Advanced Networks and 5G Deployment
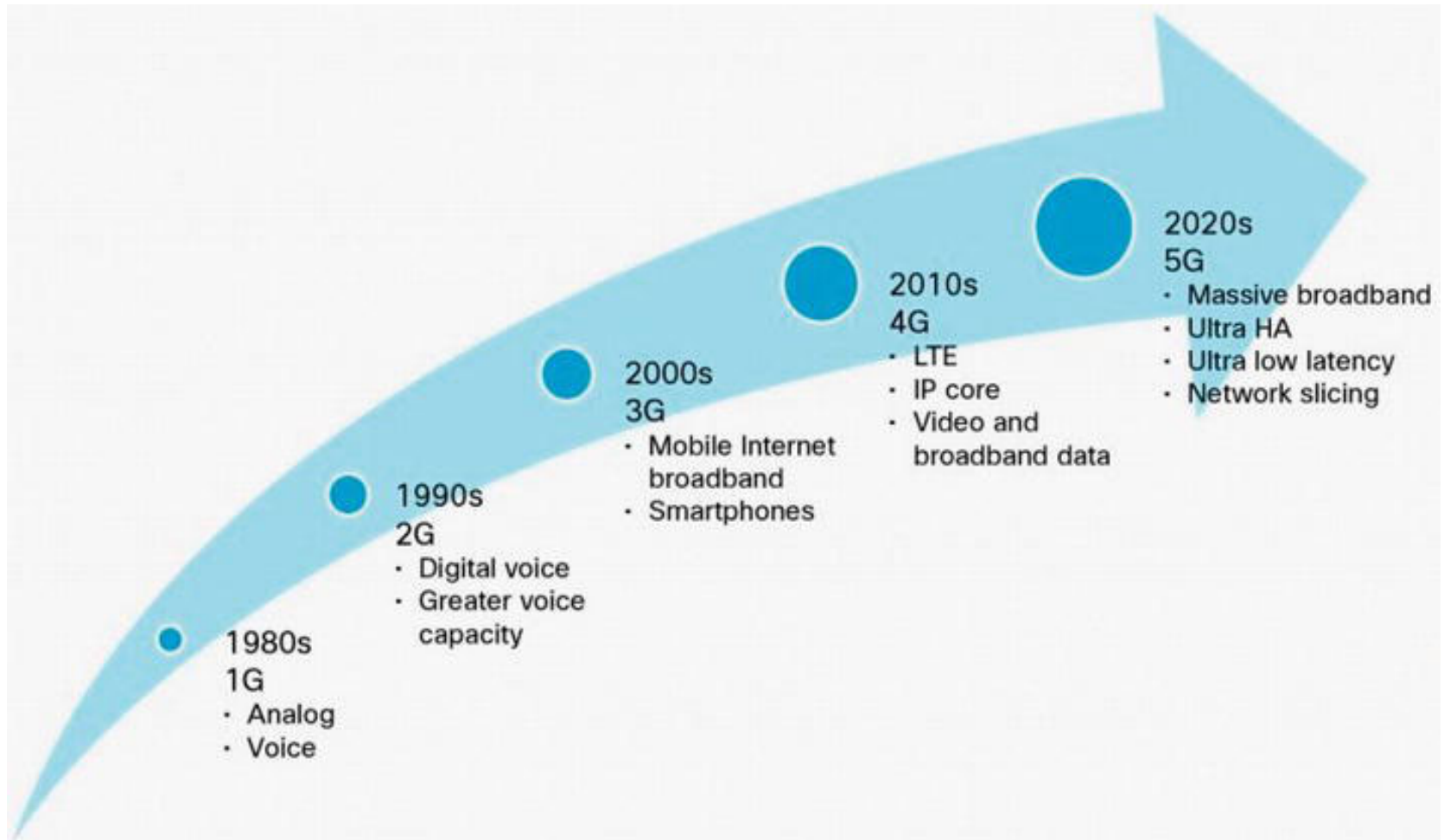
California Emerging Technology Fund

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

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

2000s
3G
· Mobile Internet
broadband
· Smartphones

1990s
2G
· Digital voice
· Greater voice
capacity

1980s
1G
· Analog
· Voice

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

Advanced Networks and 5G Deployment
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