

10/17/2013

RF Localization

Traditional Methods

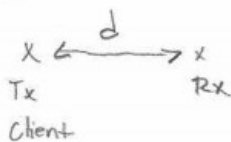
- RSSI (signal power)

- power of signal decays with distance.

- Angle of Arrival

- determine the angle at which a signal is arriving

RSSI



$$h_{dir} = \frac{\sqrt{G_t G_r} \lambda}{4\pi d} e^{-j2\pi \frac{d}{\lambda}}$$

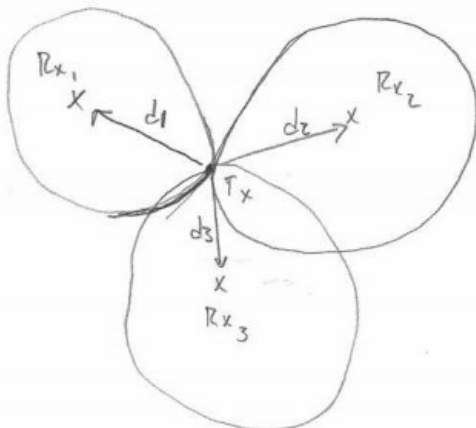
where Power $P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi d)^2}$

$$\text{Power} = |h_{dir}|^2$$

- Map Power $\rightarrow$ distance



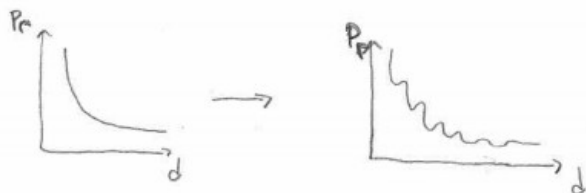
- Trilateration



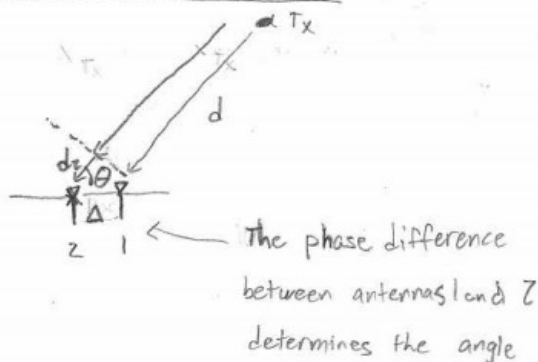
Challenges of RSSI

- 1) Noise in the power lead to large deviations in D
- 2) Multipath - due to constructive and destructive interference

$$\frac{a}{d_1} e^{-j2\pi d_1/\lambda} + \frac{a}{d_2} e^{-j2\pi d_2/\lambda}$$

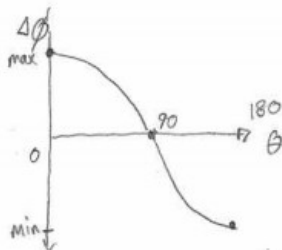


Angle of Arrival (A_oA)



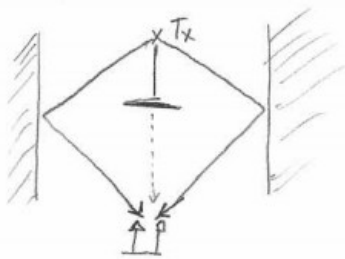
$$\frac{\Delta\phi}{2\pi} = \frac{d_2}{\lambda} \approx \frac{\Delta \cos\theta}{\lambda}$$

$$\Delta\theta = \frac{2\pi \Delta \cos\theta}{\lambda} \quad A_oA$$



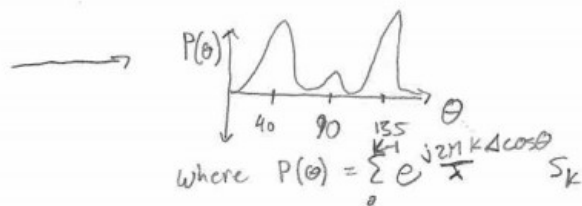
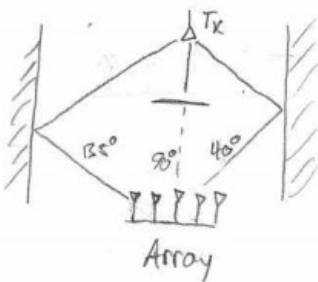
Issues

- 1) Can't distinguish front from back
- 2) The effect of noise is less between $20^\circ - 160^\circ$
- 3) Multipath

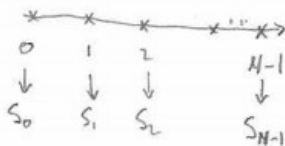


These complex numbers sum constructively and destructively
to create a false direction

Antenna Array



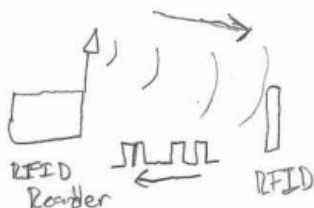
You can determine power at a given angle by projecting
onto that specific angle



Remarks

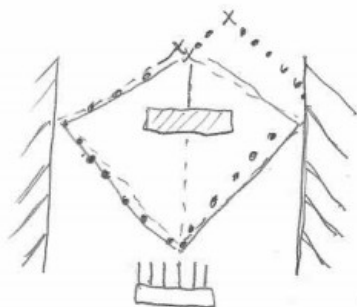
- The antenna array gives us the multipath profile but not location
- Large arrays are expensive and cumbersome

- 1) works with RFID's

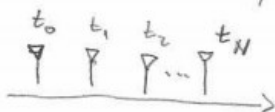


RFIDs reflect their unique pattern

- 1) It localizes mobile RFIDs to reference RFIDs with known locations



- 2) Replace Antenna Array with a sliding antenna sampled in time



- 3) Use Dynamic Time Warping (DTW) to distinguish nearby RFIDs

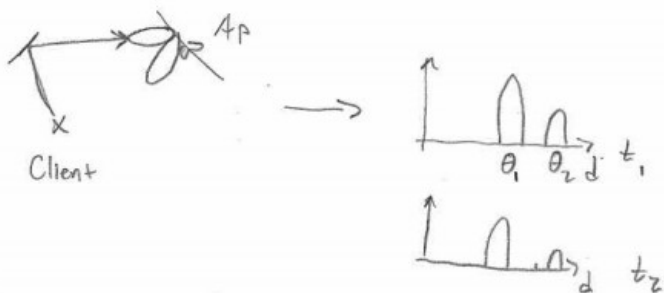


How much distance do the points of S_2 need to move to best fit S_1 ?

Array Track

Array Track cannot work without Line of Sight

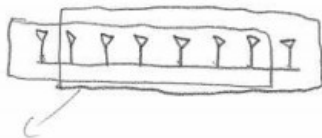
- The main concept of ArrayTrack is that in your multipath profile, the angle of the direct path changes a lot less than the angles of the indirect paths.



By comparing which path is stable over a period of time, you can do a better job of eliminating the non-direct line of sight

Trick

If the client is still, they use 7 of the 8 antennas on the AP



Taking the 2 sets of 7 antennas emulates a moving antenna array