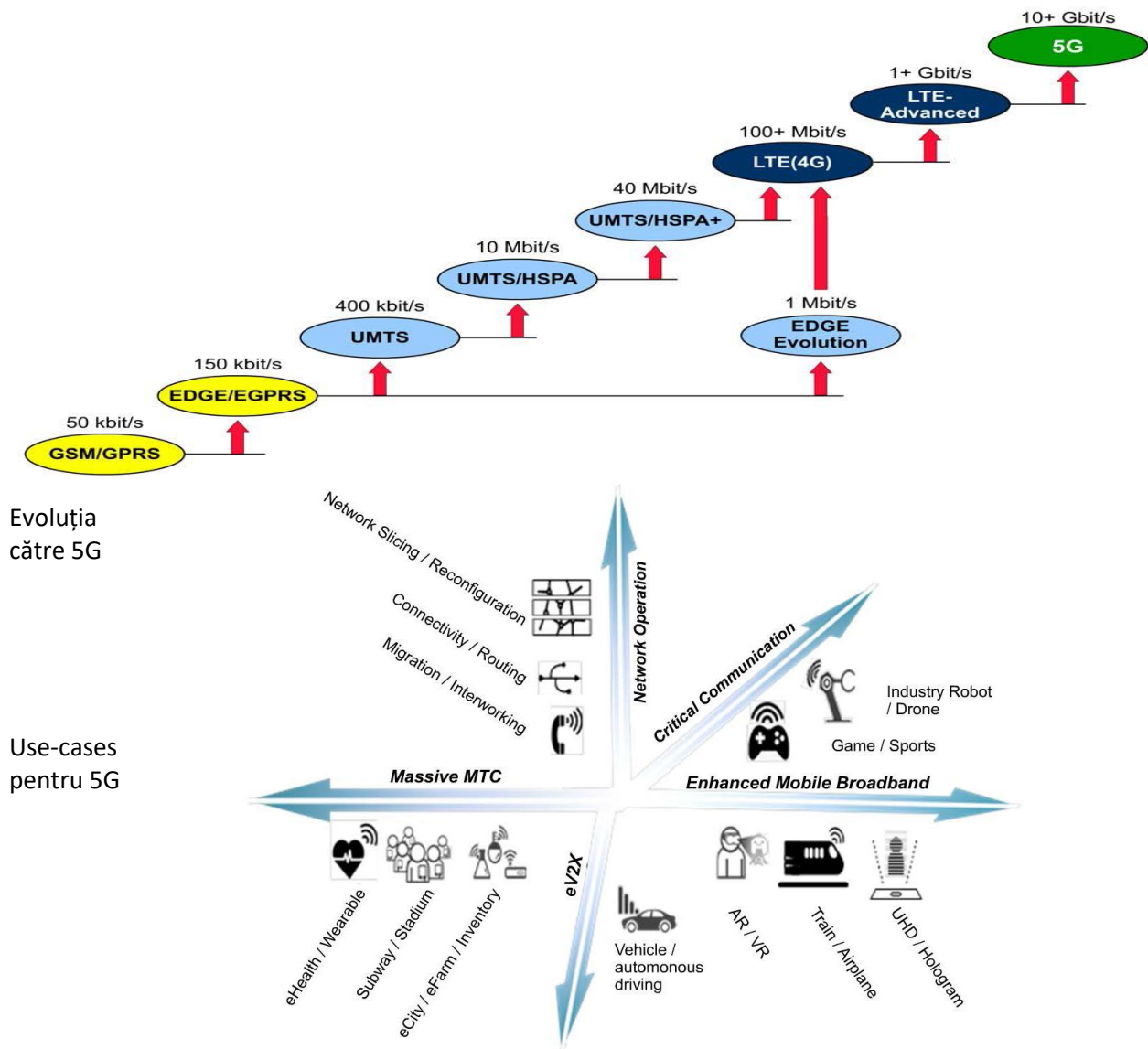
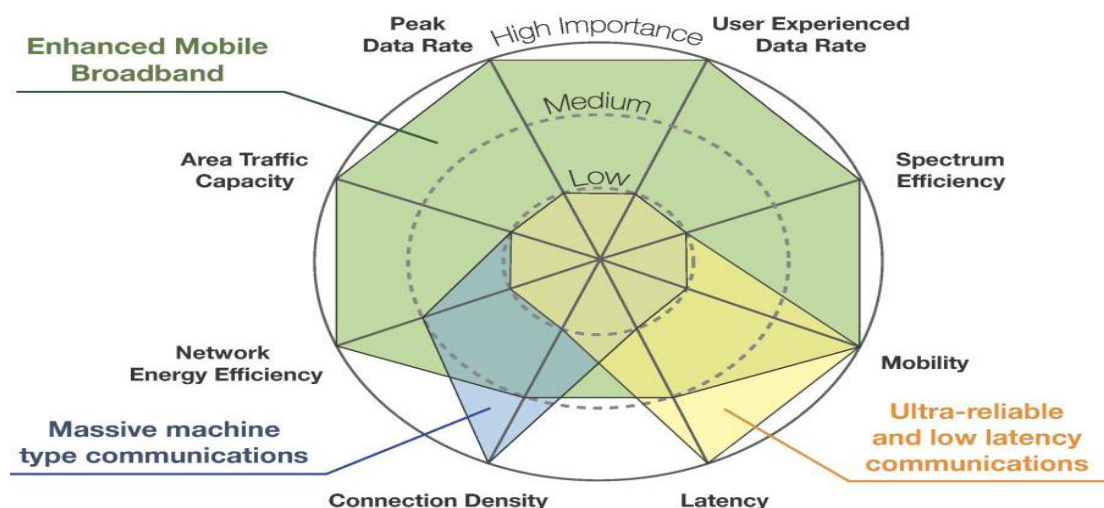


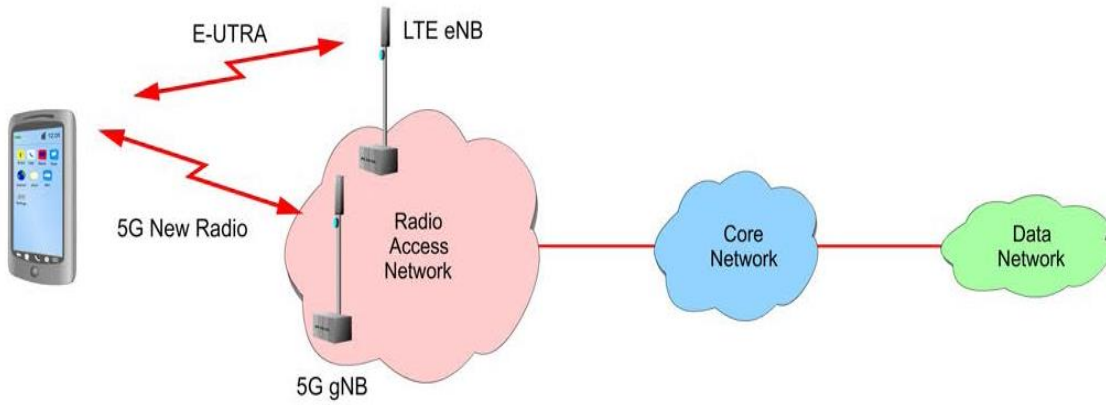
Cerințe pentru utilizatorii individuali și întreprinderi:

- debite binare de 1 până la 10 Gbps pentru video UHD și realitate virtuală
- întârzieri mai mici de 1 ms pentru aplicații de control și V2V
- comutare rapidă între diverse tehnologii de acces radio
- scalabilitate pentru a deservi zeci de milioane de aplicații și sute de miliarde de device-uri
- durată de viață extinsă a bateriei
- capacitate extinsă în zona urbane cu mare densitate
- acoperire în avioane și zone îndepărtate

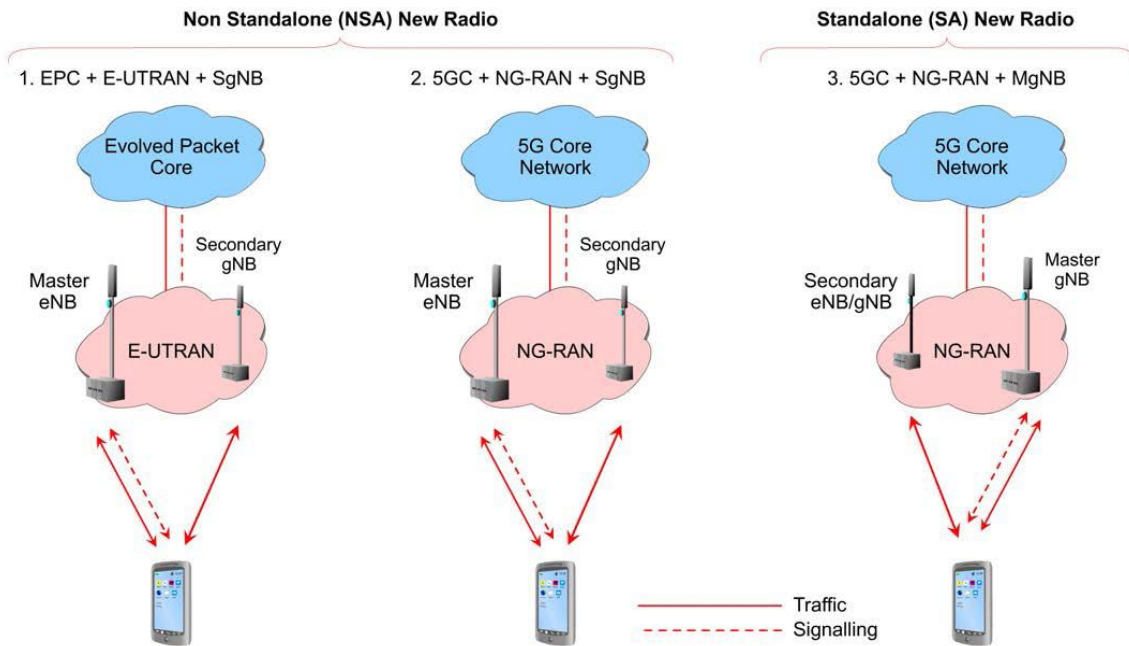


Importanța KPI pentru aplicațiile principale





Arhitectura generală a 5G

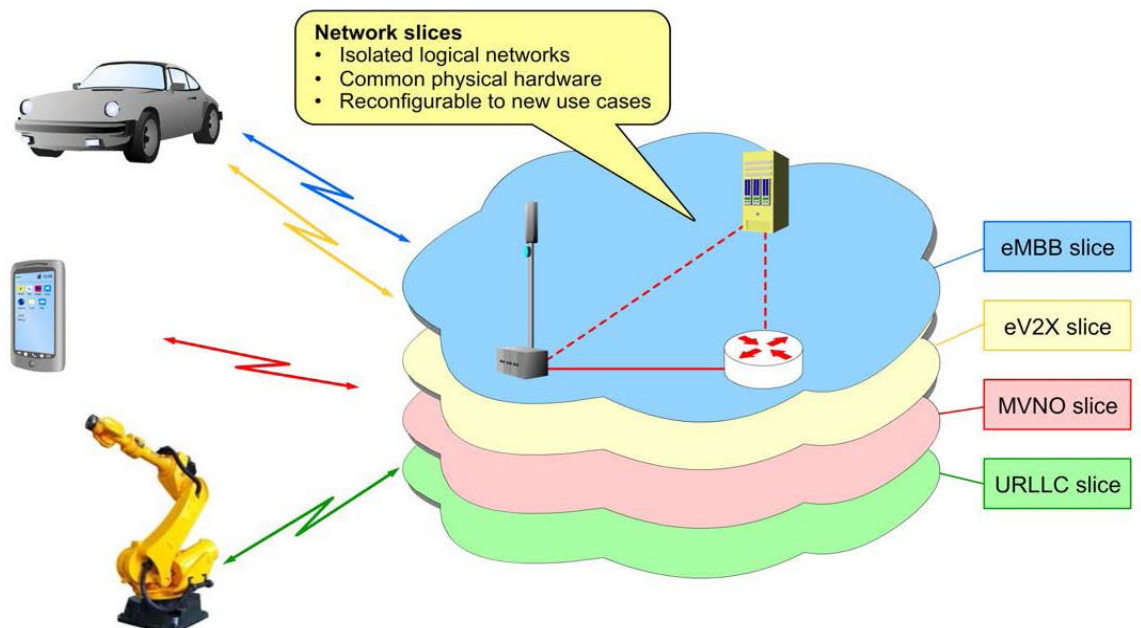


Implementarea graduală (roll-out) a 5G

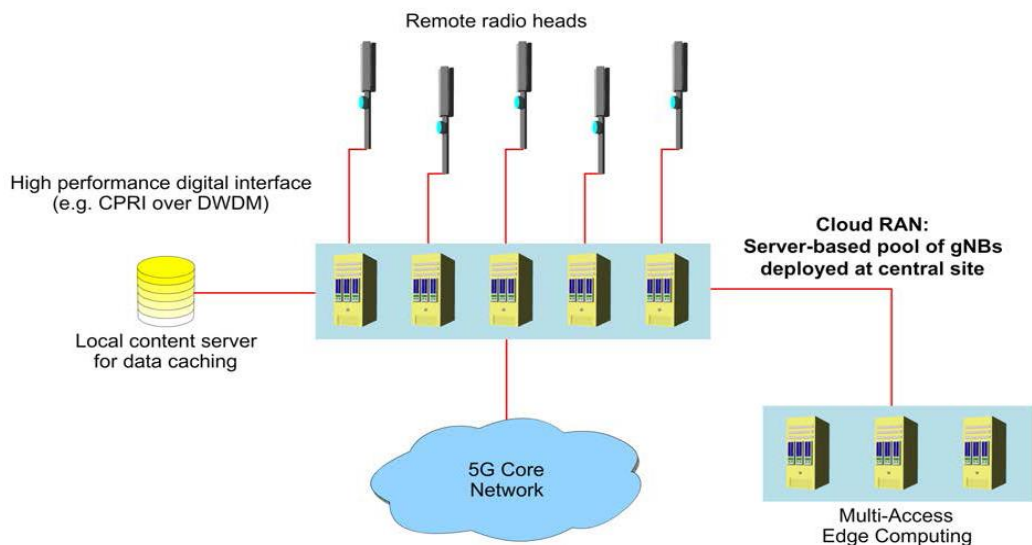
Va folosi: Network Function Virtualization (NFV), Software Defined Networking (SDN) și Network slicing

MVNO-  
mobile  
virtual  
network  
operator

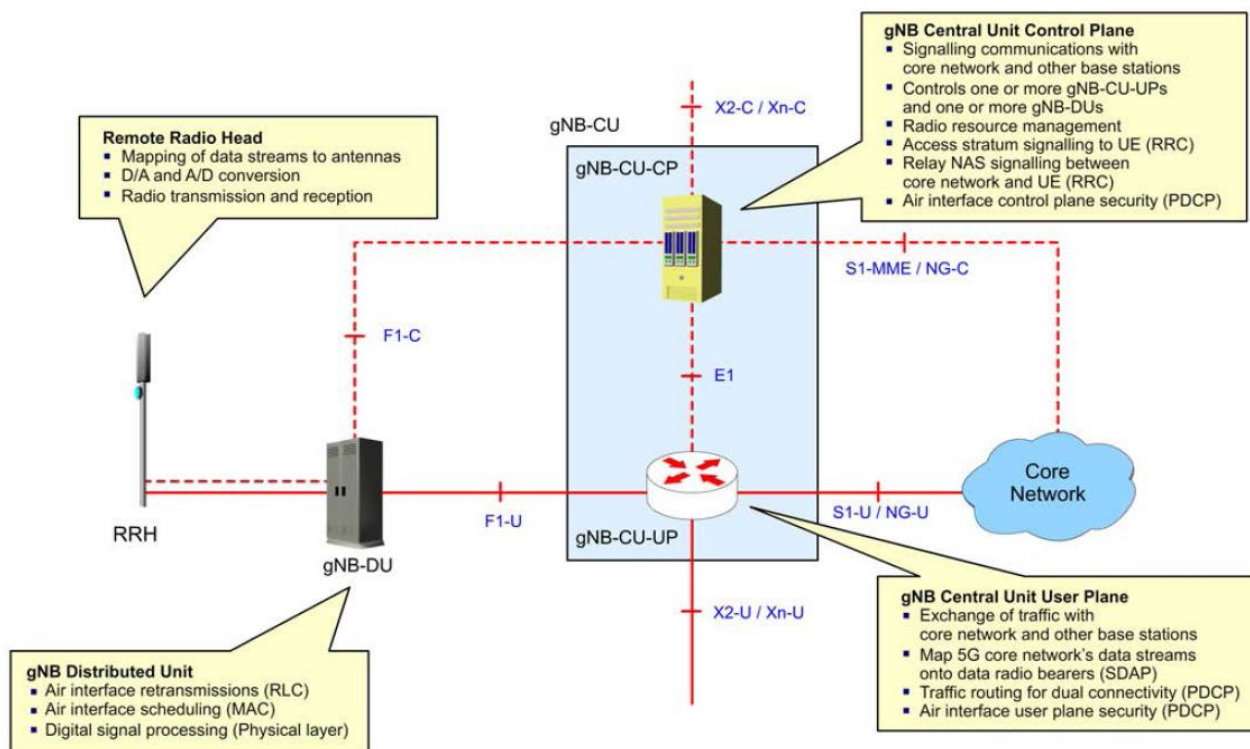
Network  
slicing



Se va folosi structura de tip Cloud RAN (CRAN)



CPRI - common public radio interface  
 DWDM - dense wavelength division multiplexing



Funcționalitățile gNodeB

QCI	Resource Type	Priority	Packet Delay Budget	Packet Error Loss Rate	Example Services
1	GBR	2	100 ms	$10^{-2}$	Conversational Voice
2		4	150 ms	$10^{-3}$	Conversational Video (Live Streaming)
3		3	50 ms	$10^{-3}$	Real-Time Gaming
4		5	300 ms	$10^{-6}$	Non-Conversational Video (Buffered Streaming)
5		1	100 ms	$10^{-6}$	IMS Signalling
6	Non-GBR	6	300 ms	$10^{-6}$	Video (Buffered Streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
7		7	100 ms	$10^{-3}$	Voice, Video (Live Streaming) Interactive Gaming
8		8	300 ms	$10^{-6}$	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
9					

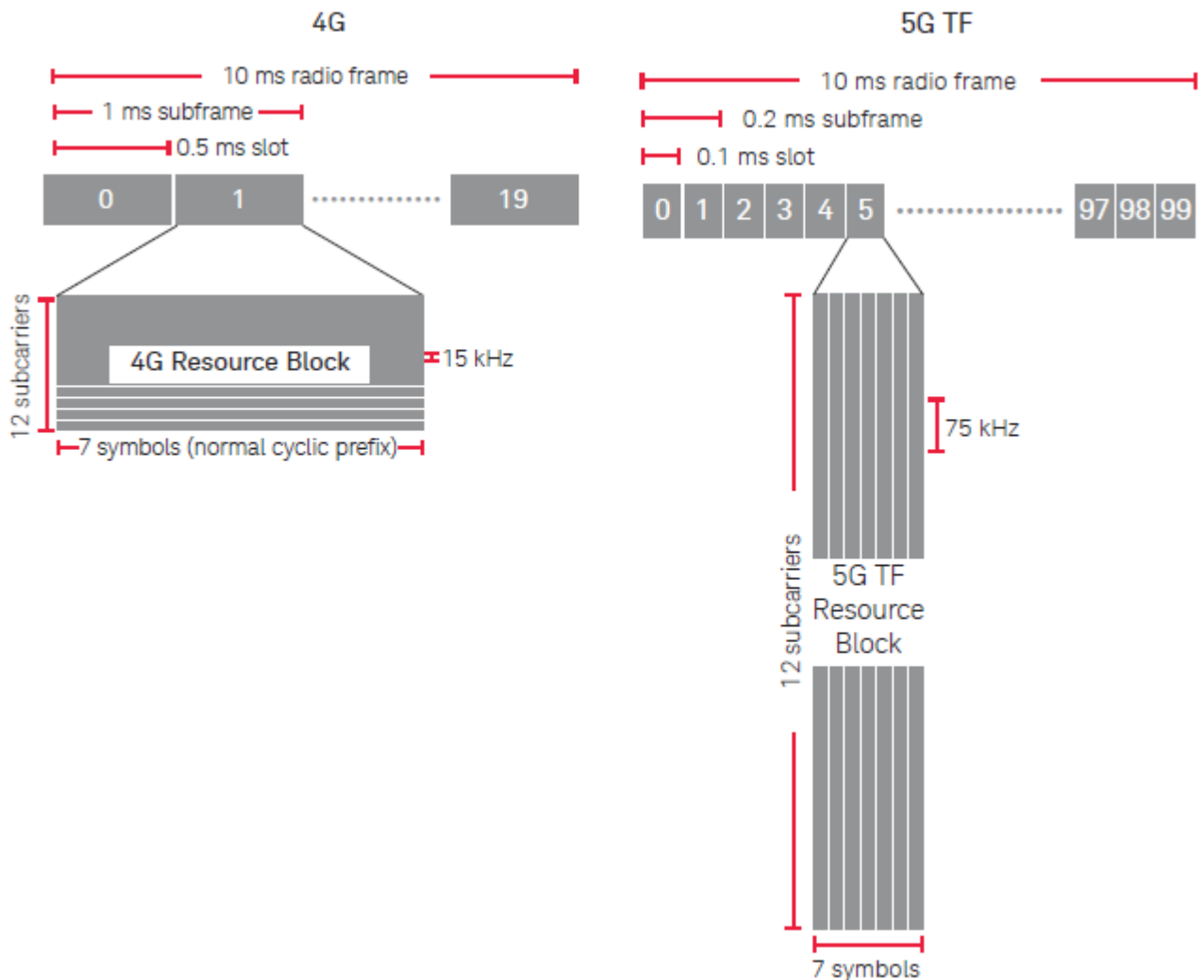
QCI (Indicatori ai claselor de QoS) GBR - Guaranteed Bit Rate IMS - IP Multimedia System

5QI	Resource type	Priority	Packet delay budget	Packet error rate	Default maximum data burst	Default averaging window	Example services
10	Delay critical GBR	11	5 ms	$10^{-5}$	160 bytes	TBD	Remote control
11		12	10 ms	$10^{-5}$	320 bytes	TBD	Intelligent transport systems
12		13	20 ms	$10^{-5}$	640 bytes	TBD	
16		18	10 ms	$10^{-4}$	255 bytes	TBD	Discrete automation
17		19	10 ms	$10^{-4}$	1358 bytes	TBD	Discrete automation
65	GBR	7	75 ms	$10^{-2}$	n/a	TBD	Mission critical push-to-talk voice
66		20	100 ms	$10^{-2}$	n/a	TBD	Non mission critical push-to-talk voice
75		25	50 ms	$10^{-2}$	n/a	TBD	V2X messages
TBD		18	10 ms	$10^{-4}$	255 bytes	TBD	Discrete automation
TBD		19	10 ms	$10^{-4}$	1358 bytes	TBD	Discrete automation
69	Non-GBR	5	60 ms	$10^{-6}$	n/a	n/a	Mission critical delay sensitive signalling
70		55	200 ms	$10^{-6}$	n/a	n/a	Mission critical data (buffered video, TCP-based)
79		65	50 ms	$10^{-2}$	n/a	n/a	V2X messages
80		66	10 ms	$10^{-6}$	n/a	n/a	Low latency eMBB (augmented reality etc)

QCI - Valori suplimentare

Table 1: Comparison of LTE, 5G TF and 3GPP 5G NR

Characteristic	LTE	5G TF	3GPP 5G NR
<b>Frame structure</b>			
Radio frame	10 ms	10 ms	10 ms
Subframes in a frame	10	50	10
Slots in a frame	20 (each 1 ms)	100 (each 0.1 ms)	20 (each 1 ms)
Resource blocks	100 max	100 max	100 or more
<b>Frequency domain</b>			
Carrier aggregation	5 (ReL10) / 32 (ReL12)	8	16
Subcarrier spacing	15 kHz	75 kHz	Flexible: $2^n \cdot 15$ kHz ( $n = -2, 0, 1, \dots, 5$ )
Carrier bandwidth	1.4, 3, 5, 10, 15, 20 MHz	100 MHz	Variable, maximum per CC is 400 MHz
Frequency bands	Under 6 GHz	28 GHz	Up to 100 GHz
Beamforming	Applicable to certain transmission modes	With DL/UL reciprocity	With and without DL/UL reciprocity
Modulation	Up to 256 QAM	QPSK, 16 QAM and 64 QAM	QPSK, 16 QAM, 64 QAM and 256 QAM
MIMO	Up to 8x8	2x2 only	Up to 8x8
Channel coding scheme	Turbo coding for data	LDPC for data	NR polar codes (control); NR LDPC (data)



Structura frame-ului în 4G și 5G TF (< 6GHz și 28-39 GHz)

În undele milimetrice se va folosi beamforming pentru a reduce atenuările. Beamforming combină semnale primite de la mai multe elemente ale antenei (de la emisie) printr-un array de antene a.î. nivelul semnalului recepționat să fie mai mare, datorită defazajelor relative alese corespunzător (interferență constructivă).