3GPP 5G 無線インターフェース検討状況

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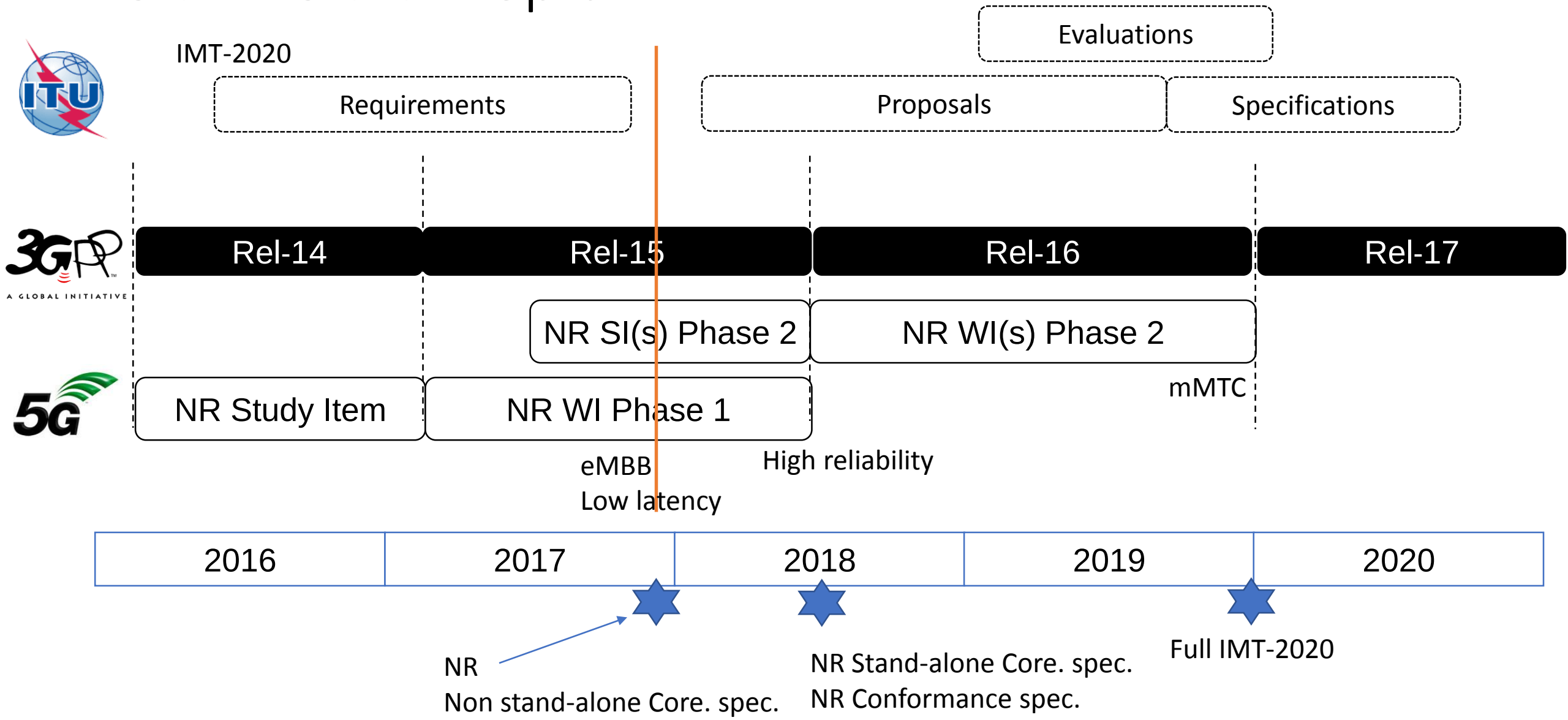
Disclaimers

- This presentation is based on the draft 3GPP specifications to be approved in RAN#78 meeting in Dec/2017.
- The Information may be subject to updates.

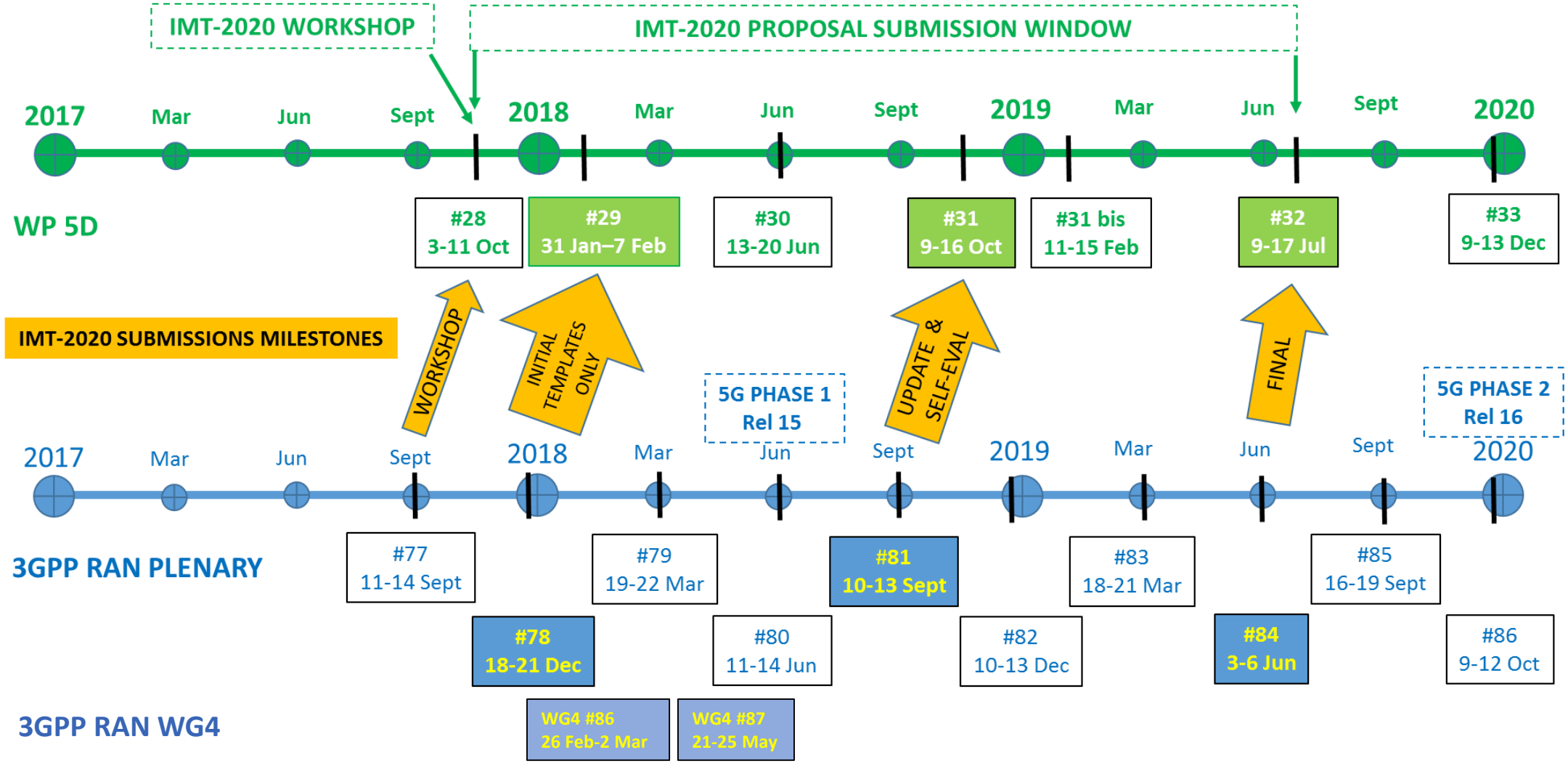
Based on the draft specifications and/or other agreements in 3GPP as of Dec. 2017

3GPP 5G timeplan



IMT-2020 submission timeplan

Source: RP-172098

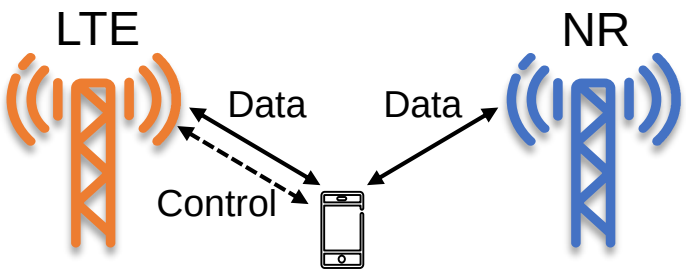


3GPP NR overview

- Flexible, scalable, and future-proof design
  - Forward compatibility
- Spectrum range up to 100GHz
  - Frequency range 1 (FR1):
    - 450MHz – 6.0GHz
    - Channel bandwidth up to 100MHz
  - Frequency range 2 (FR2):
    - 24.25GHz – 52.6GHz
    - Channel bandwidth up to 400MHz
- Support NR carrier aggregation (CA) up to 16 component carriers
- Multi-antenna
  - Massive MIMO
  - Hybrid beam-forming
  - Active antenna system (AAS)
- Low latency
  - Shorter symbol time
  - Mini-slots
- Ultra-lean design
  - Minimize any transmissions not directly related to the user data transmission
  - No cell-specific reference signal

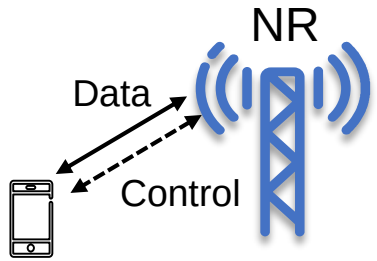
NR architecture options

- Option 3 and Option 7
  - Connectivity via EPC (option 3) or 5GC (option 7)
  - Initial access and mobility by LTE nodes

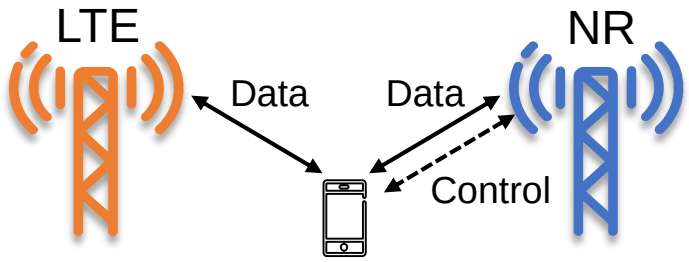


LTE/NR dual-connectivity (EN-DC)

- Option 2 and Option 4



Option 2



Option 4

NR/LTE dual-connectivity

EPC: Evolved packet core (4G core network)
5GC: 5G core network

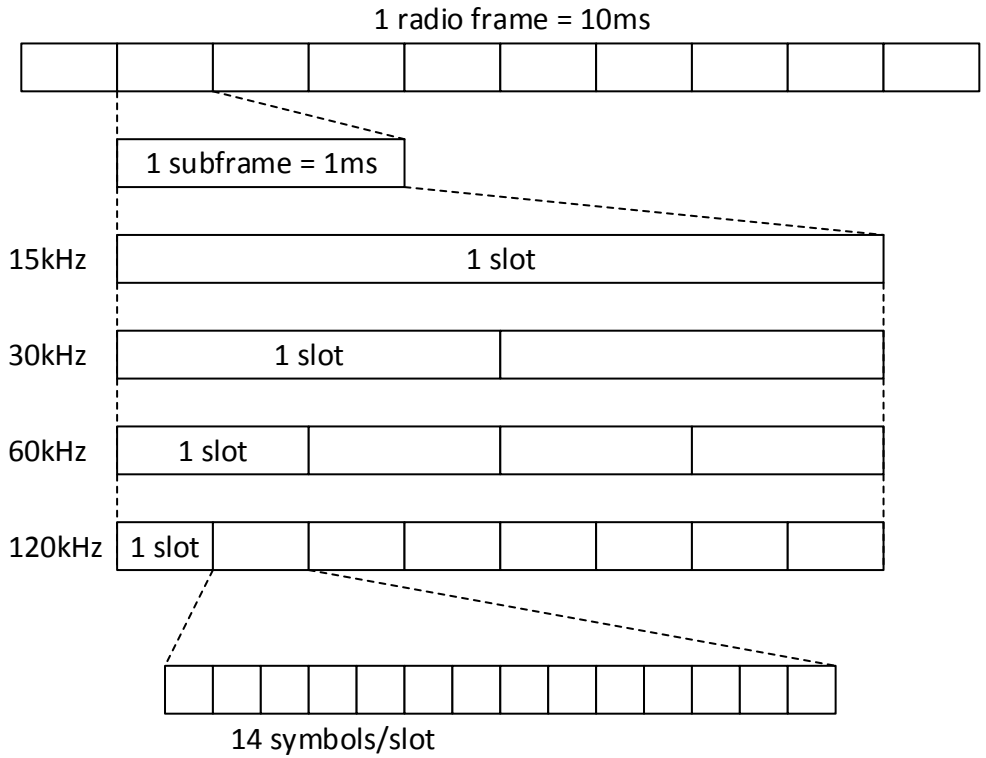
NR numerology and frequency/time structure

- Waveform: OFDM for UL and DL
  - UL also supports DFT-S-OFDM
- Subcarrier spacing (SCS)

Subcarrier spacing	Freq range	Max CBW
15kHz (Same as LTE)	FR1	50MHz
30kHz	FR1	100MHz
60kHz	FR1, FR2	200MHz
120kHz	FR2	400MHz

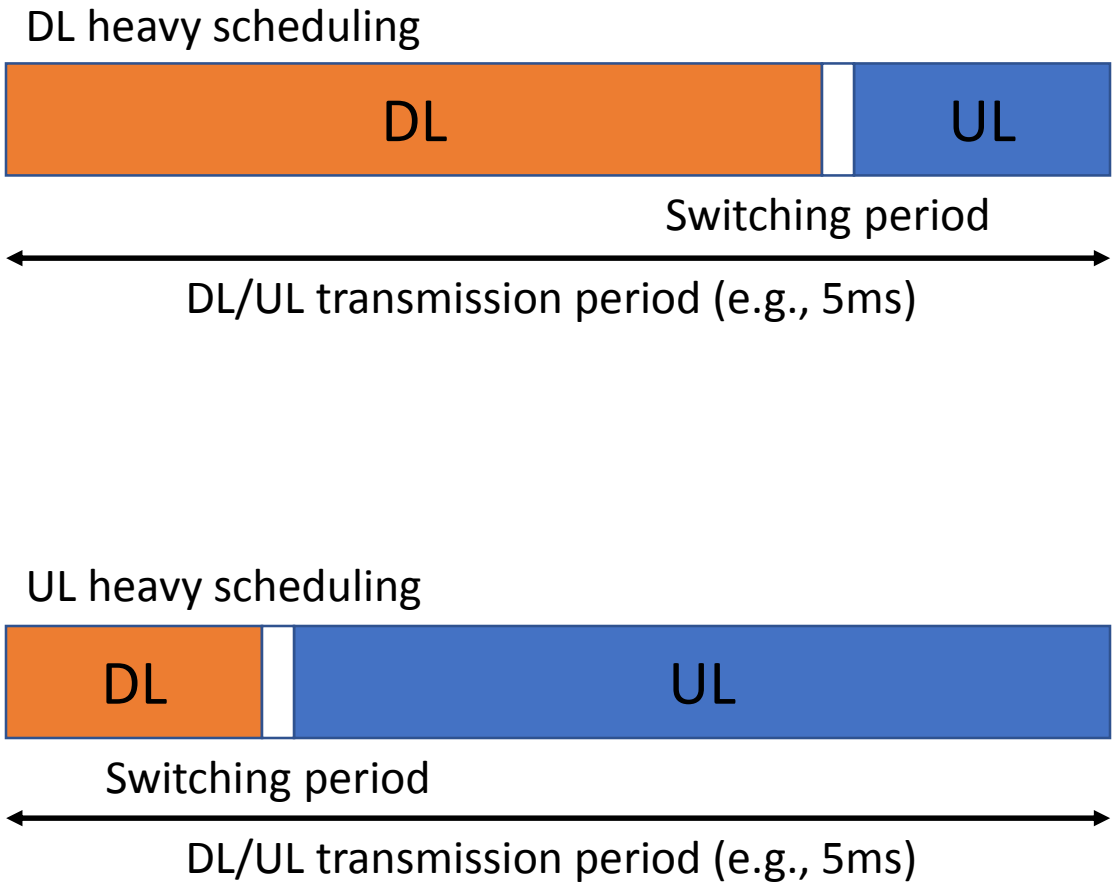
- Larger SCS
  - Shorter slot → Lower latency

- Resource block - basic unit of resources consisting of 12 sub-carriers and 1 slot (14 symbols)



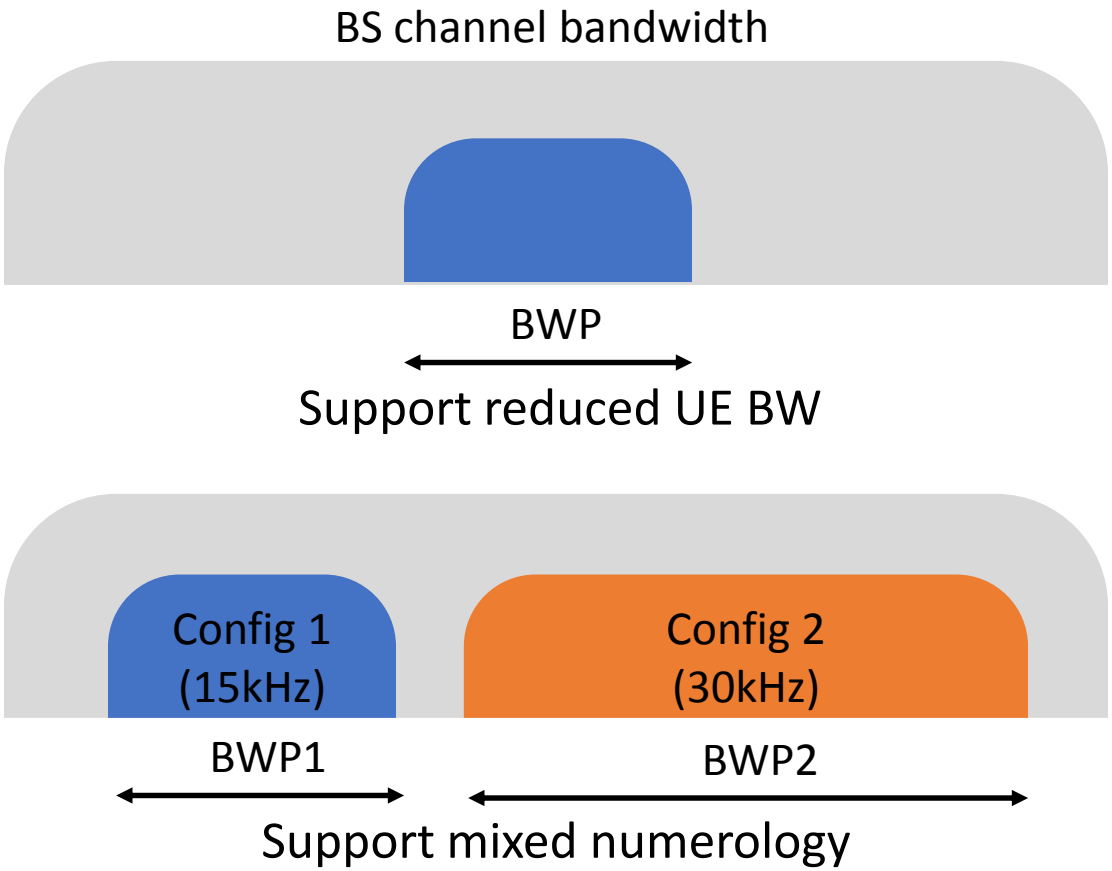
UL/DL allocation for TDD carrier

- Network configures UL/DL allocation for transmission period (e.g., 5ms)
  - Cell-specific configuration
  - Possible to reconfigure UL/DL allocation for transmission period per UE
  - It is possible to configure the same UL/DL allocation as TD-LTE such as UL:DL=1:3 and special subframe configuration



Bandwidth part (BWP)

- A part of BS channel bandwidth configured by the network
  - Configuration per UE
  - Up to 4 BWPs for UL and DL carriers per UE
  - Each BWP may have different SCS, location, and bandwidth
  - UE transmit/receive signal on one of BWPs indicated by control channel



Physical layer uplink overview

- Waveform: CP-OFDM or DFT-S-OFDM (SC-FDM)
- Physical channels
  - PUSCH – Data channel
  - PUCCH – Control channel
    - HARQ-ACK, CSI, Scheduling Request
  - PRACH – Random access channel
- Physical signals
  - DM-RS – Demodulation for PUSCH/PUCCH
  - PT-RS – Phase-tracking RS for PUSCH
  - SRS – Sounding RS
- Modulation
  - PUSCH: π/2-BPSK, QPSK, 16QAM, 64QAM, 256QAM
  - PUCCH: π/2-BPSK, QPSK
- Channel coding
  - Polar code for PUCCH
  - LDPC for PUSCH
- Multi-antenna transmission
  - PUSCH support up to 4 layers with SU-MIMO
  - PUSCH support up to 12 layers with MU-MIMO using orthogonal DM-RS

Physical layer downlink overview

- Waveform: OFDM
- Physical channels
  - PDSCH – Data channel
  - PDCCH – Control channel
  - PBCH – Broadcast channel
- Physical signals
  - DM-RS – Demodulation for PDSCH/PDCCH/PBCH
  - PT-RS – Phase-tracking RS for PDSCH
  - CSI-RS – Channel state information
    - Also used for time/frequency tracking
  - PSS/SSS – Primary/Secondary Synchronization signals
- Modulation
  - PDSCH: QPSK, 16QAM, 64QAM, 256QAM
  - PDCCH/PBCH: QPSK
- Channel coding
  - Polar code for PDCCH/PBCH
  - LDPC for PDSCH
- Multi-antenna transmission
  - PDSCH support up to 8 layers with SU-MIMO
  - PDSCH support up to 12 layers with MU-MIMO using orthogonal DM-RS

NR operating bands

- New operating bands for NR (related to Japan)

Operating band	UL frequency range	DL frequency range	Duplex mode	Frequency range
n77	3300 – 4200 MHz	3300 – 4200 MHz	TDD	FR1
n78	3300 – 3800 MHz	3300 – 3800 MHz	TDD	FR1
n79	4400 – 5000 MHz	4400 – 5000 MHz	TDD	FR1
n257	26.5 – 29.5 GHz	26.5 – 29.5 GHz	TDD	FR2
Note: Existing LTE operating bands 1, 3, 8, 28, 41, and 74 (related to Japan) are also going to be introduced as NR operating bands as n1 (FDD), n3 (FDD), n8 (FDD), n28 (FDD), n41 (TDD), and n74 (FDD)				

E-UTRA-NR-DC (EN-DC) band combination

- NSA is based on LTE dual connectivity and need LTE as an anchor carrier
- 3GPP are going to introduce the DC band combinations 1 NR band and one or more LTE bands
  - The table below summarizes the agreed EN-DC band combinations between the new NR bands and single LTE bands related to Japan as of Dec/2017

New NR bands	LTE bands
n77, n78, n79, n257	B1, B3, B8, B11, B18, B19, B21, B26, B28, B41, B42

  - Note other combinations are going to be introduced in the future.

BS channel bandwidth and SCS per NR band

- BS channel bandwidth depends on the subcarrier spacing

		BS channel bandwidth (MHz)												
NR band	SCS [kHz]	5	10	15	20	25	30	40	50	60	70	80	90	100
n77/n78	15		√		√		√	√	√					
	30		√		√		√	√	√	√	√	√	√	√
	60		√		√		√	√	√	√	√	√	√	√
n79	15							√	√					
	30							√	√	√		√		√
	60							√	√	√		√		√

		BS channel bandwidth (MHz)			
NR band	SCS [kHz]	50	100	200	400
n257	60	√	√	√	
	120	√	√	√	√

Spectrum utilization

- 3GPP assume the spectrum utilization up to 98% (cf. 90% for LTE)
- Maximum numbers of resource blocks for FR1

		BS channel bandwidth (MHz)												
		5	10	15	20	25	30	40	50	60	70	80	90	100
SCS [kHz]	15	25	52	79	106	133	[160]	216	270					
	30	11	24	38	51	65	[78]	106	133	162	[189]	217	[245]	273
	60		11	18	24	31	[38]	51	65	79	[93]	107	[121]	135

- Maximum numbers of resource blocks for FR2

		BS channel bandwidth (MHz)			
		50	100	200	400
SCS [kHz]	60	66	132	264	
	120	32	66	132	264

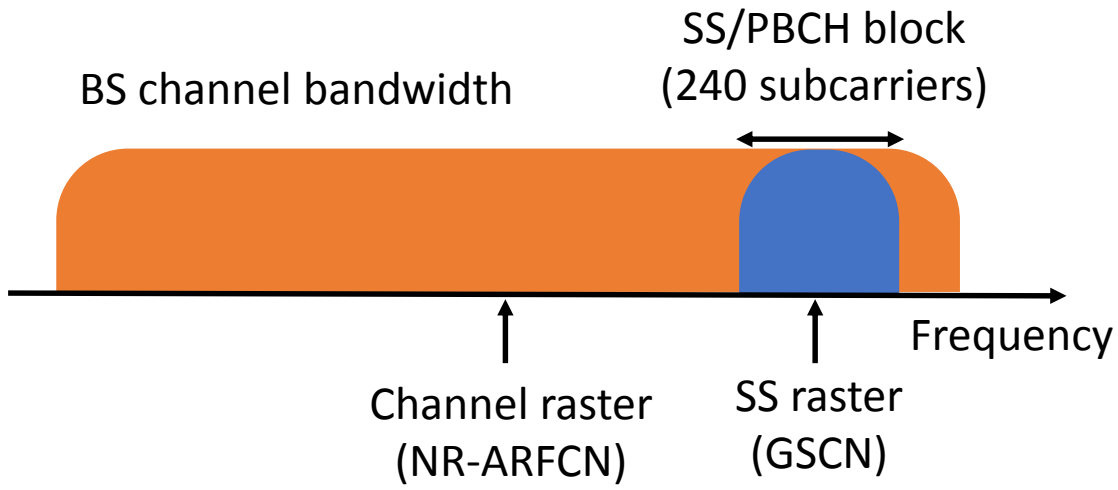
Note 1: 1 resource block consists of 12 subcarriers
Example: 12x30kHz=360kHz
Note 2: Values in [ ] mean under investigation in 3GPP

Channel raster and synchronization raster

- At the initial cell search, UE searches the synchronization signal and PBCH block (SS/PBCH block) consisting of PSS/SSS/PBCH
  - SCS for SS/PBCH block is fixed per operating band to reduce the UE complexity
  - SS/PBCH block raster is different from channel raster

	Channel		SS/PBCH block	
	SCS [kHz]	Raster [kHz]	SCS [kHz]	Raster [MHz]
n77/n78/n79	15/30/60	15	30	1.44
n257	60/120	60	120/240	[17.28]

Values in [ ] mean under investigation in 3GPP



GSCN: Global synchronization channel number
NR-ARFCN: NR absolute radio frequency channel number

Conducted/OTA requirements for NR BS and UE

- For UE, apply conducted requirements to FR1 and OTA requirements to FR2
- For BS, 3GPP agreed to specify different sets of requirements depending on NR BS type

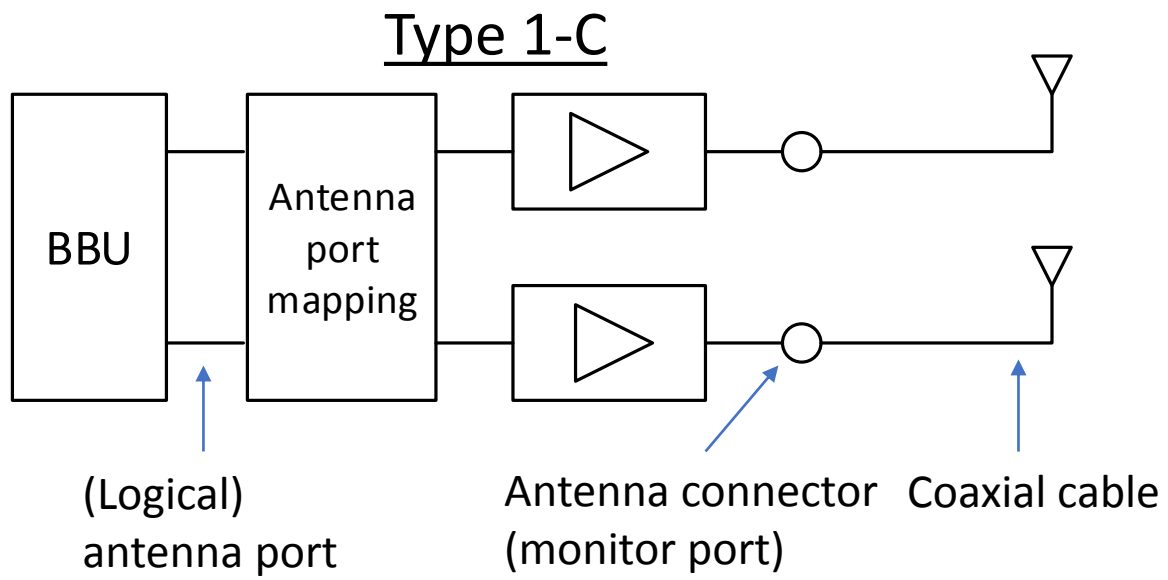
NR BS type	Frequency range	BS Description
Type 1-C	FR1	Consisting only of conducted requirements defined at individual antenna connectors
Type 1-H		Consisting of conducted requirements defined at individual TAB connectors and OTA requirements defined at RIB
Type 1-O		Consisting only of OTA requirements defined at the RIB
Type 2-O	FR2	Consisting only of OTA requirements defined at the RIB

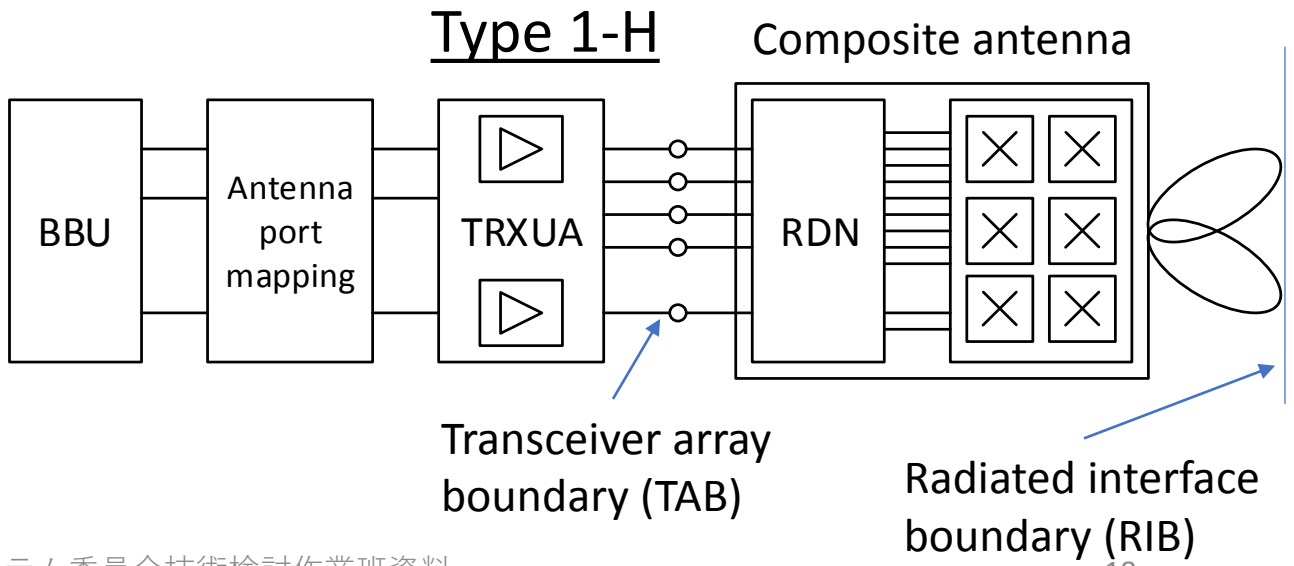
OTA: Over-the-air
TAB connector: Transceiver array boundary connector
RIB: Radiated interface boundary

BS type 1-C and 1-H

- Type 1-C (Conducted) is same as the existing LTE base station
  - Conducted test with antenna port
- TAB in type 1-H (Hybrid) is conducted interface between the TRXUA and the composite antenna
- RIB in type 1-H is radiated interface where the OTA requirements are defined

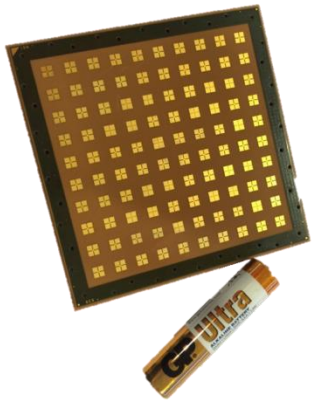
BBU: Base band unit
TRXUA: Transmitter/Receiver Unit Array
RDN: Radio Distribution Network

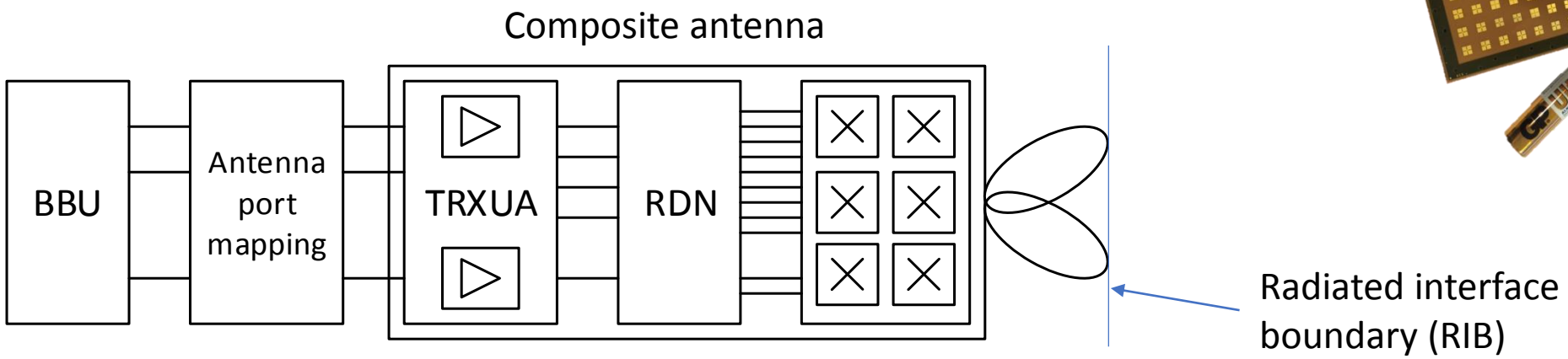




BS type 1-O/2-O

- Types 1-O/2-O (OTA) has no conducted interfaces
  - Implies that testing is performed over the air (OTA) in test chambers (e.g., anechoic chambers)
  - Only OTA requirements are specified especially for FR2





Discussion

- Regulations take into account the 3GPP requirements.
- Need to discuss how to capture three sets of BS requirements for FR1 into the regulations.
- For 1-O and 2-O, and in general for integrated AAS type products, there are significant challenges and limitations in relation to test ports (for on-site testing).