How to measure range, \( r \)?

1. **Time**
   - Hard w/o time sync.
   - and WiFi AP location

2. **From power of**

3. **Power of transmitted and received signal**

   Received power at any distance \( r \) decays as

   \[ P \propto r^{-n} \]

   Why?

   Because around the antenna is ...

   and every on the sphere should have equal received power (since ).

   Thus, \( P_r = \)

4. **But with multipath/echo, \( P_r \) becomes more complicated**

   Delayed copies adding up.

   \[ P_r = \]
\( \alpha = 2 \) in deep space
\( \alpha \approx 2.75 \) in soccer stadium
\( \alpha \approx 3.1 \) in apartment room
\( \alpha \) will vary

Also, LOS path not easy to pull out since it's a continuous mixture

\[ \Downarrow \]
This motivates WiFi RADAR

But received signal can be modeled as
\[ y = \alpha \text{los} + \]
\[ y = \]

often called channel often called impulse response (RIR)

CIR is a \( h \) of
This opens 2 opportunities

1. Estimate CIR \( 'h' \) and use it as a
2. Estimate the of CIR and that should be the
Note in reality: \( y = \)...

Freq. domain: \( Y = H X + N \)

\[ \hat{H} = \]

\[ \hat{h} = \]

\( \hat{h} \) fingerprinting still needs

Also, environment changes modify \( h \).

But WiFi system use wide bandwidth (20MHz)

using methods

This means \( (\hat{h}_{\text{sub}},) \) and fingerprint = 

With 3 WiFi APs,

more dimensional space

or

Los power technique needs to know

and ... and also erroneous,

However, not needed