Advanced Networks and 5G Deployment

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1980s 1G
- Analog
- Voice

1990s 2G
- Digital voice
- Greater voice capacity

2000s 3G
- Mobile Internet broadband
- Smartphones

2010s 4G
- LTE
- IP core
- Video and broadband data

2020s 5G
- Massive broadband
- Ultra HA
- Ultra low latency
- Network slicing
Background

• CNBC explains 5G

• What is necessary for 5G?
  • Spectrum with significant bandwidth
  • Extensive fiber backhaul
  • New devices for 5G
  • Tens of billions of dollars of capital investment
Background - Spectrum

- 5G uses different spectrum than 4G
  - 4G networks use frequencies below 6 GHz
  - 5G uses extremely high frequencies (EHF) in the 30 GHz to 300 GHz range
  - high frequencies (millimeter wave) support a huge capacity for fast data
  - highly directional and can be used right next to other wireless signals without causing interference
  - 5G uses shorter wavelengths; antennas can be much smaller than existing antennas but many more antennas are required
  - 5G can support over 1,000 more devices per meter than what’s supported by 4G
  - most of these super-high frequencies work only if there’s a clear, direct line-of-sight
  - high frequencies are easily absorbed by humidity, rain, and other objects, meaning that they don’t travel as far.
Background – Fiber Backhaul

• 5G networks requires extensive backhaul networks with minimal latency (delay)

• Today that backhaul requirement generally means fiber optic cable complemented with some microwave.
5G Network Deployment in the United States

• AT&T

• T-Mobile / Sprint

• Verizon

• New entrants?
5G Network Deployment in the United States

• Where will 5G be deployed first?

• How fast will 5G be deployed outside of the largest metropolitan areas?

• Impact of NIMBY?

• Availability of capital
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Open issues

• Availability and cost of 5G service and devices
• Consumers willingness and ability to pay
• Anchor applications (smart cities; autonomous vehicles; energy grid; health care; public safety)
• Health concerns
• Privacy concerns
• FCC policy – court challenges; administration change in 2021
• Ability to deploy – could 5G be the next high speed rail?
• Externalities