Introduction to Telecommunications
EN1052

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Lecture 8: Future Trends

Main Source of Information

- the content is essentially from the website: *Wireless Future, 5G and Beyond, Research, Popular Science* at `https://www.youtube.com/channel/UCOrjRoYJPqGiR1SZvU3xcYQ`

- more details can be found in the book (freely available): *Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency* by Emil Björnson et al., 2017.

Wireless Mobile Networks

Wireless Mobile Networks

- almost everywhere
- cellular architecture is to be improved in many aspects

Cellular Mobile Networks

Signal Decay with Distance

- signals decay rapidly with distance
- noise is inextricable
- size of the receiver?
- make receiver larger?
- directive transmissions? power is focussed $\rightarrow$ multiple antennas

Massive MIMO

MIMO

- direct the power to users
- signals are to be adjusted with different delays (precoding, MRC and blends)
- fixed beamforming and adaptive beamforming
- adaptive beamforming also known as SDM, multiuser MIMO
- today $\rightarrow$ massive MIMO

Cell-Free Massive MIMO

Cell-Free Massive MIMO

- Can Massive MIMO Solve Everything? distribution of signal strength is a problem, good for voice, not for data
- cell-free massive MIMO?
- old proposals:
  - distributing antennas geographically with necessary interconnections
  - distributed MIMO, coordinated multipoint transmission
  - challenging: laying cables underground, central controlling and computations

Cell-Free Massive MIMO

- cell-free massive MIMO?
- new proposals:
  - no dedicated cable to each antenna
  - serial fronthaul, e.g., radio strips

Radio Stripes

Radio Stripes

- install antenna elements along the line itself
- the cable itself in a part of the network architecture

Intelligent Reflecting Surfaces

Intelligent Reflecting Surfaces (IRS)

- also known as software-controlled metasurfaces
- also known as reconfigurable intelligent surfaces
- scatter the incoming wave with controllable delay/phase polarization

  item they are configured to enable

  - constructive combining of signals (at the intended Rx)
  - destructive combining of signals (at other Rx)

mmWave Communication

mmWave Bands

- low band frequencies are still there to be used
  - up to 1 GHz
  - enable wide area coverage
- mid band frequencies
  - 1 GHz up to 6 GHz
  - antennas are smaller $\rightarrow$ enable large arrays of antennas
- 30 to 300 GHz to upward (1 to 10 mm)
  - short coverage
  - a lot of BW available