



FCC Workshop

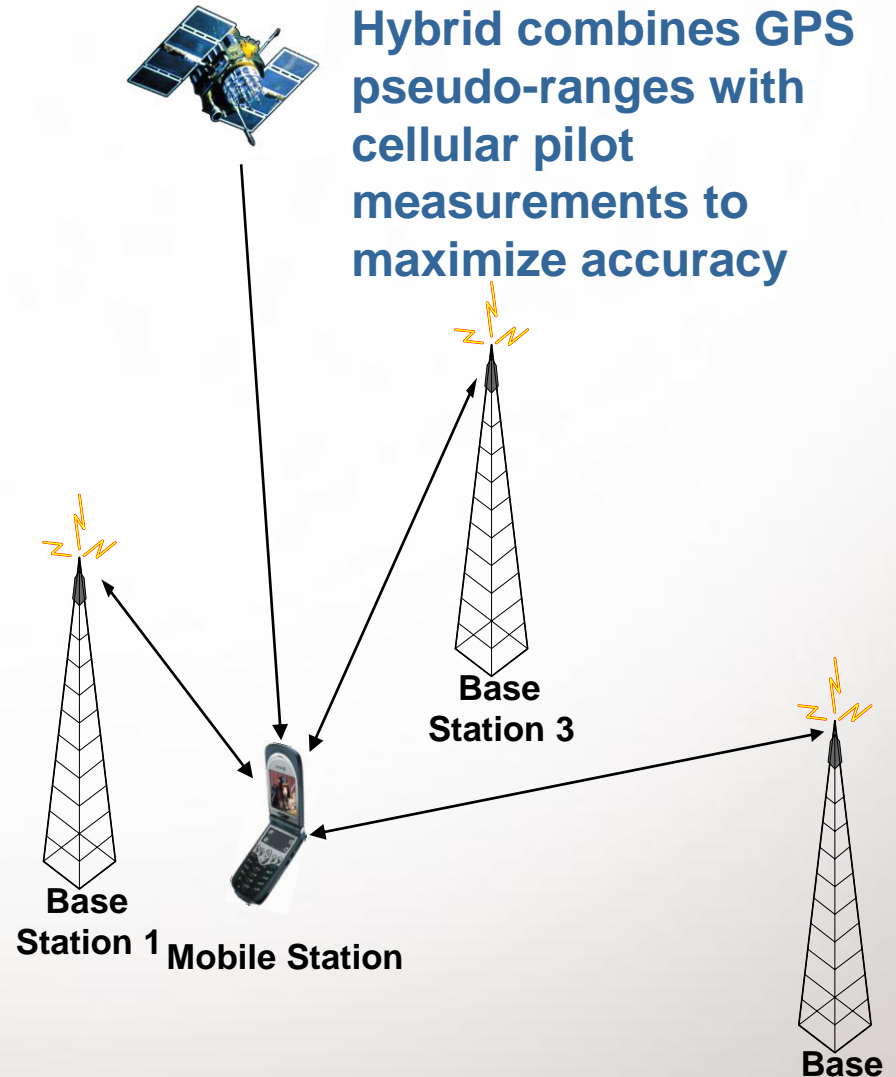
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Outline

- 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

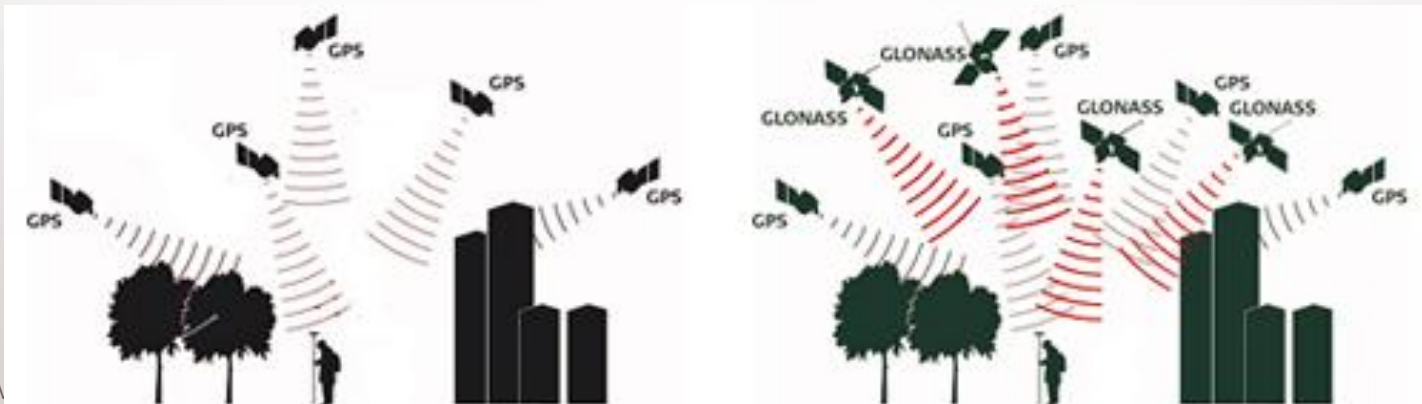
Test Bed Hybrid A-GPS/AFLT

- 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.



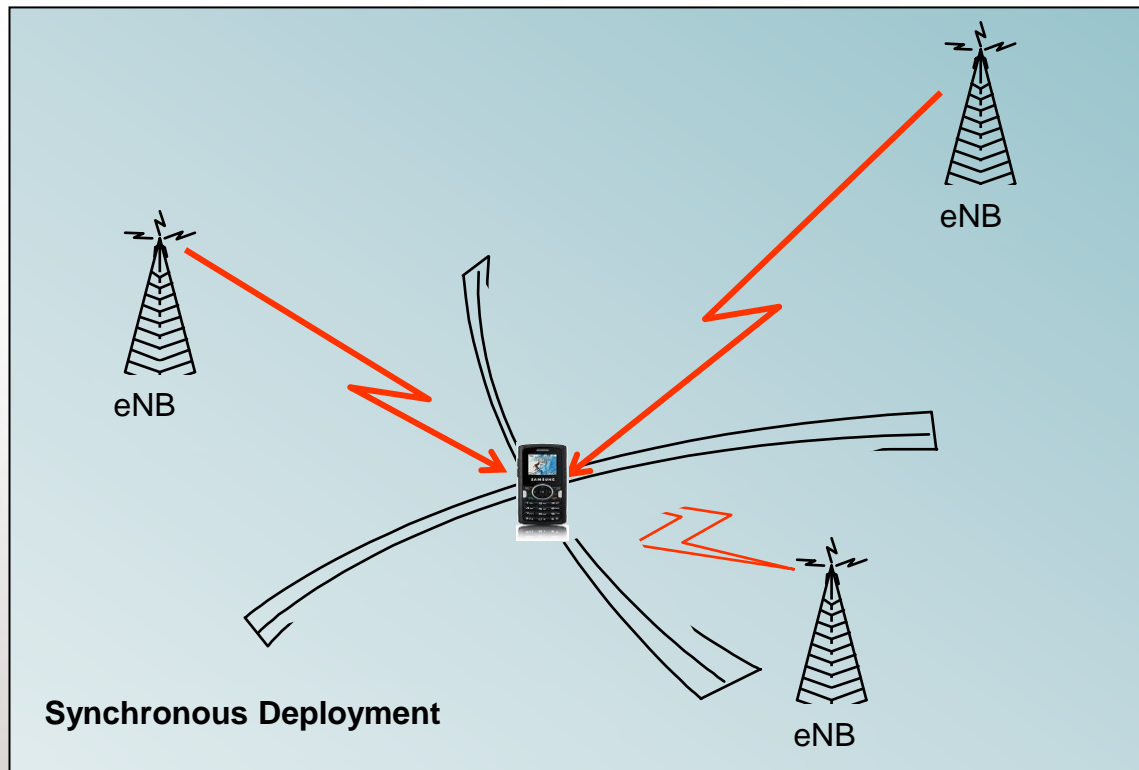
Key Benefits of Wireless WAN *(i.e. 2G/3G/4G Cellular)*

- 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)

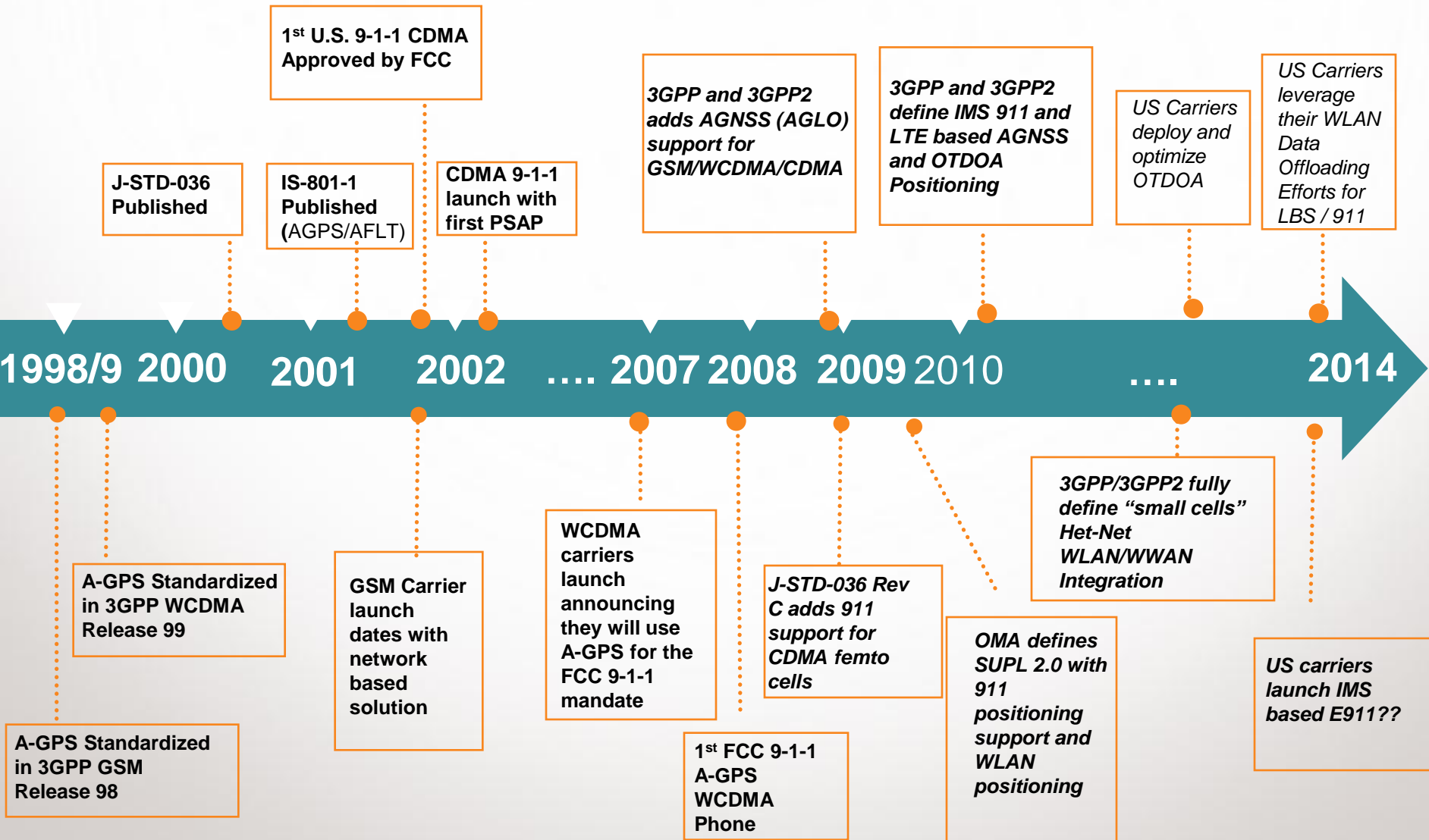
- DL positioning method (similar to AFLT) – but for 4G/LTE networks
- UE measures OTD's (difference of TOA) from between eNB pairs
- Measurements are made on highly detectable Positioning Reference Signal (PRS)
- Designed to outperform AFLT (higher bandwidth, increased hearability, inter-frequency, etc)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

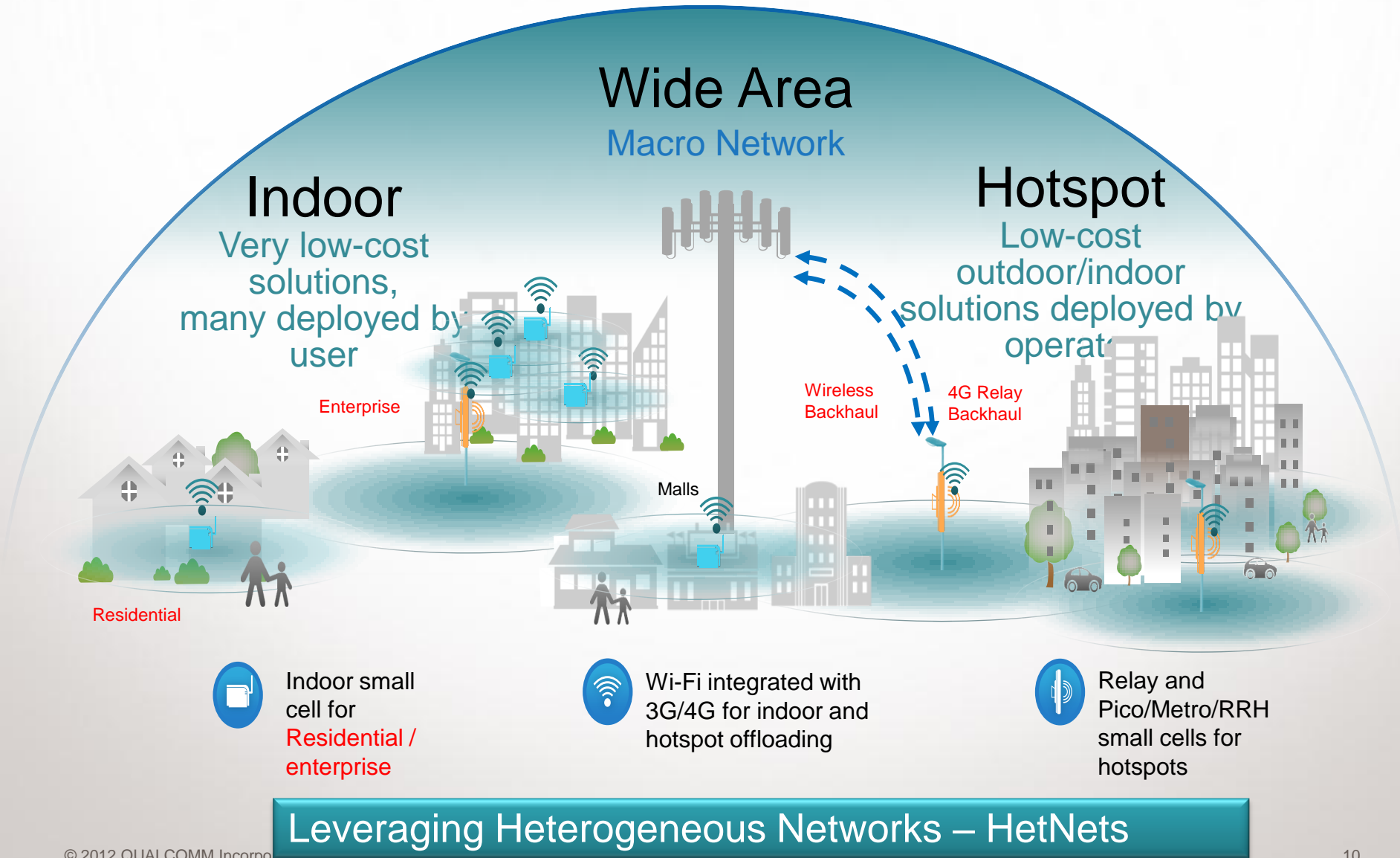
- New Constellations and A-GNSS
- New Access Networks
 - 4G/LTE with OTDOA
 - WLAN
 - Signal strength and ranging measurements which will be key for indoor positioning
- Standards Support for New Technologies
 - OMA has defined 9-1-1 “User Plane” solution standard for these new access networks
 - Better 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 .

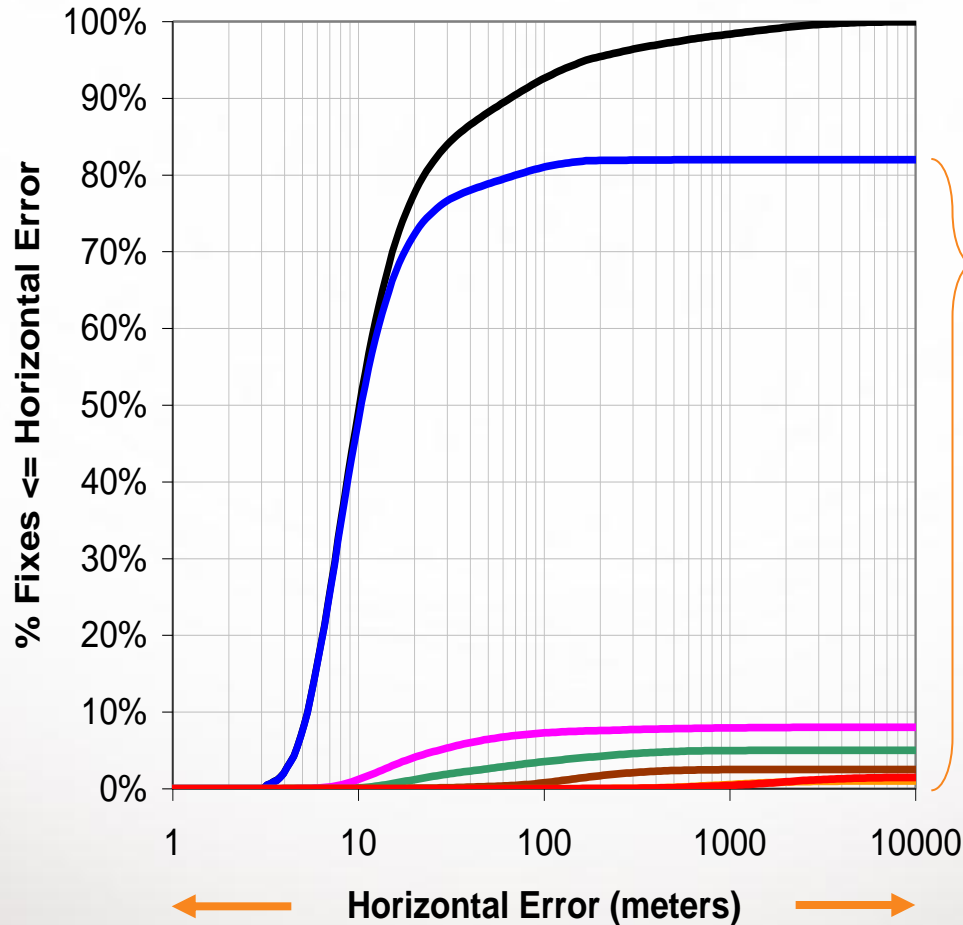
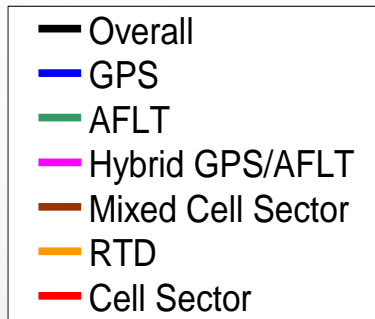
■ ***Fostering Location Evolution and Leverage of New Location Technologies***

- 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

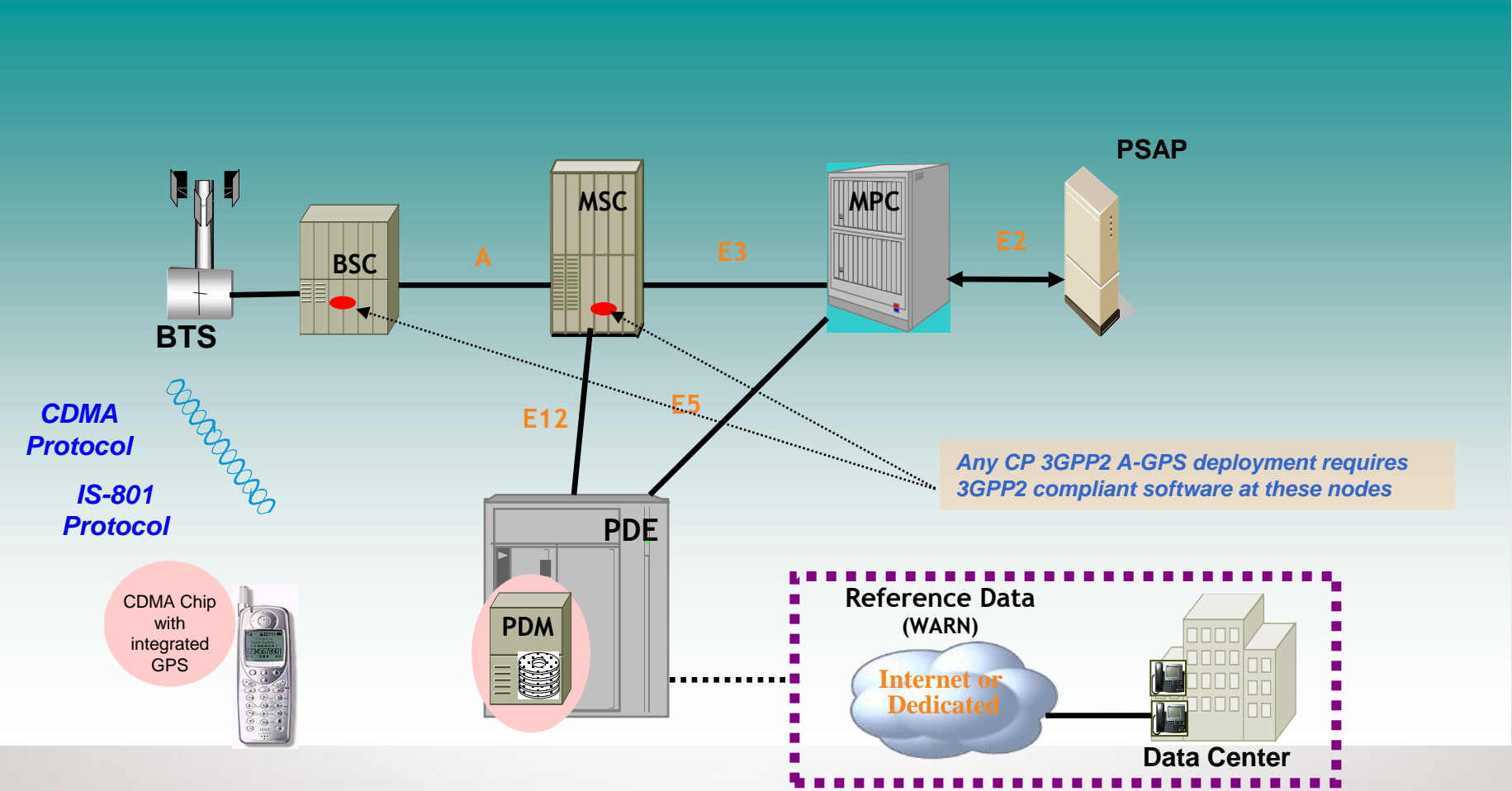
Example Fractional Cumulative Distribution Function




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.

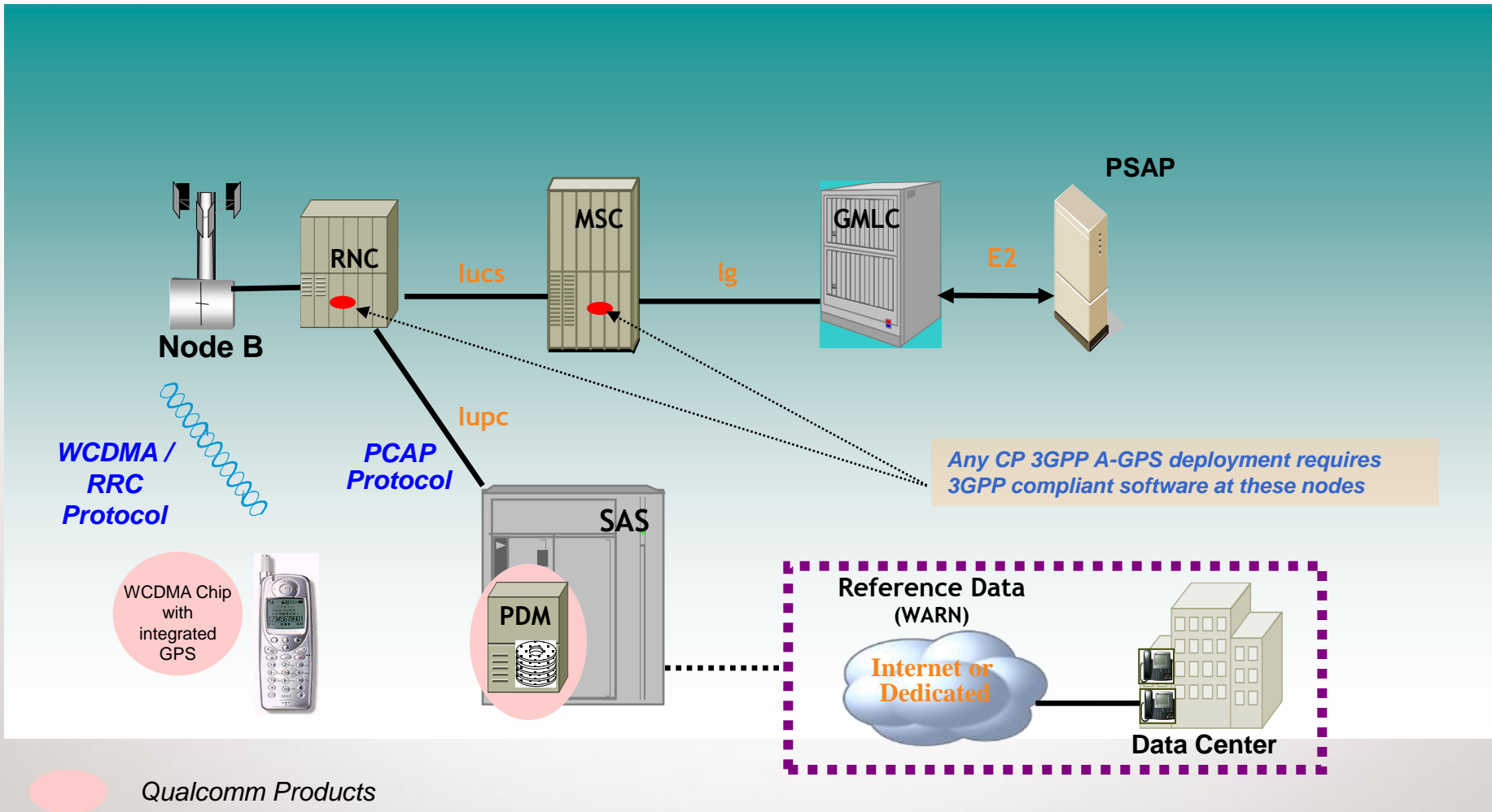
← More Accurate Horizontal Error (meters) → Less Accurate

CDMA Control Plane 9-1-1 Architecture



 *Qualcomm Products*

WCDMA Control Plane 9-1-1 Architecture



Thank You

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