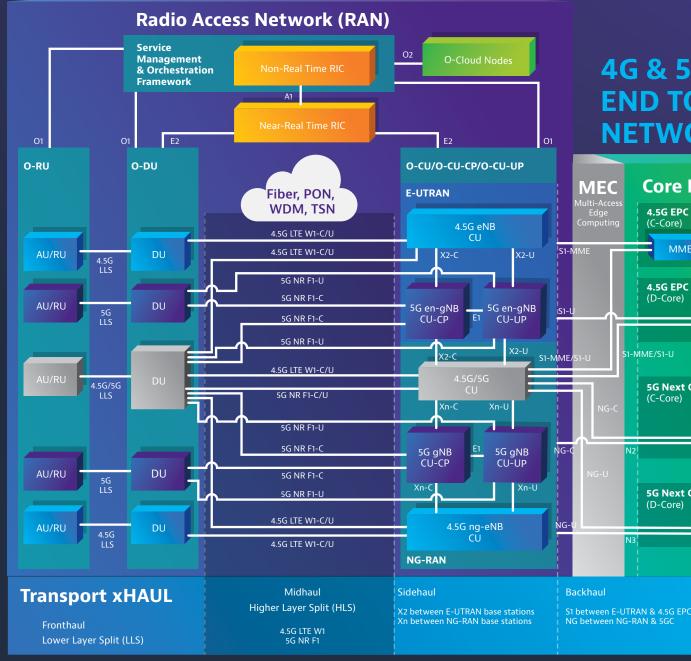
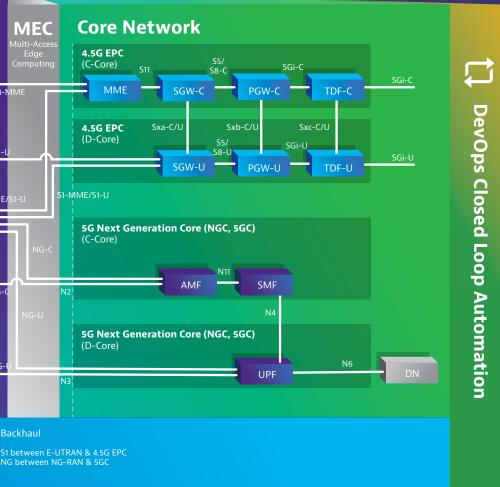
# **5G Architecture and Specifications**



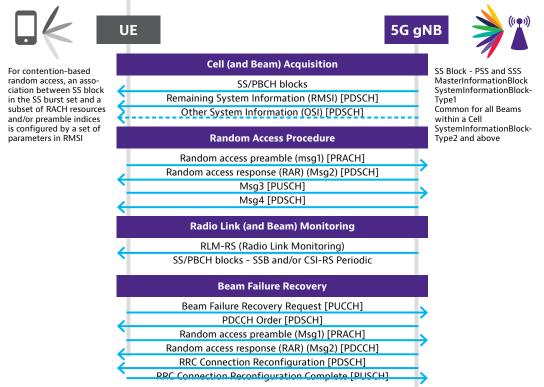
NOTES 1. LLS, AU, (O-)RU are not standardized in 3GPP 2. Some elements of 4.5G and 5G core network are not shown in this network architecture diagram

## 4G & 5G NEW RADIO (NR) END TO END (E2E) **NETWORK ARCHITECTURE**



## **5G RADIO**

Massive MIMO Beam Forming & Management



### Radio Protocols, Management & Procedures Specifications

	4G LTE-Advanced Pro	5G New Radio (NR)
Service Data Adaptation Protocol		SDAP <sup>1</sup> : 3GPP TS 37.324
Radio Resource Control	RRC: 3GPP TS 36.331	NR-RRC: 3GPP TS 38.331
Packet Data Convergence Protocol	PDCP: 3GPP TS 36.323	NR-PDCP: 3GPP TS 38.323
Radio Link Control	RLC: 3GPP TS 36.322	NR-RLC: 3GPP TS 38.322
Medium Access Control	MAC: 3GPP TS 36.321	NR-MAC: 3GPP TS 38.321
Physical Layer	РНҮ	NR-PHY
Physical channels and modulation	3GPP TS 36.211	3GPP TS 38.211
Multiplexing and channel coding	3GPP TS 36.212	3GPP TS 38.212
Physical layer procedures	3GPP TS 36.213	3GPP TS 38.213 (control) 3GPP TS 38.214 (data)
Physical layer Measurements	3GPP TS 36.214	3GPP TS 38.215
User Equipment (UE) radio transmission and reception	3GPP TS 36.101	3GPP TS 38.101-1: Part 1: Range 1 Standalone 3GPP TS 38.101-2: Part 2: Range 2 Standalone 3GPP TS 38.101-3: Part 3: Range 1 and Range 2 Interworking operation with other radios 3GPP TS 38.101-4: Part 4: Performance requirements
Base Station (BS) radio transmission and reception	3GPP TS 36.104	3GPP TS 38.104
Requirements for support of radio resource management	3GPP TS 36.133	3GPP TS 38.133
Physical layer; General description	3GPP TS 36.201	3GPP TS 38.201
Services provided by the physical layer	3GPP TS 36.302	3GPP TS 38.202
User Equipment (UE) procedures in idle mode	3GPP TS 36.304	3GPP TS 38.304
Multi-RAT Co-Existence	3GPP TR 37872 Suppleme	entary uplink (SUL) and LTE-NR co-existence

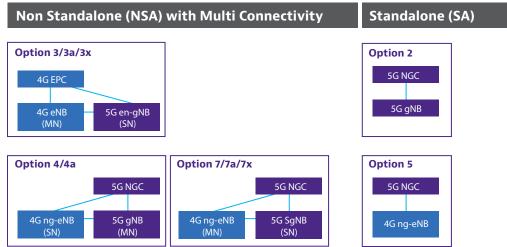
### Physical Channels & Signals

<sup>1</sup>Applicable only when the 5G gNB is connected to the 5G NGC

,		5		
	Downlink		.	
New Radio (NR)	Channels	NR-PDSCH: Physical Downlink Shared Channel NR-PBCH: Physical Broadcast Channel NR-PDCCH: Physical Downlink Control Channel		Can be used for estimation of channel- state information (CSI) to further prepare feedback reporting to gNB to assist in MCS selection, beamforming, MIMO rank selection and resource
	Signals	NR-PSS: Primary Synchronization Signal NR-SSS: Secondary Synchronization Signal NR-DM-RS: Demodulation Reference Signal		allocation. CSI-RS also can be used for interference measurement and fine frequency/time tracking purposes
di		NR-CSI-RS: Channel-State Information Reference Signal	Γ,	
/ Ra		NR-PT-RS: Phase-Tracking Reference Signal		Can be used in addition to the DM-RS for PDSCH for correcting common phase error between PDSCH symbols
e K	Uplink		N	not containing DM-RS. It may also be
	Channels	NR-PUSCH: Physical Uplink Shared Channel NR-PUCCH: Physical Uplink Control Channel NR-PRACH: Physical Random Access Channel		used for Doppler and time varying channel tracking
5G				Can be used in addition to the DM-RS for PUSCH for correcting common phase error between PUSCH symbols
	Signals	NR-DM-RS: Demodulation Reference Signal		
		NR-PT-RS: Phase-Tracking Reference Signal		not containing DM-RS. It may also be used for Doppler and time varying
		NR-SRS: Sounding Reference Signal	Ĺ	channel tracking

Reference source: 3GPP Submission of initial 5G description for IMT-2020

## **5G ARCHITECTURE OPTIONS**

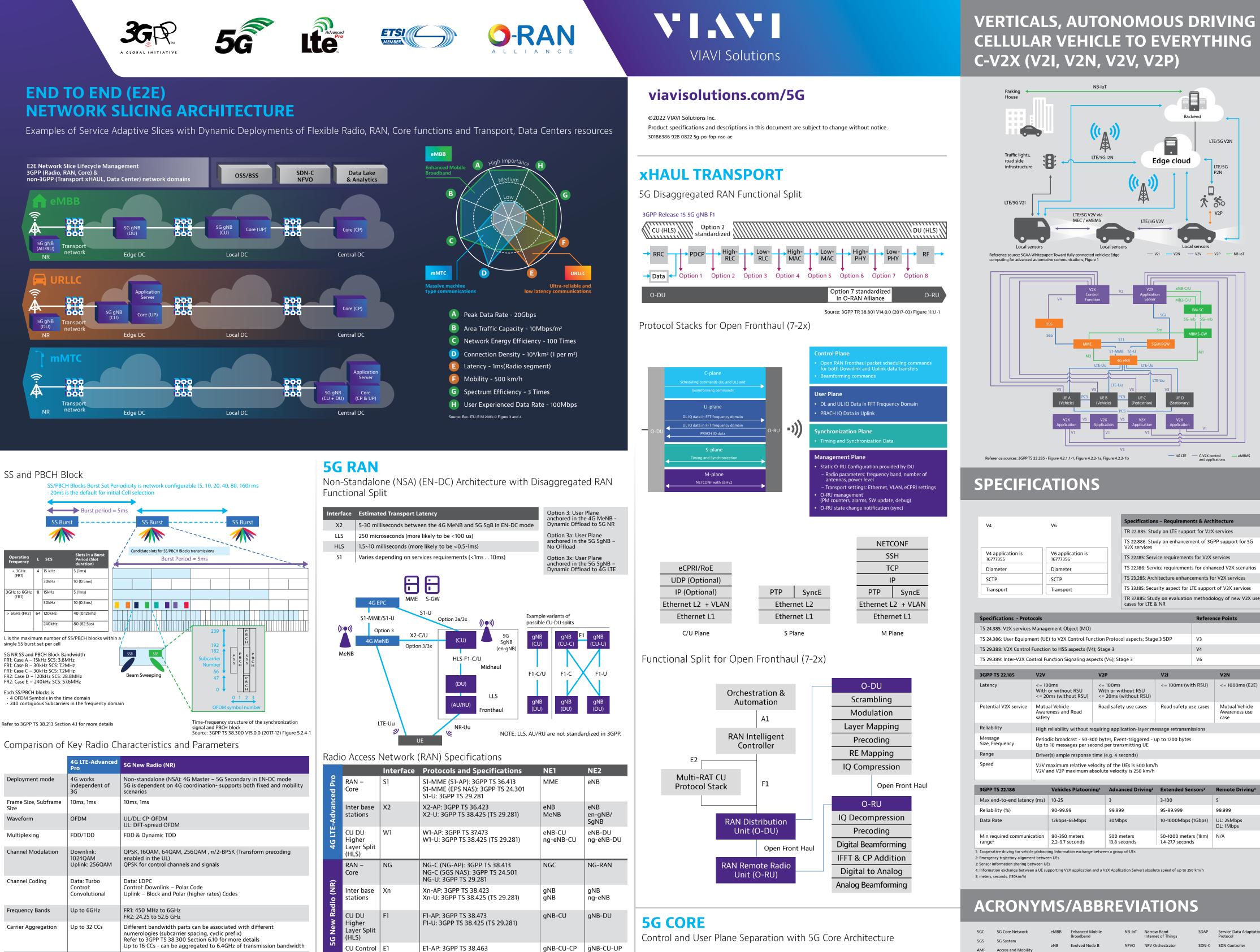


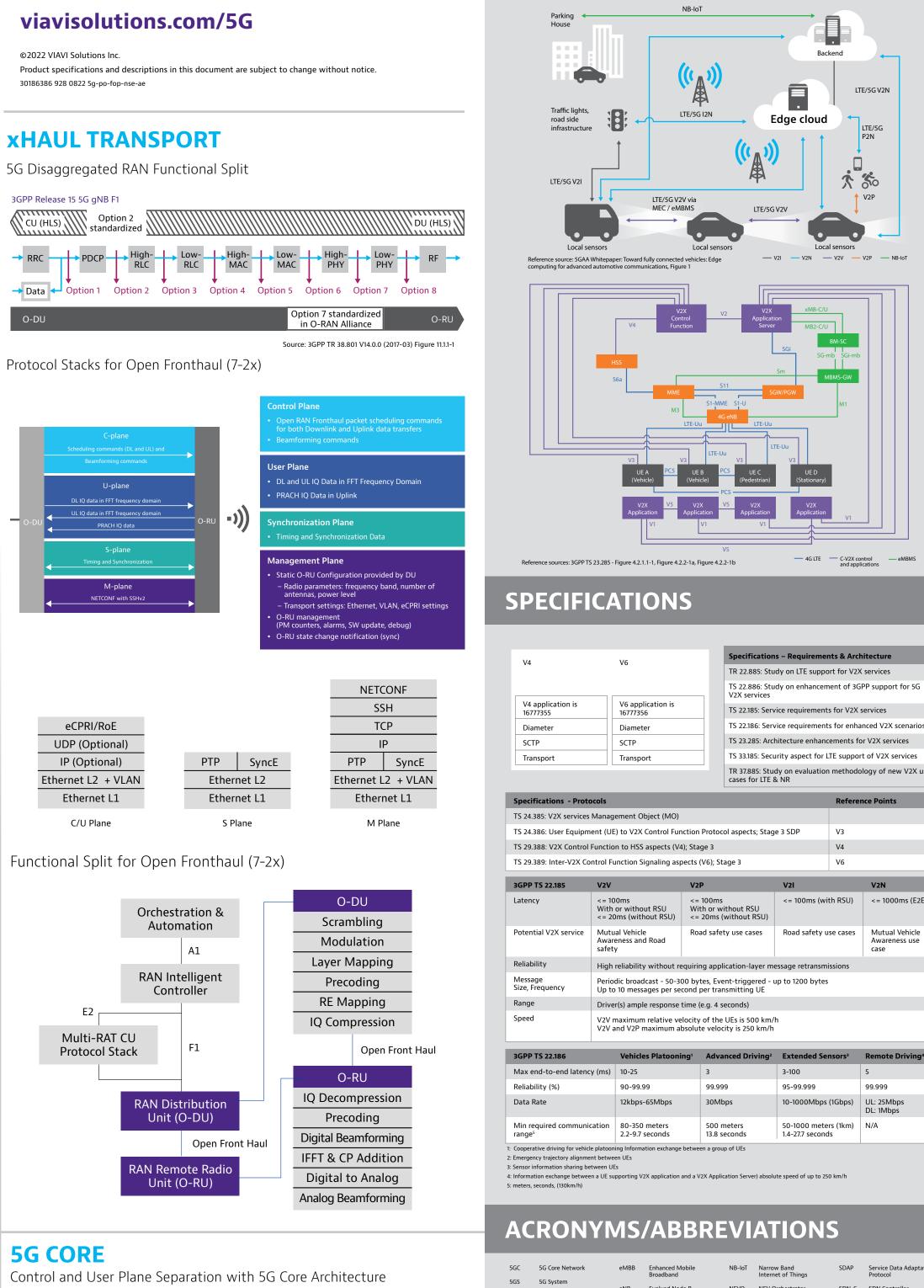
### **5G 3GPP RELEASES HIGHLIGHTS**

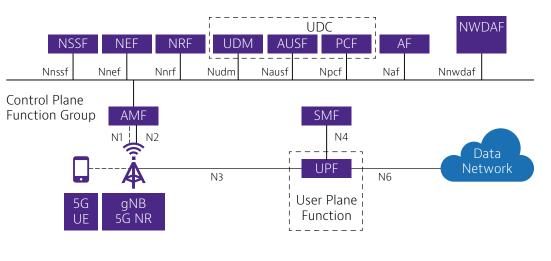
	Release 15	Release 16	Release 17	Release 18: 5G-Advanced
5G New Radio (NR)	5G NR (New Radio) - Initial release The 5G System - Phase 1	Enhancement for NR URLLC NR Industrial IoT NR-based access to unlicensed spectrum Integrated Access and Backhaul (IAB) NR V2X 5G X2X with NR sidelink NR positioning support Optimisations on UE radio capability signaling UE Power Saving in NR NR MIMO enhancement NR mobility enhancement 2-step RACH for NR LTE-NR & NR-NR Dual Connectivity and NR Carrier Aggregation enhancement LTE-based 5G terrestrial broadcast Cross Link Interference (CLI) handling and Remote Interference Management (RIM) for NR 5GS enablers for new verticals (IA, TSC, URLLC, NPN, CIoT, V2X, etc.) Railways communication 5G Wireless Wireline Convergence Network Analytics enhancement SRVCC Location Services enhancement Common API for 3GPP Northbound APIs	NR MIMO NR sidelink enhancement 52.6 - 71 GHz with existing waveform Dynamic Spectrum Sharing enhancement Industrial IoT / URLLC enhancement IoT over Non Terrestrial Network (NTN) NR over Non Terrestrial Network (NTN) NR Positioning enhancement Low complexity NR devices Power saving NR coverage enhancement NR eXtended Reality (XR) NB-IoT and LTE-MTC enhancement 5G Multicast broadcast Multi-Radio DCCA enhancement Multi SIM Integrated access and backhaul (IAB) enhancement NR Sidelink relay RAN Slicing Enhancement for small data SON / MDT enhancement NR QOE Satellite components in 5G architecture Non-Public Network enhancement Network Automation for 5G - Phase 2 Edge Computing in 5GC Proximity based services in 5GS Network Slicing Phase 2 Enhancement for V2X services Advanced interactive services Advanced priority Service (MPS) SG Wireless and Wireline Convergence SG LAN-type services UPF enhancement for control and 5G Service Based Architecture	Under study and specification work (Only RAN item listed) Al/ML for NR Air interface Evolution of NR Duplex Operation NR sidelink evolution Expanded and improved NR positioning NR RedCap UE Network Energy Saving NR Network-controlled Repeaters DSS enhancement Low-power wake-up signal and receiver Multi-carrier enhancement XR enhancement NR NTN enhancement IoT NTN enhancement NR Support for UAV Dual Tx/Rx MUSIM In-Device Co-existence (IDC) enhancement Mobile Terminated-Small Data Transmission NR Multicast and Broadcast service enhancement Mobile IAB Al/ML for NG-RAN NR QoE enhancement Resiliency for gNB-CU Data collection for SON/MDT

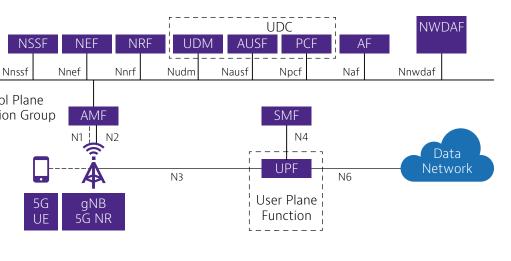
## **5G ARCHITECTURE SPECIFICATIONS**

	4G LTE-Advanced Pro	5G New Radio (NR)				
System Architecture	3GPP TS 23.401: GPRS enhancements for E-UTRAN access 3GPP TS 23.402: Architecture enhancements for non-3GPP accesses	3GPP TS 23.501: System architecture for the 5G System (5GS) 3GPP TS 23.502: Procedures for the 5G System (5GS)				
Policy and Charging Control	3GPP TS 23.203: Policy and charging control architecture	3GPP TS 23.503: Policy and charging control framework for the 5G System (5GS)				
Security Architecture	3GPP TS 33.401: 3GPP SAE; Security architecture	3GPP TS 33.501: Security architecture and procedures for 5G System				
RAN Overall Description	3GPP TS 36.300: E-UTRA and E-UTRAN; Overall description; Stage 2	3GPP TS 38.300: NR; NR and NG-RAN Overall description; Stage-2				
RAN Architecture	3GPP TS 36.401: E-UTRAN; Architecture description	3GPP TS 38.401: NG-RAN; Architecture description				
Multi-connectivity	3GPP TS 37.340: Evolved Universal Terrestrial I Multi-connectivity; Stage 2	d Universal Terrestrial Radio Access (E-UTRA) and NR; ge 2				
Control User Plane Separation	3GPP TS 23.214: Architecture enhancements for control and user plane separation of EPC nodes	Native support				
CU DU RAN functions dis-aggregation	3GPP TS 37.470: W1 interface; General aspects and principles	3GPP TS 38.470: NG-RAN; F1 general aspects and principles				









NOTE: this core network architecture diagram focuses on CUPS only and does not show all core network elements the PDCP protocol layers for control and user

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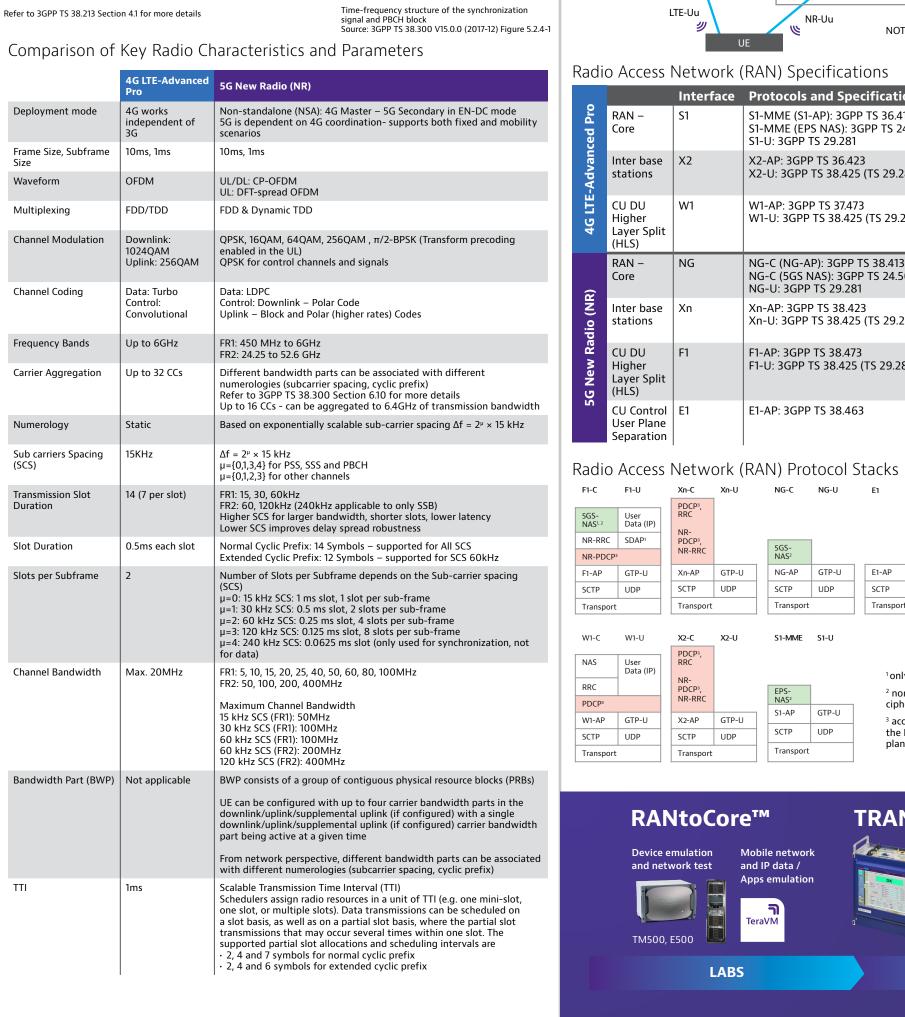
<sup>1</sup>only when connected to 5G NGC

ciphered at the NAS protocol layers

plane; user plane PDCP compressed

<sup>2</sup> non-access stratum (NAS) encrypted/

access stratum (AS) encrypted/ciphered at



User Plane

Separation |

Xn-C Xn-U

Xn-AP GTP-U

X2-U

SCTP UDP

PDCP<sup>3</sup>, RRC

NR-PDCP<sup>3</sup>,

NR-RRC

Transport

X2-C

PDCP³, RRC

NR-RRC

X2-AP GTP-U

Transport

TM500, E500

SCTP UDP

NG-C NG-U

SCTP UDP

Transport

S1-MME S1-U

S1-AP GTP-U

SCTP UDP

Transport

EPS-NAS<sup>2</sup>

NG-AP GTP-U E1-AP

5GS-NAS<sup>2</sup>

E1

SCTP

Transport





**COMMERCIAL - INSTALL** 

V4		V6		Specifications – Requirements & Architecture					
				TR 22.885: Stu	TR 22.885: Study on LTE support for V2X services				
				TS 22.886: Stu V2X services	TS 22.886: Study on enhancement of 3GPP support for 5G V2X services				
V4 application is 16777355		V6 application is 16777356		TS 22.185: Service requirements for V2X services					
Diameter Diameter				TS 22.186: Serv	TS 22.186: Service requirements for enhanced V2X scenarios				
SCTP SCTP				TS 23.285: Arcl	TS 23.285: Architecture enhancements for V2X services				
Transport		Transport		TS 33.185: Secu	urity aspect for L	TE suppor	t of V2X services		
					TR 37.885: Study on evaluation methodology of new V2X use cases for LTE & NR				
Specifications - Proto	ocols					Refere	nce Points		
S 24.385: V2X services	Manag	ement Object (MO)							
S 24.386: User Equipm	ent (Ul	E) to V2X Control Fun	ction Pro	otocol aspects; Stag	e 3 SDP	V3			
S 29.388: V2X Control	Functio	on to HSS aspects (V4	); Stage 3	3		V4			
S 29.389: Inter-V2X Co	ntrol F	unction Signaling asp	ects (V6)	); Stage 3	V6				
GPP TS 22.185	V2V V2I				V2I		V2N		
atency	< - 10	00ms	<= 100	lmc					
atticy	With	or without RSU Oms (without RSU)	With o	or without RSU ms (without RSU)	<= 1001113 (WI		<= 1000ms (E2E)		
Potential V2X service	With <= 20 Mutu	or without RSU Oms (without RSU) Jal Vehicle reness and Road	With o <= 20r	or without RSU	Road safety u		Mutual Vehicle Awareness use case		
	With <= 20 Mutu Awar safet	or without RSU Oms (without RSU) Jal Vehicle reness and Road	With o <= 20r Road s	or without RSU ms (without RSU) safety use cases	Road safety u	se cases	Mutual Vehicle Awareness use		
Potential V2X service	With <= 20 Mutu Awar safet High Perio	or without RSU Oms (without RSU) Jal Vehicle reness and Road Y	With o <= 20r Road s equiring a	or without RSU ms (without RSU) afety use cases application-layer me Event-triggered - u	Road safety u essage retransmi	se cases ssions	Mutual Vehicle Awareness use		
Potential V2X service Reliability Message	With <= 20 Mutu Awar safet High Perio Up to	or without RSU Oms (without RSU) Jal Vehicle reness and Road Y reliability without re dic broadcast - 50-30	With o <= 20r Road s equiring a 00 bytes, cond per	or without RSU ms (without RSU) safety use cases application-layer me Event-triggered - u transmitting UE	Road safety u essage retransmi	se cases ssions	Mutual Vehicle Awareness use		
Potential V2X service Reliability Message Size, Frequency	With <= 20 Mutu Awar safet High Perio Up to Drive	or without RSU Oms (without RSU) Jal Vehicle reness and Road y reliability without re odic broadcast - 50-30 o 10 messages per sec	With o <= 20r Road s equiring a 00 bytes, cond per time (e.g. locity of	or without RSU ms (without RSU) safety use cases application-layer me Event-triggered - u transmitting UE . 4 seconds) the UEs is 500 km/	Road safety u essage retransmi up to 1200 bytes h	se cases ssions	Mutual Vehicle Awareness use		
Potential V2X service Reliability Message Size, Frequency Range	With <= 20 Mutu Awar safet High Perio Up to Drive	or without RSU Oms (without RSU) Jal Vehicle reness and Road y reliability without re dic broadcast - 50-30 o 10 messages per sec er(s) ample response for maximum relative ve	With o <= 20r Road s equiring a 20 bytes, cond per time (e.g. locity of psolute v	or without RSU ms (without RSU) safety use cases application-layer me Event-triggered - u transmitting UE . 4 seconds) the UEs is 500 km/	Road safety u essage retransmi up to 1200 bytes h	se cases ssions	Mutual Vehicle Awareness use		
Potential V2X service Reliability Message Size, Frequency Range Speed	With <= 20 Mutu Awar safet High Perio Up to Drive V2V t	or without RSU Oms (without RSU) Jal Vehicle reness and Road Y reliability without re rdic broadcast - 50-3G D 10 messages per sec er(s) ample response f maximum relative ve and V2P maximum at	With o <= 20r Road s equiring a 20 bytes, cond per time (e.g. locity of psolute v	or without RSU ms (without RSU) safety use cases application-layer me Event-triggered - t transmitting UE . 4 seconds) the UEs is 500 km/h elocity is 250 km/h	Road safety u essage retransmi up to 1200 bytes h	se cases ssions	Mutual Vehicle Awareness use case		
Potential V2X service Reliability Message Bize, Frequency Range Bipeed BGPP TS 22.186	With <= 20 Mutu Awar safet High Perio Up to Drive V2V t	or without RSU Oms (without RSU) Jal Vehicle reness and Road y reliability without re dic broadcast - 50-30 o 10 messages per sec er(s) ample response f maximum relative ve and V2P maximum at Vehicles Platooni	With o <= 20r Road s equiring a 00 bytes, cond per time (e.g. locity of psolute v <b>ng<sup>1</sup> A</b> 3	or without RSU ms (without RSU) safety use cases application-layer me Event-triggered - t transmitting UE . 4 seconds) the UEs is 500 km/h elocity is 250 km/h	Road safety u essage retransmi up to 1200 bytes h <b>Extended Se</b>	se cases ssions	Mutual Vehicle Awareness use case		
Potential V2X service Reliability Message Size, Frequency Range Speed BGPP TS 22.186 Max end-to-end latence	With <= 20 Mutu Awar safet High Perio Up to Drive V2V t	or without RSU Oms (without RSU) Jal Vehicle reness and Road y reliability without re dic broadcast - 50-30 o 10 messages per sec er(s) ample response f maximum relative ve and V2P maximum at Vehicles Platoonii 10-25	With o <= 20r Road s equiring a 20 bytes, cond per time (e.g. locity of posolute v ng <sup>1</sup> A 3 99	or without RSU ms (without RSU) safety use cases application-layer me Event-triggered - u transmitting UE . 4 seconds) the UEs is 500 km/ elocity is 250 km/h dvanced Driving <sup>2</sup>	Road safety u essage retransmi up to 1200 bytes h Extended Ser 3-100	se cases ssions	Mutual Vehicle Awareness use case		

5GC	5G Core Network	eMBB	Enhanced Mobile Broadband	NB-IoT	Narrow Band Internet of Things	SDAP	Service Data Adaptation Protocol
5GS	5G System	eNB	Evolved Node B	NFVO	NFV Orchestrator	SDN-C	SDN Controller
AMF	Access and Mobility Management Function	EPC	Evolved Packet Core	NG- RAN	NG Radio Access Network	SGW	Serving GW
AS	Access Stratum	EPS	Evolved Packet System	NR	New Radio	SMF	Session Management Function
AU/RU	Antenna Unit / Radio Unit	FDD	Frequency Division Duplex	NSA	Non-Standalone	SN	Secondary Node
BHR	Backhaul Rate	FFT	Fast Fourier Transform	OSI	Other System	SUL	Supplementary Uplink
BM-SC	Broadcast Multicast Service Center	FR	Frequency Range	055	information Operations Support	TDD	Time Division Duplex
BSS	Business Support	gNB	Next Generation nodeB		System	TDF	Traffic Detection Function
BWP	System Bandwidth Part	HLS	Higher Layer Split	PDCP	Packet Data Convergence Protocol	TSN	Time-Sensitive
CBRS	Citizens Broadband Radio Service	LDPC	Low-Density Parity-Check	PFCP	Packet Forwarding Control Plane	TTI	Networking Transmission Time Interval
CoMP	Coordinated	LLS	Lower Layer Split	PGW	PDN Gateway	UE	User equipment
CP	Multipoint Control Plane	MAC	Medium Access Control	PHY	Physical Layer Passive Optical Network	UP	User Plane
СР	Cyclic Prefix	MBMS	Multimedia Broadcast Multicast Service	RAN	Radio Access Network	UPF	User Plane Function
CPRI	Common Public Radio Interface	MBMS- GW	MBMS Gateway	RAT	Radio Access Technologies	URLLC	Ultra-reliable Low Latency Communications
CU	Central Unit	MIMO	Multiple-Input Multiple-Output	RLC	Radio Link Control	V2I	Vehicle-to- Infrastructure
CUPS	Control and User Plane Separation	MME	Mobility Management	RMSI	Remaining System Information	V2N	Vehicle-to-Network
DC	Data Center	mMTC	Massive Machine Type	RRC	Radio Resource Control	V2P	Vehicle-to-Pedestrian
DN	Data Network		Communications	RSU	Roadside Unit	V2V	Vehicle-to-Vehicle
DU	Distributed Unit	MN	Master Node	SA	Standalone	V2X	Vehicle-to-Everything
eCPRI	Enhanced Common Public Radio	NAS	Non-Access Stratum	SCS	Sub carriers Spacing	WDM	Wavelength-division multiplexing

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