



FCC Workshop

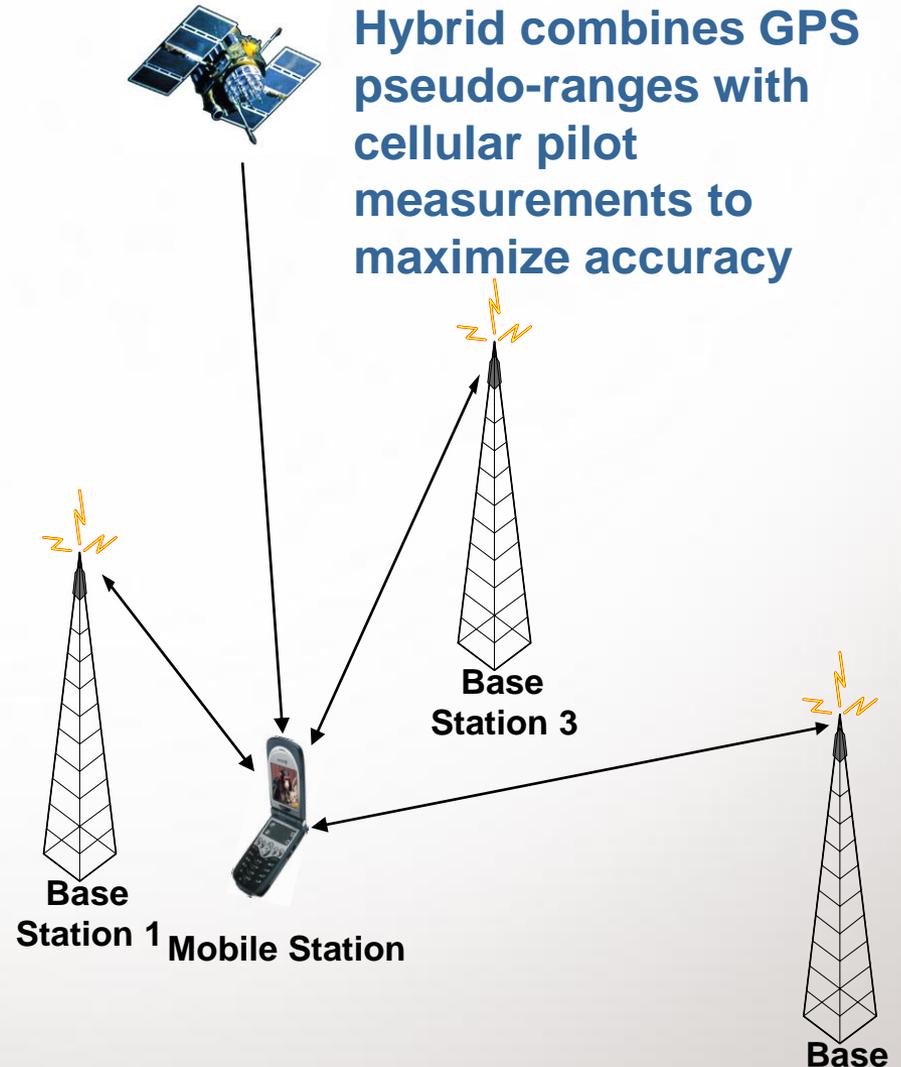
Cormac Conroy, PhD
Vice President, Engineering and Product Management
Location Products and Technology
October 24, 2012

Outline

- Test Bed A-GPS / AFLT Technology Overview
- GNSS and OTDOA
- 9-1-1 Location Ecosystem
- 9-1-1 Location Timeline
- New Technologies
- Conclusion and Looking Ahead
- Backup
 - 9-1-1 Location Standards Based Architecture

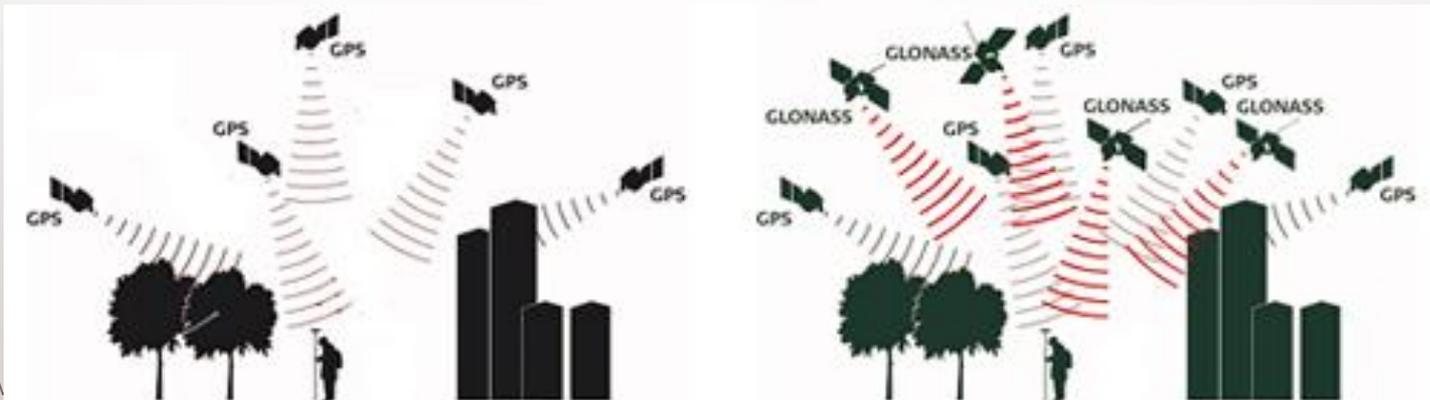
Test Bed Hybrid A-GPS/AFLT

- Qualcomm along with its network operator partners have submitted hybrid A-GPS/AFLT technology to the test bed
- Hybrid fixes uses both GPS pseudo-ranges and CDMA Pilot measurements in the same trilateration calculation when an insufficient # of GPS pseudo-ranges are available for a GPS-only fix
- Hybrid allows the maximum accuracy when a GPS-only solution is not possible (e.g., two or fewer GPS pseudo-ranges are available)



Key Benefit of GNSS – *Improved Performance, Standards Based*

- The main advantage of additional GNSS constellations in addition to GPS is increased number of available satellite signals for performance gains as follows:
 - Improved availability (of satellites at a particular location) and yield:
 - Improved ability to work in in urban canyons or mild indoors
 - Improved reliability:
 - With extra measurements the data redundancy is increased, which helps identify any measurement outlier problems
 - Improved accuracy:
 - Better positioning accuracy due to improved geometry, increased # of line of sight measurements
 - Better positioning accuracy due to improved ranging signals from modernized satellites (e.g., higher signal strength, longer codes, wide bandwidth signals)
 - Fully standards based network-assisted solutions – A-GPS, A-Glonass etc.



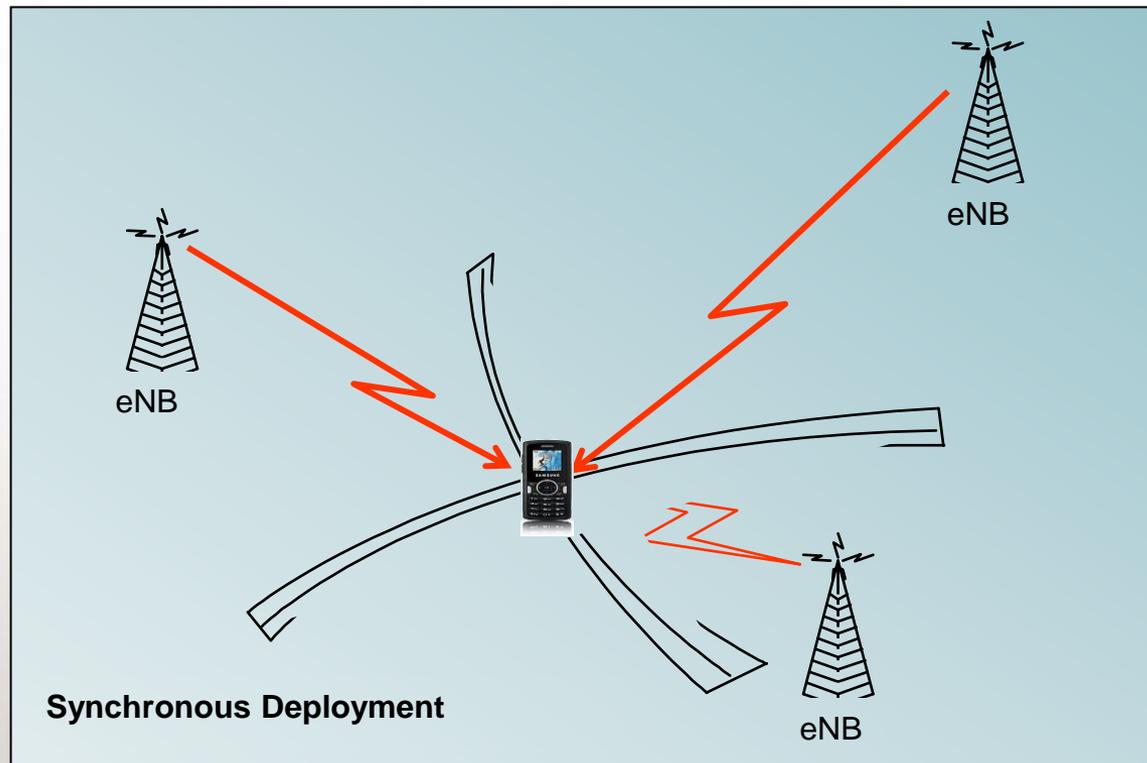
Key Benefits of Wireless WAN *(i.e. 2G/3G/4G Cellular)*

- Penetrates buildings – deep indoors
- If cellular networks are synchronized, ranging is possible from cell towers giving a position indoors
- Leverages existing infrastructure to do positioning
- Leverages trusted, accurate cell tower base station almanac of wireless operators
- Standards based
- Going forward, as 4G/LTE rolls out, with synchronized base stations, coverage to the mobile user base will grow quickly



Observed Time Difference of Arrival (OTDOA)

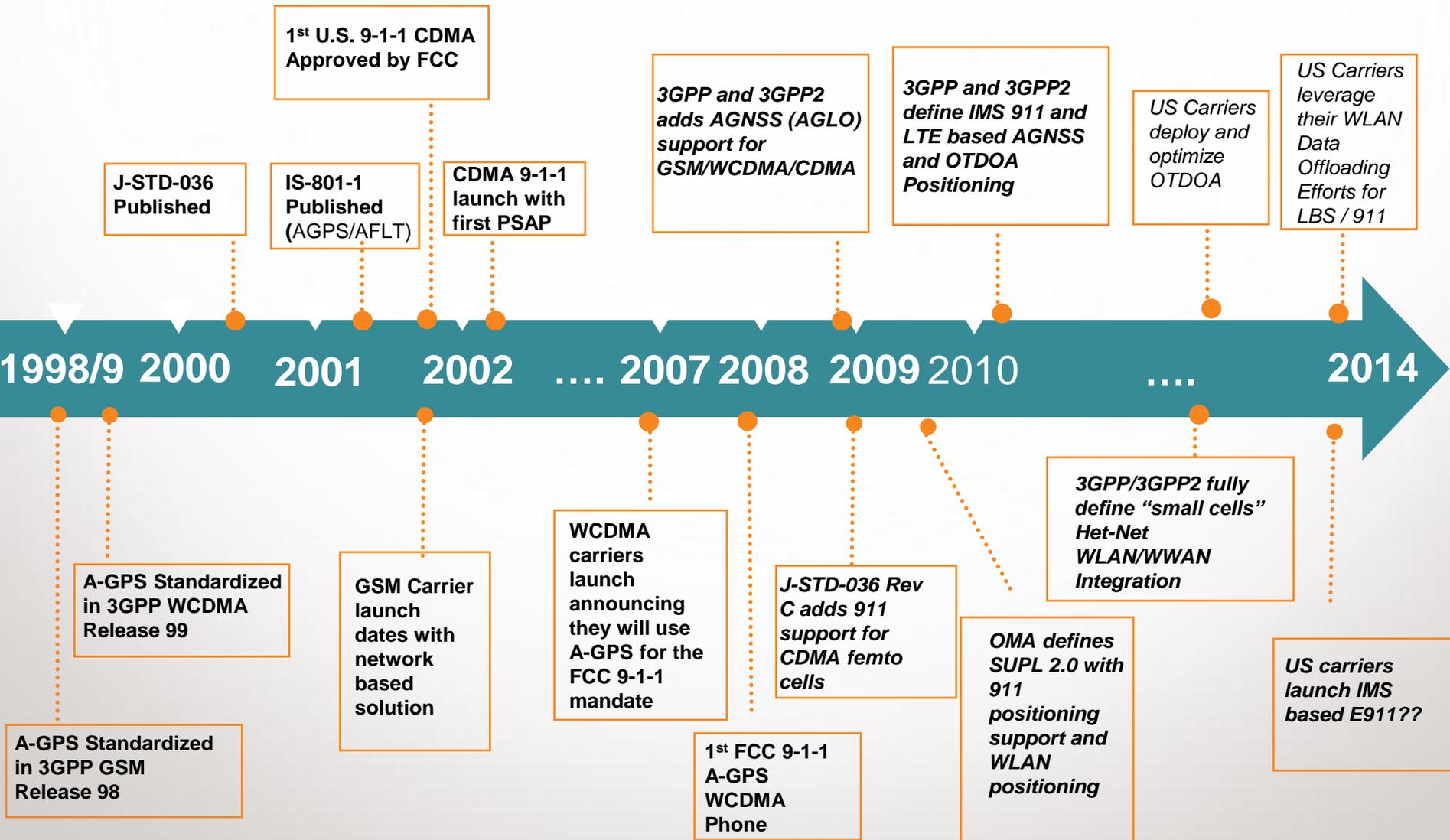
- DL positioning method (similar to AFLT) – but for 4G/LTE networks
- UE measures OTD's (difference of TOA) from between eNB pairs
- Measurements are made on highly detectable Positioning Reference Signal (PRS)
- Designed to outperform AFLT (higher bandwidth, increased hearability, inter-frequency, etc)
- Hybrid A-GNSS / OTDOA will be a useful indoor positioning technology



9-1-1 Location Ecosystem

- The 9-1-1 solution is a multi-vendor ecosystem
 - No one vendor controls the overall quality of the 9-1-1 service
 - A-GPS/A-GNSS and AFLT/OTDOA signaling is between the device and location server but the other nodes (e.g., base station, switches, etc.) are important components as well
 - The MPC/GMLC is the overall manager of the 9-1-1 call and deals with call routing and location delivery to the PSAP
 - All discrete components of the complex system must work together to ensure efficient and optimized performance
- *In any FCC rulemaking process, the complexity of the multi-vendor eco-system must be taken into account*
- Standards will help carriers deploy the new technologies
 - A-GNSS and OTDOA now
 - Small cells, both LAN and WAN later

9-1-1 / LBS Timeline



New Technologies Impact 9-1-1

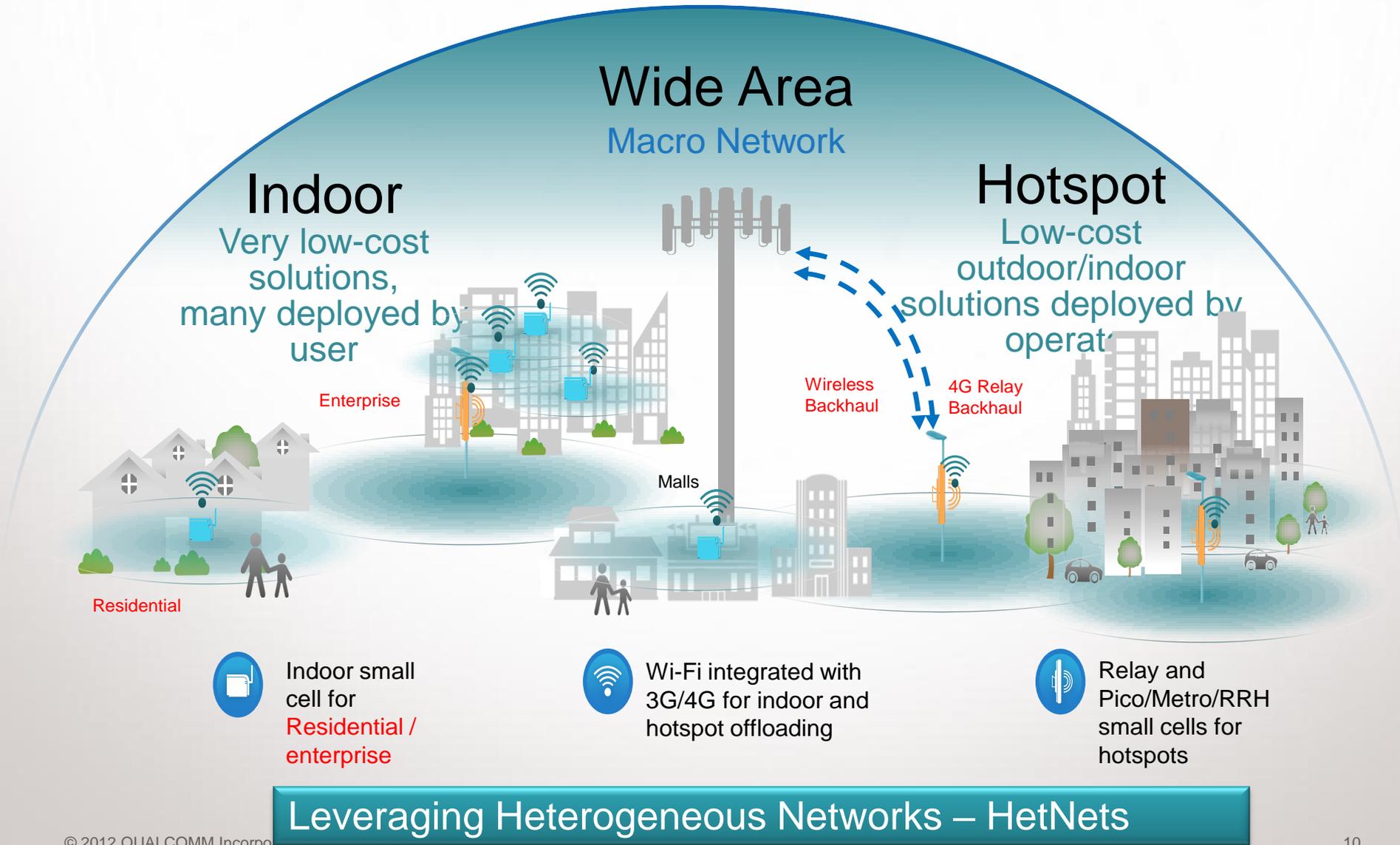
- New Constellations and A-GNSS
- New Access Networks
 - 4G/LTE with OTDOA
 - WLAN
 - Signal strength and ranging measurements which will be key for indoor positioning
- Standards Support for New Technologies
 - OMA has defined 9-1-1 “User Plane” solution standard for these new access networks
 - Better support for Multi-RAT / Hybrid positioning methods
- Changes to Network Topologies
 - Small cells (Femto / Pico Cells) per 3GPP Standards
 - WLAN data offloading
 - Managed Access Points and Small Cells are a powerful asset for wireless operators
- Beacons and other “non-traditional” solutions
 - Offer proposed indoor location solutions but may require additional infrastructure



👉 Broad Industry Collaboration Related to Indoor Location

- **In-Location Alliance** formed by industry leader to foster migration to indoor location.

More Small Cells – Bring Network Closer to User



Conclusion and Looking Ahead

■ ***Demonstrated Leadership***

- Over the years, Qualcomm has led and delivered technologies to the highest degree of 9-1-1 accuracy and will continue to enhance and deliver refinements to 9-1-1

■ ***Industry Support***

- Qualcomm fully supports all stakeholders' desire for continuous improvements in 9-1-1 accuracy and is eager to work together to develop measurable, attainable metrics to improve 9-1-1 accuracy

■ ***Realistic Goals***

- Qualcomm believes all facets of the ecosystem must participate and set realistic expectations for 9-1-1- evolution

■ ***Leverage of Standards and Deployment of Standards-Based Solutions***

- Assisted Glonass – mentioned in the standards for many years
- OTDOA – being deployed by all US operators
- Industry initiatives to small cells inclusive of WLAN for data offload and a new small cell band needed to support 1000x capacity .

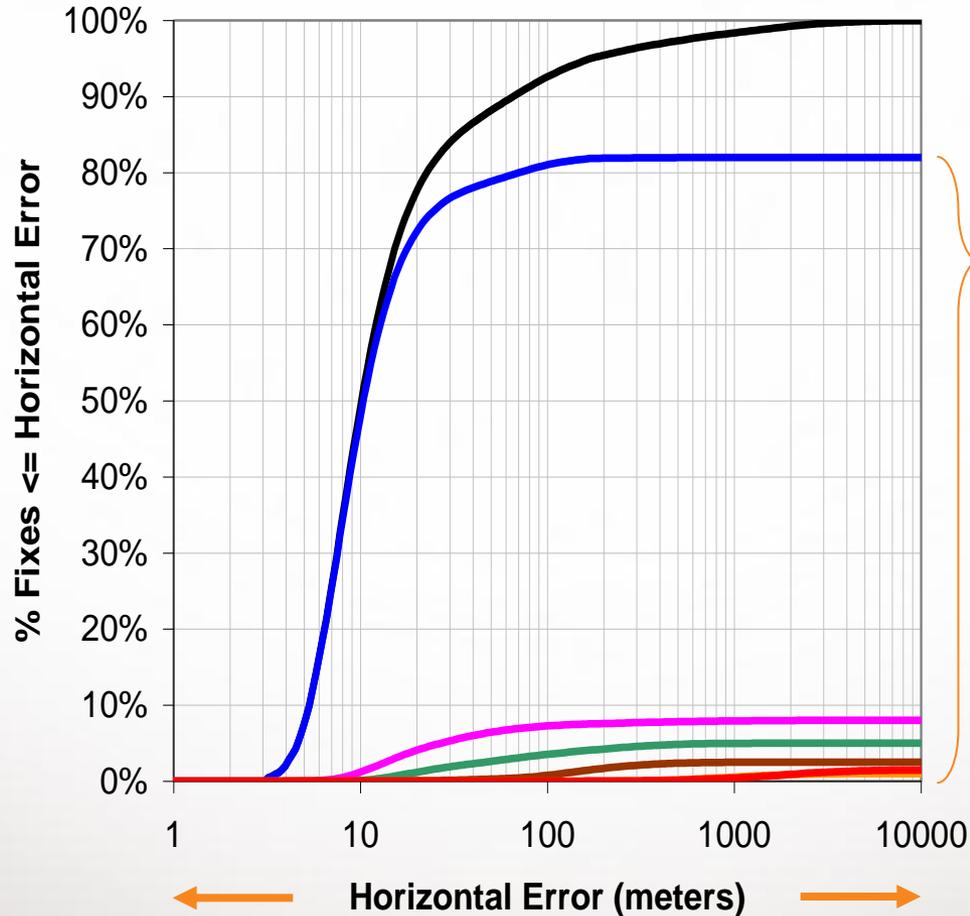
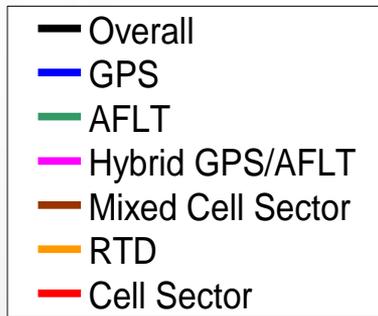
■ ***Fostering Location Evolution and Leverage of New Location Technologies***

- Qualcomm is engaged with industry leaders to foster the migration to indoor location as evidenced by participation in the **In-Location Alliance** with industry leaders.

BACKUP

Benefits Hybrid Positioning

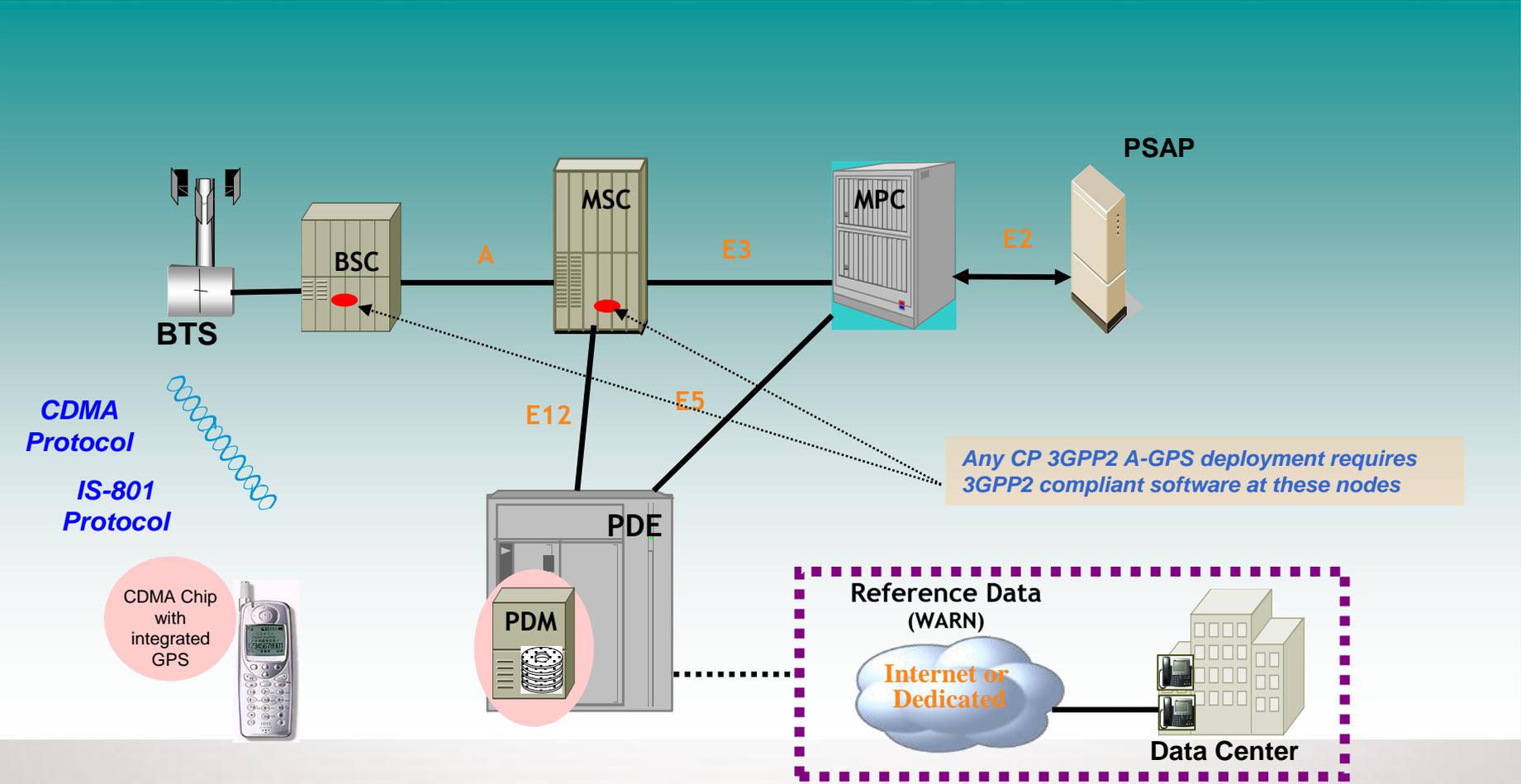
Example Fractional Cumulative Distribution Function



GPS is the most accurate solution type, but without other solution types, yield is only **82%** in this example. Other solution types fill the void when GPS is not available. **Hybrid** and **AFLT** are the best alternatives.

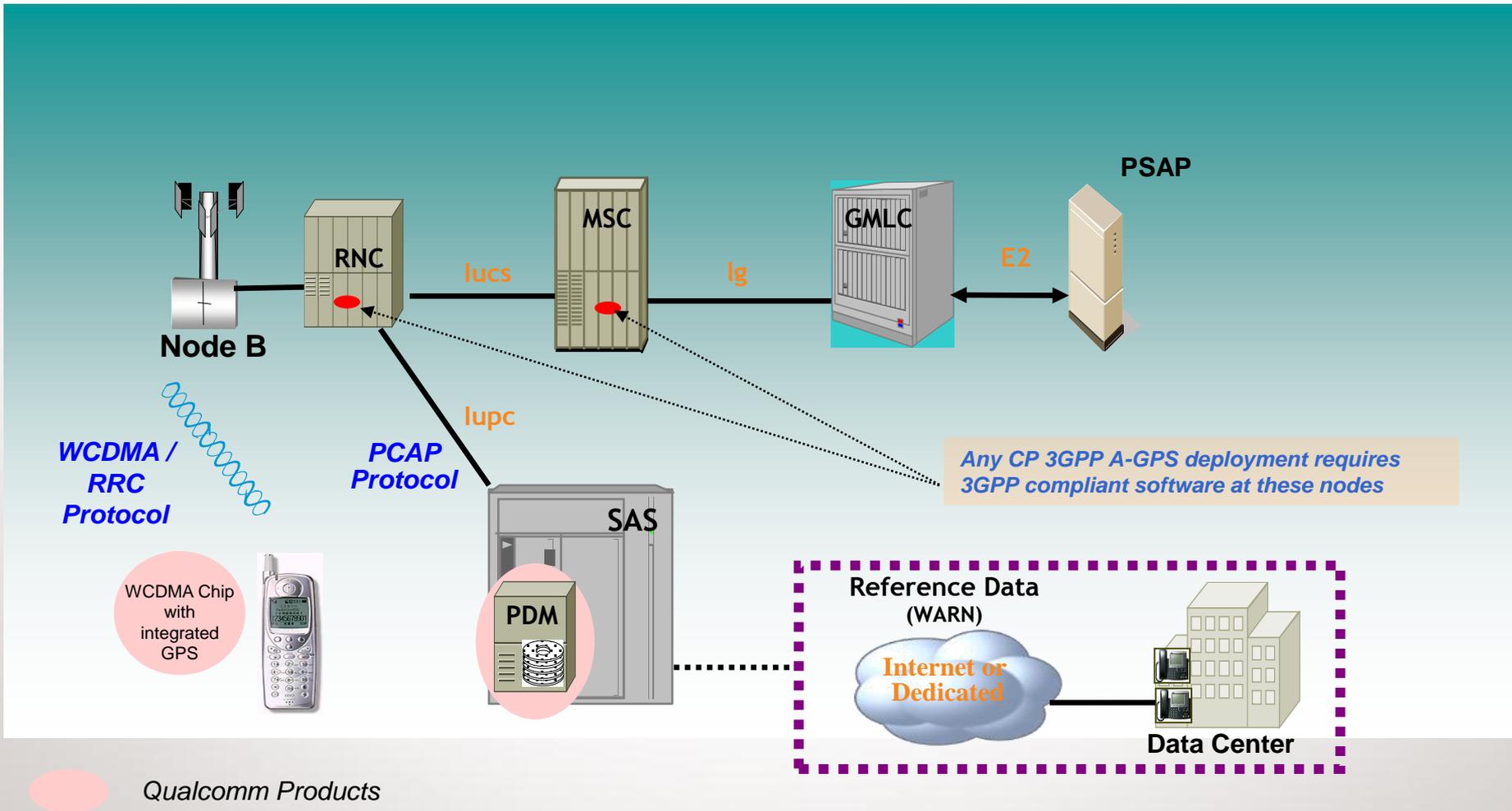
← More Accurate Horizontal Error (meters) → Less Accurate

CDMA Control Plane 9-1-1 Architecture



Qualcomm Products

WCDMA Control Plane 9-1-1 Architecture



Thank You

©2012 Qualcomm Incorporated. All rights reserved. Qualcomm is registered trademark of Qualcomm Incorporated. All the trademarks or brands in this document are registered by their respective owner.

QUALCOMM Incorporated, 5775 Morehouse Drive, San Diego, CA 92121-1714