Wireless Signatures Technology for Position Location

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Overview of *Wireless Location Signatures* Technology

Wireless Location Signatures

- **Mobile phone measures and reports signal strengths of neighbor cell control channels**
  - Reported mobile assisted handover (MAHO) information
  - Aggregated into network measurement reports (NMRs)
- **Every location creates a unique *Wireless Location Signature***
  - Combine signal strength, delay and temporal behavior
- **Components of *Wireless Location Signatures* technology**
  - **Predicted Signature Database (PSD)** provides highly accurate model of wireless radio environment
  - **Location Engine** capitalizes on proprietary statistical algorithms to estimate the location of handsets

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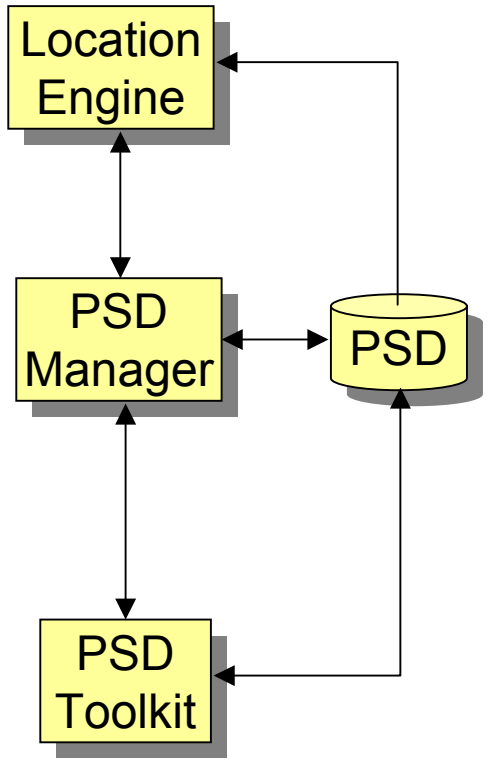
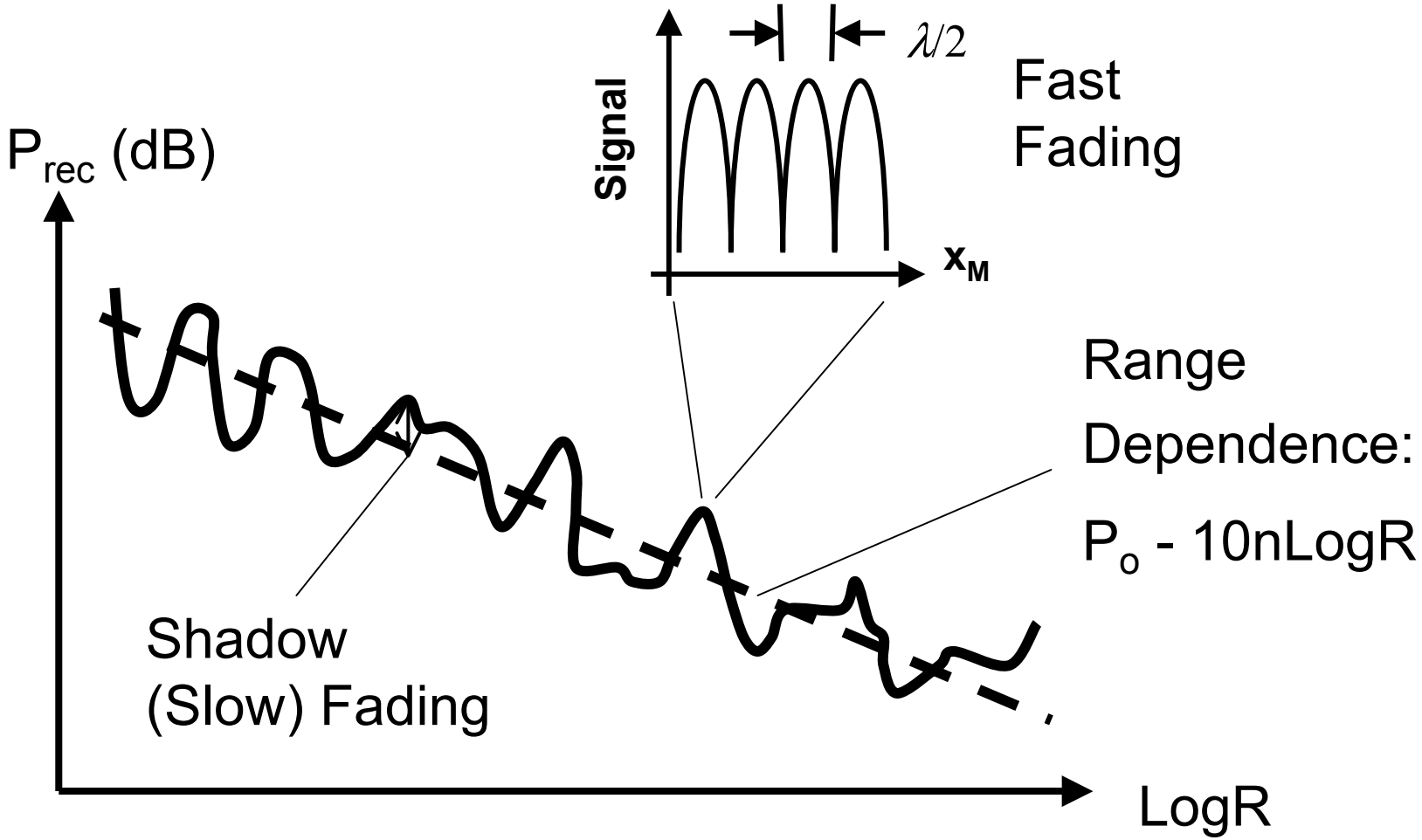
Wireless Signatures Components

- **Location Engine**
  - Process location estimation requests from network
  - Produce the position estimate
- **PSD Manager**
  - Automatically update PSD for RF network changes
  - Track and alarm PSD and network anomalies
- **PSD Toolkit**
  - Provision PSD (GIS data, parameters, etc.)
  - Maintain location system accuracy
    - Create or refresh PSD with new drive test data
    - Manage PSD for network changes and anomalies
  - Test location system accuracy off-line
    - Batch location estimation processing
    - Produce performance statistics

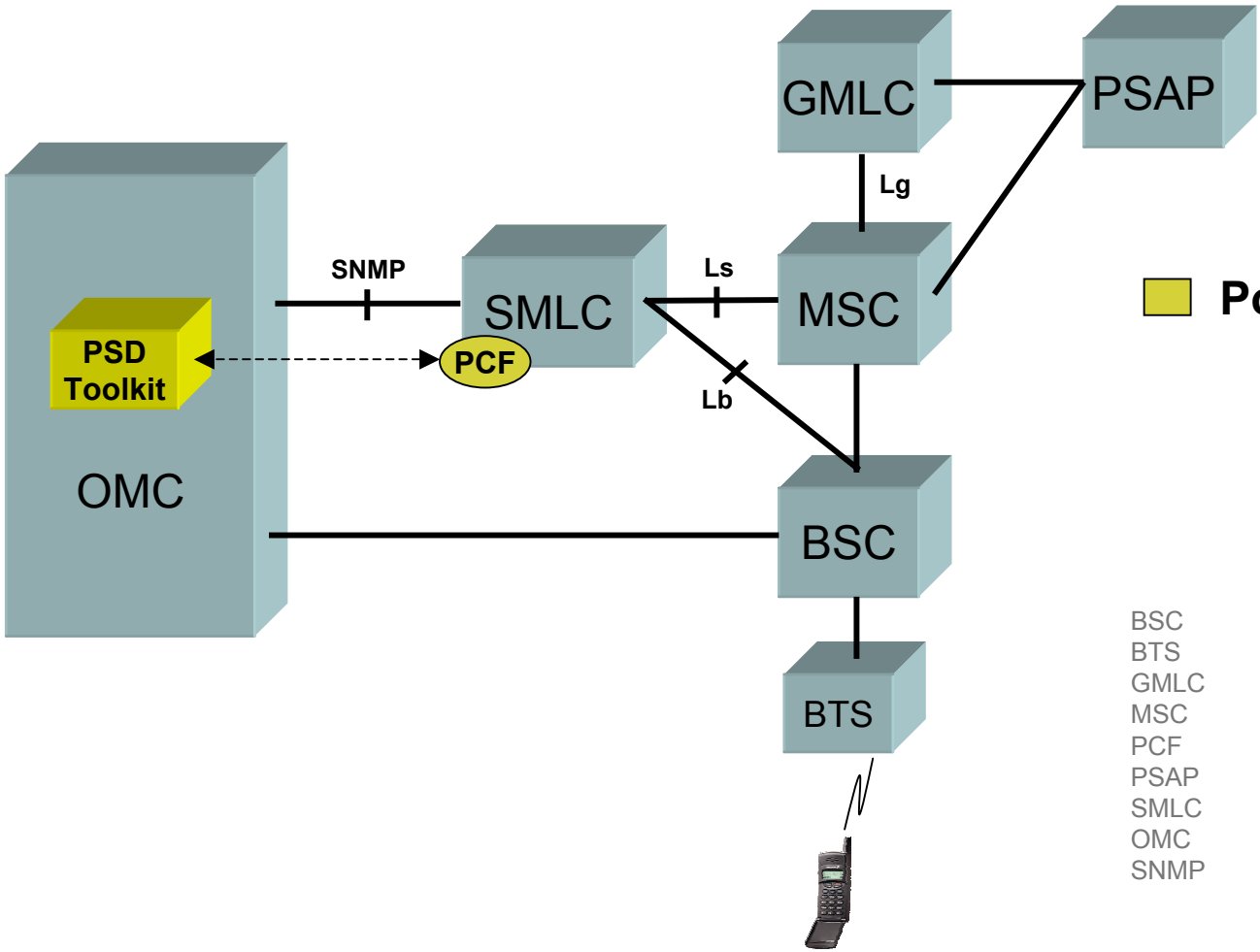


What is a *Wireless Signature*?

Take Advantage of Three Scales of RF Spatial Variation



GSM E-911 Architecture



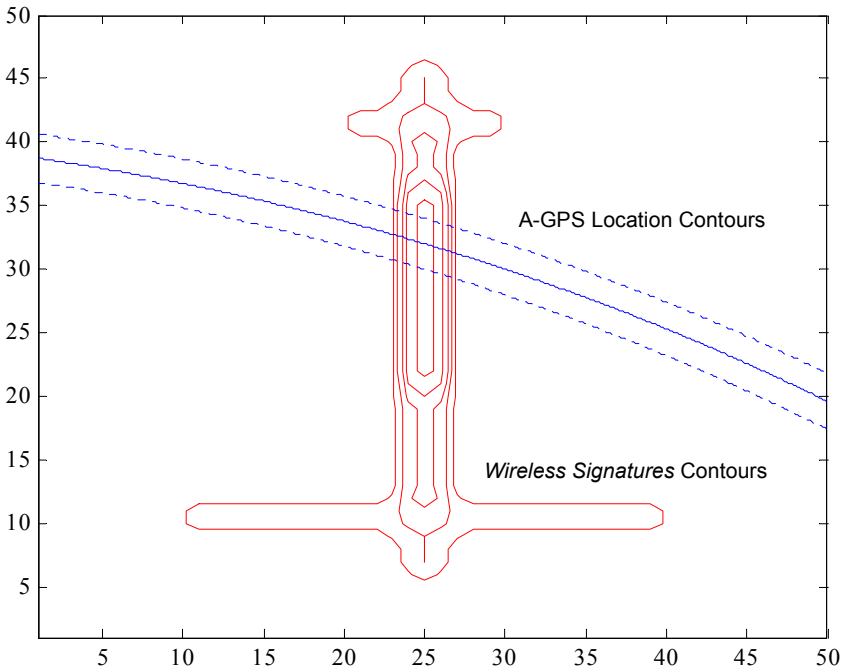
Polaris System

BSC	Base Station Controller
BTS	Base Transceiver Station
GMLC	Gateway Mobile Location Center
MSC	Mobile Switching Center
PCF	Position Calculation Function
PSAP	Public Safety Answering Point
SMLC	Serving Mobile Location Center
OMC	Operational & Maintenance Center
SNMP	Simple Network Management Protocol

Wireless Location Signatures
Combined with A-GPS

Wireless Signatures & A-GPS Combined

- **When 0-1 satellites are reported by handset, use *Wireless Signatures* location estimate**
- **When 2 satellites are reported by handset, create joint *Wireless Signatures* & A-GPS location estimate**
- **When >2 satellites reported, A-GPS can suffer from bad geometry or multipath, create joint location estimate**



Accuracy improvement over *Wireless Signatures* alone depends on collection geometry

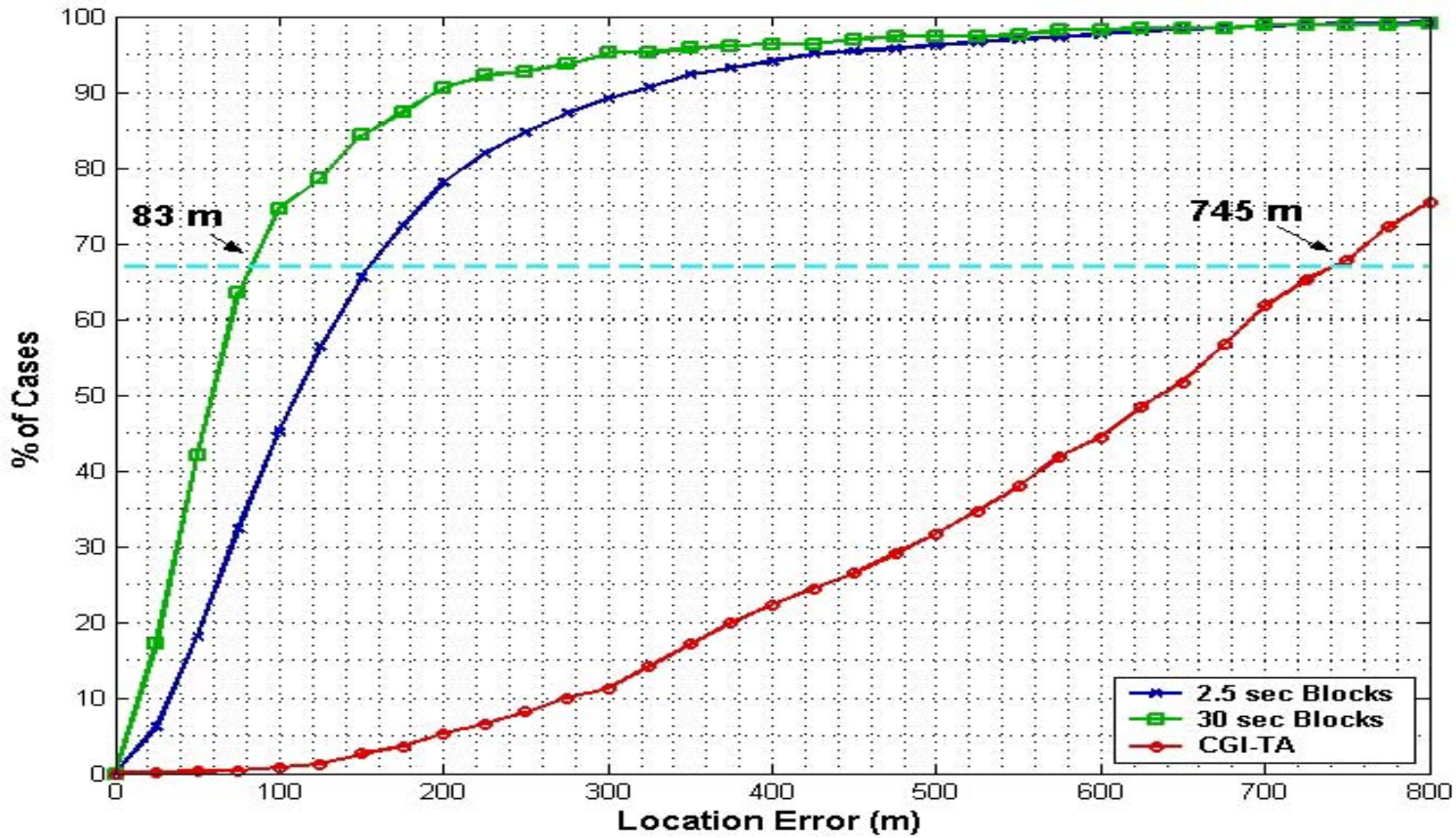
- If as shown, improvement could be significant
- If TDOA contours aligned with major axis of *Wireless Signatures* uncertainty, less improvement

Field Trial and OET Test Results

San Jose Testbed: GSM Results

***Wireless Location Signatures* performance**

- Accuracy better than 83 m, 67% of cases
- Accuracy better than 291 m, 95% of cases



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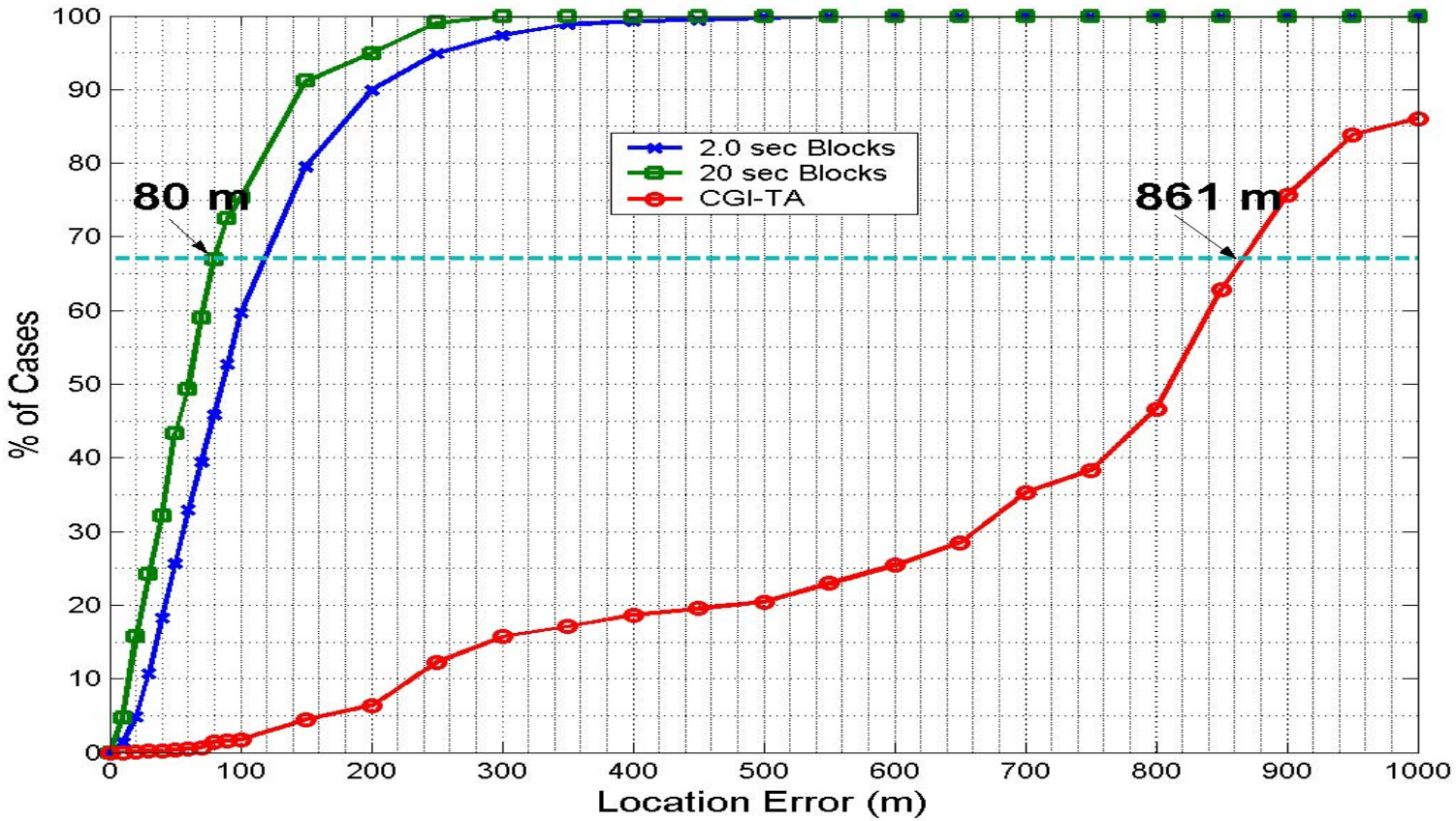
San Francisco Testbed: GSM Results

***Wireless Location Signatures* performance**

- Accuracy better than 80 m, 67% of cases
- Accuracy better than 197 m, 95% of cases



Orange UK Field Trial

- **Trial area: Bristol, England**
  - Urban & suburban areas, with 152 cell sectors
  - Urban inter-site average spacing: 290 m
  - Suburban inter-site average spacing: 720 m
  - Total number of measurement reports: ~ 29,000
- **Blind test protocol**
- **Evaluate accuracy for commercial Location Based Services (LBS)**
- **Summary of location accuracy results for combined urban & suburban areas**
  - 65 m for 67% of cases
  - 263 m for 95% of cases

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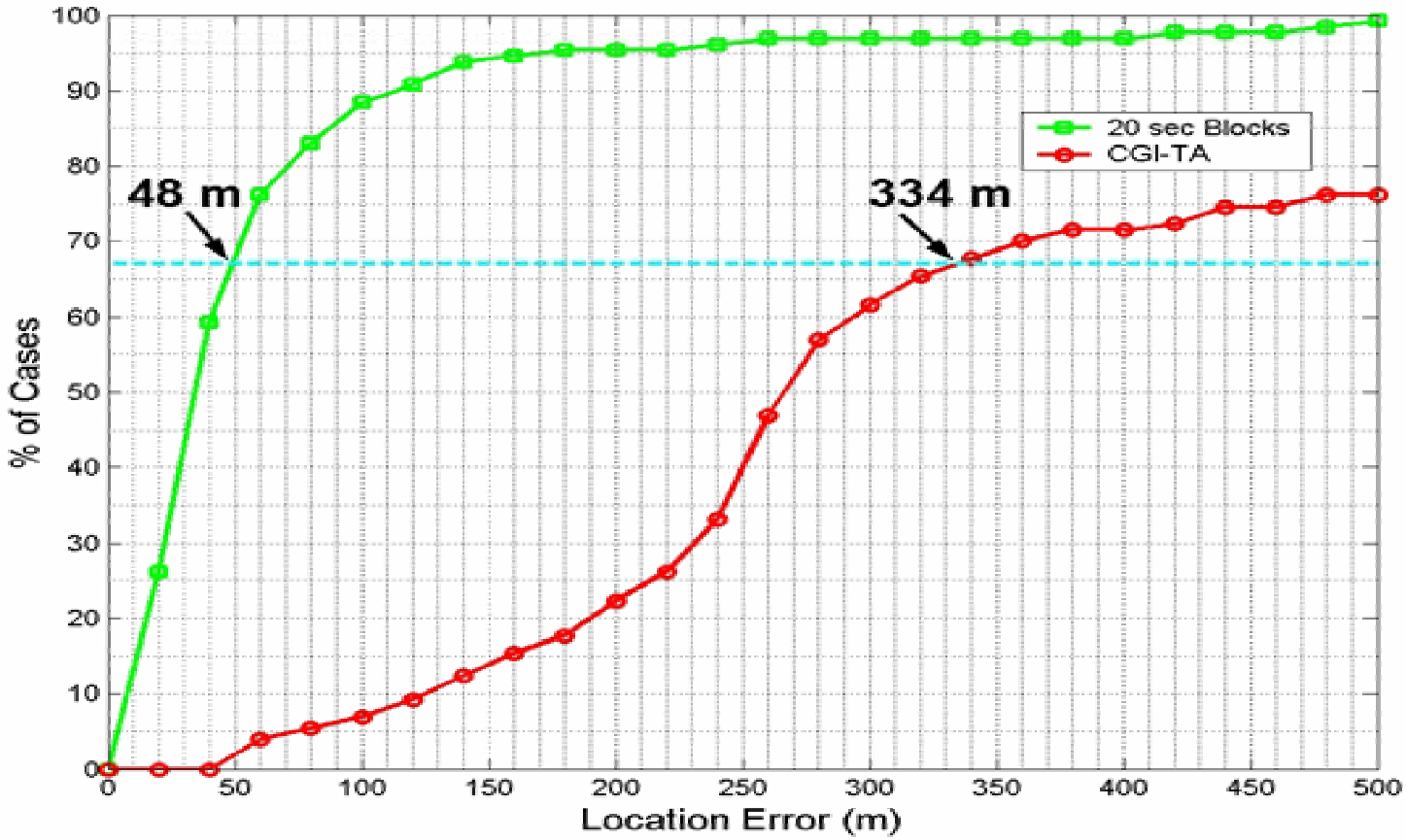
Orange UK Trial: Urban Results

***Wireless Location Signatures* performance**

- Accuracy better than 48 m, 67% of cases
- Accuracy better than 165 m, 95% of cases



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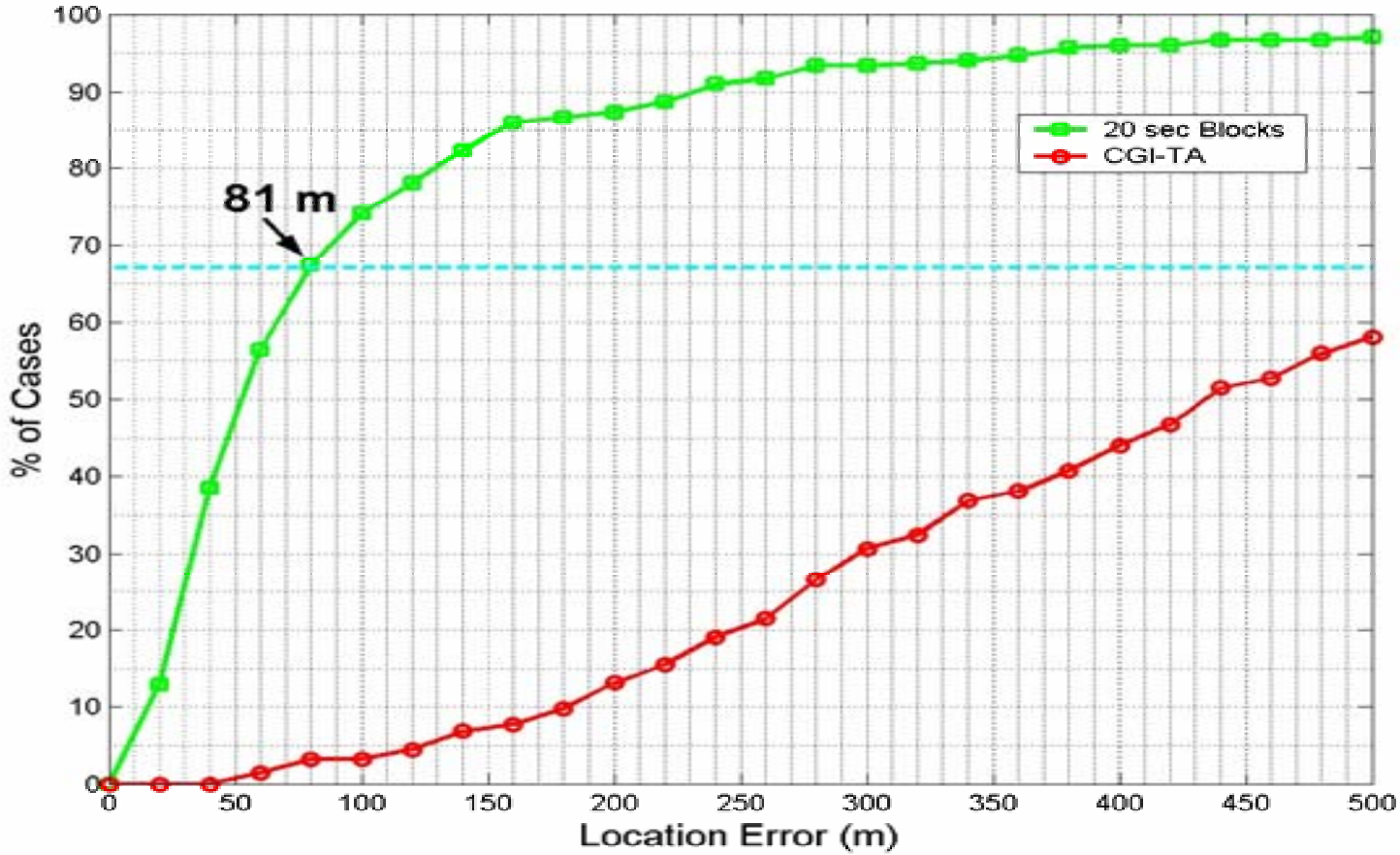
Orange UK Trial: Suburban Results

***Wireless Location Signatures* performance**

- Accuracy better than 81 m, 67% of cases
- Accuracy better than 361 m, 95% of cases



Vodafone Field Trials

- **2-phase competitive field trials in 2002 & 2003**
  - 8 - 10 network-based E-CGI location technology companies from around the world
  - **Blind test** protocol used by Vodafone
  - Dortmund, Germany; urban, suburban, & rural areas
  - London, UK; urban & suburban areas
  - Off-line & real-time testing
- **Polaris technology evaluated as having the best performance in both trial phases (>70% over closest competitor)**
- **Polaris system was the only competitor to meet stringent marketing requirements**

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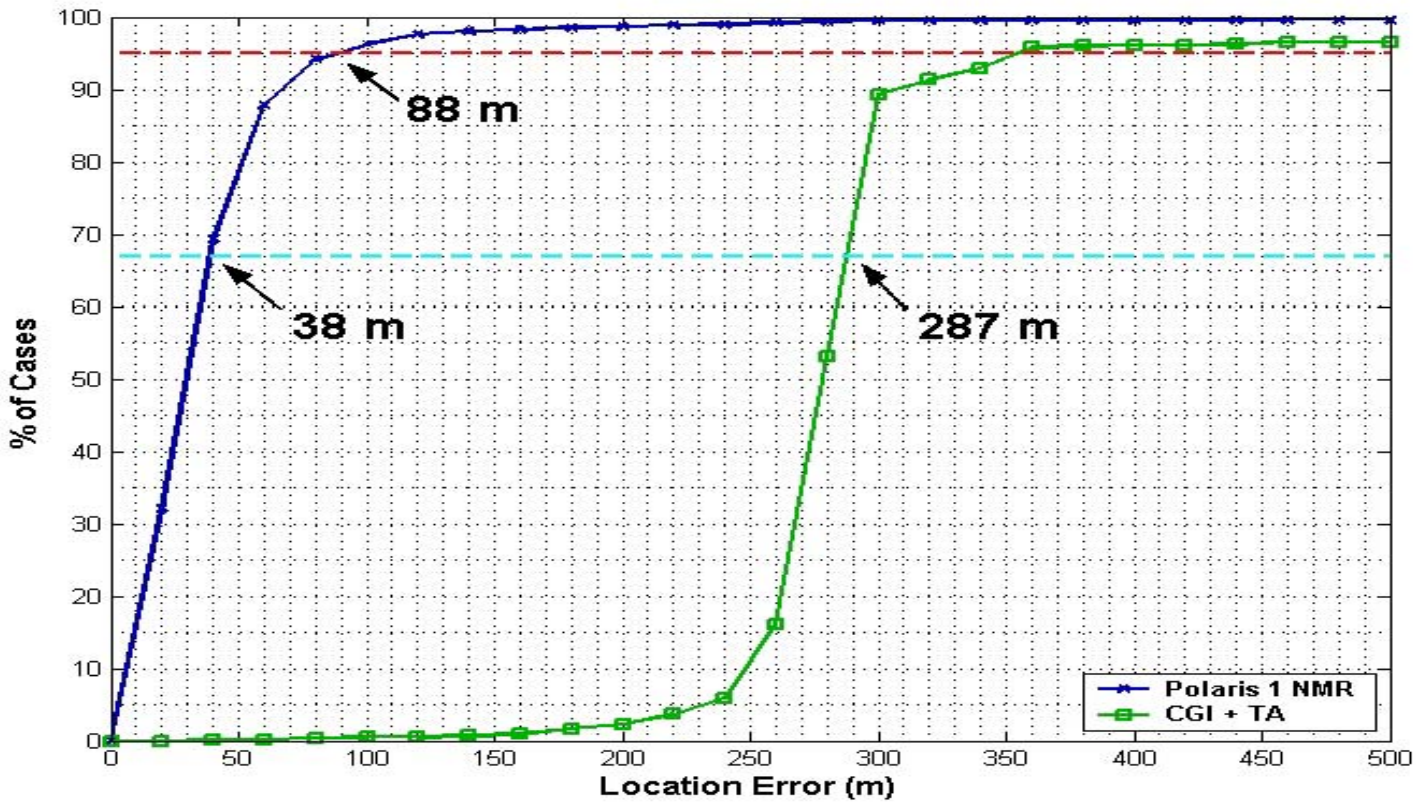
Dense Urban -- London

Used only single NMR, rather than block of 50-55 NMRs typically observed in E-911 call interval

- Accuracy better than 38 m, 67% of cases
- Accuracy better than 88 m, 95% of cases



Triton PCS: Live Network OET Tests (IS-136)

- **OET test area**
  - Spartanburg & Greenville, SC
  - Suburban, rural, & highway
  - 60 sites, 150 sectors (cells)
- **OET testing protocol**
  - End-to-end system testing with real-time processing
  - Mix of moving & stationary location fixes
  - Position response time within 30 seconds per location fix
  - MAHO data for position estimation received over E12 interface
  - Ground truth determined from GPS receiver
  - Nokia and Ericsson handsets used
- **Test results show *Wireless Location Signatures* is compliant with FCC's E-911 Phase II accuracy requirements**

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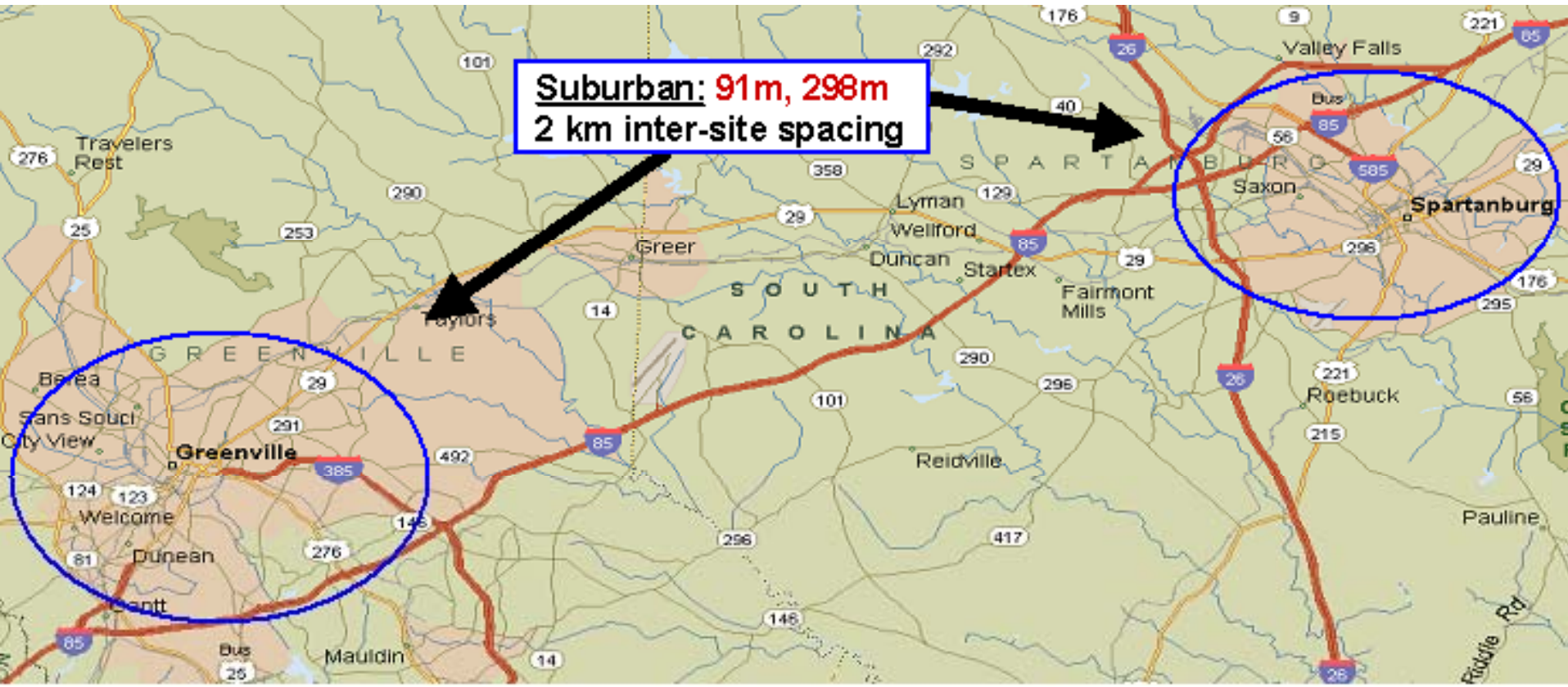
Triton PCS: OET Test Summary



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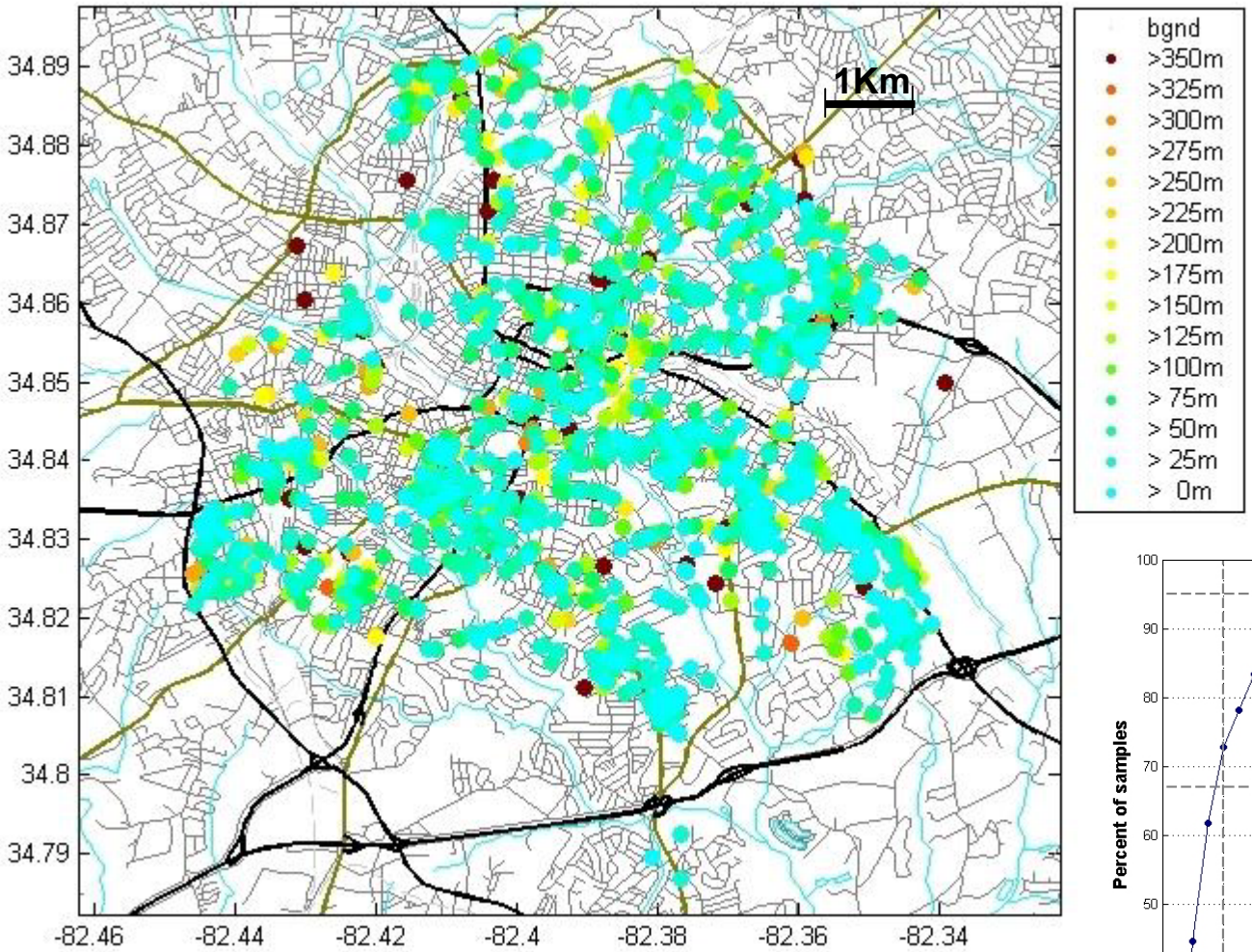
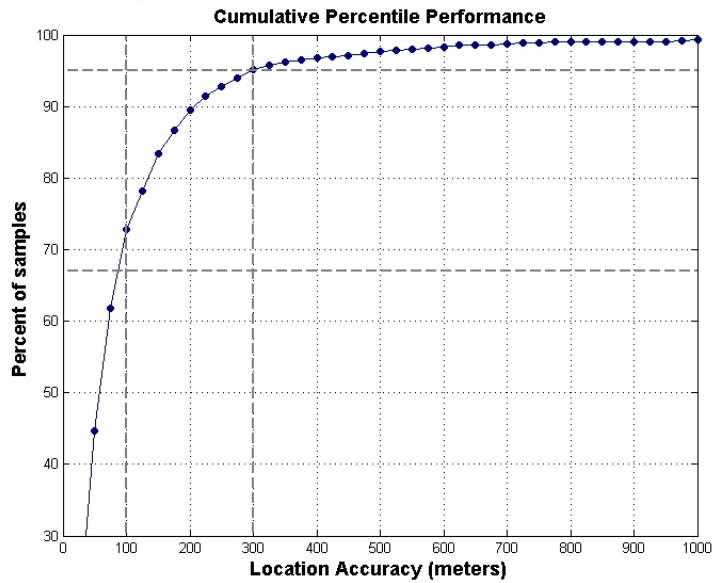
Network OET Test Results -- Suburban



1642 Calls:

67%	86m
95%	294m



Greenville, SC

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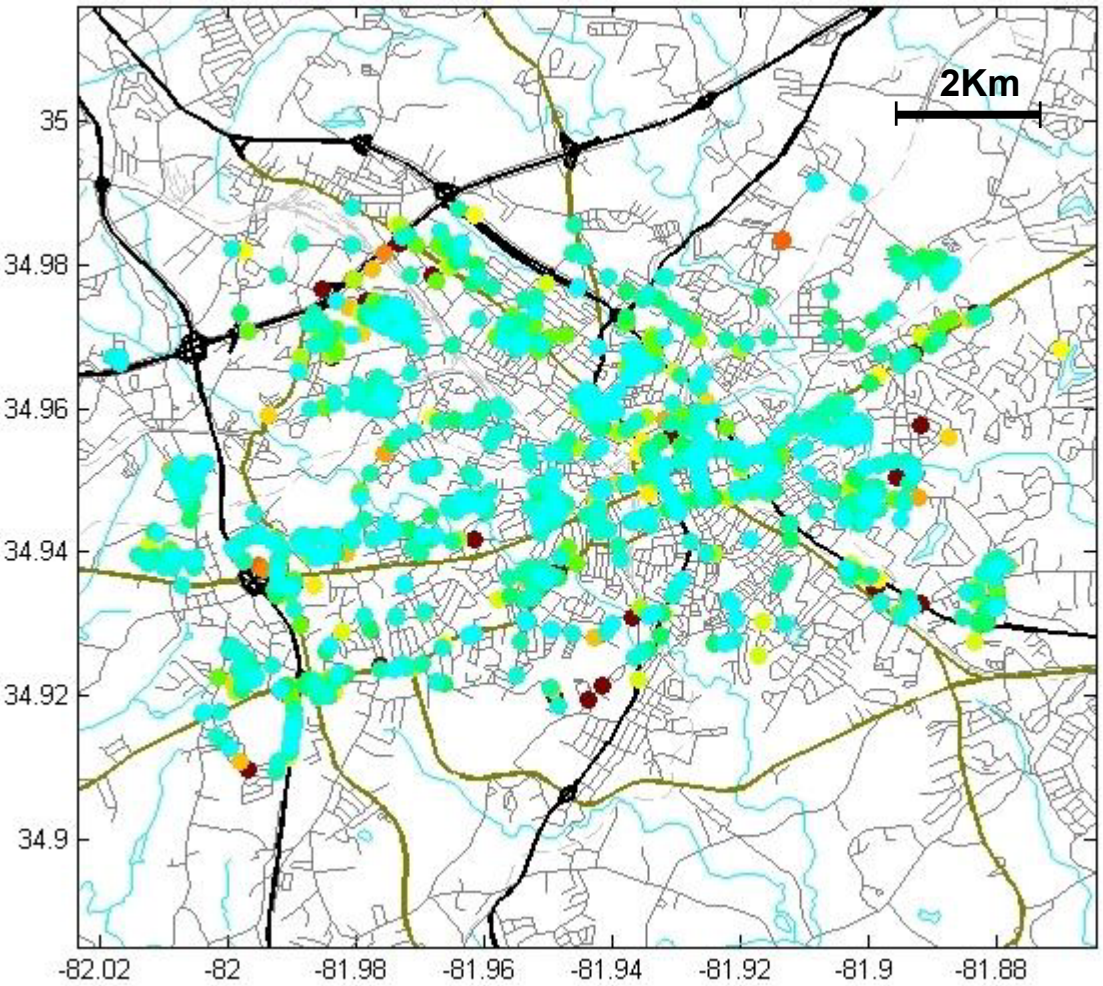
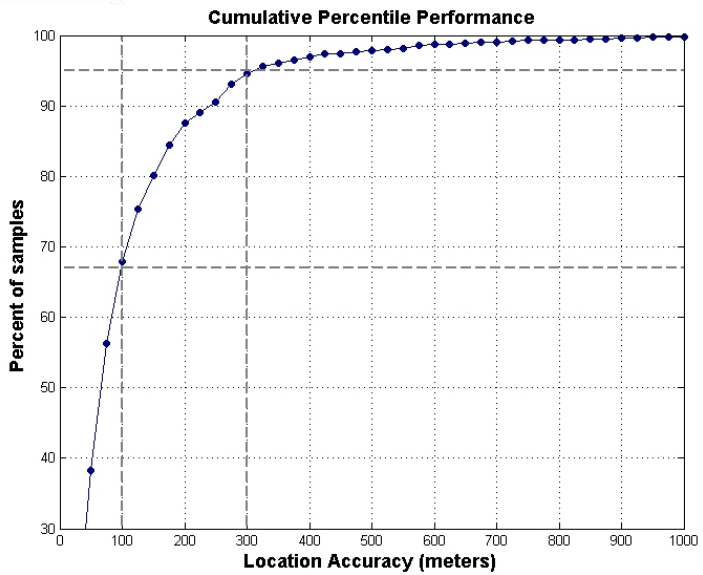
Network OET Test Results -- Suburban



1311 Calls:

67%	97m
95%	302m



Spartanburg, SC

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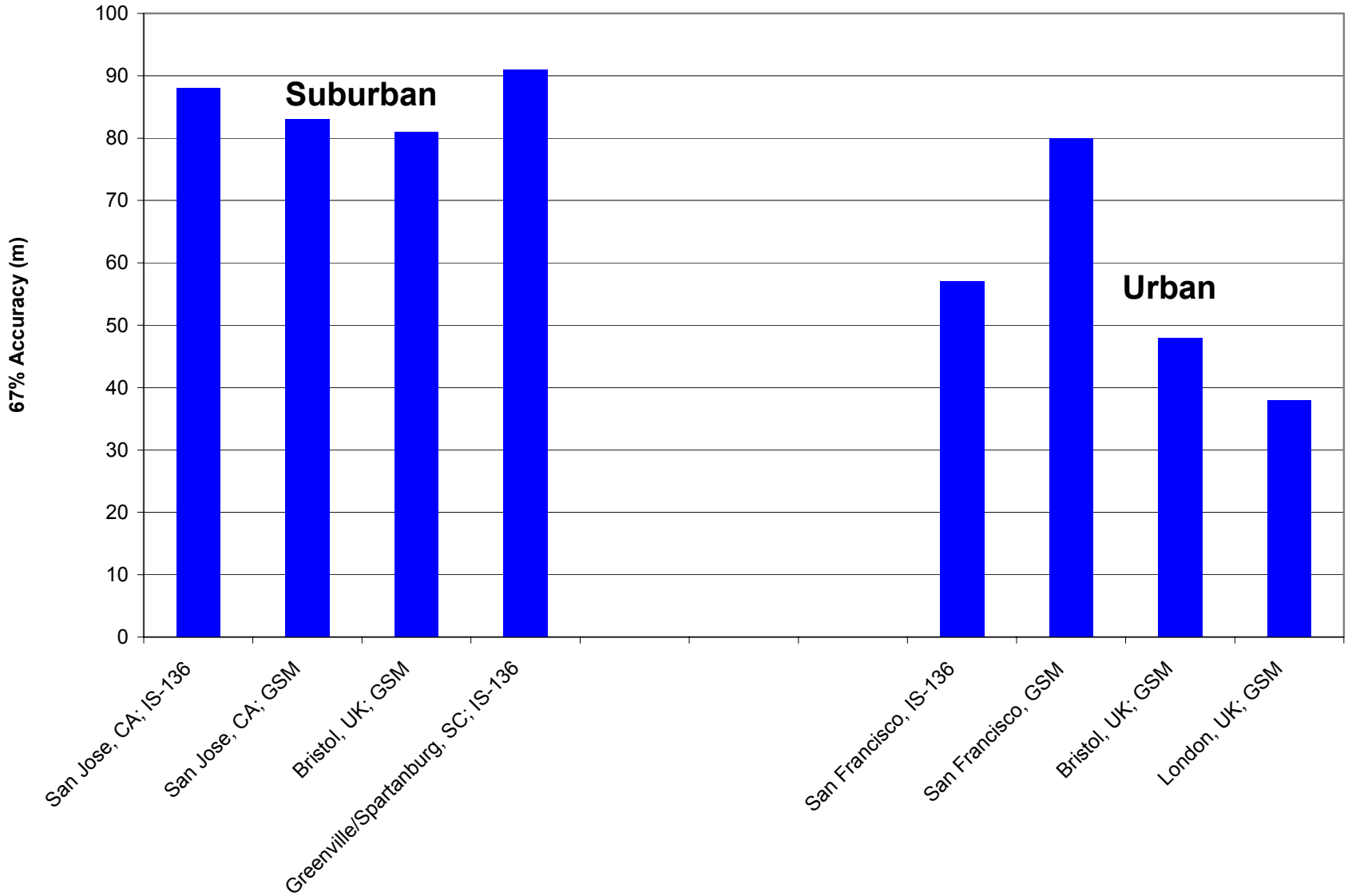
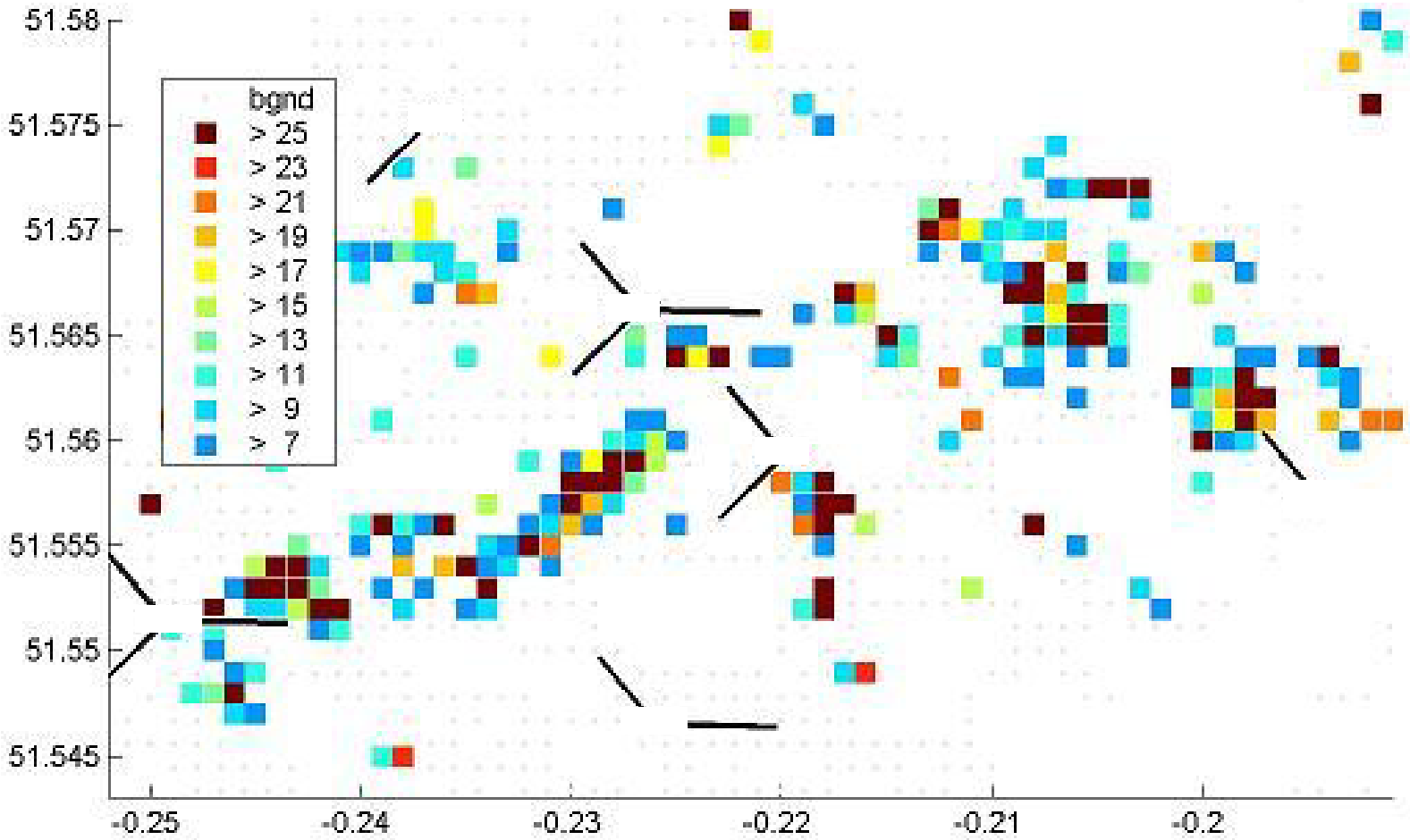
Accuracy Test Summary



Example Application: Network Optimization

Traffic Density Map

Color coding is number of calls in 100 X 100 m bins during sample hour



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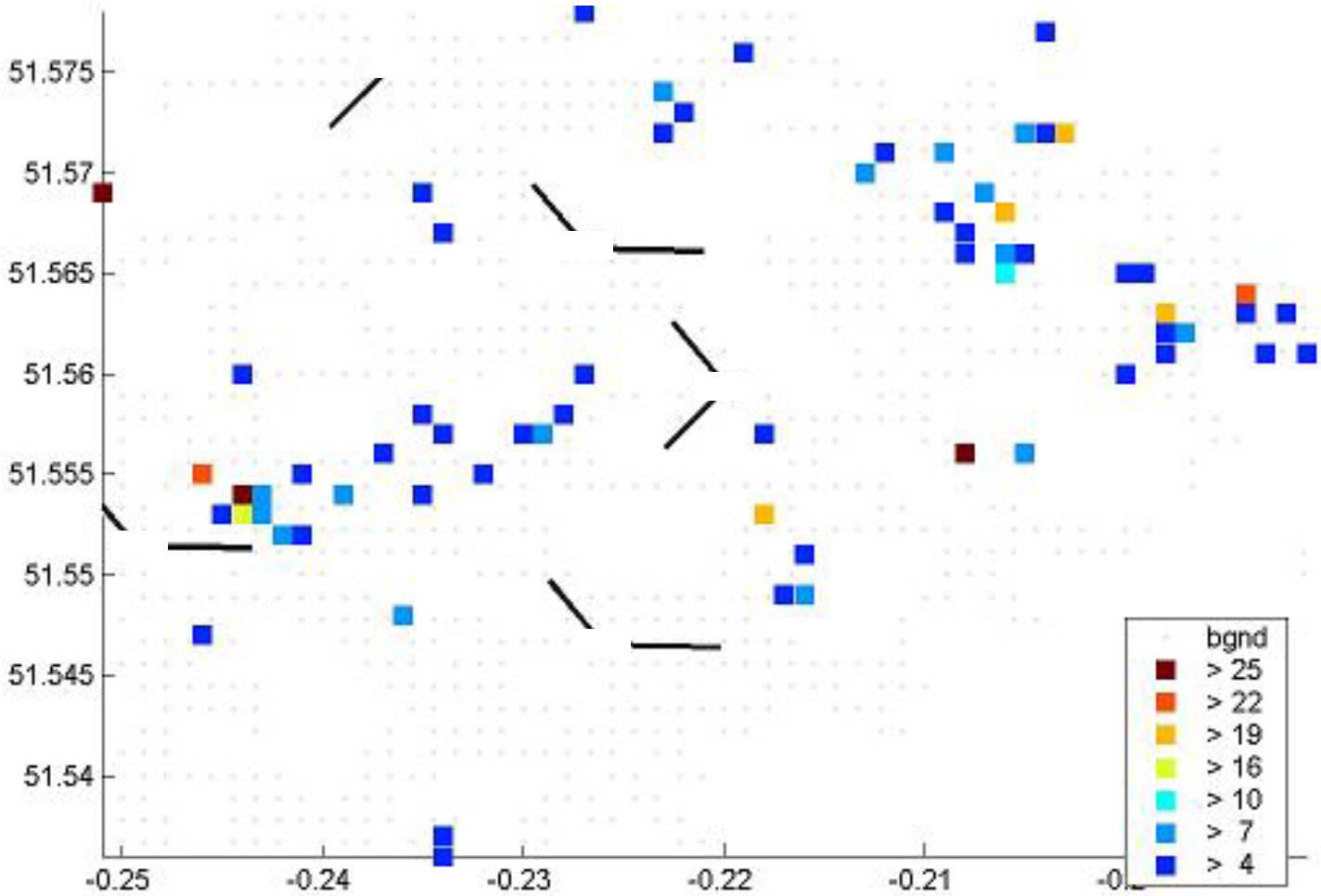
Dropped Call Map

Color coding is number of dropped calls in 100 X 100 m bins during sample hour



Conclusions

- Compliant with E-911 Phase II accuracy requirements for GSM & IS-136
- Economical for service providers and public safety community
- Immediate coverage for entire installed customer base
- High reliability/availability of location system
- Deploy as standalone or hybrid system
- Support network optimization and location based services