Wireless @ Virginia Tech

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Localization Aspects of Enforcing Spectrum Rights

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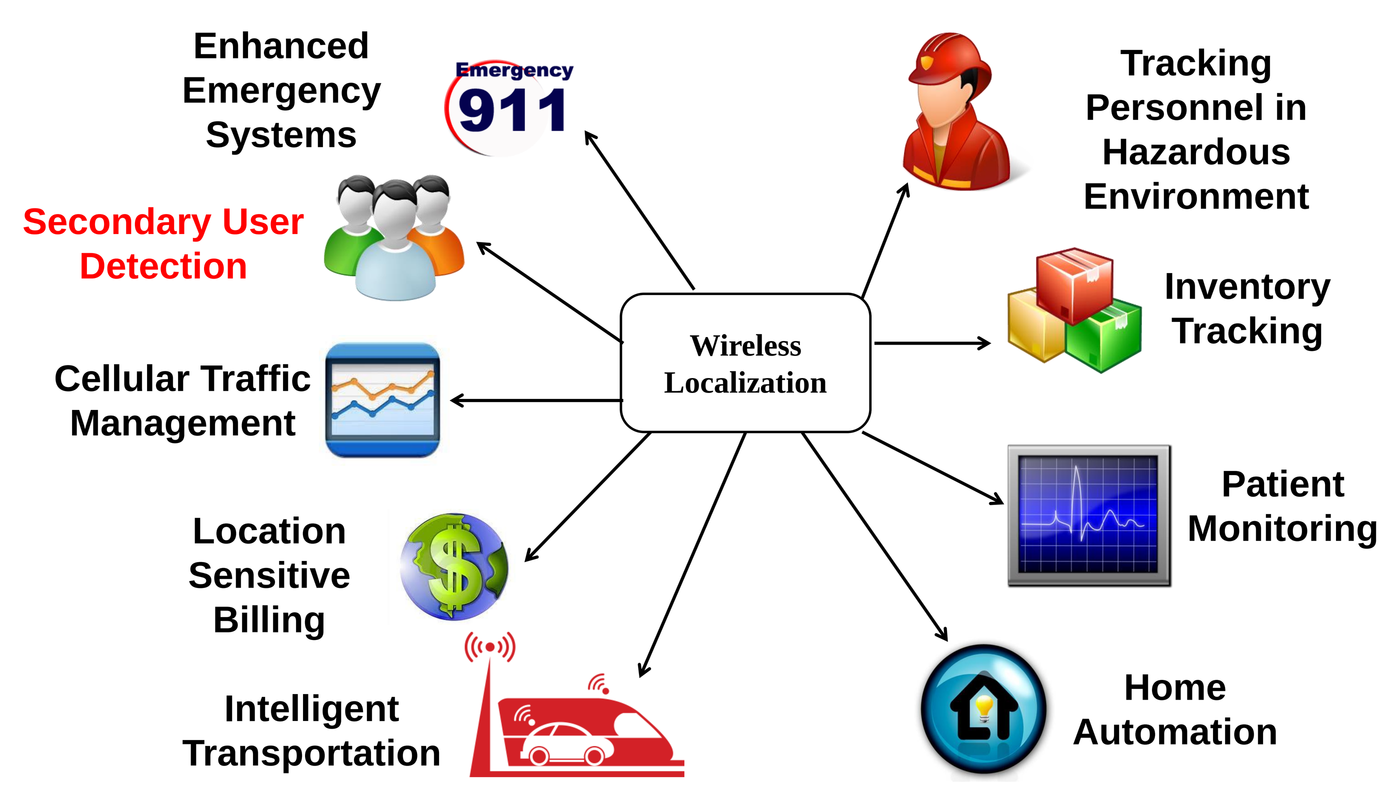
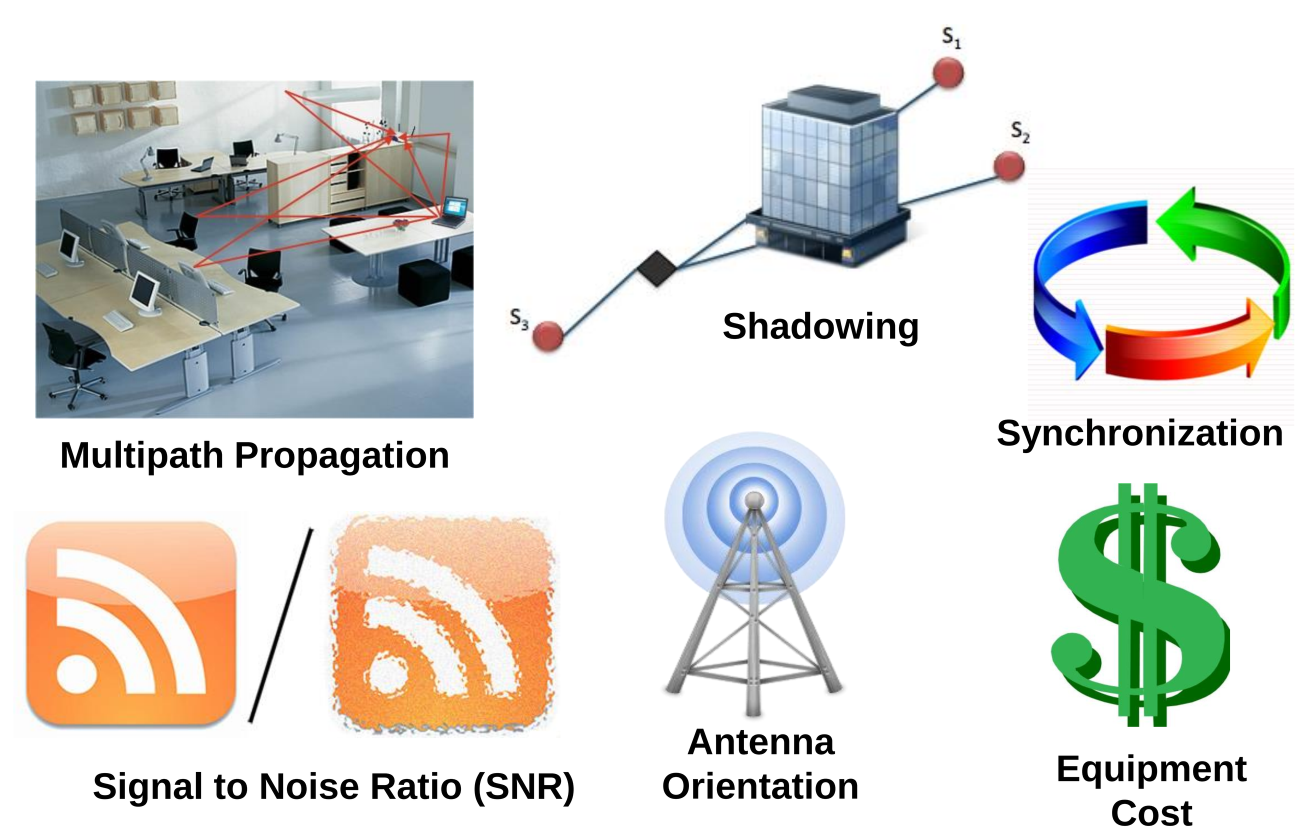
WIRELESS LOCALIZATION: APPLICATIONS



Secondary User Detection : Intrinsic part of the Enforcement scheme

WIRELESS LOCALIZATION: CHALLENGES



SUMMARY OF METHODS

	Time of Arrival (TOA)	Angle of Arrival (AOA)	Received Signal Strength (RSS)	Channel Impulse Response (CIR)
Susceptibility to Multipath and NLOS	YES	YES	NO (provided the model is accurate)	NO (provided the database is extensive)
Robustness to Noise	YES	YES	NO	YES
Low Cost	YES	NO	YES	NO (cost of maintaining the database is high)
Synchronization Required	YES	NO	NO	NO
Database	NO	NO	NO	YES

Desired **Undesired**

RSS BASED METHODS

1. Received Signal Strength (RSS)

- **Log-Distance Relationship :** $P(d_k) = P(d_0) - 10\alpha \log_{10}\left(d_k / d_0 \right)$
- **Advantage: Cost Effective Solution**
- **Drawback:** $P(d_0)$ **needs to be calibrated and hence less robust.**

2. Differential Received Signal Strength (DRSS)

- **Pairwise difference of the RSS values:** $L(d_i, d_j) = 10\alpha \log_{10}\left(d_j / d_i \right)$
- **Advantage: More robust as no calibration is required**

3. Weighted Differential Received Signal Strength (WDRSS)

- **Each pairwise difference is assigned a weight**
- **Advantage: Weights provide flexibility while retaining robustness**

SIMULATION EXAMPLE

Simulation Environment: 1000m by 1000m area with varying degrees of spatial correlation.

Log-Distance Model with spatial Correlation:

1. RSS: $L(d_k) = P(d_0) - 10\alpha \log_{10}\left(d_k / d_0 \right) + x_k$, where $X_k \sim N(0, \sigma_s^2)$

2. DRSS: $L(d_i, d_j) = 10\alpha \log_{10}\left(d_j / d_i \right) + \Delta x_{ij}$, where $\Delta X_{ij} \sim N(0, 2(1-\rho_{ij})\sigma_s^2)$, ρ spatial correlation coefficient

Preliminary Results

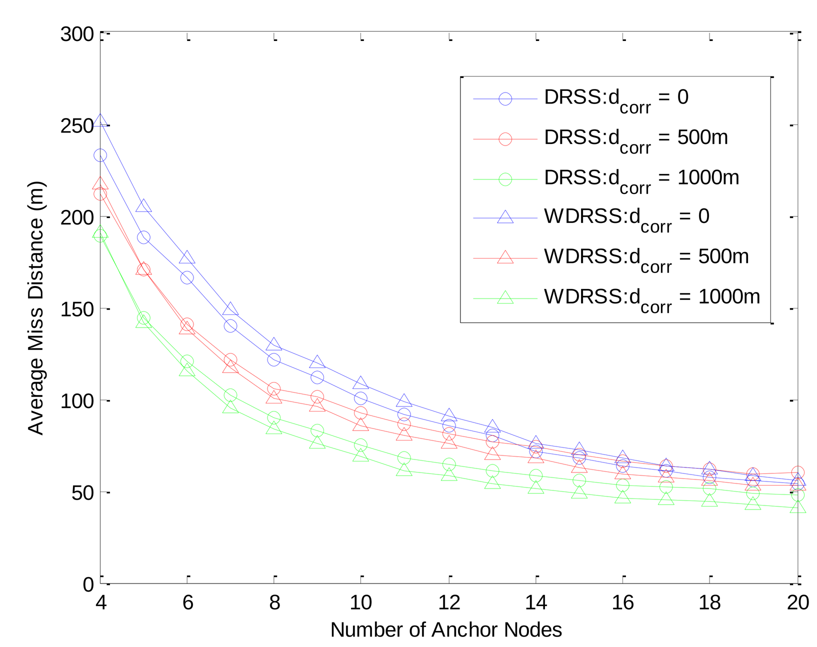


Figure 1: Average Miss Distance (AMD)

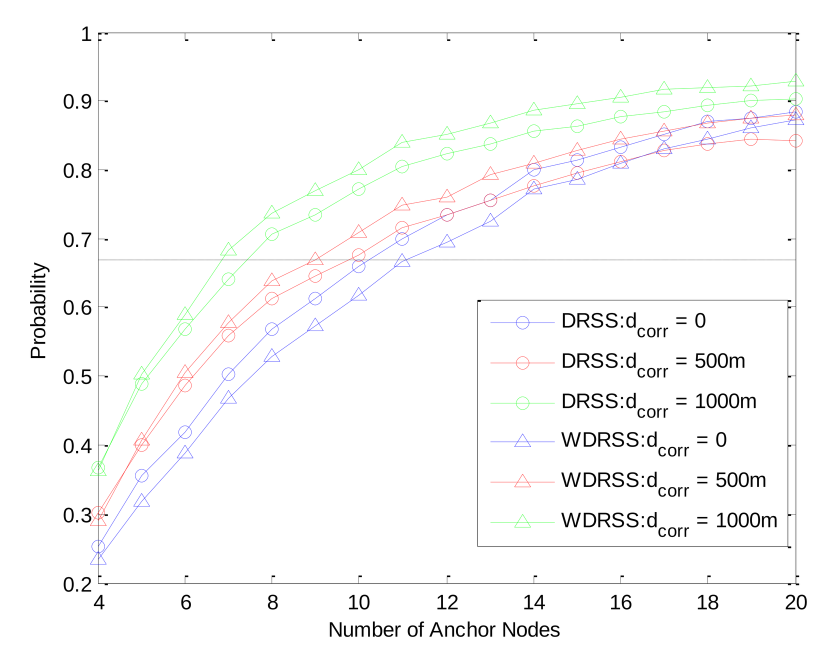


Figure 2: *P* (AMD ≤ 100m)

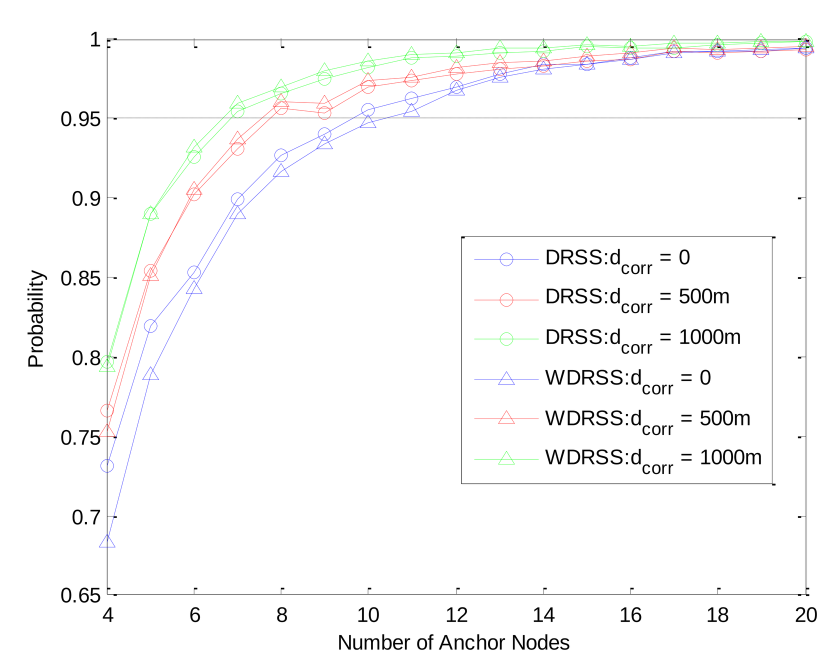


Figure 3: *P* (AMD ≤ 300m)

DISCUSSION

- In a more spatially correlated environment the performance of both DRSS and WDRSS improves.
- Figures 2 and 3 give an idea of the minimum number of sensors (anchor nodes) required to meet the FCC E-911 specifications.
- In the future, we want to investigate the performance of different methods under different simulation environments to learn which one is optimum under which conditions.