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.
In the Beginning

IF YOU NEED TO CONTACT ME, YOU CAN REACH ME ON MY CELL...
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