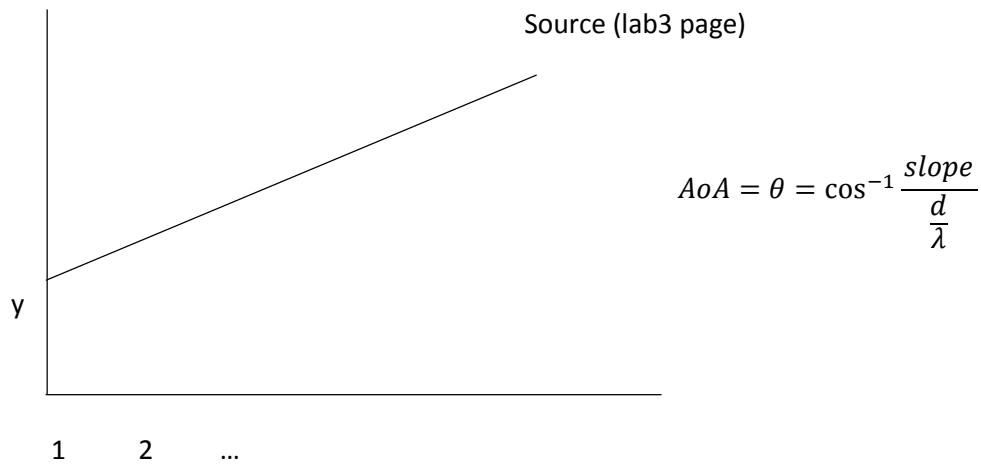
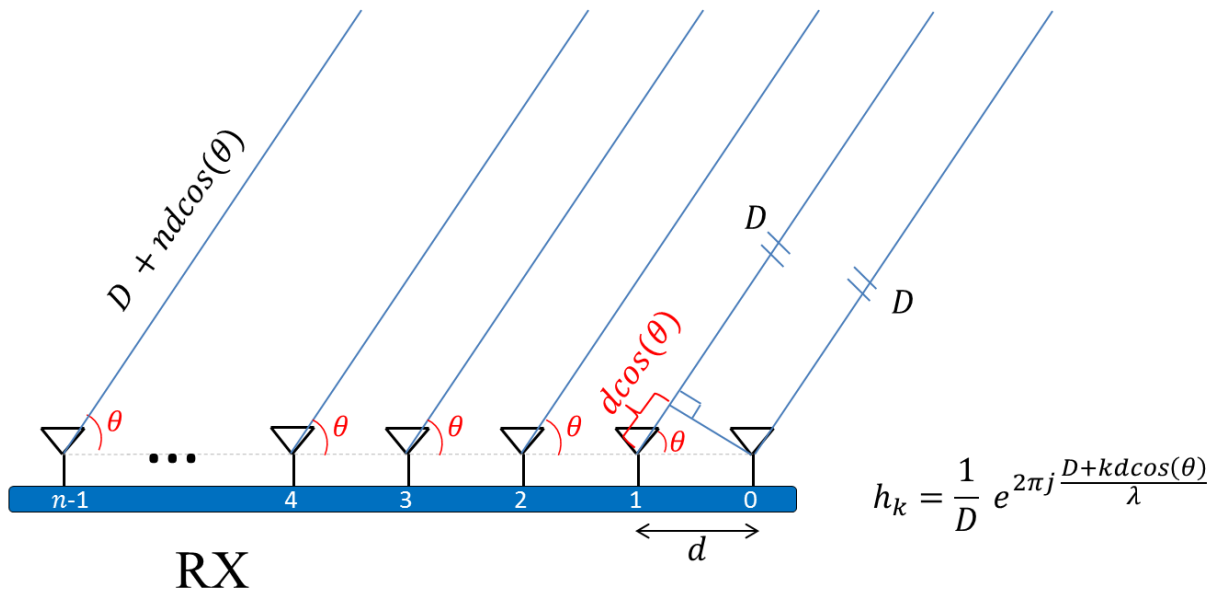


Task 1: Linear Antenna Array

Assume a single path propagation



Task 2: Multipath Profiles

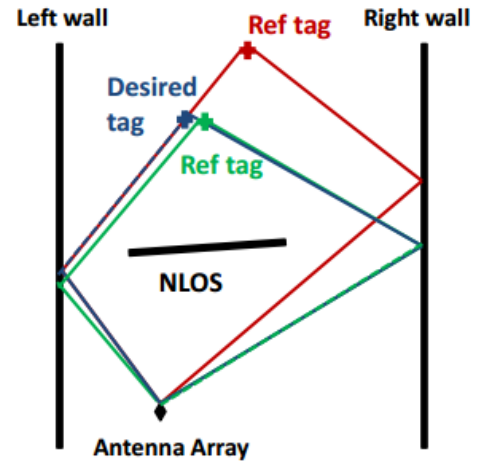
Equation for the power received at angle  $\theta$  :

$$MP(\theta) = \left| \sum_k h_k e^{-2\pi j \frac{k d \cos(\theta)}{\lambda}} \right|^2$$

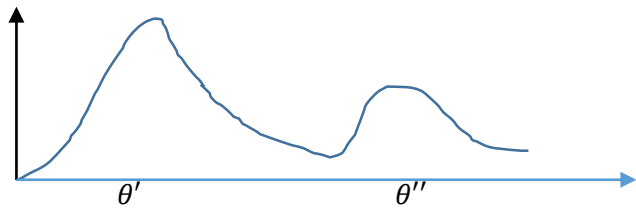
$$\theta' = \left| \sum_k \frac{c}{d} e^{j2\pi \frac{D+dk \cos \theta}{\lambda}} \cdot e^{-j2\pi \frac{D+dk \cos \theta}{\lambda}} \right|^2$$

If  $\theta' = \theta$  , then  $n(\frac{c}{d})^2$

If  $\theta' \neq \theta$  , then  $(\frac{c}{d})^2 \left| \sum_k \frac{c}{d} e^{j2\pi k \frac{d}{\lambda} (\cos \theta' - \cos \theta)} \right|^2$



(a) Multipath environment

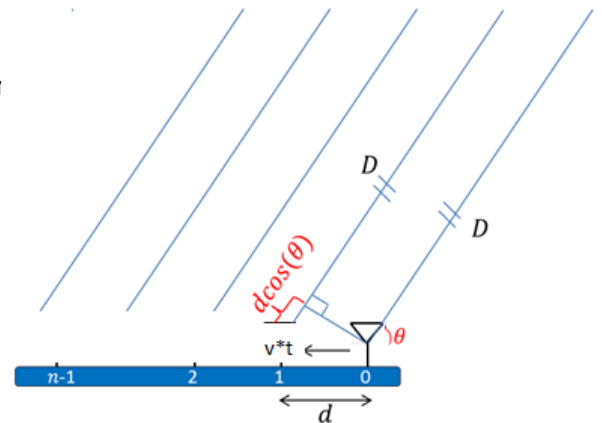


Source (pinit paper)

Task 3: Synthetic Aperture

By using sliding antenna (speed v) and sampling at intervals 0, 1, ..., n

$$h_t = \frac{c}{d} e^{j2\pi \frac{D+vt \cos \theta}{\lambda}}$$

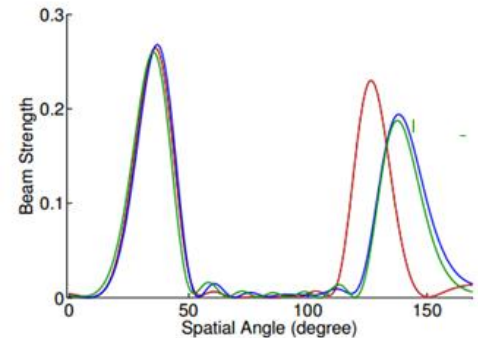
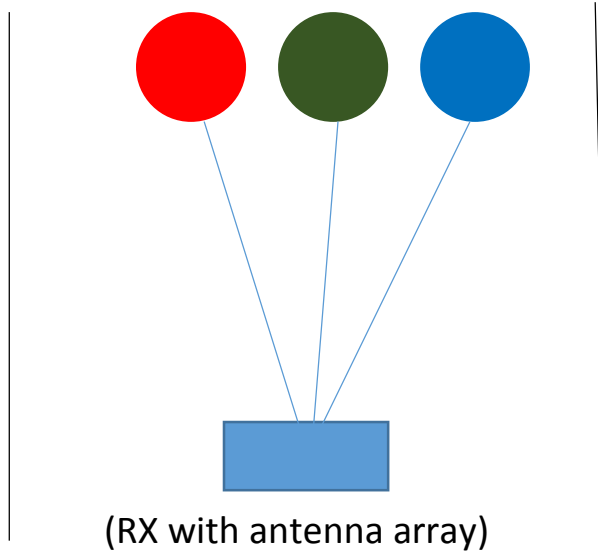


Benefit: the ability to simulate a large antenna array

Drawback: V is not constant over time

Task 4: Localization

Four nodes (i.e. objects with RFID tags) in multipath environment:



(b) Multipath profiles

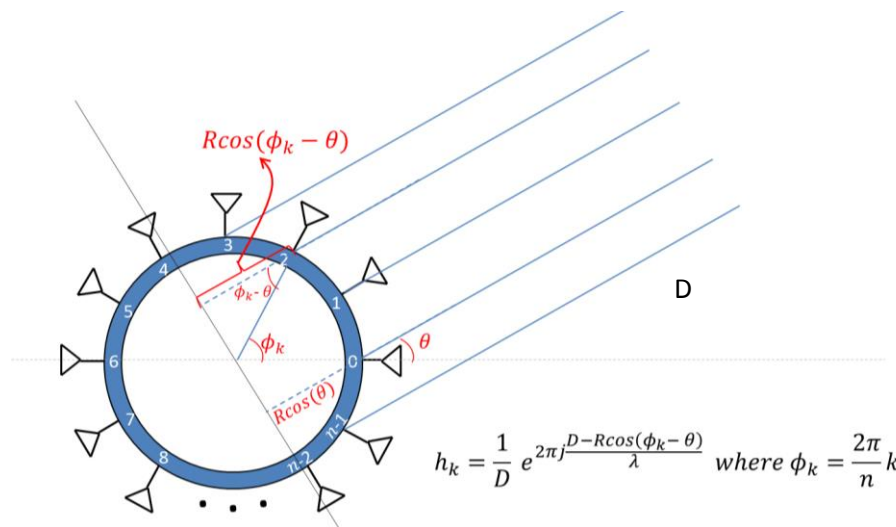
Source (pinit paper)

Inference Methods:

- 1- Correlation (issue: scaling)
- 2- Least squares (issue: time shift)
- 3- Dynamic time wrapping (handles scaling and time shifts)

Task 5: Circular Antenna Array

Assuming TX is far away so that the received signals are parallel



source( lab3 page)

for  $\phi_k$ , we have:  $\phi_k = \frac{2\pi}{n} k, \quad 0 < k < n - 1$

Also,  $|\phi_k - \theta| > \frac{\pi}{2} \rightarrow \cos(\phi_k - \theta) < 0 \rightarrow \text{distance} > D$