

# Overview of Location Technologies

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# Important Terminology

**AGPS** – Assisted GPS

**AFLT** – Advanced Forward  
Link Trilateration

**AOA** – Angle of Arrival

**BTS** – Base Transceiver  
Station

**EFLT** – Enhanced Forward  
Link Trilateration

**EOTD** – Enhanced Observed  
Time Difference

**GPS** – Global Positioning  
System

**ID** – Identifier

**LMU** – Location  
Measurement Unit

**MS** – Mobile Station

**MSC** – Mobile Switching  
Center

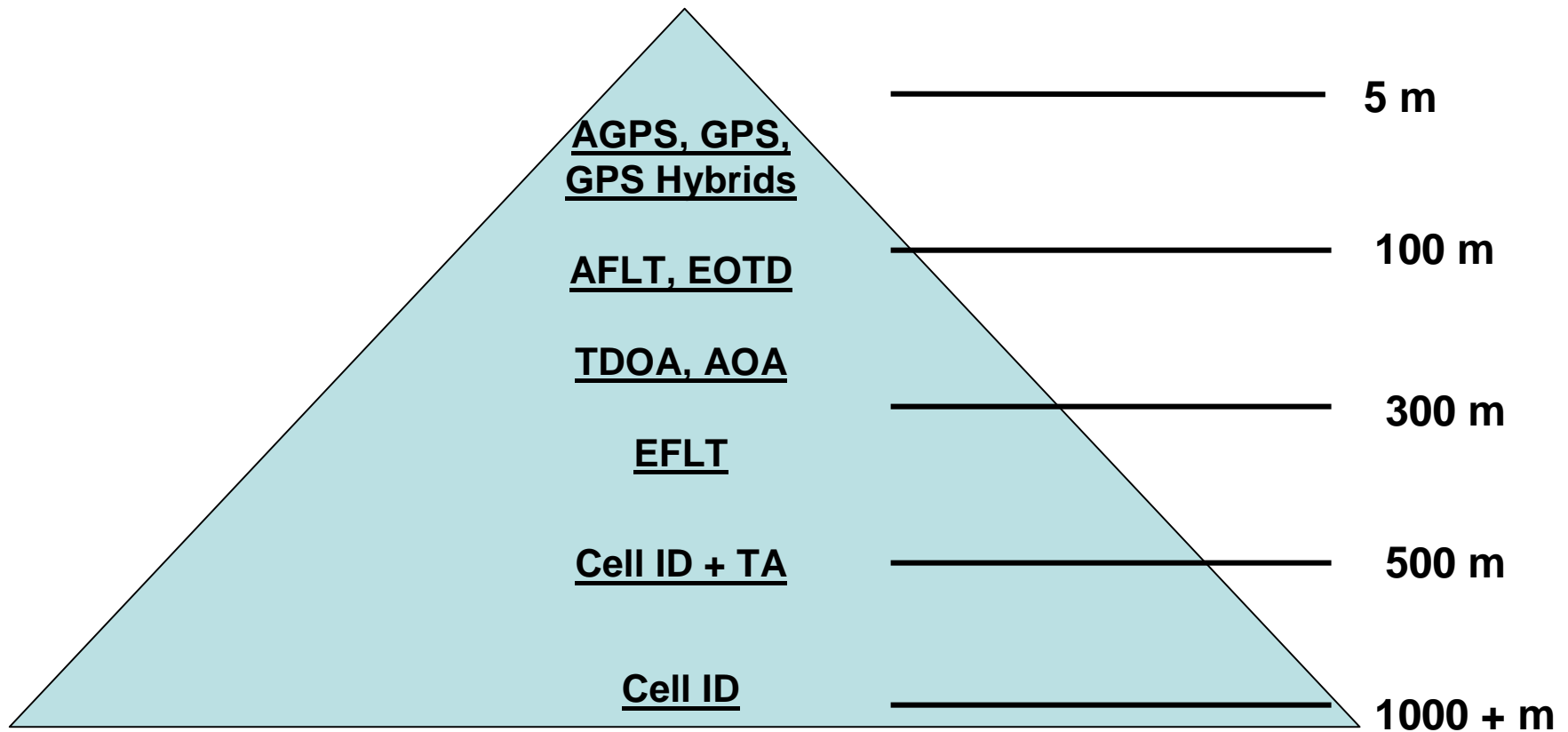
**PDE** – Position  
Determining Entity

**TA** – Timing Advance

**TDOA** – Time Difference of  
Arrival

# Location Technologies Range of Coverage

Network-based, handset-based, and hybrid solutions are available



# Cell ID – Available on All Networks

- Most basic wireless location technology
- Serving cell is used to locate the user
  - lat/long of the cell site => location
  - radius of coverage => uncertainty
- May be improved by techniques such as Timing Advance
- Relative accuracy is low and depends on size of cell

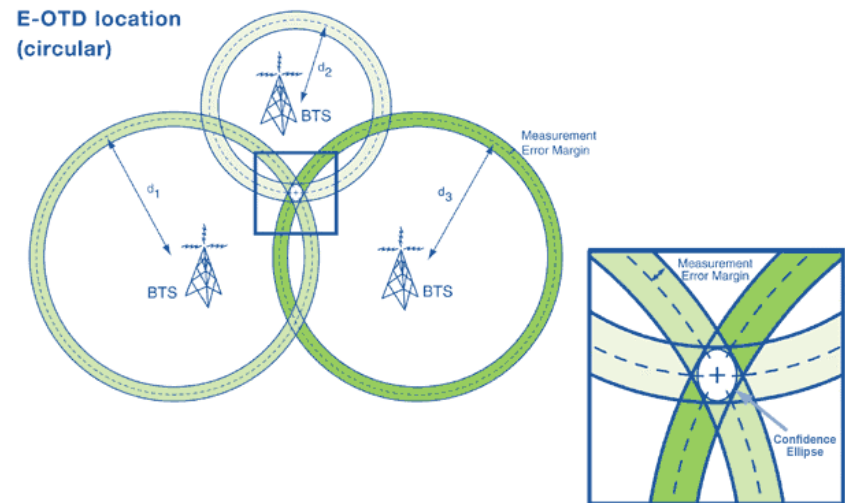


**Cell Size 100-3000m**

# Triangulation – Overview and GSM Method

- Triangulates the location by measuring the time at which signals from three sources arrive
- Network-based solutions based on AOA (Angle of Arrival) and TDOA (Time Difference of Arrival)
- GSM Methods
  - EOTD (Enhanced Observed Time Difference of arrival)
  - Requires measurements from 3 BTS also measured by an LMU
  - Position of the MS is determined by comparing the time differences between the two sets of timing measurements.
  - May be a hybrid solution when combined with A-GPS

**Accuracy 50-200m**



# Triangulation – CDMA Methods

- CDMA Methods

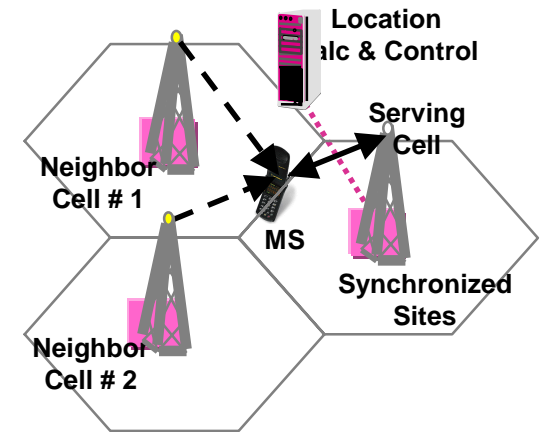
- AFLT (Advanced Forward Link Trilateration)

- 1/8 chip resolution reporting
    - Uses IS 801 messaging
    - Requires handset software changes
    - Commonly used as a hybrid with A-GPS

- EFLT (Enhanced Forward Link Trilateration)

- 1 chip resolution reporting
    - Uses existing PSMM from MS to BS
    - PSMM information sent from BTS to MSC then to PDE
    - Handles legacy handsets without any change in handsets
    - Typically used as a backup for non AFLT/A-GPS phones

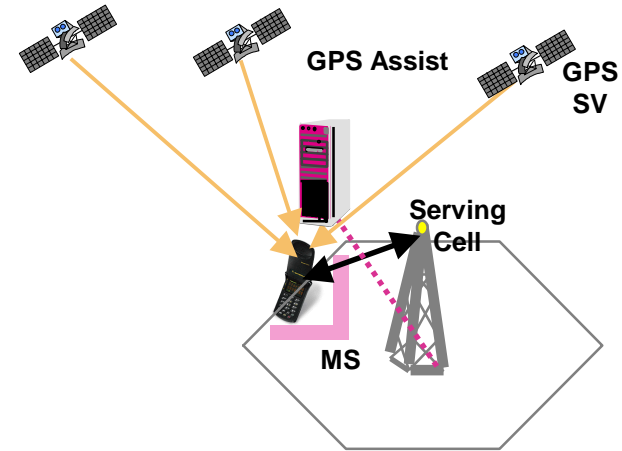
## AFLT Accuracy 50-200m



## EFLT Accuracy 250-350M

# GPS – Most Accurate Locator

- GPS
  - Cold start takes several minutes to get a fix
  - Receivers require line of sight
  - Handset HW/SW required
- Assisted GPS
  - Network-assisted GPS
  - Reduces GPS search time from minutes to seconds
  - Allows use of weaker signals than non-assisted GPS
  - Handset HW/SW required



**Accuracy 5-30m**

# Hybrids Solutions Improve Effectiveness

- Extends the coverage of a solution e.g. AGPS
- Common Hybrids
  - AFLT/AGPS
  - EOTD/AGPS
  - Cell ID/AGPS
- Benefits of both systems realized increasing the accuracy and availability of any single method



# US Carriers

Carrier	Technology Type	Solution Type
Voicestream	GSM	E-OTD
Nextel	IDEN	AGPS
Cingular	GSM TDMA	E-OTD Trueposition (network based)
AWS	GSM TDMA	E-OTD Grayson (network based)
Verizon	CDMA	AGPS/AFLT
Sprint	CDMA	AGPS/AFLT
Qwest	CDMA	AGPS/AFLT
Alltel	CDMA	AGPS

# Telecom Standards

Wireless Standard	Standards Body	Geolocation Technologies Used	Relevant Documents
GSM	ETSI SMG30	TOA AOA E-OTD A-GPS	GSM 03.71 GSM 04.71 GSM 09.31
GSM (North America)	T1P1.5 ETSI SMG31	TOA AOA E-OTD A-GPS	GSM 04.35
CDMA	TIA/EIA-95 cdma2000 TR45.5	A-FLT A-GPS	IS-801 IS-801A
TDMA	TIA/EIA-136 TR45.3	A-GPS	TIA/EIA-136

# Summary

Technology	Networks	Handset impact	Accuracy
Cell ID	All	none	Depends on the size of the cell 100m – 3km
Cell ID + TA	GSM	none	Band size configurable. Default is 500m
EFLT	CDMA	none	250-350m
TDOA	All	none	100-200m
AOA	All	none	100-200m
AFLT	CDMA	yes	50-200m
EOTD	GSM	yes	50-200m
GPS/AGPS	All	yes	5-30m

