T-Mobile's 36 Month Progress Report For Implementing the Federal Communication Commission's Fourth Report and Order on Wireless E911 Location Accuracy Requirements

August 3, 2018

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Introduction

On February 3, 2017, T-Mobile submitted its Implementation Plan and 18 Month Status Report Implementing the Federal Communication Commission's Fourth Report and Order on Wireless E911 Location Accuracy Requirements ("18 Month Report").[1] That was a requirement of the Federal Communications Commission's ("FCC") Fourth Report and Order on Wireless E911 Location Accuracy Requirements ("4th R&O") adopted on January 29, 2015.[2] In the 18 Month Report, T-Mobile detailed the many initiatives that it had undertaken in efforts to meet the Commission's new 911 location accuracy rules.

This submission of T-Mobile's 36 Month Progress Report For Implementing the Federal Communication Commission's Fourth Report and Order on Wireless E911 Location Accuracy Requirements ("36 Month Report") is meant to fulfill an additional requirement from the 4th R&O.[3] This report will provide updates to many of the initiatives that were discussed at length in the 18 Month Plan.

Of note, the 18 Month Report spent significant time focused on the concept of Dispatchable Location ("DL") which was introduced as part of the Roadmap For Improving 911 Location Accuracy.[4] In the 4th R&O, the FCC codified the concept, defining DL as a "location…that consists of the street address of the calling party, plus additional information…to adequately identify the location of the calling party."[5] In the 18 Month Report, T-Mobile detailed its significant contribution to industry technical standards work undertaken primarily by the Alliance for Telecommunications Industry Solutions ("ATIS"). This work culminated in developing the technical specification for the National Emergency Address Database ("NEAD") and the National Emergency Address Manager ("NEAM"), collectively called the NEAD Platform.

T-Mobile also spent significant time in the 18 Month Report discussing its substantial contributions to standing up an Indoor 911 Location Test Bed ("Test Bed"). This Test Bed has two specific purposes: (i) to measure performance of current technologies used for compliance purposes in meeting the 4th R&O's

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[1] Implementation Plan and 18 Month Status Report Implementing the Federal Communication Commission's Fourth Report and Order on Wireless E911 Location Accuracy Requirements of T-Mobile, PS Docket No. 07-114 (filed Feb. 3, 2017)("*18 Month Report*").
[2] *Wireless E911 Location Accuracy Requirements*, Fourth Report & Order, 30 FCC Rcd. 1259 (2015)("*4th R&O*").
[3] *Id*. at 1271.
[4] Letter from John Wright, APCO International, et al, to Marlene H. Dortch, FCC, PS Docket No. 07-114 (filed Nov. 18, 2014).
[5] *4th R&O*, 30 FCC Rcd. at 1360.

progressively more stringent horizontal accuracy requirements[6] and (ii) to evaluate new and emerging technologies.[7] The rest of the report spent time discussing other initiatives T-Mobile was undertaking to meet all of the various 4th R&O's rules. Some of these were the implementation of Observed Time Difference of Arrival ("OTDOA") location technology into its network, working with Original Equipment Manufacturers ("OEMs"), and partnering with the Illinois Institute of Technology's Graduate School of Applied Technology on DL proof of concept work. The full 18 Month Report can be accessed in Appendix A for reference.

This 36 Month Report covers the following topics:

1) T-Mobile's Implementation Plan;
2) Technical standards work;
3) The Indoor 911 Location Test Bed
4) Development of a required Z-Axis metric;[8]
5) The NEAD Platform and T-Mobile's implementation work to support the use of DL;
6) Additional efforts to improve 911 location accuracy.
7) Provisioning of uncompensated barometric pressure sensor data to Public Safety Answering Points ("PSAP"); and
8) Device Based Hybrid implementation
9) Quarterly live 911 call reporting

T-Mobile is proud of its continued work to improve and enhance the 911 service it provides to its customers.

[6] *18 Month Report* at 7.
[7] *Id*.
[8] *4th R&O*, 30 FCC Rcd. at 1261.

Implementation Plan

This document sets forth both the status of T-Mobile's implementation work to date and the timetable for future work. T-Mobile's implementation plan consists of work already completed and the going-forward steps described in each section below. At this point, T-Mobile continues to be on track to meet all indoor accuracy compliance deadlines established in the Fourth Report and Order.

T-Mobile's Implementation Plan includes the following milestones. Milestones designated with a check indicate they were completed successfully.

- ✓ April 2016
  - ✓ Ongoing OTDOA Deployment and Optimization
  - ✓ FCC Test Bed Testing
    - ✓ Dry Run
    - ✓ Stage 1
  - ✓ NEAD RFP Process and Vendor Selection

- ✓ October 1, 2016
  - ✓ Begin collecting live call data from 6 reporting regions

- ✓ December 2016
  - ✓ OTDOA activation complete across entire network
  - ✓ Live call reporting developed

- ✓ January 2017
  - ✓ New Positioning Technology (Device Based Hybrid) tested in the FCC Test Bed Stage 1A

- ✓ February 3, 2017
  - ✓ Implementation Plan and 1st Progress Report on implementation of indoor location accuracy requirements
  - ✓ NEAD Security & Privacy Plan
  - ✓ Provide quarterly reporting on live call data from 6 reporting regions

- ✓ April 3, 2017
  - ✓ 1st Benchmark: Horizontal location requirement X/Y <=50m on 40% of 9-1-1 calls (using blended composite yield metric)

- ✓ June 3, 2017
  - ✓ Certify network deployments consistent with reporting regions for April 3, 2017 horizontal requirement

- ✓ November 2017
  - ✓ FCC Test Bed Stage 1B

- ✓ February 3, 2018
  - ✓ Certify NEAD will used for only 9-1-1 purposes, unless otherwise required by law.

- ✓ April 3, 2018
  - ✓ 2nd Benchmark: Horizontal location requirement X/Y <=50m on 50% of 9-1-1 calls (using blended composite yield metric)

- ✓ June 3, 2018
  - ✓ Certify network deployments consistent with reporting regions for April 3, 2018 horizontal requirement

- ✓ August 3, 2018
  - ✓ 2nd Progress Report on implementation of indoor accuracy requirements.
  - ✓ Make uncompensated barometric pressure information available to PSAPs

- April 3, 2020
  - 3rd Benchmark: Horizontal location requirement X/Y <=50m on 70% of 9-1-1 calls (using blended composite yield metric

- June 3, 2020
  - Certify network deployments consistent with reporting regions for April 3, 2020 horizontal requirement

- April 3, 2021
  - 4th Benchmark: Horizontal location requirement X/Y <=50m on 80% of 9-1-1 calls (using blended composite yield metric)

- June 3, 2021
  - Certify network deployments consistent with reporting regions for April 3, 2020 horizontal requirement and vertical requirement (Top 25 CMAs either NEAD access point entries >= 25% of CMA population or z-axis cover 80% of CMA population)

- June 3, 2023
  - Certify network deployments consistent with vertical requirement (Top 50 CMAs either NEAD access point entries >= 25% of CMA population or z-axis cover 80% of CMA population)

Standards Work Status Update

ATIS, of which T-Mobile is a member, plays a significant role in developing 9-1-1 location solutions and establishing test methodologies and other technical and operational requirements. It is an open forum comprised of end-to-end 9-1-1 location systems stakeholders, including wireless and wireline carriers, 9-1-1 equipment vendors and public safety entities.

Emergency Services & Methodologies Subcommittee

Much of the detailed technical development necessary to realize a practical, representative environment-based Test Bed continues to be conducted within the ATIS ESIF ESM.

Recent ESIF ESM Highlights Relative to the FCC's 4th R&O

- Developed a comprehensive test methodology to evaluate compensated barometric pressure-based Vertical Axis (Z-Axis) location solutions. Specified in ATIS-0500030 released in May 2016. This methodology was followed in the recent Z-Axis Test Bed campaign.

- Developed test methodologies to evaluate and determine the veracity of dispatchable address location solutions utilizing the NEAD. Specified in ATIS-0500035 released in July 2017.

- Developed test methodologies to properly evaluate crowd-sourced Wi-Fi and Bluetooth beacon based location solutions that exhibit location memory from one location fix to the next (e.g., device based hybrid methods). Specified in ATIS-0500038 released in June 2018.

Emergency Location Task Force

The 18 Month Report discussed the creation of the ATIS Emergency Location Task Force ("ELOC") which was tasked with developing the technical standards necessary to meet the 4th R&O rules which resulted in publishing Location Accuracy Improvements for Emergency Calls (ATIS-0700028 v1.1) in September 2016.

This document included specifications covering the NEAD, NEAM and provisioning of uncompensated barometric pressure data. Since that time, ATIS completed Guidelines for Emergency Call Location Selection and Reporting by

Originating Networks (ATIS-0700039) in May 2018. This document provides guidelines and recommendations on how to incorporate DL into wireless carrier location systems and optimize DL selection algorithms, with the goal of ensuring reasonable consistency of Dispatchable Location outcomes across carrier networks under similar conditions. Currently, work is being done to allow NEAD access to 3rd party, external Wi-Fi and Bluetooth databases so as to increase the number of access points available for DL. As ELOC continues its work on the NEAD, NEAM and DL, T-Mobile will continue to play an active and productive role.

Indoor 911 Location Test Bed Status Update

The 18 Month report provided detail on the background and purpose of the Indoor 911 Location Test Bed, including organizational structure and funding, indoor location test methodology (including building selection), and data collection. At the time of that report Stage 1 (to evaluate then current carrier 911 technology deployments) and Stage 2 (evaluating emerging technologies) testing had been completed. Since that time, additional testing has occurred. T-Mobile is a member of the Test Bed Technical Advisory Committee (TAC) and is actively involved in Test Bed planning, execution, and analysis of results.

To date, T-Mobile has participated in three Test Bed campaigns to assess compliance with the accuracy requirements in the 4th R&O – Stages 1, 1A, and 1B. The results from these test stages have enabled T-Mobile to certify full compliance with the first two horizontal location accuracy benchmarks, and to monitor and track continued performance improvement of location technologies and location system algorithms deployed for 911.

In addition, there have been two Test Bed campaigns to evaluate new and emerging horizontal location technologies – Stages 2 and 2A. The results from these test stages have served to inform wireless carriers and public safety organizations on performance expectations from various emerging location technologies of interest.

Test Z-Axis Testing

In addition to the test stages discussed above, the Test Bed has been used to evaluate wireless vertical location technologies. As part of the 4th R&O, carriers were required to recommend to the Commission a vertical location accuracy metric no later than August 3, 2018.[9]

T-Mobile was heavily involved with the development of the Z-Axis testing methodology used for the Test Bed "Stage Z", and provided technical guidance throughout the entire process. The testing was extensive, incorporating over 300 unique test points in 48 buildings in San Francisco, Atlanta and Chicago. The exercise was useful in many respects, such as identifying technical challenges and key sources of error in barometric pressure-based altitude estimation systems. The report, which ultimately makes a recommendation on a vertical accuracy metric, is being submitted by CTIA to the FCC on the same day as this document, August 3, 2018.

NEAD Status Update

In the 18 Month Report, T-Mobile provided substantial detail about the NEAD Platform, including the formation of a NEAD LLC and its organizational structure, platform design and functionality, and planned access point acquisition. Since that time, progress on the NEAD Platform has been made and T-Mobile has made significant contributions.

As a member of the NEAD LLC's TAC, T-Mobile has worked closely with NEAD vendor West Safety Services, advising on a wide range of issues, including functionality and access point provisioning. In fact, the NEAM began formally accepting production grade reference points in June 2018.

The NEAD has been operational for testing purposes since late 2017. T-Mobile was the first wireless carrier to utilize the NEAD to complete functional testing of its Dispatchable Location system in Q4 2017. The test proved successful and T-Mobile is incorporating insights learned to further improve upon its DL 911 implementation, including making refinements to its location selection algorithms. T-Mobile also freely shared relevant 'lessons learned' from this first functional DL test with the other national wireless carriers, to allow them to benefit from our experience. It is expected that T-Mobile will conduct formal DL performance testing by the end of 2018.

[9] *4th R&O*, 30 FCC Rcd. at 1261.

As required, under the umbrella of the NEAD LLC, wireless carriers filed a NEAD Privacy & Security Plan with the FCC on February 3, 2017.[10] T-Mobile technical and privacy subject matter experts played a significant role in the document's drafting. The plan incorporated privacy and security by design and included strict controls over the use of information stored in the database. It was adopted without change on November 13, 2017, with the Commission noting that the plan received broad support and that it fully met the requirements set forth in the 4th R&O.[11]

There are a variety of other NEAD efforts underway, all of which have substantial involvement from T-Mobile. First, T-Mobile and other stakeholders are working to identify PSAPs with whom to conduct end-to-end functional testing of DL. Second, T-Mobile supported the establishment of a website by the NEAD LLC to educate and inform interested parties about the NEAD. Finally, T-Mobile continues to encourage the NEAD LLC to actively engage with third party access point providers to encourage them to help populate the NEAD with access points under their control.

Other Efforts to Improve 9-1-1 Location Accuracy

In addition to working with industry to establish the NEAD and testing various location technologies in the Test Bed, T-Mobile has engaged in other efforts in order to meet the requirements set forth in the 4th R&O.

Location Server and Handset Enhancements

T-Mobile continues to refine its location server and location selection algorithms in efforts to further improve location information made available to PSAPs. Additionally, T-Mobile continues to work with its handset vendors to ensure that the devices it offers contribute to improving 911 location. For example, T-Mobile has incorporated a requirement to OEMs that devices coming in since mid-2018 have capability to turn on Wi-Fi and Bluetooth capabilities when placing a 911 call. This feature will ensure that calls from these devices may provide a DL for an emergency call. Furthermore, T-Mobile is incorporating insights learned from NEAD functional testing to further improve upon its DL 911 implementation, including making several refinements to its location algorithms and

[10] 47 C.F.R. 20.18(h)(3)(i)(4)(iii).
[11] *Wireless E911 Locations Accuracy Requirements*, Memorandum Opinion & Order, 32 FCC Rcd. 9699, 9702 (2017).

performance. T-Mobile will continue to make network and handset refinements that benefit 911.

Uncompensated Barometric Pressure Data

As part of the 4th R&O, wireless carriers are required to provide uncompensated barometric pressure data to PSAPs with respect to any 911 call placed from any handset that has the capability to deliver barometric sensor information, by August 3, 2018. T-Mobile has worked with handset OEMs and implemented the requisite modifications to its network to meet this obligation. Uncompensated barometric pressure data will be provided to supporting ALI systems. PSAPs, working with their equipment and ALI vendors, can decide to leverage this information or disable it at their discretion. T-Mobile will be fully compliant with this obligation.

Device Based Hybrid

As discussed above, T-Mobile has led the wireless industry in pursuing the development and implementation of handset-based improvements to 911 location performance. T-Mobile has demonstrated that Device Based Hybrid ("DBH") location, where the handset merges satellite-based location with crowdsourced Wi-Fi positioning and makes use of additional sensors in the handset beneficial to location determination, significantly complements existing location technologies by improving 911 location accuracy and availability – especially in challenging indoor environments. DBH was formally evaluated by T-Mobile in the Test Bed and results verified that this hybrid combination of complementary location methods provides consistent high-accuracy, high-availability performance across all four morphologies.

As T-Mobile stated in its comments in response to the FCC's Notice of Inquiry on Location Based Routing, it has been leveraging Apple's Hybridized Emergency Location (HELO) since 2015 in the selection of location information made available to PSAPs for 911 calls from iOS devices.[12] Of note, T-Mobile was the first carrier to incorporate this technology from Apple.

In addition, T-Mobile has led the industry in working to make Google's Emergency Location Service (ELS) available for the selection of location information to be sent to PSAPs for 911 calls from Android devices. This

[12] Comments of T-Mobile USA, Inc., PS Docket No. 18-64 (filed May 7, 2018).

functionality has been made available for supported Android devices on T-Mobile's network as of June 2018.

Quarterly Live 911 Call Reporting

On February 3, 2017, T-Mobile issued its first quarterly live 911 call data report to the FCC, Association of Public Safety Officials – International, National Emergency Number Association and National Association of State 911 Administrators. Since that time, T-Mobile has met its obligations under the 4th R&O[13] and delivered quarterly live 911 call data reports to the above-mentioned organizations in a timely manner. T-Mobile is confident it will continue to meet this requirement moving forward.

Conclusion

Since the 18 Month Report, T-Mobile has continued to make improvements and enhancements to its 911 service to meet the requirements set out in the 4th R&O. T-Mobile has continued to execute successfully its implementation plan, meeting all requisite benchmarks. As a leader in industry standards and technical work, T-Mobile has played a large roll in both the development of technical specifications and operation of the Test Bed, thereby advancing the efforts to improve 911 location and implement DL. The company has also worked hard to make progress on other initiatives meant to advance 911 location, most notably being the industry leader in integrating DBH into its 911 network. T-Mobile takes seriously its obligations to provide reliable 911 service, is proud of the work it has done on emergency calling to date and looks forward to making further 911 improvements for the benefit of its customers.

[13] *4th R&O*, 30 FCC Rcd. at 1262.

Appendix A

T-Mobile's 18 Month Report can be found here: 18 Month Report.