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# Comparison of Location Technologies for Phase II Wireless E-911

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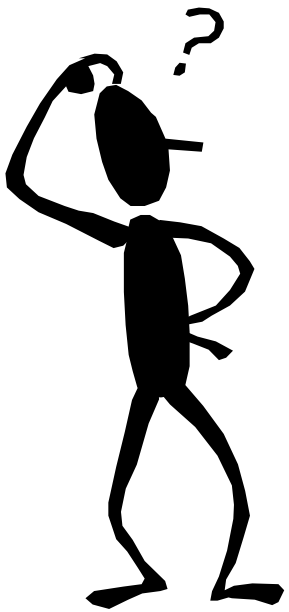
Wireless Location Leaders

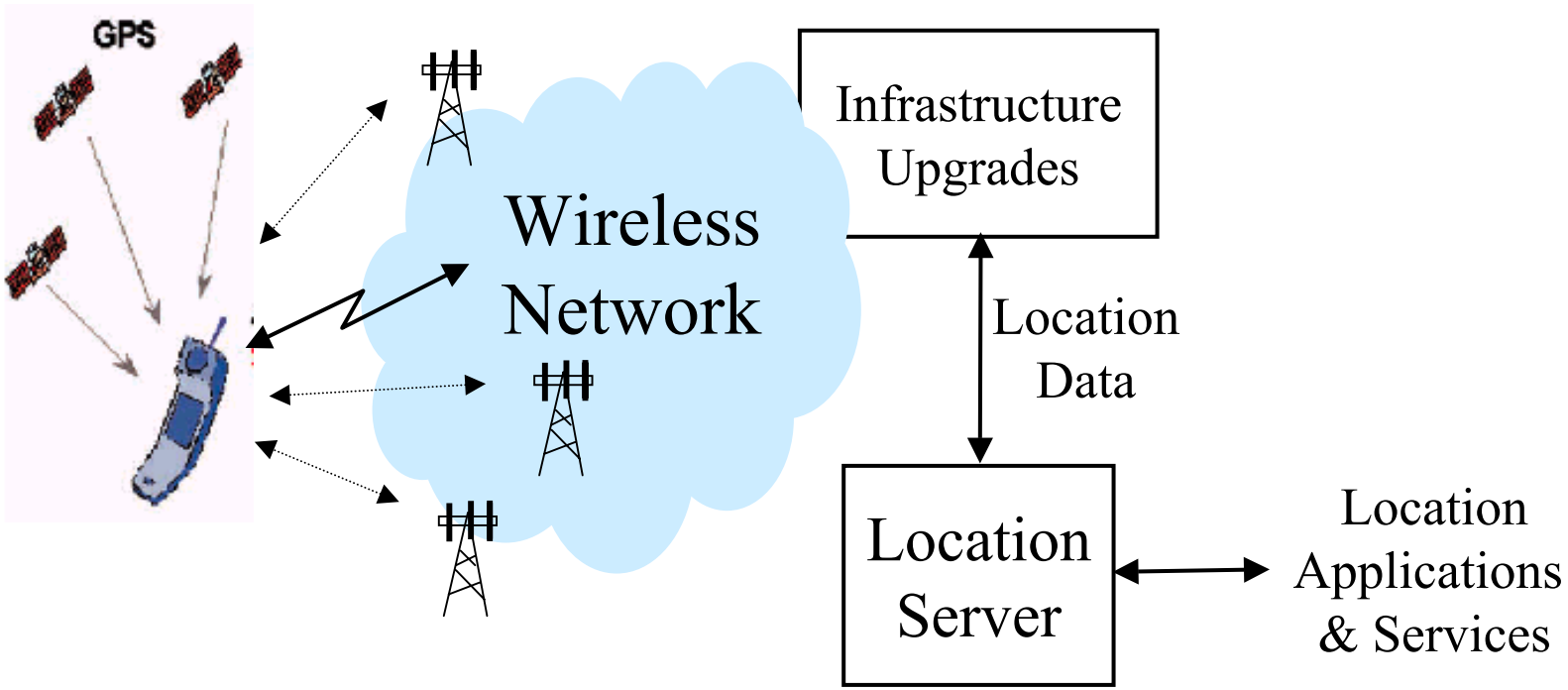
# Some Location Technology Choices for E-911



- AOA; TDOA; TDOA/AOA; TOA; TOA/AOA; UL-TOA
- OTD; E-OTD
- FLT; AFLT; EFLT; RTD
- GPS; DGPS; Inverse DGPS; Assisted GPS
- Multipath Pattern Recognition
- Mobile-Assisted Handoff Power Measurement (MNLS)
- Hybrids

**[Glossary located at end of presentation.]**

# Generalized Location System Block Diagram



# Leading Contenders by Network Type

| | AMPS | TDMA | GSM | CDMA |
|---|---|---|---|---|
| **Network-based** | TDOA/AOA | TDOA/AOA | TDOA/AOA | TDOA/AOA |
| **Handset-based** | - - | MNLS * | AGPS | AGPS |
| **Hybrid** | - - | - - | E-OTD | AFLT |

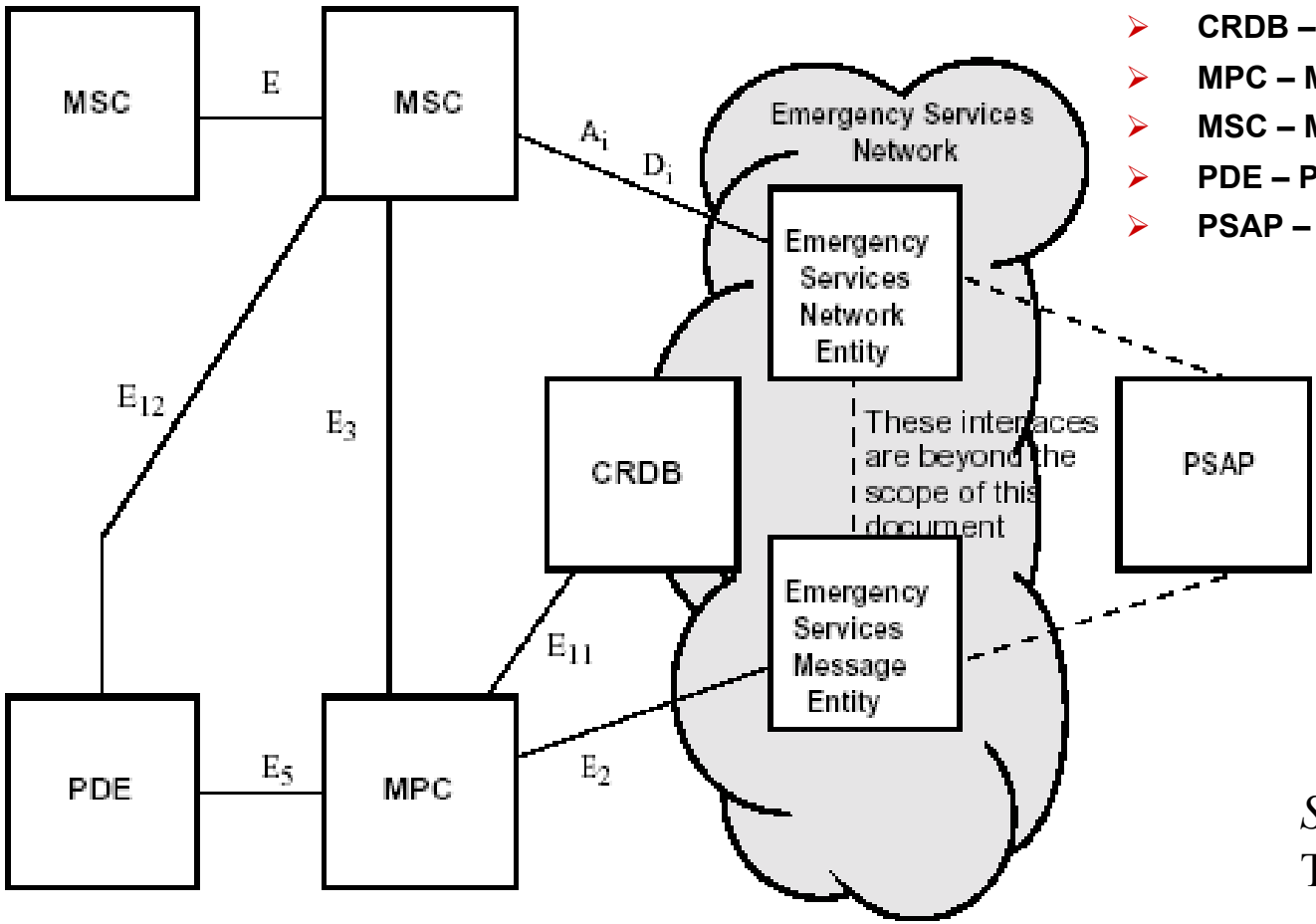
*** FCC waiver approval required.**

# FCC-Approved Selections of National Carriers

| | Network Type | Location Technology | Other / Pending Choices |
|---|---|---|---|
| **AT&T** | GSM | E-OTD | TDOA / AOA for AMPS & TDMA |
| **Cingular** | GSM | E-OTD | TDOA / AOA for AMPS & TDMA |
| **Nextel** | iDEN | AGPS | - - |
| **Sprint** | CDMA | AFLT / AGPS | - - |
| **Verizon** | CDMA | AFLT / AGPS | TDOA / AOA for AMPS & TDMA |
| **VoiceStream** | GSM | E-OTD | - - |

*Source:* NENA Web Site (10/01) - www.nena9-1-1.org

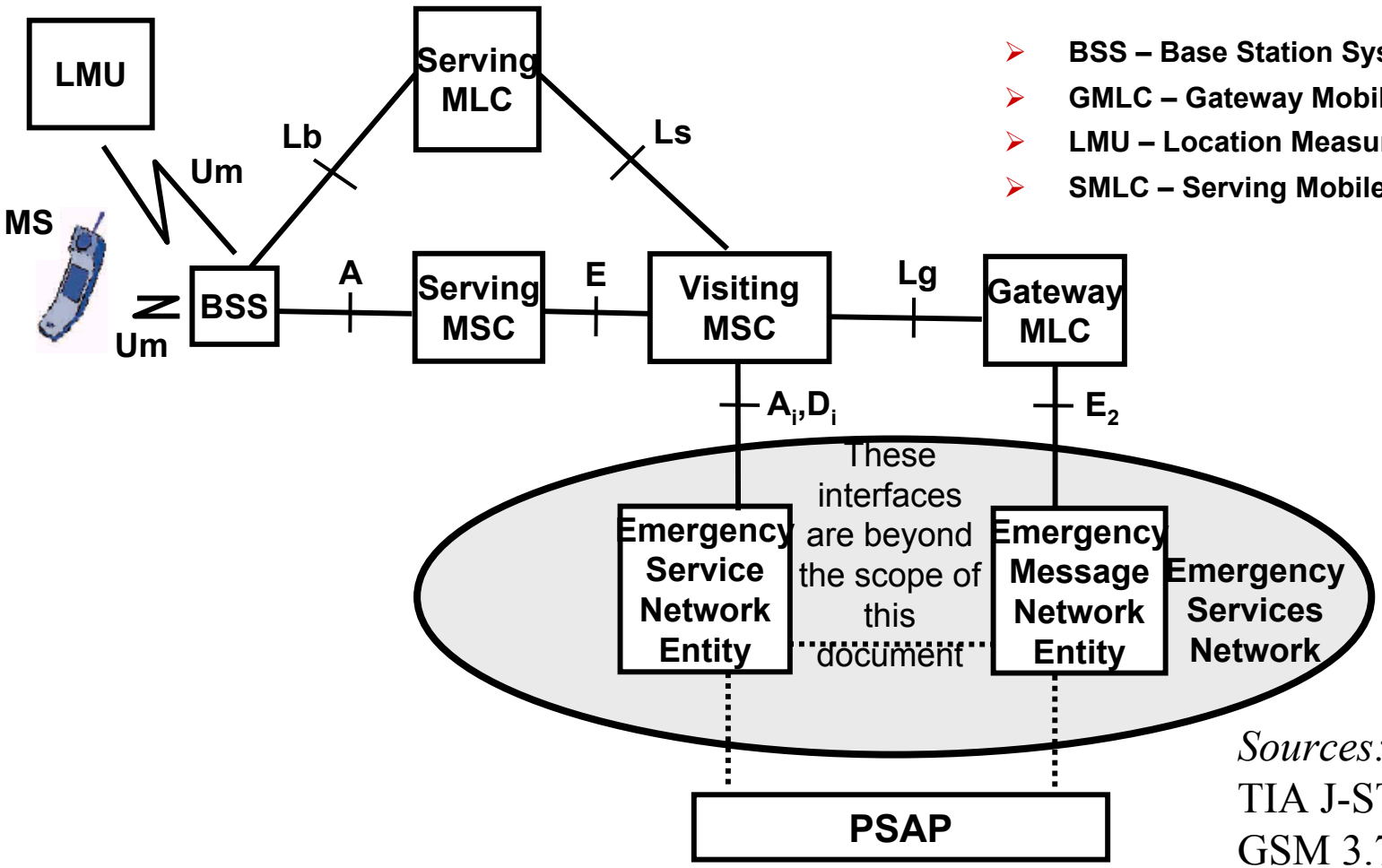
# Reference Model for AMPS, TDMA & CDMA




- **CRDB – Coordinate Routing Database**
- **MPC – Mobile Position Center**
- **MSC – Mobile Switching Center**
- **PDE – Position Determining Entity**
- **PSAP – Public Safety Answering Point**

*Source:*
TIA J-STD-036

# Reference Model for GSM (PCS 1900)

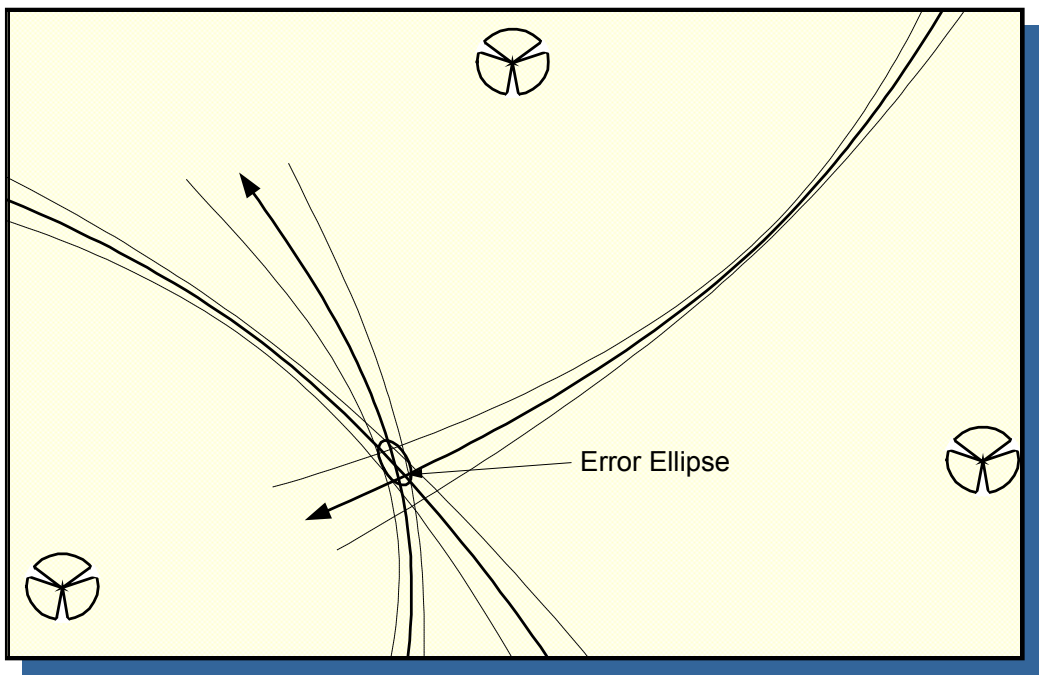



- BSS – Base Station System
- GMLC – Gateway Mobile Location Center
- LMU – Location Measurement Unit
- SMLC – Serving Mobile Location Center

*Sources:*
TIA J-STD-036
GSM 3.71

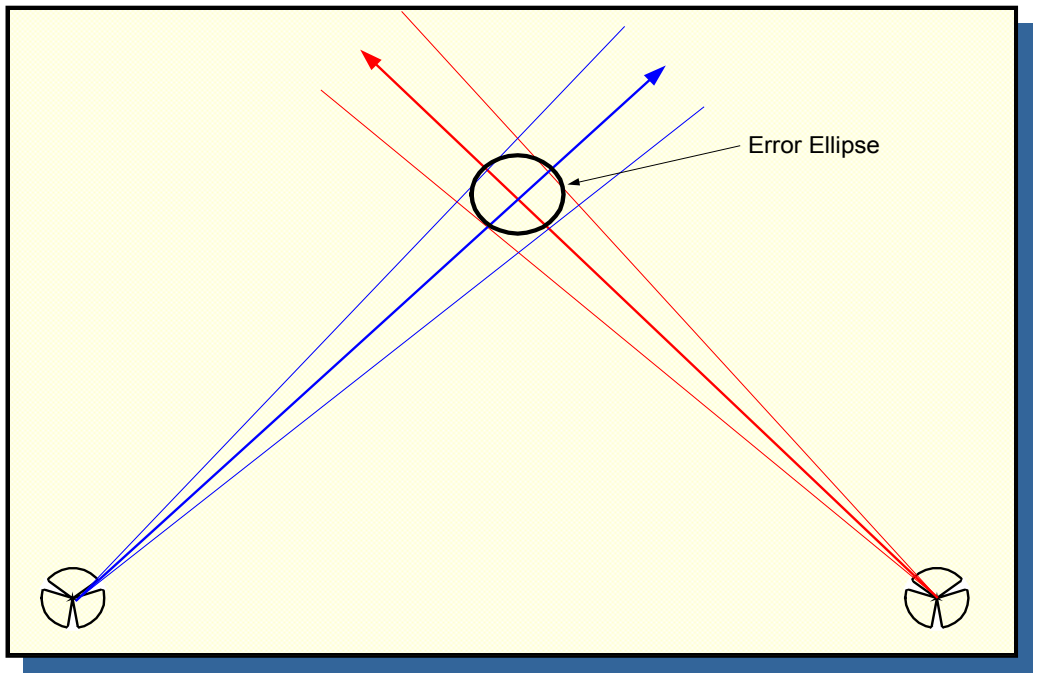
# Solutions Based on Signal Propagation Time

- TDOA, xOTD, xFLT, xGPS
  (Network, Handset-based, or Hybrid)



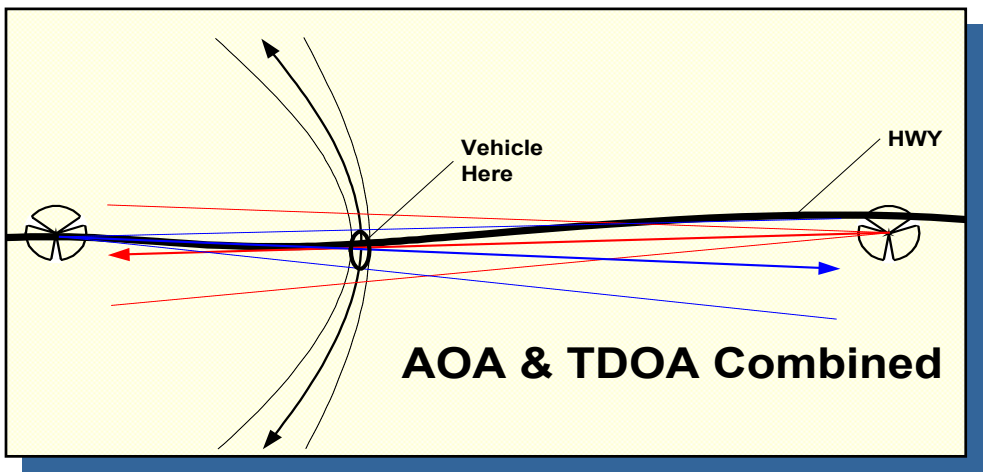
# Angle of Arrival-based Solutions

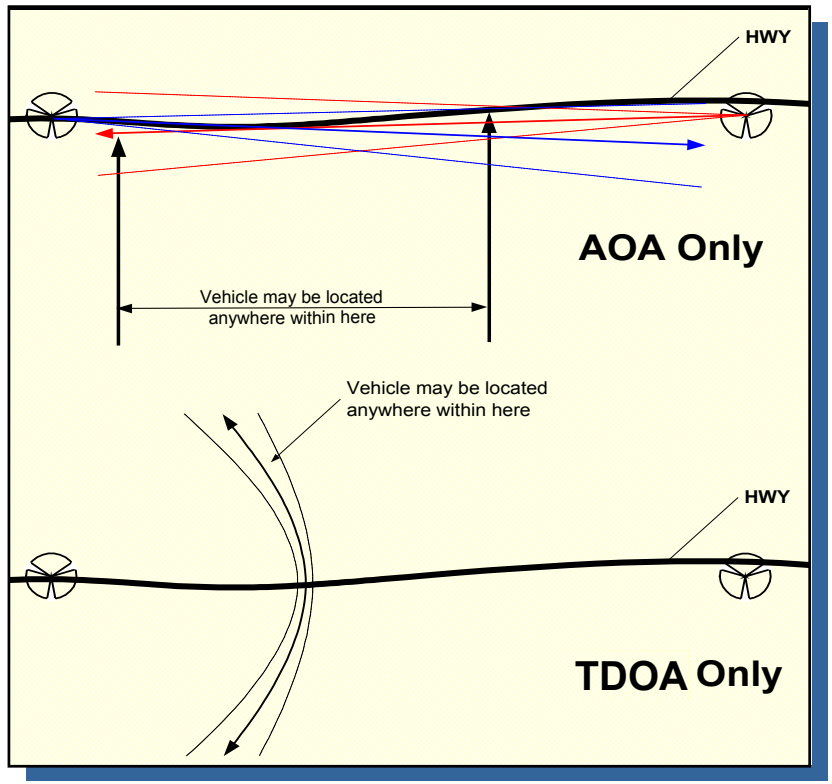
- AOA (Network-based)



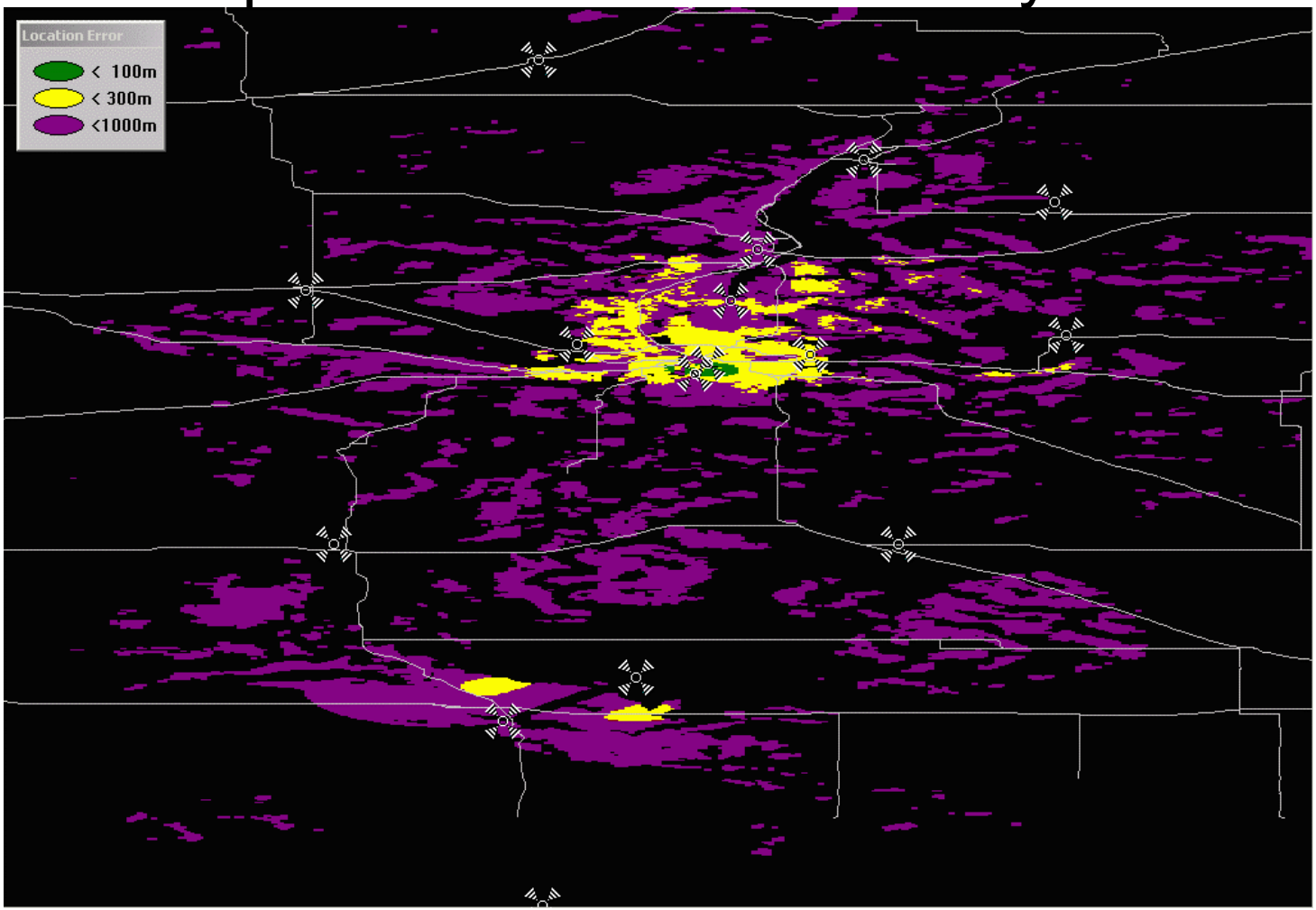
# Combined Angle & Time-based Solutions

- AOA/TDOA, AOA/xOTD, or AOA/xFLT (Network-based or Hybrid)

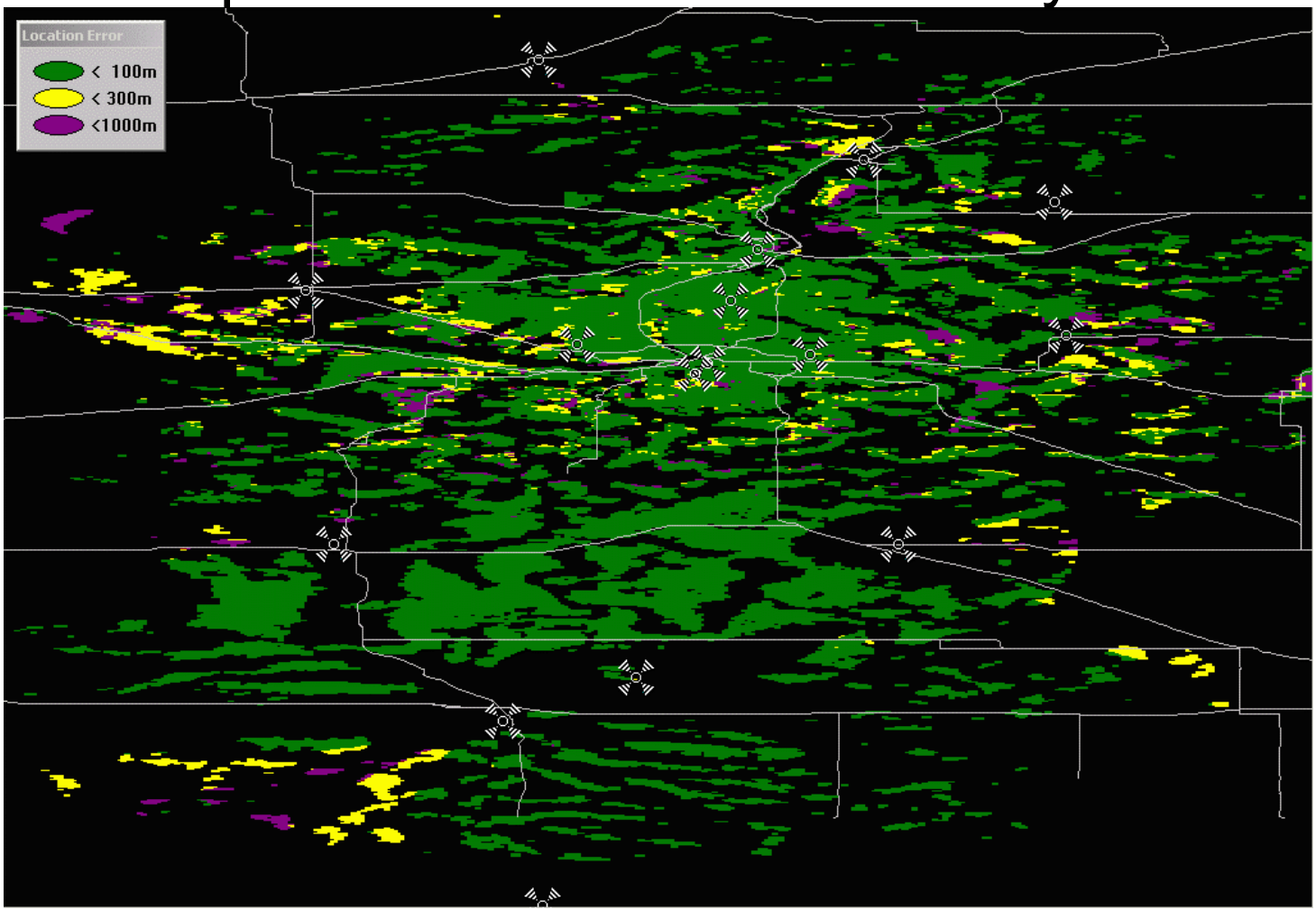


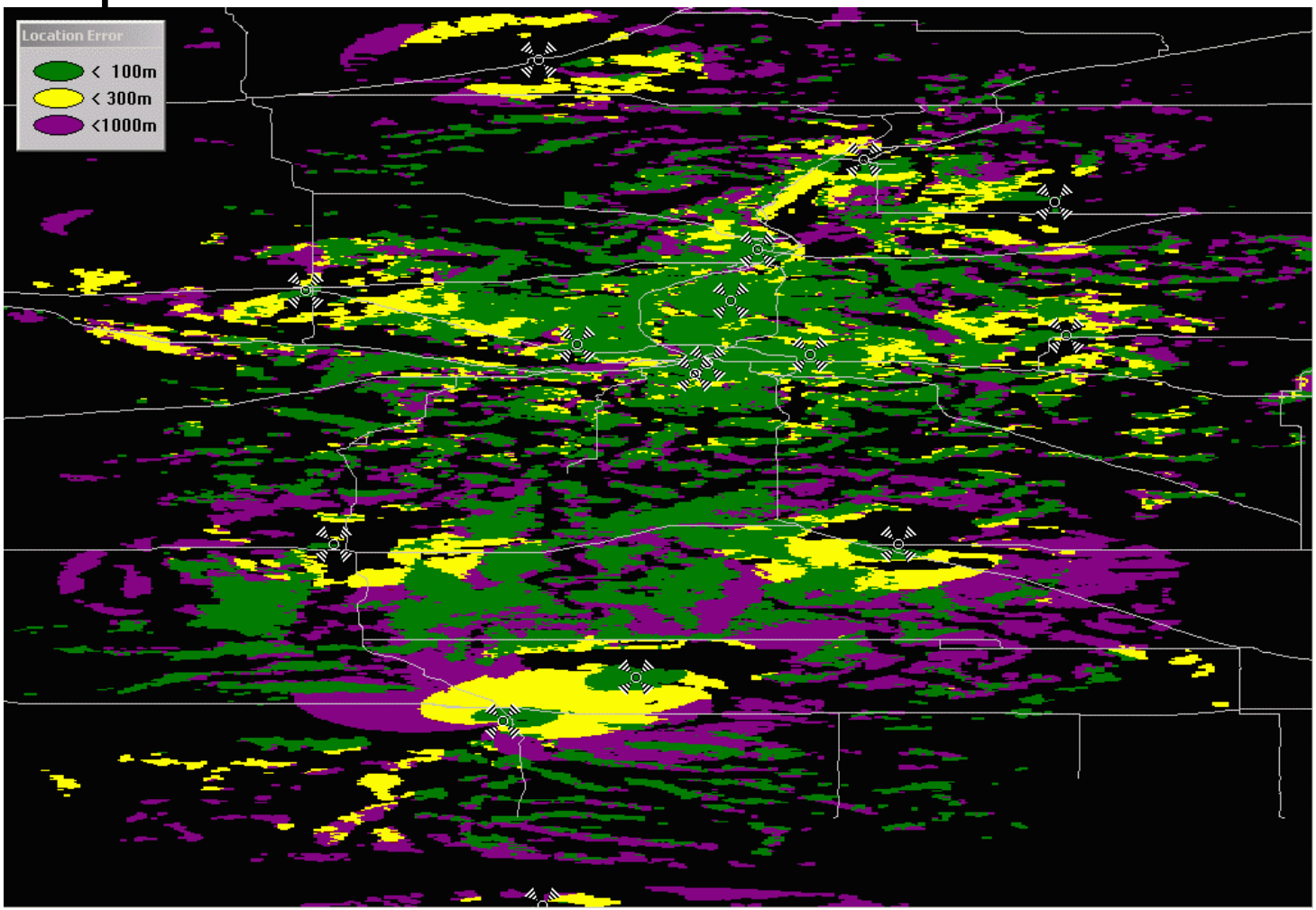
# Sample Performance – AOA System



# Sample Performance – TDOA System



# Sample Performance – Combined AOA/TDOA



# Performance Comparisons

- Network-based & Hybrid (non-AGPS):
  - FCC accuracy requirement: 100 meters – 67%<br>300 meters – 95%
  - Tend to be less accurate & less reliable in rural areas vs. xGPS
  - Can increase infrastructure for better performance in selected areas
- Handset-based (AGPS):
  - FCC accuracy requirement: 50 meters – 67%<br>100 meters – 95%
  - Faster fix & better sensitivity vs. conventional GPS
  - Better performance in rural & suburban areas vs. network-based
  - Can be augmented by network for better indoor & urban performance

# Summary

- A variety of location technologies will be deployed
  - Network-based
  - Handset-based
  - Hybrids
- Best choice depends on many factors
  - Wireless network technology
  - Operating environment
  - Application (requirements)
  - Cost

# Glossary of Terms

- AFLT Advanced Forward Link Trilateration
- AGPS Assisted Global Positioning System
- AMPS Advanced Mobile Phone System
- AOA Angle Of Arrival
- BSS Base Station System
- CDMA Code Division Multiple Access
- CRDB Coordinate Routing Database
- DGPS Differential Global Positioning System
- EFLT Enhanced Forward Link Trilateration
- EOTD Enhanced Observed Time Difference
- FLT Forward Link Trilateration
- GMLC Gateway Mobile Location Center
- GSM Global System for Mobile comm.
- GPS Global Positioning System
- iDEN Integrated Dispatch Enhanced Network
- LMU Location Measurement Unit
- MNLS Mobile-Assisted Network Location System
- MPC Mobile Position Center
- MS Mobile Station
- MSC Mobile Switching Center
- NENA National Emergency Number Assoc.
- OTD Observed Time Difference
- PDE Position Determining Entity
- PSAP Public Safety Answering Point
- RTD Roundtrip Time Delay
- SMLC Serving Mobile Location Center
- TDMA Time Division Multiple Access
- TDOA Time Difference of Arrival
- TIA Telecommunications Industry Association
- TOA Time Of Arrival
- UL-TOA Uplink Time Of Arrival