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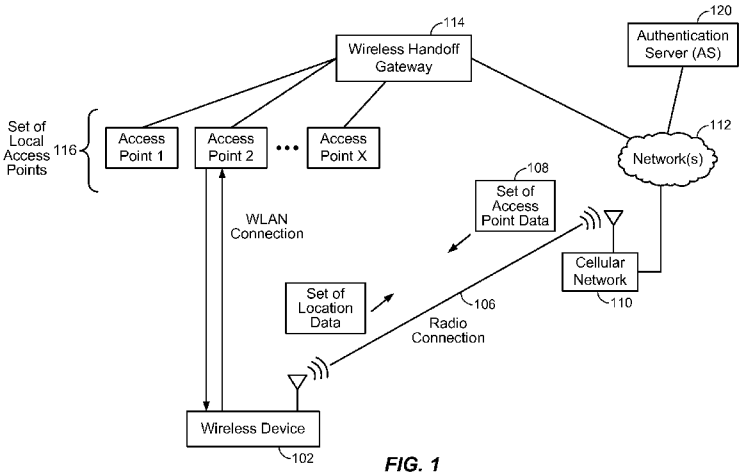

FIG. 1

(57) Abstract: Embodiments relate to systems and methods for an enhanced network handoff to wireless local area networks. A network element, referred to as a network handoff gateway (WHG), can be introduced between a wireless wide area network (WWAN) and a local wireless area network (WLAN). The WHG can maintain c links with both a set of WiFiTM or similar access points local to a wireless device, as well as a cellular network (or other WWAN) to which the device is registered. The wireless device can be tracked by the WHG using GPS or other data. The WHG can proactively acquire and pre-stage data needed to hand a data link of the wireless device off from the WWAN connection to the WiFiTM access points. The acquired data can include authentication information, IP address, or other information to facilitate a faster, more robust transition between the WWAN and WiFiTM or other WLAN connections.

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SYSTEMS AND METHODS FOR ENHANCED NETWORK HANDOFF TO WIRELESS LOCAL AREA NETWORKS

Related Application

[001] This application claims priority to U.S. Provisional Application No. 61/661,713, filed June 19, 2012, entitled "Systems and Methods for Enhanced Network Handoff to Wireless Local Area Networks," by the same inventors herein, assigned or under obligation of assignment to the same entity as this application, and which application is incorporated herein by reference in its entirety.

Field

[002] The present teachings relate to systems and methods for an enhanced network handoff to wireless local area networks. The present teachings more particularly relate to platforms and techniques for managing handoff events from a wireless device operating on a wireless wide area network to a wireless local area network through a wireless handoff gateway, where the wireless handoff gateway is configured to prepare the wireless device for fast association with wireless access points within local connection range.

Background

[003] In the field of telecommunications services, cellular carriers and other service providers have developed and deployed data networking services of steadily increasing speed and robustness. Smart phones and other devices capable of wide area network (WWAN) connections, such as cellular broadband data connections, can now routinely provide users with data rates in the range of hundreds of kilobytes per second, megabytes per second, or more. However, the consumption of relatively high-speed

data services over the cellular network fabric faces constraints to both the user and service provider. From the user's point of view, many cellular and other subscriptions impose a cap or limit on data usage over a month or other time period, and exceeding those types of caps or limits can incur an overage cost. In addition, exceeding data caps can also cause the temporary downgrading of allowed data rates, or other constraints or effects.

[004] From the perspective of the network service provider, providing a user with relatively high-speed data services can impose an increased occupancy load on the expensive licensed spectrum operated by the provider. The delivery of those data services can likewise increase the load on the core network of the service provider, reducing the total throughput available to additional voice, data, or other users.

[005] Wireless local area networks (WLANs) such as WifFi™-based networks or others can provide smart phone users, or users of other devices, with a comparatively low-cost and widely-available alternative data connection through open routers or public access points. In addition, different WiFi™ implementations can deliver data rates that are comparable or greater than those available through the cellular network. WiFi™ connections using the IEEE 802.11ac standard can, for instance, achieve data rates of approximately 500 megabits per second, using 80 MHz bandwidth and two receiving antennas. Many smart phone and other devices today incorporate the capability to use either a WWAN or WLAN type of data connection.

[006] However, generating a transition, on-the-fly, from a cellular data or other WWAN connection to a WiFi™ or other WLAN connection is presently not an easy transition to facilitate or perform. One of the notable challenges is that a significant delay can be imposed before the user can be securely moved from a WWAN connection

to a WiFi™ or similar connection, which can interrupt the user experience, such as, merely for example, causing a lag or stoppage in a video data stream.

[007] One of the factors contributing to the network-to-network handoff delay is the overhead that is needed to discover, authenticate, and transition the user from a cellular data connection to a WiFi™ connection, which in many cases must be selected from a potentially large number of WiFi™ channels. In aspects, the 5 GHz band used in current WiFi™ implementations can include over 20 possible channels to be searched. Once a selected WiFi™ channel is identified from among that collection of channels, the user next, in addition, needs to be authenticated. The authentication stage can include backhaul traffic to an authentication server and/or other authentication site or service, to ensure that the user is entitled to connect via the subject WiFi™ router or other access point. Depending on the keys, encryptions, and other techniques used, the authentication process can incur a significant processing delay, in itself. Even further, once a channel is selected and authentication is complete, the user's smart phone or other wireless device will typically require an assignment of an Internet protocol (IP) address for their WiFi™ session, a process which can impose additional processing overhead and delay.

[008] It may be desirable to provide methods and systems for an enhanced network handoff to wireless local area networks, in which a wireless handoff gateway platform can be interposed in a wireless network environment, and speed and facilitate the association of a wireless device with a WiFi™ or other network, in part by pre-loading necessary device, access point, and network data before a handoff event takes place.

DESCRIPTION OF DRAWINGS

[009] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present teachings and together with the description, serve to explain the principles of the present teachings. In the figures:

[0010] FIG. 1 illustrates an overall network environment which can be used in systems and methods for an enhanced network handoff to wireless local area networks, according to various embodiments;

[0011] FIG. 2 illustrates a diagram of network elements and a flowchart of a call flow between those elements, according to various embodiments;

[0012] FIG. 3 illustrates a flowchart of data connection handoff processing, in certain regards;

[0013] FIG. 4 illustrates a flowchart of data connection handoff processing, in certain further regards;

[0014] FIG. 5 illustrates a flowchart of data connection handoff processing, in certain additional regards; and

[0015] FIG. 6 illustrates exemplary hardware, software, and other resources that can be used in a wireless handoff gateway used in systems and methods for an enhanced network handoff to wireless local area networks, according to various embodiments.

DESCRIPTION OF EMBODIMENTS

[0016] Embodiments of the present teachings relate to systems and methods for an enhanced network handoff to wireless local area networks. More particularly,

embodiments relate to platforms and techniques which can be implemented in a wireless network environment, in which a smart phone and/or other wireless or mobile device can travel while connected to a WWAN, such as a broadband cellular network. The wireless device can establish or maintain a data link, such as packet data service, to networks such as the Internet via the WWAN, using for example the Fourth Generation (4G) LTE (Long Term Evolution) wireless network standard. In implementations, while in transit, the position or location of the wireless device can be reported to, and tracked by, a platform or element introduced into the network fabric, referred to herein as a "wireless handoff gateway." The wireless handoff gateway (or WHG) can be or include a server, node, application, and/or service established in the WWAN to communicate with the wireless device. The wireless handoff gateway can likewise, in cases, be implemented in whole or part in a cloud-based network.

[0017] The wireless handoff gateway can perform a number of tasks to facilitate and accelerate the transition from a data connection in the WWAN to a data connection to a local WLAN. One of those tasks performed by the wireless handoff gateway is to identify one or more access points to a WLAN that are within connection range of the wireless device. The access point that is detected in the WLAN can be or include a WiFi™ router or other access point, but can also or instead be other types of devices or connections for either WiFi™ or other wireless local area networks. When available. access points are detected based on the position information for the smart phone or other wireless device, the wireless handoff gateway can begin a series of operations to acquire and authenticate the data that will be necessary to transition the wireless device from a data link connected through the WWAN, to a data link connect through a selected access point in the WLAN.

[0018] Those preparatory operations can include authentication stages, channel or signaling selection, the assignment of Internet protocol (IP) address information, and/or other operations required to hand the wireless device off from the WWAN to the WLAN. In part by acquiring the necessary data and pre-staging or loading those operations or data before the actual connection is established or fully activated, the wireless handoff gateway can facilitate handoff events, reduce overhead processing and delays, and increase the perceived responsiveness of the network-to-network switching process by the user of the wireless device. In aspects, that transition can take place with little or no perceived lag or interruption, by the user or the wireless device.

[0019] Reference will now be made in detail to exemplary embodiments of the present teachings, which are illustrated in the accompanying drawings. Where possible the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0020] FIG. 1 illustrates an overall network environment 100 in which systems and methods for an enhanced network handoff to wireless local area networks can operate, according to aspects. In aspects as shown, a wireless device 102 can communicate with a cellular network 110 via a radio connection 106. In aspects, the wireless device 102 can be or include a cellular telephone, a smart phone, a portable computer, a tablet device, a media player device, a global positioning system (GPS) device, a personal digital assistant (PDA) device, a laptop computer, and/or other network-enabled, mobile and/or wireless device or platform. In aspects, the radio connection 106 can be or include one or more wireless connections or channels, such as, merely for example, a WiMax™ channel or connection, a CDMA (code division multiple access) channel or connection, TMDA (time division multiple access) channel or connection, a 3G, 4G, and/or other channel or connection using LTE (long term

evolution) industry standards, and/or channel, connection, or communications link. The cellular network 110 can be or include, for example, a set of hardware, software, radio frequency, and/or other resources or services deployed for the purposes of supporting voice communications, text communications, broadband data links, and/or other proprietary or other services over licensed spectrum or other radio frequency bands, channels, connections, or ranges.

[0021] According to aspects, the cellular network 110 can also be connected to one or more networks 112, such as the Internet and/or other public or private networks. The cellular network 110 can connect to the one or more networks 112 via optical and/or other high-speed connections, edge or core servers, and/or other transmission connections, relays, or links. The network environment 100 can likewise include a wireless handoff gateway 114, which can also be connected to the one or more networks 112 via one or more transmission links, and/or to other networks, layers, and/or channels. In aspects, it may be noted that the wireless handoff gateway 114 can likewise be connected or have access to the authentication server (AS) 120 that supports or services authentication protocols and operations for the wireless device 102, among other resources. It may be noted that in general, in implementations, the wireless handoff gateway 114 and/or other logic, platforms, elements, or services can access or interface to the authentication server 120 at any time during operation of platforms and techniques described herein, to authenticate users, devices, and/or other entities using known and/or publicly available authentication techniques, as appropriate.

[0022] It may be noted that in aspects, in cases where the wireless device 102 can not establish or maintain a data connection to or through the cellular network 110, the wireless device 102 can be configured to communicate with the wireless handoff gateway 114 using alternative channels, connections, or services, such as the short

messaging service (SMS) and/or others. For further example, extensions to the SIP (session initiation protocol) can likewise be used for signaling between the wireless device 102 and the wireless handoff gateway 114.

[0023] The wireless handoff gateway 114 can be configured and/or provisioned to perform a number of management tasks in connection with the delivery of data link services to the wireless device 102. In aspects, the wireless handoff gateway 114 can be configured to receive a set of location data 104 from the wireless device 102. In aspects, the set of location data 104 can be or include geographical or other position data, such as, the latitude and/or longitude of the wireless device 102, the speed and direction of the wireless device 102, acceleration of the wireless device 102, altitude of the wireless device 102, bearing of the wireless device 102, and/or other positional or location data or information. In aspects, additional location information can include cellular network information such as PLMN ID, base station ID, pilot PN, SID, NID, and/or other information that can be used to locate the wireless device 102 via techniques other than GPS-based techniques, such as base station mapping or signal triangulation. For instance, relative signal strengths of different base stations can also be used as a means to determine the location of the wireless device 102. In aspects, the set of location data 104 can be reported from the wireless device 102 to the wireless handoff gateway 114 using data acquired from an onboard or integrated GPS (Global Positioning System) receiver. In aspects, the set of location data 104 can, as noted, also or instead be generated or reported using other techniques, such as pilot measurements from a neighboring base station in the cellular network 110, using geographic cell identifiers in the cellular network 110, and/or other positioning platforms, techniques, and/or services, such as Doppler effect data. In aspects, the wireless device 102 can report the set of location data 104 to the wireless handoff gateway 114 via the radio link

106, cellular network 110, one or more networks 112, and/or other channels, links, or connections. The information can for instance be exchanged over a direct data connection between the wireless device 102 and the wireless handoff gateway 114 using TCP/IP (transmission control protocol/Internet protocol), and/or over http (hyper text transfer protocol).

[0024] In aspects, the reporting and updating of the set of location data 104 can also or instead be performed using a secure link from the wireless device 102 to the wireless handoff gateway 114, which can be or include a secure link over the top of the cellular service provided by the cellular network 110. For instance, the set of location data 104 can be reported to the wireless handoff gateway 114 via the cellular network 110 using an https (hyper text transfer protocol secure), and/or other layer, connection, or link. Other secure layers or links can be used, such as, for instance, a virtual private network (VPN) link, a transport layer security (TLS) link, and/or other links, channels, and/or layers.

[0025] According to aspects, the frequency with which the set of location data 104 is reported to the wireless handoff gateway 114 can be fixed, and/or can vary, and can be configured to be dependent on selected factors. For instance, the frequency with which the set of location data 104 is updated and/or reported to the wireless handoff gateway 114 can be configured to depend on the speed of movement of the wireless device 102. When speed is used as a triggering criteria, slower detected speeds can cause a lower rate of updating to be used, with higher speeds causing a higher rate of updating. Below certain speeds, the wireless device 102, wireless handoff gateway 114, and/or other hardware or resources can be configured to stop sending updates of the wireless handoff gateway 114. A stop or interruption of location reporting can for instance be imposed when the wireless device 102 is moving too fast, such as above

pedestrian speeds or other thresholds. A stop or interruption of location reporting can likewise be imposed when the wireless device 102 is determined to have stopped moving for a predetermined period of time, so that the wireless device 102 is assumed to be at rest. Other techniques, rates, and/or factors can be used to schedule the updating and/or reporting of the set of location data 104 to the wireless handoff gateway 114.

[0026] At various times, and as likewise shown in FIG. 1, while in transit, the wireless device 102 can enter the proximity of a set of local access points 116. The set of local access points 116 can be or include wireless routers, switches, hubs, and/or other hardware, receivers, nodes, and/or services capable of connecting a wireless or mobile device to a wireless local area network (WLAN), such as a WiFi™ network operation under the IEEE (Institute of Electrical and Electronics Engineers) 802.11 family or other of standards. According to aspects, the set of local access points 116 can be or include a set of WiFi™ routers with which the wireless device 102 has reached, and/or is approaching, radio connection range. According to aspects, the set of local access points 116 can initially detect and/or communicate with the wireless device 102 using a set of transmitted beacon information, and/or other signals. In aspects, any one or more devices in the set of local access points 116 can be configured to provide a data link to the one or more networks 112, allowing the set of local access points 116 to provide an alternative communication link to the one or more networks 112, instead of the cellular network 110 acting as a WWAN. The wireless handoff gateway 114 can, in aspects, be configured to initiate those types of handoff events from the cellular network 110 to the set of local access points 116, and/or other nodes or access points.

[0027] The wireless handoff gateway 114 can, more particularly, be configured to process and analyze the set of location data 104, a set of station data 118, and/or other

associated information, and identify the set of local access points 116 in proximity or vicinity of the wireless device 102 for potential data link handoff. According to aspects, the wireless handoff gateway 114 can determine the proximity of the wireless device 102 to the set of local access points 116 using, for example, database records, directories, maps, location services, and/or other sources recording the location of WiFi™ and/or other access points or nodes. Once the wireless handoff gateway 114 has identified one or more wireless routers and/or other access points located within proximity of the wireless device 102, the wireless handoff gateway 114 can access, retrieve, filter, and/or otherwise process a set of access point data 108 associated with the set of local access points 116, as well as other information, for purposes of preparing and managing a handoff event from the cellular network 110 to the set of local access points 116.

[0028] In aspects, the set of access point data 108 can be or include a set of information such as the service set identification (SSID) information for available access points in the set of local access points 116, the WiFi™ channel or channels of operation of those available access points, the media access control (MAC) address of the available access points, any key or keys used for encryption, authentication, and/or other security processing or protocols including fast authentication protocols, and/or a pre-assigned Internet protocol (IP) address for the wireless device 102, acting as a station in a WiFi™ network provided by the set of local access points 116. The set of access point data 108 can, further, also be or include information such as an identification of the services provided by any one or more access points in the set of local access points 116, any cost of access through the set of local access points 116, and/or other information that is needed to perform an association process between the wireless device 102 and one or more access points in the set of local access points 116.

[0029] According to aspects, after accessing, retrieving, and organizing the set of access point data 108, the wireless handoff gateway 114 can transmit that data to the wireless device 102 via the cellular network 110, radio connection 106, and/or other networks or channels, to prepare the wireless device 102 for association with one or more access points in the set of local access points 116.

[0030] In possession of the set of location data 104, the radio connection 106, and/or other associated information, the wireless handoff gateway 114 likewise or instead perform and/or initiate operations to stage and prepare the set of local access points 116 for contact by, and association or registration of, the wireless device 102 to the WiFi™ and/or other networks supported by the set of local access points 116. According to aspects, the wireless handoff gateway 114 can transmit a set of station data 118 to the set of local access points 116, to pre-load the set of local access points 116 with information necessary to register and associated the wireless device 102. The set of station data 118 can include information such as one or more authentication, encryption, and/or other security keys for quick identification of the wireless device 102 to each of the access points in the set of local access points 116. In aspects, the set of key information pushed to the set of local access points 116 can be or include a temporary key generated by the wireless handoff gateway 114 itself, and/or other keys or data, such as temporary or permanent keys already associated with the wireless device 102 and/or user of the device. Receipt of advance key information as part of the set of station data 118 can permit the one or more access points to which a connection is made to authenticate the wireless device 102 relatively quickly.

[0031] Besides information related to security keys, the wireless handoff gateway 114 can in addition initiate an IP address assignment procedure for the wireless device 102 at one or more of the access points in the set of local access points 116.

Again, the IP address to be assigned to the wireless device 102 can be generated and/or provided by the wireless handoff gateway 114 itself, by the wireless device 102 itself, a network service provider, and/or by other nodes, services, and/or sources. The wireless handoff gateway 114 can also inform the wireless device 102 (acting as a station, STA) whether the device can continue to use the same IP address it currently has in use, or whether it needs to request a new IP address. In addition, the wireless handoff gateway 114 may allocate the IP address for the wireless device 114 (acting as a station, STA) and send it to the wireless device 102, using the data connection setup over the cellular network 110 before the wireless device 102 has transitioned to a data connection via the set of local access points 116.

[0032] According to aspects, in general and as noted, the wireless handoff gateway 114 can receive the set of location data 104, the set of station data 118, the set of access point data 108, and/or other associated information, and use that data to conduct and/or initiate a set of operations by itself and/or in conjunction with the wireless device 102 and/or set of local access points 116 to enhance the speed, robustness, transparency, reliability, and security of a handoff event to transition the wireless device 102 from a data connection through the cellular network 110 to a data connection through the set of local access points 116. In aspects, once the wireless device 102 has received the set of access point data 108 and/or other information, the wireless device 102 can initiate a set of operations to prepare itself for connection to one or more access point in the set of local access points 116. In aspects, the wireless device 102 can for instance perform an active or passive scan on the WLAN channels identified in the set of access point data 108, to determine if any one or more of the access points identified in the set of access point data 108 is available for registration.

[0033] According to aspects, by restricting or initially restricting the channel scan to only those available access points identified by the wireless handoff gateway 114 in the set of access point data 108, the wireless device 102 can avoid performing an exhaustive search of all active channels of some or all of the access points in the set of local access points 116. It may be noted that an active/passive scan may be required if the wireless device 102 does not already have the MAC (media access control) address of the access point or points with which it wishes to communicate within the set of local access points 116.

[0034] In aspects, the wireless device 102 can also or instead be configured to directly proceed to an association request with one or more of the available access points identified in the set of access point data 108. In those cases, an active/passive scan process can be omitted. In aspects, once a target access point is identified or selected, the wireless device 102 and the one or more access points identified in the set of access point data 108 can perform a mutual authentication process. Authentication can include the verification of possession by one or both devices of a key or keys obtained or received from the wireless handoff gateway 114. In implementations, the fast authentication process performed by or between the wireless device 102 and the selected access point or points in the set of local access points 116 can be or include the Otway Rees protocol, designed for insecure network transactions, and/or the Extensible Authentication Protocol Re-Authentication (ERP) authentication protocols. In another embodiment, the keys may be distributed using PMK Key caching techniques. It will however be appreciated that other authentication algorithms, techniques, and/or protocols can be used. It may be noted that in implementations, the processing carried out by the wireless device 102 can be performed by a software application installed on

the wireless device 102, which can be installed and used without any changes required to the operating system or other software of the wireless device 102.

[0035] In addition to processing performed or initiated by the wireless device 102, conversely, the access point(s) in the set of local access points 116 can likewise perform a set of operations to prepare for the handoff of the data link of the wireless device 102 to the set of local access points 116. In aspects, when one or more access points in the set of local access points 116 receive data from the wireless handoff gateway 114 associated with the wireless device 102, the access point(s) can receive and store a set of handoff information, including the set of station data 118 for the wireless device 102 received from the wireless handoff gateway 114. The set of station data 118 for the wireless device 102 provided by the wireless handoff gateway 114 can be or include, for instance, information associated with the registration and connection of the wireless device 102 to the set of access points 106, such as the media access control (MAC) address of the wireless device 102, as well as any key information associated with the wireless device 102 that can be used for a fast authentication process between the access point(s) and the wireless device 102.

[0036] The set of station data 118 received by the access point(s) can also include an assigned Internet protocol (IP) address for the wireless device 102, if that data is likewise included in the information sent by the wireless handoff gateway 114. It will be appreciated that other information related to or associated with the wireless device 102 can be transmitted in the set of station data 118 received by the access point(s) in the set of local access points 116. That data can include additional or other data besides key data or address data, including data that is in addition to that required or permitted under the WiFi™ networking standards.

[0037] In implementations, the access point or points which receive the set of station data 118 or other information about the wireless device 102 can be configured to delete that information if the wireless device 102 does not attempt to initiate an association with the access point after a predetermined timeout period, for security and other reasons.

[0038] Overall call flow and processing operations for systems and methods for an enhanced network handoff to wireless local area networks are illustrated in FIG. 2. In 202, the wireless device 102 can communicate with the wireless handoff gateway 114, for instance via an https (hyper text transfer protocol secure) and/or other secure channel, connection, or layer, to transmit a set of location data 104 for the wireless device 102 to the wireless handoff gateway 114. In 204, the wireless handoff gateway 114 can transmit the set of access point data 108 to the wireless device 102, including access point ID, active or available channel, service set identification (SSID), and/or other information. In 206, the wireless handoff gateway 114 can transmit a set of station data 118 including authentication key, Internet protocol (IP) address information, and/or other data related to the wireless device 102 to one or more access points in the set of local access points 116.

[0039] In 208, an active/passive scan process can be carried out between the wireless device 102 and the access point(s) in the set of local access points 116, to determine which one or more of the access points in the set of local access points 116 is available to accept association of the wireless device 102. In 210, an authentication and/or association process or processes can be carried out between the wireless device 102 and the access point(s) in the set of local access points 116. As noted, the authentication process can be or include the Otway Rees protocol, the Extensible

Authentication Protocol Re-Authentication (ERP) authentication protocol, and/or other protocols, processes, services, or standards.

[0040] In 212, a set of handoff signaling operations can be performed between the wireless device 102 and the cellular network 110 and/or other wireless wide area network to which the wireless device 102 is registered and/or communication. For instance, the wireless device 102 can request that the state or context of any current data transfers, services, and/or applications be preserved, in anticipation of the handoff transaction.

[0041] In 214, a data link can be established between the wireless device 102 and an access point or points in the set of local access points 116, and the wireless device 102 can begin to transmit and/or receive data from the network or networks to which the set of local access points 116 is connected, such as the Internet or others. Processing can then repeat, return to a prior processing point, jump to a further processing point, or end.

[0042] FIG. 3 illustrates various processing operations that can be carried out in WWAN and WLAN networks, including data exchanges and processing carried out by the wireless device 102, according to implementations. In 302, processing can begin. In 304, the wireless device 102 can register to the cellular network 110 via the radio connection 106, and/or other connections, links, or channels. In 306, the wireless device 102 can respond to one or more requests from the wireless handoff gateway 114 and transmit a set of information including, for instance, a set of location data 104, a set of station data 118 including key information, IP address information, MAC information, , QoS information and/or other information or data to the wireless handoff gateway 114.. In 308, the wireless device 102 can enter the range of a set of local access points 116, such as by arriving at an airport, train station, restaurant, or other

commercial site, for instance with the wireless device 102 being carried to those or other locations, while walking, bicycling, riding in a vehicle, or otherwise transiting to within range of the set of local access points 116.

[0043] In 310, the wireless device 102 can receive a set of access point data 108 from the wireless handoff gateway 114, for instance, via the existing connection with the cellular network 110. In 312, the wireless device 102 can execute an active passive scan process with the set of local access points 116, for instance, using the set of access point data 108 received from the wireless handoff gateway 114. In 314, the wireless device 102 can execute one or more authentication and/or association routines, for instance by interacting with the wireless handoff gateway 114 and using the authentication server 120 to verify key information. In 316, the wireless device 102 can execute handoff signaling with the cellular network 110 and/or other WWAN. In aspects, handoff signaling can be or include instructions to preserve or forward the context or state of data transfers, services, applications, and/or other processes taking place on the wireless device 102. In implementations, the handoff signaling can likewise include requests to forward metering, billing, and/or other usage information from the cellular network 110, one or more networks 112, and/or other entities, networks, or services to the wireless device 102, wireless handoff gateway 114, and/or other destination

[0044] In 318, the wireless device 102 can establish a data link with an access point or points in the set of local access points 116, for instance, by way of a WiFi™ association with that device or devices. In 320, the wireless device 102, wireless handoff gateway 114, and/or other device, service, and/or logic can maintain or store the state of the wireless device 102 and any running applications, services, or transfers, and/or transfer the context for those processes to the access point(s) to which the

wireless device 102 is now connected. In 322, the data link and/or other connection from the cellular network 110 or other WWAN to the wireless device 102 can be terminated. In 324, processing can repeat, jump to a prior processing point, jump to a further processing point, or end.

[0045] FIG. 4 illustrates various processing operations that can be carried out in WWAN and WLAN networks, including data exchanges and processing carried out by the set of local access points 116 according to implementations. In 402, processing can begin. In 404, one or more access points in the set of local access points 116 can respond to a request from the wireless handoff gateway 114 and transmit a set of access point data 108 to the wireless handoff gateway 114. The set of access point data 108 can be or include, as noted, various information such as service set identification (SSID) information describing services available from the set of local access points 116, WiFi™ or other channel usage information, security key or protocol information, media address or other address information, and/or other data.

[0046] In 406, the set of local access points 116 can receive the set of station data 108 from the wireless handoff gateway 114, pre-staging some or all information that will be necessary to associated the wireless device 102 with one or more access points in the set of local access points 116. That information can include for instance an identification of that device, IP address of the wireless device 102, data context information for the wireless device 102, and/or other information. In 408, the set of local access points 116 can receive a notification and/or detect the arrival or approach of the wireless device 102 within local radio range. In 410, the set of local access points 116, in conjunction with the wireless device 102, can perform an active/passive scan of available channels in the set of local access points 116. In 412, the set of local access points 116, in conjunction with the wireless device 102, can perform one or more

authentication and/or association processes for the wireless device 102. In 414, the selected access point(s) can establish a data connection with the wireless device 102, such as by establishing an assigned WiFi™ channel for the device. In 416, processing can repeat, jump to a prior processing point, jump to a further processing point, or end.

[0047] FIG. 5 illustrates various processing operations that can be carried out in WWAN and WLAN networks, including data exchanges and processing carried out by the wireless handoff gateway 114, according to implementations. In 502, processing can begin. In 504, the wireless handoff gateway 114 can interrogate the wireless device 102 and acquire a set of location data 102, such as GPS or other data, via the cellular network 110, one or more networks 112, and/or other channels, networks, or connections. In 506, the wireless handoff gateway 114 can interrogate the set of local access points 116, and acquire a set of access point data 108, for instance, via the one or more networks 112, and/or other channels or connections. In 508, the wireless handoff gateway 114 can transmit the set of access point data 108 to the wireless device 102, for instance via the cellular network 110. In 510, the wireless handoff gateway 114 can transmit the set of station data 118 to the set of local access points 116. In 512, the wireless handoff gateway 114 can receive a notification that the wireless device 102 has associated with one or more access points in the set of local access points 116. In 514, the wireless handoff gateway 114 can acquire an updated set of location data 104 and/or other information for the wireless device 102, for instance, when the wireless device 102 has terminated its WiFi™ session with the set of local access points 116. In 516, processing can repeat, jump to a prior processing point, jump to a further processing point, or end.

[0048] FIG. 6 illustrates various hardware, software, and other resources that can be used in implementations of systems and methods for enhanced network handoff

to wireless local area networks, according to embodiments. In embodiments as shown, the wireless handoff gateway 114 can comprise a platform including processor 130 communicating with memory 132, such as electronic random access memory, operating under control of or in conjunction with an operating system 136. The processor 130 in embodiments can include or can be incorporated in one or more servers, clusters, and/or other computers or hardware resources, and/or can be implemented using cloud-based resources. The operating system 136 can be, for example, a distribution of the Linux™ operating system, the Unix™ operating system, or other open-source or proprietary operating system or platform. The processor 130 can communicate with the storage 138, such as a database stored on a local hard drive or drive array, to access or store data related to the management of handoff operations as described herein, including location information and/or association data, and/or subsets of selections thereof, along with other content, media, or other data. The processor 130 can further communicate with a network interface 134, such as an Ethernet or wireless data connection, which in turn communicates with the one or more networks 112, such as the Internet or other public or private networks. The processor 130 can, in general, be programmed or configured to execute control logic and to control various processing operations, including to generate, manage, process, and/or distribute the set of location data 104, the set of access point data 108, the set of station (STA) and/or other data related to association of the wireless device 102 with the set of local access points 116, and/or other data or information. In aspects, it may be noted that the wireless device 102, along with the individual access points in the set of local access points 116, as well as servers and/or other nodes or resources of the cellular network 110, can be or include resources similar to those of the wireless handoff gateway 114, and/or can include additional or different hardware, software, and/or other resources. Other configurations of the wireless

handoff gateway 114, the wireless device 102, the cellular network 110, the set of local access points 116, associated network connections, and other hardware, software, and service resources are possible.

[0049] The foregoing description is illustrative, and variations in configuration and implementation may occur to persons skilled in the art. For example, while embodiments have been described in which a single wireless handoff gateway 114 services one wireless device 102 and one set of local access points 116, in implementations, two or more wireless handoff gateways 114 can support the wireless device 102 and the set of local access points 116. Conversely, in implementations, one, two, or more wireless handoff gateways 114 can communicate with and support two or more wireless devices 102, and/or two or more separate sets of local access points 116. Similarly, while implementations have been described which utilize the WiFi™ standard for wireless local area network operations, in implementations, other networks which employ other wireless standards or protocols can be used in addition or instead of a WiFi™ network deployment. Other resources described as singular or integrated can in embodiments be plural or distributed, and resources described as multiple or distributed can in embodiments be combined. The scope of the present teachings is accordingly intended to be limited only by the following claims.

What is claimed is:

1. A method of managing a wireless device, comprising:

receiving a set of location information for the wireless device via a wireless wide area network interface;

identifying a set of access points within connection range of the wireless device via a wireless local area network interface using the set of location information;

transmitting a set of access point information associated with the set of access points to the wireless device via the wireless wide area network interface;

transmitting a set of station information associated with the wireless device to at least one access point in the set of access points within connection range of the wireless device; and

initiating a handoff of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point based on the set of access point information and the set of station information.

2. The method of claim 1, wherein the wireless wide area network interface comprises a cellular network interface.

3. The method of claim 2, wherein the cellular network interface is configured to connect to at least one of a third-generation (3G) network, a fourth-generation (4G) network, a code division multiple access (CDMA) network, a time division multiple access (TDMA) network, a WiMax™ network, or a long-term evolution (LTE) network.

4. The method of claim 1, wherein the wireless local area network interface comprises a WiFi™ network interface.

5. The method of claim 1, wherein the wireless device comprises at least one of a cellular telephone, a smart phone, a portable computer, a tablet device, a media player device, a global positioning system (GPS) device, or a personal digital assistant (PDA) device.

6. The method of claim 1, wherein the set of station information comprises station (STA) information associated with the wireless device.

7. The method of claim 6, wherein the station (STA) information comprises at least one of media access control (MAC) information associated with the wireless device, key information associated with the wireless device, or Internet protocol (IP) address information associated with the wireless device.

8. The method of claim 1, wherein the set of access point information comprises at least one of media access control (MAC) information associated with the at least one access point, a set of channel information associated with the at least one access point, a set of service set identification (SSID) information associated with the at least one access point, or cost information for data link access through the at least one access point.

9. The method of claim 1, further comprising transmitting a set of security key information to the wireless device and the at least one access point.

10. The method of claim 9, further comprising initiating a fast authentication process between the wireless device and the at least one access point based on the set of security key information.

11. The method of claim 1, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

12. The method of claim 1, wherein at least one of the receiving a set of location information, transmitting a set of access point information, or the transmitting a set of station information comprises initiating a transmission over a secure transmission link with the wireless device.

13. A system, comprising:

a wireless wide area network interface to a wireless device;

a wireless local area network interface to the wireless device; and

a processor, communicating with the wireless device via at least one of the wireless wide area network interface and the wireless local area network interface, the processor being configured to-

receive a set of location information for the wireless device via the wireless wide area network interface,

identify a set of access points within connection range of the wireless device via the wireless local area network interface using the set of location information,

transmit a set of access point information associated with the set of access points to the wireless device via the wireless wide area network interface,

transmit a set of station information associated with the wireless device to at least one access point in the set of access points within connection range of the wireless device, and

initiate a handoff of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point based on the set of access point information and the set of station information.

14. The system of claim 13, wherein the wireless wide area network interface comprises a cellular network interface.

15. The system of claim 14, wherein the cellular network interface connects to at least one of a third-generation (3G) network, a fourth-generation (4G) network, a code division multiple access (CDMA) network, a time division multiple access (TDMA) network, or a long-term evolution (LTE) network.

16. The system of claim 13, wherein the wireless local area network interface comprises a WiFi™ network interface.

17. The system of claim 13, wherein the wireless device comprises at least one of a cellular telephone, a smart phone, a portable computer, a tablet device, a media player device, a global positioning system (GPS) device, or a personal digital assistant (PDA) device.

18. The system of claim 13, wherein the set of station information comprises station (STA) information associated with the wireless device.

19. The system of claim 18, wherein the station (STA) information comprises at least one of media access control (MAC) information associated with the wireless device, key information associated with the wireless device, or Internet protocol (IP) address information associated with the wireless device.

20. The system of claim 13, wherein the set of access point information comprises at least one of media access control (MAC) information associated with the at least one access point, a set of channel information associated with the at least one access point, a set of service set identification (SSID) information associated with the at least one access point, or cost information for data link access through the at least one access point.

21. The system of claim 13, wherein the processor is further configured to transmit a set of security key information to the wireless device and the at least one access point.

22. The system of claim 21, wherein the processor is further configured to initiate a fast authentication process between the wireless device and the at least one access point based on the set of security key information.

23. The system of claim 13, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

24. The system of claim 13, wherein at least one of the receiving a set of location information, transmitting a set of access point information, or the transmitting a set of station information comprises initiating a transmission over a secure transmission link with the wireless device.

25. A system, comprising:

means for a wireless wide area network interface to wireless device means;

means for a wireless local area network interface to the wireless device means; and

processor means, communicating with the wireless device means via at least one of the means for a wireless wide area network interface and the means for a wireless local area network interface, the processor means being configured to-

receive a set of location information for the wireless device means via the means for a wireless wide area network interface,

identify a set of access points means within connection range of the wireless device means via the means for a wireless local area network interface using the set of location information,

transmit a set of access point information associated with the set of access point means to the wireless device means via the means for a wireless wide area network interface,

transmit a set of station information associated with the wireless device means to at least one access point means in the set of access point means within connection range of the wireless device means, and

initiate a handoff of the wireless device means from the means for a wireless wide area network interface to the means for a wireless local area network interface via the at least one access point means based on the set of access point information and the set of station information.

26. The system of claim 25, wherein the means for a wireless wide area network interface comprises means for a cellular network interface.

27. The system of claim 26, wherein the means for a cellular network interface connects to at least one of a third-generation (3G) network, a fourth-generation (4G) network, a code division multiple access (CDMA) network, a time division multiple access (TDMA) network, or a long-term evolution (LTE) network.

28. The system of claim 25, wherein the means for a wireless local area network interface comprises means for a WiFi™ network interface.

29. The system of claim 25, wherein the wireless device means comprises at least one of cellular telephone means, smart phone means, portable computer means, tablet

device means, media player device means, global positioning system (GPS) device means, or personal digital assistant (PDA) device means.

30. The system of claim 25, wherein the set of station information comprises station (STA) information associated with the wireless device.

31. The system of claim 30, wherein the station (STA) information comprises at least one of media access control (MAC) information associated with the wireless device means, key information associated with the wireless device means, or Internet protocol (IP) address information associated with the wireless device means.

32. The system of claim 25, wherein the set of access point information comprises at least one of media access control (MAC) information associated with the at least one access point means, a set of channel information associated with the at least one access point means, a set of service set identification (SSID) information associated with the at least one access point means, or cost information for data link access through the at least one access point means.

33. The system of claim 25, wherein the processor means is further configured to transmit a set of security key information to the wireless device means and the at least one access point means.

34. The system of claim 33, wherein the processor means is further configured to initiate a fast authentication process between the wireless device means and the at least one access point means based on the set of security key information.

35. The system of claim 25, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

36. The system of claim 25, wherein at least one of the receiving a set of location information, transmitting a set of access point information, or the transmitting a set of station information comprises initiating a transmission over a secure transmission link with the wireless device.

37. A computer program product, comprising:

computer-readable medium comprising:

at least one instruction for causing a computer to receive a set of location information for the wireless device via a wireless wide area network interface,

at least one instruction for causing a computer to identify a set of access points within connection range of the wireless device via a wireless local area network interface using the location information,

at least one instruction for causing a computer to transmit a set of access point information associated with the set of access points to the wireless device via the wireless wide area network interface,

at least one instruction for causing a computer to transmit a set of station information associated with the wireless device to at least one access point in the set of access points within connection range of the wireless device, and

at least one instruction for causing a computer to initiate a handoff of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point based on the set of access point information and the set of station information.

38. The computer program product of claim 37, wherein the wireless wide area network interface comprises a cellular network interface.

39. The computer program product of claim 38, wherein the cellular network interface is configured to connect to at least one of a third-generation (3G) network, a fourth-generation (4G) network, a code division multiple access (CDMA) network, a time division multiple access (TDMA) network, or a long-term evolution (LTE) network.

40. The computer program product of claim 37, wherein the wireless local area network interface comprises a WiFi™ network interface.

41. The computer program product of claim 37, wherein the wireless device comprises at least one of a cellular telephone, a smart phone, a portable computer, a tablet device, a media player device, a global positioning system (GPS) device, or a personal digital assistant (PDA) device.

42. The computer program product of claim 37, wherein the set of station information comprises station (STA) information associated with the wireless device.

43. The computer program product of claim 42, wherein the station (STA) information comprises at least one of media access control (MAC) information associated with the wireless device, key information associated with the wireless device, or Internet protocol (IP) address information associated with the wireless device.

44. The computer program product of claim 37, wherein the set of access point information comprises at least one of media access control (MAC) information associated with the at least one access point, a set of channel information associated with the at least one access point, a set of service set identification (SSID) information associated with the at least one access point, or cost information for data link access through the at least one access point.

45. The computer program product of claim 37, wherein the computer readable medium further comprises at least one instruction for causing a computer to transmit a set of security key information to the wireless device and the at least one access point.

46. The computer program product of claim 45, wherein the computer readable media comprises at least one instruction for causing a computer to initiate a fast authentication process between the wireless device and the at least one access point based on the set of security key information.

47. The computer program product of claim 37, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

48. The computer program product of claim 37, wherein at least one of the receiving a set of location information, transmitting a set of access point information, or the transmitting a set of station information comprises initiating a transmission over a secure transmission link with the wireless device.

49. A method of configuring data connections on a wireless device, comprising:

transmitting a set of location information for the wireless device via a wireless wide area network interface to a wireless handoff gateway;

receiving, in the wireless device from the wireless handoff gateway, a set of access point information associated with a set of access points within connection range of the wireless device via a wireless local area network;

transmitting a set of station information associated with the wireless device to the wireless handoff gateway;

identifying at least one access point in the set of access points to establish a data connection for the wireless device via the wireless local area network; and

transitioning the data connection of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point in the set of access points.

50. The method of claim 49, wherein the transmitting the set of location information comprises at least one of transmitting the set of location information at predetermined intervals, or transmitting the set of location information on an event-triggered basis.

51. The method of claim 49, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

52. The method of claim 49, wherein the transitioning the data connection comprises performing an authentication process with the at least one access point based on the set of access point information and the set of station information.

53. The method of claim 49, wherein the authentication process comprises a fast authentication process.

54. The method of claim 53, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

55. The method of claim 49, wherein the transitioning the data connection comprises performing an association process with the at least one access point.

56. The method of claim 55, wherein the association process comprises an active/passive scan process.

57. A wireless device, comprising:

a first interface to a wireless wide area network;

a second interface to a wireless local area network; and

a processor, communicating with the first interface and the second interface, the processor being configured to-

transmit a set of location information for the wireless device via a wireless wide area network interface to a wireless handoff gateway,

receive, in the wireless device from the wireless handoff gateway, a set of access point information associated with a set of access points within connection range of the wireless device via the wireless local area network,

transmit a set of station information associated with the wireless device to the wireless handoff gateway,

identify at least one access point in the set of access points to establish a data connection for the wireless device via the wireless local area network, and

transition the data connection of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point in the set of access points.

58. The system of claim 57, wherein the transmitting the set of location information comprises at least one of transmitting the set of location information at predetermined intervals, or transmitting the set of location information on an event-triggered basis.

59. The system of claim 57, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

60. The system of claim 57, wherein the transitioning the data connection comprises performing an authentication process with the at least one access point based on the set of access point information and the set of station information.

61. The system of claim 57, wherein the authentication process comprises a fast authentication process.

62. The system of claim 61, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

63. The system of claim 57, wherein the transitioning the data connection comprises performing an association process with the at least one access point.

64. The system of claim 63, wherein the association process comprises an active/passive scan process.

65. A wireless device, comprising:

first interface means to a wireless wide area network;

second interface means to a wireless local area network; and

processor means, communicating with the first interface means and the second interface means, the processor means being configured to-

transmit a set of location information for the wireless device via a wireless wide area network interface to a wireless handoff gateway,

receive, in the wireless device from the wireless handoff gateway, a set of access point information associated with a set of access points within connection range of the wireless device via the wireless local area network,

transmit a set of station information associated with the wireless device to the wireless handoff gateway,

identify at least one access point in the set of access points to establish a data connection for the wireless device via the wireless local area network, and

transition the data connection of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point in the set of access points.

66. The system of claim 65, wherein the transmitting the set of location information comprises at least one of transmitting the set of location information at predetermined intervals, or transmitting the set of location information on an event-triggered basis.

67. The system of claim 65, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

68. The system of claim 65, wherein the transitioning the data connection comprises performing an authentication process with the at least one access point based on the set of access point information and the set of station information.

69. The system of claim 65, wherein the authentication process comprises a fast authentication process.

70. The system of claim 69, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

71. The system of claim 65, wherein the transitioning the data connection comprises performing an association process with the at least one access point.

72. The system of claim 71, wherein the association process comprises an active/passive scan process.

73. A computer program product, comprising:

computer-readable medium comprising:

at least one instruction for causing a computer to transmit a set of location information for a wireless device via a wireless wide area network interface to a wireless handoff gateway;

at least one instruction for causing a computer to receive, in the wireless device from the wireless handoff gateway, a set of access point information associated with a set of access points within connection range of the wireless device via a wireless local area network;

at least one instruction for causing a computer to transmit a set of station information associated with the wireless device to the wireless handoff gateway;

at least one instruction for causing a computer to identify at least one access point in the set of access points to establish a data connection for the wireless device via the wireless local area network; and

at least one instruction for causing a computer to transition the data connection of the wireless device from the wireless wide area network interface to the wireless local area network interface via the at least one access point in the set of access points.

74. The computer program product of claim 73, wherein the transmitting the set of location information comprises at least one of transmitting the set of location information at predetermined intervals, or transmitting the set of location information on an event-triggered basis.

75. The computer program product of claim 73, wherein the set of location information comprises at least one of location information captured via global position system (GPS) data, base station pilot data, geographic cell identifier data, cellular network data, Doppler effect data, or signal strength data.

76. The computer program product of claim 73, wherein the at least one instruction for causing a computer to transition the data connection comprises at least one instruction for causing a computer to perform an authentication process with the at least one access point based on the set of access point information and the set of station information.

77. The computer program product of claim 73, wherein the authentication process comprises a fast authentication process.

78. The computer program product of claim 77, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

79. The computer program product of claim 73, wherein the at least one instruction for causing a computer to transition the data connection comprises at least one instruction for causing a computer to perform an association process with the at least one access point.

80. The computer program product of claim 79, wherein the association process comprises an active/passive scan process.

81. A method of associating a wireless device with an access point, comprising:

transmitting, from the access point to a wireless handoff gateway, a set of access point information;

receiving, from the wireless handoff gateway, a set of location information for the wireless device via a wireless wide area network interface;

transmitting a set of access point information associated with the access point to the wireless handoff gateway;

receiving, via the wireless handoff gateway, a set of station information associated with the wireless device in the access point; and

establishing, with the access point, a data connection with the wireless device via the wireless local area network based on the set of access point information and the set of station information.

82. The method of claim 80, further comprising receiving a set of location information for the wireless device via the wireless handoff gateway.

83. The method of claim 80, wherein the receiving the set of station information comprises receiving the set of station information when the wireless device is approaching or within range of the access point, based on the set of location information.

84. The method of claim 80, wherein the establishing a data connection comprises performing an authentication process with the access point based on the set of station information.

85. The method of claim 83, wherein the authentication process comprises a fast authentication process.

86. The method of claim 84, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

87. The method of claim 80, wherein the establishing the data connection comprises performing an association process with the at least one access point.

88. The method of claim 86, wherein the association process comprises an active/passive scan process.

89. The method of claim 80, wherein the data connection comprises a connection to the Internet.

90. An access point device, comprising:

a first interface to a wireless wide area network;

a second interface to a wireless local area network; and

a processor, communicating with the first interface and the second interface, the processor being configured to-

transmit, from the access point to a wireless handoff gateway, a set of access point information,

receive, from the wireless handoff gateway, a set of location information for the wireless device via the first interface,

transmit a set of access point information associated with the access point to the wireless handoff gateway,

receive, via the wireless handoff gateway, a set of station information associated with the wireless device, and

establish a data connection with the wireless device via the wireless local area network based on the set of access point information and the set of station information.

91. The device of claim 88, wherein the processor is further configured to receive a set of location information for the wireless device via the wireless handoff gateway.

92. The device of claim 89, wherein the receiving the set of station information comprises receiving the set of station information when the wireless device is approaching or within range of the access point, based on the set of location information.

93. The device of claim 88, wherein the establishing a data connection comprises performing an authentication process with the access point based on the set of station information.

94. The device of claim 91, wherein the authentication process comprises a fast authentication process.

95. The device of claim 92, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

96. The device of claim 88, wherein the establishing the data connection comprises performing an association process with the at least one access point.

97. The device of claim 94, wherein the association process comprises an active/passive scan process.

98. The device of claim 88, wherein the data connection comprises a connection to the Internet.

99. An access point device, comprising:

first interface means to a wireless wide area network;

second interface means to a wireless local area network; and

processor means, communicating with the first interface means and the second interface means, the processor means being configured to-

transmit, from the access point to a wireless handoff gateway, a set of access point information,

receive, from the wireless handoff gateway, a set of location information for the wireless device via the first interface,

transmit a set of access point information associated with the access point to the wireless handoff gateway,

receive, via the wireless handoff gateway, a set of station information associated with the wireless device, and

establish a data connection with the wireless device via the wireless local area network based on the set of access point information and the set of station information.

100. The device of claim 88, wherein the processor is further configured to receive a set of location information for the wireless device via the wireless handoff gateway.

101. The device of claim 89, wherein the receiving the set of station information comprises receiving the set of station information when the wireless device is

approaching or within range of the access point, based on the set of location information.

102. The device of claim 88, wherein the establishing a data connection comprises performing an authentication process with the access point based on the set of station information.

103. The device of claim 91, wherein the authentication process comprises a fast authentication process.

104. The device of claim 92, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

105. The device of claim 88, wherein the establishing the data connection comprises performing an association process with the at least one access point.

106. The device of claim 94, wherein the association process comprises an active/passive scan process.

107. The device of claim 88, wherein the data connection comprises a connection to the Internet.

108. A computer program product, comprising:

computer-readable medium comprising:

at least one instruction for causing a computer to transmit, from the access point to a wireless handoff gateway, a set of access point information;

at least one instruction for causing a computer to receive, from the wireless handoff gateway, a set of location information for the wireless device via a wireless wide area network interface;

at least one instruction for causing a computer to transmit a set of access point information associated with the access point to the wireless handoff gateway;

at least one instruction for causing a computer to receive, via the wireless handoff gateway, a set of station information associated with the wireless device in the access point; and

at least one instruction for causing a computer to establish, with the access point, a data connection with the wireless device via the wireless local area network based on the set of access point information and the set of station information.

109. The computer program product of claim 107, further comprising at least one instruction for causing a computer to receive a set of location information for the wireless device via the wireless handoff gateway.

110. The computer program product of claim 108, wherein the receiving the set of station information comprises receiving the set of station information when the wireless device is approaching or within range of the access point, based on the set of location information.

111. The computer program product of claim 107, wherein the establishing a data connection comprises performing an authentication process with the access point based on the set of station information.

112. The computer program product of claim 110, wherein the authentication process comprises a fast authentication process.

113. The computer program product of claim 111, wherein the fast authentication process comprises at least one of an Otway Rees protocol, or an Extensible Authentication Protocol Re-Authentication (ERP) protocol.

114. The computer program product of claim 107, wherein the establishing the data connection comprises performing an association process with the at least one access point.

115. The computer program product of claim 113, wherein the association process comprises an active/passive scan process.

116. The computer program product of claim 107, wherein the data connection comprises a connection to the Internet.

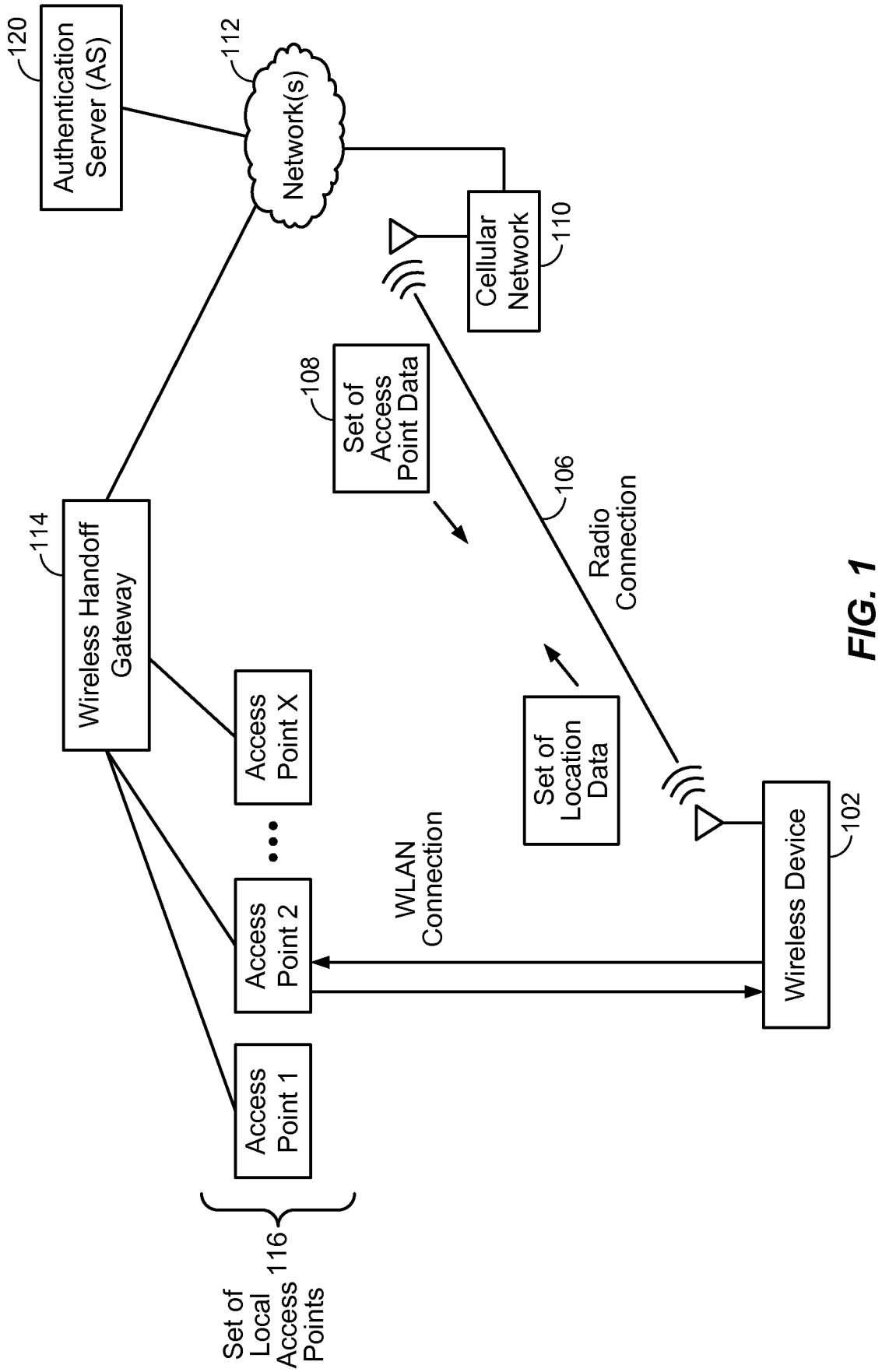
120
Authentication Server (AS)
112
Network(s)
Cellular Network
110
108
Set of Access Point Data
106
Radio Connection
114
Wireless Handoff Gateway
Access Point X
Set of Location Data
WLAN Connection
Access Point 2
Wireless Device
102
Access Point 1
116
Set of Local Access Points

FIG. 1

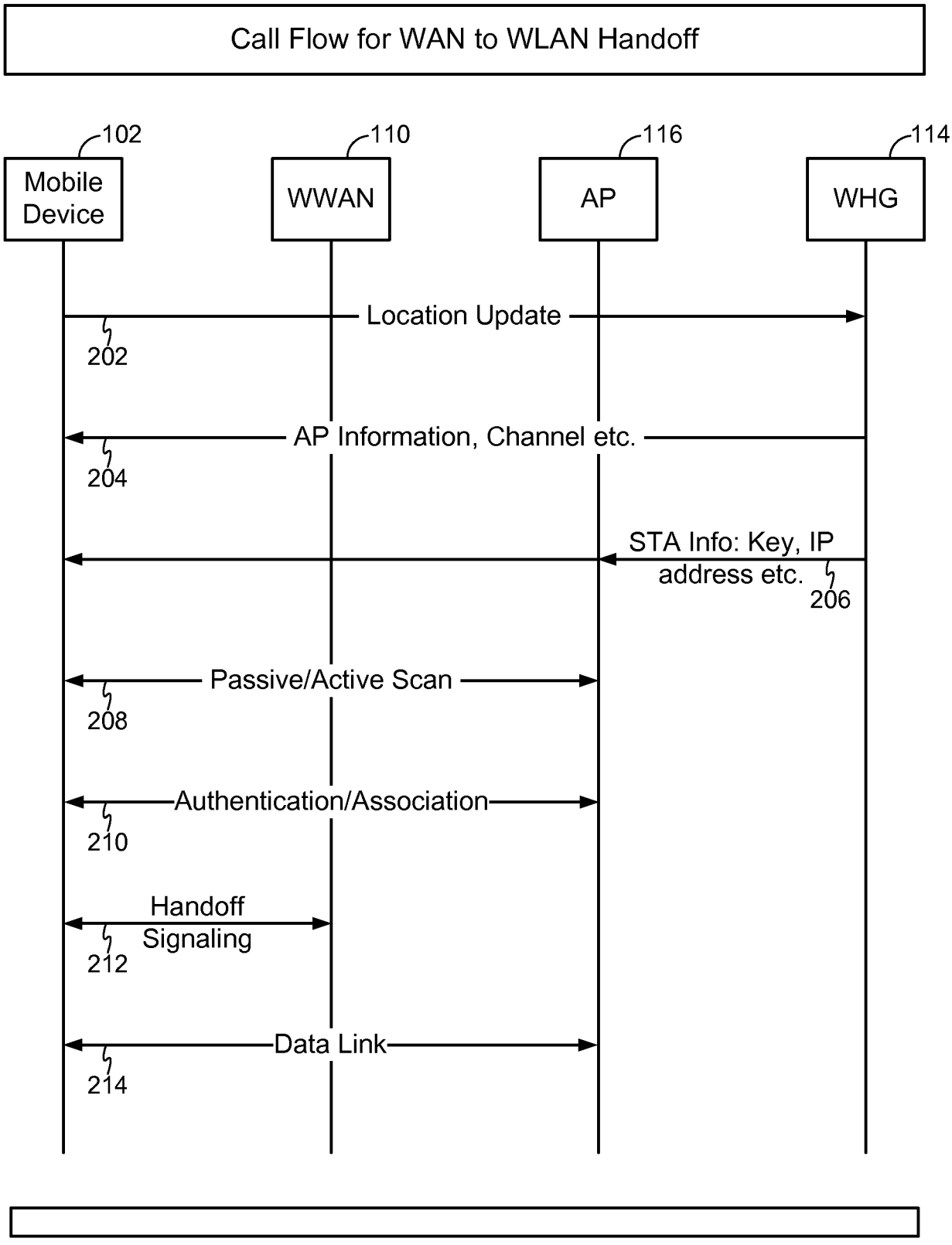
Call Flow for WAN to WLAN Handoff
102
Mobile Device
110
WWAN
116
AP
114
WHG
Location Update
202
AP Information, Channel etc.
204
STA Info: Key, IP address etc.
206
Passive/Active Scan
208
Authentication/Association
210
Handoff Signaling
212
Data Link
214

FIG. 2

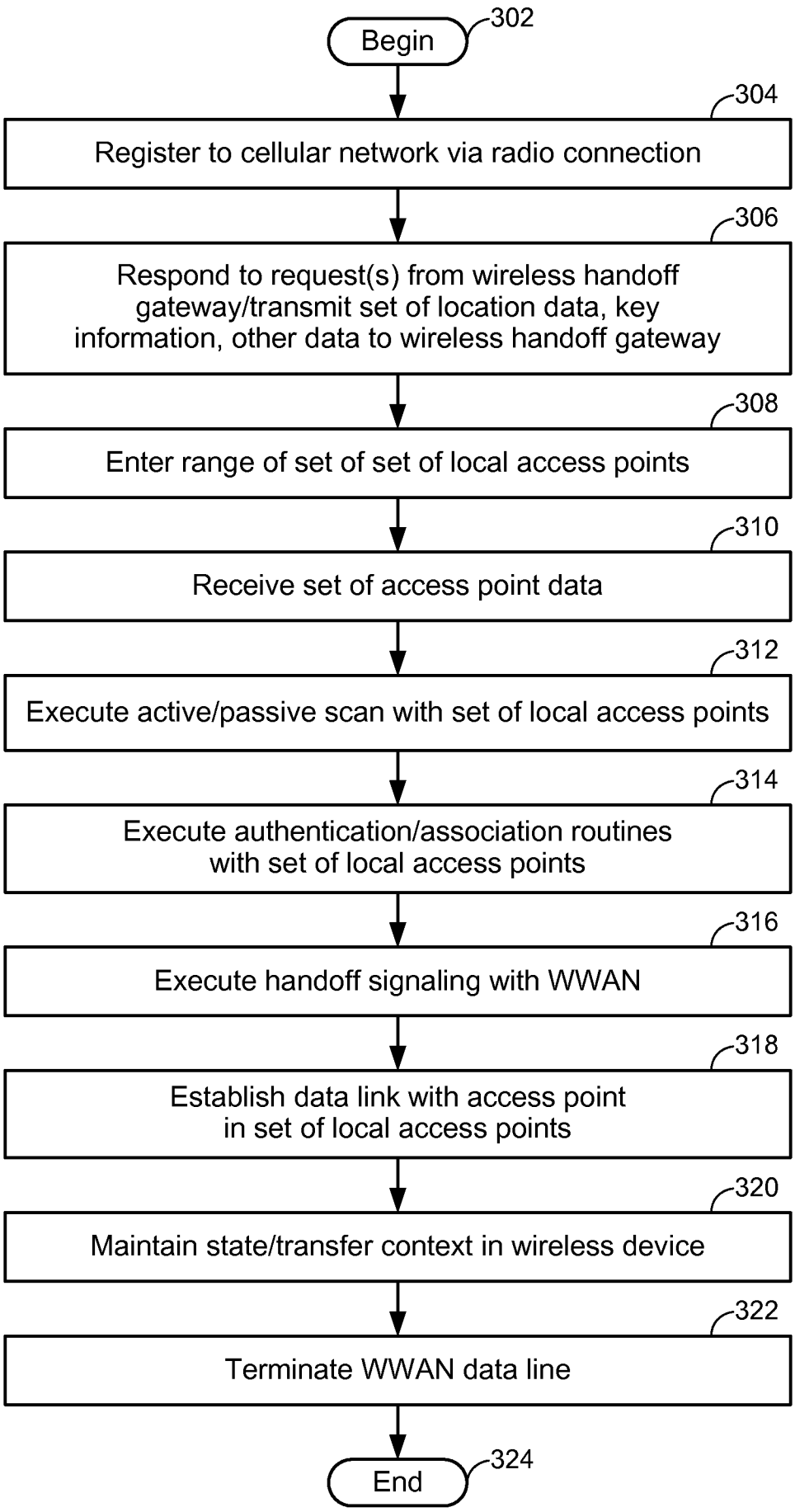
Begin
302
Register to cellular network via radio connection
304
Respond to request(s) from wireless handoff gateway/transmit set of location data, key information, other data to wireless handoff gateway
306
Enter range of set of set of local access points
308
Receive set of access point data
310
Execute active/passive scan with set of local access points
312
Execute authentication/association routines with set of local access points
314
Execute handoff signaling with WWAN
316
Establish data link with access point in set of local access points
318
Maintain state/transfer context in wireless device
320
Terminate WWAN data line
322
End
324

FIG. 3

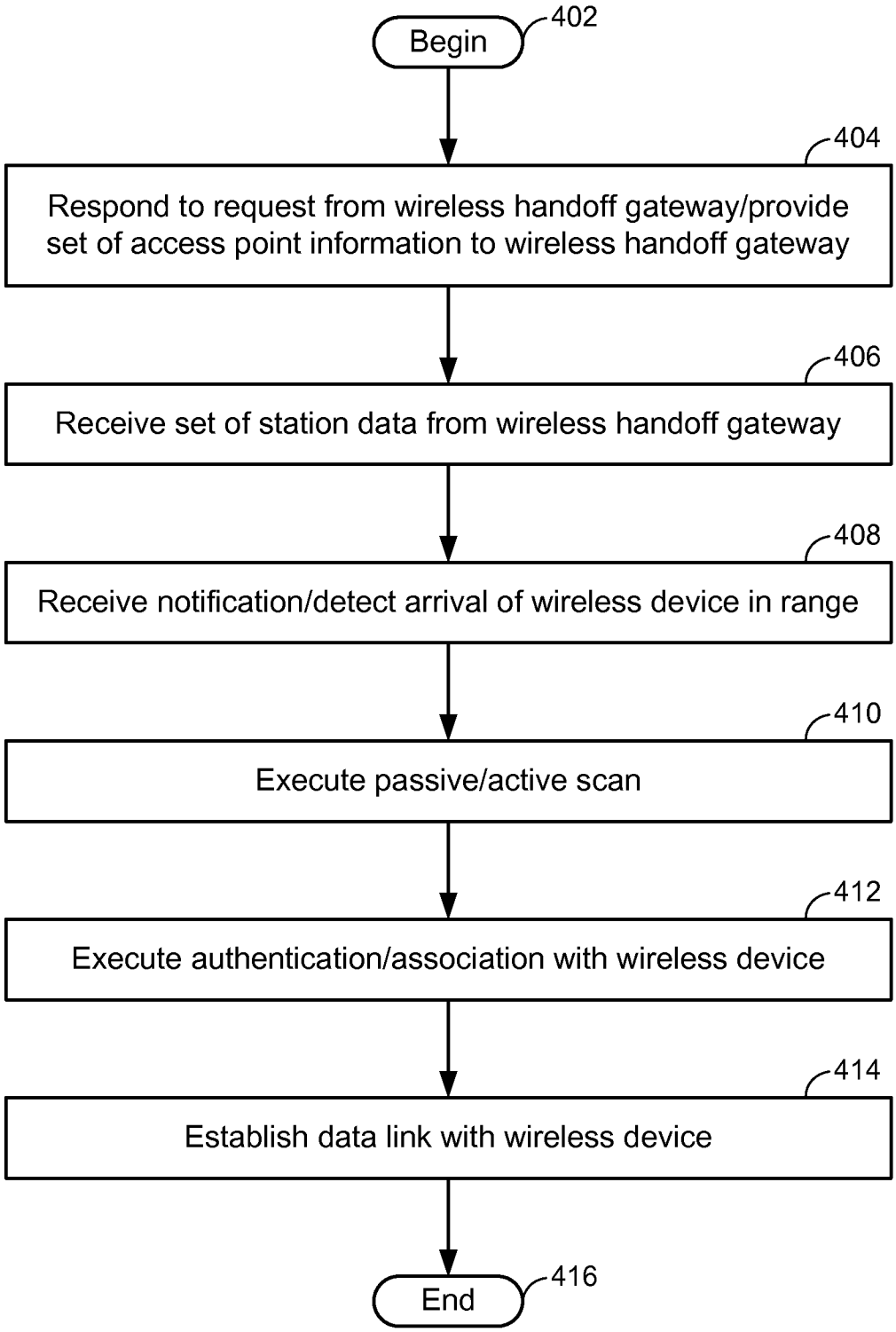
Begin
402
Respond to request from wireless handoff gateway/provide set of access point information to wireless handoff gateway
404
Receive set of station data from wireless handoff gateway
406
Receive notification/detect arrival of wireless device in range
408
Execute passive/active scan
410
Execute authentication/association with wireless device
412
Establish data link with wireless device
414
End
416

FIG. 4

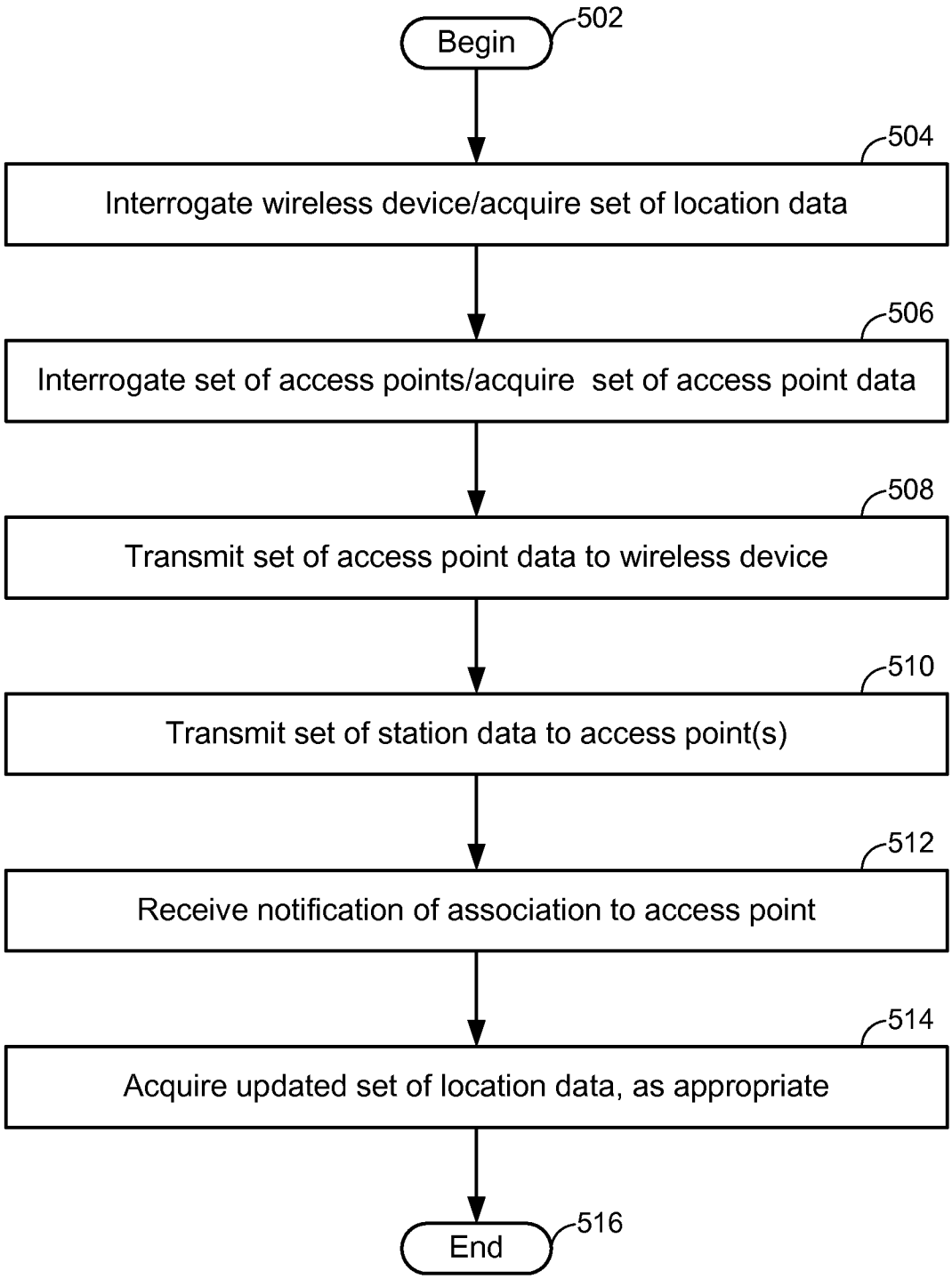
Begin
502
Interrogate wireless device/acquire set of location data
504
Interrogate set of access points/acquire set of access point data
506
Transmit set of access point data to wireless device
508
Transmit set of station data to access point(s)
510
Receive notification of association to access point
512
Acquire updated set of location data, as appropriate
514
End
516

FIG. 5

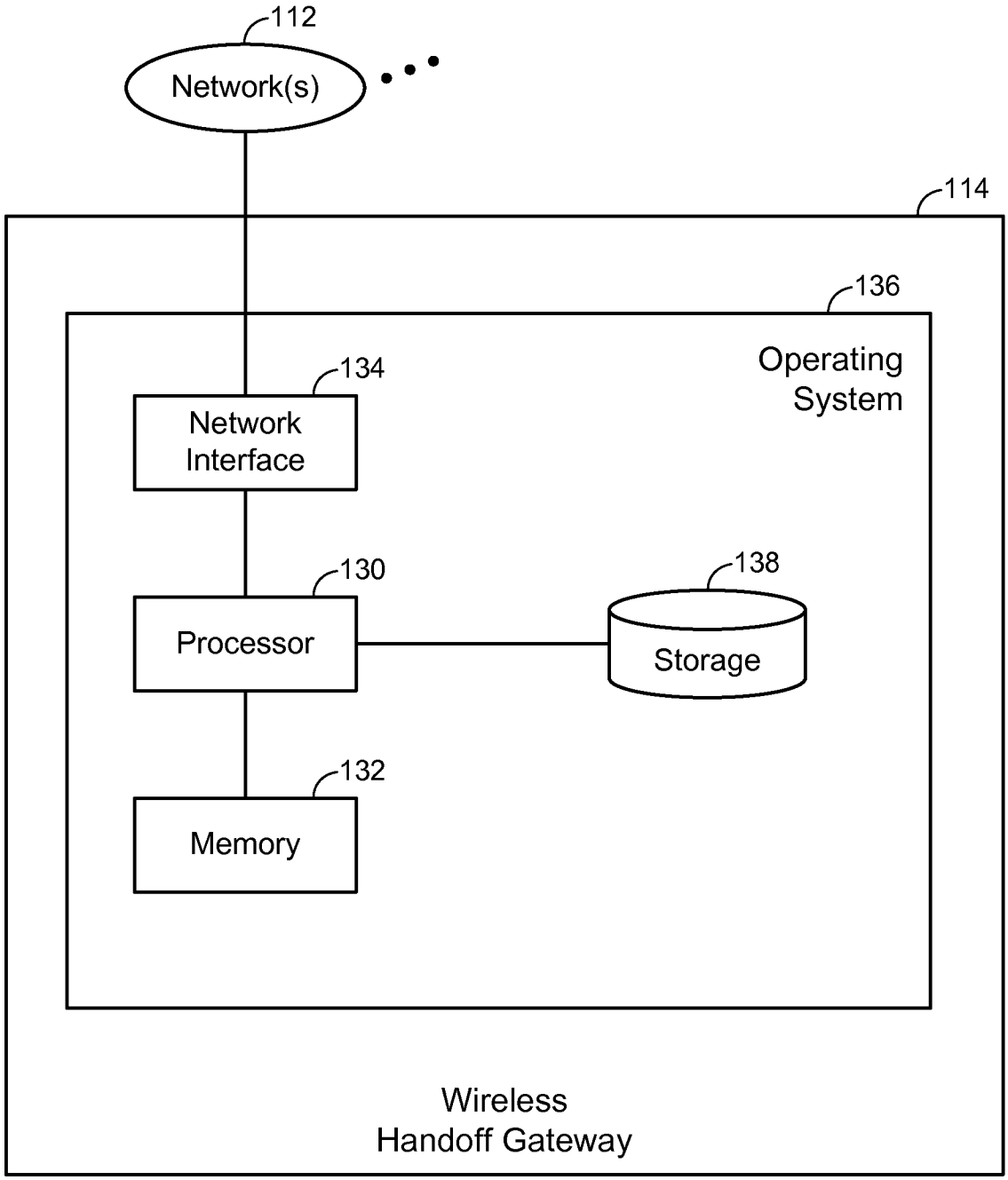
112
Network(s)
114
136
Operating System
134
Network Interface
130
Processor
138
Storage
132
Memory
Wireless Handoff Gateway

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/040979

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/00
ADD.

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)
H04W

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 8 180 349 B1 (MOHAN DAVID [US] ET AL) 15 May 2012 (2012-05-15) abstract column 3, line 1 - line 29 column 3, line 43 - column 4, line 45 -----	1-116
Y	US 2007/249291 A1 (NANDA SANJIV [US] ET AL) 25 October 2007 (2007-10-25) abstract paragraph [0005] - paragraph [0007] paragraph [0025] paragraph [0031] - paragraph [0032] -----	1-116
A	US 2009/232096 A1 (TANIUCHI KENICHI [JP]) 17 September 2009 (2009-09-17) abstract paragraph [0006] -----	1-116

☐ 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

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"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
17 September 2013	30/09/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Larcinese, Concetta

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/040979

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 8180349 B1	15-05-2012	NONE	
US 2007249291 A1	25-10-2007	CN 101416548 A	22-04-2009
		EP 2008478 A1	31-12-2008
		HK 1131496 A1	11-05-2012
		JP 2009534952 A	24-09-2009
		JP 2012075117 A	12-04-2012
		KR 20090008387 A	21-01-2009
		TW 200803564 A	01-01-2008
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		WO 2007130800 A1	15-11-2007
US 2009232096 A1	17-09-2009	CN 101534522 A	16-09-2009
		JP 2009218929 A	24-09-2009
		US 2009232096 A1	17-09-2009