



US 20170013435A1

(19) **United States**

(12) **Patent Application Publication**
SINGER et al.

(10) **Pub. No.: US 2017/0013435 A1**

(43) **Pub. Date: Jan. 12, 2017**

(54) **AUTOMATED PROXIMATE LOCATION
ASSOCIATION MECHANISM FOR
WIRELESS EMERGENCY SERVICES**

G01S 5/02 (2006.01)

H04W 4/02 (2006.01)

(52) **U.S. Cl.**

CPC **H04W 4/22** (2013.01); **H04W 4/02**
(2013.01); **H04W 76/007** (2013.01); **G01S**
5/0257 (2013.01)

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(57)

ABSTRACT

(21) Appl. No.: **15/175,567**

(22) Filed: **Jun. 7, 2016**

Related U.S. Application Data

(63) Continuation of application No. 13/705,312, filed on
Dec. 5, 2012, now Pat. No. 9,374,696.

(60) Provisional application No. 61/566,923, filed on Dec.
5, 2011.

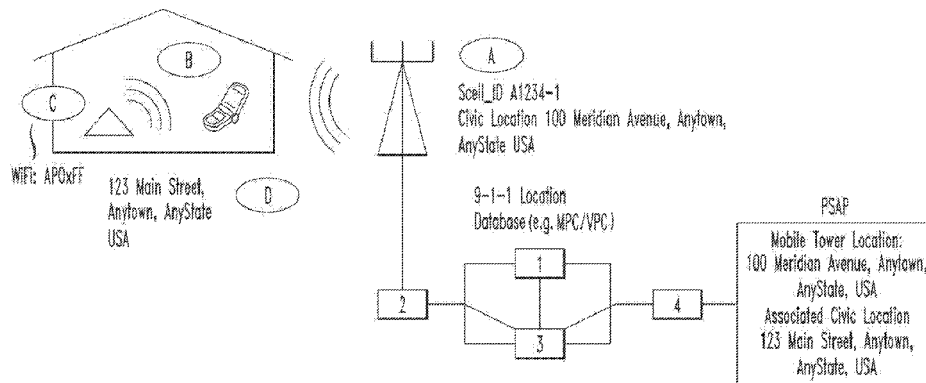
Publication Classification

(51) **Int. Cl.**

H04W 4/22 (2006.01)

H04W 76/00 (2006.01)

Automatic Location Information (ALI) data that is representative of a landline address is digitally retrieved, and automatically transferred to an emergency call taker over a wireless system emergency network. Importantly, the ALI information is determined based on association to a proximate location. Before an emergency call is initiated, additional environmental information, such as a RFID tag, location beacon, WiFi access point, Bluetooth device, or other communication signal with a known location, is included in the wireless session data exchange, used to match one or more location inputs to a fixed civic location (street address) which is used to dispatch emergency responders. Alternatively, the mechanism matches to a precise geodetic location (e.g., where no civic location is available).



Cell_ID (A)	Cell Site Provisioned Location	SNR Threshold	Lat/Lon (B)	Uncertainty	Loc. Ref. (C)	SNR Tolerance	Fixed Civic Location (D)
A1234-1	100 Meridan Avenue, Anytown, AnyState USA	30dB	44.14. ~123.23	50m	WiFi AP0xFF	37dB	123 Main Street, Anytown, AnyState USA
A1234-1	100 Meridan Avenue, Anytown, AnyState USA	30dB	44.12. ~123.19	50m	WiFi AP0xFA	37dB	125 Main Street, Anytown, AnyState USA
A1234-1	100 Meridan Avenue, Anytown, AnyState USA	30dB	44.12. ~123.19	50m	WiFi AP0x2C	37dB	44.1267890, ~123.1926543

TABLE 1

Fig. 1A

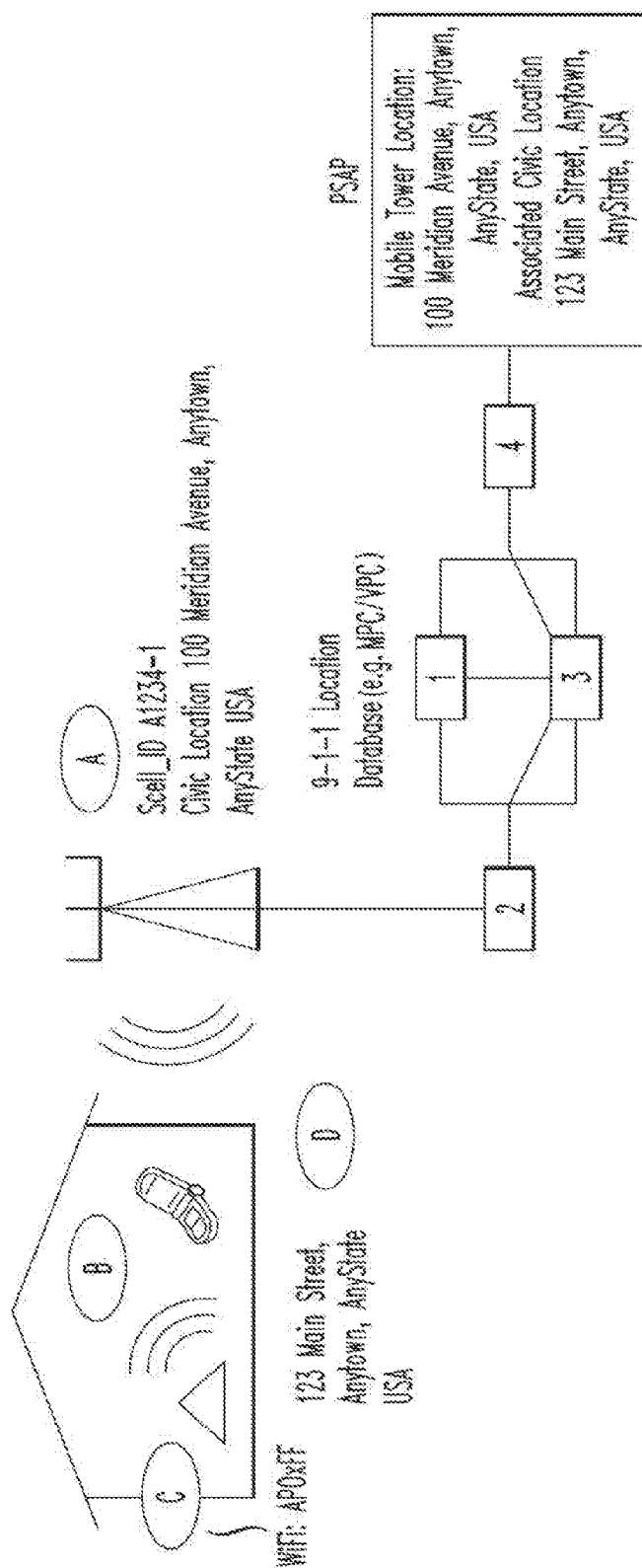


Fig. 1B

Scell ID (A)	Cell Site Provisioned Location	SNR Threshold	Lat/Lon (B)	Uncertainty	Loc. Ref. (C)	SNR Tolerance	Fixed Civic Location (D)
A1234-1	100 Meridan Avenue, Anytown, AnyState USA	30dB	44.14. -123.23	50m	WiFi AP0xFF	37dB	123 Main Street, Anytown, AnyState USA
A1234-1	100 Meridan Avenue, Anytown, AnyState USA	30dB	44.12. -123.19	50m	WiFi AP0xFFA	37dB	125 Main Street, Anytown, AnyState USA
A1234-1	100 Meridan Avenue, Anytown, AnyState USA	30dB	44.12. -123.19	50m	WiFi AP0x2C	37dB	44.1267890. -123.1926543

TABLE 1

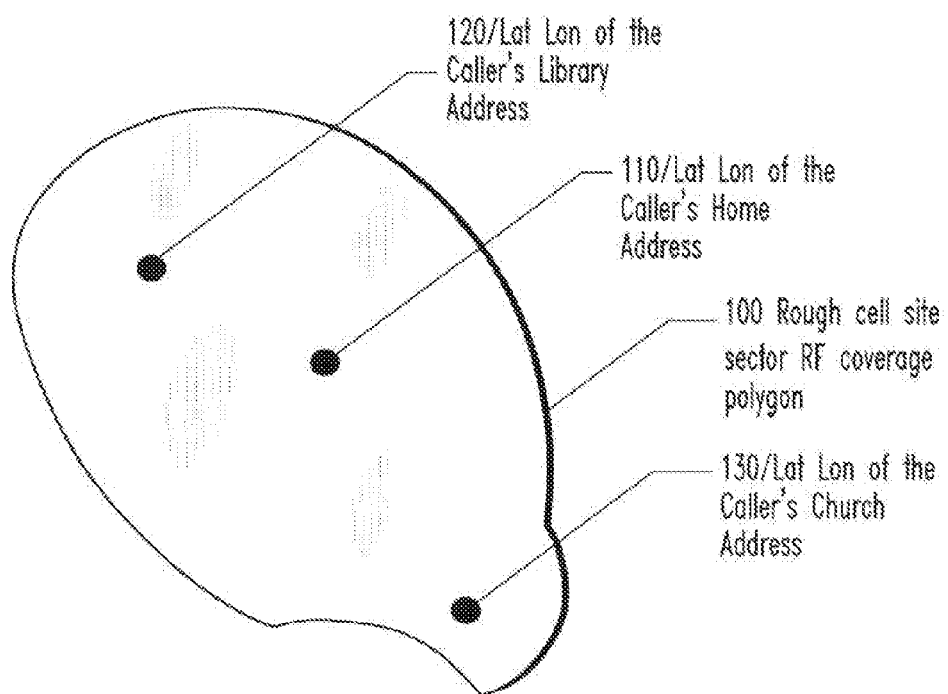


Fig. 2A

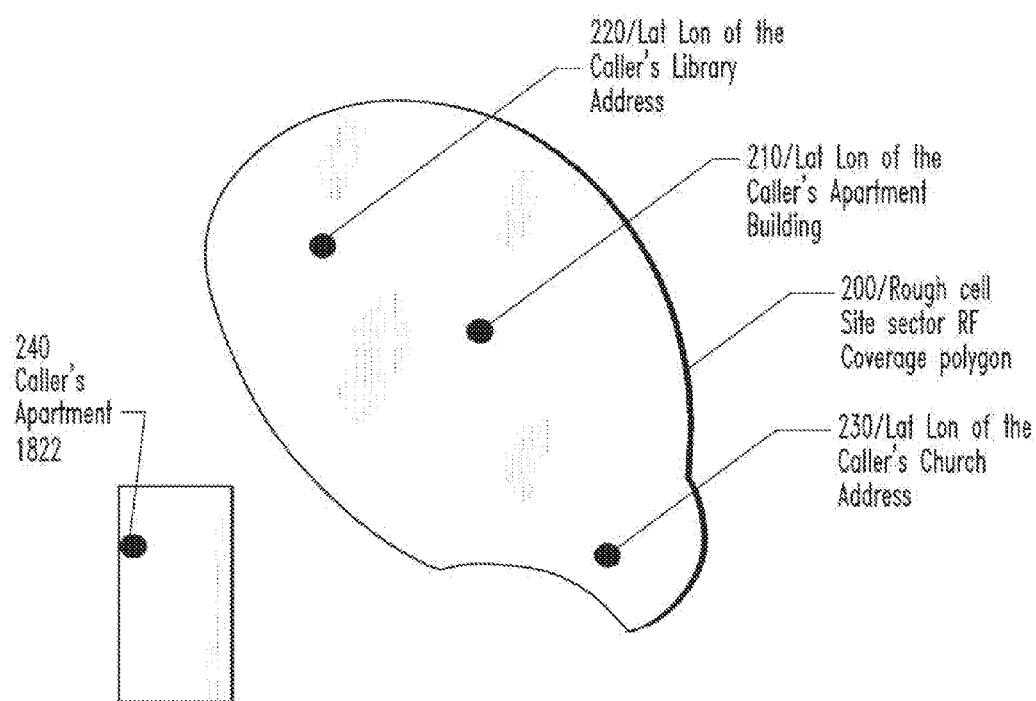
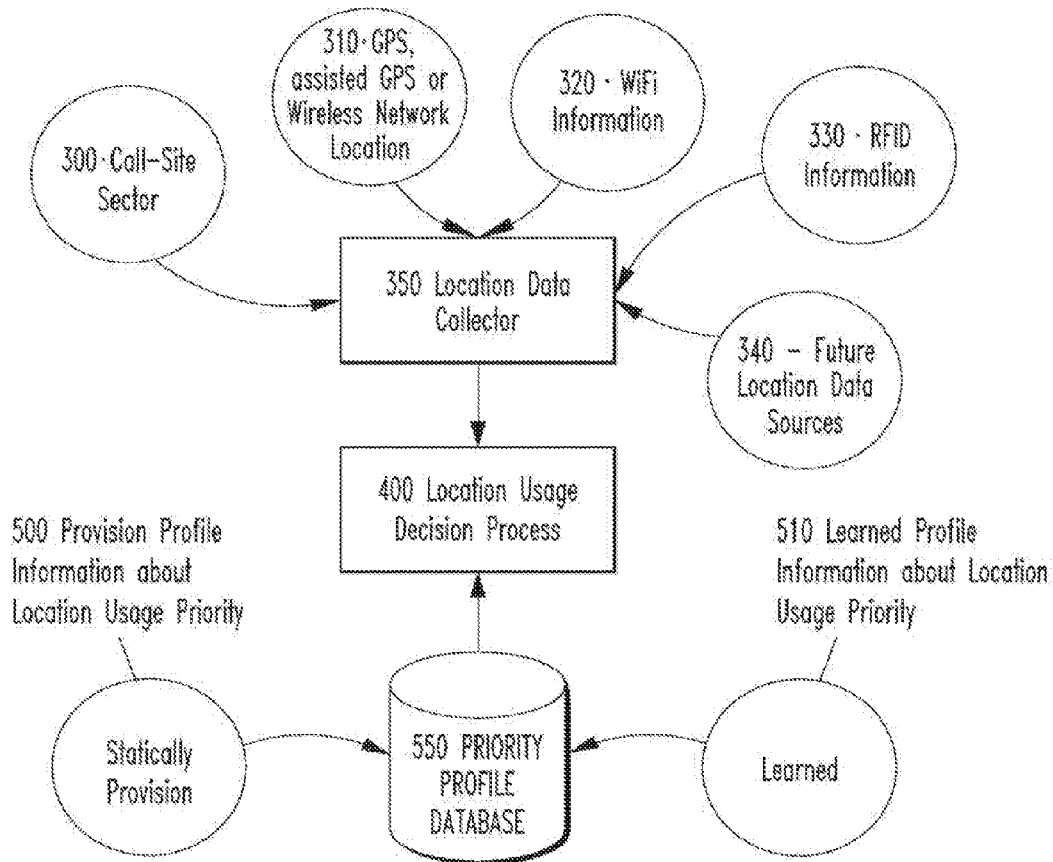


Fig. 2B



During an emergency services call, the 350 location data collector retrieves and processes information from some or all of the available sources.

- 300 - Cell Site Sector
- 310 - Calculated position from Assisted GPS, GPS, or Network Based Positioning
- 320 - WiFi Data
- 330 - RFID Data
- 340 - Future Location data sources

The 400 Location Usage Decision Process uses the processed data from 350 Location Data Collector and determines location to be delivered as part of the 911 incident data by using information from the 550 Priority Profile Database which has information which is either 500 Provisioned Profile information about Location Usage Priority or 510 Learned Profile information about location Usage Priority.

Fig. 3

AUTOMATED PROXIMATE LOCATION ASSOCIATION MECHANISM FOR WIRELESS EMERGENCY SERVICES

[0001] The present invention is a continuation of U.S. Ser. No. 13/705312, filed 5 Dec. 2012, which claims priority from U.S. Provisional No. 61/566,92, entitled “Automated Proximate Location Association Mechanism for Wireless Emergency Services”, to Singer et al., the entirety of which is explicitly incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates generally to telecommunications. More particularly, it relates to wireless telecommunications and public safety.

[0004] 2. Background of Related Art

[0005] Wireless emergency calls often are made from residences that no longer have fixed wireline service. Wireless calls don't have the equivalent fixed landline civic location information available that was expected to exist in the fixed wireline case, and so are limited to the current Cell site ID information and/or precise position information during or after the call is delivered to the PSAP. Precise location information is sometimes insufficient to provide a definitive civic location (address) for dispatching an emergency response. A solution is needed to provide a fixed landline equivalent civic location in the case where a mobile phone is used as a replacement for fixed landline service.

SUMMARY OF THE INVENTION

[0006] A physical address-determining system provisioned with associated location information to provide reliable location information of a wireless caller to a requesting party in accordance with the present invention comprises retrieving a provisioned physical address of a caller. Current proximate location information is obtained from the caller. Automatic location information (ALI) information is determined based on a best match to pre-provisioned association to the proximate location information.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Features and advantages of the present invention become apparent to those skilled in the art from the following description with reference to the drawings:

[0008] FIG. 1A shows exemplary short call flow for retrieval of ALI information determined based on association to a proximate location, in accordance with the principles of the present invention.

[0009] FIG. 1B shows a table listing several entries in an exemplary proximate location database.

[0010] FIGS. 2A and 2B are two exemplary use cases of proximate location for wireless emergency services, in accordance with the principles of the present invention.

[0011] FIG. 3 shows a system for collecting, retrieving, and processing information from a plurality of available resources.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0012] The present invention provides digital retrieval of Automatic Location Information (ALI) data that is representative of a landline address, with automatic transfer of the

same to an emergency call taker over a wireless system emergency network. Importantly, in accordance with the principles of the present invention, the ALI information is determined based on association to a proximate location.

[0013] In accordance with the invention, before an emergency call is initiated, additional environmental information, such as a RFID tag, location beacon, WiFi access point, Bluetooth device, or other communication signal with a known location, is included in the wireless session data exchange, which is then used to match one or more location inputs to a fixed civic location (street address) which is used to dispatch emergency responders. Alternatively, in another aspect of the invention, a match may be searched and made to a precise geodetic location (e.g., where no civic location is available).

[0014] During or after an emergency call has been initiated, additional location information is received, and/or queried for, that is used by an emergency 9-1-1 location database (e.g., MPCNPC/LIS) to associate a provisioned civic address representative of the fixed location that the call is being initiated from (e.g., residence, enterprise, landmark, etc.). During the call, additional information is received, and/or retrieved, that when compared alongside other key information yields a reliably probable associated fixed location that the PSAP can successfully be dispatched to.

[0015] The present invention provides a landline replacement enabler—or location information adjunct, which is helpful in many high-density-living situations, e.g., for high rise apartment dwellers. In accordance with the invention, upon receipt of a wireless emergency call, emergency responders can access a separate proximity parameter matching database, and based on proximity parameter matching, a “better” LVF valid address can be presented to the call taker.

[0016] FIG. 1 shows exemplary short call flow for retrieval of ALI information determined based on association to a proximate location, in accordance with the principles of the present invention.

[0017] In particular, as shown in step 1 of FIG. 1A, a location from which a wireless emergency call may be placed is updated with a location that is associated with a fixed environment, and tied to a location reference—ahead of an emergency call.

[0018] For instance, Table 1 shows several entries in an exemplary proximate location database. In the example of Table 1, an association is made between cell ID (step A in FIG. 1A), a physical address of the cell site provisioned location, a signal-to-noise ratio (SNR) threshold, a lat/ion (step B in FIG. 1A), a distance uncertainty, a WiFi or other RF location reference (step C in FIG. 1A), an SNR tolerance, and a fixed civic location of the wireless device (step D in FIG. 1A).

[0019] In step 2 of FIG. 1A, a wireless emergency call is initiated, and provides proximate location information to the 9-1-1 location database.

[0020] In step 3, a 9-1-1 location database processes location retrieved with proximate location information and associates a fixed civic location.

[0021] In step 4, a wireless emergency call is presented to the public safety access point (PSAP).

[0022] FIGS. 2A and 2B are two exemplary use cases of proximate location for wireless emergency services, in accordance with the principles of the present invention.

[0023] In particular, as shown in the exemplary use case of FIG. 2A, a calling wireless device calls emergency services, e.g., “9-1-1”.

[0024] In the given example, the latitude/longitude (lat/lon) of the calling device owner’s house **110** is within a cell site sector rough polygon **100**. The lat/lon of the caller’s library address **120** is also within the cell site sector rough polygon **100**. And in this particular example, the lat/lon of the caller’s church **130** is also within the cell site sector rough polygon **100**. Furthermore in this example, there is no WiFi or RFID information available. The day/time is, e.g., Sunday afternoon @3 pm.

[0025] In such a case, a stored historical location profile for this user indicates a 95% chance (probability) that the user of that given wireless device, at 3 pm on a Sunday, is at the caller’s provisioned home address **110**. However, because this address is provided via the inventive cell site sector association to a location profile, the returned address of the emergency call is provided with information indicating its reliability, e.g., “Home address information is provided to the Emergency Call Processing System with a 60% Confidence”.

[0026] But in accordance with the present invention, with additional associated location information, a more precise lat/lon may be calculated, and delivered back to the requesting system. For example, here the precise lat/lon intersects most completely with the rough area of what is provisioned as the caller’s church **130**. And because in accordance with the principles of the present invention this is a precise lat/lon association to location profile, the respond-to address may be provided more accurately to emergency personnel as, e.g., “Lat/lon & Church address information is provided to the Emergency Call Processing System with a 95% Confidence”.

[0027] In another use case shown in FIG. 2B, a calling wireless device near an apartment building calls emergency services, e.g., “9-1-1”.

[0028] In particular, as shown in FIG. 2B, a given wireless device places a call to emergency services, e.g., a “9-1-1” call. In this example the reported lat/lon of the call is placed at the caller’s apartment building **210**, which is within a cell site sector rough polygon **200**. Also the lat/lon of the caller’s library **220** is within the cell site sector rough polygon **200**, and the lat/lon of the caller’s church **230** is within the cell site sector rough polygon **200**. And there is WiFi information available, but no RFID information available. The day/time is Sunday afternoon @3 pm.

[0029] In such a use case, the user’s stored historical location profile indicates a 95% chance that the user is at the caller’s apartment building **210** at 3 pm on Sunday. However, because this is a cell site sector association to location profile, the reliability of the location information may be reported to the requesting system as, e.g., “Home address information is provided to the Emergency Call Processing System with a 60% Confidence”.

[0030] A precise lat/lon is calculated and delivered back to the system, and the precise lat/lon intersects most completely with the rough area of the caller’s apartment building **210**. Because this is a precise lat/lon association to location profile, the “Lat/lon & caller’s apartment address information **210** is provided to the Emergency Call Processing System”. The WiFi access point MAC [Media Access Control] address information is gathered, and delivered back to

the system. The WiFi access point MAC addresses lat/lon indicates a most likely intersection with a caller’s apartment **1822** on the 18th floor **240**.

[0031] Because this is a WiFi association to location profile, the reliability of the location may be reported along with a statement such as, e.g., “Calculated Lat/lon from the Wireless phone system, and the apartment address & apartment number information from the location profile is provided to the Emergency Call Processing System”.

[0032] While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention.

1. (canceled)

2. A method comprising:

receiving a location request for a mobile device from a requesting device;

retrieving an historical address profile of the mobile device, the historical address profile including civic address information and communication signal information, wherein the communication signal information characterizes a communication signal received by the mobile device while at a corresponding civic address included in the historical address profile;

receiving a current proximate location from the mobile device that characterizes an identifier (ID) of a current serving cell of the mobile device, wherein the address profile of the mobile device includes at least two previous civic addresses for the mobile device corresponding to the ID of the current serving cell and a time associated with each of the at least two civic addresses; determining automatic location information (ALI) data based on a best match of the current proximate location to each of the at least two previous civic addresses and the associated time in the historical address profile, wherein the ALI data includes a fixed civic location and a confidence value characterizing a probability that the wireless device is located at the fixed civic location; and

providing a reliability of the determined ALI data to the requesting device, wherein the reliability includes data characterizing the confidence value.

3. The method of claim 2, wherein:

the fixed civic location is a street address employed to dispatch an emergency responder.

4. The method of claim 2, wherein:

the historical address profile is populated prior to an emergency call being initiated by the mobile device.

5. The method of claim 2, wherein:

a given one of the at least two previous civic addresses is further associated with an identity of a radio frequency identification (RFID) tag.

6. The method of claim 2, wherein:

a given one of the at least two previous civic addresses is further associated with an identity of a WiFi access point.

7. The method of claim 2, wherein:

a given one of the at least two previous civic addresses is further associated with an identity of a Bluetooth device.

8. The method of claim 2, further comprising:

receiving an emergency call initiated by the mobile device.

9. The method of claim **2**, wherein:
the ALI data further includes latitude and longitude coordinates for the fixed civic location.

10. The method of claim **2**, wherein:
the requesting device is a Public Answering Safety Point (PSAP) computing terminal.

11. A server comprising:
a non-transitory memory to store machine readable instructions; and
one or more processors that access the memory and execute the machine readable instructions, the machine readable instructions causing the server to:
receive a location request for a mobile device from a requesting device in response to an emergency call from the mobile device;
retrieve an historical address profile of the mobile device, the historical address profile including civic address information and associated communication signal information, wherein the associated communication signal information characterizes a communication signal being received by the mobile device while at a corresponding civic address included in the historical address profile;
receive information that characterizes an identifier (ID) of a current serving cell of the mobile device, wherein the address profile of the mobile device includes at least two previous civic addresses for the mobile device corresponding to the ID for the current serving cell and a time associated with each of the at least two civic addresses;
determine automatic location information (ALI) data based on a best match of the current serving cell to each one of the at least two previous civic addresses and the associated time in the historical address profile, wherein the ALI data includes a fixed civic location and a confidence value characterizing a probability that the mobile device is located at the fixed civic location; and
provide a reliability of the determined ALI data to the requesting device, wherein the reliability includes data characterizing the confidence value.

12. The server of claim **11**, wherein:
the fixed civic location is a street address employed to dispatch an emergency responder.

13. The server of claim **11**, wherein:
the historical address profile is populated prior to an emergency call being initiated by the mobile device.

14. The server of claim **11**, wherein:
a given one of the at least two previous civic addresses is further associated with an identity of a radio frequency identification (RFID) tag.

15. The server of claim **11**, wherein:
a given one of the at least two previous civic addresses is further associated with an identity of a WiFi access point.

16. The server of claim **11**, wherein:
a given one of the at least two previous civic addresses is further associated with an identity of a Bluetooth device.

17. The server of claim **11**, further comprising:
receiving an emergency call initiated by the mobile device.

18. The server of claim **11**, wherein:
the ALI data further includes latitude and longitude coordinates for the fixed civic address.

19. A method comprising:
receiving a current serving cell for a mobile device and location information characterizing latitude and longitude coordinates of the mobile device;
determining a plurality of candidate locations for the mobile device that are within a polygon corresponding to a cell site sector of the serving cell;
determining automatic location information (ALI) data based on a best match of the plurality of candidate locations based on the location information, wherein the ALI data includes a fixed civic location and a confidence value characterizing a probability that the mobile device is located at the fixed civic location; and
providing a reliability of the determined ALI data to a requesting device, wherein the reliability includes data characterizing the confidence value.

20. The method of claim **19**, wherein:
the requesting party is a Public Safety Answering Point (PSAP) terminal.

21. The method of claim **19**, further comprising:
receiving data characterizing a WiFi access point in communication with the mobile device.

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