I Am the Antenna: Accurate Outdoor AP Location using Smartphones

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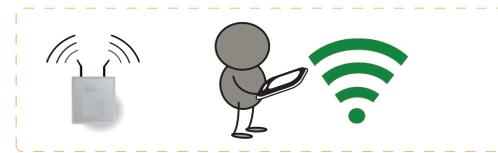
Outdoor AP Location

Why important?
+ Deploy a network: avoid interference
+ Monitor a network: find malicious APs

Where is the AP?

Design goal
+ Cheap, accurate, online (real-time) AP location system

Design Insights

Facing AP

Back Facing AP

Body blocking effect
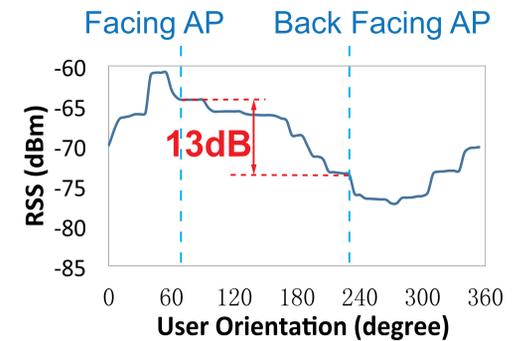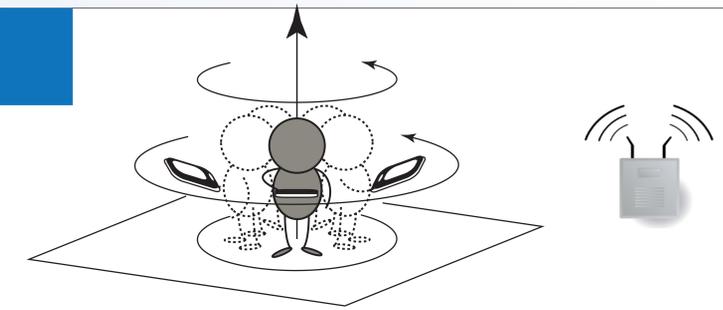+ Facing the AP: strong signal strength
+ Back facing AP: weak signal strength

Rotate your body
+ Hold the phone close to user body
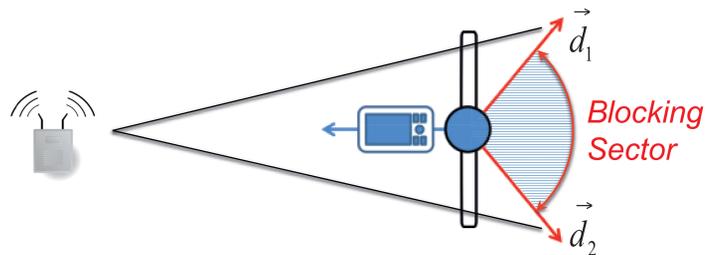+ Generate the RSS curve during rotation

AP location?
+ Can we use this to find the direction of AP?

Facing AP   Back Facing AP

13dB

RSS (dBm) vs User Orientation (degree)

Borealis System   *User body + Phone = Directional Antenna*

Why not minimum RSS direction?
+ Using minimum RSS direction introduces large errors
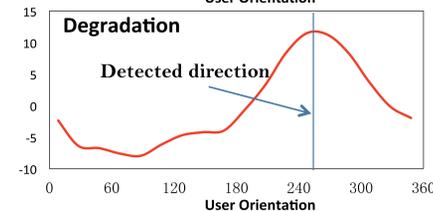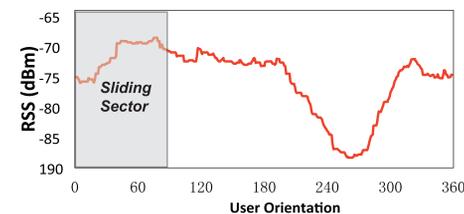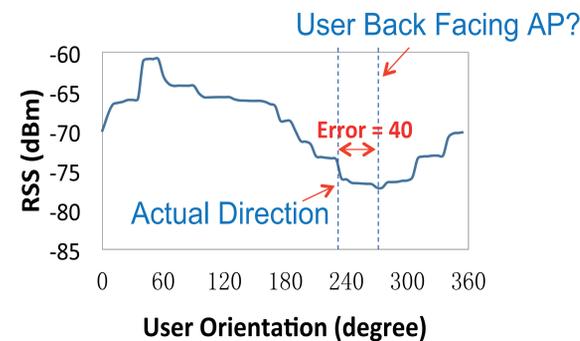+ For 35% of the cases, the **Error** > 45 degree

$\vec{d}_1$

$\vec{d}_2$

Blocking Sector

+ The phone is not only blocked in one **single angle**, but a **range of angles** -> a *Blocking Sector*

Find the AP direction
+ Find the sector with the largest RSS *Degradation*

+ Sliding sector
+ *Sin*: average RSS inside the sliding sector
+ *Sout*: average RSS outside the sliding sector
+ *Degradation = Sout - Sin*

User Back Facing AP?

Error = 40

Actual Direction

RSS (dBm) vs User Orientation (degree)

Sliding Sector

RSS (dBm) vs User Orientation
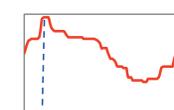
Degradation

Detected direction

User Orientation

Evaluation
+ **Offline Analysis**: Cluster based ML algorithm optimized by large training set
+ **Borealis**: Sliding sector based algorithm
+ **Min RSS**: Minimum RSS direction algorithm
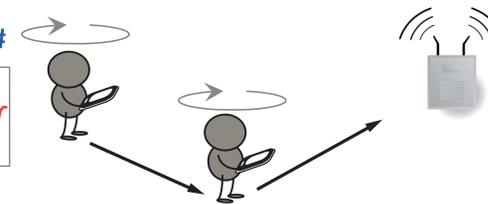+ **GUIDE**: RSS gradient based algorithm

Navigation
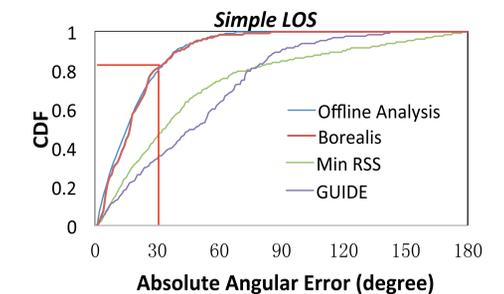+ Walk- rotate- walk
+ Adaptive algorithm to minimum the steps

AP direction#

RSS Profile

Error < 30 degree for 80% of the cases

Simple LOS

CDF vs Absolute Angular Error (degree)
- Offline Analysis
- Borealis
- Min RSS
- GUIDE

Future Work
+ Leverage the blocking effect for *indoor* AP location
+ Smartphone location without GPS: given the AP location, can we locate the phone via rotating?