

CILoS: A CDMA Indoor Localization System

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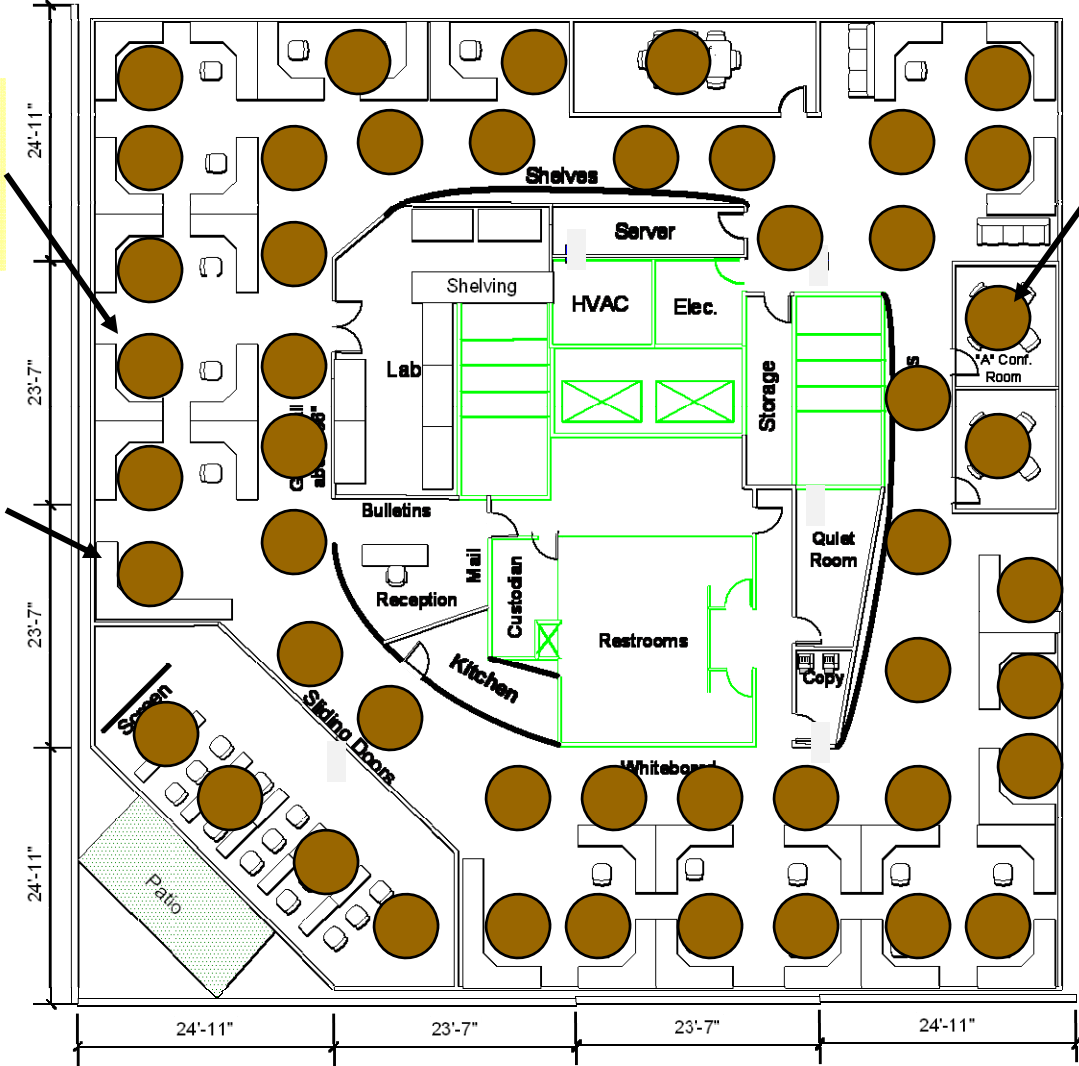


Fingerprinting – Building a radio map

AP1: -41
AP2: -54
AP3: -92

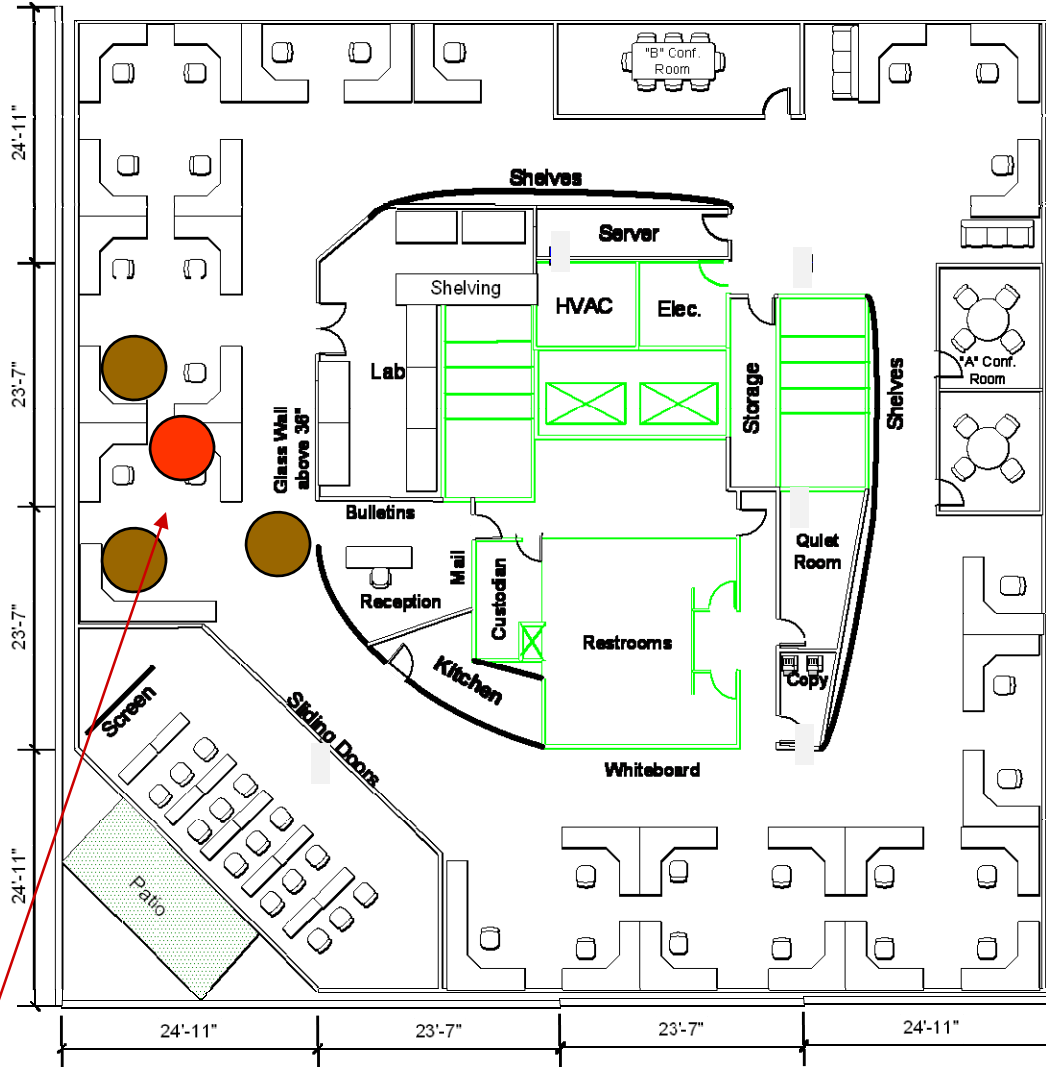
AP1: -41
AP2: -54
AP3: -92

AP4: -35
AP5: -64
AP6: -72



Fingerprinting – K Nearest Neighbors

AP1: -40
AP2: -56
AP3: -83



Current Fingerprint

Signal Fingerprinting Approaches

- 802.11

- GSM



Signal strength

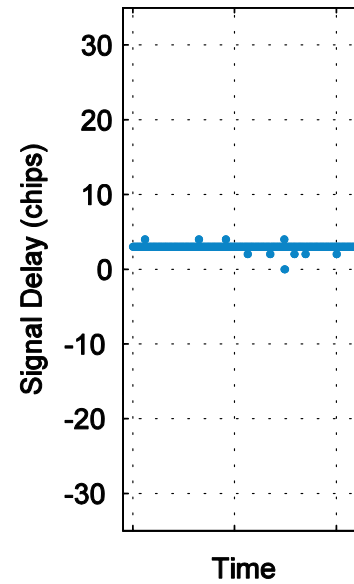
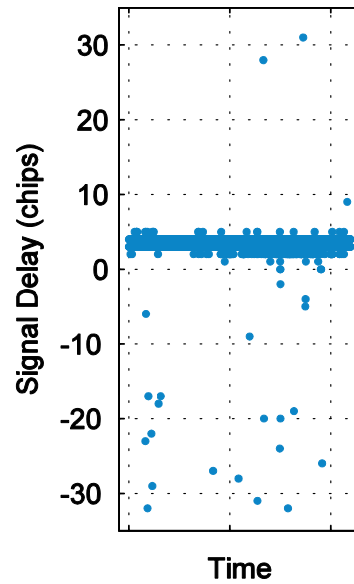
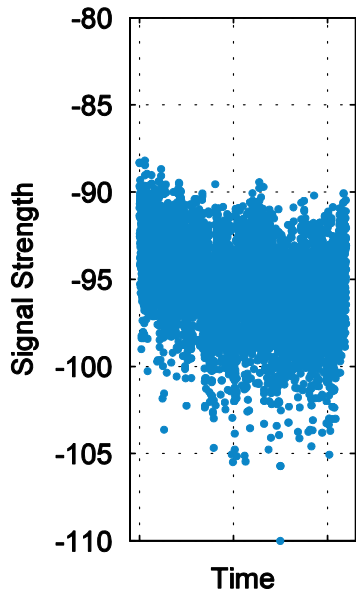
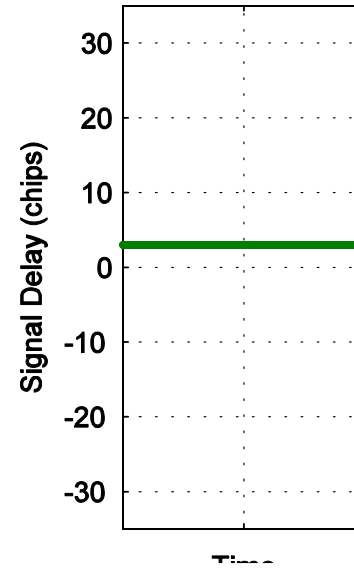
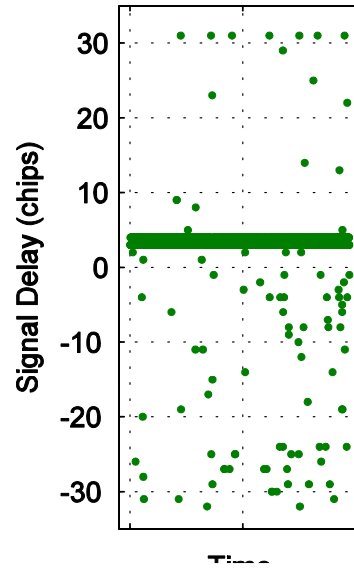
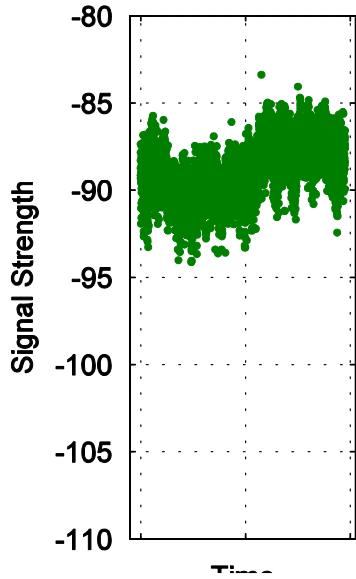
- CDMA

- Power adaptation to accommodate network load

- High temporal variations in signal strength

- Use signal delay

Signal Strength vs. Signal Delay Variations



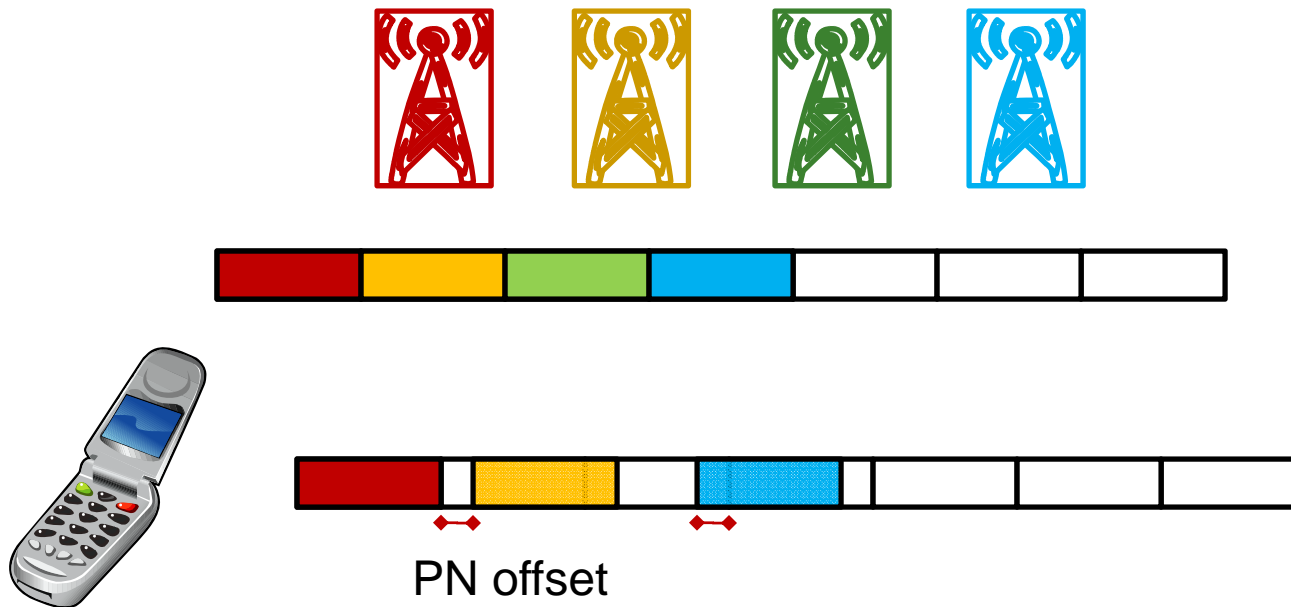
CDMA Networks

- Base stations share the same spectral bandwidth
- Base stations are tightly synchronized with GPS
- Base stations cooperate to transmit pilot signal



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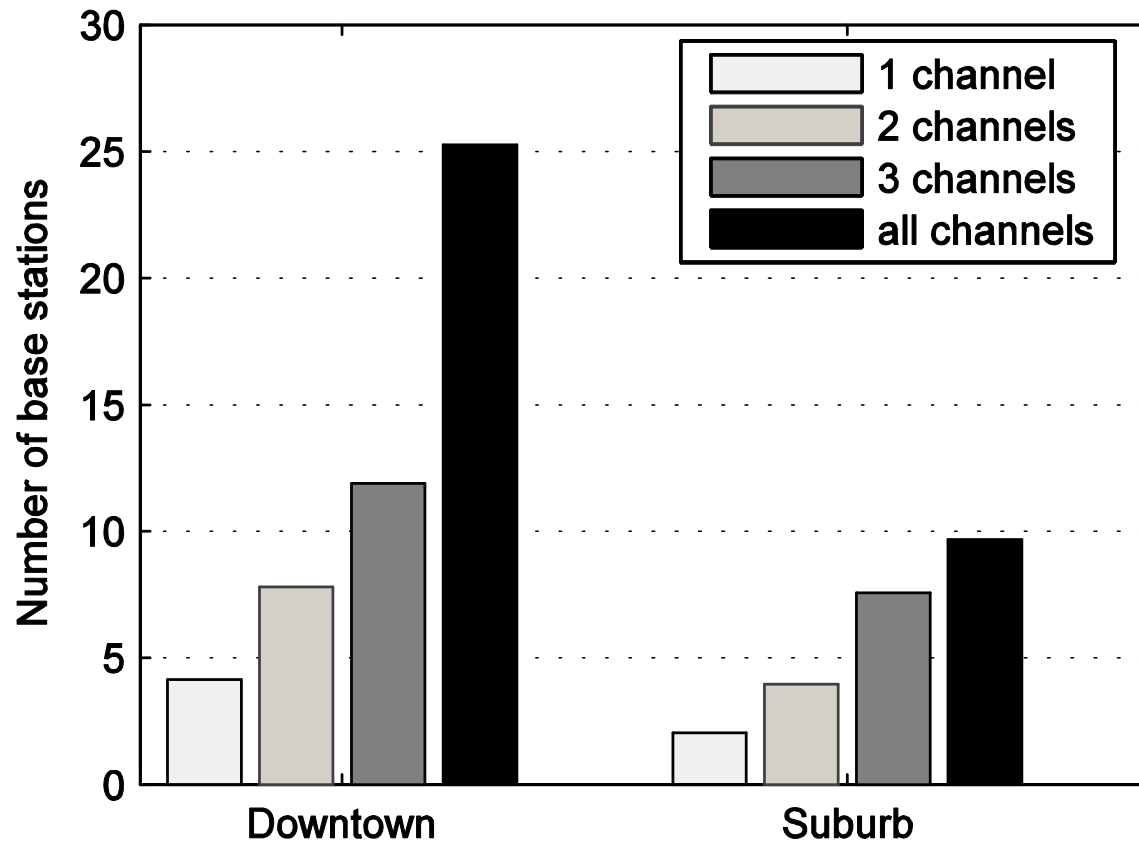
Key idea: Fingerprint PN offsets

Data Collection

- Condor CDMA scanner
- Recorded signal delay and strength over all channels in
 - Downtown
 - Suburb
- 6 channels in downtown
- 4 channels in suburb



Average Visible PNs

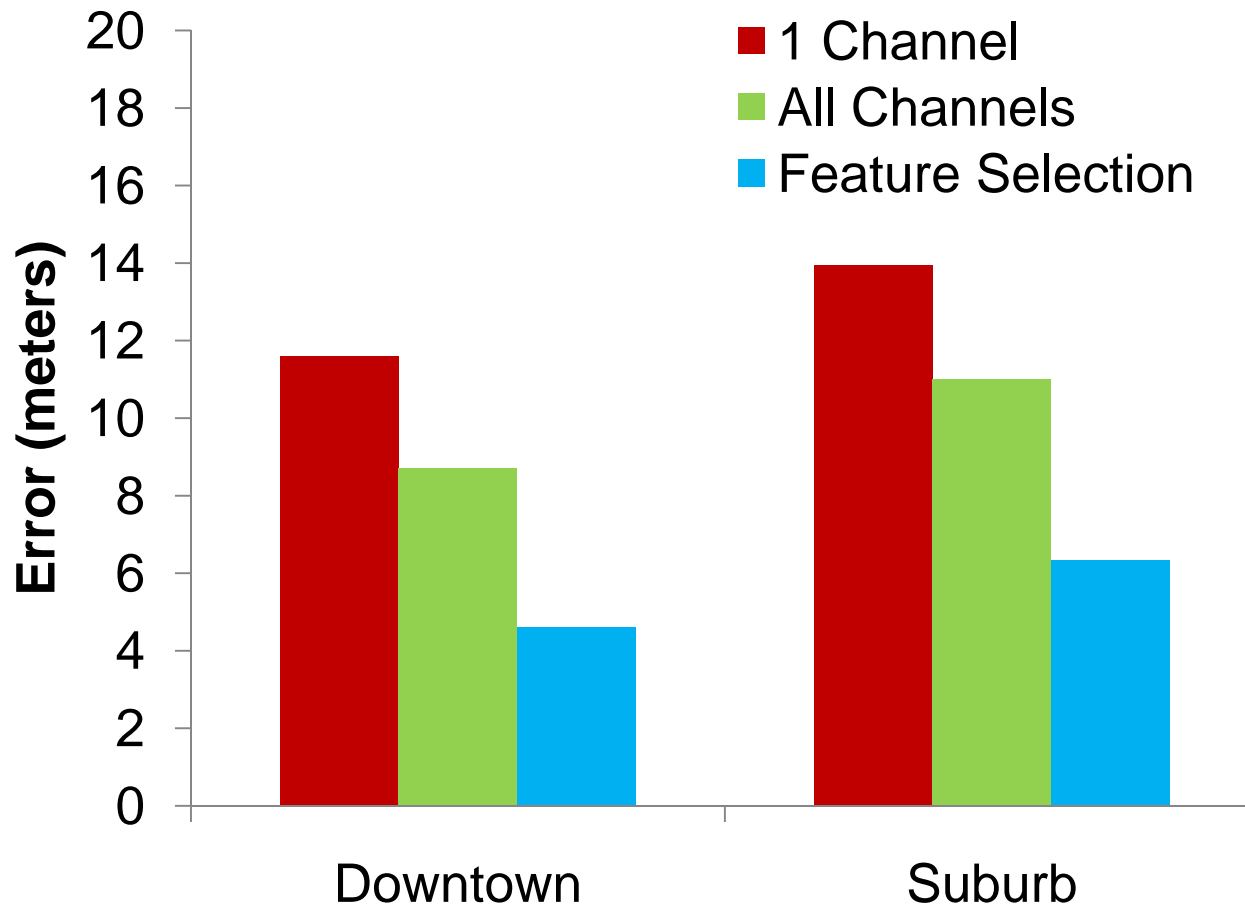


- Interference limits # of visible base stations
- Wide fingerprints require scanning multiple frequency bands

Localization Algorithms

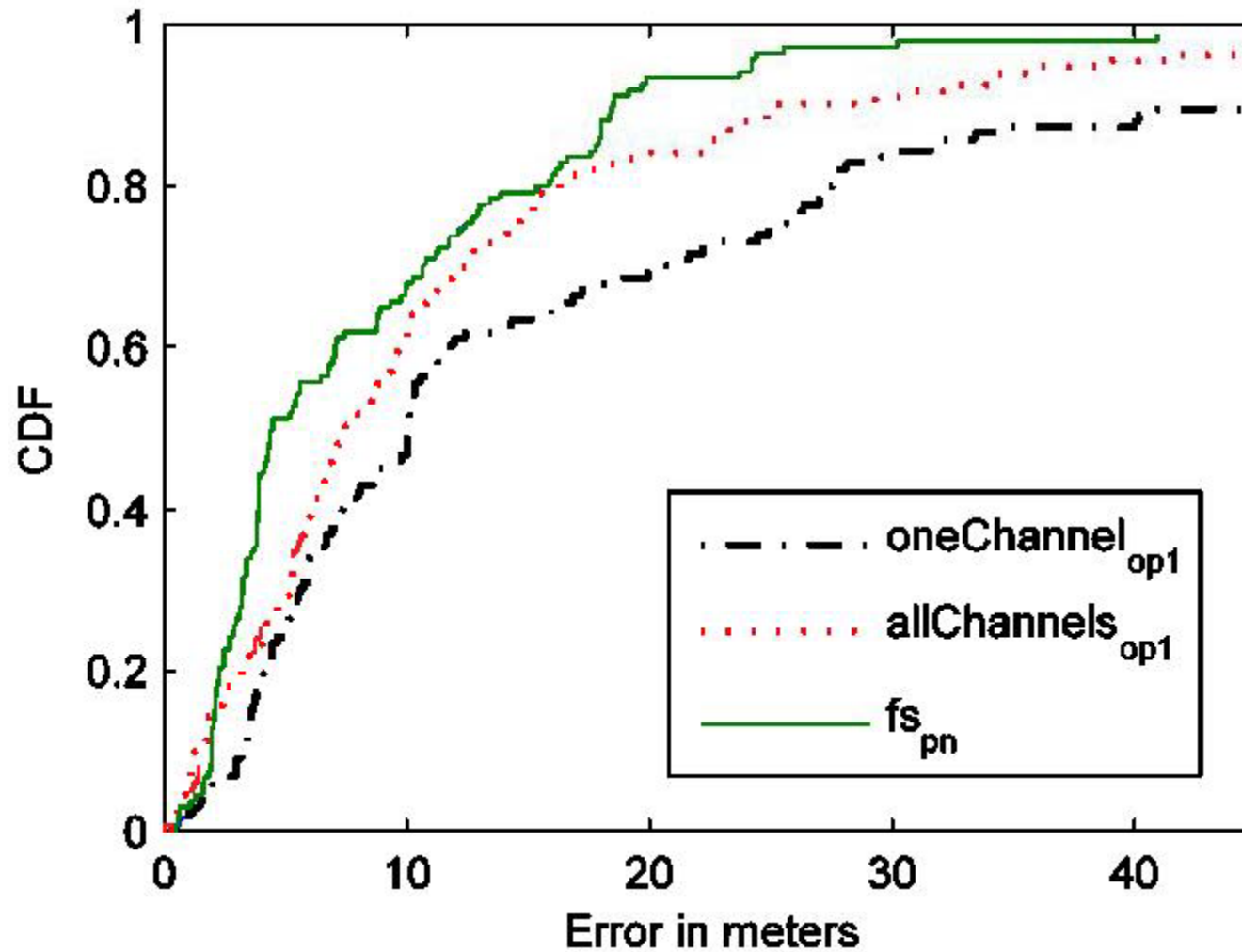
- Simple Algorithms
 - *1 Channel*
 - *All Channel*
- Feature Selection Algorithms

Localization Error

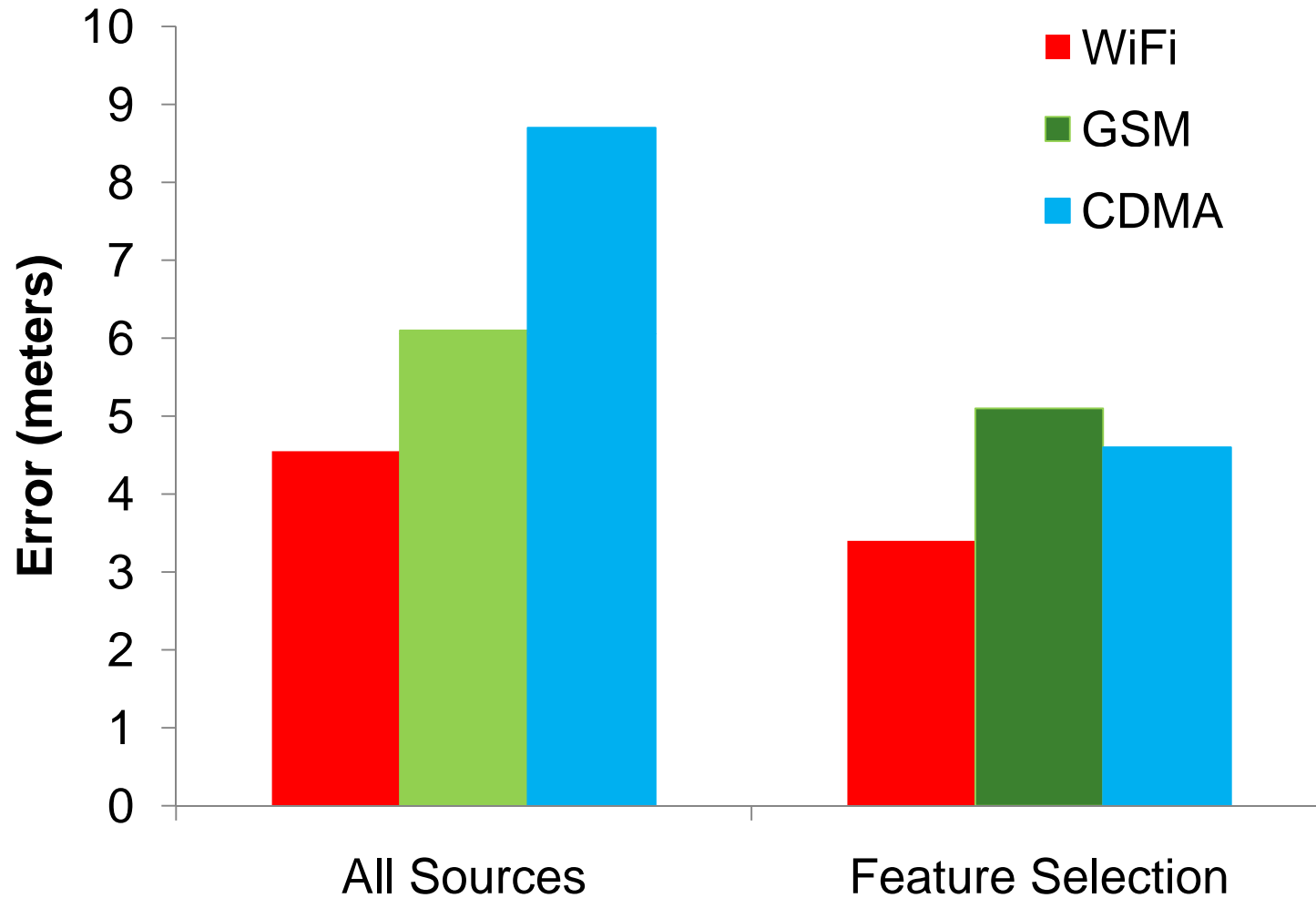


- Wide fingerprints help
- Careful PN selection critical

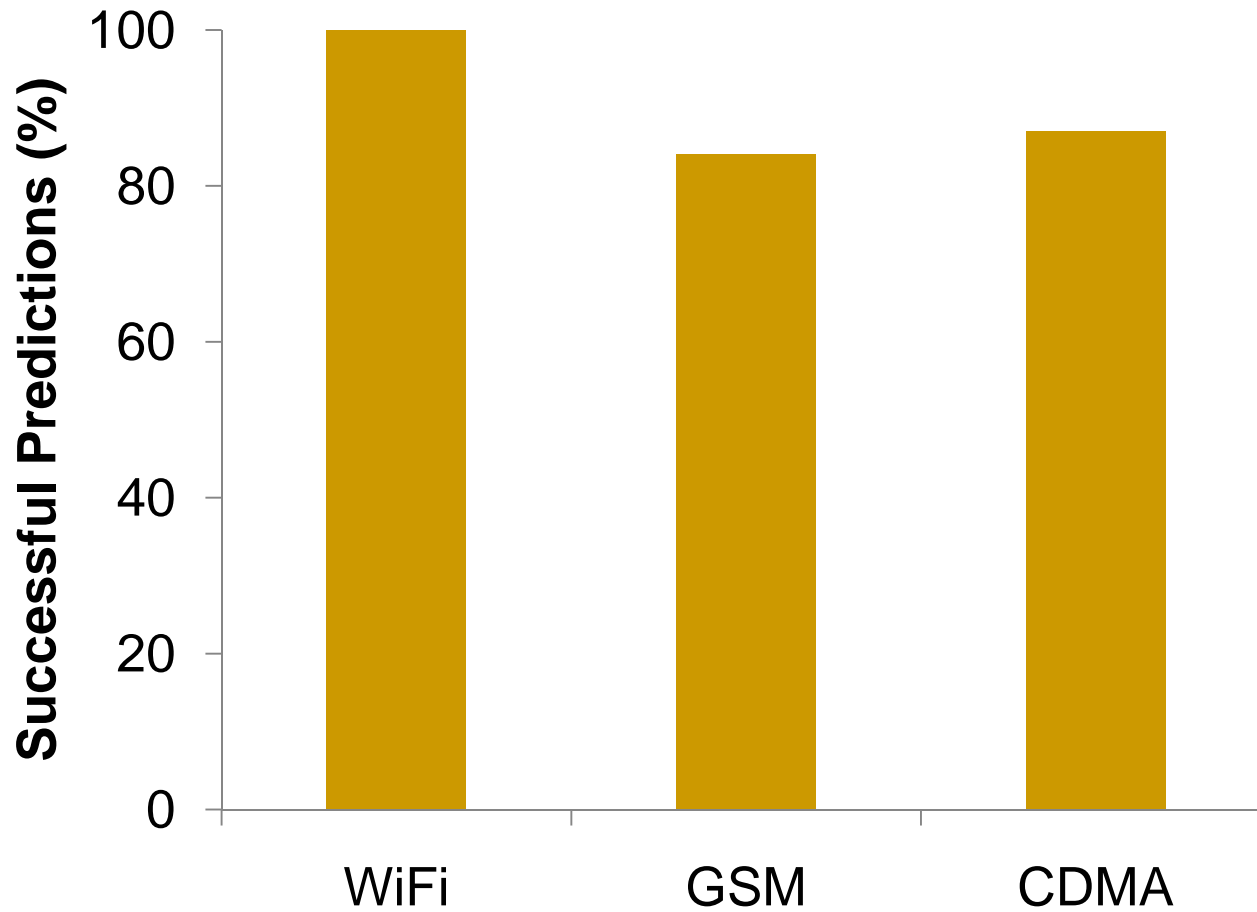
Localization Error CDF (Downtown)



Comparison with WiFi and GSM



Floor Level Localization



Conclusions

- Signal delay is a reliable metric for fingerprinting
 - Temporal stability
 - Spatial variability
- CILoS achieves median accuracy of 5 meters
- Wide signal fingerprints critical to accuracy
- Feature selection really helps

Future Works

- Get it to work on commodity cell phone
- Requires
 - Access to PN offsets
 - Scan multiple frequency bands

Question?

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