

Roadmap for Improving E911 Location Accuracy

This paper describes a roadmap for achieving improved location accuracy for both outdoor and indoor 9-1-1 calls, and is based on an agreement between APCO, NENA, and AT&T, T-Mobile USA, Sprint and Verizon Wireless (“wireless carriers”) (“signatories to the Agreement”). This roadmap includes short term (0-2 years), medium term (2-4 years), and long term (4+ years) initiatives that will advance E911 location accuracy utilizing a variety of technological solutions including those based on traditional latitude/longitude methods for both outdoor and indoor calls (e.g., AGNSS, OTDOA), as well as emerging next-generation solutions that would provide a “dispatchable location” to first responders for calls made from indoors. Dispatchable location is the civic address of the calling party plus additional information such as floor, suite, apartment or similar information that may be needed to adequately identify the location of the calling party. A chronological summary of some of the more critical initiatives is provided below (with estimated timelines based on date of signed Agreement of Nov. 14, 2014):

Short Term (0-2 years)

- Advance implementation of improved latitude/longitude-based solutions that have been recently developed (i.e., OTDOA and A-GNSS) (6-12 months) **[[3(a)]]**;
- Conduct a pre-standards demonstration of a dispatchable location solution (9 months)**[[2(c)]]**;
- Develop and implement a technology test bed in accordance with CSRIC recommendations and work undertaken by ATIS (12 months) **[[1(a)]]**;
- Develop the design, operations and maintenance requirements for the National Emergency Address Database (NEAD) (12 months) **[[2(e)(ii)]]**;
- Establish a database owner, funding mechanisms, and other requirements for the NEAD (12-24 months) **[[2(e)(iii)]]**;
- Develop outreach program to promote the development of dispatchable location solutions (12 -24 months) **[[2(e)(iv)]]**;
- Introduce new products and devices that improve location accuracy, e.g., new wireless products that support dispatchable location and new mobile devices that support A-GNSS (18-24 months) **[[2(b)(i) & 3(c)(i)]]**;
- Promote development and approval of 3GPP standards that support the delivery of dispatchable location data (18 months) **[[2(d)]]**; and
- Obtain a location fix using heightened accuracy location technologies for 40% of all wireless 9-1-1 calls (24 months) **[[4(c)(i)]]**.

Medium Term (2-4 years)

- Continue introduction of products and devices that support advanced solutions (e.g., A-GNSS, dispatchable location solutions) (24-48 months) **[[2(b)(i) & 3(c)(i)-(iii)]]**;
- Design, develop, and implement the NEAD (36 months) **[[2(e)]]**;

- Obtain a location fix using heightened location accuracy technologies for 50% of all wireless 9-1-1 calls (36 months) **[[4(c)(ii)]]**;
- Enable the delivery of dispatchable location information across voice over LTE (VoLTE) networks (42 months) **[[2(g)(i)]]**; and
- Demonstrate support for the end-to-end functionality of such solutions (48 months) **[[2(h)(i)]]**.

Long Term (4+ years)

- Obtain a location fix using heightened accuracy location technologies for 75% of all VoLTE wireless 9-1-1 calls (60 months) **[[4(c)(iii)]]**; and
- Obtain a location fix using heightened accuracy location technologies for 80% of all VoLTE wireless 9-1-1 calls (72 months) **[[4(c)(iv)]]**.

As described below, implementation and execution of the elements within this document may be subject to a number of variables, including but not limited to standards development and third party resources, which may require the signatories to reassess the progress of this Agreement. In any event, the objective of these initiatives is to increase the accuracy of location information for wireless 9-1-1 calls. Each of the carrier signatories to this Agreement has made an individual decision to implement the provisions below. Moreover, carriers agree to comply with this Agreement on a prospective basis, in particular as they implement new VoLTE networks and handsets.

Beacons and battery backup. We recognize that battery backup for WiFi Access Points when used for locating 9-1-1 calls from indoor locations is important. Most managed WiFi Access Points will be powered by commercial power and many can be expected to have some amount of backup power. WiFi Access Points used in enterprise locations, for example, will typically have some type of Uninterruptible Power Supplies (UPS) that will provide backup power on the order of a couple of hours which will survive most power outages. Bluetooth Low Energy (LE) beacons draw an extremely small amount of power and batteries can be expected to support operations for 2 years. We anticipate that some Bluetooth LE beacons used for 9-1-1 would also be connected to commercial power, which would further extend operations well beyond 2 years.

1) Test Bed

- a) Carriers agree to support a test bed that will facilitate the testing of 9-1-1 location technologies that will provide location information for outdoor and indoor 9-1-1 calls. The test bed will be operated in a technology neutral manner, and will be used to test OTDOA/A-GNSS, dispatchable location solutions, and other possible location solutions (including but not limited to technologies described in PS Docket No. 07-114). Carriers agree to work with APCO and NENA to establish the test bed within 12 months of this Agreement.
 - i) The test bed will be managed by a non-governmental entity (e.g., Alliance for Telecommunications Industry Solutions (ATIS)) and operated in an open, transparent, and competitively neutral manner, as to technologies, carriers and location solution vendors;
 - ii) The test bed will be utilized both to demonstrate vendor performance of E911 location solutions and to characterize performance of E911 location technologies, including OTDOA/A-GNSS, in order to establish appropriate E911 location benchmarks. While the test bed will be available to and can be used by vendors to assess the performance of solutions not yet standardized or commercially available, only testing of solutions based on industry standards and commercial configurations will be relied on to verify performance expectations to an E911 location benchmark.
 - iii) The test bed will be consistent with the elements recommended by the Communications Security, Reliability and Interoperability Council (CSRIC) III Working Group and with the work undertaken by the Emergency Services Interconnection Forum (ESIF) established by ATIS.
- b) Carriers, APCO and NENA agree to work together to develop an appropriate funding framework for the test bed that includes funding support from carriers and affected E911 location vendors, and also to investigate the potential for obtaining other sources of funding (e.g., government grants).

2) Location Solutions Providing Dispatchable Location

- a) Dispatchable location is the civic address of the calling party plus additional information such as floor, suite, apartment or similar information that may be needed to adequately identify the location of the calling party. The civic address of the calling party number will be validated. In addition, the civic address will be corroborated against other location information prior to delivery of the address with the 9-1-1 call to the PSAP to the extent possible.
- b) Some dispatchable location solutions will require a National Emergency Address Database (NEAD), which is described in Section 2(e), while other solutions can be implemented without the use of the NEAD. Prior to the completion of the NEAD, carriers will take steps to make such non-NEAD dispatchable location information available for delivery to PSAPs (through a variety of carrier-provisioned and third party sources), and further commit to the following:
 - i) To the extent that a carrier plans to introduce new wireless consumer home products, such carrier agrees to introduce such products that will provide dispatchable location within 18-24 months of the date of the Agreement. Products not installed by carrier representatives may require the customer to input dispatchable location data (e.g., apartment number) into the product or device.
 - (1) Signatories will work with public safety to study and consider further steps to providing wireline equivalent routing for wireless consumer home products that provide a dispatchable location.
 - ii) Within 30 days of the anniversary of the Agreement, CTIA will report the total number of sources that carriers utilize to make dispatchable location information available for delivery to PSAPs until the completion of the NEAD in Section 2(e).
- c) Conduct a pre-standards demonstration of a dispatchable location 9-1-1 solution within 9 months from the date of the Agreement.
 - i) While Bluetooth LE and WiFi are standardized technologies, there are no standards for use of these technologies with 9-1-1 calls. This proof of concept demonstration will show how such technologies could be used including a demonstration of handsets detecting Bluetooth LE and/or WiFi location beacons, reporting to the network, followed by a database look-up of dispatchable location (for display on a map or other signaling to a PSAP).
- d) Promote development and approval of standards within 18 months of the date of the Agreement.
 - i) Carriers agree to formally sponsor 3GPP Study Item RP-141003 as the standards vehicle that will allow handsets to deliver Bluetooth LE and WiFi information to the network, and to work through the standards process to incorporate the Bluetooth LE and WiFi

dispatchable location concept into the 3GPP technical report within 12 months of the Agreement.

- ii) Carriers agree to participate actively in the work of the relevant standards organizations, and to work with APCO and NENA, technology companies, and others in the private sector to promote efforts to prioritize the completion of those standards described above – at a minimum including –
 - (1) Relevant 3GPP Specifications (e.g., LTE control plane location 3GPP LPP spec 36.355)
 - (2) Standards to support dispatchable location (e.g., J-STD-036)
- iii) Carriers agree to sponsor standards activities to operationalize the display of dispatchable location in pre NG-911 PSAPs.
- e) Design, develop, and implement the NEAD within 36 months from the date of the Agreement.
 - i) The NEAD is the database that provides the correlation between MAC address and dispatchable location.
 - ii) Carriers, APCO and NENA agree to work together to develop the design, operations, and maintenance requirements for the NEAD within 12 months of the Agreement.
 - iii) Carriers, APCO and NENA agree to work together to establish a database owner, funding mechanisms, provisions for defining security/privacy, performance, and management aspects, and to launch the initial database within 12-24 months after the development of the design requirements described above.
 - iv) Carriers, APCO and NENA agree to work together at the federal, state, and local level to develop an outreach program that will promote a broader integration of a variety of dispatchable location sources into the NEAD, and enlist the support of other organizations (e.g., hotel associations) to achieve this goal.
- f) Handset Design and Development
 - i) 25% of all new VoLTE handset models offered by carriers will have the capability to support delivery of beacon information, e.g., Bluetooth LE and WiFi, to the network in conjunction with a 9-1-1 call made on VoLTE within 18-24 months after the completion of standards.
 - ii) 50% of all new VoLTE handset models offered by carriers will have the capability to support delivery of beacon information, e.g., Bluetooth LE and WiFi, to the network in conjunction with a 9-1-1 call made on VoLTE within 24-30 months after completion of standards.
 - iii) 100% of all new VoLTE handset models offered by carriers will have the capability to support delivery of beacon information, e.g., Bluetooth LE and WiFi, to the network in

conjunction with a 9-1-1 call made on VoLTE within 30-36 months after completion of standards.

- iv) Carriers, APCO and NENA will jointly work with original equipment manufacturers, operating system providers, the Federal Communications Commission, and other stakeholders as necessary to address issues that may arise concerning the NEAD's and carriers' access to Bluetooth LE, WiFi beacon, and other handset-related information necessary for the NEAD and other dispatchable location methods to function effectively.
- g) Network Design and Development
 - i) Carriers will enable their VoLTE networks to deliver beacon information from the handsets to the Location Server within 24 months after completion of standards.
- h) Initial End-to-End Functionality
 - i) Carriers agree to provide initial end-to-end dispatchable location functionality on their respective VoLTE networks no later than 48 months from the date of this Agreement, after completion of the steps specified in Sections 2(b)-(e).
- i) 36 Month Assessment of Dispatchable Location
 - i) Carriers, APCO and NENA agree to jointly conduct a formal assessment of the progress made in developing and implementing dispatchable location solutions 36 months after the date of the Agreement in accordance with Section 6.

3) Location Solutions Providing Latitude/Longitude

- a) Carriers agree to conduct testing of OTDOA and A-GNSS (GPS and GLONASS) for both outdoor and indoor accuracy on each of their respective VoLTE platforms within 6-12 months from the date of the Agreement, and to conduct formal test bed evaluations once the formal test bed process is established. Since OTDOA for use with 9-1-1 calls requires VoLTE, any operational testing of OTDOA in conjunction with 9-1-1 calls will necessarily hinge on VoLTE implementation, which will vary by carrier and by market.
- b) Carriers agree to deploy OTDOA in their networks in association with VoLTE, with implementation (including related testing) in each market as they transition 9-1-1 calls to VoLTE. OTDOA will be used in conjunction with A-GNSS as the primary location solution, and will operate on a standalone basis only when A-GNSS is not available. Until such time as OTDOA implementation is complete, carriers will provide APCO and NENA with reports on the progress of its OTDOA implementation for use with 9-1-1 calls on a semi-annual basis.
- c) Carriers agree to introduce new devices with A-GNSS 9-1-1 capabilities in accordance with the following benchmarks:
 - i) 50% of all new VoLTE handset models offered by carriers will have the capability to support A-GNSS (e.g., GPS and GLONASS) for 9-1-1 calls made on VoLTE within 24 months of the date of the Agreement.
 - ii) 75% of all new VoLTE handset models offered by carriers will have the capability to support A-GNSS (e.g., GPS and GLONASS) for 9-1-1 calls made on VoLTE within 36 months of the date of the Agreement.
 - iii) 100% of all new VoLTE handset models offered by carriers will have the capability to support A-GNSS (e.g., GPS and GLONASS) for 9-1-1 calls made on VoLTE within 48 months of the date of the Agreement.
- d) Carriers agree to test delivery of crowd-sourced latitude/longitude from WiFi beacons once the capability becomes available (estimated to be 30-36 months from the date of the Agreement).

4) Metrics for Assessing Performance of Location Methods

- a) Carriers agree to collect data for all live wireless 9-1-1 calls on a monthly basis that would show the percentage of time that each 'positioning source method' is used to deliver a wireless 911 call, consistent with the following:
 - i) 'Positioning source method' would include dispatchable location methods as well as positioning based on latitude/longitude (e.g., A-GPS, GLONASS, OTDOA, AFLT, RTT, Cell ID or a hybrid of any of the listed or future technologies); and
 - ii) Data would be collected in and reported for six geographic areas that correspond to the six geographic test regions recommended by ATIS ESIF. After careful consideration by public safety, wireless carriers and other relevant stakeholders, these test regions were selected to be representative of common indoor use-cases for wireless 9-1-1 calls across the nation. The test regions include dense urban, urban, suburban, and rural morphologies, are generally distributed across the country, and cover various building construction materials, densities, and heights. Data would be collected in the six cities recommended by ATIS ESIF, subject to carrier provision of service in those cities.

- b) Carriers would provide reports to APCO and NENA on a quarterly basis, subject to appropriate confidentiality protections, with the first report due 18 months after the date of this Agreement. Carriers, APCO and NENA will use the data from these reports to assess the trend in positioning performance over time.

- c) Carrier signatories commit to obtain a location fix using "heightened location accuracy technologies" for the following percentage of wireless 9-1-1 calls from the date of the Agreement consistent with Section 4(a). (call data):
 - i) 40% of all wireless 9-1-1 calls within two years;
 - ii) 50% of all wireless 9-1-1 calls within three years;
 - iii) 75% of all VoLTE wireless 9-1-1 calls within five years; and
 - iv) 80% of all VoLTE wireless 9-1-1 calls within six years.

Wireless 9-1-1 calls that originate from "heightened location accuracy technologies" are calls with fixes for A-GNSS (GPS and/or GLONASS), dispatchable location, and the proportion of calls from any other technology or hybrid of technologies capable of location accuracy performance of 50m using a blended composite of indoor and outdoor based on available data from a test bed and/or drive test performance. For example, if OTDOA is shown through testing to deliver 50m accuracy in 60% of calls, then 60% of OTDOA calls can be used to support the metrics above.

- d) Each carrier will ensure that its location technology deployment is consistent between the geographic areas designated for reporting and coverage areas outside these areas, so that empirical test results established in the test bed regions are reflective of performance

achievable from a particular location technology under similar environmental conditions in a mature deployment in other indoor locations where 9-1-1 calls are made. In addition, carriers will continue to ensure that handset models offered by carriers provide location performance consistent with handsets used for testing in the regional test beds, consistent with Sections 2(f) and 3(c).

5) Vertical Location Information

- a) Carriers agree to promote the development and approval of standards within 18 months of the date of the Agreement that would enable the delivery of uncompensated barometric pressure data to PSAPs with 911 calls.
- b) Carriers agree to work with APCO, NENA, and other interested parties to conduct and complete
 - i) a study within six months of the Agreement to evaluate options for utilizing uncompensated barometric pressure data to obtain a z-axis and any corresponding benefits to PSAPs and first responders; and
 - ii) a further study within 24 months of the Agreement that would include test bed evaluation of z-axis solutions (including compensated barometric pressure sensor-based location solutions) and the readiness of PSAPs to effectively utilize z-axis data.
- c) If the signatories determine that there is sufficient benefit to PSAPs associated with the delivery of uncompensated barometric pressure data, carriers agree to deliver such data to the PSAPs from any handset that supports such a capability within 3 years, subject to timely availability of standards referenced in paragraph (a) above.
- d) A z-axis location accuracy metric will be established pursuant to standards necessary for industry and PSAP utilization. The z-axis metric shall be expressed in terms of a vertical component for a specific percentage of VoLTE 9-1-1 calls from z-axis capable handsets, and shall be based on the location accuracy achieved by at least two proven candidate technologies as demonstrated in the test bed.

6) 36 Month Assessment of Dispatchable Location

- a) Signatories agree to determine, within 36 months after the execution of this Agreement, whether dispatchable location solutions are on track, consistent with the timeframes described in Section 2, to provide improved location estimates.
- b) If the dispatchable location solutions are not on track, the dispatchable location provisions contained in this document would be supplanted with provisions designed to promote the implementation of alternative location solutions, in accordance with this section. Carrier signatories may, however, continue to implement dispatchable location solutions and such implementations may be used to demonstrate compliance with location commitments.
 - i) Any solutions implemented as an alternative to dispatchable location must be technically feasible, and fit within network plans and architectures, and must satisfy the following conditions:
 - (1) Solutions must be standardized, scalable and commercially available across carrier networks from multiple sources;
 - (2) Solutions may require consumers to purchase equipment and/or to incur additional costs but would not include additional 9-1-1 service fees. For example, to the extent that new handset hardware is needed or existing handset software cannot be updated over-the-air or manually, a consumer may need to purchase a new handset and, depending on the service provider and the customer's existing plan, a modified service plan;
 - (3) Solutions must demonstrate through the test bed the ability to provide a meaningful, substantial improvement in indoor location accuracy and reliability over currently implemented location solutions or those location solutions in deployment (including OTDOA and A-GNSS) in all test bed environments.
 - ii) Carrier signatories agree to the following commitments regarding provision of z-axis solutions:
 - (1) Carriers will implement either a dispatchable location or z-axis location solution that satisfies the z-axis metric in the most populous 25 CMAs within 36 months of the assessment in Section 6(a) and most populous 50 CMAs within 60 months of the assessment in Section 6(a).
 - (2) If necessary, carriers agree to introduce new handsets that are capable of delivering z-axis location information that satisfies the z-axis metric in accordance with the following benchmarks:
 - (a) 25% of all new VoLTE handset models offered by carriers will have the capability to deliver z-axis location information for 9-1-1 calls made on VoLTE within 36 months of the assessment in Section 6(a).
 - (b) 50% of all new VoLTE handset models offered by carriers will have the capability to deliver z-axis location information for 9-1-1 calls made on VoLTE within 48 months of the assessment in Section 6(a).

- (c) 100% of all new VoLTE handset models offered by carriers will have the capability to deliver z-axis location information for 9-1-1 calls made on VoLTE within 60 months of the assessment in Section 6(a).
- (3) Implementation timelines for z-axis solutions must recognize the interdependence of different activities, e.g., development of industry standards, handset availability, phased-in deployment over covered POPs, PSAP readiness, etc.; and
- (4) Any z-axis solution implemented to satisfy these commitments must meet the conditions specified in Section 6(b)(i).

7) Sections for Inclusion in the FCC's Rules

- a) The signatory parties have identified the following sections to develop regulatory language, consistent with the intent of the parties to the Agreement, for inclusion in the FCC's rules:

Section 2(a);

Section 2(f)(i), (ii), (iii);

Section 2(g);

Section 2(h);

Section 3(c); and

Section 4(a), (b), (c).