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BY ELECTRONIC DELIVERY

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street S.W.
Washington D.C. 20554

Re: Update on Standardization and Commercialization of the Metropolitan Beacon System
PS Docket No. 07-114

Dear Ms. Dortch:

NextNav, LLC ("NextNav") provides herein the following updates regarding the status of the development of standards for use of Metropolitan Beacon System ("MBS") location technology and the integration of MBS-capable chipsets into forthcoming mobile phone models.

NextNav's MBS is one implementation of indoor location beacon technology known generically among standards organizations as terrestrial beacon systems ("TBS"). NextNav has been working closely with the Open Mobile Alliance ("OMA"), the Alliance for Telecommunications Industry Solutions ("ATIS"), and the Third Generation Partnership Project ("3GPP"), to address standards for TBS air interface, and messaging between the handset and the network. Once completed, TBS will effectively be an open platform that will allow multiple parties to build and deploy TBS networks, including third party location vendors and the carriers themselves.[1] Developed by NextNav, the 'Indoor Positioning' study item includes the standardization of TBS/MBS systems and has wide industry support from carriers such as AT&T, Verizon, and T-Mobile, and other industry stakeholders such as Broadcom, Intel, the US Department of Commerce (FirstNet), Qualcomm, NSN, and Ericsson.[2]

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[1] *See, e.g.*, Study on inclusion of Terrestrial Beacon Systems (TBS) in LTE, RP-140446, 3GPP TSG RAN (3-6 March 2014); included as an attachment to Letter from John W. Kuzin, Senior Director, Government Affairs – Regulatory, Qualcomm, to Marlene Dortch, Secretary, Federal Communications Commission, PS Docket No. 07-114 (May 1, 2014) ("*3GPP Paper on TBS Standardization*").

[2] *Id*. at unnumbered page 6.

MBS has been designed to minimize the number of changes required to support the positioning function both within the handset and the network. MBS takes advantage of the GPS/GNSS infrastructure already in place in typical wireless networks. In fact, TBS is expected to be standardized as another positioning constellation similar to GPS and GLONASS, therefore taking advantage of the core network elements and the digital positioning engine on the handset. Further, because MBS is an overlay network that functions independently of the wireless networks of the carriers, MBS is compatible with all wireless network technologies in use today and under development for the future. TBS is also structured to work seamlessly with existing Phase II compliant Public Safety Answering Points ("PSAPs") over the control plane. As a result, minimal modification is required to incorporate TBS into the existing standards framework and wireless network infrastructure, and progress on adoption of the necessary standards has been proceeding relatively well.

On May 23, 2014, the Public Safety and Homeland Security Bureau ("Bureau") sent letters to 3GPP and OMA encouraging each organization to continue the "prioritization and expeditious completion of work and study items" relevant to indoor location technologies.[3] These letters reiterated the findings of the Commission's Communications, Security, Reliability, and Interoperability Council ("CSRIC"), which noted in its indoor location test bed report that standardization was "crucial for the efficient and cost-effective implementation and operation" of TBS, and that "[p]ublic safety expects that the standardization, commercial availability and deployment of such technologies are priorities for all stakeholders."[4]

Following the Bureau's letters, 3GPP and OMA have made significant progress on the standardization of indoor location technologies. Work on these issues began in October 2014 and is planned to be completed in the fourth quarter of 2015, with much of the study likely to be completed by the summer of 2015.[5] This timetable is consistent with the anticipations of NextNav and Verizon that standardization should be completed in the fourth quarter of 2015.[6]

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[3] *Public Safety and Homeland Security Bureau Released Letters to 3rd Generation Partnership Program and Open Mobile Alliance*, PS Docket No. 07-114, Public Notice, DA 14-750 (May 23, 2014).

[4] "Indoor Location Test Bed Report," CSRIC III, Working Group 3, at 9 and 53 (March 14, 2013) ("*CSRIC Test Bed Report*").

[5] *See* New SID: Study on Indoor Positioning Enhancements to UTRA and LTE, 3GPP, RP-141003 (Jun. 13, 2014).

[6] Reply Comments of NextNav, LLC, PS Docket No. 07-114 (July 14, 2014) ("*NextNav Reply Comments*"); Comments of Verizon Wireless, PS Docket No. 07-114, at 20 (May 12, 2014) ("*Verizon Comments*").

The support of manufacturers, public safety, and carriers in particular is critical to the progress of standardization, and, assuming continued support from industry stakeholders, these timetables for standardization and commercialization of TBS are very attainable.

Several technical factors have contributed to the reduced cost and accelerated development cycle of TBS/MBS-capable equipment and supporting standards. First, NextNav's MBS technology is designed to reuse the GPS functionality already widespread in commercial handsets (the MBS system leverages the digital baseband of GPS chipsets). Multiple chipset partners have already signed license agreements to incorporate MBS into their GPS/GNSS functionality, whether in standalone GPS/GNSS chips; in combination chips with Bluetooth, Wi-Fi, and GPS; or in baseband LTE modems. One manufacturer has produced early engineering samples of a standalone MBS capability on its latest GPS chip. Another major chipset provider has signed a licensing agreement to include MBS, likely paired with GNSS or another functionality. Several other chipset manufacturers are in different stages of licensing and several are likely to incorporate MBS as part of their LTE functionality. NextNav expects engineering samples of these chipsets to become available during 2015, with commercial production to meet the requirements of handset manufacturers by 2016.

The availability of MBS capability through multiple chipset manufacturers does not, absent ongoing carrier support, ensure that MBS-capable consumer devices will become available or achieve significant market penetration by 2016 or 2017. With reasonable carrier support, however, it is certainly appropriate to expect that an adequate number of commercial handsets could be available for initial market availability and compliance testing within the two years specified in the proposed rules. NextNav as well as others have proposed allowing carriers to implement any chosen handset technology on a staged basis during the two to five year benchmark milestones of the proposed rules.[7]

Since commercial handsets with MBS-capable GPS chips are not currently available, MBS technology was tested by CSRIC with an external receiver ("sleeve") that communicated with the handset. The sleeve contained the NextNav-programmed processor to recognize the

[7] *See NextNav Reply Comments* at 28; Reply Comments of NENA, PS Docket No. 07-114, at 17 (July 14, 2014) (proposing a timeline for the phased introduction of compliant handsets); Reply Comments of NCTA, PS Docket No. 07-114, at 4 (urging the Commission to "recognize rural consumers' reluctance to swap existing operational equipment for new, more expensive handsets" and that "for any new technology to reach critical mass, it will likely take longer for rural subscribers to adopt"); *Verizon Comments* at 25 (suggesting that service providers should not be liable for deadlines as long as they are compliant before indoor location capable handsets become available).

MBS beacon transmissions as well as a commercially-available barometric pressure sensor used for establishing altitude measurements. The sleeve operates as an attachment to a normal mobile phone and was made available for the CSRIC indoor location test bed, independent carrier testing, and NextNav's internal Rev 2 testing.[8]

The CSRIC test procedures, including use of the sleeve, were developed in cooperation with all parties associated with the CSRIC testing, and each of those parties (including carriers, chipset and handset manufacturers) worked to ensure that the performance of the sleeve configuration was consistent with the constraints of a commercial handset configuration, including antenna performance. In fact, based on this peer review process, the CSRIC requirement of comparable commercial configuration was so stringent that certain other vendors of location services were compelled to withdraw their technologies from the tests.[9]

Despite the carefully-controlled and cooperatively-developed CSRIC test conditions, some parties dispute the validity of the CSRIC results, claiming that the use of the sleeve may have improved the apparent performance of NextNav's MBS receiver.[10] CSRIC Working Group 3 considered this possibility and incorporated several measures into its test bed procedures to address this concern. Based on peer review, the MBS sleeve was attenuated by 2 dB at the output of the RF antenna to ensure that the MBS receiver functioned "more equivalent to the envisioned handset based implementation."[11] The sleeve implementation also provided an ARM 7 processor equivalency and processed results consistent with a normal GPS chipset implementation using a host-based architecture. These steps, as well as other measures, were taken by CSRIC to assure the validity of the test results. Identical equipment configurations were used during the independent tests of NextNav's Rev 2 technology.

Some commenters have also asserted that the barometric pressure sensors used in the CSRIC sleeve configuration were not commercially available.[12] As NextNav explained in its Reply Comments, this is inaccurate.[13] The MEMS barometric sensor used throughout the

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[8] *CSRIC Test Bed Report* at 24.

[9] *See id.* at 55.

[10] *See* Reply Comments of T-Mobile, PS Docket No. 07-114, at 19 (July 14, 2014).

[11] *See CSRIC Test Bed Report* at 24; *see also* Reply Comments of Transit Wireless, LLC, PS Docket No. 07-114, at 6 (acknowledging the use of an attenuator to ensure accurate MBS results).

[12] Comments of Qualcomm, Inc., PS Docket No. 07-114, at 14 (May 12, 2014) ("*Qualcomm Comments*"); Comments of iPosi, PS Docket No. 07-114, at 21 (May 12, 2014).

[13] *NextNav Reply Comments* at 17.

CSRIC testing as well as NextNav's internal and third party testing was the commercially-available Bosch BMP90, which was an older model of the Bosch BMP180 and BMP280 sensors. The Bosch BMP180 was included in the Samsung Galaxy S4 handset[14] and the Bosch BMP280 was recently used in the iPhone 6.[15] Thus, not only was the vertical location hardware tested by CSRIC commercial grade, it is deployed in commercially available handsets and has been improved significantly since it was tested by CSRIC in 2012.

Commenters also questioned whether small MEMS barometers are physically capable of floor level accuracy.[16] Bosch's comments in the docket respond directly to such criticisms, explaining that "[t]he BMP180 is capable of measuring ambient pressure with an absolute accuracy of approximately 0.12 hectopascal units, which is equivalent to approximately 1 meter of change in altitude at standard sea level."[17] The CSRIC test bed results of less than 3 meters in dense urban and urban environment clearly demonstrate that MEMS barometers are physically capable of achieving highly accurate results in practical application.[18] Subsequent tests of the Rev 2 system demonstrated even better accuracy, achieving less than 1.6 meters in all environments.[19] NextNav has also demonstrated its MBS local calibration capability with other barometric sensors, and expects similar performance.

Other commenters continue to assert that the vertical accuracy results that can be achieved using MEMS barometers will vary significantly over time as a result of changing

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[14] Samsung Galaxy S4 Teardown, iFixit, http://www.ifixit.com/Teardown/Samsung+Galaxy+S4+Teardown/13947 (last visited Oct. 29, 2014).

[15] *See* https://www.apple.com/iphone-6/technology/ (last visited Oct. 29, 2014). Apple explains that the barometer in the iPhone 6 "senses air pressure to determine your relative elevation . . . so as you move, you can keep track of the elevation you've gained . . . it can even measure stairs climbed or hills conquered." *Id.*

[16] *See Qualcomm Comments* at 14 (asserting that "the specifications for currently available barometric sensors…support[] ±0.2 kPa accuracy, which translates to approximately 36 meters of variation"); Reply Comments of iPosi, PS Docket No. 07-114, at 5 (June 11, 2014) (asserting that Bosch's comments are "inconsistent" with the data provided on the specification sheet for the BMP180).

[17] Comments of Bosch Sensortec, PS Docket No. 07-114, at 3 (May 12, 2014).

[18] *CSRIC Test Bed Report* at 36;

[19] *See* NextNav, LLC, Ex Parte Letter, PS Docket No. 07-114 (Aug. 14, 2013).

weather conditions.[20] Such comments ignore the fact that the very purpose of including MEMS sensor technology in the CSRIC trials was to determine whether ongoing weather changes could be precisely measured at each MBS beacon location and transmitted in real time to barometric sensors in user devices in order to enable the accurate calculation of true altitude. The CSRIC results clearly demonstrate this capability.[21]

Some of these same commenters argue that altitude readings from MEMS sensors can be unreliable inside tall buildings because pressure variations inside such building may be different than outside the building.[22] The results of vertical testing in urban conditions, however, demonstrate that the actual effects of such pressure variations are relatively minor and do not prevent small barometric sensors from providing highly reliable readings in the overwhelming majority of cases. During the CSRIC trials, for example, test locations were specifically chosen to include a wide variety of building sizes, heights, ages, and construction methods.[23] Tests took place over many weeks in widely varying weather conditions and times of day.[24] Nevertheless, the vast majority of altitude readings measured were highly accurate,[25] and repeatable six months later in different seasonal conditions.[26] The fact that a minor percentage of measurements fell outside of the 3 meter objective, potentially due to indoor pressure variations, is entirely consistent with the Commission's proposed vertical location rules, which require 3 meter

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[20] *See, e.g.*, Technical and Environmental Factors Affecting Indoor E911 Location Accuracy Wireless E-911 Location Accuracy Requirements, Blind Tiger Communications, Inc., at 5, *filed as undated attachment to* Reply Comments of CTIA, PS Docket No. 07-114 (July 14, 2014) ("*CTIA Paper*").

[21] *See CSRIC Test Bed Report* at 9 (noting the demonstration of "substantial progress in the vertical dimension").

[22] *See CTIA Paper* at 6.

[23] *See* CSRIC III WG3, Indoor Test Report to CSRIC III WG3 Bay Area Stage-1 Test Bed (Jan. 31, 2013), available at http://transition.fcc.gov/bureaus/pshs/advisory/csric3/WG3_Indoor_Test_Report_Bay_Area_Stage_1_Test_Bed_Jan_31%20_2013.pdf (last visited Oct. 30, 2014) ("*CSRIC Test Bed Detail Report*") (providing NextNav's per test point vertical accuracy results for each of the tested buildings).

[24] *See, e.g.*, Weather History for San Francisco, CA for November and December 2012 (available at http://www.wunderground.com/history/airport/KSFO/2012/12/1/MonthlyHistory.html) (last visited Oct. 30, 2014) (showing range of variations in wind and barometric pressure during CSRIC testing window).

[25] *See CSRIC Test Bed Detail Report* at 46, Table 6.1.2-4 (providing test results).

[26] *See* NextNav, LLC, Ex Parte Letter, PS Docket No. 07-114, at 7-9 (Aug. 14, 2013) (providing the vertical results of NextNav's Rev 2 testing).

accuracy for 67 percent (not 100 percent) of vertical readings by the third year and 80 percent by the fifth year.

Finally, with respect to NextNav's MBS infrastructure, NextNav's beacon transmitters are FCC-certified, use commercially manufactured components, are currently deployed in 47 of the largest cellular market areas around the country, and have been operating for a number of years. The MBS beacons are telemetered and controlled through a national network control center, and the currently deployed network can be expanded to serve other markets (including both urban and suburban areas) as required to achieve the indoor location requirements of the Commission's proposed rules.

In summary, the standards development for MBS and the integration of MBS-capable components into commercially available devices is proceeding positively with support from various carriers and chipset partners. Provided carriers remain supportive of MBS technology, commercial handsets should be available for use consistent with the timeline set forth in the Commission's proposed indoor location accuracy rules.

Thank you for your attention to this matter.

Sincerely,

Bruce A. Olcott