

How Innovation in the Wireless Industry is Improving 9-1-1 Location Accuracy

Ryan Jensen, T-Mobile

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Collaborative Efforts to Improve Indoor Location

- 'Roadmap' Agreement ⇒ FCC Fourth Report & Order
 - 50m accuracy or 'Dispatchable Location' for wireless callers
- ATIS – Develop Technical Standards and Industry Best Practices
 - ESIF – Test Methodologies
 - ELOC – NEAD Technical Specifications
- CTIA Working Groups – Support Activities to Meet Roadmap Commitments
- CTIA LLC Programs – Operationalize Industry Initiatives
 - Test Bed – Evaluate Indoor Location Performance
 - Compliance Testing for Deployed E911 Technologies
 - Evaluation of New and Emerging Location Technologies
 - NEAD – Provide Dispatchable Locations



Improved Indoor Location Progress

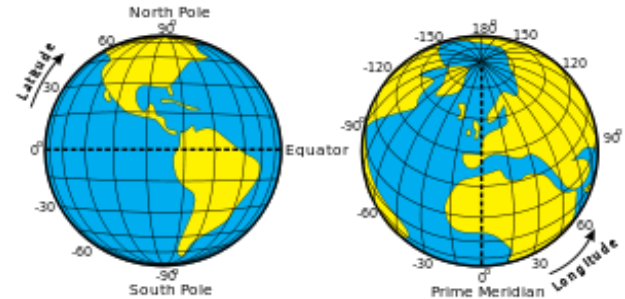
- Recent Performance Trends
 - **Very high indoor location availability**
 - **Significantly improved indoor location accuracy**
 - Ahead of FCC location accuracy requirements
 - Lower time-to-first-fix (Latency)
 - Emerging methods can provide high accuracy fixes within ~5 sec
 - Uniform Confidence Level for Uncertainty Estimates
 - 90% across all wireless providers

Key Location Technologies

- AGNSS – AGPS + Additional Satellite Constellations
- Observed Time Difference of Arrival – OTDOA
- Device Based Hybrid – DBH
- Dispatchable Location (DL) / NEAD
(National Emergency Address Database)
- Small Cells
- Vertical Location
 - LTE supports simultaneous location processes

AGNSS – AGPS + Additional Satellite Constellations

- AGPS in use for 15 Years for E9-1-1
- **Enter: GLONASS, Galileo, BeiDou**
- 2nd constellation helpful for many indoor environments
 - Improves availability indoors
 - Improves accuracy indoors and outdoors
- High Accuracy, Medium Availability, High Latency
- Handsets ready to go
- Bureaucratic challenges pacing use for E9-1-1
 - Work in Progress



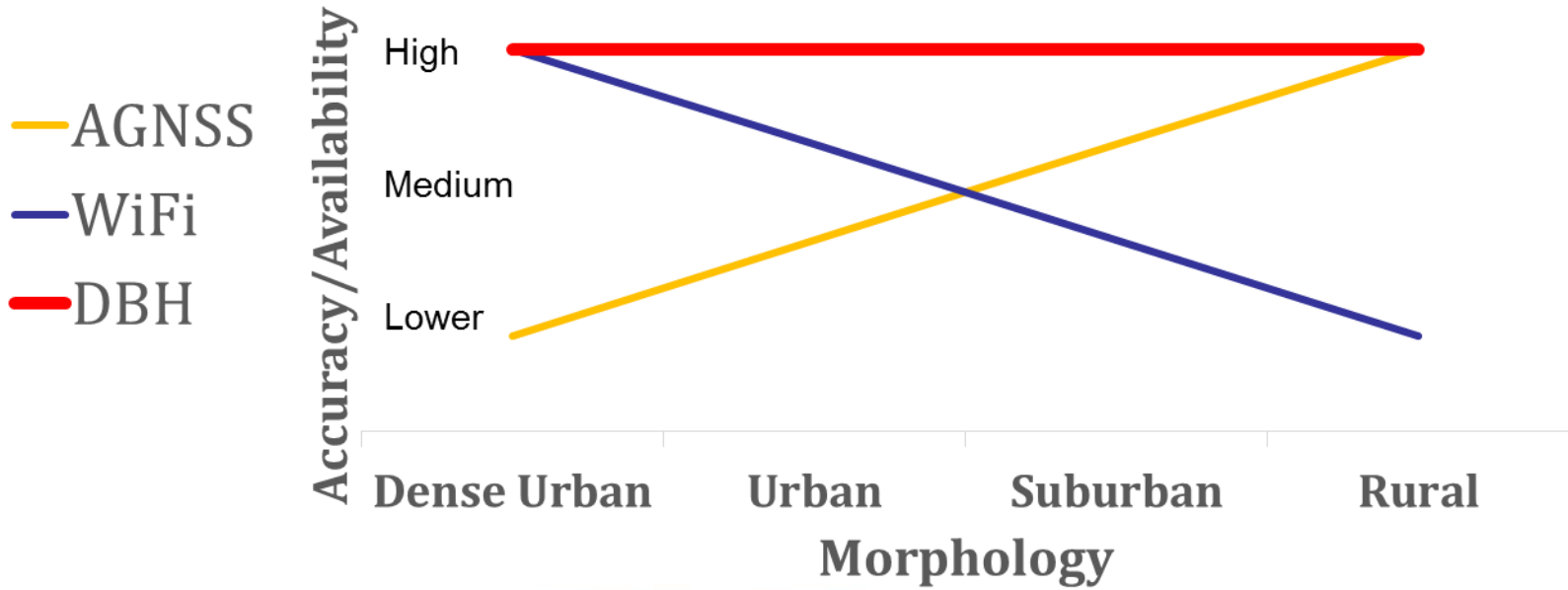
OTDOA – Observed Time Difference of Arrival

- Handset measures downlink of surrounding basestations – Multilateration
 - Integrated into Voice over LTE (VoLTE) signaling
- Accurate network provisioning is fundamental to location accuracy
 - Network synchronization, antenna locations, cable delays, neighbor lists
- Already contributing to meeting the FCC accuracy standard
- Medium Accuracy, High Availability, Low Latency
- Functional improvements standardized, moving into production

DBH – Device Based Hybrid

- Crowdsourced WiFi based positioning paired with AGNSS
 - Combination of two very powerful positioning methods is complementary across morphologies
- Already contributing to meeting the FCC accuracy standard
- **High Accuracy, High Availability, Low Latency – even in very challenging indoor environments**
- Leveraging Successful Commercial Methods for E911!
- **No longer: *“Why can Uber find me but 911 can’t?”***

Device Based Hybrid Performance Illustration



Device Based Hybrid – Implementation Options

- Device Based Position Calculation – “Device Based Hybrid”
 - May utilize available handset sensors
 - Gyroscopes, Accelerometers, Magnetometers, Barometer
 - Massive crowdsourced WiFi database
 - Handset OS Providers
 - Chipset OEMs
- Network Based Position Calculation – “Network Hybrid”
 - Handset provides measurements to network
 - WiFi database provided by location technology vendor

Dispatchable Location - NEAD

- The National Emergency Address Database (NEAD) platform provides a '*Dispatchable Location*' for a wireless 9-1-1 caller using provisioned 'reference points' in proximity to the caller
 - WiFi Access Points
 - Bluetooth Beacons
- *Dispatchable Location* is defined as the street address of the calling party, plus additional information such as suite, apartment or similar information necessary to adequately identify the location of the calling party

Dispatchable Location - NEAD

- Directly Actionable – eliminates inaccuracy of reverse geo-coding a Lat/Long fix into a dispatchable civic address for First Responders
- Includes vertical component for multi-story buildings
- Development of the NEAD platform is fully underway
 - Testing scheduled for 4Q2017-1Q2018
- Expected: High Accuracy, Low ⇒ High Availability, Low Latency
- **Calling all owners of provisionable WiFi AP's/Bluetooth beacons!**
 - Wireless providers taking the first step to populate the NEAD

Small Cells

- Increasing use of Small Cells (femto, pico) to expand wireless coverage and increase capacity
- Limited coverage range naturally provides high accuracy location capability for 9-1-1 calls served by those cells
 - In many cases, these results can be provided as dispatchable locations, rather than a Lat/Long
- High Accuracy, Low Availability, Low Latency



Vertical Location (Z-Axis)

- **NEAD – Vertical component of DL**
- **Barometric Pressure Systems - *Backstop***
 - Barometers becoming prevalent in newer smart phones
 - Significant technical challenges for consistent accuracy
 - Local atmospheric/weather variations – local calibration
 - Outdoor to indoor pressure deltas – cannot be calibrated out
 - Sensor calibration/aging – no practical method to resolve
 - Translation from HASL to ‘floor level’ – non-trivial
 - Will be tested in Test Bed – 1H2018
 - Z-Axis accuracy metric provided to FCC

Summary of Indoor Location Performance

Position Method	Accuracy	Availability	Latency	Morphology (DU, U, S, R)
OTDOA	Medium	High	Low	DU, U, S
AGNSS	High	Medium	High	U, S, R
Small Cells	High	Low	Low	DU, U
DBH	High	High	Low	All
DL/NEAD	High	Low ⇒ High	Low	All

How Can You Help?

- Encourage participation in the NEAD Data Provisioning Process (WiFi APs, Bluetooth Beacons)
 - Broadband Service Providers
 - Large Enterprises
 - Public Institutions
- Prepare PSAPs to receive additional location information
- Encourage governmental approval of use of additional satellite constellations for E9-1-1

Summary/Observations

- No single positioning method fills all location needs in all environments
 - Key is multiple methods with intelligent combining/selection
 - New location methods are being added to supplement (not replace) existing methods
- Significant location improvements (accuracy, availability, latency) already seen in indoor environments – with more to come in the near-future
- Some hurdles cleared, others still ahead
- Collaborative model is best for improving E9-1-1