


QUALCOMM CDMA TECHNOLOGIES



PAGE 1 Opportunistic RF Localization for Next Generation Wireless Devices



Hybrid Positioning In CDMA Networks

June 17, 2008

The slide features a world map with a horizontal bar across it. The bar is divided into four colored segments: orange, red, blue, and green. The Qualcomm logo is in the top left, and the title and date are in a blue box at the bottom.

Content

- Overview of Assisted GPS (A-GPS)
- Hybrid Position Location
- Conclusion



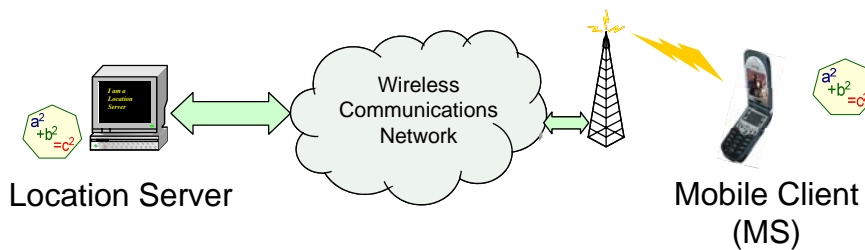
PAGE 2 Opportunistic RF Localization for Next Generation Wireless Devices

The slide contains a bulleted list of three items. The gpsOne logo is in the top right. The Qualcomm logo is in the bottom left, and the page number and title are in a grey bar at the bottom.



Assisted GPS (A-GPS)

What is "Assisted" GPS?



- **Assisted-GPS** means that a **Location Server** assists a wireless device client to produce location fixes
- Some form of wireless network exists between the two to enable communication
- Key terms (more on each later):
 - **MS-Based**: The mobile performs the actual location calculations
 - **MS-Assisted**: The location server performs the calculations



Benefits of Assisted-GPS

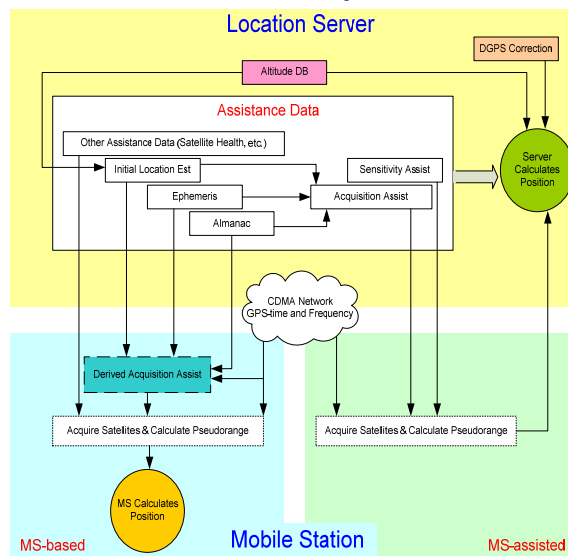


- **A-GPS uses a location server in the wireless network and the wireless network itself to improve:**
 - **Location Accuracy:** how close the reported fix position is to the true position
 - **Yield:** percentage of fix attempts that produce a successful fix
 - **Time to Fix:** how long it takes to get a fix
 - **Battery Consumption:** how much power is needed to produce a fix
 - **Mobile Device Cost**
- **There are many aspects to A-GPS, and many different architectures and modes of operation**
 - Different modes of operation can take advantage of different aspects of A-GPS



PAGE 5

Application of Assistance Data (MS-based vs. MS-assisted)



PAGE 6



Hybrid Position Location

Integration with Non-GPS Location Technologies

- **gpsOne® Assisted-GPS allows non-GPS location technologies to be combined with GPS:**
 - **Advanced Forward Link Trilateration (AFLT):** ranging to cell towers using the Pilot phase measurement
 - **Round Trip Delay (RTD)*:** use measurements made by the Base Stations
 - **Cell/Sector Centroids*:** use knowledge of which cell sector is serving the mobile, and which are seen by the mobile, to determine position
- **Benefit**
 - **Higher Yield:** while these technologies are not as accurate as GPS, they can fill in the gaps when GPS is not available

* RTD and Cell/Sector solution types are not discussed in this presentation

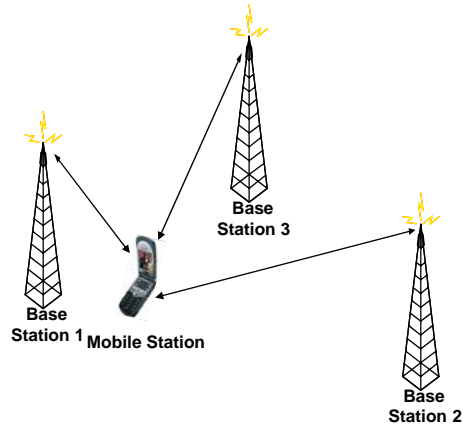


Advanced Forward Link Trilateration (AFLT) gpsOne by Qualcomm

➤ **Advanced Forward Link Trilateration (AFLT)** solution was developed by Qualcomm and commercially deployed in 2000

➤ **How it works:**

- Mobile measures phase of CDMA Pilot signals that it sees
- A location server associates each Pilot measurement to a nearby tower
- Tower position is maintained in a database known as the "Base Station Almanac"
- Trilateration is used to turn the tower positions and Pilot measurements in to a position solution, much like GPS



PAGE 9

Opportunistic RF Localization for Next Generation Wireless Devices

AFLT Detail gpsOne by Qualcomm

- Presently supported **only on CDMA networks**
- Pilot phase offsets (AFLT) are measured by gpsOne® mobiles
- Requires an accurate Base Station Almanac
 - Cell sector identity information
 - Cell sector location (latitude, longitude, altitude)
 - AFLT calibration
 - Values for uncertainties in measurements
- The CDMA Pilots used for AFLT measurement can be lower in signal strength than those required for providing CDMA service



PAGE 10

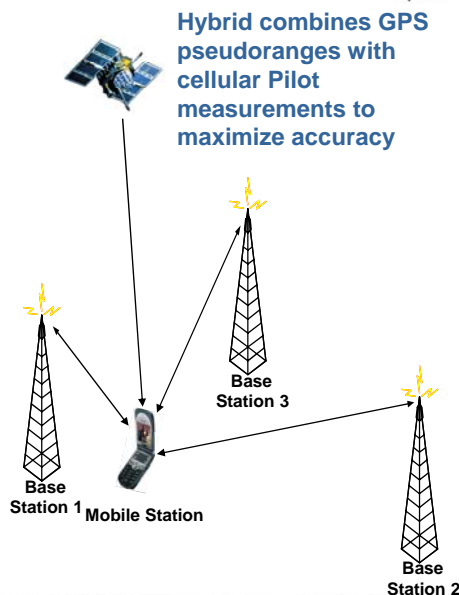
Opportunistic RF Localization for Next Generation Wireless Devices



Hybrid GPS/AFLT

gpsOne
by Qualcomm

- gpsOne® Hybrid uses both GPS pseudoranges and CDMA Pilot measurements in the same trilateration calculation
- Hybrid is typically more accurate than AFLT-only, but less accurate than GPS
- Hybrid allows the maximum in accuracy when a GPS-only solution is not possible (e.g., two or fewer GPS pseudoranges are available)



QUALCOMM
CDMA Technologies

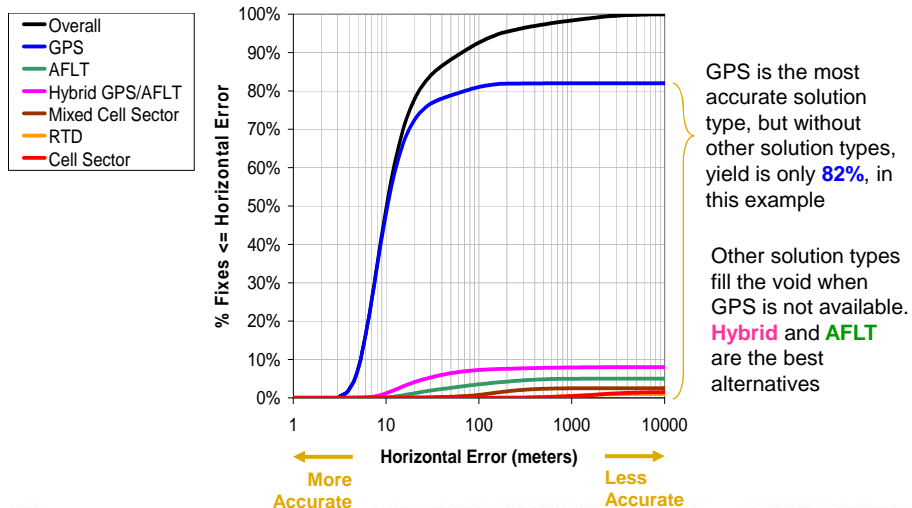
PAGE 11

Opportunistic RF Localization for Next Generation Wireless Devices

Benefits Hybrid Positioning

gpsOne
by Qualcomm

Example Fractional Cumulative Distribution Function



QUALCOMM
CDMA Technologies

PAGE 12

Opportunistic RF Localization for Next Generation Wireless Devices



Conclusion



- Hybrid positioning technology, first deployed by Qualcomm in 2000, can provide excellent fallback solution types when a GPS-only solution is not possible
- Hybrid GPS/AFLT and AFLT-only solution types offer improved accuracy over conventional Cell ID or mixed cell/sector solutions
- Hybrid augmentation of GPS with other positioning technologies are, and will continue to be, an important component in the future of location technology

