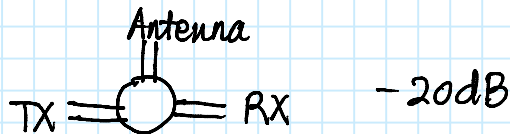# Lecture #17 10/20

Full Duplex Radio

Benefits:

- Higher throughput (TX/RX at the same time)
- Same channel for uplink and downlink $\Rightarrow$ less BW required
- No need to switch between TX/RX $\Rightarrow$ same oscillator
- Simpler MAC $\Rightarrow$ Detect collision early on $\Rightarrow$ less wasted time
   • Rate adaptation more efficient
- Synchronization TX & RX together
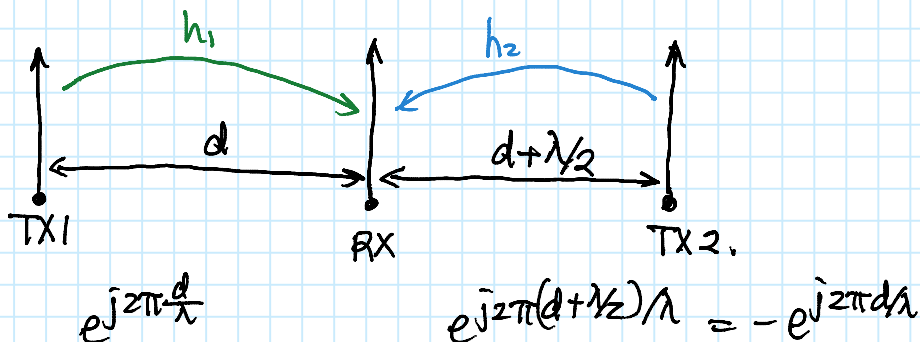
- Jamming & Security : Jam, still receive

Why is it hard?

• TX power is so high $\Rightarrow$ Saturates A/D, amplifiers,... Hardware

• Want to receive small signal $\Rightarrow$ anything above noise floor

$$\Rightarrow -90 dBm \text{ (WiFi) noise floor}$$
$$\Rightarrow -110 dB \text{ cancellation}$$

*Assume +20dBm Pout

Solution 1 : Put circulator

Antenna

TX ◯ RX $-20dB$

Solution 2 : Nulling

h_1 h_2

TX1 ←— d —→ RX ←— $d + \lambda/2$ —→ TX 2.

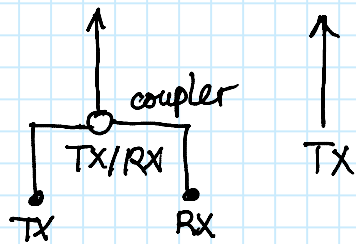$$e^{j2\pi \frac{d}{\lambda}} \qquad e^{j2\pi(d+\frac{1}{2})/\lambda} = -e^{j2\pi d\lambda}$$
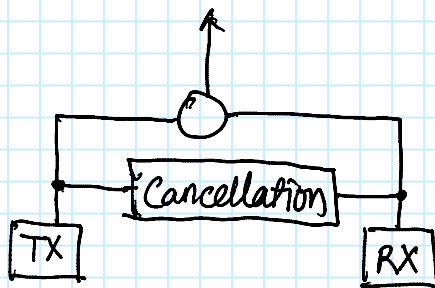
- Placement problem: accuracy

— Nulling could be done easier

— Nulling in other places

— Narrowband .

— Multipath

— 3 antenna MIMO — 3X vs. this design < 2X

Solution 3:

— Nulling done at hardware

software radio.

Solution 4:

— Non-linearity

$$x = e^{j2\pi f_c t}$$

$$y = ax$$

$$y = a_1 x + a_2 x^2 + a_3 x^3 + \dots$$

— Multipath

* Need hardware

Solution 5: Extend to MIMO.

— Crosstalk

— Complexity grows $\propto N^2$.