5G - General

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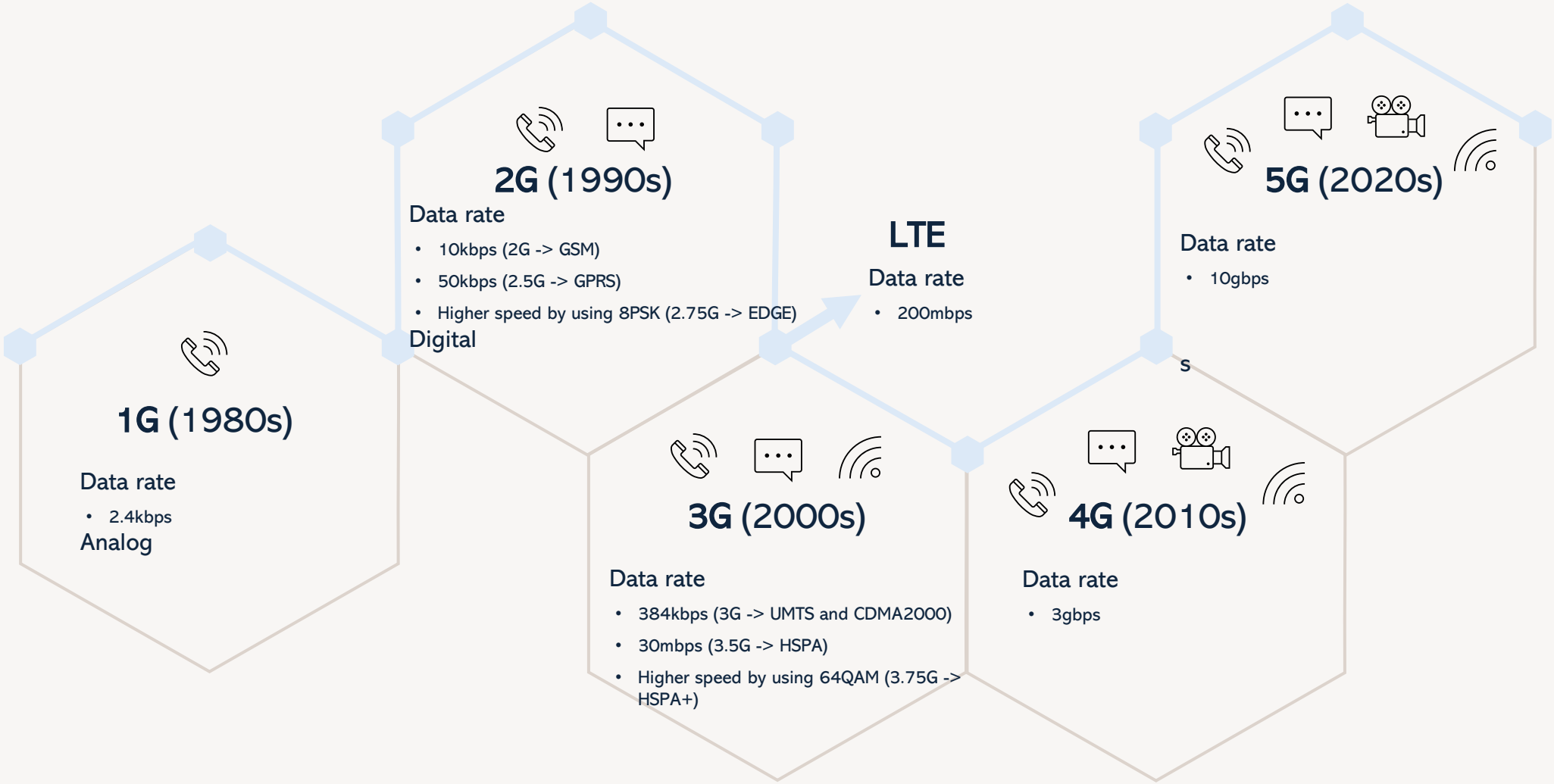
Introduction



How does 5G Work?

- 5G uses cell towers connected wirelessly or via wired connections to networks transmitting data via radio waves.
- Works by modifying the way data is encoded, considerably increasing the number of radio waves usable for operators.
- To achieve the high speeds, 5G incorporates a new band of radio spectrum from 4G, broadcasting between 30 and 300 GHz.

This frequency range is then divided into three subcategories:

Sub-6GHz (Low Band)

- Uses existing 3G/4G frequencies for wider coverage but has limited speed gains over 4G.

Sub-6GHz (Midband/C-band)

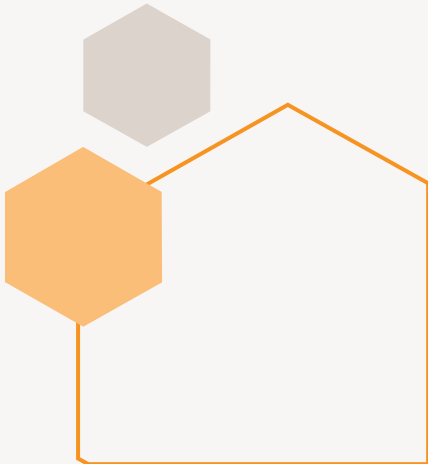
- Frequencies between 2.5 GHz and 4.7 GHz offer a balance of range and speed, delivering near-gigabit performance levels.

mmWave

- Broadcasts between 30 GHz and 300 GHz, providing high-speed performance but limited coverage without numerous small network cells.

Advancements Compared to 4G

- 5G has better **speed**, **coverage**, lower **latency**, bigger **bandwidth** than 4G.
- **Techniques Driving Advancements:**
  - Massive MIMO (Multiple-Input Multiple-Output)
    - Utilizes numerous antennas for simultaneous user connections.
    - Enhances capacity and spectral efficiency.
  - Beamforming
    - Increases the effectiveness of the transmission by directing wireless signals toward specific users.
    - Reduces interference and improves transmission effectiveness.
- **Security Enhancements:**
  - 5G encrypts user identification and position data.
- **Network Slicing:**
  - Gives isolation and protection to sensitive data.



Possible and Potential Applications

Enhanced Mobile Broadband (eMBB)

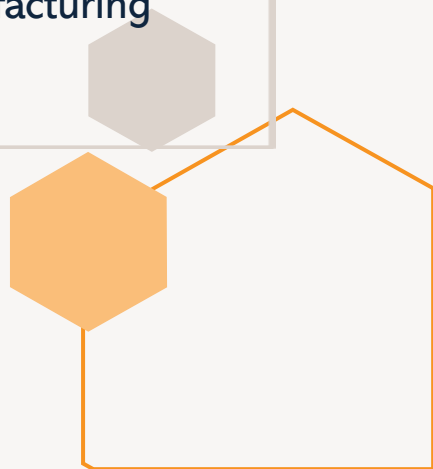
- Faster data rates and increased bandwidth
- Enables high-resolution multimedia streaming, fast downloads, and smooth online gaming experiences
- Facilitates innovative services like virtual reality (VR) and augmented reality (AR)

Ultra-Reliable and Low Latency Communications (URLLC)

- Ultra-fast real-time responsiveness and high reliability
- Beneficial for applications such as assisted driving, remote medical services, and industrial automation
- Focuses on high mobility and moderate data rates

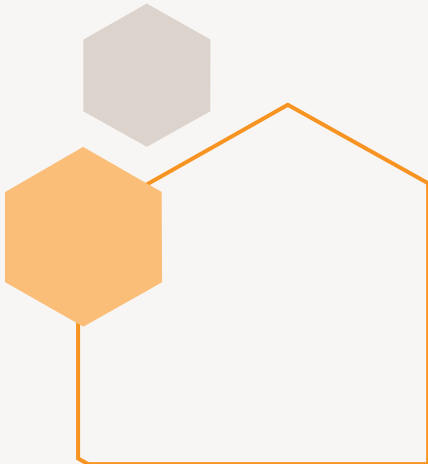
Massive Machine Type Communications (mMTC)

- Supports many IoT devices
- Enables communication of moderate data amounts over long periods
- Impacts sectors like smart cities, healthcare, and manufacturing



Challenges of 5G

- **Spectrum Availability**
  - Issue: Finite and saturated frequency spectrum
  - Solution: Utilization of higher, currently unsaturated frequencies alongside traditional bands (300 MHz to 3 GHz)
- **Security**
  - Concern: Mitigating eavesdropping and ensuring customer security and privacy
  - Challenge: Implementing robust security measures across 5G networks
- **Access Mode**
  - Deployment Modes: StandAlone (SA) and Not-StandAlone (NSA)
  - Considerations:
    - Varying capacities, features, and costs
    - Operators choose deployment mode based on specific scenarios and needs.
- **Device-to-Device Communication**
  - Feature: Direct communication between devices with minimal network involvement
  - Challenges:
    - Security concerns due to reduced network oversight
    - Pricing considerations for operators due to decentralized communication



Conclusion

- Mobile communications technology has evolved and will continue to do so in the foreseeable future. 5G represents a big evolution in mobile communications technology, enabling more use cases, higher data rates, higher efficiency, and a better perceived quality of service.
- In this presentation, we went over some of the improvements of 5G in comparison to previous iterations, how it works, exploring its advancements, some of its new features, and design and implementation challenges.