US 20110310865A1

(19) United States

(12) Patent Application Publication

Kennedy et al.

(10) Pub. No.: US 2011/0310865 A1

(43) Pub. Date: Dec. 22, 2011

(54) METHODS AND APPARATUS TO ACCESS NETWORK CONNECTIVITY INFORMATION USING PREDICTED LOCATIONS

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(21) Appl. No.: **12/820,883**

(22) Filed: **Jun. 22, 2010**

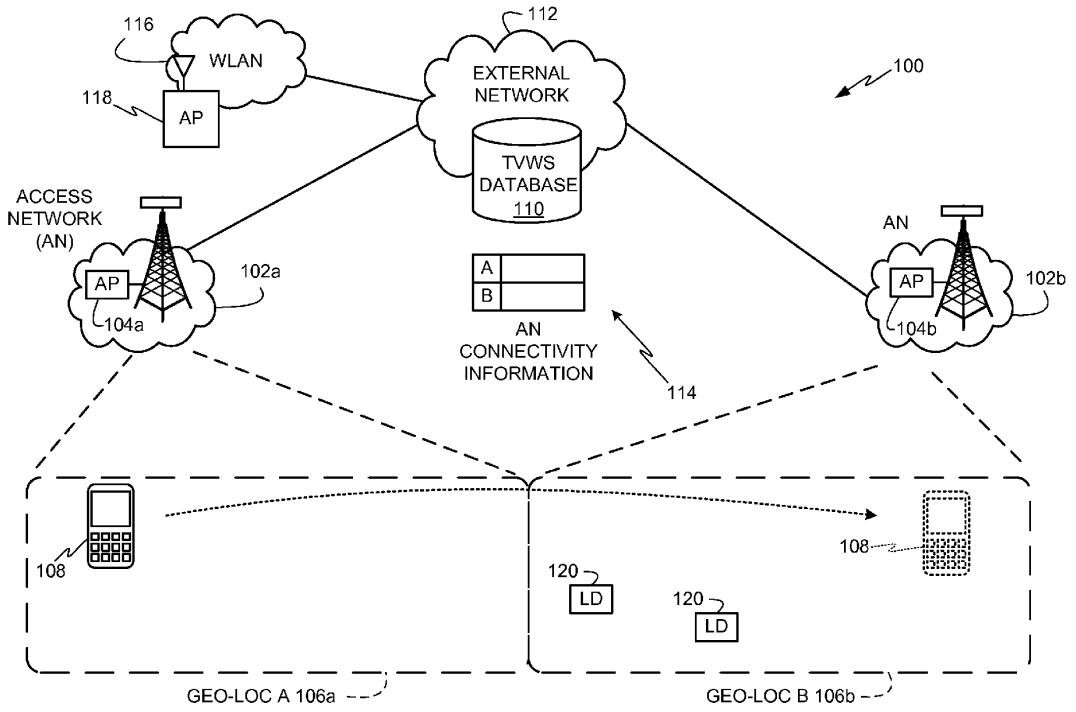
Publication Classification

(51) **Int. Cl.**
H04W 84/02 (2009.01)
H04W 40/00 (2009.01)

(52) **U.S. Cl.** **370/338**; 370/328

(57) **ABSTRACT**

Example methods and apparatus to access network connectivity information based on predicted future locations of wireless terminals are disclosed. A disclosed example method involves predicting at least one future location of a wireless terminal. The example method also involves requesting at least first and second network connectivity information sets for connecting to at least one access network providing wireless communication coverage at the at least one future location. The first network connectivity information is associated with a first geographic location, and the second network connectivity information is associated with a second geographic location.



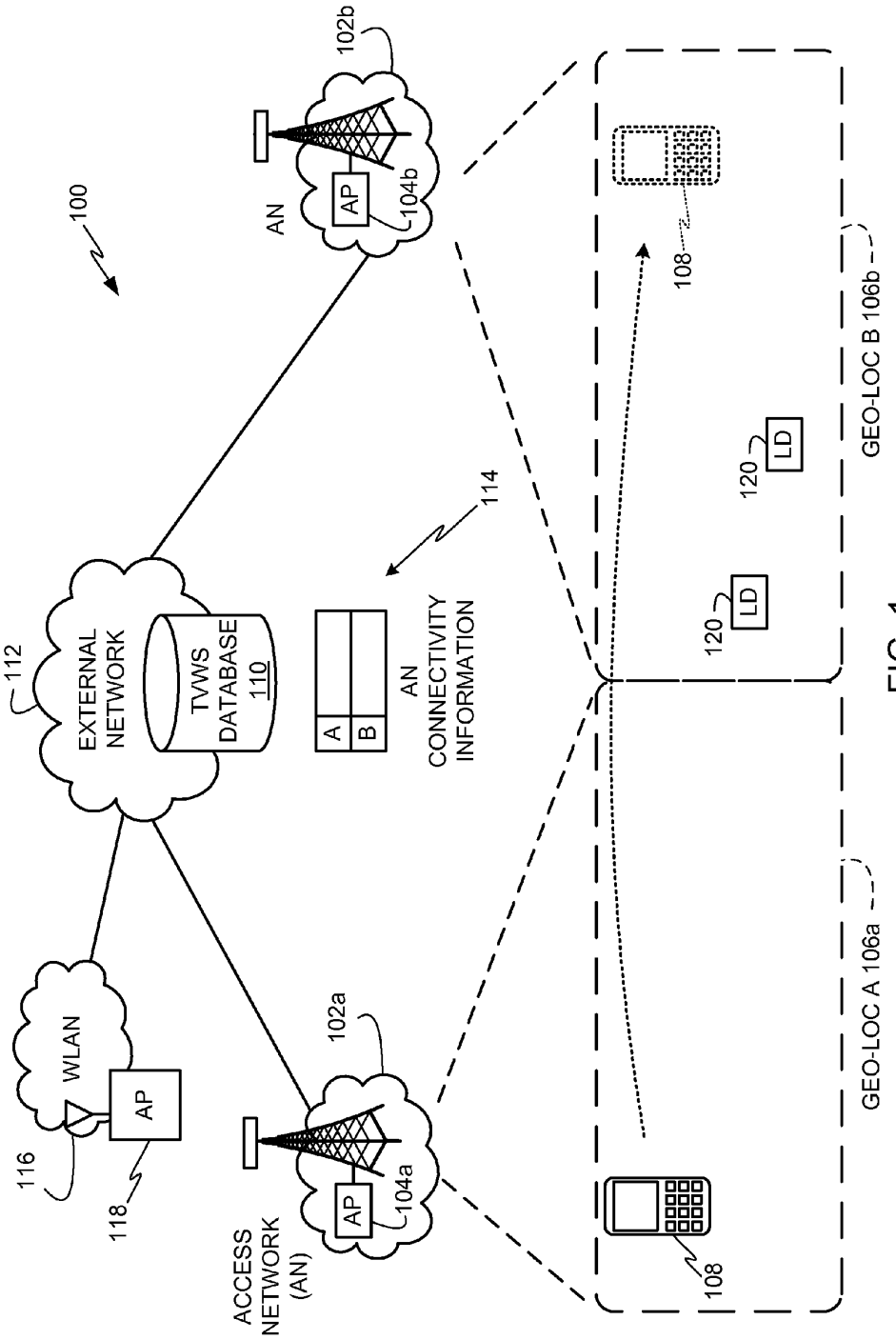

100
102b
AN
AP
104b
112
EXTERNAL NETWORK
TVWS DATABASE 110
114
A
B
AN CONNECTIVITY INFORMATION
108
GEO-LOC B 106b
120
LD
120
LD
GEO-LOC A 106a
WLAN
AP
116
118
102a
ACCESS NETWORK (AN)
AP
104a
108

FIG. 1

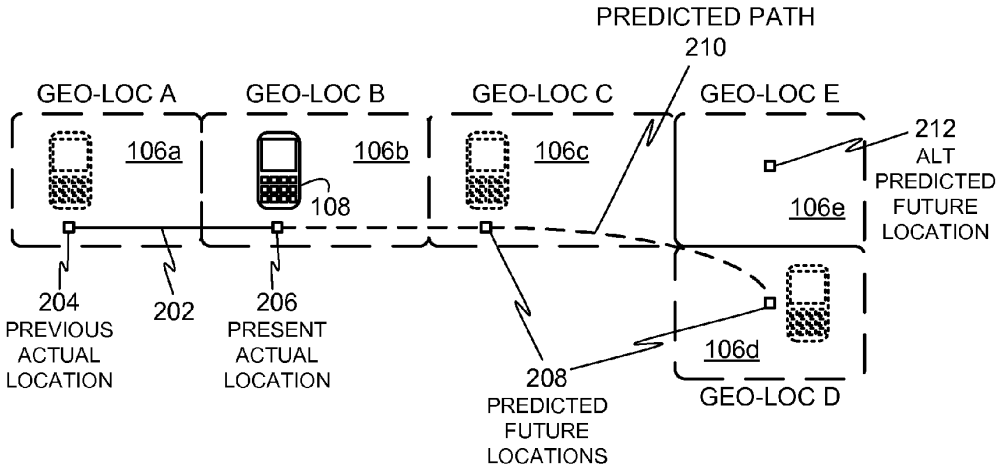

PREDICTED PATH
210
GEO-LOC A
GEO-LOC B
GEO-LOC C
GEO-LOC E
106a
106b
106c
106e
106d
GEO-LOC D
108
212
ALT
PREDICTED
FUTURE
LOCATION
204
PREVIOUS
ACTUAL
LOCATION
202
206
PRESENT
ACTUAL
LOCATION
208
PREDICTED
FUTURE
LOCATIONS

FIG. 2

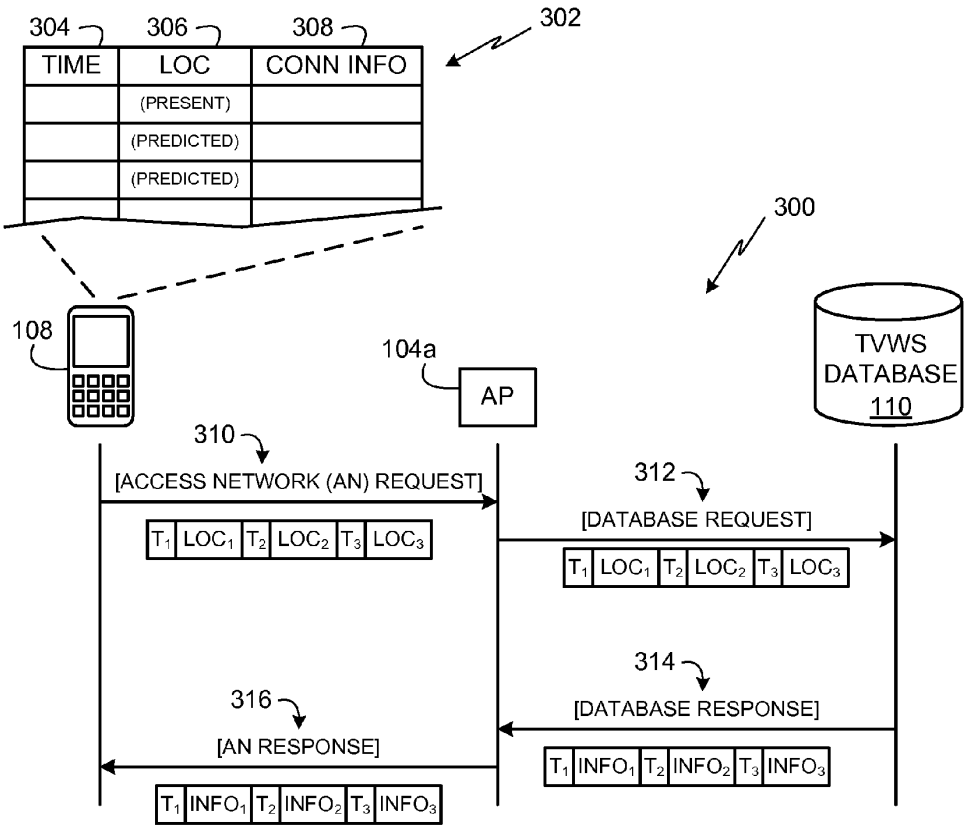

304
306
308
302
TIME
LOC
CONN INFO
(PRESENT)
(PREDICTED)
(PREDICTED)
300
108
104a
AP
TVWS
DATABASE
110
310
[ACCESS NETWORK (AN) REQUEST]
T1 LOC1 T2 LOC2 T3 LOC3
312
[DATABASE REQUEST]
T1 LOC1 T2 LOC2 T3 LOC3
314
[DATABASE RESPONSE]
T1 INFO1 T2 INFO2 T3 INFO3
316
[AN RESPONSE]
T1 INFO1 T2 INFO2 T3 INFO3

FIG. 3

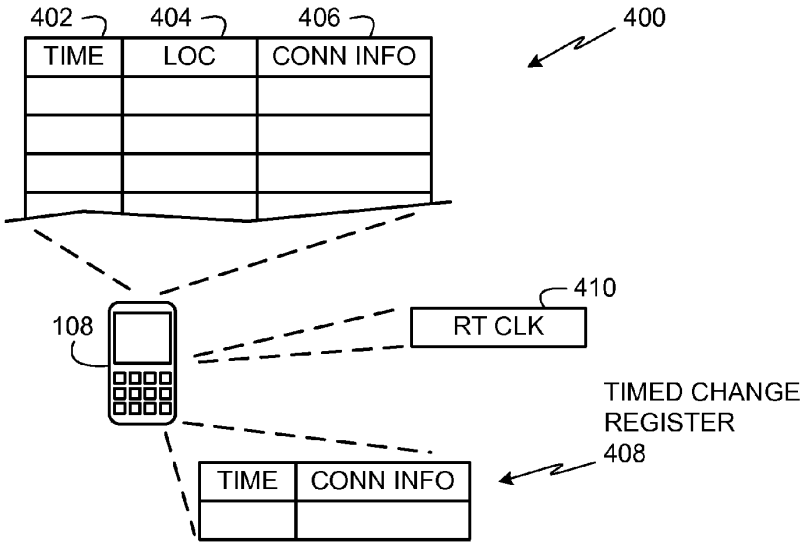

402
404
406
400
TIME
LOC
CONN INFO
410
108
RT CLK
TIMED CHANGE
REGISTER
408
TIME
CONN INFO

FIG. 4

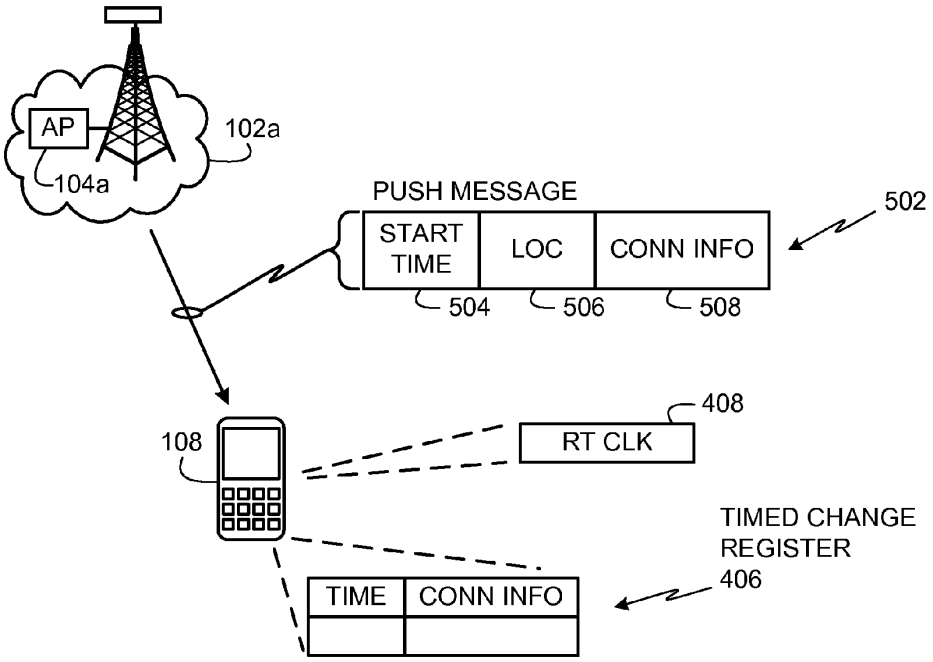

AP
102a
104a
PUSH MESSAGE
502
START
TIME
LOC
CONN INFO
504
506
508
408
108
RT CLK
TIMED CHANGE
REGISTER
406
TIME
CONN INFO

FIG. 5

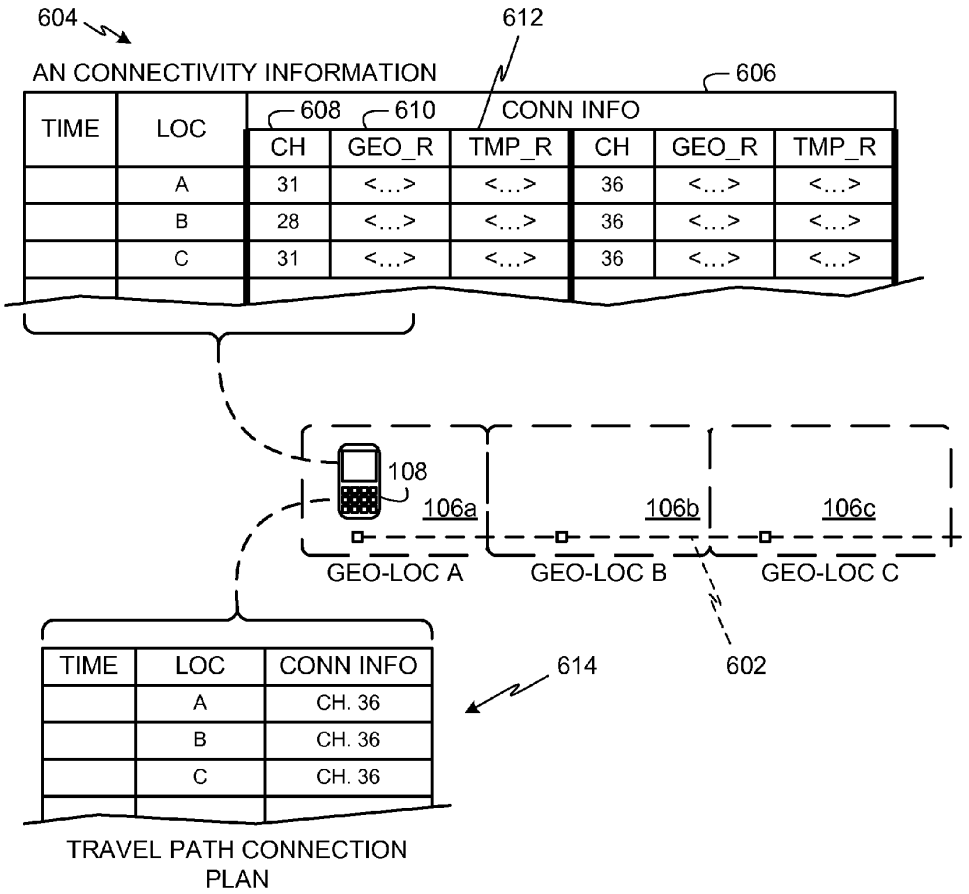

604
612
AN CONNECTIVITY INFORMATION
606
TIME
LOC
608
610
CONN INFO
CH
GEO_R
TMP_R
CH
GEO_R
TMP_R
A
31
<...>
<...>
36
<...>
<...>
B
28
<...>
<...>
36
<...>
<...>
C
31
<...>
<...>
36
<...>
<...>
108
106a
106b
106c
GEO-LOC A
GEO-LOC B
GEO-LOC C
602
614
TIME
LOC
CONN INFO
A
CH. 36
B
CH. 36
C
CH. 36
TRAVEL PATH CONNECTION PLAN

FIG. 6

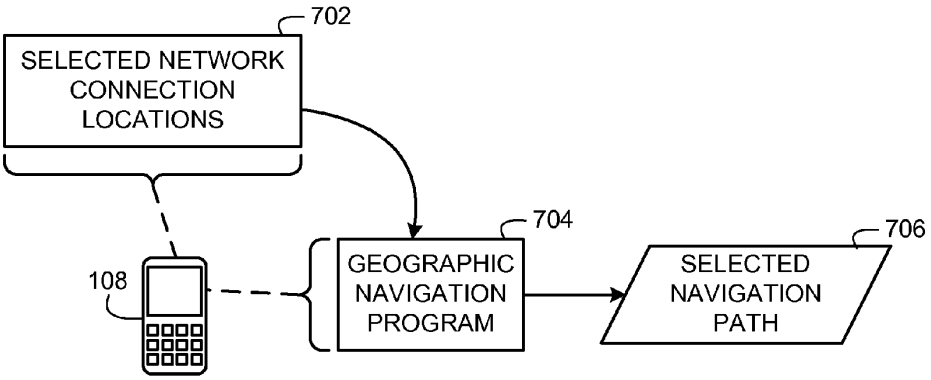

702
SELECTED NETWORK CONNECTION LOCATIONS
704
706
108
GEOGRAPHIC NAVIGATION PROGRAM
SELECTED NAVIGATION PATH

FIG. 7

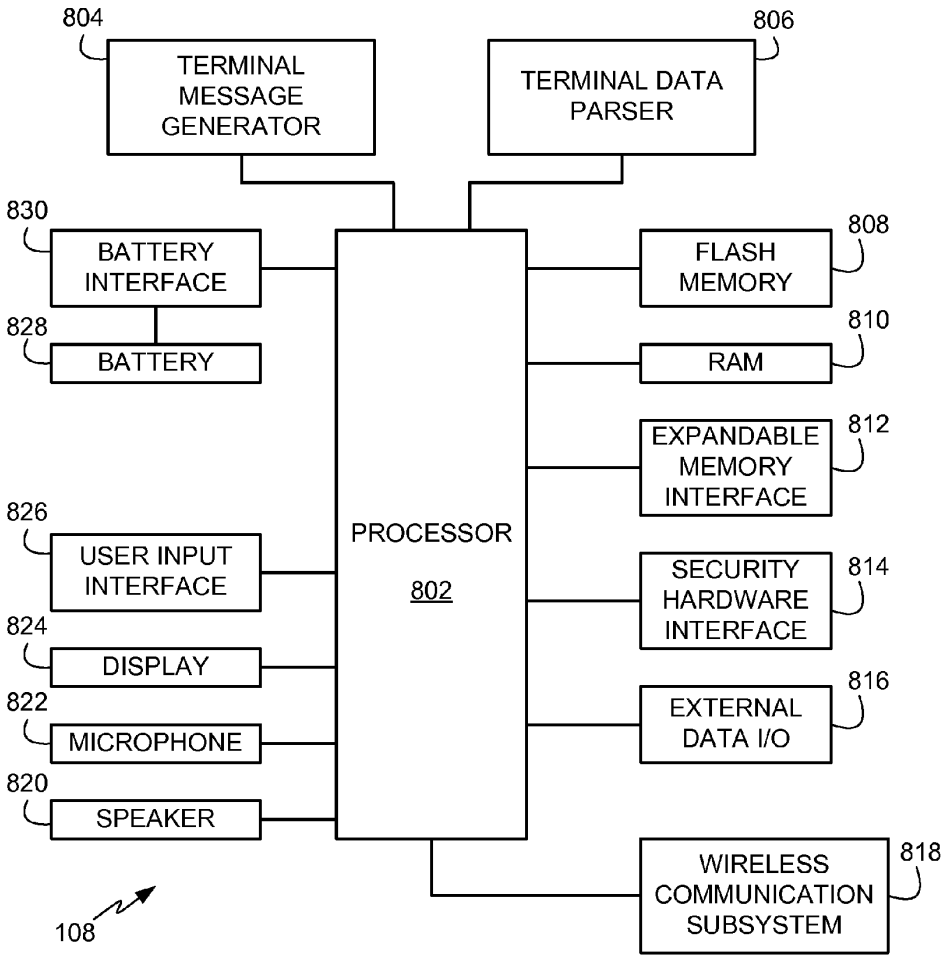

804
TERMINAL MESSAGE GENERATOR
806
TERMINAL DATA PARSER
830
BATTERY INTERFACE
828
BATTERY
808
FLASH MEMORY
810
RAM
812
EXPANDABLE MEMORY INTERFACE
826
USER INPUT INTERFACE
PROCESSOR
802
814
SECURITY HARDWARE INTERFACE
824
DISPLAY
816
EXTERNAL DATA I/O
822
MICROPHONE
820
SPEAKER
818
WIRELESS COMMUNICATION SUBSYSTEM
108
WIRELESS TERMINAL

FIG. 8

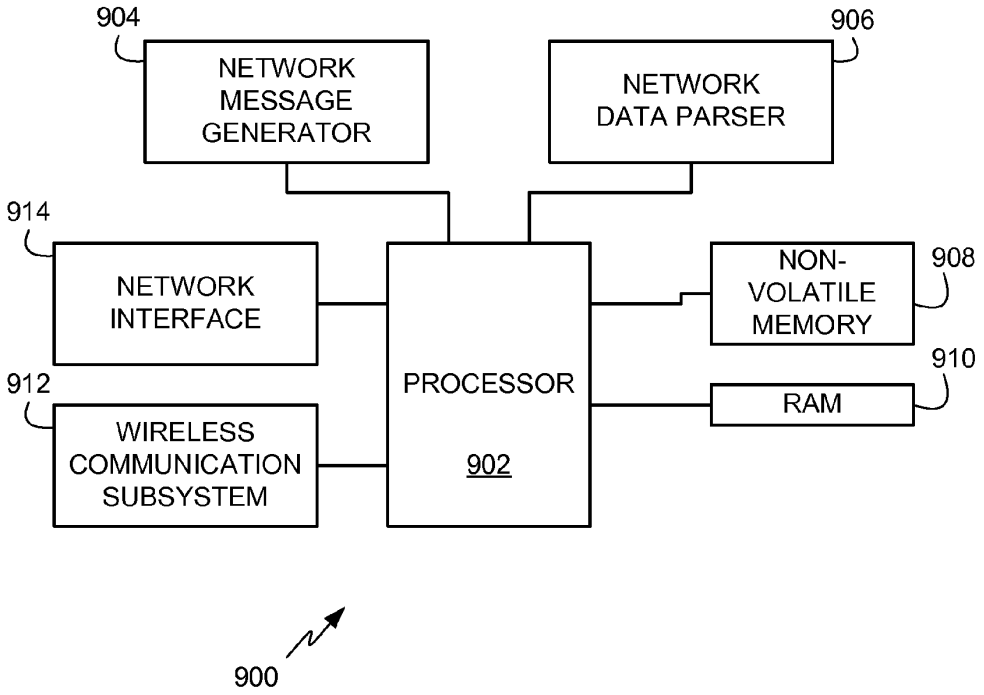

904
NETWORK MESSAGE GENERATOR
906
NETWORK DATA PARSER
914
NETWORK INTERFACE
PROCESSOR
902
NON-VOLATILE MEMORY
908
910
RAM
912
WIRELESS COMMUNICATION SUBSYSTEM
900

FIG. 9

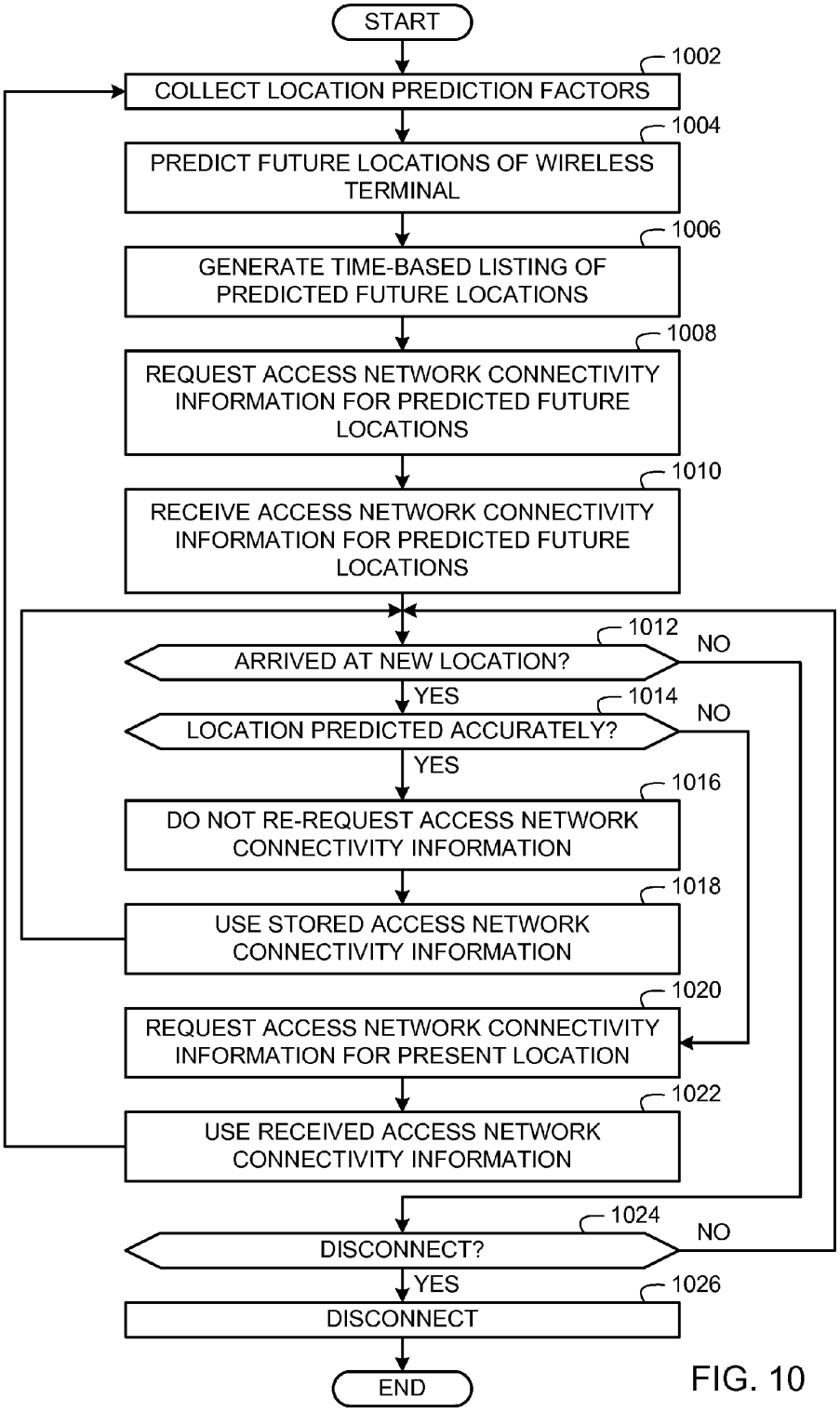

START
1002
COLLECT LOCATION PREDICTION FACTORS
1004
PREDICT FUTURE LOCATIONS OF WIRELESS TERMINAL
1006
GENERATE TIME-BASED LISTING OF PREDICTED FUTURE LOCATIONS
1008
REQUEST ACCESS NETWORK CONNECTIVITY INFORMATION FOR PREDICTED FUTURE LOCATIONS
1010
RECEIVE ACCESS NETWORK CONNECTIVITY INFORMATION FOR PREDICTED FUTURE LOCATIONS
1012
ARRIVED AT NEW LOCATION?
NO
YES
1014
LOCATION PREDICTED ACCURATELY?
NO
YES
1016
DO NOT RE-REQUEST ACCESS NETWORK CONNECTIVITY INFORMATION
1018
USE STORED ACCESS NETWORK CONNECTIVITY INFORMATION
1020
REQUEST ACCESS NETWORK CONNECTIVITY INFORMATION FOR PRESENT LOCATION
1022
USE RECEIVED ACCESS NETWORK CONNECTIVITY INFORMATION
1024
DISCONNECT?
NO
YES
1026
DISCONNECT
END

FIG. 10

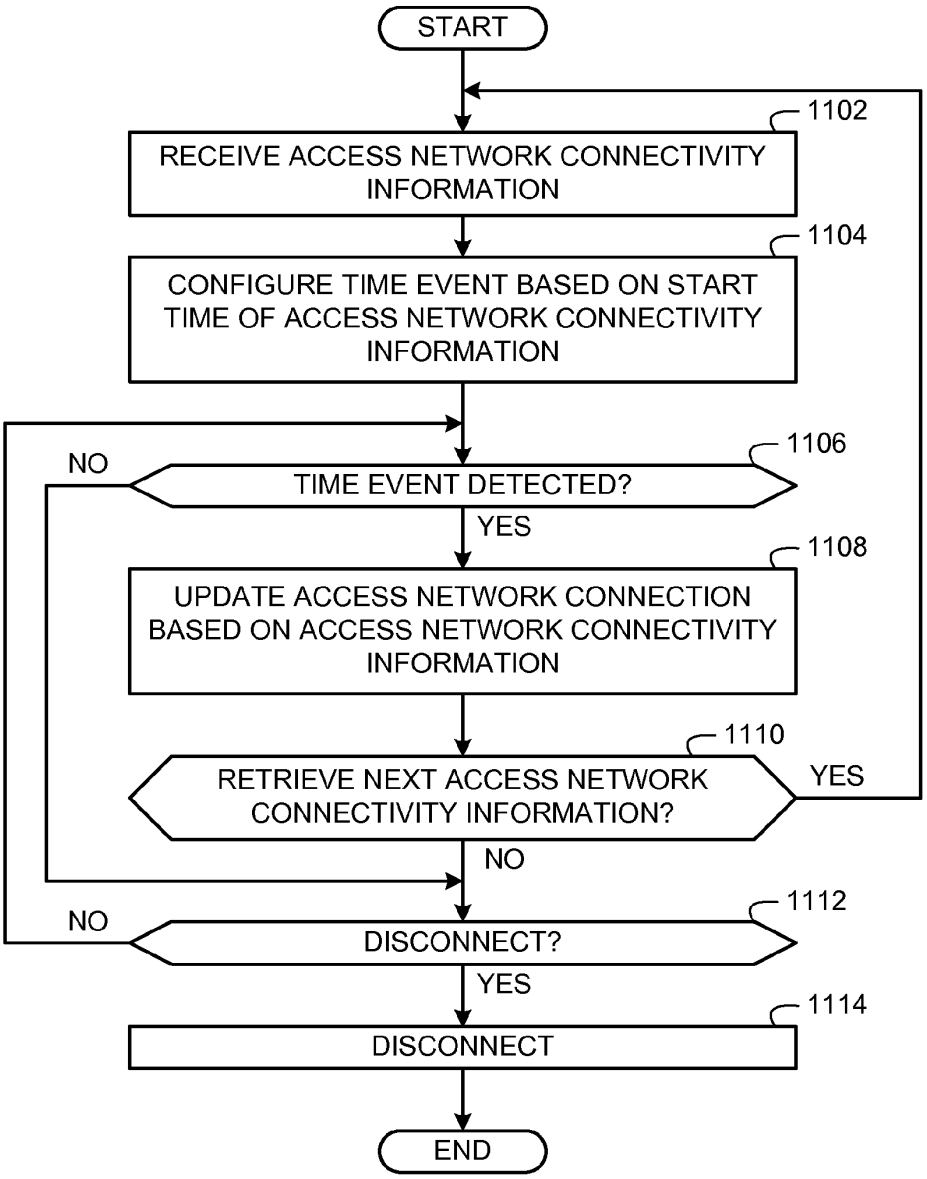

START
1102
RECEIVE ACCESS NETWORK CONNECTIVITY INFORMATION
1104
CONFIGURE TIME EVENT BASED ON START TIME OF ACCESS NETWORK CONNECTIVITY INFORMATION
1106
NO
TIME EVENT DETECTED?
YES
1108
UPDATE ACCESS NETWORK CONNECTION BASED ON ACCESS NETWORK CONNECTIVITY INFORMATION
1110
RETRIEVE NEXT ACCESS NETWORK CONNECTIVITY INFORMATION?
YES
NO
1112
NO
DISCONNECT?
YES
1114
DISCONNECT
END

FIG. 11

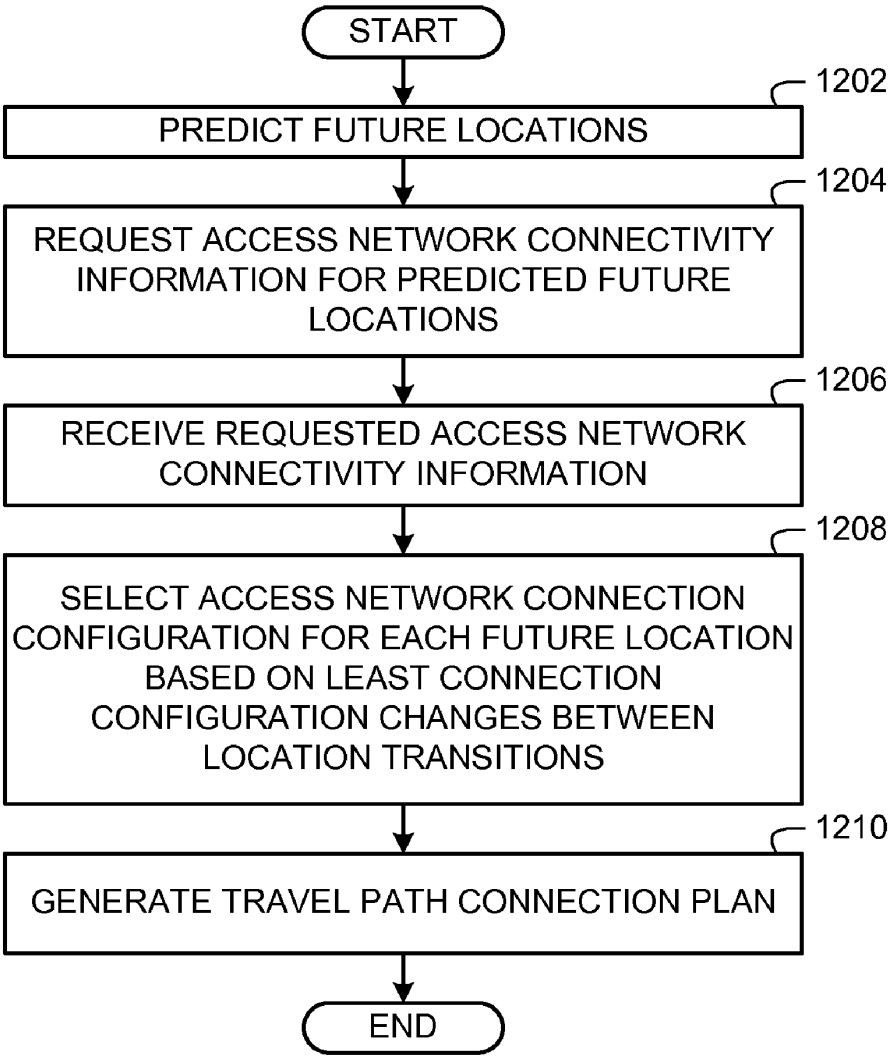

START
1202
PREDICT FUTURE LOCATIONS
1204
REQUEST ACCESS NETWORK CONNECTIVITY INFORMATION FOR PREDICTED FUTURE LOCATIONS
1206
RECEIVE REQUESTED ACCESS NETWORK CONNECTIVITY INFORMATION
1208
SELECT ACCESS NETWORK CONNECTION CONFIGURATION FOR EACH FUTURE LOCATION BASED ON LEAST CONNECTION CONFIGURATION CHANGES BETWEEN LOCATION TRANSITIONS
1210
GENERATE TRAVEL PATH CONNECTION PLAN
END

FIG. 12

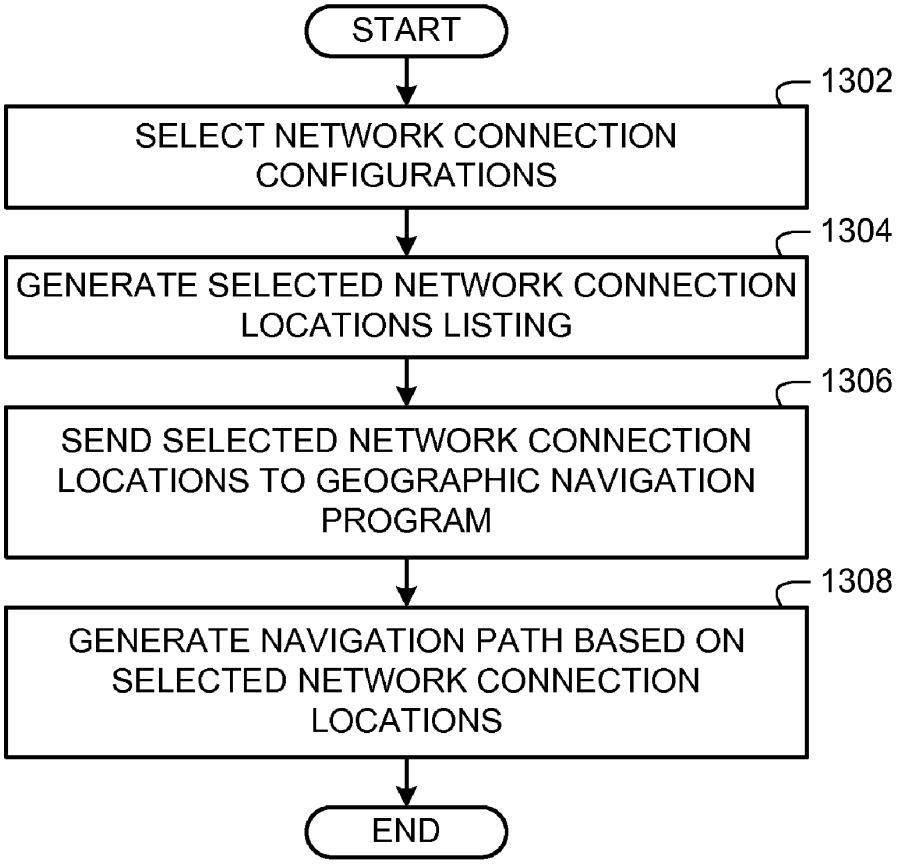

START
1302
SELECT NETWORK CONNECTION CONFIGURATIONS
1304
GENERATE SELECTED NETWORK CONNECTION LOCATIONS LISTING
1306
SEND SELECTED NETWORK CONNECTION LOCATIONS TO GEOGRAPHIC NAVIGATION PROGRAM
1308
GENERATE NAVIGATION PATH BASED ON SELECTED NETWORK CONNECTION LOCATIONS
END

FIG. 13

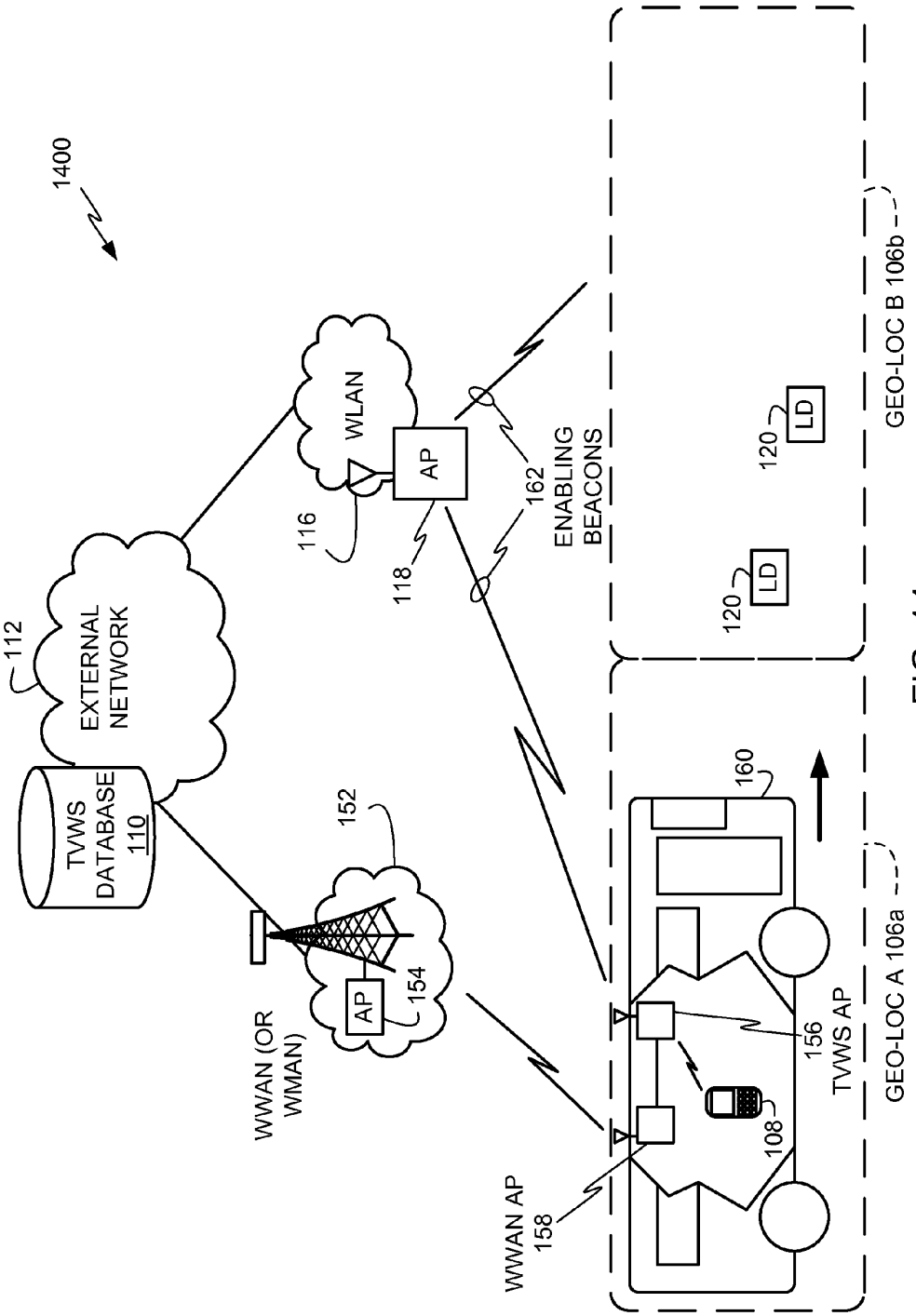

1400
112
EXTERNAL NETWORK
TVWS DATABASE 110
WLAN
AP
116
118
162
ENABLING BEACONS
120
LD
120
LD
GEO-LOC B 106b
152
AP
154
WWAN (OR WMAN)
160
156
TVWS AP
108
WWAN AP 158
GEO-LOC A 106a

FIG. 14

METHODS AND APPARATUS TO ACCESS NETWORK CONNECTIVITY INFORMATION USING PREDICTED LOCATIONS

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates generally to network communications and, more particularly, to methods and apparatus to access network connectivity information using predicted locations.

BACKGROUND

[0002] Wireless network deployments, such as wireless local area networks (WLANs), allow wireless terminals to access network and Internet services when within proximity of wireless communication signals of those wireless networks. Some wireless networks use portions of the radio frequency (RF) spectrum that are shared between different types of devices (e.g., primary devices and secondary devices). Such different types of devices must share or use the shared RF spectrum in such a way that they do not interfere with one another when operating in close proximity of one another or in the same geographical area.

[0003] Sometimes, users of wireless terminals move between different locations in which there are located other devices with which the wireless terminals share the same portions of a frequency spectrum. To avoid interfering with the other devices, the wireless terminals can change their wireless connection settings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. **1** depicts an example communication network in which an example wireless terminal retrieves access network (AN) connectivity information from an example television white space (TVWS) database for connecting to wireless access networks.

[0005] FIG. **2** depicts the wireless terminal of FIG. **1** predicting future locations for use in retrieving AN connectivity information for connecting to the access networks of FIG. **1**.

[0006] FIG. **3** depicts example message exchanges between the wireless terminal, an access point, and the TVWS database of FIG. **1** for requesting AN connectivity information from the TVWS database.

[0007] FIG. **4** depicts an example implementation of the wireless terminal of FIG. **1** that may be used to make changes to connectivity between the wireless terminal and an access network based on timing information indicating the start of enforcing new AN connectivity information.

[0008] FIG. **5** depicts an example communication technique for pushing AN connectivity information to the wireless terminal of FIG. **1**.

[0009] FIG. **6** depicts the wireless terminal of FIG. **1** using an AN connection configuration selection technique to establish an AN connection configuration requiring the relatively fewer, lesser, or least amounts or quantities of AN connection configuration changes while traveling between different geographic locations associated with different AN connectivity requirements.

[0010] FIG. **7** depicts an example travel path selection technique that may be used in connection with a geographic navigation program based on AN connection plans selected by the wireless terminal of FIG. **1** along a predicted path.

[0011] FIG. **8** depicts a detailed diagram of the example wireless terminal of FIGS. **1-7** that may be used to implement the example methods and apparatus described herein.

[0012] FIG. **9** depicts an example processor system for use in a network and that may be used to implement the example methods and apparatus described herein.

[0013] FIG. **10** depicts an example flow diagram representative of a process that may be implemented using computer readable instructions that may be used to predict near-future locations for use in selecting AN connection configurations for connecting to access networks.

[0014] FIG. **11** depicts an example flow diagram representative of a process that may be implemented using computer readable instructions that may be used to implement AN connectivity changes between the wireless terminal and an access network based on timing information corresponding to the start of enforcing AN connectivity information.

[0015] FIG. **12** depicts an example flow diagram representative of a process that may be implemented using computer readable instructions that may be used to select AN connection configurations for establishing AN connections requiring relatively fewer, lesser, or least amounts or quantities of configuration changes while traveling along different geographic locations associated with different AN connectivity requirements.

[0016] FIG. **13** depicts an example flow diagram representative of a process that may be implemented using computer readable instructions that may be used to select a travel path in connection with a geographic navigation program based on AN connection locations selected by the wireless terminal of FIGS. **1-7**.

[0017] FIG. **14** depicts another example communication network in connection with a mobile AN.

DETAILED DESCRIPTION

[0018] Although the following discloses example methods and apparatus including, among other components, software executed on hardware, it should be noted that such methods and apparatus are merely illustrative and should not be considered as limiting. For example, it is contemplated that any or all of these hardware and software components could be embodied exclusively in hardware, exclusively in software, exclusively in firmware, or in any combination of hardware, software, and/or firmware. Accordingly, while the following describes example methods and apparatus, persons having ordinary skill in the art will readily appreciate that the examples provided are not the only way to implement such methods and apparatus.

[0019] The example methods and apparatus described herein can be used to predict future locations (e.g., near-future locations) of wireless terminals, obtain network connectivity information from network connectivity databases indicative of capabilities and requirements for connecting (and/or maintaining connectivity while in motion) to access networks at different locations (e.g., at predicted future locations), select network connectivity configurations, and establish (or maintain) connections with access networks based on such configurations. The example methods and apparatus described herein can be used in connection with mobile communication devices, mobile computing devices, or any other device (including stationary communication devices) capable of communicating wirelessly with a wireless network. Such devices, also referred to as terminals, wireless terminals, television white space (TVWS) devices, TV band devices

(TVBDs), or user equipment (UE), may include mobile smart phones (e.g., a BLACKBERRY® smart phone), wireless personal digital assistants (PDAs), laptop/notebook/netbook computers with wireless adapters, etc. The example methods and apparatus described herein may be implemented in connection with TVWS networks and associated standards and communication protocols. In addition, the example methods and apparatus described herein may be implemented in connection with the wireless local area network (WLAN) communication standard known as IEEE® (Institute for Electrical and Electronics Engineers) 802.11, which, among other things, defines interworking with external networks. However, the example methods and apparatus may additionally or alternatively be implemented in connection with other wireless communication standards including, but not limited to, other WLAN standards, other standards for operating in spectrum white space, personal area network (PAN) standards, wide area network (WAN) standards, wireless metropolitan area network (WMAN) standards (e.g., IEEE® 802.16 or WiMAX networks), wireless regional area network (WRAN) standards (e.g., IEEE® 802.22), cellular communication standards, or mobile satellite communications standards.

[0020] As described herein, some wireless networks use portions of radio frequency (RF) spectrum that is shared by different types of devices including TVWS devices, TVBDs, and/or other registered licensed devices. To avoid interfering with devices (e.g., registered licensed devices which may operate as primary devices having priority over secondary devices) in these shared RF spectrum portions, wireless communication devices (e.g., which may operate as secondary devices) can access network databases to obtain access network connectivity requirements to enable sharing the RF spectrum portions without interfering with other devices (e.g., primary devices). Such AN connectivity requirements may specify uses of channels (or frequency segments) based on geographical locations of other, licensed devices so that wireless terminals may use those channels (or frequency segments) without interfering with the other, licensed devices.

[0021] In the illustrated examples described herein, wireless terminals may operate as secondary devices in TVWS bands, while not interfering with primary devices such as TV broadcast equipment and licensed wireless microphones. For example, a TVWS database may be used to provide AN connectivity information to wireless terminals based on locations (e.g., defined by global positioning system (GPS) coordinates) in which those wireless terminals operate. The AN connectivity information specifies unused (and therefore available) channels and other data required to enable the wireless terminals to operate without interfering with primary, licensed users. In this manner, the primary, licensed users can be afforded protection from radio interference in a specified radius or area (e.g., a protection contour) around their licensed devices.

[0022] The example methods and apparatus described herein can be advantageously used to inform wireless terminals of the types of network connectivity that are available in different locations before the wireless terminal attempts connecting at those locations. For example, a person travelling between different locations may, in advance, query a network database about access network availability and connectivity capabilities/requirements at a predicted future location, so that upon arrival at the predicted future destination, the person's wireless device can connect to the available access network based on the retrieved access network connectivity capabilities/requirements information. Such predicted future locations may be near-future locations in a relatively small geographic area such as within two or more neighboring towns, within different parts of a town (e.g., near-future locations within blocks of one another), or any other relatively small geographic area in which a person may walk or move around using, for example, ground-based transportation. In some example implementations, the predicted future locations may be more distant future locations associated with relatively larger geographic areas such as different states or countries.

[0023] Such predictive retrieval of access network connectivity information may be advantageously used to ensure that wireless terminals use the appropriate frequency spectrum at their predicted future locations, as may be required by regulatory rules with respect to licensed users of frequency bands. Such is the case in TVWS frequency spectrum shared by TVBDs and other licensed white space devices such as television broadcast equipment or wireless microphones. Networks using TVWS frequency spectrum may be associated with one or more TVWS databases that store geographic protection contours for individual licensed devices (e.g., broadcast TV stations or licensed wireless microphones) that share TVWS frequency spectrum with mobile communication terminals (e.g., TVBDs implemented as mobile phones or other communication devices). In addition, the licensed wireless microphones using TVWS frequency spectrum may be mobile (e.g., for on-site news gathering) and subject to frequent changes to their protection boundaries as they are used at different remote locations. Thus, operating class information for such moving licensed devices may change frequently over time. The example methods and apparatus described herein may be used to keep mobile communication devices updated as to available access network connectivity capabilities to prevent interfering with licensed devices operating in the same frequency spectrum.

[0024] To protect individual licensed devices that are registered to use particular TVWS channels (e.g., TVWS frequency spectrum channels), the example methods and apparatus described herein may be used to enable mobile communication devices to determine their current locations and predict future locations to which the mobile communication devices may travel. Such locations may be near individual licensed devices that must be protected from interference caused by mobile communication device communications that are capable of using the same frequency channels as those individual licensed devices. The example methods and apparatus described herein may also be used to change access network connection configurations including making changes to channels of operation, operating bandwidth, transmit power of mobile devices to avoid such interference with the licensed devices, and/or any other parameter associated with access network connectivity information. The access network connectivity information described herein may be implemented as Regulatory Classes or Operating Classes defining different operational and location parameters for use in selecting access network connection configurations.

[0025] The predictive retrieval of access network connectivity information described herein may be advantageously used by wireless terminals to make decisions in advance regarding channel use (or other connection parameter use) to require fewer AN connection configuration changes during actual connection time, to optimize network connectivity,

and/or to minimize power consumption. In some example implementations, the techniques described herein may also be used to select travel routes based on desired qualities of network connections.

[0026] Although the example methods and apparatus are described herein as retrieving and selecting access network information obtained from a TVWS database, the example methods and apparatus may similarly be used to access databases (e.g., information servers) storing information about accessing and connecting to other types of networks (e.g., WLAN access networks, cellular networks, etc.), including networks that use white space in bands other than TV bands, as regulatory domains make them available. In addition, the information message exchanges described herein between a TVBD and a TVWS database may be implemented using any suitable techniques including, for example, network query protocols, network message exchanges, email, short messaging service (SMS), and instant messaging, using both wired and wireless communication media.

[0027] In the illustrated examples described herein, example wireless terminals used to connect with TVWS access networks may be implemented using dual-mode or other multi-mode wireless terminals having wireless capabilities for connecting to the TVWS access networks (using TVWS protocols and TVWS channels) and for connecting to an IEEE® 802.11 WLAN access network. In other example implementations, the example methods and apparatus described herein may be used by wireless terminals having TVWS connectivity capabilities in addition to capabilities for connecting to access network technologies other than IEEE® 802.11 WLAN access networks. Such other access network technologies may include both wireless and wired technologies such as cellular, Ethernet LAN and universal serial bus (USB), for example.

[0028] A dual-mode wireless terminal can be advantageously used to connect to a TVWS database via a non-TVWS access network (e.g., a WLAN access network or a cellular network) to retrieve information about TVWS access network connectivity capabilities/requirements/availability before attempting to connect to a TVWS access network. In this manner, if TVWS connectivity is not available or not possible, a wireless terminal need not consume battery power in attempting to connect to a TVWS access network when such an access network is not available or such a connection is not possible.

[0029] Turning now to FIG. **1**, an example communication network **100** in which the example methods and apparatus described herein may be implemented is shown. As shown in FIG. **1**, the example communication network **100** includes access networks (ANs) **102***a-b*, each having a respective access point (AP) **104***a-b*. In the illustrated example, the ANs **102***a-b* are TVWS ANs. As shown, the AN **102***a* provides wireless coverage to a geographic location (GEO-LOC) A **106***a*, and the AN **102***b* provides wireless coverage to a GEO-LOC B **106***b*. When a wireless terminal **108** is located in the GEO-LOC A **106***a*, the wireless terminal **108** can establish a connection with the AN **102***a*. When the wireless terminal **108** moves to the GEO-LOC B **106***b*, the wireless terminal **108** can establish a connection with the AN **102***b*.

[0030] To provide the wireless terminal **108** with AN connectivity information for establishing connections with the access networks **102***a-b*, the communication network **100** is provided with a network database **110**, which is a TVWS database **110** in the illustrated example. The TVWS database **110** is shown located in an external network **112** that is logically external or separate from the ANs **102***a-b* and logically separate from any other access network through which wireless terminals connect to the TVWS database **108**. Although not shown, the ANs **102***a-b* may connect with the external network **112** through another intermediate network (e.g., the Internet, a private network, etc.). In some example implementations, the TVWS database **110** may be distributed between different regions, with a hierarchy of databases that are managed and synchronized. In some example implementations, the ANs **102***a-b* or any other AN (e.g., a WLAN **116**) may cache local copies of relevant portions (e.g., based on a limited geographical region) or all of the TVWS database **110**.

[0031] As shown, the TVWS database **110** stores AN connectivity information **114**, which includes AN connectivity information for establishing connections with the AN **102***a* and for the AN **102***b*. Access network connectivity information may include, for example, connection frequencies (e.g., frequency channels), available bandwidth, allowed transmission power, downlink transmission power availability, policies, locations, timing information, temporal range and/or geographic range of usage from a present position (e.g., based on protection contours stored in the TVWS database **110**), and/or access rights to channels allocated for access network connectivity (e.g., connections with TVWS access networks). This information can be provided for different locations in which access networks (e.g., the access networks **102***a-b*) provide wireless coverage.

[0032] In the illustrated example of FIG. **1**, the wireless terminal **108** may access the TVWS database **110** from either of the ANs **102***a-b* or from any other AN to retrieve access network connectivity information for either of the ANs **102***a-b* or any other AN. That is, the wireless terminal **108** can request AN connectivity information for any location (or all locations) to which it may be moved in the future even though the wireless terminal **108** is not presently in communication with an access network of that location. To retrieve relevant information, the wireless terminal **108** can predict its future locations based on any number of prediction factors (e.g., speed of travel, direction of travel, geographic map data, prior history, user input, web browser searches (e.g., map queries, travel direction search queries, etc.), etc.) and access the TVWS database **110** from any AN to retrieve AN connectivity information associated with connecting with any other AN, or maintaining a connection to the same AN, at the predicted future locations. In some example implementations, manual user input may also be used to provide the wireless terminal **108** with predicted future locations. Such manual user input may be advantageously used for instances in which the predicted future locations are relatively far from a current location such as in a different state or a different country or when the wireless terminal **108** is not expected to be located in such predicted future locations until the distant future (e.g., in the next few days, the next week, etc.).

[0033] In addition, the wireless terminal **108** may access the TVWS database **110** from any other type of AN different from a TVWS AN type used to implement the ANs **102***a-b* to request AN connectivity information for the ANs **102***a-b*. For example, the communication network **100** includes a WLAN access network **116** having a WLAN access point (AP) **118** that also provides access to the TVWS database **110** in the external network **112**. In some example implementations, the wireless terminal **108** (e.g., implemented as a multi-mode wireless terminal) may predict that it will be located in GEO-

LOC A **106***a* and GEO-LOC B **106***b* in the future and access the TVWS database **110** through the WLAN AN **116** to request AN connectivity information for connecting with the AN **102***a* and the AN **102***b*.

[0034] In the illustrated example of FIG. **1**, the AN connectivity information for the AN **102***a* may be different from the AN connectivity information for the AN **102***b*. In particular, as shown in FIG. **1**, the GEO-LOC B **106***b* may have licensed devices (LDs) **120** (e.g., licensed wireless microphones, TV broadcast stations, etc.) that use the same wireless spectrum (e.g., the same frequency channels) also used by the wireless terminal **108** to connect with the AN **102***b*. The LDs **120** can be registered with the TVWS database **110** so that the TVWS database **110** can notify other devices of which frequency channels the LDs **120** will be occupying for their operations at particular dates/times in the GEO-LOC B **106***b*. In this manner, the TVWS database **110** can inform mobile communication devices such as the wireless terminal **108** that such frequency channels are not available for use in the GEO-LOC B **106***b* during the registered dates/times. Thus, if the wireless terminal **108** is using a frequency channel in the GEO-LOC A **106***a* that is restricted or unavailable in the GEO-LOC B **106***b* (due to operation of one or more of the LDs **120**), the wireless terminal **108** must change its AN connection configuration when it moves into the GEO-LOC B **106***b* and its wireless connection is handed off from the AN **102***a* to the AN **102***b*.

[0035] In some example implementations, AN connectivity information retrieved from the TVWS database **110** may also include temporal range and/or geographic range of usage to indicate a duration (e.g., a temporal range) for which or an area (e.g., a geographic range) in which the AN connectivity information is valid for use. In some instances, the temporal range and/or geographic range may indicate that the AN connectivity information is valid for use in one AN or over a span of several ANs. Temporal range of usage for AN connectivity information may be more relevant for fixed wireless terminals or wireless terminals that do not move very often, while geographic range of usage may be more relevant to mobile wireless terminals that move relatively more often between different locations. Such temporal and/or geographic range of usage may be advantageously used by the wireless terminal **108** to prioritize selected AN connectivity configurations or identify preferred AN connectivity configurations. For example, if the wireless terminal **108** is subject to a substantial amount of travel (e.g., travel by car on a highway), the wireless terminal **108** may prioritize a preference to have a uniform or same channel selection to prevent the need to perform frequent channel changeovers or handovers when traveling between different ANs based on a geographic range. If the wireless terminal **108** is subject to a near stationary state (e.g., the wireless terminal **108** experiences very little or no change in location as may be the case when the wireless terminal **108** is carried by a pedestrian while walking) or short range mobility (e.g., during indoor usage of the wireless terminal **108**), the wireless terminal **108** may prioritize a preference to have the longest duration channel selection (e.g., select a channel that may remain selected for the longest duration) to prevent the need to perform frequent channel changeovers or handovers during the duration of a connection session with a current AN or a group of ANs based on a temporal range.

[0036] Although not shown, the ANs **102***a-b* and **116** may also be provided with network access servers (NASs) in communication with respective APs **104***a-b* and **118**. In such example implementations, the NASs may be used to determine whether wireless terminals are permitted to gain network access and, thus, communicate with the ANs **102***a-b* and **116** and other networks (e.g., the external network **112**). In addition, NASs may process communications sent by the wireless terminal **108** to the APs **104***a-b* and **118** intended for delivery to the TVWS database **110** and forward such communications or related portions (e.g., IEEE® 802.11 Information Elements used with an Access Network Query Protocol to form TVWS protocol (TVWSP) frames) to the TVWS database **110**. In addition, the NASs may be used to receive responses from the TVWS database **110** and forward the response information (e.g., via TVWSP frames) to the wireless terminal **108** through respective ones of the APs **104***a-b* and **118**.

[0037] Turning briefly to FIG. **14**, the example methods and apparatus described herein may also be implemented in connection with mobile ANs that are moved between different geographic locations (e.g., the GEO-LOCs A-B **106***a-b*). In the illustrated example of FIG. **14**, the wireless terminal **108** is shown in another example network system **1400** having some elements in common with the network system **100** of FIG. **1** and may be implemented in connection with the network system **100**, in some example implementations. The network system **1400** is shown as having an AN **152** including an AP **154**. The AN **152** may be a wireless wide area network (WWAN), a wireless metropolitan area network (WMAN), a WiMAX AN, a Long Term Evolution (LTE) AN, or any other type of AN that is in communication with the external network **112** and capable of communicating with mobile devices and mobile APs.

[0038] In the illustrated example, the wireless terminal **108** is shown in communication with a mobile TVWS AP **156** forming a mobile TVWS AN. To access the external network **112** or any other network (e.g., the Internet), the mobile TVWS AP **156** is in communication with a mobile WWAN AP **158** which, in turn, is in communication with the AP **154** of the AN **152**. In the illustrated example, the conveyance vehicle for the wireless terminal **108**, the mobile TVWS AP **156** and the mobile WWAN AP **158** is a bus **160**, but may be any other type of vehicle including, for example, an automobile, a person (e.g., a person carrying a portable device forming an ad-hoc AP), etc.

[0039] In the illustrated example, the mobile TVWS AP **156** may be provided with a WLAN radio to communicate with the WLAN AP **118**. During operation, an enabling AP such as the WLAN AP **118** transmits enabling beacons **162** that, when detected and decoded by the TVWS AP **156** cause the TVWS AP **156** to access the external network **112** via the mobile WWAN AP **158**. The mobile TVWS AP **156** may query the TVWS database **110** through the WWAN AP **158** requesting TVWS channel availability information as described herein for a present actual location (e.g., the GEO-LOC A **106***a*) in which the bus **160** is located and/or any predicted future locations (e.g., the GEO-LOC A **106***b*) in which the bus **160** may be located in the future. The TVWS AP **156** may locally store the received TVWS channel availability information, and the wireless terminal **108** may request the TVWS channel availability information from the TVWS AP **156** to establish a non-interfering connection with the TVWS AP **156**.

[0040] As the wireless terminal **108**, the mobile TVWS AP **156**, and the mobile WWAN AP **158** move between different locations, they may cross protection contours associated with

the operations of primary devices (e.g., licensed, registered devices of white space channels), such as the LDs **120**, located at those different locations. During such movement, the mobile TVWS AP **156** can query the TVWS database **110** for updated TVWS channel availability information for approaching locations and send the TVWS channel availability information to the wireless terminal **108** to enable the wireless terminal **108** to maintain valid AN connections through the mobile TVWS AP **156** even though they are traversing areas in which protections are enforced for primary devices (e.g., the LDs **120**). Thus, even though the wireless terminal **108** and the mobile TVWS AP **156** move between different protection contours they can remain in communication with one another without interfering with nearby primary devices by using TVWS channel availability information received from the TVWS database **110**.

[0041] In the illustrated example, when the mobile TVWS AP **156** is in GEO-LOC A **106***a* and moving toward GEO-LOC B **106***b*, the TVWS AP **156** may query the TVWS database **110** to request updated TVWS channel availability information for the GEO-LOC B **106***b* and determine the available channels in that new location. If the channel selected for a current location (e.g., GEO-LOC A **106***a*) is no longer available in the approaching new location (GEO-LOC B **106***b*), the TVWS AP **156** selects a channel that is available in the new location and instructs all of its attached wireless terminals (e.g., the wireless terminal **108**) to change the configurations of their AN connections with the TVWS AP **156** to use the new channel. In the illustrated example, the TVWS AP **156** can continue to provide TVWS network coverage to wireless terminals as long as it receives the enabling beacons **162** from the WLAN AP **118**.

[0042] Turning now to the illustrated example of FIG. **2**, the wireless terminal **108** of FIG. **1** predicts future locations (e.g., near-future locations along a current path of travel **202**) for use in retrieving AN connectivity information for connecting to the ANs **102***a-b* of FIG. **1**. The current path of travel **202** includes a previous actual location **204** (in the GEO-LOC A **106***a*) and a present actual location **206** (in the GEO-LOC B **106***b*) of the wireless terminal **108**. In the illustrated example, the wireless terminal **108** may be provided with a global positioning system (GPS) device or other location awareness technology to determine the current path of travel **202**, the previous actual location **204** and the present actual location **206**. In some example implementations, the wireless terminal **108** may send its present actual location **206** to the TVWS database **110** of FIG. **1**, and the TVWS database **110** may use the present actual location **206** (e.g., a location in the GEO-LOC B **106***b*) to determine the geo-physical range of each frequency channel that is presently available to the wireless terminal **108** for connecting to, for example, the AN **102***b* (FIG. **1**) of the GEO-LOC B **106***b*. Thus, the TVWS database **110** may perform the function of geographic prediction based on information provided by the wireless terminal **108**.

[0043] The wireless terminal **108** may use prediction factors to determine predicted future locations **208** at which the wireless terminal **108** predicts it will be located in the future (e.g., the near future). Prediction factors may include, for example, the previous actual location **204** (and/or other previous actual locations), the present actual location **206**, speed of travel, direction of travel, and/or any other information that may be used to predict future locations. Any known and suitable techniques for predicting the predicted future locations **208** may be employed, including manual user input of future locations. In some example implementations, by comparing predictions with periodic sample readings of actual locations, the accuracy of subsequent predictions can be improved.

[0044] In addition, the wireless terminal **108** may use speed of travel and direction of travel information to determine how often it needs to check-in with or request updated AN connectivity information from the TVWS database **110**. For example, if the wireless terminal **108** is moving relatively slowly or not moving at all, the wireless terminal **108** may determine that it needs to check-in (e.g., request AN connectivity information) with the TVWS database **110** less often than if it were moving relatively faster and, thus, traversing different locations (e.g., the GEO-LOCs A-B **106***a-b* of FIGS. **1** and **2**) served or covered by different ANs (e.g., the AN's **102***a-b* of FIG. **1**). In some example implementations, when the wireless terminal **108** goes beyond a temporal range or geographic range of usage for a particular channel, the wireless terminal **108** may be triggered to re-request relevant AN connectivity information from the TVWS database **110**.

[0045] As shown in FIG. **2**, predicted paths of travel may follow non-linear paths such as predicted path **210**. Such non-linear path predictions may be facilitated through the use of map data showing available paths of travel matching current paths of travel of mobile devices (e.g., the current path of travel **202** of the wireless terminal **108**). For example, if the current path of travel **202** follows an interstate highway that follows one or more bends, such bends in the available path of travel for the wireless terminal **108** may be identified from map data indicative of the same. Although the predicted path **210** is shown in FIG. **2**, the disclosed example methods and apparatus may be implemented using less granular predictions such that relatively few locations forming the predicted path **210** are predicted. In some example implementations, the wireless terminal **108** (or a network device) may predict the predicted future locations **208** without predicting paths (e.g., the predicted path **210**) between the predicted future locations **208**.

[0046] In the illustrated examples described herein, the wireless terminal **108** may use the predicted future locations **208** to request AN connectivity information from the TVWS database **110** (FIG. **1**) for ANs providing wireless coverage at the predicted future locations **208**. In this manner, the wireless terminal **108** can maintain AN connectivity with those ANs when the wireless terminal **108** is moved to the predicted locations **208**.

[0047] In the illustrated example, the wireless terminal **108** also predicts an alternative predicted future location **212**. For example, the alternative predicted future location **212** may be a viable choice if the wireless terminal **108** determines that there are two possible routes (e.g., a route in GEO-LOC D **106***d* and another route in GEO-LOC E **106***e*) for travel when leaving the GEO-LOC C **106***c*. In such instances, the wireless terminal **108** may request AN connectivity information from the TVWD database **110** from alternative predicted future locations (e.g., the alternative predicted future location **212**) in addition to predicted future locations (e.g., the predicted future locations **208**) to which the wireless terminal **108** is more likely to travel or equally likely to travel.

[0048] In some example implementations, the TVWS database **110** (or a server associated therewith) may use predicted locations (e.g., the predicted locations **208**) or other information (e.g., prediction factors) sent to it by wireless terminals to predict future connections with different wireless terminals.

The TVWS database **110** may provide forecasts of connection loads to different ANs (e.g., the ANs **102***a-b* of FIG. **1**) to inquiring wireless terminals, and the wireless terminals may use such connection load forecasts to select a travel route for a user to follow that would result in connecting to relatively lesser congested ANs.

[0049] Turning to FIG. **3**, the wireless terminal **108** may use the predicted locations **208** of FIG. **2** in connection with example message exchanges **300** between the wireless terminal **108** (FIGS. **1** and **2**), the AP **104***a*, and the TVWS database **110** of FIG. **1** to request AN connectivity information from the TVWS database **110**. For example, after predicting a path of travel including the predicted locations **208**, the wireless terminal **108** may request AN connectivity information sets corresponding to the predicted locations **208** for connecting to ANs providing wireless communication coverage along the predicted path of travel at the predicted locations **208**.

[0050] As shown in FIG. **3**, the wireless terminal **108** may store a predicted connectivity data structure **302** used to store time entries **304**, location entries **306**, and AN connectivity information sets **308** for each predicted location (e.g., the predicted locations **208**) of the wireless terminal **108**. Each of the time entries **304** indicates a time at which the wireless terminal **108** will arrive at a corresponding predicted location (e.g., one of the predicted future locations **208** of FIG. **2**), each of the location entries **306** indicates an identifier of a corresponding predicted future location (e.g., one of the predicted future locations **208**), and each of the AN connectivity information sets **308** stores AN connectivity information pertaining to a respective predicted future location at a corresponding future time (e.g., one of the time entries **304**). In the illustrated example of FIG. **3**, when the wireless terminal **108** detects that it is actually located in a location identified by a predicted future location in the location entries **306**, the wireless terminal **108** may change its current AN connection based on a corresponding one of the AN connection information sets **308**, if the current AN connection (or AN connection configuration) is no longer available. For example, if the wireless terminal **108** is on a current AN connection using channel **5** and subsequent AN connectivity information for a predicted future location allows the use of channel **5** (in addition to the use of other channels), then the wireless terminal **108** need not change the configuration of its current AN connection when it arrives at the predicted future location because the AN connectivity information for the predicted future location allows the use of channel **5**, which is already being used by the wireless terminal **108** for its already established AN connection. However, if the AN connectivity information for the predicted future location does not allow the use of channel **5**, then the wireless terminal **108** can change or adjust its AN connection to use a different channel as allowed according to the AN connectivity information of the predicted future location.

[0051] To retrieve AN connectivity information from the TVWS database **110**, the wireless terminal **108** sends an access network (AN) request message **310** to query the TVWS database **110** through the AP **104***a*. In the illustrated example, the AN request message **310** includes predicted times (T_1-T_3) and respective predicted future locations (LOC_1-LOC_3) from the predicted connectivity data structure **302**. The predicted times (T_1-T_3) and respective predicted future locations (LOC_1-LOC_3) in the AN request message **310** indicate that the wireless terminal **108** is requesting AN connectivity information that is valid for the indicated locations (LOC_1-LOC_3) at the indicated times (T_1-T_3). In the illustrated example, the indicated location LOC_1 may be indicative of a GEO-LOC C **106***c* of FIG. **2** and the indicated location LOC_2 may be indicative of a GEO-LOC D **106***d* of FIG. **2**. Upon receiving the AN request message **310**, the AP **104***a* sends a database request **312** to the TVWS database **110** forwarding the times (T_1-T_3) and respective predicted future locations (LOC_1-LOC_3) from the AN request **310**.

[0052] In the illustrated example, the TVWS database **110** responds to the database request **312** with a database response message **314** that includes the requested AN connectivity information sets ($INFO_1$-$INFO_3$) along with the corresponding predicted times (T_1-T_3). In the illustrated example, the AN connectivity information set $INFO_1$ includes connectivity information for connecting to an AN (e.g., similar to the ANs **102***a-b* of FIG. **1**) at the GEO-LOC C **106***c* of FIG. **2** at or around the predicted time T_1 and the AN connectivity information set $INFO_2$ includes connectivity information for connecting to an AN of a GEO-LOC D **106***d* of FIG. **2** at or around the predicted time T_2. After receiving the database response **314**, the AP **104***a* sends an AN response message **316** to the wireless terminal **108** including the requested AN connectivity information sets ($INFO_1$-$INFO_3$) along with the corresponding times (T_1-T_3) from the database response **314**.

[0053] In some example implementations, the predicted times (T_1-T_3) may be omitted from the database response **314** and the AN response **316** and the wireless device **108** can assume that the ordering of the requested AN connectivity information sets ($INFO_1$-$INFO_3$) in the AN response **316** corresponds to the ordering of the times (T_1-T_3) in the AN request **310** to match each of the requested AN connectivity information sets ($INFO_1$-$INFO_3$) to a respective one of the times (T_1-T_3) and a respective one of the locations (LOC_1-LOC_2).

[0054] In some example implementations, the TVWS database **110** may modify the predicted times (T_1-T_3) and the predicted future locations (LOC_1-LOC_3) to times and locations that indicate better time/location points at which requested AN connectivity information sets change. For example, the predicted time T_1 provided by the wireless terminal **108** may be temporally near a time-based change boundary (e.g., $T_{1'}$) for a corresponding AN connectivity information set $INFO_1$ such that the wireless terminal **108** would immediately or relatively quickly need to change its AN connection in accordance with an updated AN connectivity information set $INFO_{1'}$ after having arrived at a corresponding location LOC_1 at the predicted time T_1. Additionally or alternatively, the predicted location LOC_1 provided by the wireless terminal **108** may be geographically near a location-based change boundary (e.g., $LOC_{1'}$) for a corresponding AN connectivity information set $INFO_1$ such that the wireless terminal **108** would immediately or relatively quickly need to change its AN connection in accordance with an updated AN connectivity information set $INFO_{1'}$ after having arrived at the location LOC_1 at the predicted time T_1. Thus, to avoid such frequent changes in AN connections, the TVWS database **110** can provide one or more recommended or suggested AN connectivity information sets ($INFO_{1'}$-$INFO_{3'}$) in the database response **314** corresponding to one or more of the modified predicted times (T**1'**-T**3'**) and one or more of the modified predicted future locations (LOC**1'**-LOC**3'**).

[0055] In some example implementations, to provide some tolerance or allowances on the predicted times (T_1-T_3), the

TVWS database **110** may respond to the database request **312** by providing two or more AN connectivity information sets in the database response message **314** for each of the predicted times (T_1-T_3). For example, multiple AN connectivity information sets (e.g., $INFO_{1(-1)}$, $INFO_{1(0)}$, $INFO_{1(1)}$ for the predicted time T_1 may correspond to valid AN connectivity information ($INFO_{1(-1)}$) demarked by a time boundary ($T_{1(-1)}$) occurring prior to the predicted time T_1, valid AN connectivity information ($INFO_{1(0)}$) during the predicted time (T_1), and valid AN connectivity information ($INFO_{1(1)}$) demarked by a time boundary ($T_{1(1)}$) occurring after the predicted time T_1. In this manner, if the temporal trajectory of the wireless terminal **108** along a predicted path changes, the wireless terminal **108** can use the multiple AN connectivity information sets (e.g., $INFO_{1(-1)}$, $INFO_{1(0)}$, $INFO_{1(1)}$) received for each subsequent predicted future location based on the adjusted time (e.g., $T_{1(-1)}$) or $T_{1(1)}$) at which the wireless terminal **108** arrived at that subsequent predicted future location.

[0056] Additionally or alternatively, the wireless terminal **108** may re-request AN connectivity information updates from the TVWS database **110** using the AN request message **310** each time it updates the predicted times (T_1-T_3) and the predicted times (T_1-T_3) change by a sufficient amount (e.g., due to increases or decreases in travel speed of the wireless terminal **108**) such that the wireless terminal **108** predicts it will arrive at the predicted future locations (LOC_1-LOC_3) at different times associated with different AN connectivity information than previously received (e.g., different from the previously received AN connectivity information sets ($INFO_1$-$INFO_3$)). To enable the wireless terminal **108** to detect when it should retrieve updated AN connectivity information sets ($INFO_1$-$INFO_3$), the TVWS database **110** may enforce a standardized time or duration threshold. In this manner, when a change in one or more of the predicted times (T_1-T_3) changes by more than the duration threshold, the wireless terminal **108** may request one or more corresponding updated AN connectivity information sets. Such time or duration threshold may be a fixed threshold value applied to all predicted times or the TVWS database **110** may generate time or duration thresholds that are specific to each AN connectivity information set based on registration information in the TVWS database **110**. The TVWS database **110** may communicate such specific time or duration thresholds to the wireless terminal **108** in the database response message **314** in connection with respective ones of the AN connectivity information sets ($INFO_1$-$INFO_3$).

[0057] The AN request message **310** and the AN response message **316** may be implemented using Generic Advertisement Service (GAS) query/response formatted frames. The GAS protocol, as defined in IEEE® 802.11, provides transport mechanisms for advertisement services between the wireless APs and wireless terminals while the wireless terminals are in a non-associated state (or an associated state) with the wireless APs.

[0058] FIG. **4** depicts an example implementation of the wireless terminal **108** (FIGS. **1-3**) that may be used to make changes to connectivity between the wireless terminal **108** and an AN (e.g., one of the ANs **102***a-b* of FIG. **1**) based on timing information indicating the start of enforcing new AN connectivity information. The example implementation of FIG. **4** may be used in instances in which the wireless terminal **108** is mobile and/or when it is implemented as a stationary device at a fixed location. Predicting changes in AN connectivity information based on timing information (e.g., times of day or count-down times at which the changes will take effect) enables the wireless terminal **108** to implement the changes without determining or taking a reading of its location. This may be advantageously used to reduce the overall processing activity of the wireless terminal **108** during the moments approaching the changes in the AN connectivity information (e.g., Regulatory Class changes). In addition, communicating such predicted changes to other devices (e.g., TV transmitters and other TVBDs) may facilitate proper operation of co-located devices operating within the same or neighboring frequency channels.

[0059] In the illustrated example, the wireless terminal **108** stores a time-based connectivity information data structure **400** that stores time entries **402** and corresponding AN connectivity information sets **406**. The time entries **402** indicate times at which their respective AN connectivity information sets **406** start to be enforced by one or more respective ANs (e.g., the AN **102***a-b*). Alternatively, the time entries **402** may contain count-down times or durations remaining before respective AN connectivity changes become effective. In the illustrated example, the time-based connectivity information data structure **400** also includes location entries **404** (e.g., similar to the location entries **306** of FIG. **3**) corresponding to respective ones of the time entries **402** and AN connectivity information sets **406**.

[0060] In the illustrated example, the wireless terminal **108** is provided with a timed change register **408** and a real-time clock **410**. The wireless terminal **108** can use the timed change register **408** to load one of the time entries **402** and corresponding AN connectivity information sets **406** that is next-in-time or is about to start being enforced by corresponding ANs (e.g., the ANs **102***a-b* of FIG. **1**). The wireless terminal **108** uses the real-time clock **410** to trigger a time event when a time value of the real-time clock **410** matches a time value in the timed change register **408**. In response to the time event, the wireless terminal **108** implements an AN connectivity change to enable an AN connection based on the requirements of the AN connectivity information set stored in the timed change register **408**. In example implementations in which the time entries **402** correspond to count-down times (e.g., remaining times prior to upcoming AN connectivity information changes becoming effective), a counter may be used instead of the real-time clock **410** to detect when the wireless terminal **108** should implement AN connection changes based on corresponding ones of the AN connection information sets **406**.

[0061] In some example implementations, the location entries **404** may be used to update or re-calculate subsequent predicted times in the time entries **402** based on actual locations (e.g., the previous actual location **204** and the present actual location **206** of FIG. **2**) of the wireless terminal **108** along its path of travel. For example, subsequent predicted times in the time entries **402** may be offset or incorrect if the wireless terminal **108** is delayed in reaching predicted future locations indicated in the location entries **404**. In response to such delays, the wireless terminal **108** may update subsequent predicted times in the time entries **402** to obtain valid updated AN connectivity information for the updated predicted times at corresponding locations. The wireless terminal **108** may retrieve such valid updated AN connectivity information at times and locations prior to requiring AN connection changes and that are convenient based on some criteria to, for example, avoid significant communication exchanges

between the wireless terminal **108** and a network temporally near to the time that an AN connection change should be implemented.

[0062] In some example implementations, the wireless terminal **108** may use the AN connectivity information in the time-based connectivity information data structure **400** to change AN connection configurations based on detected current locations of the wireless terminal **108** rather than based on the time information in the time entries **402**. For example, if the wireless terminal **108** detects (e.g., using a GPS device or other location detection technique) that it has arrived at a predicted future location indicated in the location entries **404** but a current time has not yet reached the predicted time indicated in a corresponding one of the time entries **402**, the wireless terminal **108** may change its AN connection configuration based on having arrived at the predicted future location even though the predicted time information in the corresponding time entry **402** does not match a current time. The wireless terminal **108** can then proceed to update its subsequent predicted times in the time entries **402** and subsequent predicted locations in the location entries **404** and retrieve updated valid AN connectivity information from the TVWS database **110** for the updated times and locations.

[0063] FIG. **5** depicts an example communication technique for pushing AN connectivity information to the wireless terminal **108** (FIGS. **1-4**). The example communication technique of FIG. **5** may be used in instances in which the wireless terminal **108** is mobile and/or when it is implemented as a stationary device at a fixed location. As shown, the AN **102***a* pushes a message **502** addressed or directed to the wireless terminal **108** including a start time **504**, a location **506**, and an AN connectivity information set **508**. In some example implementations, the location **506** may be omitted if the AN connectivity information set **508** corresponds to a present actual location (e.g., the present actual location **206** of FIG. **2**) of the wireless terminal **108**. In the illustrated example, the AN connectivity information set **508** includes information about upcoming AN connectivity information changes and is based on the AN connectivity information **114** in the TVWS database **110** (FIG. **1**) (or a local proxy database at the AN). For example, a network device (e.g., the APs **104***a-b*, the WLAN AP **118**, associated NASs, and/or the TVWS database **110** of FIG. **1**) may detect a present actual location (e.g., the present actual location **206**) of the wireless terminal **108** and/or may collect location prediction parameters from the wireless terminal **108** and/or other sources and predict the future locations (e.g., the predicted future locations **208** of FIG. **2**) of the wireless terminal **108**. The network device may then push AN connectivity information via the push message **502** corresponding to the present actual location **206** and/or the predicted future locations **208** to the wireless terminal **108**.

[0064] In some example implementations, the push message **502** may include information about the positions of individual licensed devices (e.g., wireless microphones) registered to use one or more frequency channels otherwise available to the wireless terminal **108**. In other example implementations, the push message **502** may indicate frequency channels no longer available for use by TVBDs such as the wireless terminal **108** or that will once again be available after not previously being available for use due to use by other registered licensed devices (e.g., wireless microphones). The push messages **502** may be triggered for transmission by the TVWS database **110** based on a change in the TVWS database **110** associated with radio environment configurations, device registrations, device density, etc. For example, information in the TVWS database **110** may change in response to a time change (e.g., certain AN connection configurations are allowed or restricted during certain times) or in response to one or more licensed devices (e.g., the LDs **120** of FIG. **1**) operating or ceasing operation in a particular location.

[0065] The start time **504** indicates a remaining time prior to the upcoming AN connectivity information changes becoming effective or a time of day at which the changes become effective. The wireless terminal **108** can use such time-based information to implement the Regulatory/Operating Class changes in the AN connectivity information set **508** as required, and thus, reduce the overall activity (e.g., communication activity, location determination activity, etc.) of the wireless terminal **108** at the moment of the Regulatory Class change by relying on the time-based information to make such changes.

[0066] The push message **502** can be pushed down to the wireless terminal **108** from the TVWS database **110** during or after a connection initialization session (e.g., registration, initial query time), at regular intervals (e.g., once every hour), or when an event occurs in the TVWS database **110** (e.g., a concert venue will require the use of wireless microphones or has ended its use of wireless microphones). In some example implementations, the AP **104***a* of the AN **102***a* may filter AN connectivity information changes based on actual locations (e.g., the present actual location **206** of FIG. **2**) or predicted future locations (e.g., the predicted future locations **208** of FIG. **2**) of the wireless terminal **108** to ensure that only relevant AN connectivity information is pushed to the wireless terminal **108** for its predicted route, and thus, avoid unnecessary data transmissions. The pushing of relevant AN connectivity information corresponding to the predicted route of the wireless terminal **108** may be performed by a server in the network (e.g. as an associated function of a local database or NAS of the AP **104***a*, a third-party proxy within the AN **102***a*, etc.) that has been informed of the predicted route.

[0067] In the illustrated example of FIG. **5**, the wireless terminal **108** may use the timed change register **408** and the real-time clock **410** in a manner as described above in connection with FIG. **4** to implement AN connectivity changes based on the AN connectivity information **508** and the start time **504** received in the push message **502**.

[0068] FIG. **6** depicts the wireless terminal **108** (FIGS. **1-5**) using an AN connection configuration selection technique to establish an AN connection configuration requiring relatively fewer, lesser, or least amounts or quantities of AN connection configuration changes while the wireless terminal **108** travels between different geographic locations associated with different AN connectivity requirements. In the illustrated example, the AN connection configuration selection is associated with selecting a channel that will require relatively fewer or lesser (e.g., the least) amounts of changes when the wireless terminal **108** is moved between the GEO-LOCs A-C **106***a-c*.

[0069] In the illustrated example of FIG. **6**, the wireless terminal **108** predicts a predicted path of travel **602** that traverses the GEO-LOCs A-C **106***a-c*. In other example implementations, the predicted path of travel **602** may be predicted by a network device (e.g., a NAS of one of the ANs **102***a-b* of FIG. **1**, a third-party proxy within an AN, or the

TVWS database **110** of FIG. **1**). The wireless terminal **108** stores an AN connectivity information data structure **604** in which it stores predicted future locations along the predicted path of travel **602** and corresponding AN connectivity information sets **606** received from the TVWS database **110** of FIGS. **1** and **3**. In the illustrated example, the AN connectivity information sets **606** for the GEO-LOCs A-C **106***a-c* define a device protection contour along the predicted path **602** to protect other registered licensed devices (e.g., the LDs **120** of FIG. **1**) from interference caused by wireless terminals, such as the wireless terminal **108**, sharing the same frequency spectrum with the registered licensed devices.

[0070] In the illustrated example of FIG. **6**, the AN connectivity information sets **606** for the GEO-LOCs A-C **106***a-c* include channel identifiers **608** and corresponding geographic range information (GEO_R) **610** and temporal range information (TMP_R) **612** for each of the channel identifiers **608**. The geographic range information (GEO_R) **610** specifies a distance or area of usage based on a corresponding predicted future location (e.g., based on protection contours stored in the TVWS database **110**) in which a corresponding channel is available or valid for use. The geographic range information (GEO_R) **610** may be provided by the TVWS database **110** in the AN connectivity information sets ($INFO_1$-$INFO_3$) for corresponding predicted future locations (LOC_1-LOC_3) as described above in connection with FIG. **3**. The temporal range information (TMP_R) **612** specifies a duration (e.g., based on protection contours stored in the TVWS database **110**) during which a corresponding channel is available or valid for use. The temporal range information (TMP_R) **612** may be provided by the TVWS database **110** in the AN connectivity information sets ($INFO_1$-$INFO_3$) for corresponding predicted times (T_1-T_3) as described above in connection with FIG. **3**.

[0071] As shown in the AN connectivity information data structure **604**, the GEO-LOC A **106***a* is shown as allowing use of channels **31** and **36**, the GEO-LOC B **106***b* is shown as allowing use of channels **28** and **36**, and the GEO-LOC C **106***c* is shown as allowing use of channels **31** and **36**. Using the predicted path **602**, the wireless terminal **106** may select one or more channel(s) that will require the fewest changes over the course of travel via the predicted path **602** (or over a particular duration), thus reducing or minimizing AN connection configuration changes during an AN connection session. The wireless terminal **108** may form AN connection configurations for each of the GEO-LOCs A-C **106***a-c* and store the AN connection configurations in a travel path connection plan data structure **614**. Such channel selection(s) may be determined by the wireless terminal **108** based on, for example, the geographic range information (GEO_R) **610** and/or the temporal range information (TMP_R) **612** for each channel. Alternatively, the wireless terminal **108** may be instructed by a network entity (e.g., a NAS of one of the ANs **102***a-b* of FIG. **1**, a third-party proxy within an AN, or the TVWS database **110** of FIG. **1**) to select a particular channel. In some example implementations, the TVWS database **110** may send the wireless terminal **108** only channels that have the longest geographic range (GEO_R) and/or the longest temporal range (TMP_R) to facilitate selection by the wireless terminal **108** of one or more channel(s) that will require the fewest changes over the course of travel via the predicted path **602** or over a particular duration.

[0072] In the illustrated example, the wireless terminal **108** may select to use channel **36** to maintain an AN connection in each of the GEO-LOCs A-C **106***a-c* because channel **36** is available for use in each of the GEO-LOCs A-C **106***a-c*. In some example implementations, the wireless terminal **108** may select channel **36** even though it may not be the channel with the strongest signal available at the time of receiving the AN connection information sets **606**. For example, channel **31** may have a better signal strength than channel **36**, but is only available for the limited durations during which the wireless terminal **108** traverses the GEO-LOC A **106***a* and the GEO-LOC C **106***c*.

[0073] FIG. **7** depicts an example travel path selection technique that may be used in connection with a mapping application based on AN connection plans selected by the wireless terminal **108** (FIGS. **1**-**6**) along a predicted path (e.g., the predicted path **602** of FIG. **6**). For example, if the wireless terminal **108** knows the general locations to which it will travel, the wireless terminal **108** may use AN connectivity information associated with the locations and determine a path traversing some of those locations that will allow it to establish the best AN connections available based on the AN connectivity information. For instance, if two neighboring geographic locations associated with different AN connectivity requirements are available to the wireless terminal **108**, the wireless terminal **108** may indicate that one of the locations is preferable over the other because its associated AN connectivity information indicates the availability of a better connection with an AN (e.g., one of the ANs **102***a-b* of FIG. **1**). Such a better connection may be based on channels with strongest transmission powers (e.g., signal strengths) or channels requiring the relatively lesser or the least channel changes when the wireless terminal **108** moves between different geographic locations as described above in connection with FIG. **6**. In the same manner, the wireless terminal **108** can select a path of travel traversing selected network connection locations **702** that provide the overall best AN connectivity.

[0074] In the illustrated example of FIG. **7**, a user-interactive geographic navigation program **704** may provide a user-selectable option to select a best connectivity route as a travel path selection criterion when the wireless terminal **108** selects a path of travel. When the wireless terminal **702** selects a path of travel traversing selected network connection locations **702** that provide AN connectivity per user-selected criteria (e.g., best signal strength, least connection configuration changes, maximizing duration of connectivity with one or more networks of a preferred network operator, etc.), the geographic navigation program **704** can generate selected path of travel data **706** (e.g., GPS waypoints) for use in providing navigation directions or assistance to a user. The geographic navigation program **704** may be a GPS-based program or any other type of geographic navigation program.

[0075] FIG. **8** is an example implementation of the wireless terminal **108** (FIGS. **1**-**7**) shown in block diagram form. In the illustrated example, the wireless terminal **108** includes a processor **802** that may be used to control the overall operation of the wireless terminal **108**. The processor **802** may be implemented using a controller, a general purpose processor, a digital signal processor, or any combination thereof.

[0076] The wireless terminal **108** also includes a terminal message generator **804** and a terminal data parser **806**. The terminal message generator **804** may be used to generate queries and/or requests (e.g., the AN request message **310** of FIG. **3**). The terminal data parser **806** may be used to retrieve frames of information from memory (e.g., a RAM **810**) and

retrieve particular information of interest from those frames. For example, the terminal data parser **806** may be used to retrieve information communicated in the AN response message **316** of FIG. **3**. Although the terminal message generator **804** and the terminal data parser **806** are shown as separate from and connected to the processor **802**, in some example implementations, the terminal message generator **804** and the terminal data parser **806** may be implemented in the processor **802** and/or in a wireless communication subsystem (e.g., a wireless communication subsystem **818**). The terminal message generator **804** and the terminal data parser **806** may be implemented using any desired combination of hardware, firmware, and/or software. For example, one or more integrated circuits, discrete semiconductor components, and/or passive electronic components may be used. Thus, for example, the terminal message generator **804** and the terminal data parser **806**, or parts thereof, could be implemented using one or more circuit(s), programmable processor(s), application specific integrated circuit(s) (ASIC(s)), programmable logic device(s) (PLD(s)), field programmable logic device(s) (FPLD(s)), etc. The terminal message generator **804** and the terminal data parser **806**, or parts thereof, may be implemented using instructions, code, and/or other software and/or firmware, etc. stored on a machine accessible medium and executable by, for example, a processor (e.g., the example processor **802**). When any of the appended apparatus claims are read to cover a purely software implementation, at least one of the terminal message generator **804** and the terminal data parser **806** is hereby expressly defined to include a tangible medium such as a solid state memory, a magnetic memory, a DVD, a CD, etc.

[0077] The wireless terminal **108** also includes a FLASH memory **808**, a random access memory (RAM) **810**, and an expandable memory interface **812** communicatively coupled to the processor **802**. The FLASH memory **808** can be used to, for example, store computer readable instructions and/or data. In some example implementations, the FLASH memory **808** can be used to store one or more of the type of information and/or data structures discussed above in connection with FIGS. **1-7**. The RAM **810** can also be used to, for example, store data and/or instructions.

[0078] The wireless terminal **108** is optionally provided with a security hardware interface **814** to, for example, receive a subscriber identity module (SIM) card, a universal SIM (USIM) card, or a near field communication (NFC) secure element from a wireless service provider. A SIM card may be used as an authentication parameter or registration parameter (e.g., a Federal Communications Commission (FCC) identifier in the United States of America) to authenticate or register the wireless terminal **108** for establishing a connection with a database (e.g., the TVWS database **110** of FIGS. **1** and **3**), an access network (e.g., the ANs **102***a-b* and/or the WLAN AN **116** of FIG. **1**), and/or an external network (e.g., the external network **112** of FIG. **1**). The wireless terminal **108** is also provided with an external data I/O interface **816**. The external data I/O interface **816** may be used by a user to transfer information to the wireless terminal **108** through a wired medium (e.g., Ethernet, universal serial bus (USB), etc.). A wired data transfer path may, for example, be used to communicate with the TVWS database **110**.

[0079] The wireless terminal **108** is provided with a wireless communication subsystem **818** to enable wireless communications with APs (e.g., the APs **104***a-b* and/or the WLAN AP **118** of FIG. **1**). Although not shown, the wireless terminal **108** may also have a long-range communication subsystem to receive messages from, and send messages to, a cellular wireless network. In the illustrated examples described herein, the wireless communication subsystem **818** can be configured in accordance with the IEEE® 802.11 standard and/or a TVWS standard for communicating with TVWS access networks (e.g., the ANs **102***a-b*). In other example implementations, the wireless communication subsystem **818** can be implemented using a BLUETOOTH® radio, a ZIGBEE® device, a wireless USB device, a radio frequency identification (RFID) device, an NFC device, an ultra-wideband (UWB) radio, a PAN radio, a WAN radio, a WMAN radio (e.g., for use in IEEE® 802.11 or WiMAX networks), a WRAN radio (e.g., for use in IEEE® 802.22 networks), a cellular radio, or a satellite communications radio. In some example implementations, the wireless communication subsystem **818** may be provided with multiple radio transceivers for multiple types of radio access technologies.

[0080] To enable a user to use and interact with or via the wireless terminal **108**, the wireless terminal **108** is provided with a speaker **820**, a microphone **822**, a display **824**, and a user input interface **826**. The display **824** can be an LCD display, an e-paper display, etc. The user input interface **826** could be an alphanumeric keyboard and/or telephone-type keypad, a multi-direction actuator or roller wheel with dynamic button pressing capability, a touch panel, etc. In the illustrated example, the wireless terminal **108** is a battery-powered device and is, thus, provided with a battery **828** and a battery interface **830**.

[0081] Turning now to FIG. **9**, an example processor system **900** for use in a network system (e.g., the network system **100** of FIG. **1**) is shown in block diagram form. Processor systems similar or identical to the processor system **900** may be used to implement the APs **104***a-b*, the WLAN AP **118** of FIG. **1**, and/or associated NASs. The processor system **900** includes a processor **902** to perform the overall operations of the processor system **900**. In addition, the processor system **900** includes a network message generator **904** to generate messages (e.g., the database request **312** and the AN response message **316** of FIG. **3**) and a network data parser **906** to retrieve information from received messages (e.g., the AN request message **310** and the database response **314** of FIG. **3**). The network message generator **904** and the network data parser **906** may be implemented in the processor **902** and/or a communication subsystem (e.g., a wireless communication subsystem **912** and/or a network interface **914**) using any combination of hardware, firmware, and/or software including instructions stored on a computer-readable medium.

[0082] The processor system **900** also includes a FLASH memory **908** and a RAM **910**, both of which are coupled to the processor **902**. The FLASH memory **908** may be configured to store one or more of the types of information and/or data structures discussed above in connection with FIGS. **1-7**.

[0083] In some example implementations (e.g., the APs **102***a-b* and the WLAN AP **118** of FIG. **1**), to communicate with wireless terminals such as the wireless terminal **108**, the processor system **900** is provided with a wireless communication subsystem **912**, which may be substantially similar or identical to the wireless communication subsystem **818** (FIG. **8**) of the wireless terminal **108**. To exchange communications with the TVWS database **110** (and/or any intermediate network entities (e.g., the APs **104***a-b*, the WLAN AP **118** of

FIG. **1**, associated NASs, etc.), the processor system **900** is provided with a network interface **914**.

[0084] FIGS. **10-13** depict example flow diagrams representative of processes that may be implemented using, for example, computer readable instructions that may be used to predict future locations of wireless terminals, obtain network connectivity information from a database (e.g., the TVWS database **110** of FIGS. **1** and **3**) indicative of capabilities and requirements for connecting to access networks (e.g., the ANs **102***a-b* of FIG. **1**), select network connectivity configurations, and establish connections with access networks based on such configurations. The example processes of FIGS. **10-13** may be performed using one or more processors, controllers, and/or any other suitable processing devices. For example, the example processes of FIGS. **10-13** may be implemented using coded instructions (e.g., computer readable instructions) stored on one or more tangible computer readable media such as flash memory, read-only memory (ROM), and/or random-access memory (RAM). As used herein, the term tangible computer readable medium is expressly defined to include any type of computer readable storage and to exclude propagating signals. Additionally or alternatively, the example processes of FIGS. **10-13** may be implemented using coded instructions (e.g., computer readable instructions) stored on one or more non-transitory computer readable media such as flash memory, read-only memory (ROM), random-access memory (RAM), cache, or any other storage media in which information is stored for any duration (e.g., for extended time periods, permanently, brief instances, for temporarily buffering, and/or for caching of the information). As used herein, the term non-transitory computer readable medium is expressly defined to include any type of computer readable medium and to exclude propagating signals.

[0085] Alternatively, some or all of the example processes of FIGS. **10-13** may be implemented using any combination (s) of application specific integrated circuit(s) (ASIC(s)), programmable logic device(s) (PLD(s)), field programmable logic device(s) (FPLD(s)), discrete logic, hardware, firmware, etc. Also, some or all of the example processes of FIGS. **10-13** may be implemented manually or as any combination (s) of any of the foregoing techniques, for example, any combination of firmware, software, discrete logic and/or hardware. Further, although the example processes of FIGS. **10-13** are described with reference to the flow diagrams of FIGS. **10-13**, other methods of implementing the processes of FIGS. **10-13** may be employed. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, sub-divided, or combined. Additionally, any or all of the example processes of FIGS. **10-13** may be performed sequentially and/or in parallel by, for example, separate processing threads, processors, devices, discrete logic, circuits, etc.

[0086] Now turning to FIG. **10**, the depicted example process may be used to predict near-future locations for use in selecting AN connection configurations for connecting to the ANs (e.g., the ANs **102***a-b* of FIG. **1**). Initially, the wireless terminal **108** collects location prediction factors (block **1002**). For example, location prediction factors may include travel speed, direction of travel, geographic map data, prior history, previous actual locations (e.g., the previous actual location **204** of FIG. **2**), present actual locations (e.g., the present actual location **206** of FIG. **2**), user input, web browser searches (e.g., map queries, travel direction search queries, etc.), and/or any other types of information that may be used to predict future locations of the wireless terminal **108**.

[0087] The wireless terminal **108** predicts its future locations (block **1004**) and generates a time-based listing of the predicted future locations (block **1006**). For example, the wireless terminal **108** may predict the future locations **208** of FIG. **2** and store the predicted future locations **208** in the predicted connectivity data structure **302** of FIG. **3** along with corresponding times in the time entries **304** of when the wireless terminal **108** will be located at those locations.

[0088] The wireless terminal **108** requests AN connectivity information for the predicted future locations (block **1008**) using, for example, the AN request message **310** as described above in connection with FIG. **3**. The wireless terminal **108** receives the requested AN connectivity information for the predicted future locations (block **1010**). For example, the wireless terminal **108** may received the requested AN connectivity information via the AN response message **316** as described above in connection with FIG. **3**. The wireless terminal **108** may store the received AN connectivity information in the predicted connectivity data structure **302** as ones of the AN connectivity information sets **308**.

[0089] Although the operations of blocks **1002**, **1004**, **1006**, **1008**, and **1010** are described as being performed by the wireless terminal **108**, in some example implementations, such operations may instead be performed by a network device (e.g., the APs **104***a-b*, the WLAN AP **118**, associated NASs, and/or the TVWS database **110** of FIG. **1**). For example, such network devices may collect location prediction parameters from the wireless terminal **108** and/or other sources, predict the future locations of the wireless terminal **108**, push AN connectivity information (e.g., via the push message **502** of FIG. **5**) corresponding to such predicted future locations to the wireless terminal **108**.

[0090] When the wireless terminal **108** determines that it has arrived at a new location (block **1012**), it determines whether the new location corresponds to an accurate prediction of one of the predicted future locations in the predicted connectivity data structure **302** (block **1014**). If the new location matches one of the predicted future locations, the wireless terminal **108** determines that the location was predicted accurately (block **1014**) and does not need to re-request AN connectivity information from the TVWS database **110** (FIGS. **1** and **3**) (block **1016**). Instead, the wireless terminal **108** uses the AN network connectivity information stored in one of the AN network connectivity information sets **308** corresponding to the new location to establish or maintain an AN connection (block **1018**). Control then returns to block **1012**.

[0091] If at block **1014**, the new location was not accurately predicted (i.e., the wireless terminal **108** determines that its new location does not match one of the predicted future locations in the predicted connectivity data structure **302**), the wireless terminal **108** requests AN connectivity information for its present location (block **1020**) from the TVWS database **110**. For example, the wireless terminal **108** may request the AN connectivity information using the AN request message **310** as described above in connection with FIG. **3** for its present location. The wireless terminal **108** then uses the received AN connectivity information **1022** to establish or maintain an AN connection (block **1022**). Control then

returns to block **1002**, and the wireless terminal **108** can predict subsequent future locations based on its present location.

[0092] When the wireless terminal **108** determines at block **1012** that it has not arrived at a new location, the wireless terminal **108** determines whether it should disconnect (block **1024**). For example, the wireless terminal **108** may disconnect in response to receiving a power off signal or a disconnect command from a user. If the wireless terminal **108** determines not to disconnect (block **1024**), control returns to block **1012** to monitor the location of the wireless terminal **108**. Otherwise, the wireless terminal **108** disconnects a present AN connection (block **1026**), and the example process of FIG. **10** ends.

[0093] FIG. **11** depicts an example process that may be used to implement AN connectivity changes between the wireless terminal **108** and an access network based on timing information corresponding to the start of enforcing AN connectivity information. Initially, the wireless terminal **108** receives AN connectivity information (block **1102**). For example, the wireless terminal **108** may retrieve the AN connectivity information as discussed above in connection with FIG. **3** or may receive the AN connectivity information via the push message **502** as described above in connection with FIG. **5**.

[0094] The wireless terminal **108** configures a time event based on a start time corresponding to the received AN connectivity information (block **1104**). For example, the wireless terminal **108** can store an approaching start time from one of the time entries **402** and a corresponding AN connectivity information set **406** into the timed change register **408** as described above in connection with FIG. **4**. Alternatively, as described above in connection with FIG. **5**, the wireless terminal **108** can store the start time **504** and corresponding AN connectivity information **508** from the push message **502** in the timed change register **408**.

[0095] When the wireless terminal **108** detects an assertion or triggering of the time event (block **1106**) as described above in connection with FIGS. **4** and **5**, the wireless terminal **108** updates an AN connection based on the AN connectivity information (block **1108**). The wireless terminal **108** determines whether it should retrieve next AN connectivity information (block **1110**). For example, if the wireless terminal **108** determines that another one of the time entries **402** is approaching a current time, the wireless terminal **108** can retrieve a corresponding one of the AN connectivity information sets **406**. Alternatively, the wireless terminal **108** may receive a push message (e.g., the push message **502**) with next AN connectivity information. If the wireless terminal **108** determines that it should retrieve next AN connectivity information (block **1110**), control returns to block **1102**.

[0096] If the wireless terminal **108** determines that it should not retrieve next AN connectivity information (block **1110**) or if the wireless terminal **108** has not detected the time event (block **1106**), the wireless terminal **108** determines whether it should disconnect an AN connection (block **1112**). If the wireless terminal **108** determines that it should not disconnect an AN connection (block **1112**), control returns to block **1106**. Otherwise, the wireless terminal **108** disconnects the AN connection (block **1114**) and the example process of FIG. **11** is ended.

[0097] FIG. **12** depicts an example process that may be used to select AN connection configurations (e.g., connection configurations stored in the travel path connection plan data structure **614** of FIG. **6**) for establishing AN connections requiring relatively lesser or the least amount of configuration changes while traveling along different geographic locations (e.g., the GEO-LOC A-C **106***a-c* of FIG. **6**) associated with different AN connectivity requirements. Initially, the wireless terminal **108** (or a network device) predicts future locations (e.g., the predicted future locations **208** of FIG. **2**) of the wireless terminal **108** (block **1202**). The wireless terminal **108** requests AN connectivity information for predicted future locations (e.g., the predicted future locations **208**) of the wireless terminal **108** (block **1204**) via, for example, the AN request message **310** as described above in connection with FIG. **3**. The wireless terminal **108** receives the requested AN connectivity information (block **1206**) via, for example, the AN response message **316** as described above in connection with FIG. **3**. Alternatively, the AN connectivity information may be pushed by a network device via, for example, the push message **502** as described above in connection with FIG. **5** without requiring the wireless terminal **108** to request the AN connectivity information.

[0098] The wireless terminal **108** selects AN connection configurations for each predicted future location based on relatively lesser or the least connection configuration changes that would be required when the wireless terminals **108** moves between the predicted future locations (block **1208**) as described above in connection with FIG. **6**. The wireless terminal **108** then generates a travel path connection plan (block **1210**) including the AN connectivity configurations for each of the predicted future locations. For example, the wireless terminal **108** may store the AN connectivity configurations in the travel path connection plan data structure **614** of FIG. **6**. The example process of FIG. **12** then ends.

[0099] FIG. **13** depicts an example process that may be used to select a travel path (e.g., the selected navigation path **706** of FIG. **7**) in connection with the geographic navigation program **704** (FIG. **7**) based on AN connection locations selected by the wireless terminal **108** of FIGS. **1-8**. Initially, the wireless terminal **108** selects AN connection configurations (block **1302**). For example, the wireless terminal **108** may select AN connection configurations along selected locations as described above in connection with FIGS. **6** and **12**. The wireless terminal **108** generates the selected network connection locations listing **702** (FIG. **7**) (block **1304**), and sends the selected network connection locations listing **702** to the geographic navigation program **704** (block **1306**). The geographic navigation program **704** generates the selected navigation path **706** (FIG. **7**) based on the selected network connection locations **702** (block **1308**). The example process of FIG. **13** then ends.

[0100] Although certain methods, apparatus, and articles of manufacture have been described herein, the scope of coverage of this patent is not limited thereto. To the contrary, this patent covers all methods, apparatus, and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

1. A method to retrieve network connectivity information based on a predicted future location of a wireless terminal, the method comprising:

predicting at least one future location of a wireless terminal; and

requesting at least first and second network connectivity information sets for connecting to at least one access network providing wireless communication coverage at the at least one future location, the first network connec-

tivity information associated with a first geographic location, and the second network connectivity information associated with a second geographic location.

2. A method as defined in claim **1**, wherein the requesting of the at least first and second network connectivity information sets comprises requesting the first and second network connectivity information sets from a database located in an external network relative to the at least one access network providing the wireless communication coverage.

3. A method as defined in claim **2**, wherein the database is a television white space database.

4. A method as defined in claim **1**, wherein the requesting of the at least first and second network connectivity information sets is performed by sending a request to a second access network before the wireless terminal is in the first or second geographic locations.

5. A method as defined in claim **4**, wherein the at least one access network and the second access networks are white space networks.

6. A method as defined in claim **4**, wherein the at least one access network is a white space network and the second access network is one of a wireless local area network or a cellular network.

7. A method as defined in claim **4**, wherein the at least one access network is one of a wireless local area network or a cellular network and the second access network is one of a wireless local area network or a cellular network.

8. A method as defined in claim **1**, wherein the predicting of the at least one future location of the wireless terminal is performed based on at least one of a traveling speed of the wireless terminal or a direction of travel of the wireless terminal.

9. A method as defined in claim **1**, wherein the first network connectivity information set includes network connectivity requirements to avoid interfering with at least one other device operating in the same frequency channels over which the at least one access network is capable of connecting with the wireless terminal.

10. A method as defined in claim **9**, wherein the at least one other device is a licensed device registered to operate in the first geographic location using at least one of the same frequency channels.

11.-**14**. (canceled)

15. A tangible machine readable medium having instructions stored thereon that, when executed, cause a machine to perform the method of claim **1**.

16. An apparatus to retrieve network connectivity information based on a predicted future location of a wireless terminal, the apparatus comprising:

a processor configured to:

predict at least one future location of a wireless terminal; and

request at least first and second network connectivity information sets for connecting to at least one access network providing wireless communication coverage at the at least one future location, the first network connectivity information associated with a first geographic location, and the second network connectivity information associated with a second geographic location.

17. An apparatus as defined in claim **16**, wherein the processor is configured to request the at least first and second network connectivity information sets by requesting the first and second network connectivity information sets from a database located in an external network relative to the at least one access network providing the wireless communication coverage.

18. An apparatus as defined in claim **17**, wherein the database is a television white space database.

19. An apparatus as defined in claim **16**, wherein the processor is configured to request the at least first and second network connectivity information sets by sending a request to a second access network before the wireless terminal is in the first or second geographic locations.

20. An apparatus as defined in claim **19**, wherein the at least one access network and the second access networks are white space networks.

21. An apparatus as defined in claim **19**, wherein the at least one access network is a white space network and the second access network is one of a wireless local area network or a cellular network.

22. An apparatus as defined in claim **19**, wherein the at least one access network is one of a wireless local area network or a cellular network and the second access network is one of a wireless local area network or a cellular network.

23. An apparatus as defined in claim **16**, wherein the processor is configured to predict the at least one future location of the wireless terminal based on at least one of a traveling speed of the wireless terminal or a direction of travel of the wireless terminal.

24. An apparatus as defined in claim **16**, wherein the first network connectivity information set includes network connectivity requirements to avoid interfering with at least one other device operating in the same frequency channels over which the at least one access network is capable of connecting with the wireless terminal.

25.-**29**. (canceled)

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