

# Overview of Wireless Communications @ NYU-Poly

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# Motivation

- Wireless channels
  - Bandwidth and power limited
  - Multi-user interference
  - Unreliable due to signal fading
  - Vulnerable to attacks
- Multimedia applications
  - High data rates
  - Error sensitive, delay intolerant
- We need
  - Higher transmission rates, reliability and security at the physical layer as well as at higher layers
  - End-to-end performance metrics
  - Cross-layer optimization

# Motivation



# Wireless Research @ NYU-Poly

- Strong wireless group
  - Frank Cassara
  - Elza Erkip
  - David Goodman
  - Mike Knox
  - I-Tai Lu
  - Shiv Panwar
  - Peter Voltz
- Emphasis on the physical layer, MAC and networking layers as well as cross-layer design
- Wireless applications
  - Yao Wang
- Theory, simulations, experimentation
- Research centers WICAT and CATT, support from NSF
  - Close relation with industry and government

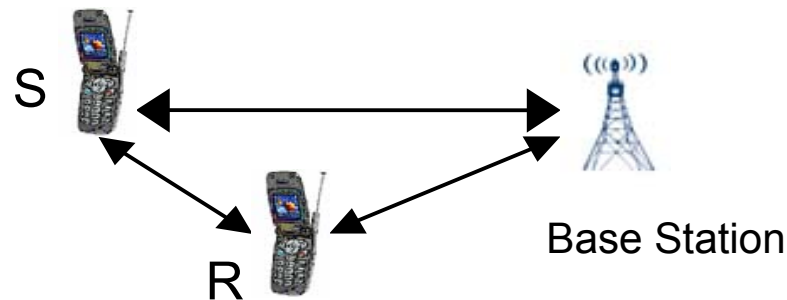
# Wireless Research @ NYU-Poly

- Example projects on wireless
  - Multi-input multi-output (MIMO) systems
  - Broadband systems: OFDM, SC-FDMA
  - Cooperative communications
  - Power efficient communications
  - Wireless multimedia
  - Implementation using software defined radios and open source drivers
- Technology
  - 4G wireless (WiMAX, LTE)
  - WiFi
  - And beyond...

# Cooperative Communications

- Wireless devices helping each other to communicate with other devices or fixed infrastructure
- Cooperation provides a good solution to many of the problems arising in wireless systems

# Cooperative Communications



- Wireless antennas omnidirectional
- Relay/ partner “overhears” source-destination communication, processes and re-transmits
- Destination processes signals from both nodes
- Inter-user channel is noisy but
  - Virtual antenna array → Spatial diversity → Higher reliability
  - Higher data rates

# Cooperative Networking

- Benefits
  - Robustness to fading
  - Opportunistic use of network energy and bandwidth
  - Higher data rates, fewer retransmissions so less network delay
  - Higher signal quality
  - Lower total transmitted energy which reduces interference and extends the battery life
  - Extended coverage
- Applications
  - Cellular
  - WiFi
  - Enterprise networking
  - Vehicular ad-hoc networks
  - Tactical networks
- Currently a “hot” area both in academia and in industry

# Poly's Accomplishments

- Poly has pioneered research in cooperative communications
- IEEE Comsoc paper award, cited extensively, top 10 downloaded TCOM article in IEEE Xplore
  - A. Sendonaris, E. Erkip and B. Aazhang. User cooperation diversity- Part I and Part II, *IEEE TCOM* 2003
- One of the first papers on cooperative MAC, and PHY+ MAC
  - Top 100 downloaded article in IEEE Xplore
    - P. Liu, Z. Tao, Z. Lin, E. Erkip and S. Panwar. Cooperative wireless communications: A cross-layer approach, *IEEE Wireless Magazine*, 2006.
- IEEE ICC Communication Theory Best Paper
  - M. Yuksel and E. Erkip. Diversity-multiplexing tradeoff in half-duplex relay systems.
- One of the first groups to implement a cooperative networking testbed

# Our Team

- Multiple Poly faculty and students working on different aspects
  - Erkip (**PHY**, MAC, Video, Security, Implementation)
  - Knox (PHY, **Implementation**)
  - Memon (**Security**)
  - Liu (**MAC**, Video, **Implementation**)
  - Panwar (PHY, **MAC**, Video, Security, Implementation)
  - Wang (PHY, MAC, **Video**, Implementation)
- Collaboration with industry
- Funded by NSF, WICAT, CATT, Poly Angel Funds
- For more information: *<http://coop.poly.edu>*

# Wireless Courses @ Poly

- EL 6303 Probability Theory
- EL 5013 Wireless Personal Communication Systems
- EL 5023 Wireless Information Systems Laboratory I
- EL 5023 Wireless Information Systems Laboratory I
- EL 6013 Principles of Digital Communications: Modulation & Coding
- EL 6023 Wireless Communications: Channel modeling and receiver design
- EL 6033 Modern Wireless Communication Techniques and Systems
- EL 6063 Information Theory
- EL 6073 Error Control Coding
- EL 6753 UHF Propagation for Wireless Systems
- EL 7023 Space-Time Wireless Communications
- EL 90X3 Selected Topics Courses in Wireless
  - Recent selected topics: Advances at the Physical Layer (MIMO, cooperative communications etc)