Overview of 5G Technology

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Agenda

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- Radio Access Network
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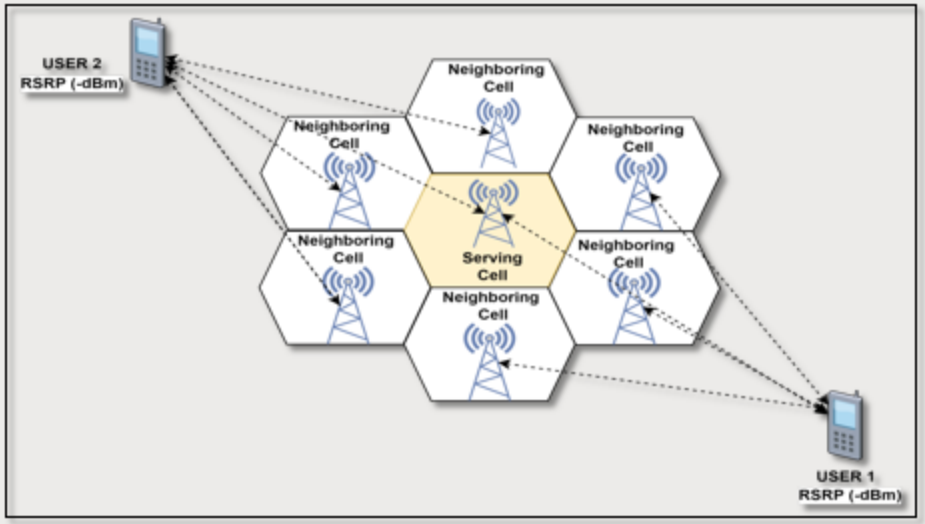
Introduction

- To provide communication for the portable/movable devices wireless cellular communication is introduced.
- Cellular Network Basics
  - Cells, Frequency Bands, Mobile Devices
- Key Network Components
  - Base Stations, Core Network, SIM cards
- Generations of Cellular Technology
- Mobile Communication Services
  - Voice Calls, Short Message Service (SMS), Mobile Data Service.

5G (Fifth Generation) is a wireless mobile communication technology.

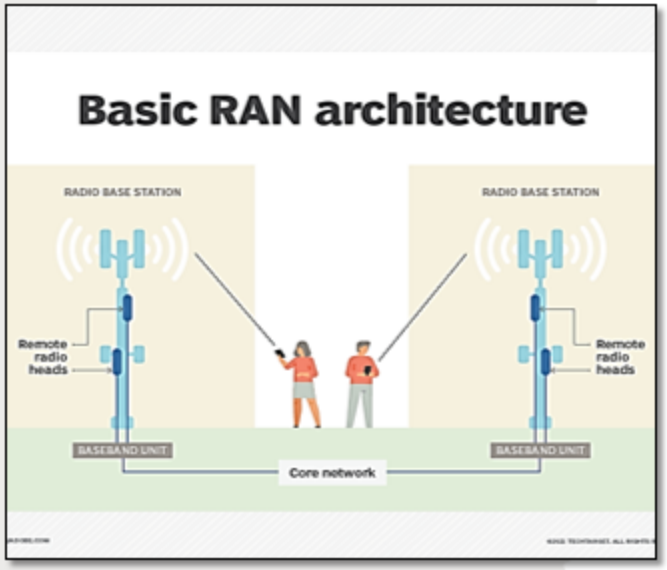
Basic Cellular Concepts



Cell Towers on a Geographical Area

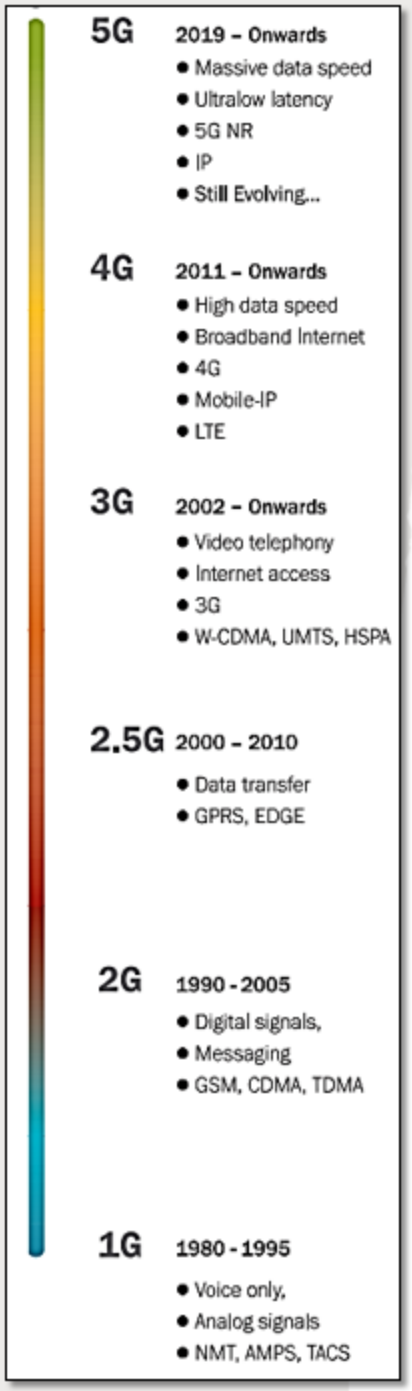
Radio Access Network

- A **Radio Access Network ("RAN")** connects wireless devices to other parts of the network through radio waves.
- A RAN comprises of a
  - Base station
  - Antenna
  - Remote Radio Units
  - Baseband Units
  - Distributed and Centralized Architectures
  - Small Cells
  - RAN Controllers
  - Fronthaul and Backhaul Networks

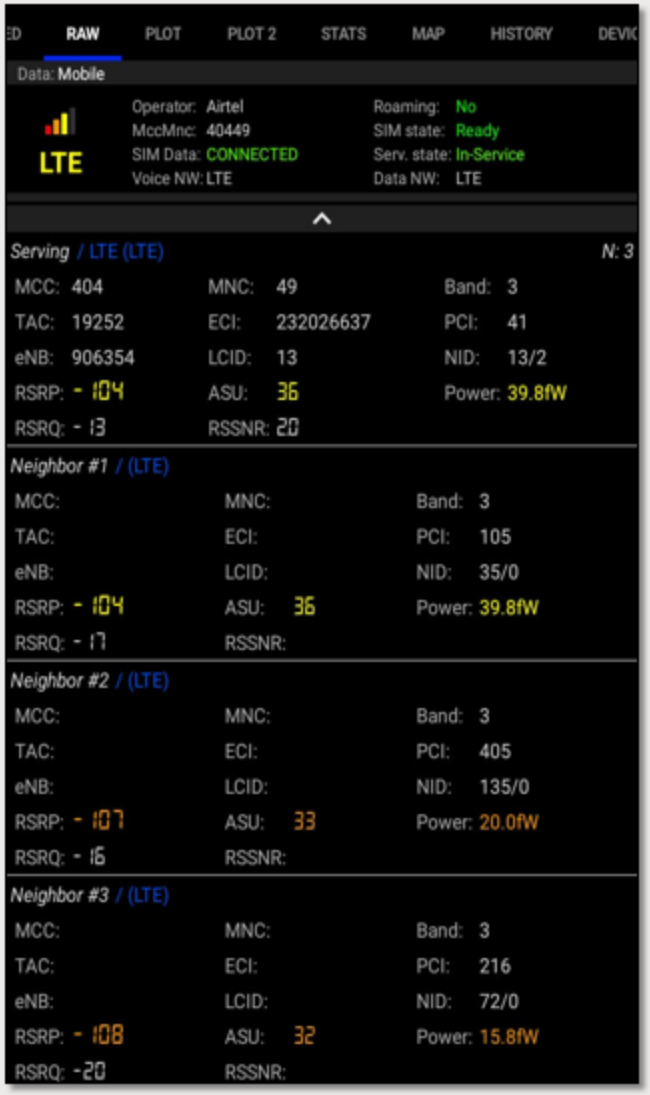


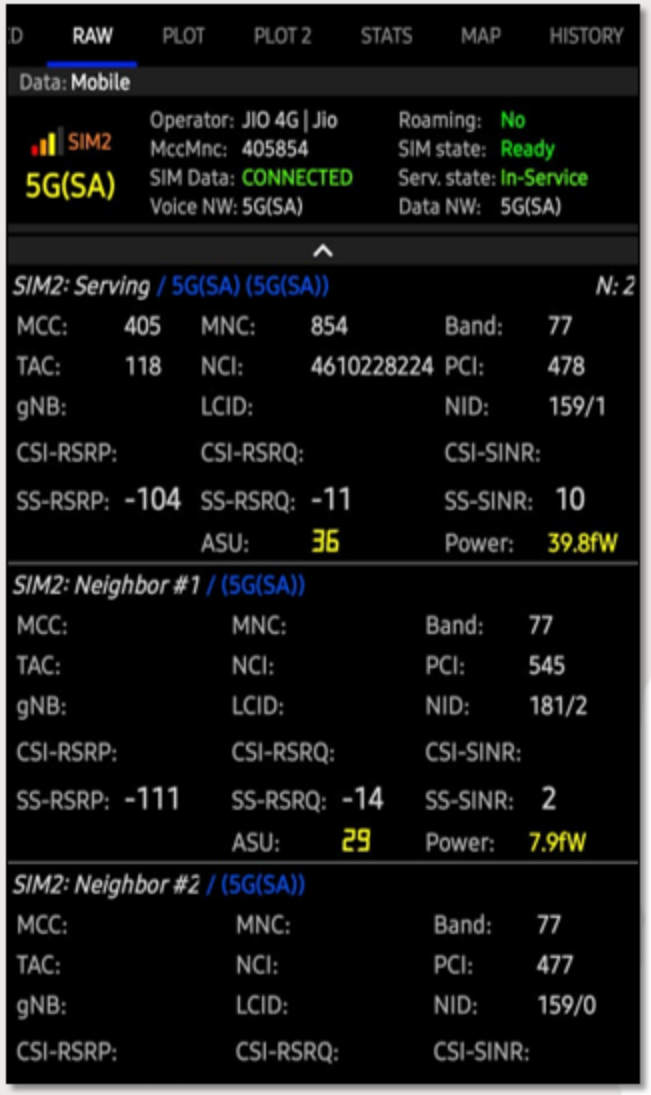
Evolution Mobile Communication Technologies

V · T · E	Cellular network **standards**	[hide]
	List of mobile phone generations	
0G radio telephones (1946)		MTS · IMTS · Altai · OLT · MTA · MTB · MTC · MTD · AMTS · Autotel (PALM) · ARP · B-Netz · AMR
1G (1979)	AMPS family	AMPS · N-AMPS · TACS · ETACS
	Other	NMT · C-450 · Hicap · Mobitex · DataTAC · CT1
2G (1991)	GSM/3GPP family	GSM · CSD · HSCSD
	3GPP2 family	cdmaOne (IS-95)
	AMPS family	D-AMPS (IS-54 and IS-136)
	Other	CDPD · iDEN · PDC · PHS · CT2
2G transitional (2.5G, 2.75G, 2.9G)	GSM/3GPP family	GPRS · EDGE/EGPRS · Evolved EDGE
	3GPP2 family	CDMA2000 1X (TIA/EIA/IS-2000) · CDMA2000 1X Advanced
	Other	WiDEN · DECT
3G (1998) IMT-2000 (2001)	3GPP family	UMTS (UTRA-FDD / W-CDMA (FOMA) · UTRA-TDD LCR / TD-SCDMA · UTRA-TDD HCR / TD-CDMA)
	3GPP2 family	CDMA2000 1xEV-DO Release 0 (TIA/IS-856)
3G transitional (3.5G, 3.75G, 3.9G)	3GPP family	HSPA (HSDPA · HSUPA) · HSPA+ (DC-HSDPA) · LTE (E-UTRA)
	3GPP2 family	CDMA2000 1xEV-DO Revision A (TIA/EIA/IS-856-A) · EV-DO Revision B (TIA/EIA/IS-856-B) · EV-DO Revision C
	IEEE family	Mobile WiMAX (IEEE 802.16e) · Flash-OFDM · iBurst (IEEE 802.20) · WiBro
	ETSI family	HiperMAN
4G (2009) IMT Advanced (2013)	3GPP family	LTE Advanced (E-UTRA) · LTE Advanced Pro (4.5G Pro/pre-5G/5G E/4.9G)
	IEEE family	WiMAX (IEEE 802.16m) (WiMax 2.1 (LTE-TDD / TD-LTE) · WiBro)
5G (2018) IMT-2020 (2021)	3GPP family	5G NR · 5G-Advanced · NR-IIoT · LTE-M · NB-IoT
	Other	DECT-5G
Related articles		Cellular networks · Mobile telephony · History · Comparison of standards · Channel access methods (FDMA (OFDMA) · TDMA (STDMA) · SSMA (CDMA) · SDMA) · Spectral efficiency comparison table · Frequency bands (GSM · UMTS · LTE · 5G NR · CDMA) · Mobile broadband · Multimedia Broadcast Multicast Service · NGMN Alliance · Push-to-talk · MIMO · IMS (VoLTE · ViLTE · VoNR · ViNR · Wi-Fi Calling) · Osmocom
		Telecommunication portal · Telephones portal



Mobile Communication Signal Parameters





Legacy Mobile Network Communication

The Signal Strength depends on the multiple factors:

- Antenna Gain and Power
- Geographical Area
- Distance from the cell tower
- Based on capability of the mobile
- Weather Conditions
- Heavy Usage

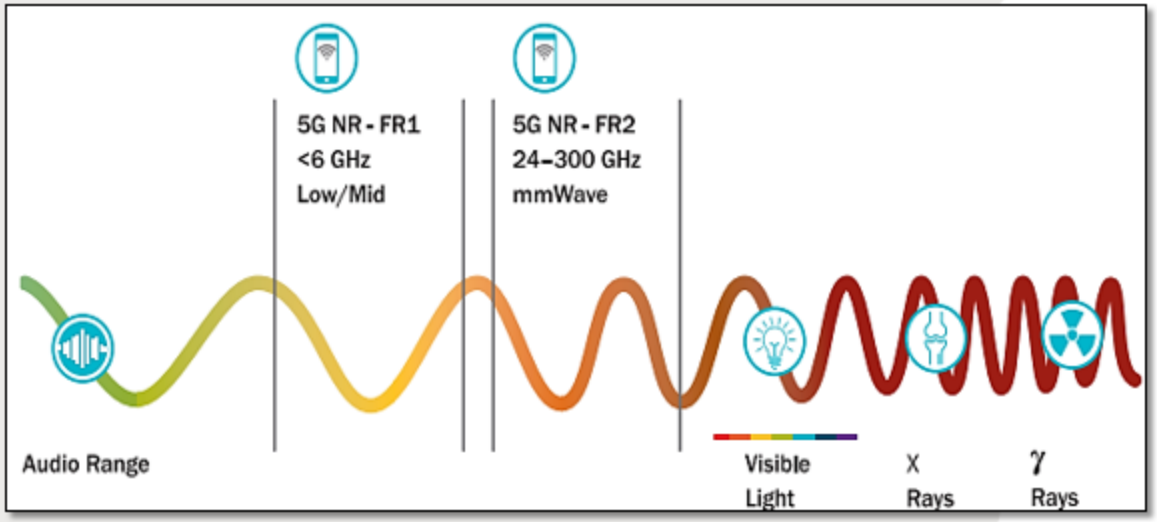
Legacy Network Selection:

- Based on the received signal strength the cell phone decides which network or cell must be chosen.
- **Here the service provider and cell phone modem should support legacy network feature.**
- Based on the geographical area the cell phone decides the legacy network based on the signal parameters.

To Facilitate Seamless Connectivity legacy networks are needed.

5G Communication Classification

- 5G works in three different frequency ranges
  - Low Band, Mid Band, Millimeter Wave (mm Wave)
- Low Band 5G uses the same frequency as 4G
  - Uses below 3GHz
  - Slightly more data speed than 4G
- Mid Band 5G uses frequency up to 6GHz
  - Used by Wi-Fi, to provide downlink speed of 1Gbps
- Millimeter wave uses
  - Frequency range 24GHz and 300 GHz
  - Downlink speed of 2Gbps, which can even go up to 20 Gbps.



5G NR

- The 3GPP, has proposed 5G NR (New Radio) as a new global standard for air interface of 5G Networks.
- **Under 5G NR there are two frequencies ranges:**
  - FR1 < 6 GHz (Range 3.3 – 4.2 Ghz) with max channel bandwidth 100 Mhz
  - FR2 > 24 Ghz (Range 24 Ghz to 300 GHz) with channel bandwidth min 50Mhz and max 400 Mhz.
- ***The low band 5G can be built on the existing 4G infrastructure***.
- **Mid band and mm Wave** require new spectrum auctions, low band 5G fully rolled out in coming years

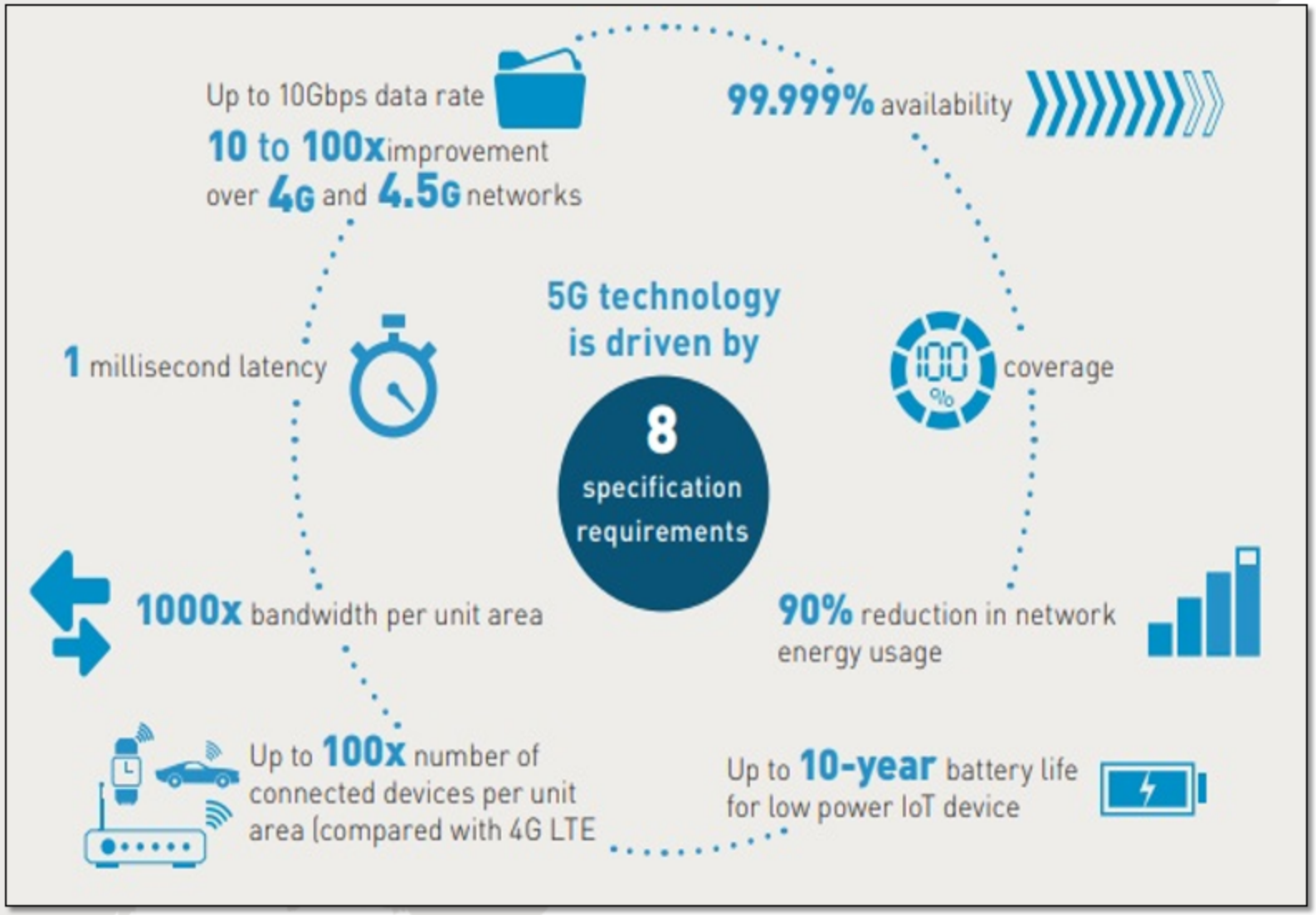
$$\lambda = c/f$$

- More cell towers will be required to build a seamless 5G network.

Technologies used in *5G*

- Millimeter Wave
- Small Cell
- Massive MIMO
- Beam forming
- Full Duplex

5G Specification Requirements



5G Pros and Cons

Pros

- Higher data transfer speeds – more than 10x.
- Ultralow latency for synchronous communication.
- Significantly more device connections in a coverage area.
- Increased bandwidth due to more available frequency channels.
- Convergence of cellular and wi-fi technologies.
- Greater energy efficiency per bits of data transferred.
- Utility for new technologies – e.g. AI, drones, AR/VR.
- More applications – e.g. commercial, entertainment, defense.

Cons

- Massive capital expenditure required for new installations.
- Larger scale of infrastructure deployment due to small cells.
- Greater operational and maintenance costs.
- Limited coverage area due to shorter reach of the signal.
- Susceptible to atmospheric absorption and blocking through material.
- Need new 5G capable devices.
- Interference with more applications in the same frequency.
- New security and privacy issues.

5G Use Cases

- Use cases associated with low latency are:
  - *V2X, V2I, V2V, autonomous, connected cars*
  - *Immersive Virtual Reality Gaming*
  - *Remote surgical operations*

References

- https://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/5G-Technology-in-India.pdf
- https://www.youtube.com/watch?v=GEx_d0SjvS0

Thank You..!!