NyxCell

Training Course

2021

2G/3G/4G/5G Mobile Networks

Provider	4G					3G		2G		
	B20(800)	B8(900)	B3(1800)	B1(2100)	B7(2600)	B8(900)	B1(2100)	B8(900)	B3(1800)	B31(450)
PLUS	?	3526	1300	326	2850	3030	10737 / 10762	3-40	850	
PLAY	6275		1474	523	3350	2938		997		
ORANGE	6200		1749	79	3025	3082	10614	33-124		
T-MOBILE	6350		1599	227	3175	3055	10688	16-36		

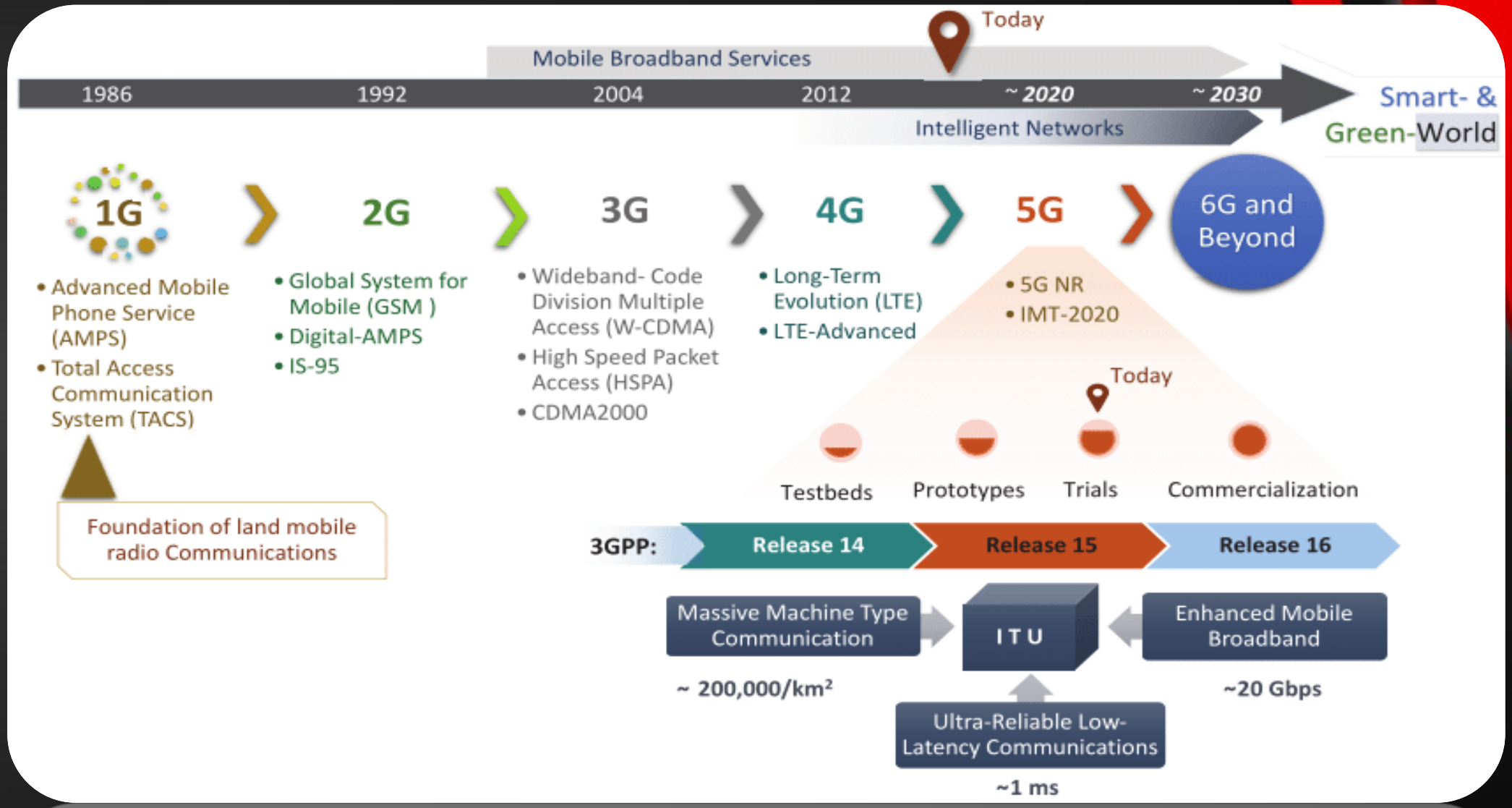
4G TO 5G/NR Network Architecture

- MAIN ADVANTAGES OF 5G NETWORK PHONE MOBILITY
- 5G/NR NON-STANDALONE TO STANDALONE NETWORK ARCHITECTURE
- *5G / NR IMSI-CATCHER CHALLENGES*

Training 2021

GENERAL ASPECTS – NETWORK RADIO INTERFACE

*Network **R**(andom) **A**(ccess) **T**(echnology) Evolution*



4G TO 5G/NR NETWORK ARCHITECTURE

Main Advantages of 5G Network

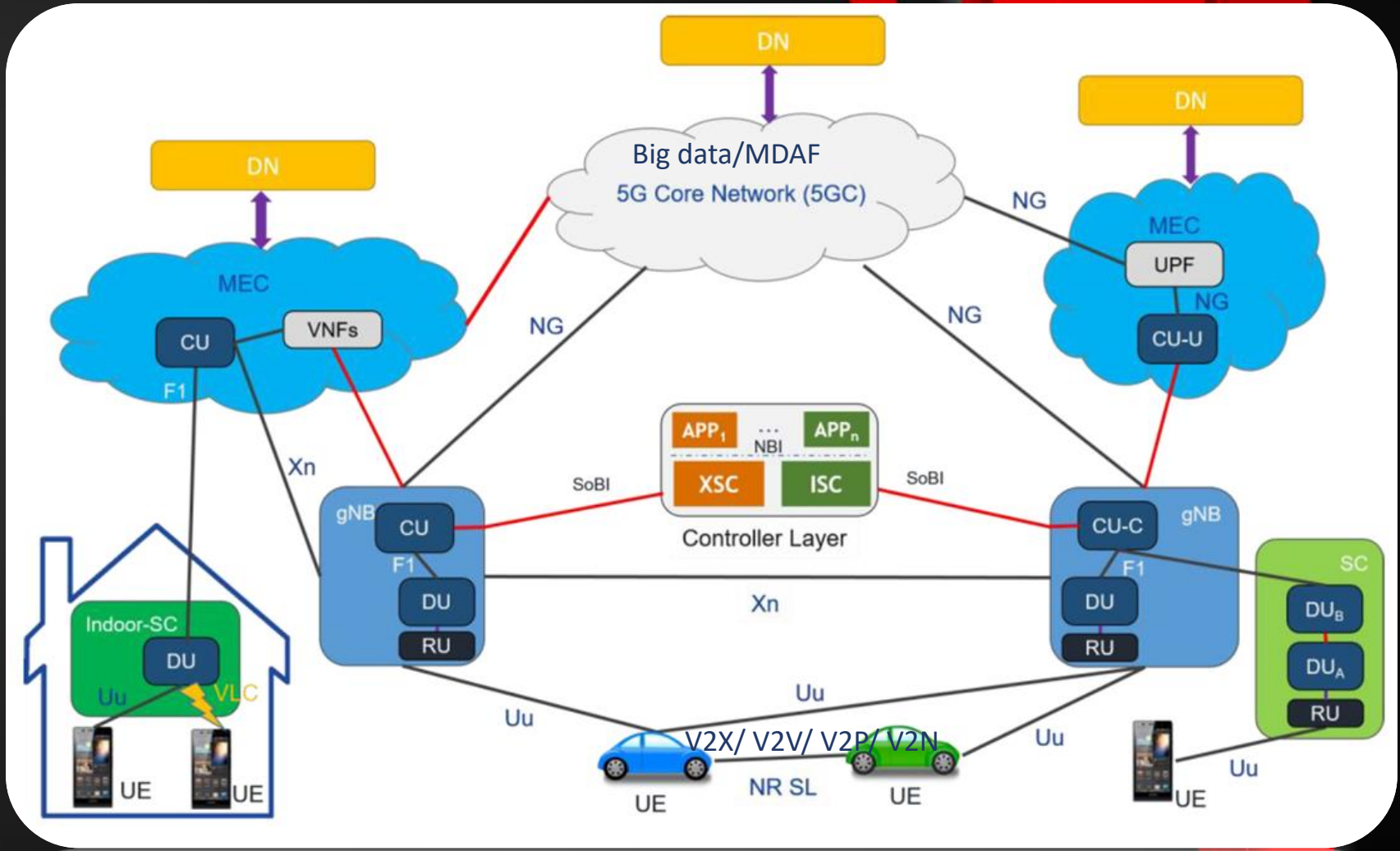
- Network latency is the time required for a set of data to travel between two points

4G TO 5G/NR NETWORK ARCHITECTURE

5G Overall Radio Access Network Architecture

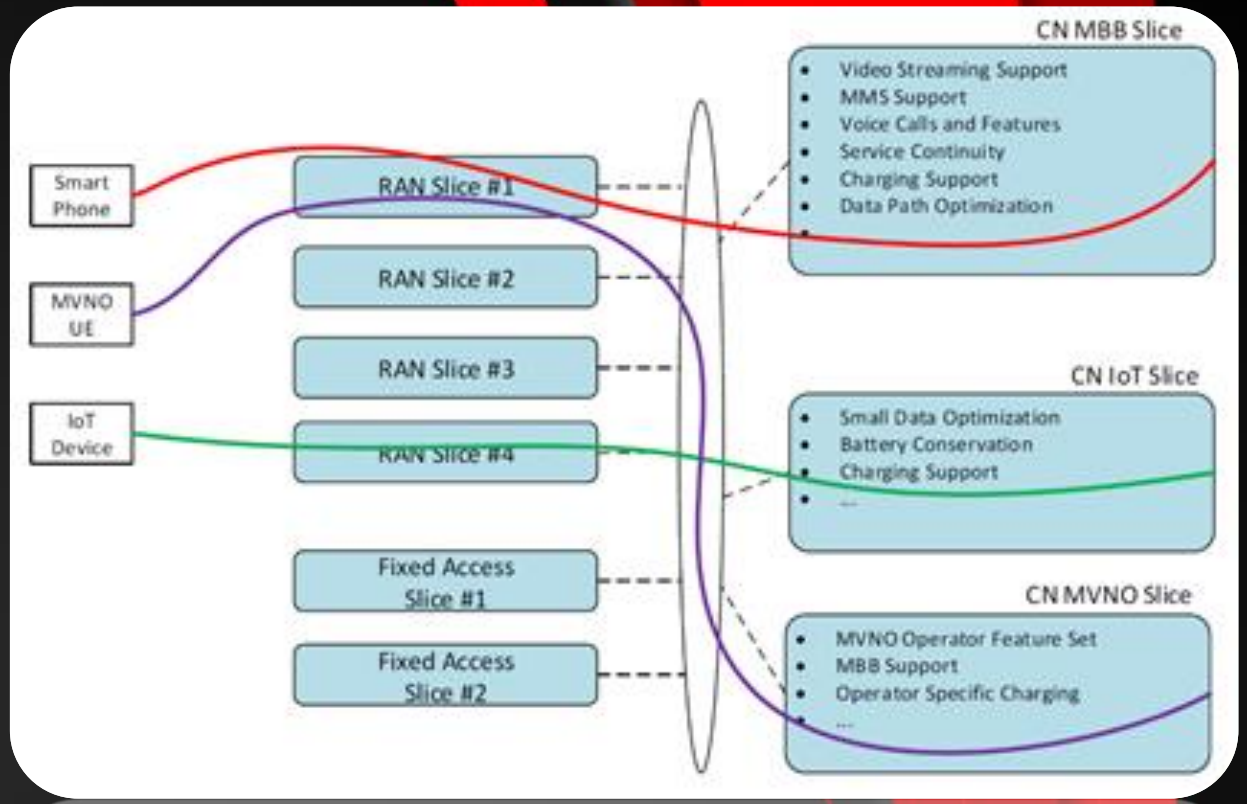
- CU - Centralised Unit
- DU - Distributed Unit
- SC - Small Cell
- RU - Radio Unit
- NR SL – Sidelink
- V2X - Vehicle-to-Everything
- VLC - Visible Light Communication

- DN - Data Network
- MEC - Multi-Access Edge Computing
- BD/MDAF - BigData and Management & Orchestration
- NBI - Northbound Interface
- APP - Application
- AMF - Access and Mobility Management Function
- UPF - User Plane Function
- SMF - Session Management Function
- VNF - Virtualized Network Function
- XSC - Cross-Slice Controller
- ISC - Intra-Slice Controller

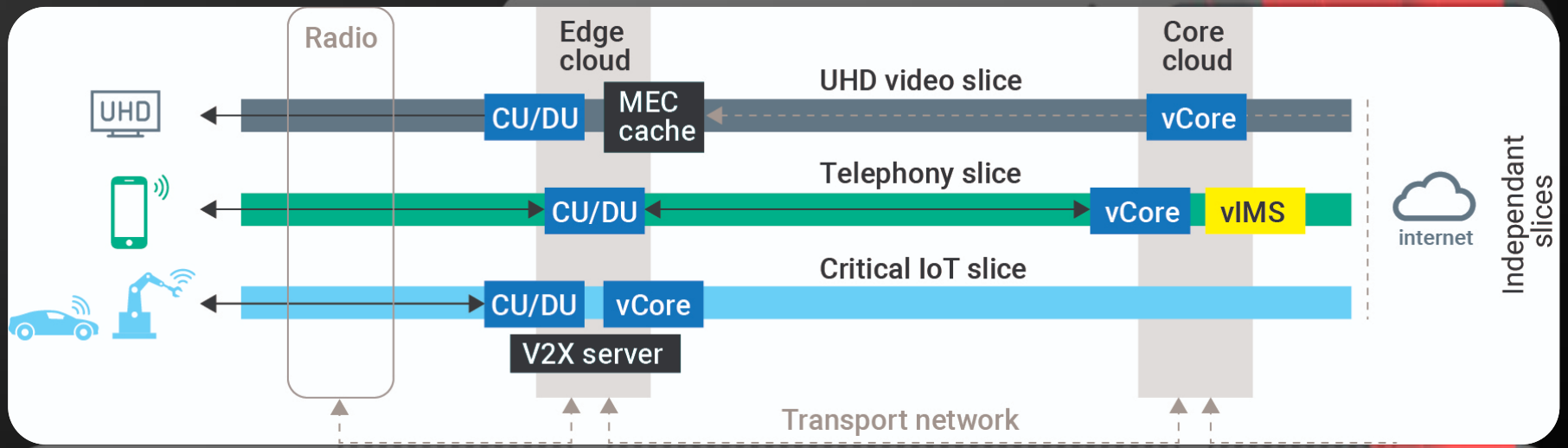


4G TO 5G/NR NETWORK ARCHITECTURE
Slicing

- End-to-end network slicing is, arguably, the defining 5G feature
- 5G network slicing splits resources into logical or virtual networks (“slices”) to address use cases with distinct characteristics and service level agreement (SLA) requirements



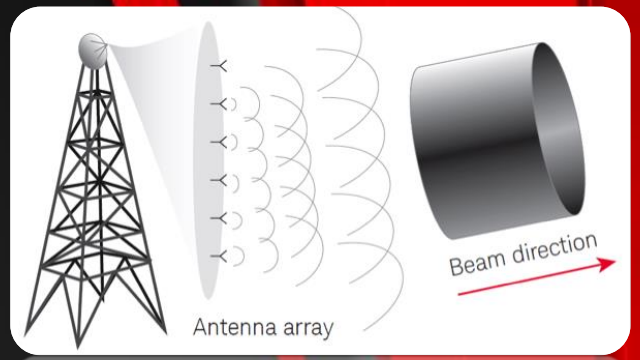
- CU/DU: centralized/distributed unit
- IMS: IP multimedia subsystem
- IoT: internet of things
- MEC: multi-access edge computing
- UHD: ultra high definition
- V2X: vehicle to anything



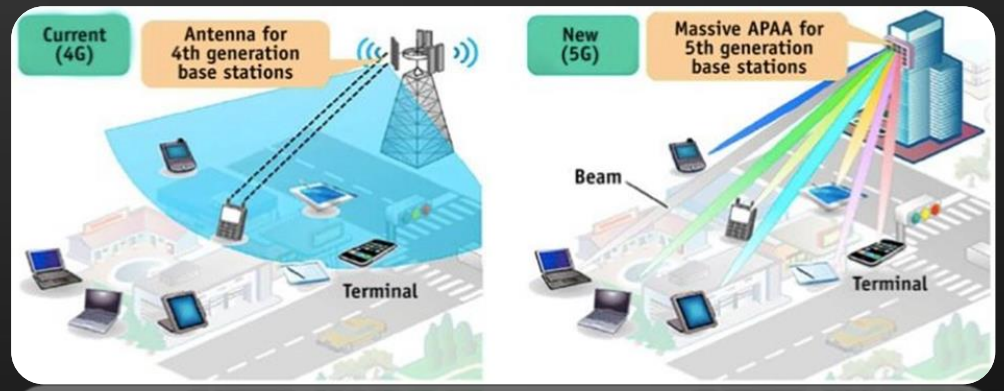
4G TO 5G/NR NETWORK ARCHITECTURE

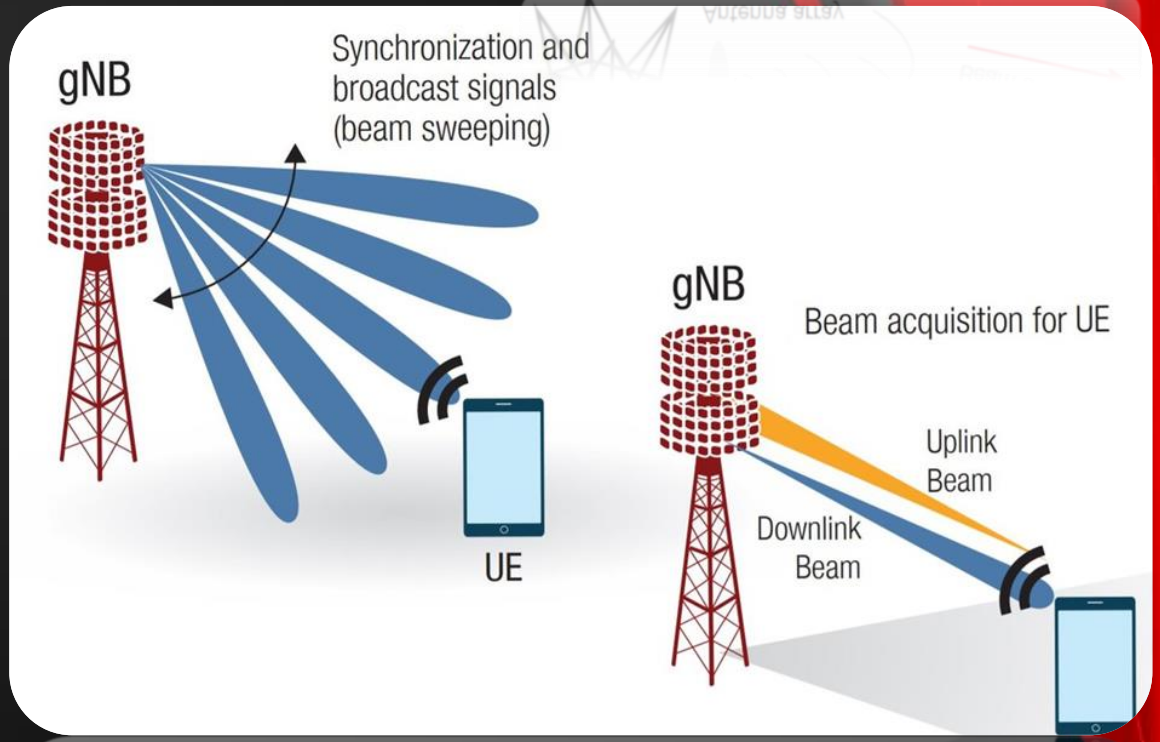
Massive MIMO - Beamforming

- Massive MIMO (massive multiple-input multiple-output) is a type of wireless communications technology in which base stations are equipped with a very large number of antenna elements to improve spectral and energy



- Beamforming is a technique that focuses a wireless signal towards a specific receiving device
  - 5G Beamforming has been introduced to combat signal power and/or quality degradation
  - Beamforming is important for 5G deployments above 3GHz carrier frequencies, but is especially important for 5G mmWave deployments

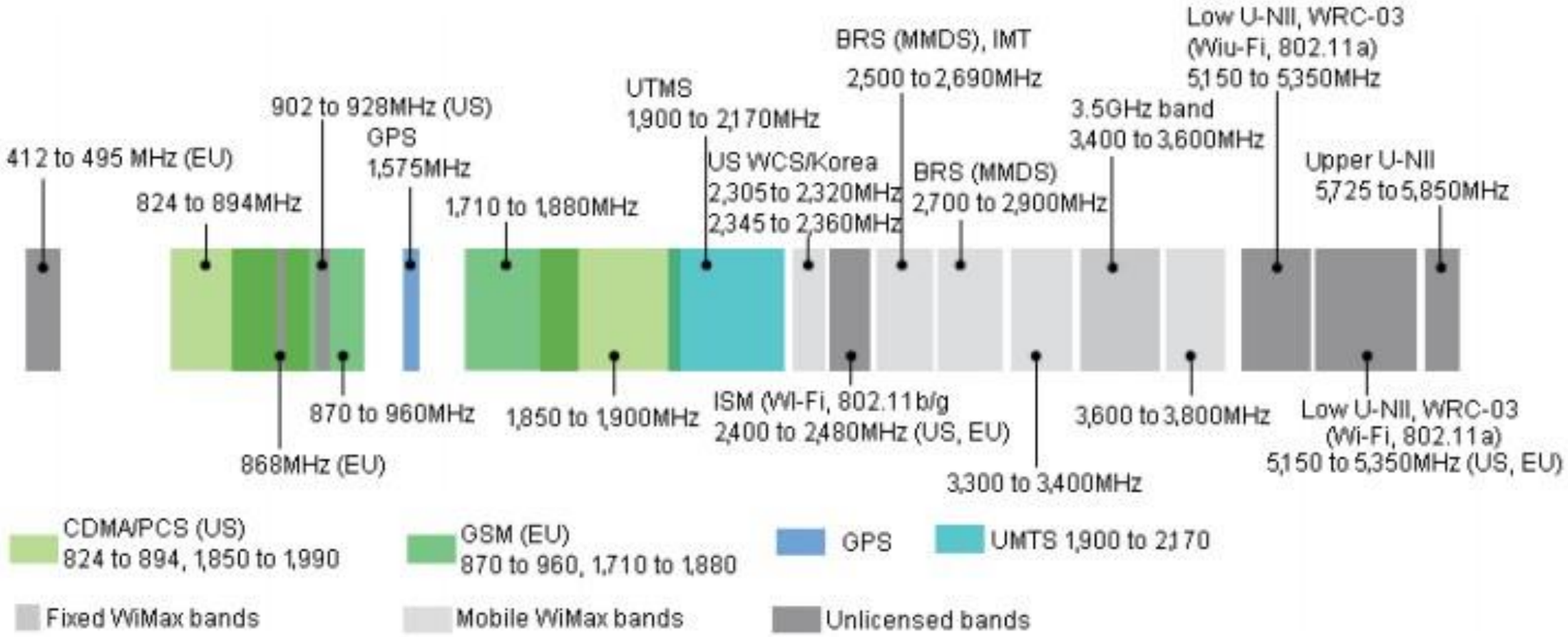




GENERAL ASPECTS – NETWORK RADIO INTERFACE

Cellular Network Basics - Network Architecture

- Cellular Spectrum Bands-



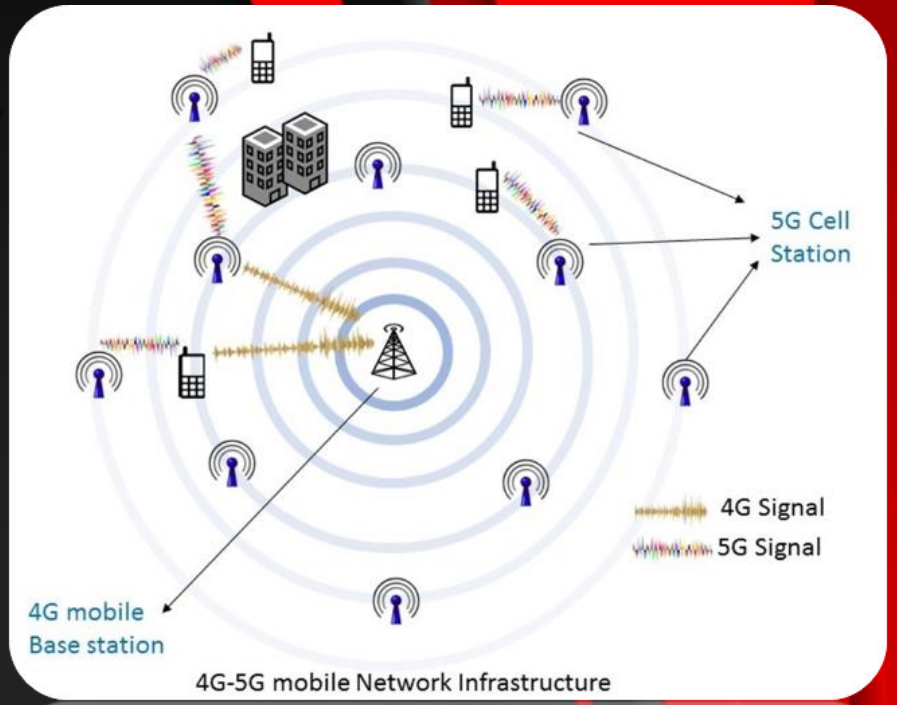
4G TO 5G/NR NETWORK ARCHITECTURE

5G / NR Bands

Band	Duplex mode[A 1]	*f* (MHz)	Common name	Subset of band	Uplink[A 2] (MHz)	Downlink[A 3] (MHz)	Duplex spacing (MHz)	Channel bandwidths[5] (MHz)
n1	FDD	2100	IMT	n65	1920 – 1980	2110 – 2170	190	5, 10, 15, 20
n2	FDD	1900	PCS[A 4]	n25	1850 – 1910	1930 – 1990	80	5, 10, 15, 20
n3	FDD	1800	DCS		1710 – 1785	1805 – 1880	95	5, 10, 15, 20, 25, 30
n5	FDD	850	CLR		824 – 849	869 – 894	45	5, 10, 15, 20
n7	FDD	2600	IMT-E		2500 – 2570	2620 – 2690	120	5, 10, 15, 20, 25, 30, 40, 50
n8	FDD	900	Extended GSM		880 – 915	925 – 960	45	5, 10, 15, 20
n12	FDD	700	Lower SMH[A 5]		699 – 716	729 – 746	30	5, 10, 15
n14	FDD	700	Upper SMH		788 – 798	758 – 768	−30	5, 10
n18	FDD	850	Lower 800 (Japan)		815 – 830	860 – 875	45	5, 10, 15
n20	FDD	800	Digital Dividend (EU)		832 – 862	791 – 821	−41	5, 10, 15, 20
n25	FDD	1900	Extended PCS[A 6]		1850 – 1915	1930 – 1995	80	5, 10, 15, 20, 25, 30, 40
n28	FDD	700	APT		703 – 748	758 – 803	55	5, 10, 15, 20[A 7]
n29	SDL	700	Lower SMH[A 8]		N/A	717 – 728	N/A	5, 10
n30	FDD	2300	WCS[A 9]		2305 – 2315	2350 – 2360	45	5, 10
n34	TDD	2100	IMT		2010 – 2025		N/A	5, 10, 15
n38	TDD	2600	IMT-E[A 10]		2570 – 2620		N/A	5, 10, 15, 20, 40
n39	TDD	1900	DCS–IMT Gap		1880 – 1920		N/A	5, 10, 15, 20, 25, 30, 40
n40	TDD	2300	S-Band		2300 – 2400		N/A	5, 10, 15, 20, 25, 30, 40, 50, 60, 80
n41	TDD	2500	BRS	n90	2496 – 2690		N/A	10, 15, 20, 30, 40, 50, 60, 80, 90, 100
n77	TDD	3700	C-Band		3300 – 4200		N/A	10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100
n78	TDD	3500	C-Band	n77	3300 – 3800		N/A	10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100

4G TO 5G/NR NETWORK ARCHITECTURE

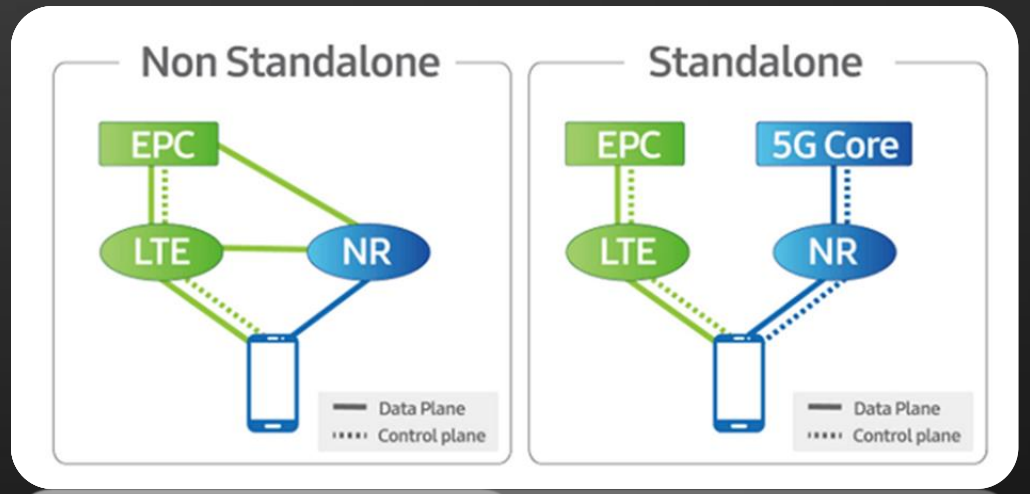
5G/NR Non-Standalone to Standalone Network Architecture



4G-5G mobile Network Infrastructure

NSA Non-Standalone

- there are new 5G NR (radio base stations)
- 5G NSA network cannot run independently, it must rely on the existence of the 4G network
- But device will be connected to the 4G base station and the 4G core network for the signaling plane - ***anchor***
- 5G base station only performs data offload, whether it is data offload from our 4G base station or data offload from the 4G core network EPC (*Evolved Packet Core*)



SA Standalone

- new 5G equipment and devices from the base station to the core network
- 5G networks can operate independently
- 5G devices fully operate in 5G
- operation between 4G and 5G is performed :
  - through the interoperation between the 5G core network and the 4G EPC
  - through the operation between the upgraded LTE base station and the new 5G core network

GENERAL ASPECTS – NETWORK RADIO INTERFACE

Cellular Network Basics - Network Architecture

- Radio Interface – Netmonitor Apps -