SIGCOMM Preview Talk
Session 8: Wireless Low Power and High Data Rates (Thursday 11am)

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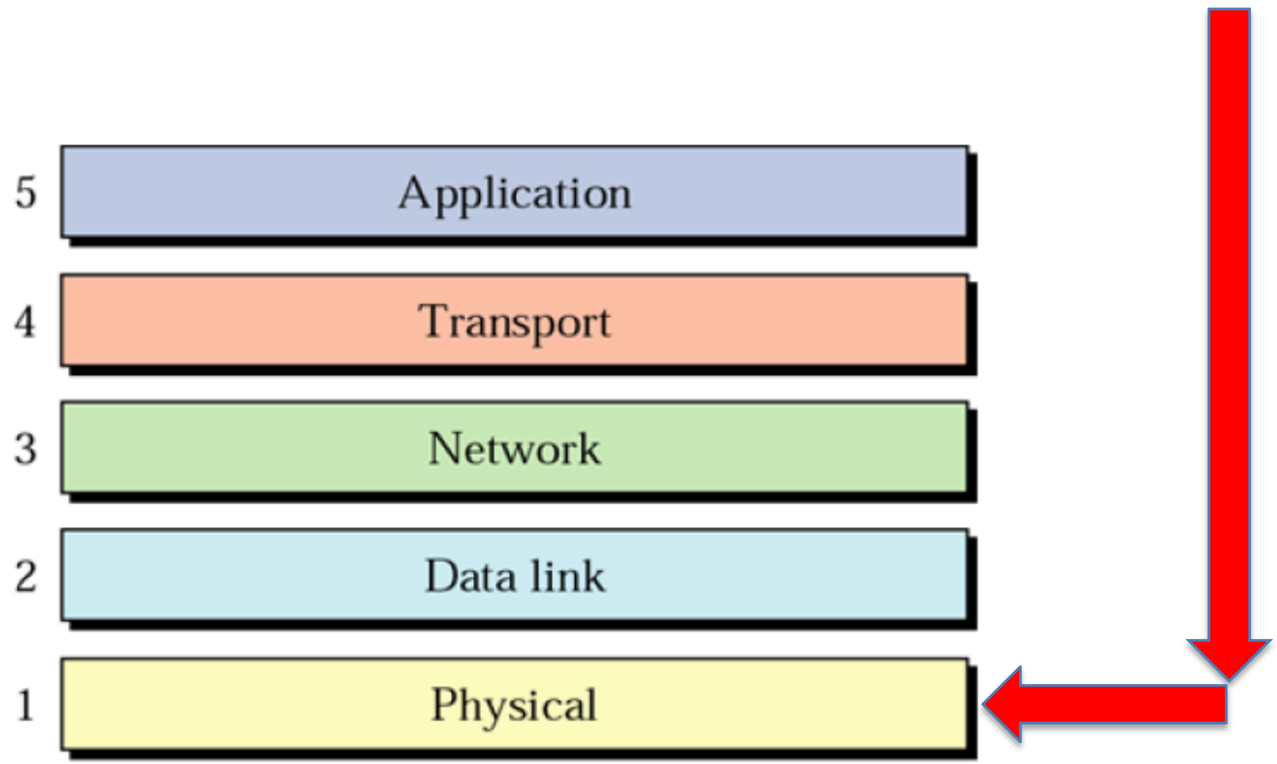
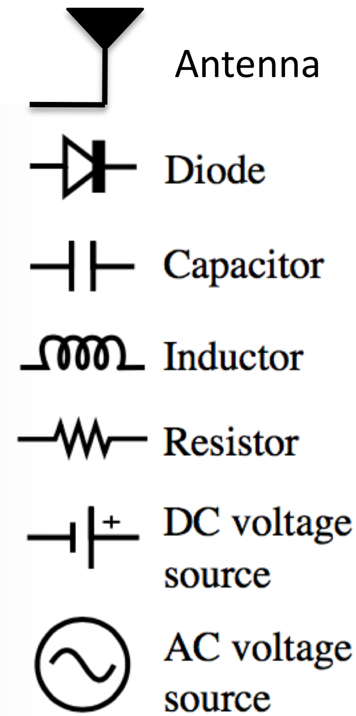
Let’s Go on a Journey…



You are here, and it’s ok! – or -
How I learned to stop worrying about congestion control and love the PHY layer (and you can too).

Who This Talk is *Not* For

- PHY layer researchers
- Recent EE graduates
- People who doodle with these: (and by “doodle” I mean draw pictures (by hand))
- If I say something incorrect, please tell me offline.



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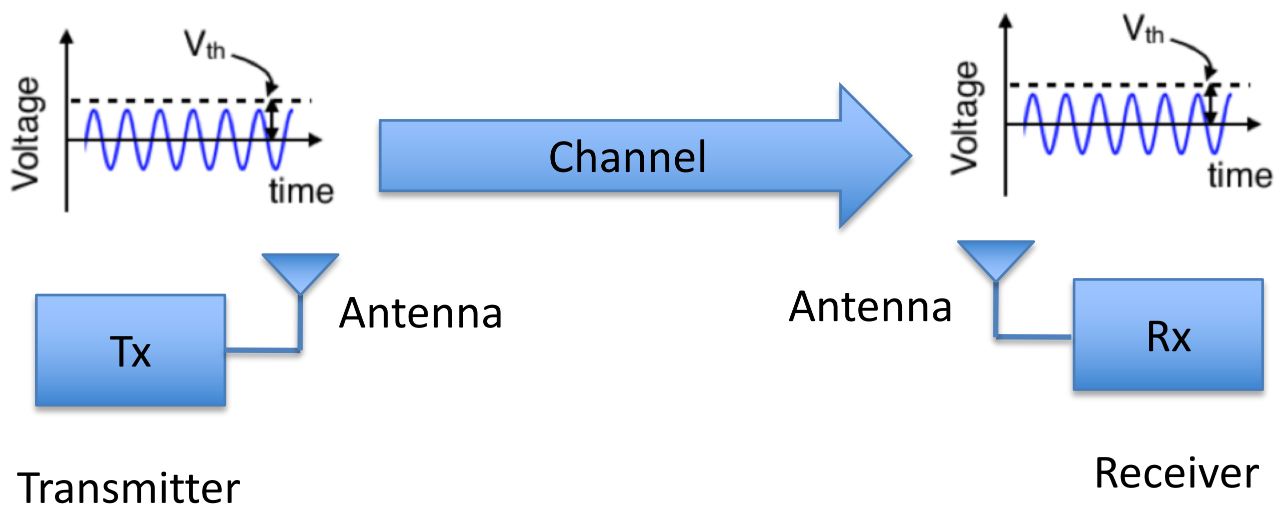
In the Beginning

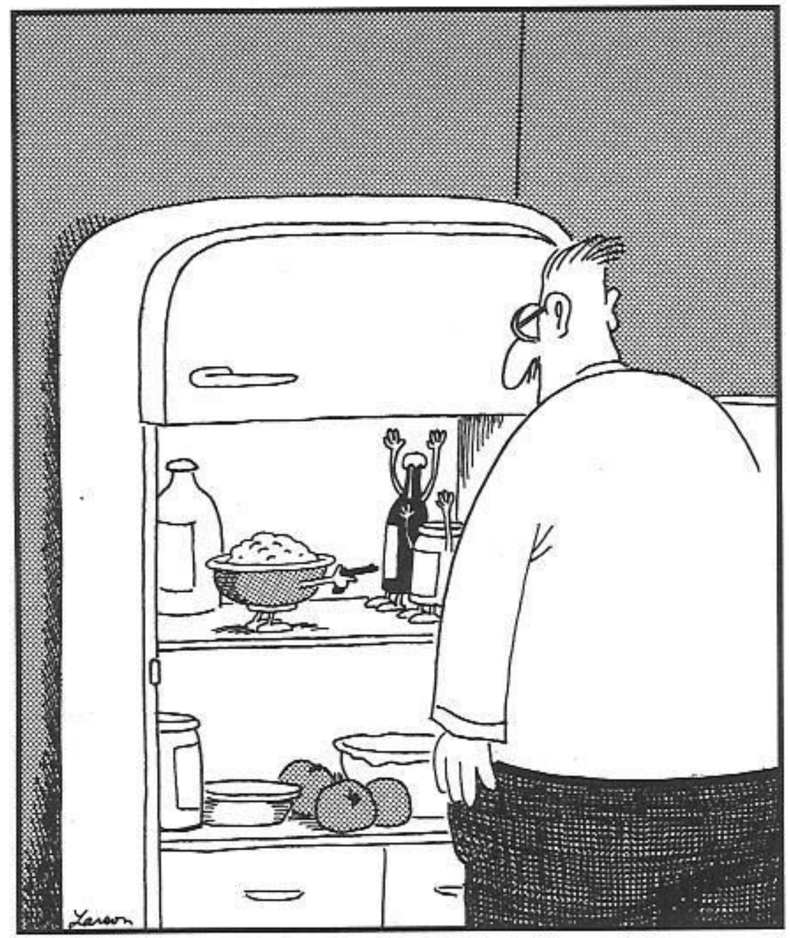
Wireless Physical Layer 101

- Transmitter, Receiver, Antennas
- Channel
- Signal: frequency, amplitude
- Ideal: signal in = signal out



When Channels Go Bad

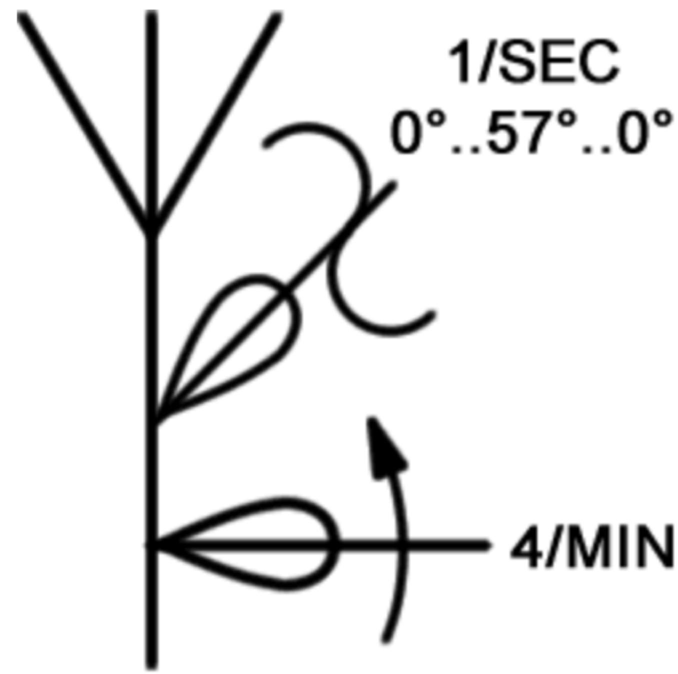
- Attenuation
  - Amplitude in != amplitude out
- Frequency distortion
  - Frequency in != frequency out



When potato salad goes bad

Antennas

- An antenna converts electric current in metal conductors to radio waves in space, and vice versa. Antenna's have reciprocity.
- A directional antenna concentrates power in one direction

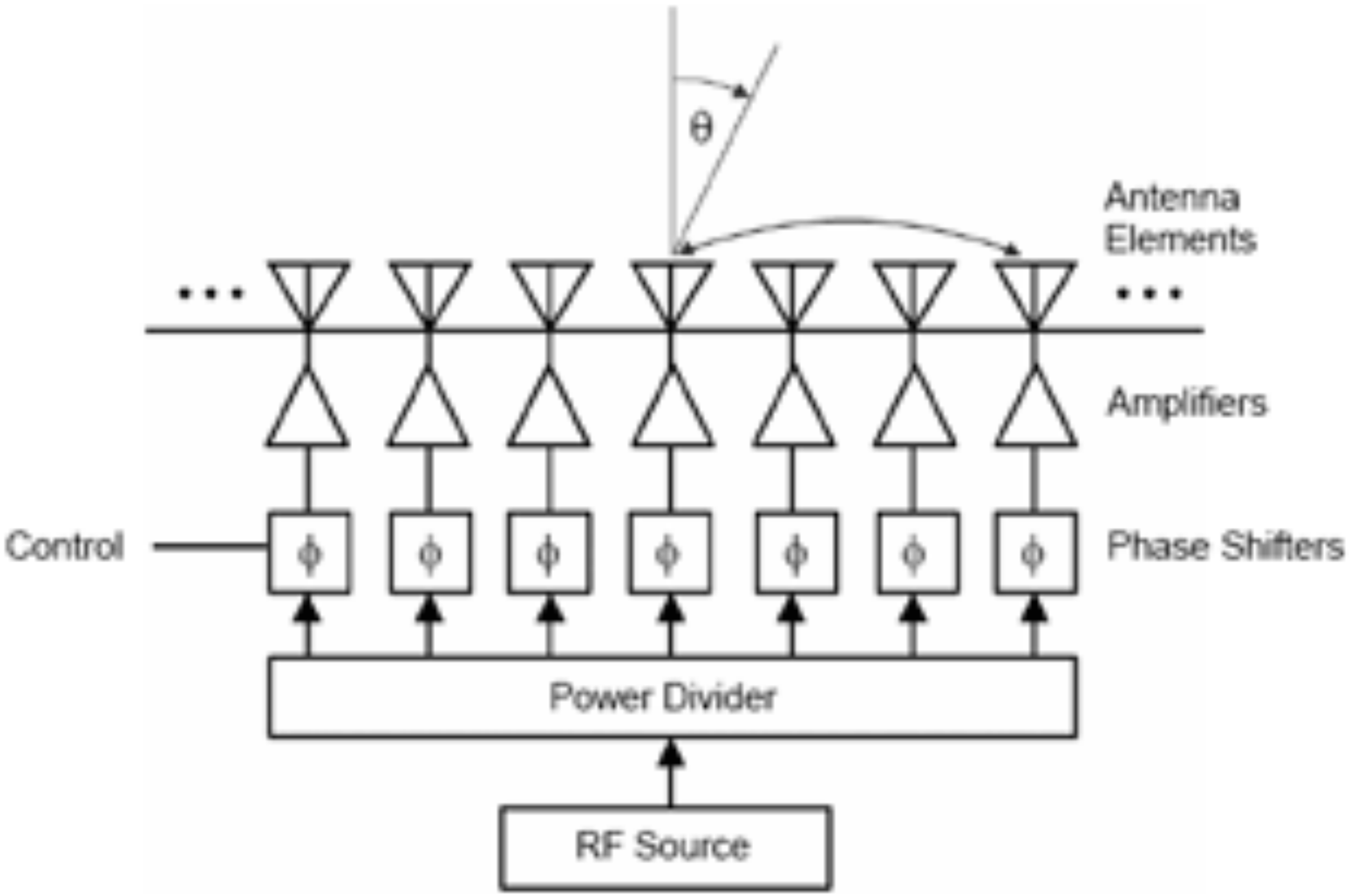


- "Two antennas met on a roof, fell in love, and got married. The wedding wasn't great, but the reception was excellent."

Beam Forming

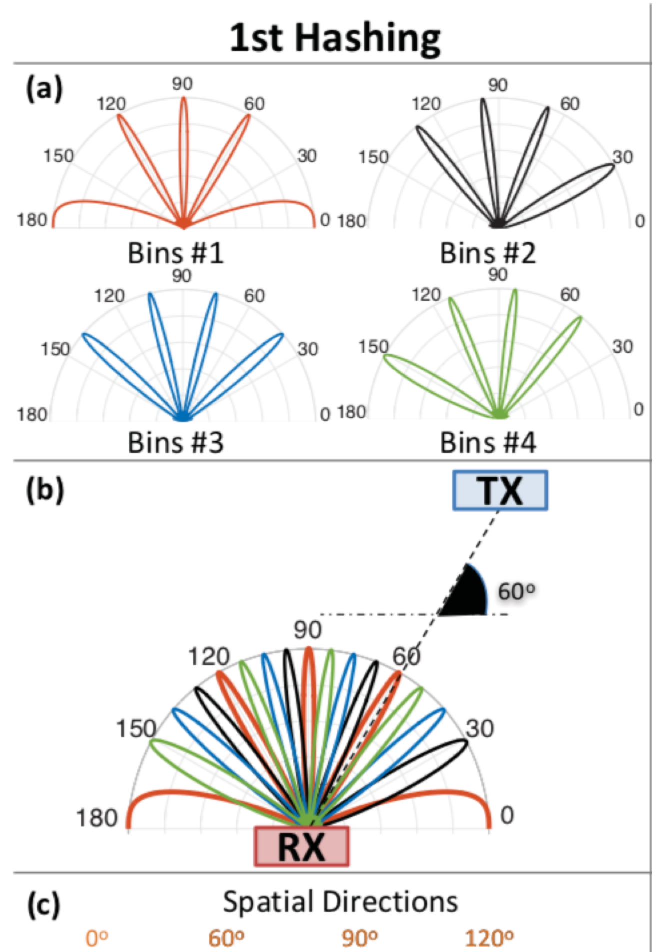
- Idea: Use *multiple* antennas, focus their energy for *constructive interference* at receiver, increasing energy received (a sort of bombardment approach)
- The antennas can be co-located and controlled tightly (e.g., phased array)
- The antennas can be non-co-located yet controlled at a distance (e.g., massive MIMO)

Phased Arrays



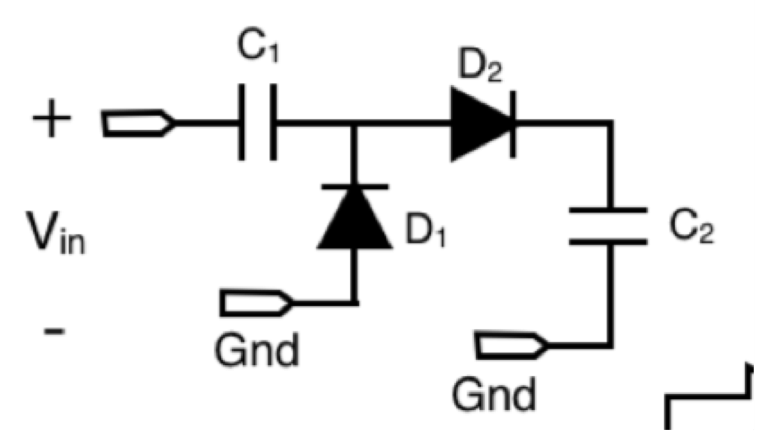
Paper #2: Fast Millimeter Wave Beam Alignment

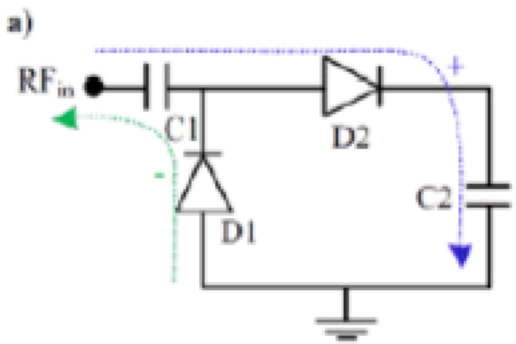
- mmWave frequencies offer more bandwidth
- But…rapid attenuation with distance
- Need phased arrays with narrow beam
- Must align transmitter and receiver's beams (quickly) which is *hard*



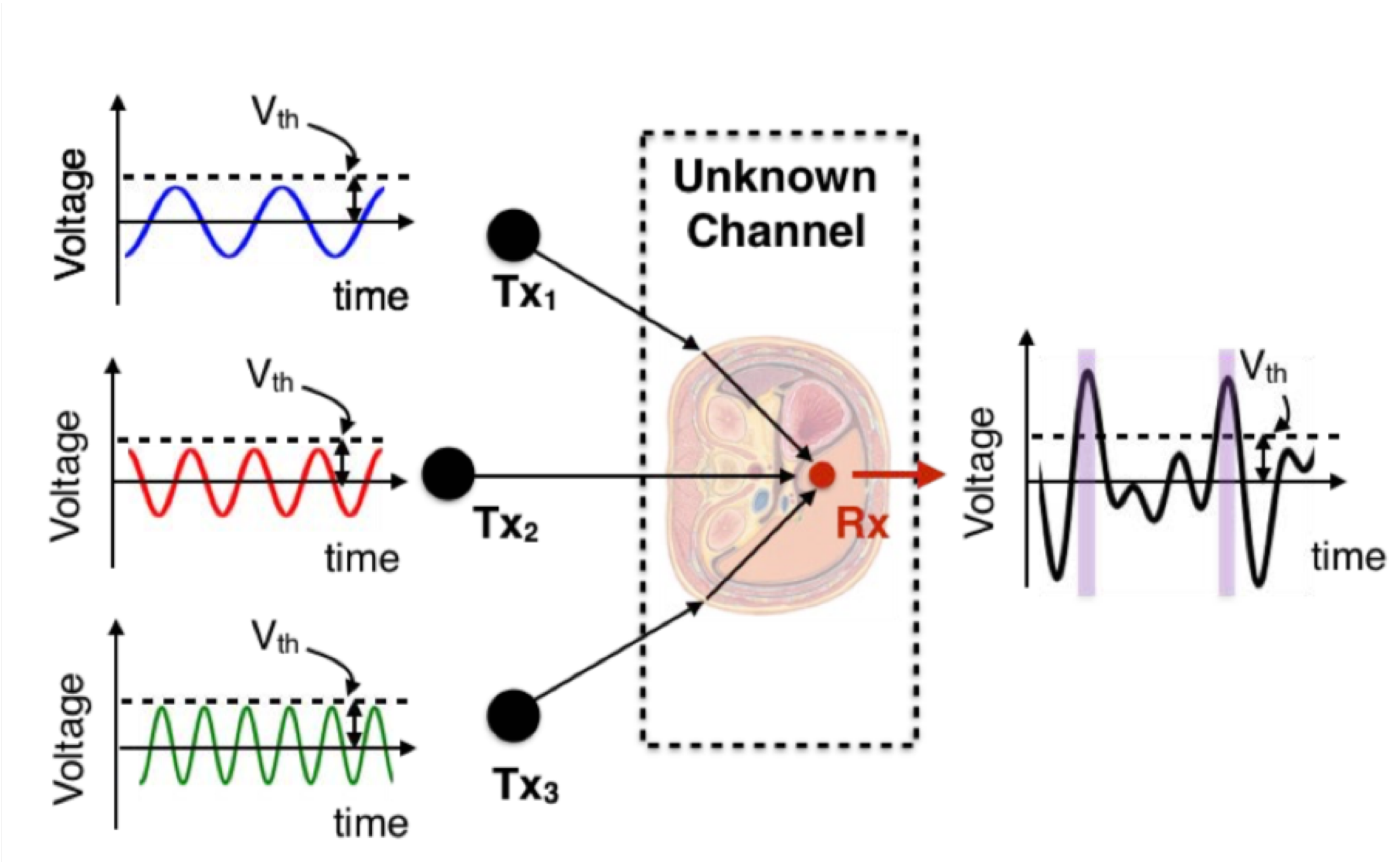
Paper #1: Enabling Deep-Tissue Networking

- Power (and communicate with) a battery-free sensor in a human body
- Energy harvesting!
- But…exponential attenuation through tissue
- And no feedback from sensor



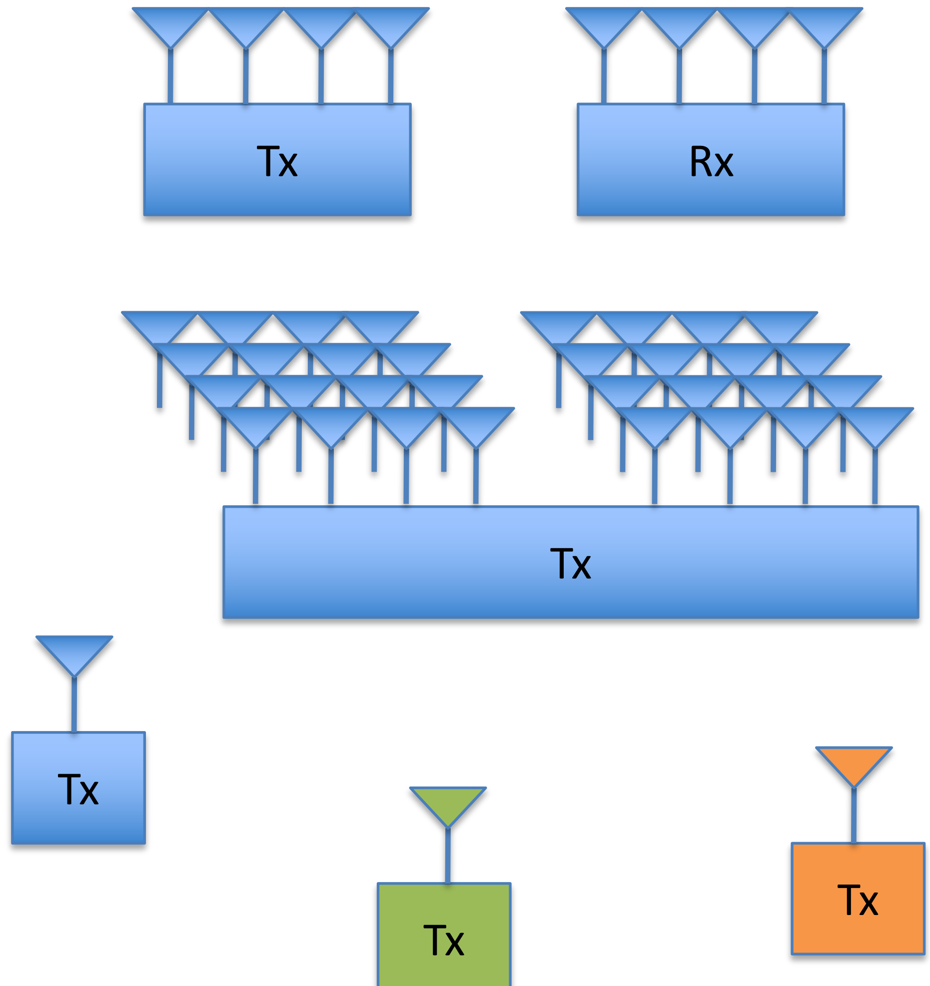


Another Form of Beam Forming



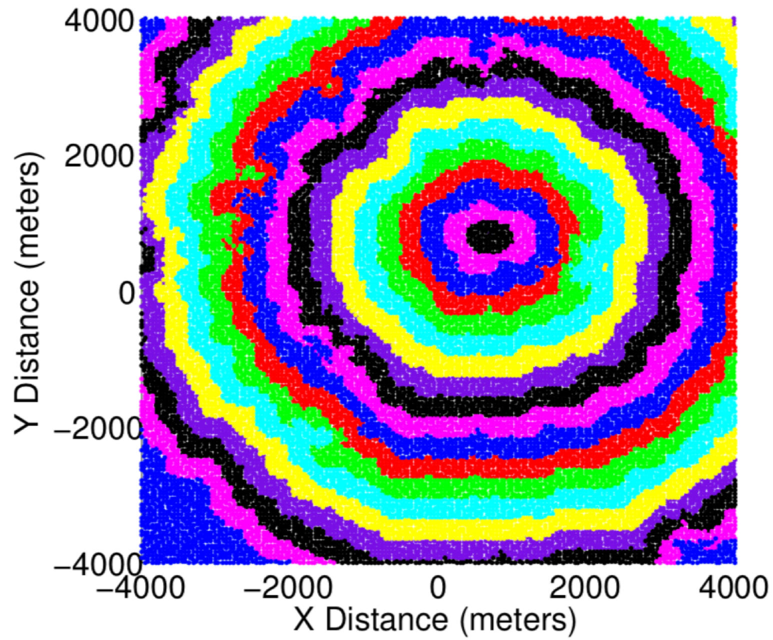
More Antennas (MIMO)

- Multiple Input Multiple Output
- Traditional MIMO: small number of antennas
- Massive MIMO: 100s of antennas
- Distributed MIMO: antennas *not co-located*



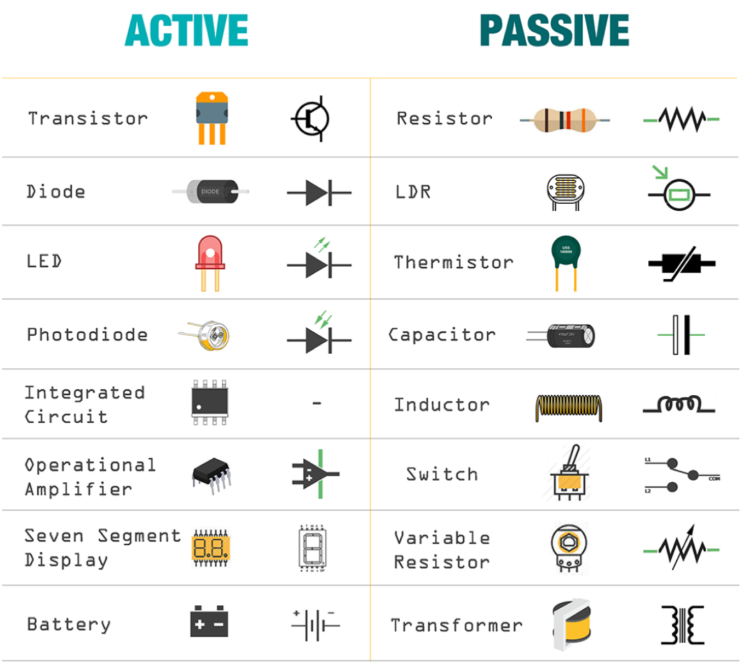
Paper #4: Chorus: Truly Distributed Distributed-MIMO

- Synchronize the oscillators to a common reference phase so they act like M-MIMO
- Traditionally: single leader that all nodes can hear
- Limitations: scale, resilience management
- Chorus: no leader; synchronize by listening to sync signals from other nodes in area

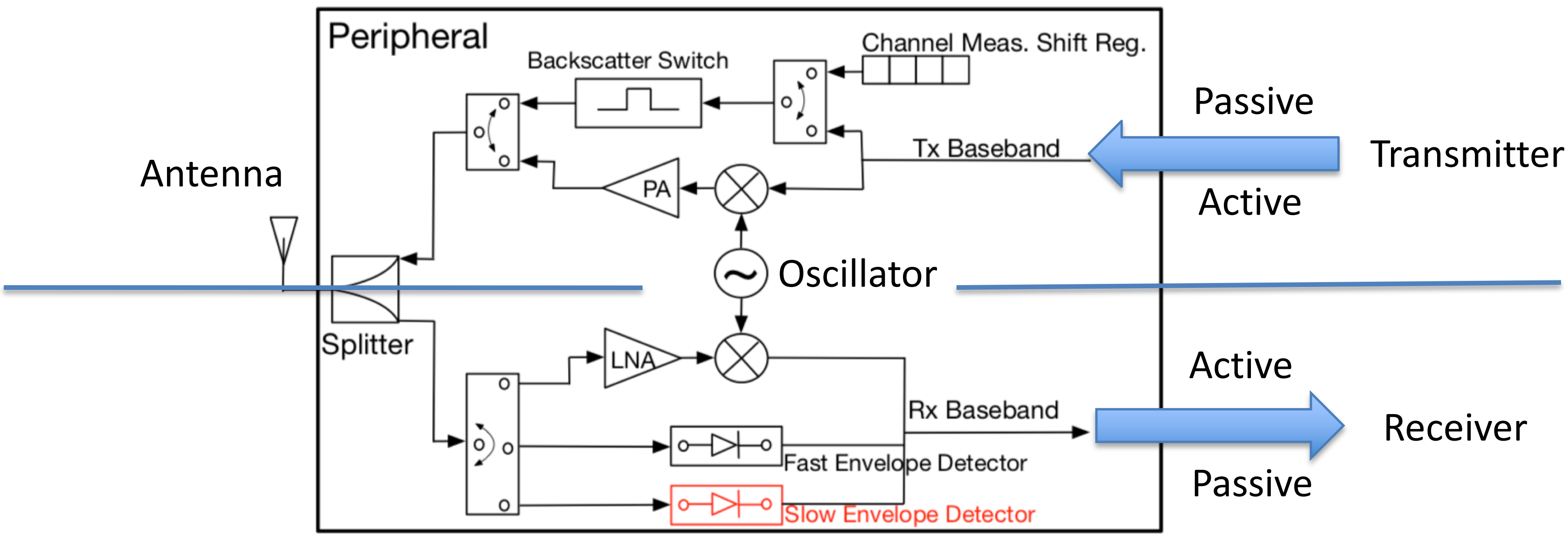


Paper #3: Polymorphic Radios

- Achieve low-power radio, without duty cycling
- Leverage channel dynamics to transmit at low power (passively) when possible and at high power (actively) when necessary
- Switch between these, without application impact



Peripheral (cell phone, IoT sensor)



Thank you

- To all authors for high quality writing
- To Justine Sherry for advice on these types of talks (“don’t pre-fetch the talk”)
- To all who listened and took something away, be it a laugh or a slightly new understanding