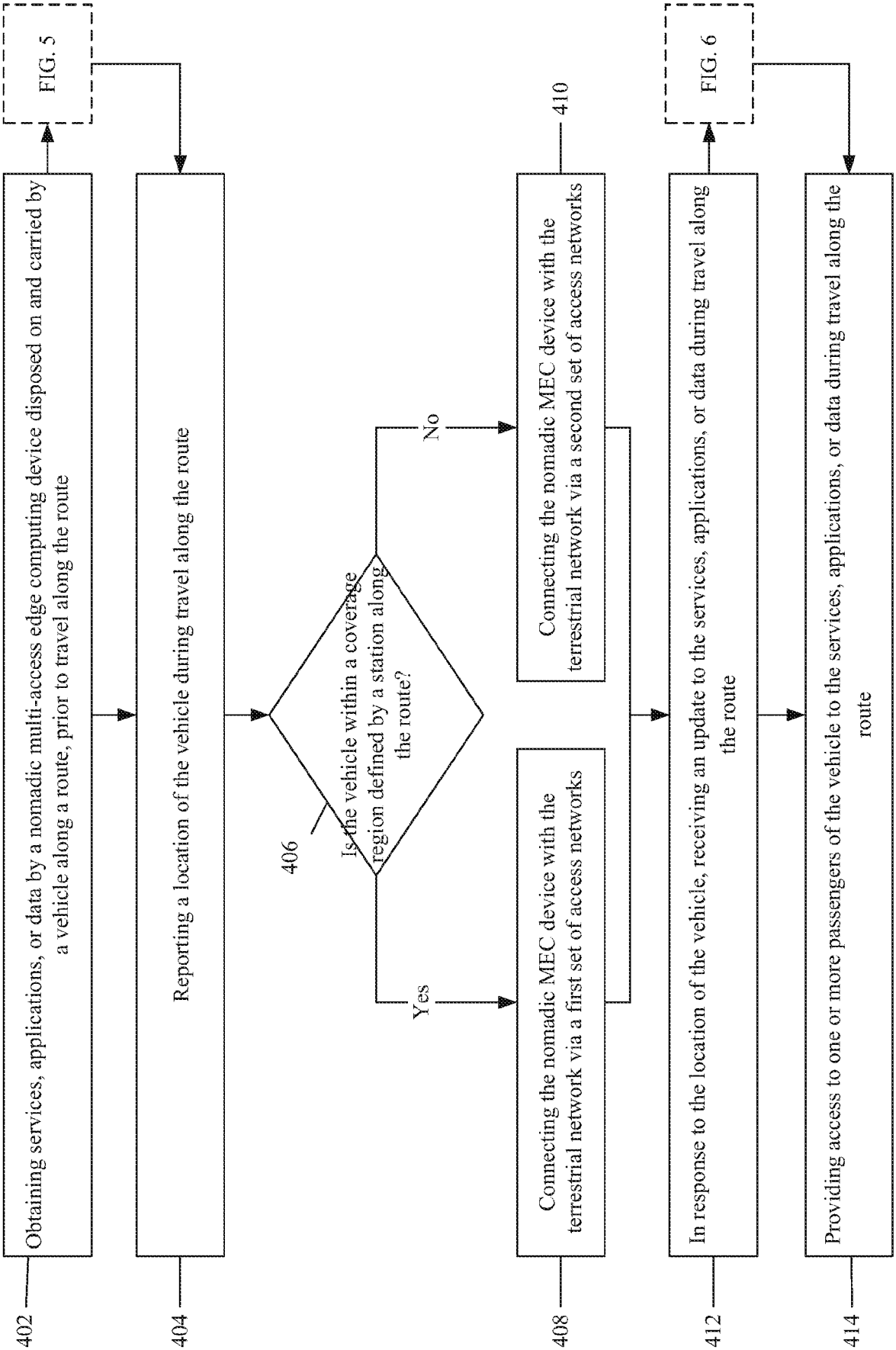

400
Obtaining services, applications, or data by a nomadic multi-access edge computing device disposed on and carried by a vehicle along a route, prior to travel along the route
FIG. 5
402
Reporting a location of the vehicle during travel along the route
404
406
Is the vehicle within a coverage region defined by a station along the route?
Yes
No
Connecting the nomadic MEC device with the terrestrial network via a first set of access networks
408
Connecting the nomadic MEC device with the terrestrial network via a second set of access networks
410
In response to the location of the vehicle, receiving an update to the services, applications, or data during travel along the route
412
FIG. 6
Providing access to one or more passengers of the vehicle to the services, applications, or data during travel along the route
414

FIG. 4

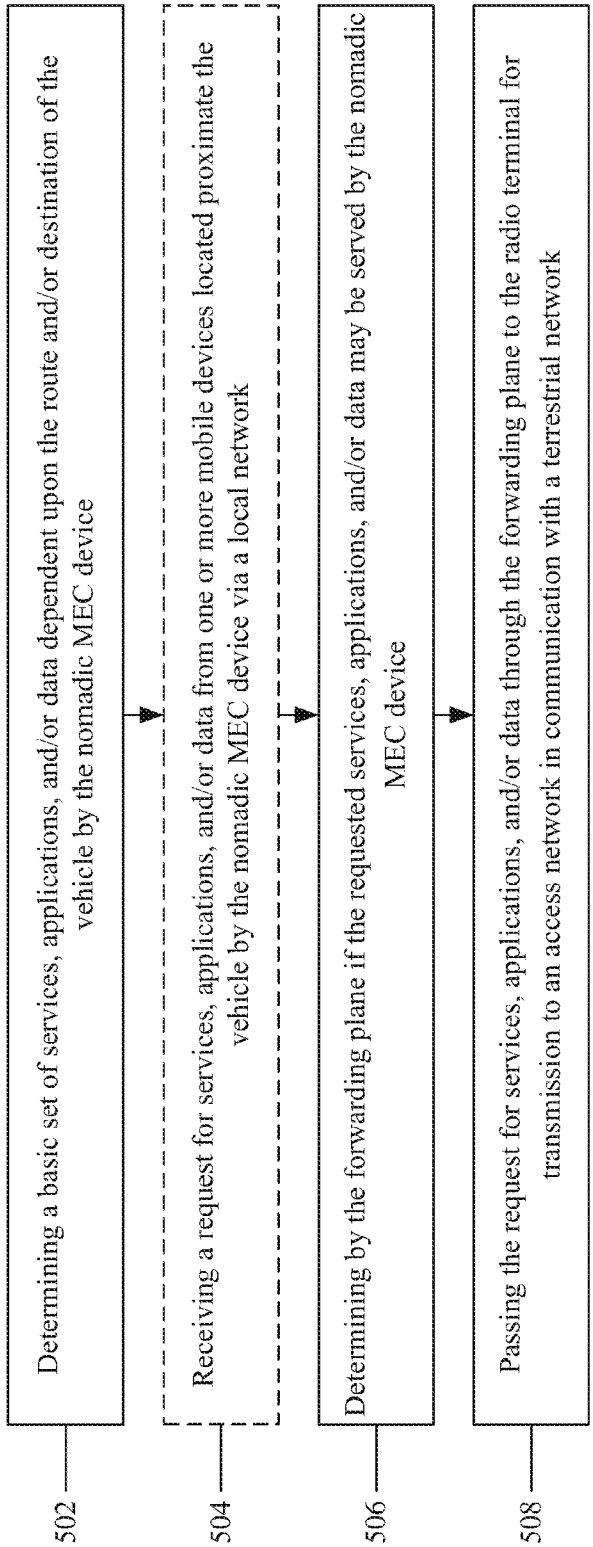

500
Determining a basic set of services, applications, and/or data dependent upon the route and/or destination of the vehicle by the nomadic MEC device
502
Receiving a request for services, applications, and/or data from one or more mobile devices located proximate the vehicle by the nomadic MEC device via a local network
504
Determining by the forwarding plane if the requested services, applications, and/or data may be served by the nomadic MEC device
506
Passing the request for services, applications, and/or data through the forwarding plane to the radio terminal for transmission to an access network in communication with a terrestrial network
508

FIG. 5

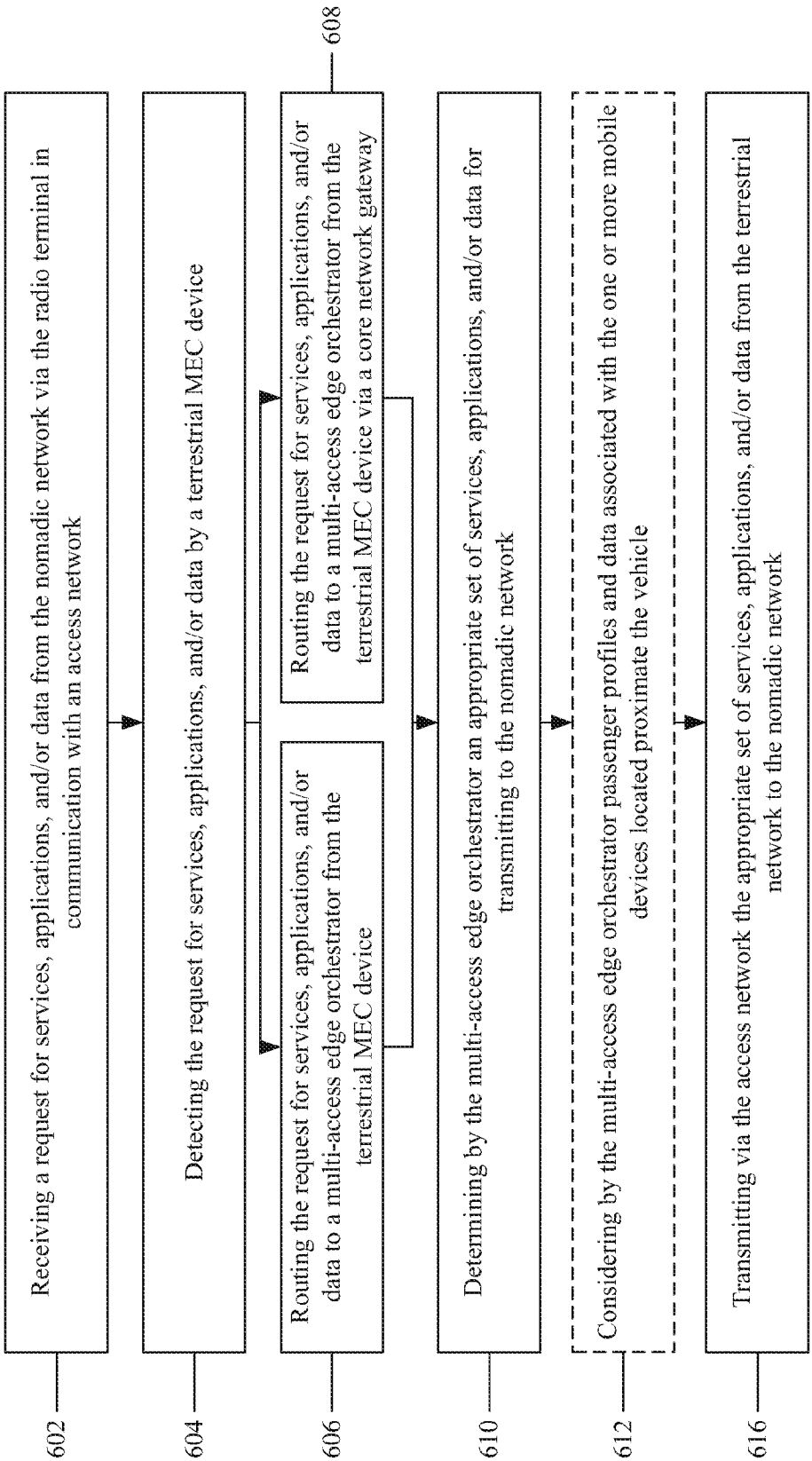

600
Receiving a request for services, applications, and/or data from the nomadic network via the radio terminal in communication with an access network
602
Detecting the request for services, applications, and/or data by a terrestrial MEC device
604
Routing the request for services, applications, and/or data to a multi-access edge orchestrator from the terrestrial MEC device
606
Routing the request for services, applications, and/or data to a multi-access edge orchestrator from the terrestrial MEC device via a core network gateway
608
Determining by the multi-access edge orchestrator an appropriate set of services, applications, and/or data for transmitting to the nomadic network
610
Considering by the multi-access edge orchestrator passenger profiles and data associated with the one or more mobile devices located proximate the vehicle
612
Transmitting via the access network the appropriate set of services, applications, and/or data from the terrestrial network to the nomadic network
616

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/052541

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04L, H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1517505 A2 (NEC CORP), 23 March 2005 (2005-03-23); abstract; paragraphs [0045], [0055], [0058], [0090]-[0094], [0105]	1-32
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A	US 20120039212 A1 (KALIYAPERUMAL GANESAN ET AL), 16 February 2012 (2012-02-16); abstract	1-32
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A	EP 1209928 A2 (NOKIA CORP), 29 May 2002 (2002-05-29); abstract	1-32
	--	
A	US 20090282469 A1 (LYNCH MICHAEL ET AL), 12 November 2009 (2009-11-12); abstract	1-32
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31-01-2018	31-01-2018

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/052541

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 20080032711 A1 (MACHT ALOIS ET AL), 7 February 2008 (2008-02-07); abstract -- --------	1-32

International application No.
PCT/IB2017/052541

Continuation of: second sheet

International Patent Classification (IPC)

H04W 84/00 (2009.01)
H04L 12/16 (2006.01)
H04L 29/06 (2006.01)
H04W 4/02 (2018.01)
H04W 24/02 (2009.01)

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				JP	4131457	B2	13/08/2008
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				US	8353006	B2	08/01/2013
WO	2009011936	A1	22/01/2009	US	20090024742	A1	22/01/2009
US	20080032711	A1	07/02/2008	DE	102006023319	A1	13/12/2007
				EP	1858182	A2	21/11/2007
				US	7844312	B2	30/11/2010