

5G DEVICES CATEGORIZATION



5G Devices Categorization

by NGMN Alliance

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Abstract: Short introduction and purpose of document

The purpose of this document is to provide a use-case based categorization of 5G Devices implementing 3GPP Rel-15 relevant Technical Specifications.

In particular, 5G Devices coming to market between 2H 2019 and 1H 2020 are addressed.

For each 5G Devices category (among eMBB, Fixed Wireless Access and Industrial), a set of mandatory and recommended features is defined.

Document History

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1 OVERALL CATEGORIZATION

Use-case based categories of 5G Devices addressed by V 1.0 of this White Paper are:

- eMBB 5G Devices: mainly Smartphones, Tablets and Mobile Hotspot Routers
- Outdoor and Indoor CPE for 5G Fixed Wireless Access services
- Different Types of 5G S-Modules for Industrial applications

For each 5G Devices category, a set of mandatory and recommended features is defined. Mandatory features shall be supported starting from the very first generation of 5G Devices (the ones launched to market in 2019), while recommended features shall be supported, basically, by 5G Devices coming to market from 1H 2020.

2 EMBB 5G DEVICES

 $\mathsf{eMBB}\xspace$ 5G Devices are mainly Smartphones, Tablets and Mobile Hotspot Routers.

For the eMBB case, following general requirements are considered:

- Downlink peak throughput higher than 1.5 Gbps
- Uplink peak throughput higher than 100 Mbps
- Average RTT latency between 10 and 15 ms, with minimum RTT latency below 10 ms (for Option 3x scenarios)
- Average RTT latency between 5 and 10 ms, with minimum RTT latency below 5 ms (for Option 2 scenarios)
- Full 5G intra-RAT and inter-RAT mobility support

eMBB 5G Devices shall be compliant with following technical requirements, in terms of supported features and expected performances:

1. 5G Deployment Options		
Option 3x	First Generation	
Option 3a	Not Supported	
Option 3	Not Supported	
Option 2	First Generation	
Option 7	Not Supported	
Option 7a	Not Supported	
Option 7x Starting from 1H 20		
Option 5 Starting from 1H 2		
Option 4 Starting from 1H 202		
Option 4a	Not Supported	

Rationale for 5G Deployment Options requirements: first generation of eMBB 5G Devices shall mainly work with Non-Standalone Option 3x and Standalone Option 2 architectures.

Implications of 5G Deployment Options requirements: starting from 1H 2020, eMBB 5G Devices shall support necessary Deployment Options, in order to allow Operators to exploit different architectures for their actual commercial services.



2. Multi-RAT Support		
5G NR as per	Mandatory	
Deployment Options in		
Table 1.		
LTE Rel-15	Mandatory	
WCDMA/HSPA Rel-9	Mandatory	
GSM/GPRS/EDGE Rel-9	Mandatory	

Rationale for Multi-RAT Support requirements: at least in 2019 - 2020 timeframe, Operators still need 3G and 2G support by eMBB 5G Devices.

Implications of Multi-RAT Support requirements: at least in 2019 - 2020 timeframe, Chipsets for eMBB 5G Devices shall be fully Multi-RAT. Removal of 3G and 2G support could be considered starting from 2021.

3. Operating Frequency Bands		
NR n78	Mandatory	
NR n77	Mandatory	
NR n79	Mandatory	
NR n75	Recommended	
NR n76	Recommended	
NR n41	Mandatory	
NR n40	Mandatory	
NR n1	Mandatory	
NR n3	Mandatory	
NR n5	Mandatory	
NR n7	Mandatory	
NR n8	Mandatory	
NR n20	Mandatory	
NR n25	Mandatory	
NR n28	Mandatory	
NR n66	Mandatory	
NR n71	Mandatory	
NR n80	Recommended	
NR n82	Recommended	
NR n83	Recommended	
NR n257	Recommended	
NR n258	Recommended	
NR n261	Recommended	
LTE B1	Mandatory	
LTE B2	Mandatory	
LTE B3	Mandatory	
LTE B5	Mandatory	
LTE B7	Mandatory	
LTE B8	Mandatory	
LTE B12	Mandatory	
LTE B13	Mandatory	
LTE B14	Mandatory	
LTE B20	Mandatory	



LTE B25	Mandatory
LTE B28	Mandatory
LTE B32	Mandatory
LTE B34	Mandatory
LTE B38	Mandatory
LTE B39	Mandatory
LTE B40	Mandatory
LTE B41	Mandatory
LTE B48	Mandatory
LTE B66	Mandatory
LTE B71	Mandatory

Rationale for Operating Frequency Bands requirements: ensure 5G Global Roaming for eMBB 5G Devices from the standpoint of supported NR and LTE frequency bands. NR FDD bands shall be supported as well.

Implications of Operating Frequency Bands requirements: requirements for NR SDL and SUL bands, together with FR2 bands, are recommended, so those frequency bands shall be supported by eMBB 5G Devices coming to market from 1H 2020.

4.	MIMO Capabilities	
Frequency Bands	DL	UL
Any supported	2x2 Mandatory,	1x1 Mandatory,
Sub 1 GHz NR Band	4x4 Recommended	2x2 Recommended
Any supported	4x4 Mandatory	1x1 Mandatory,
NR FR1 Band above 1 GHz		2x2 Recommended
Any supported NR FR2 Band	2x2 Mandatory,	2x2 Mandatory
	4x4 Recommended	
Any supported	2x2 Mandatory	1x1 Mandatory,
Sub 1 GHz LTE Band	4x4 Recommended	2x2 Recommended
Any supported	4x4 Mandatory	1x1 Mandatory,
LTE Band above 1 GHz		2x2 Recommended

Rationale for MIMO Capabilities requirements: maximize the usage, by eMBB 5G Devices, of as many as possible MIMO spatial layers both in Downlink and Uplink, in order to enhance spectral efficiency.

Implications of MIMO Capabilities requirements: UL MIMO 2x2 (for both NR and LTE) shall be supported by eMBB 5G Devices coming to market from 1H 2020.

5. Modulation Schemes		
Frequency Bands	DL	UL
Any supported NR FR1 Band	256QAM Mandatory	64QAM Mandatory,
		256QAM Recommended
Any supported NR FR2 Band	64QAM Mandatory,	64QAM Mandatory,
	256QAM Recommended	256QAM Recommended
Any supported LTE Band	256QAM Mandatory,	64QAM Mandatory,
	1024QAM Recommended	256QAM Recommended



Rationale for Modulation Schemes requirements: maximize NR and LTE spectral efficiency, both in DL and UL.

Implications of Modulation Schemes requirements: UL 256QAM (for both NR and LTE) shall be supported by eMBB 5G Devices coming to market from 1H 2020.

6. LTE-NR Dual Connectivity Configurations		
Minimum Configuration	DL	UL
to be supported	4 LTE inter-band CCs (at least 12	1 LTE CC
	MIMO layers) + 1 NR FR1 CC (4	+ 1 NR FR1 CC (at least 2 MIMO
	MIMO layers)	layers)
	2 LTE CCs (at least 6 MIMO layers) + 8 NR FR2 intra-band CCs (at least 2 MIMO layers)	1 LTE CC + 2 NR FR2 CCs (at least 2 MIMO layers)

Rationale for LTE-NR Dual Connectivity Configurations requirements: eMBB 5G Devices shall be able to support Multi-Gigabit DL peak throughput and UL peak throughput above 100 Mbps.

Implications of LTE-NR Dual Connectivity Configurations requirements: no particular constraints for eMBB 5G Devices to combine LTE and NR frequency bands in EN-DC configurations.

7. NR Carrier Aggregation Configurations			
DL UL			
NR CA 3DL/2UL 3 NR FR1 inter-band CCs		2 NR FR1 inter-band CCs	
NR CA 10DL/4UL	2 NR CCs FR1+ 8 NR FR2	2UL CCs FR1 + 2 NR FR2	
	CCs	CCs	

Rationale for NR Carrier Aggregation Configurations requirements (supported in Deployment Options mentioned in Table 1.): eMBB 5G Devices shall be able to support Multi-Gigabit DL peak throughput and UL peak throughput above 100 Mbps.

Implications of NR Carrier Aggregation Configurations requirements: no particular constraints for eMBB 5G Devices to aggregate NR TDD and NR FDD frequency bands in NR Carrier Aggregation.

8.	Other Physical Layer Req	uirements
23 dBm Max	kimum output power	Mandatory



26 dBm Maximum output power	Recommended
supportedSubCarrierSpacingDL:	Mandatory
Simultaneous reception or transmission with	
different numerologies in inter-band	
NR CA in FR1	
supportedSubCarrierSpacingDL:	Mandatory
Simultaneous reception or transmission with	
different numerologies in inter-band NR CA	
including both FR1 and FR2 bands	
srs-TxSwitch	Mandatory
SCS 15kHz-Normal CP	Recommended
SCS 30kHz-Normal CP	Mandatory
SCS 60kHz-Normal CP	Recommended
SCS 60kHz-Extended CP	Recommended
Support SIB static frame structure	Mandatory
configuration	
Support SIB+RRC semi-static frame	Mandatory
structure configuration	
Support DCI dynamic frame structure	Recommended
configuration is recommended	
Support regular slots as well as slots	Mandatory
containing uplink-downlink switchpoints	
Support 2, 4, 7 OFDM symbols in a mini-slot	Mandatory
Support Uplink-Downlink Switch Period:	Mandatory
5ms	
Support Uplink-Downlink Switch Period:	Mandatory
3ms+2ms	
The GP in an uplink / downlink switching	Mandatory
period contains 4 OFDM symbols	
The GP in an uplink / downlink switching	Mandatory
period contains 2 OFDM symbols	
The GP in an uplink / downlink switching	Recommended
period contains 1 OFDM symbol	
Support DL/UL switching GP duration and	Mandatory
starting position configurable	
1 UE-specific RRC configured DL/UL BWP	Mandatory
per carrier. RRC reconfiguration of any	
parameters related to BWP	
Up to 2 UE-specific RRC configured DL/UL	Mandatory
BWPs per carrier. Active BWP switching by	
DCI and timer. Same numerology for all the	
UE-specific RRC configured BWPs per	
carrier	
Up to 4 UE-specific RRC configured DL/UL	Mandatory
BWPs per carrier. Active BWP switching by	
DCI and timer. Same numerology for all the	
UE-specific RRC configured BWPs per	
carrier	
Up to 4 UE-specific RRC configured DL/UL	Recommended
BVVPs per carrier. Active BWP switching by	
DCI and timer. More than one numerology	



for the UE-specific RRC configured BWPs	
per carrier	
Uplink DFT-S-OFDM	Mandatory
Uplink CP-OFDM	Mandatory
Downlink CP-OFDM	Mandatory
Support the waveform in Msg3	Mandatory
Waveform for grant free PUSCH	Mandatory
UL waveform via reconfiguration or PDCCH	Mandatory
indication	
PBCH, PDCCH, PDSCH	Mandatory
PRACH, PUCCH, PUSCH	Mandatory
Support PBCH subcarrier spacing	Mandatory
configurable	
Support PBCH period configurable in the	Mandatory
range {5 ms, 10 ms, 20 ms, 40 ms, 80 ms}	
Support the number of SSBs configurable	Mandatory
(1~8) for PBCH	
Support PBCH combined detection, the	Mandatory
times of combination is 4 at most	
The number of OFDM symbols occupied by	Mandatory
PDCCH is configurable, range are 1,2,3	
OFDM symbols	
The number of CCEs occupied by PDCCH	Mandatory
is configurable, range are 1,2,4,8 and 16	
PDCCH QPSK modulation	Mandatory
PDCCH Beamforming	Mandatory
PDCCH Non-interleaving mapping mode	Mandatory
Support interleaving mapping mode, the	Mandatory
size of REG bundle and interleaved	
mapping is configurable for PDCCH	
PDCCH transmission format: Format0_0,	Mandatory
Format0_1, Format1_0, Format1_1	
PDCCH transmission format: Format2_0,	Recommended
Format2_1, Format2_2, Format2_3	
PDSCH RMSI is transmitted with beam	Mandatory
sweeping	
PRACH format 0	Mandatory
PRACH format C2 (15kHz SCS)	Mandatory
PRACH format format B4 (15kHz, 30kHz	Mandatory
SCS)	
PRACH format 3	Recommended
PUCCH format0, 1, 2, 3	Mandatory
PUCCH format4	Recommended
PUCCH Intra-slot frequency hopping	Mandatory
PUCCH Inter-slot frequency hopping	Mandatory
PUCCH BPSK, QPSK modulation	Mandatory
Support periodic CQI/PMI/RI reporting on	Mandatory
PUCCH and reporting modes in different	
multiantenna transmission modes	
PUSCH π/2-BPSK, QPSK, 16QAM,	Mandatory



64QAM	
Support periodic BW/NW CQI/PMI/RI	Mandatory
reporting on PUSCH	
Support aperiodic BW/NW CQI/PMI/RI	Recommended
reporting on PUSCH	
DL synchronous signal, DMRS, CSI-RS	Mandatory
UL DMRS, SRS	Mandatory
Support transmiting PSS/SSS in SSB, and	Mandatory
support SSB coverage enhancement with	
beam sweeping	
Support Type 1 and type 2 DMRSs for	Mandatory
PDSCH mapping type A	
Support Type 1 and type 2 DMRSs for	Mandatory
PDSCH mapping type B	
Support additional DMRS for high-speed	Mandatory
scenarios	
Support PBCH DMRS	Mandatory
Support PBCH beam sweeping	Mandatory
Support PDCCH DMRS	Mandatory
PDCCH USS beamforming	Mandatory
PDCCH CSS beam sweeping.	Mandatory
Support single-port CSI-RS for connected	Mandatory
mode RLM measurement, multi-beam	
sweepingis supported	
Support 4 ports CSI-RS beamforming	Mandatory
transmission for CQI/RI, support 8/16/32	
ports CSI-RS beamforming transmission for	
PMI measurement	
Support single-port CSI-RS for connected	Recommended
mode RRM measurement, multi-beam	
sweeping is supported	
Support single-port CSI-RS for TRS	Mandatory
When PUSCH mapping type A or type B	Mandatory
are used, the uplink waveform CP-OFDM is	
used to configure type 1 and type 2 DMRSs.	
The uplink waveform DFT-S-OFDM can be	
used to configure type 1 DMRS	
Support 4 OFDM symbols for SRS resource	Mandatory
in a Uplink-Downlink Switch Period	
For SA, support 2Tx SRS transmission	Mandatory
For NSA, support 1Tx SRS transmission	Mandatory
Support SRS switching in transmission	Mandatory
antennas for 4 ports: NSA, 1T4R, SA 2T4R	
UL codebook-based transmission mode	Mandatory
UL non codebook-based transmission mode	Recommended
DL transmission mode 1	Mandatory
Support UL resource indication type0 and	Mandatory
type1	Maria Inte
Support DL resource indication type0 and	iviandatory
non-interleaved type1	



Support DL resource indication interleaved	Recommended
Support UL and DL resource indication adaptive. The minimum allocation of granularity 1 PRB	Mandatory
The PRB bundle size can be statically configured for the PDSCH	Mandatory
Support PDSCH dynamic indication of PRB BundleSize via PDCCH	Recommended
Intra-slot UL PUSCH frequency hopping	Recommended
Inter-slot UL PUSCH frequency hopping	Recommended
Support slot interval K2=1~8 from UL Grant PDCCH to PUSCH	Mandatory
Support the minimum slot interval 0 from PDCCH to PUSCH	Recommended
Support the minimum slot interval 0 from PDCCH to PDSCH	Mandatory
Support slot interval (K0=1~8) from DL Grant from PDCCH to PDSCH	Recommended
PDCCH to PDSCH interval	Recommended
Support buffer status report, support all the formats of BSR	Mandatory
Support periodicBSR-Timer,retxBSR-Timer	Mandatory
etc. related timer and parameters	-
Support uplink type1 schedule-free, period,	Recommended
resource location, Modulation coding level etc. are configurable	
Support downlink semi-continuous	Recommended
schedule, period, the number of process	
etc. are configurable	
Periodic wideband CQI/PMI/RI reporting on the PUCCH	Mandatory
Periodic narrowband CQI/PMI/RI reporting on the PUCCH	Mandatory
Periodic wideband CQI/PMI/RI reporting on the PUSCH	Mandatory
Periodic narrowband CQI/PMI/RI reporting on the PUSCH	Mandatory
Aperiodic wideband CQI/PMI/RI reporting on the PUSCH	Recommended
Aperiodic narrowband CQI/PMI/RI reporting on the PUSCH	Recommended
The UL and DL incremental redundancy (IR), at least 4 redundancy versions	Mandatory
UL and DL asynchronous adaptive HARQ	Mandatory
16 downlink HARQ processes	Mandatory
16 uplink HARQ processes	Mandatory
Support the code block group (CBG)-based HARQ processing. A single TB contains a maximum of 8 code blocks (CBs)	Recommended



HARQ-ACK-spatial-bundling Reporting	Mandatory
modes	
Non-HARQ-ACK-spatial-bundling Reporting	Mandatory
modes	
Semi-static codebook	Recommended
Dynamic codebook	Mandatory
HARQ ACK information can be reported on	Mandatory
the PUCCH and PUSCH	
Statically configure Rate Offset of HARQ	Mandatory
ACK information on the PUSCH	
Dynamic configure (PDCCH) Rate Offset of	Recommended
HARQ ACK information on the PUSCH	
Support slot interval K1 = 0 from PDSCH to	Optional
HARQ ACK feedback	
Support slot interval K1 = 1 ~ 8 from	Mandatory
PDSCH to HARQ ACK feedback	

9. Access Stratum Requirements (RLC, PDCP, SDAP, RRC, DRX)	
Upper Layer Indicator	Mandatory
Three transmission mode: TM, UM, AM	Mandatory
ARQ function	Mandatory
RLC re-establish function	Mandatory
Segmentation (AM and UM) and re-segmentation	Mandatory
(AM only) of RLC SDUs	
Reassembly of SDU (AM and UM)	Mandatory
Duplicate Detection (AM only)	Mandatory
RLC SDU discard (AM and UM)	Mandatory
Protocol error detection (AM only)	Mandatory
RoHC Profile 0x0001	Mandatory
RoHC Profile 0x0002	Mandatory
RoHC Profile 0x0000	Optional
RoHC Profile 0x0004	Optional
RoHC Profile 0x0006	Optional
NEA0	Mandatory
128-NEA1	Mandatory
128-NEA2	Mandatory
128-NEA3	Mandatory
Support RRC Integrity protection : 128-NIA1	Mandatory
Support RRC Integrity protection : 128-NIA2	Mandatory
Support RRC Integrity protection : 128-NIA3	Mandatory
Support user plane Integrity protection	Recommended
Three transmission mode:TM, UM, AM	Mandatory
PDCP PDU Reordering and duplicate detection	Mandatory
PDCP PDU routing (in case of split bearers)	Mandatory
PDCP SDU Retransmission and PDCP SDU discard	Mandatory
PDCP re-establishment and data recovery for RLC	Mandatory
AM	



PDCP duplication	Recommended
Mapping between QoS flows and DRBs	Mandatory
Marking QoS flow ID (QFI) in both DL and UL packets	Mandatory
Establishment, maintenance and release of an RRC	Mandatory
connection between the UE and NG-RAN	
Establishment, configuration, maintenance and	Mandatory
release of Signalling Radio Bearers (SRBs) and Data	
Radio Bearers (DRBs)	
UE measurement reporting and control of the	Mandatory
reporting	
QoS management functions	Mandatory
Detection of and recovery from radio link failure	Mandatory
NAS message transfer to/from NAS from/to UE	Mandatory
Mobility functions: Handover and context transfer; UE	Mandatory
cell selection and reselection and control of cell	
selection and reselection; Inter-RAT mobility	
Access control: support unified access banning	Mandatory
mechanism	
Support system messages Minimum SI and Other SI,	Mandatory
and support periodical broadcasting Minimum SI and	
on-demand transferring other SI	
Paging function	Mandatory
Paging DRX in idle mode	Mandatory
Connected-discontinuous reception (C-DRX), long	Mandatory
DRX cycle, and short DRX cycle in RRC connected	
mode are configurable	
Support mobility management functions in the	Mandatory
RRC_INACTIVE state: RAN-based Notification Area	
(RNA) management, RAN-based Notification Area	
update (RNAU), and transition from RRC_INACTIVE	
to RRC_CONNECTED	
UDC of PDCP packets	Recommended
Uplink header compression (uplink only ROHC) of	Recommended
data radio bearers (DRBs)	
Support of E-UTRA and NR neighbour report in EN-	Recommended
DC	
Support of dynamic spectrum sharing	Mandatory

10. Non-Access Stratum Requirements	
Support QoS Flow based QoS mechanism, support	Mandatory
GBR and Non-GBR Qos Flow	
Support the reflective QoS function. Uplink data flows	Recommended
can be mapped to different QoS flows based on QoS	
rules. Devices can report the reflective QoS capability	
to the network side	
IPv4	Mandatory
IPv6	Mandatory
IPv4v6	Mandatory



Session and Service Continuity Mode: 1	Mandatory
Session and Service Continuity Mode: 2	Mandatory
Session and Service Continuity Mode: 3	Mandatory
Support receiving and storage configuration from URSP	Mandatory
Support PDU session configuration based on URSP parameters	Mandatory
Support network slice selection process when accessing the network	Mandatory
The Network Slice Selection Assistance Information (NSSAI) can be carried in RRC and NAS signaling	Mandatory
Support storage and update of UE Network Slice configuration	Mandatory

11. Basic Processes	
For SA network mode, the network selection priority:	Mandatory
5G > LTE	
For NSA network mode, the network selection priority:	Mandatory
LTE > 3G > 2G	
For the UEs supporting NSA and SA, the network	Mandatory
selection priority: SA > NSA	
(anyway NSA could provide better peak rates)	
Support RSRP/RSRQ/SINR measurement, including	Mandatory
NR intra-frequency and inter-frequency	
measurements	
Support Intra-RAT Cell reselection and Handover	Mandatory
Support single-registration mode in SA network mode	Mandatory
with N26 interface	
Support 5G->4G interworking procedure w/ the N26	Mandatory
interface: Cell reselection, Handover and Redirection	
Support 4G->5G interworking procedure w/ the N26	Mandatory
interface: Cell reselection and Redirection	
Support 4G->5G interworking procedure w/ the N26	Recommended
interface: Handover	
Support single-registration mode in SA network mode	Mandatory
without N26 interface	
Support 5G->4G interworking procedure w/o the N26	Mandatory
interface: Cell reselection and Redirection	
Support 4G->5G interworking procedure w/o the N26	Mandatory
interface: Cell reselection and Redirection	
At the end of EPS Fallback voice service, UEs	Mandatory
support fast return to NR network	
Support NR frequency search and access according	Mandatory
to RRC Connection Release message when Fast	



return by Redirection signaling is supported by	
TIELWOIK	
Support NR frequency search and access when Fast	Mandatory
return by Redirection signaling is not supported by	
network	
Support the above return mechanism at the end of	Recommended
VoLTE voice service after performing handover from	
VoNR voice service to VoLTE voice service and if	
there is no data service	
For 4G->5G interoperability, support background	Recommended
search in idle state in the case that 4G network is not	
configured with 5G neighbourhood cell	
In a EN-DC configuration, addition of SCG with	Mandatory
asynchronous E-UTRAN and NR networks	

12. Service Requirements	
In SA network mode, UEs support EPS Fallback	Mandatory
In SA network mode, UEs support VoNR	Recommended
In NSA network mode, UEs support VoLTE/CSFB	Mandatory
Support SIP/IMS protocol in 5G	Mandatory
Support fall back to 4G voice solution by handover or	Mandatory
Support voice setup over 5G	Recommended
For VoNR, Support header compression, RLC segmentation, Slot aggregation, Downlink SPS, and	Recommended
Configured Grant	
Support voice code codec adjustment triggered by network through MAC CE	Recommended
Support AMR-NB codec : 12.2kbps, 10.2kbps,	Mandatory
7.95kbps, 7.40kbps, 6.70kbps, 5.90kbps, 5.15kbps, 4.75kbps	
2)Support AMR-WB codec : 23.85kbps, 23.05kbps,	Mandatory
19.85kbps, 18.25kbps, 15.85kbps, 14.25kbps, 12.65 kbps, 8.85kbps, 6.6kbps	
Support EVS codec : 13.2kbps, 24.4kbps	Mandatory
Support H.264, H.265 Video codec	Mandatory
Support NR IMS Emergency call	Mandatory
Support fall back (Redirection, Handover) to LTE for	Mandatory
Emergency call	
SMS over IP	Mandatory



SMS over NAS	Mandatory
Support distinguishing between 4G USIM card and 5G USIM card in SA mode	Mandatory
In the scenario of using 4G USIM card to access NR network, in the case that 4G USIM card does not support 5G related fields: UE support storing 5G as the highest priority, for HPLMN, UPLMN and OPLMN selection	Mandatory
In the scenario of using 4G USIM card to access NR network, in the case that 4G USIM card does not support 5G related fields: UE support storing 5G PLMN information that has been successfully registered and will use it for the next switch-on network selection	Mandatory
In the scenario of using 4G USIM card to access NR network, in the case that 4G USIM card does not support 5G related fields: UE support storing 5G NAS security context	Mandatory
Have the capability to support TDD CA and FDD- TDD CA operation	Mandatory
Support Pcell and Scell related configurations	Recommended
Support SCell Activation/Deactivation	Recommended
Support Non-cross carrier scheduling	Recommended
Support Cross carrier scheduling	Recommended
Support different SCS between CCs: 15kHz, 30kHz, 60kHz	Recommended
LTE in EN-DC: 2CC CA	Recommended
LTE in EN-DC: 3CC CA	Recommended
In SA network mode, UEs support EPS Fallback	Mandatory
In SA network mode, UEs support VoNR	Recommended
In NSA network mode, UEs support VoLTE/CSFB	Mandatory
Support SIP/IMS protocol in 5G	Mandatory
Support fall back to 4G voice solution by handover or redirection	Mandatory
Support voice setup over 5G	Recommended
For VoNR, Support header compression, RLC segmentation, Slot aggregation, Downlink SPS, and Configured Grant	Recommended
Support voice code codec adjustment triggered by	Recommended

13. Uplink enhancements	
Support the network side to configure a separate uplink spectrum	Recommended
resource as the uplink transmission spectrum resource of the NR cell,	
that is, the upstream and downlink decoupling of the NR cell.	
Support allocate static part of uplink frequency as the uplink frequency	Recommended
resource of NR cell	



Support dynamic TDM sharing the same part of frequency resource, NR	Recommended
cell adopt the dynamic frequency as uplink frequency resource.	
Support different SCS between SUL and non-SUL carrier	Recommended
Support different SCS between uplink frequency and downlink	Recommended
frequency	
Support Power Control for SUL CC	Recommended
Support for SRS transmission in downlink data transmission band	Recommended
For UE in idle state, support the indication of uplink carrier frequency	Recommended
and uplink carrier selection threshold by system broadcast messages.	
Support PUSCH switching between SUL/non-SUL by RRC	Recommended
reconfiguration	
Support PUSCH switching between SUL/non-SUL by L1 PDCCH – DCI	Recommended
indication	
Support of Single-UL transmission when TDM pattern is supported	Mandatory
Support Single-UL transmission and TDM pattern	
Support of UL Dynamic power sharing	Mandatory
NR MIMO full UL Transmission power	Mandatory

14. Performance Requirements (including OTA)		
LTE	TRP, TRS (see	Mandatory refer to
	table below)	GSMA TS.24-V4.0
FR1	TRP, TRS	Mandatory
FR2	EIRP, EIS, spherical	Mandatory
	coverage	
NR DL peak data rate	1.7 Gbps	Mandatory
	(Bandwidth: 100	
	MHz, DL 4 layers,	
	256QAM, downlink-	
	to-uplink subframe	
	ratio: 8:2)	
	2.5 Gbps	Recommended
	(Bandwidth: 100	
	MHz, DL 8 layers,	
	64QAM, downlink-	
	to-uplink subframe	
	ratio: 8:2)	
NR UL peak data rate	190 Mbps	Mandatory
	(Bandwidth: 100	
	MHz, UL 2 layers,	
	64QAM, downlink-	
	to-uplink subframe	
	ratio: 8:2)	
	250 Mbps	Mandatory



	(Bandwidth: 100	
	MHz. UL 2 lavers.	
	256QAM, downlink-	
	to-uplink subframe	
	ratio: 8:2)	
	280 Mbpc	Pacammandad
	(Denduridthe 100	Recommended
	(Bandwidth: 100	
	MHZ, UL 4 layers,	
	64QAM, downlink-	
	to-uplink subframe	
	ratio: 8:2)	
NR UL and DL concurrency peak	UL: 190 Mbps, DL:	Mandatory
data rate	1.7 Gbps	
	(Bandwidth: 100	
	MHz, UL 2 layers,	
	UL 64QAM, DL 4	
	lavers. DL 256QAM.	
	downlink-to-uplink	
	subframe ratio: 8:2)	
	LIL: 250Mbps DL:	Mandatory
	17 Ghns	Mandatory
	(Rondwidth: 100	
	UL 256QAM, DL 4	
	layers, DL 256QAM,	
	downlink-to-uplink	
	subframe ratio: 8:2)	
	UL: 380Mbps, DL:	Recommended
	2.5Gbps	
	(Bandwidth: 100	
	MHz, UL 4 layers,	
	UL 64QAM, DL 8	
	layers, DL 64QAM,	
	downlink-to-uplink	
	subframe ratio: 8:2)	
User-plane (UP)	User-plane Latency	Mandatory
	(LIL) is shorter than	indiracite. y
	or equal to 6 ms	
		Mandatory
	(DL) is charter than	Inal luator y
		Maria da Cara
control-plane (CP)	Control-plane	Mandatory
	Latency is close to	
	20 ms	
High Speed Train Scenarios	Support the	Mandatory
	capability of	
	demodulation on the	
	speed of 500 km/h	
	for high speed train.	
	Support the	
	optimised solution of	



3GPP for high	
speed train scenario	

15. GSMA Operator Acceptance Values for TRP [dBm], from GSMA TS.24 V4.0			
	BHH	Browsing	Free Space
	(Note 1)	5	
FDD Band 1	13.5	15.5	18.5
FDD Band 2	13.5	15.5	18.5
FDD Band 3	13.5	15.5	18.5
FDD Band 4	13.5	15.5	18.5
FDD Band 5	9.8	14.3	18.0
FDD Band 7	13.5	15.5	18.5
FDD Band 8	9.8	14.3	18.0
FDD Band 11	11.5	14.5	18.0
FDD Band 12	9.8	14.3	18.0
FDD Band 13	9.8	14.3	18.0
FDD Band 17	9.8	14.3	18.0
FDD Band 18	9.8	14.3	18.0
FDD Band 19	9.8	14.3	18.0
FDD Band 20	9.8	14.3	18.0
FDD Band 21	11.5	14.5	18.0
FDD Band 25	13.5	15.5	18.5
FDD Band 26	9.8	14.3	18.0
FDD Band 28	9.8	14.3	18.0
TDD Band 38	13.5	15.5	18.5
TDD Band 39	13.5	15.5	18.5
TDD Band 40	13.5	15.5	18.5
TDD Band 41	13.5	15.5	18.5
TDD Band 42	13.5	15.5	18.5
TDD Band 43	13.5	15.5	18.5

16. GSMA Operator Acceptance Values for TRS [dBm], from GSMA TS.24 V4.0			
	BHH (Note 1)	Browsing	Free Space
FDD Band 1	-89.0	-91.0	-94.0
FDD Band 2	-89.0	-91.0	-94.0
FDD Band 3	-89.0	-91.0	-94.0
FDD Band 4	-89.0	-91.0	-94.0
FDD Band 5	-85.0	-89.5	-93.5
FDD Band 7	-89.0	-91.0	-94.0
FDD Band 8	-85.0	-89.5	-93.5
FDD Band 11	-87.0	-90.0	-93.5
FDD Band 12	-85.0	-89.5	-93.5
FDD Band 13	-85.0	-89.5	-93.5
FDD Band 17	-85.0	-89.5	-93.5
FDD Band 18	-85.0	-89.5	-93.5
FDD Band 19	-85.0	-89.5	-93.5
FDD Band 20	-85.0	-89.5	-93.5
FDD Band 21	-87.0	-90.0	-93.5



FDD Band 25	-89.0	-91.0	-94.0
FDD Band 26	-85.0	-89.5	-93.5
FDD Band 28	-85.0	-89.5	-93.5
TDD Band 38	-89.0	-91.0	-94.0
TDD Band 39	-89.0	-91.0	-94.0
TDD Band 40	-89.0	-91.0	-94.0
TDD Band 41	-89.0	-91.0	-94.0
TDD Band 42	-89.0	-91.0	-94.0
TDD Band 43	-89.0	-91.0	-94.0

Note 1: BHH and Browsing acceptance values are the same for PDA and Wide Grip hand phantom.

	17. RF Requirements	
Maximum output	The UE power class defines the nominal	Mandatory
power	maximum output power. UE support a	
	total maximum output power of 23 dBm	
	(Power Class 3)	
	and should support 26 dBm	
	(Power Class 2)	
	23dBm+23dBm and 20dBm+20dBm	Mandatory
	26dBm+23dBm	Recommended
	Support a total maximum output power of	Mandatory
	26 dBm and 23dBm for PUCCH and	
	PRACH for resp. PC2 and PC3	
Minimum output	The minimum controlled output power of	Mandatory
power	the UE is defined as the power in the	
	channel bandwidth for all transmit	
	bandwidth configurations (resource	
	blocks), when the power is set to a	
	minimum value. For details, see section	
	3GPP TS 38.101-1, section 6.3.1	
Transmit OFF	Transmit OFF power is defined as the	Mandatory
power	mean power in the channel bandwidth	
	when the transmitter is OFF. The transmit	
	OFF power shall not exceed -50 dBm. For	
	details, see section 3GPP TS 38.101-1,	



	section 6.3.2	
UE maximum	Maximum Power Reduction (MPR)	Mandatory
output power	depends on higher order modulation and	
reduction	transmission bandwidth configuration	
	(resource blocks). The specific	
	requirements for MPR are described in	
	section 6.2.2 of 3GPP TS 38.101-1	
Transmit	The conversion time of the transmitter	
ON/OFF time	from the off-power to the maximum	
mask	transmit power and the transition time	
	from the maximum transmit power to the	
	off-power shall not be higher than 10 µs.	
	For the corresponding general ON/OFF	Mandatory
	time profile. PRACH time profile. PUCCH	
	time profile. SRS time profile and other	
	requirements, refer to section 3GPP TS	
	38.101-1 section 6.3.3	
Frequency error	The difference between the UE's transmit	Mandatory
	frequency and the set frequency should	
	be kept within +0.1 PPM	
Error vector	The vector difference between the UF	Mandatory
magnitude	transmit waveform and the reference	
(EVM)	modulation waveform should meet the	
(= +)	following requirements. For details, see	
	3GPP TS 38 101-1 section 6 4 2 1 For	
	the LIFs supporting uplink dual-antenna	
	transmission each RE port shall meet the	
	requirements above	
Occupied	Occupied bandwidth is defined as the	Mandatory
bandwidth	bandwidth containing 99 % of the total	mandatory
banamatri	integrated mean power of the transmitted	
	spectrum on the assigned channel. The	
	bandwidth should be less than the	
	channel bandwidth For details see 3GPP	
	TS 38 101-1 section 6.5.1 For the UEs	
	supporting uplink dual-antenna	
	transmission each RE port shall meet the	
	requirements above	
ACLR	ACLR should not be higher than -30dBc	Mandatory
	for the maximum transmit power of	
	terminals at power class 3. For details	
	see 3GPP TS 38.101-1 section 6.5.2.2.	
	For the UEs supporting uplink dual-	
	antenna transmission each RF port shall	
	meet the requirements above	
	ACLR should not be higher than -31dBc	Mandatory
	for the maximum transmit power of	
	terminals at power class 2 For details	
	see 3GPP TS 38,101-1 section 6.5.2.2	
	For the UEs supporting uplink dual-	
	antenna transmission. each RF port shall	



	meet the requirements above	
Spectrum	The SEM indicator requirements for the	Mandatory
emission mask	maximum transmit power of the terminal	
(SEM)	are defined in TS38.101-1 section 6.5.2.1.	
	For the UEs supporting uplink dual-	
	antenna transmission, each RF port shall	
	meet the requirements above	
Spurious	Spurious emissions are emissions which	Mandatory
emissions	are caused by unwanted transmitter	
	effects such as harmonics emission,	
	parasitic emissions, intermodulation	
	products and frequency conversion	
	products, but exclude out of band	
	emissions unless otherwise stated.Unless	
	otherwise stated, the spurious emission	
	limits apply for the frequency ranges that	
	are more than FOOB (MHz) of	
	'BWChannel + 5MHz' from the edge of the	
	channel bandwidth. For details, see 3GPP	
	TS 38.101-1 section 6.5.3.1. For the UEs	
	supporting uplink dual-antenna	
	transmission, each RF port shall meet the	
	requirements above	
	Spurious emission requirements for UE	Mandatory
	coexistence, see 3GPP TS 38.101-1 section	
	6.5.3.2. For the UEs supporting uplink dual-	
	antenna transmission, each RF port shall	
	meet the requirements above	

18. Power Consumption (Modem only)			
Standby mode	In 5G mode, standby current is not	Recommended	
	higher than 15mA at 1.28ms paging		
	cycle		
	RRC Inactive state, current is not	Recommended	
	higher than 15mA		
Data transmission	In C-DRX state, current is not higher	Recommended	
mode	than 100mA		
	Downlink data transmission 1Gbps	Recommended	
	(high rate), the uplink power is 0dBm		
	(low power), the current is not higher		
	than 600mA		
	Downlink data transmission 1Gbps	Recommended	
	(high rate), the uplink power is 23dBm		
	(high power), the single-Tx terminal		
	current is not higher than 900mA, and		
	double-Tx terminal current is not higher		
	than 1000mA		
	Downlink data transmission 1Gbps	Recommended	
	(high rate), the uplink power is 26dBm		



(high power), the double-Tx terminal	
current is not higher than 1200mA	
Downlink data transmission 10Mbps	Recommended
(low rate). the uplink power is 0dBm	
(low power), the current is not higher	
than 300mA	
Downlink data transmission 10Mbps	Recommended
(low rate), the uplink power is 23dBm	
(high power), the single-Tx teminal	
current is not higher than 600mA,and	
the double-Tx teminal current is not	
higher than 720mA	
Downlink data transmission 10Mbps	Recommended
(low rate), the uplink power is 26dBm	
(high power), the single-Tx teminal	
current is not higher than 800mA and	
the double-Tx teminal current is not	
higher than 950mA	
Uplink data transmission single stream	Recommended
100Mbps (high rate), uplink power	
0dBm (low power), single-Tx terminal	
current is not higher than 400mA,	
double-Tx terminal current is not higher	
than 500mA	
Uplink data transmission single stream	Recommended
100Mbps (high rate), uplink power	
23dBm (high power), single-Tx	
terminal current is not higher than	
700mA, double-Tx terminal current is	
not higher than 900mA	
Uplink data transmission single stream	Recommended
100Mbps (high rate), uplink power	
26dBm (high power), single-Tx	
terminal current is not higher than	
900mA, double-Tx terminal current is	
not higher than 1100mA	
Uplink data transmission 10Mbps (low	Recommended
rate), uplink power 0dBm (low power),	
single-Tx terminal current is not higher	
than 300mA, double-Tx terminal	
current is not higher than 350mA	
Uplink data transmission 10Mbps (low	Recommended
rate), uplink power 23dBm (high	
power), single-Tx terminal current is	
not higher than 600mA, double-Tx	
terminal current is not higher than	
750mA	
Uplink data transmission 10Mbps (low	Recommended
rate), uplink power 26dBm (high	
power), single-Tx terminal current is	
not higher than 750mA, double-Tx	



	terminal current is not higher than 900mA	
Standby mode	In 5G mode, standby current is not higher than 15mA at 1.28ms paging cvcle	Recommended
	RRC Inactive state, current is not higher than 15mA	Recommended
Data transmission mode	In C-DRX state, current is not higher than 100mA	Recommended

3 FIXED WIRELESS ACCESS 5G DEVICES

These 5G Devices are dependent on operating location (Outdoor or Indoor), generally to insure best coverage and continuity of the service, CPE with power class 2 are used. Hence, all the requirements listed above in Tables 1... 18 for PC2 are Mandatory for Fixed Wireless Access 5G Devices. Furthermore, features that insure URLLC are required to provide user-experience comparable to the fixed access performance with optical fiber.

19. Physical Layer Requirements for URLLC			
Interrupted	Allow coexistence between eMBB and	Recommended	
transmission indication	URLLC users		
Fast UL channel		Recommended	
access			
Guarantee packet	target BLER of 10^-5	Recommended	
reception with one	_		
transmission			
Fast feedback for		Recommended	
PUSCH			

Finally, for FWA 5G Devices additional requirements shall be considered, in order to allow such 5G CPE to be remotely managed by Operators' Device Management Platforms (see below, Table 20.)

20. Device Management			
Basic	Support of BBF TR-069	Mandatory	
Device Management			
Performance	Support of BBF TR-143	Mandatory	
Measurements			
Performance	Support of BBF TR-390	Recommended	
Measurements			

4 INDUSTRIAL 5G DEVICES (5G S-MODULES)

For the Industrial use cases, following general requirements are considered:



- Downlink peak throughput higher than 1.5 Gbps
- Uplink peak throughput higher than 100 Mbps
- Average RTT latency between 10 and 15 ms, with minimum RTT latency below 10 ms (for Option 3x scenarios)
- Average RTT latency between 5 and 10 ms, with minimum RTT latency below 5 ms (for Option 2 scenarios)
- Support of URLLC is mandatory for some use cases such as healthcare and autonomous vehicles, so the requirements in above Table 20. are mandatory

Based on variety of characteristics (form factor, sizes, etc) the 5G S-Modules can be classified into 3 types shown below: Basic Type, Smart Type and All-in-one Type.

21. 5G S-Modules Types			
Туре	Basic Type	Smart Type	All-in-one Type
Characteristics	Only communication capability	High performance Application Processor	Built-in antennas
Form Factor	LGA and M.2	LCC+LGA	Dongle
Size	≤ 41mm*44mm ≤ 30mm*52mm	≤ 44mm*45mm	≤ 52mm*93mm ≤ 44mm*70mm

Furthermore, following Management, SIM, Debug and Firmware Upgrade functions shall be supported by 5G S-Modules

Identity Management

5G S-Modules shall have module identity. The module identity could be IMEI or IMSI on user card.

Status Management

5G S-Modules shall have capability of status management. It could be achieved by interface to indicate Module's working status.



Parameter Preset Management

5G S-Modules shall be preset for cellular network bearer access parameters, including but not limited to APN, SMS center number, IP (or URL) and port number.

SIM Functions

5G S-Modules shall support one or more of pluggable SIM/USIM/CSIM interface, SMD type SIM/USIM/CSIM (eUICC) and other SIM form. The following table shows the pins of pluggable SIM/USIM/CSIM. One of two voltage levels should be supported: 3V±10% or 1.8V±10%.

22. SIM Interface			
Interface Type	Interface Name	Interface Description	Interface Characteristics
SIM interface	USIM_DETEC T	USIM DETECT Signal	1
	USIM_RESET	USIM RESET Signal	0
	USIM_CLK	USIM CLK Signal	0
	USIM_DATA	USIM DATA Signal	I/O
	USIM_VCC	USIM Power Output	0

Debug Functions

5G S-Modules shall support developing debug log, opening and closing debug log and outputting debug log via UART or USB or SPI interface.

Firmware Upgrade Functions

5G S-Modules shall support secured firmware upgrade. The firmware of 5G S-Modules could be upgraded by FOTA. The implementation of firmware upgrade depends on device implementation but Standard protocols (such as LwM2M or TR-069) are recommended.

The update workflow includes FOTA initializing, downloading update package segment, getting FOTA update result, getting package name, getting package version and firmware upgrading.