3GPP TSG RAN Meeting #91-e
Electronic Meeting, March 16 - 26, 2021

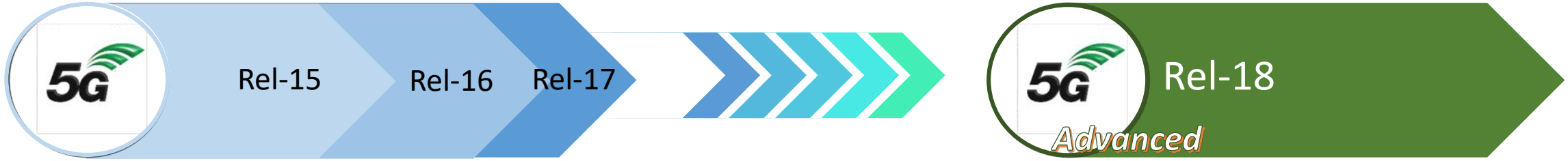
RP-210293

Initial Views on Release 18 NR

SAMSUNG

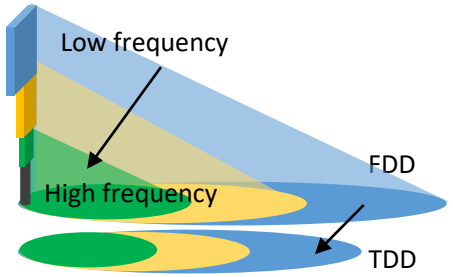
What is the Role of Rel-18?

- Rel-15 has enabled commercialization of 5G on a global scale
  - It has also brought to light some key areas which need immediate attention
- Rel-16 and Rel-17 have focused on completing the foundation of 5G that was not fully addressed in Rel-15
- Rel-18 should take a big leap forward in terms of innovation and should address new market needs
  - Significance and role of Rel-18 in 5G NR should be similar to that of Rel-10 in LTE
  - 3GPP needs to consider promotional marketing aspects of Rel-18 as well as its technical aspects

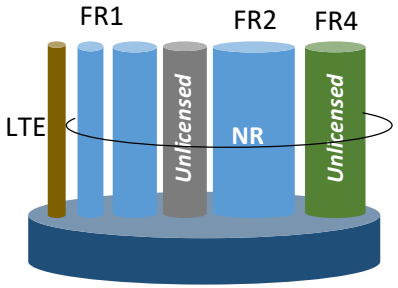


Key Issues Identified during Initial 5G Deployments

- Overcoming the coverage reduction due to use of TDD in high frequency bands (e.g., 3.5 GHz, mmWave)
- Support of diverse frequency bands from sub-1GHz to 71GHz for licensed/unlicensed/shared usage
- Addressing the escalating concerns on security and privacy
- Embracing new technologies such as AI/ML for enhanced performance and reduced operational complexity
- Support of new terminal types and applications

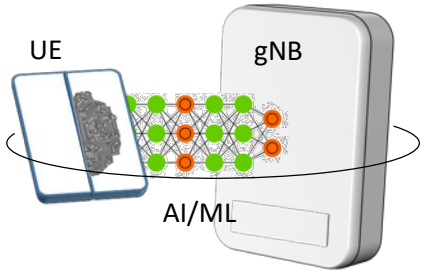


Overcoming coverage reduction



Support diverse frequency bands

Improved security and privacy

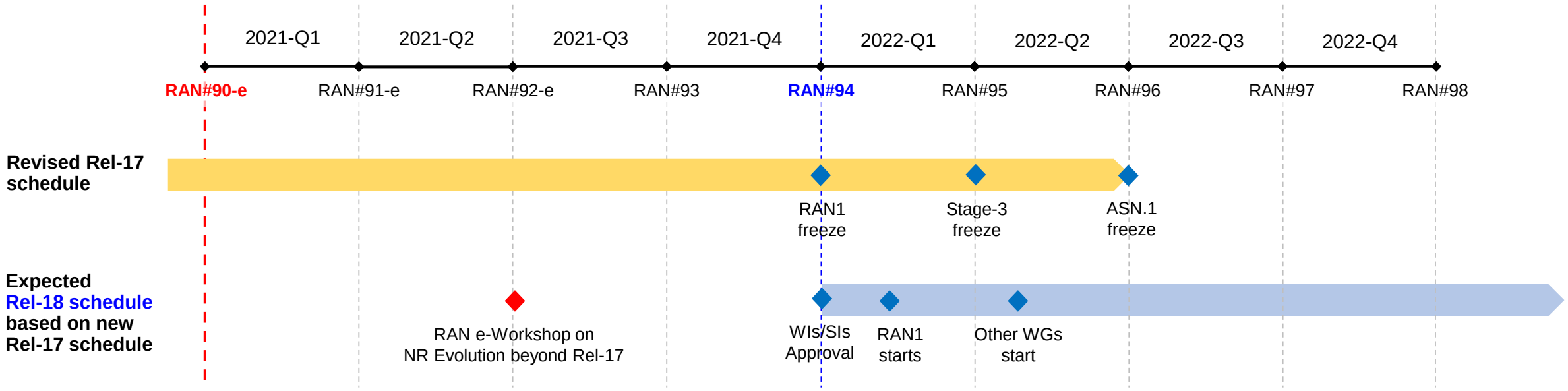


Embracing new technology (AI/ML)

New terminal types and applications

Expected Schedule for Rel-18

- Based on the revised schedule for Rel-17, it is expected that Rel-18 work can start in Q1 of 2022 (in RAN1)
  - RAN will need to endorse the first batch of Rel-18 work/study items in RAN#94 (Dec, 2021)
  - We are open to plan longer than 15 months for Rel-18 as long as its scope is meaningful



- RAN should provide sufficient opportunity for diverse opinions from different sectors to be heard and considered in finalizing the Rel-18 work scope

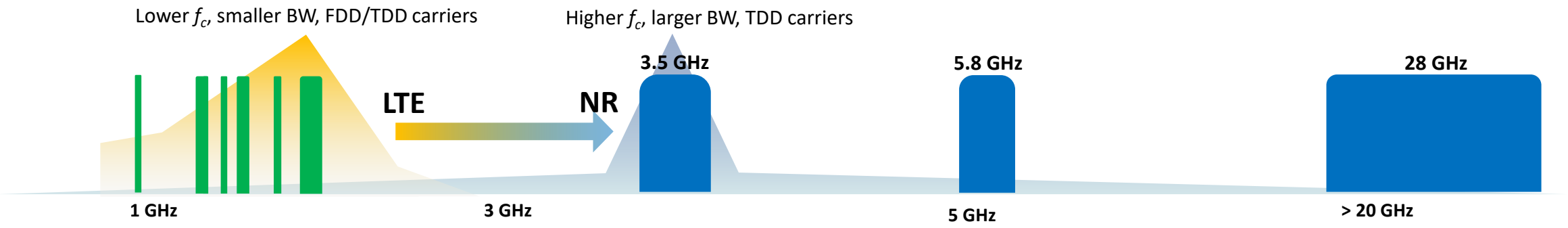
Candidate Rel-18 Items

New items	• XDD (Cross Division Duplex) – for coverage enhancement • AS security enhancement – for improved security • Application of AI to physical layer • AI-enabled NG-RAN
Enhancements on existing features	• MIMO enhancement – support of low frequency bands and other enhancements • High speed packetization • Multi-RAT Multi-Connectivity – efficient/flexible support of diverse frequency ranges • RedCap enhancement – scope depending on the outcome of Rel-17 • High speed train scenario for FR2 – scope depending on the outcome of Rel-17 • Sidelink enhancement • Positioning enhancement • Serving node change enhancement in MR-DC • Multi-SIM enhancement • Mobile IAB • NTN enhancement

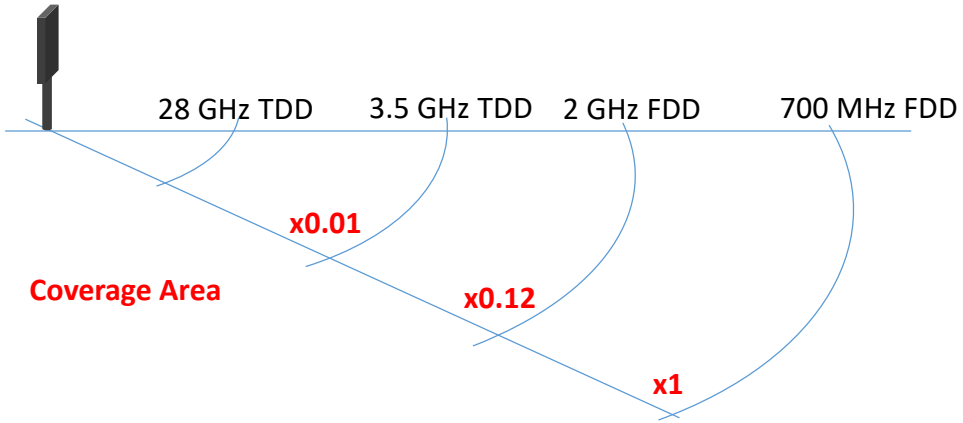
New Items: XDD (Cross Division Duplex)

- NR deployments are utilizing larger bandwidths for enhanced data rate and latency performance
  - At the cost of a larger path loss due to higher carrier frequency (FSPL increases by 6dB for every doubling of f_c)

FSPL: Free Space Path Loss



- NR carriers on >3 GHz are all TDD which is suitable for asymmetric DL – UL traffic such as video streaming
  - At the cost of a coverage imbalance between downlink and uplink due to a DL dominant time resource allocation



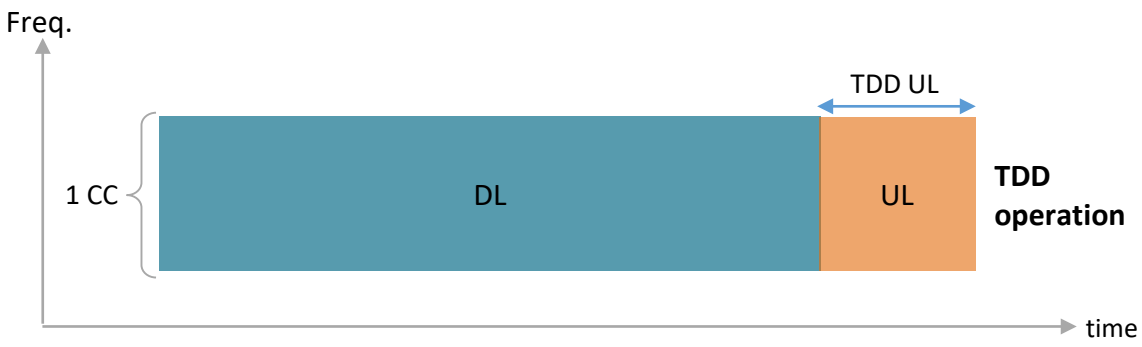
From FSPL perspective, a TDD cell on 3.5 GHz has an uplink coverage area that is 10% of an FDD cell on 2 GHz

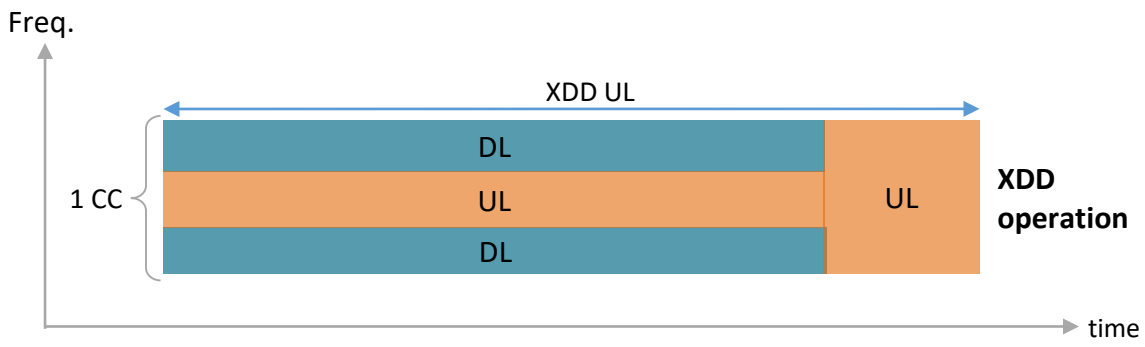
➔ 10 cells on 3.5 GHz needed to replace a cell on 2 GHz

New Items: XDD (Cross Division Duplex)

- For superior data rate and latency performance, 5G spectrum on higher frequency bands is inevitable
  - Remaining question is whether it is possible to overcome the coverage reduction on such carriers

- XDD is a new duplexing scheme that enables simultaneous use of downlink and uplink within a TDD carrier using non-overlapping frequency resources
  - Intention is to extend the duration over which uplink TX can occur for improved uplink coverage and capacity
  - Simultaneous use of DL and UL is only at gNB and not at UE side
  - gNB may be required to handle self-interference to support simultaneous TX and RX





New Items: AS Security Enhancement

- The current AS security protects only L3 in connected mode, leaving the other parts unprotected

	IDLE/INACTIVE	TRANSITION	CONNECTED
L3 RRC	System Information, Paging	CCCH	DCCH
L3 UP data	N/A	N/A	DTCH
L2 control	N/A	MAC CE	MAC CEs, Control PDU
L2 header	N/A	MAC	PDCP/RLC/MAC
L1 PHY	DCI for SI, Paging	DCI for the initial access	DCI, PUCCH

Protected
Unprotected

Fake Base Station attack could lead to *throughput degradation*

Fake Base Station attack could lead to *out-of-service*

  - Fake base station attack exploiting the unprotected parts could be potential security threats degrading system throughput and QoE
  - Rel-17 SA3 SI "Study on 5G Security Enhancement against False Base Station" mainly covers System Information protection. Other unprotected parts (e.g. MAC CE etc.) are also being discussed but a feasible solution is not expected due to lack of RAN input.
  - In addition to the ongoing SA3 work, we feel that additional efforts should be made in RAN to more accurately evaluate the potential damage and solutions from air interface design point of view
- Proposal
  - Normative work in RAN can commence depending on the outcome of the discussion in SA and RAN

New Items: AS Security Enhancement

- Examples: Consequence of compromised AS information

Category	Compromised AS information	Consequence
L3 Control	PagingRecord in paging message	Multiple UEs miss their paging
L3 Control	masterCellGroup IE in RRCSetup message	A single UE applies wrong configuration resulting in communication broken for the UE
L2 Header	MAC-I in PDCP PDU	A single UE experiences Integrity Check failure resulting in RLF declaration of the UE
L2 Control	ACK_SN in RLC STATUS PDU	A single UE experiences data loss from RLC SDUs wrongly discard
L2 MAC CE	SCS in Guard Symbols MAC CE	A single IAB node applies wrong guard symbols resulting in degradation of IAB operation
L1 DCI	DCI 1_0 with SI-RNTI	Multiple UEs miss system information blocks
L1 DCI	DCI 2_0 for Slot Format Indicator	Multiple UEs apply wrong slot format indicator

15 types of System Information, 30 types of MAC CE and 6 types of L2 control SDU are defined in 2020 December version

New Items: Application of AI

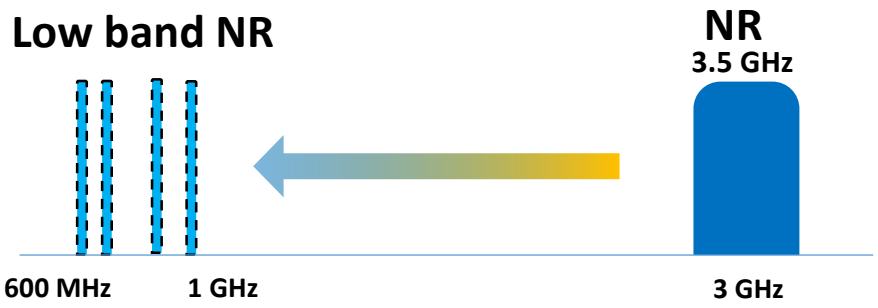
- AI for 5G NR air interface
  - Over the last decade, artificial intelligence has made its way to a wide range of applications and industries
  - However, it is still not clear from 3GPP point of view, how this new technology can be efficiently harnessed in the evolution of 5G NR air interface standard
  - A new study item is required in RAN1/RAN2 over the entire duration of Rel-18 to evaluate possible benefit and feasibility of applying AI on 5G NR air interface

- AI enabled NG-RAN
  - The high level principles and the standard impact for RAN intelligence are being studied in RAN3
  - Based on the outcome of the RAN3 study, the AI-based load balancing, energy saving and mobility optimization need to be supported by normative specifications in Rel-18

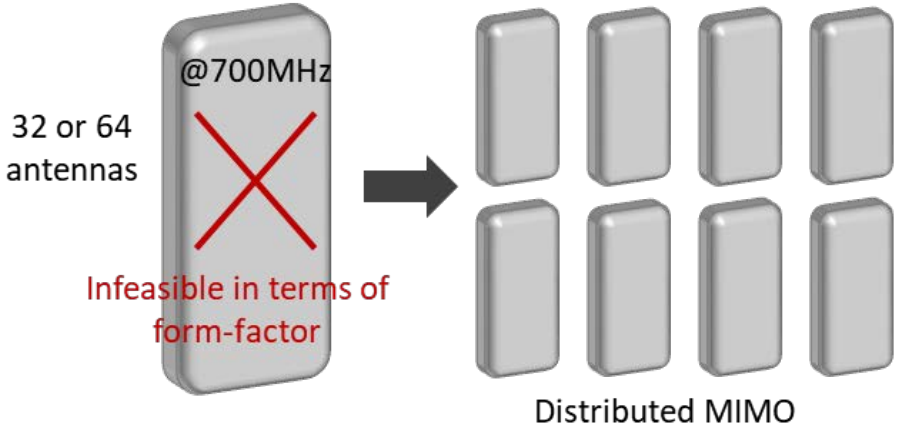
Enhancements on Existing Features: NR MIMO

- NR MIMO has been designed to support SU/MU-MIMO (with various codebooks and high-resolution CSI compression in spatial and frequency-domain), multi-beam, and multi-TRP/panel

- The following areas need further enhancement
  - Area #1: distributed MIMO in low band
    - Low band (<1GHz) helps to reach wider geographical areas in large cities and suburban. Due to the large wave length in low band, utilizing a large number of antennas may not be feasible in practice.
    - In the current NR spec, the support of distributed MIMO is lacking especially in terms of the geographically distributed antenna panels and having different number of antenna elements for different panels

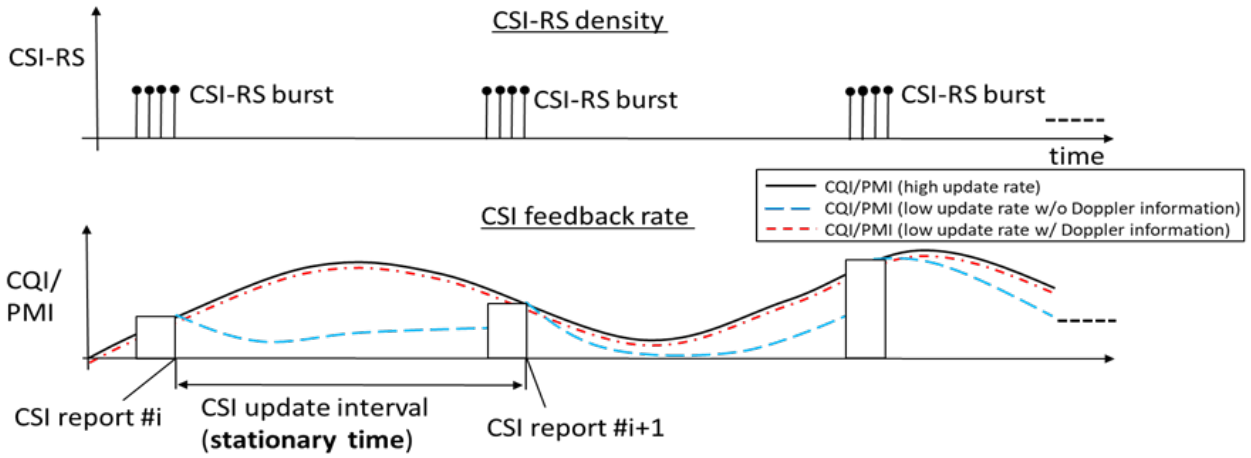


Spectrum reallocation from TV as well as LTE for low band



Enhancements on Existing Features: NR MIMO

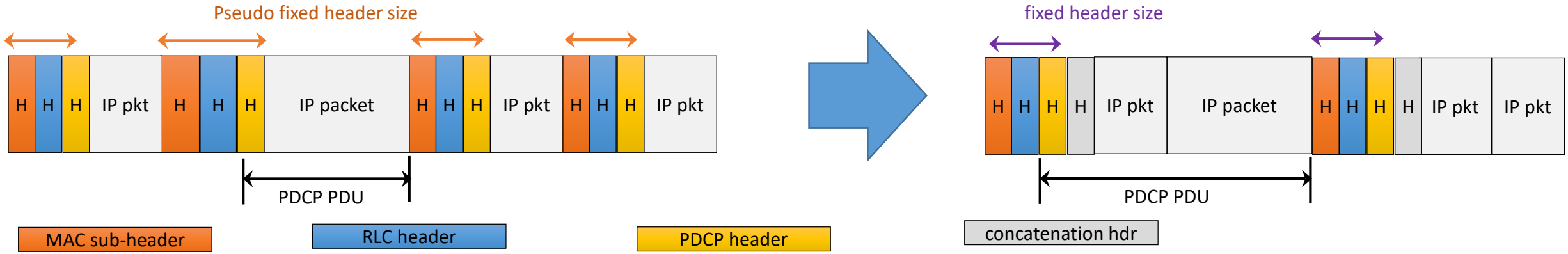
- Area #2: high resolution and overhead reduction of CSI
  - DFT-based codebook in NR can be limited in providing more precise CSI feedback. Different approaches need to be considered, e.g., explicit feedback of eigenvectors and progressively-refined CSI reporting, for further enhancing MU-MIMO performance.
  - For high-speed UEs, accurate time-domain channel tracking requires frequent CSI update. Doppler-domain CSI compression can facilitate time-domain overhead reduction.



- Area #3: incomplete support of multi-beam and multi-TRP/panel especially in FR2
  - Rel-17 unified TCI framework can be extended to support more efficient intra- and inter-cell beam management including beam tracking (predictive), refinement, as well as positioning-assisted and UE-initiated beam management
  - Multi-TRP/multi-panel support in Rel-17 is limited to only synchronous inter-TRP/panel and up to 2-panel reception. It can be extended to support asynchronous scenario and more than 2 panels in Rel-18.

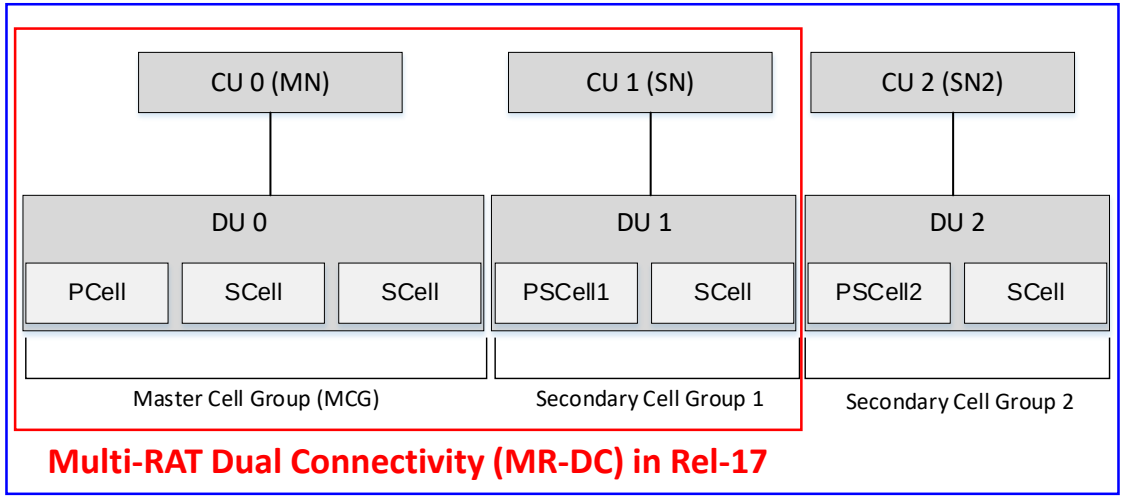
Enhancements on Existing Features: High-Speed Packetization

- Significant increase of processing requirement since Release 16 due to the followings
  - Mandatory support of UPIP
  - More and more wide bandwidth being available in high frequency bands
- NR layer 2 was designed to support tens of Gbps data rate but still needs to be improved in the following areas
  - Too many L2 headers due to the header-per-IP packet approach: 1.6 million instances of headers per second @ 20 Gbps
  - Pseudo-fixed L2 header size: different header sizes depending on segmentation etc.
- We propose to specify the following enhancements
  - Concatenation of PDCP SDUs (IP packets) into a single PDCP PDU
    - Packet processing can be more friendly to hardware accelerator
    - Enable application of a single security protection to multiple IP packets
    - Reduce the number of headers
  - Fixed size L2 headers at the cost of overhead

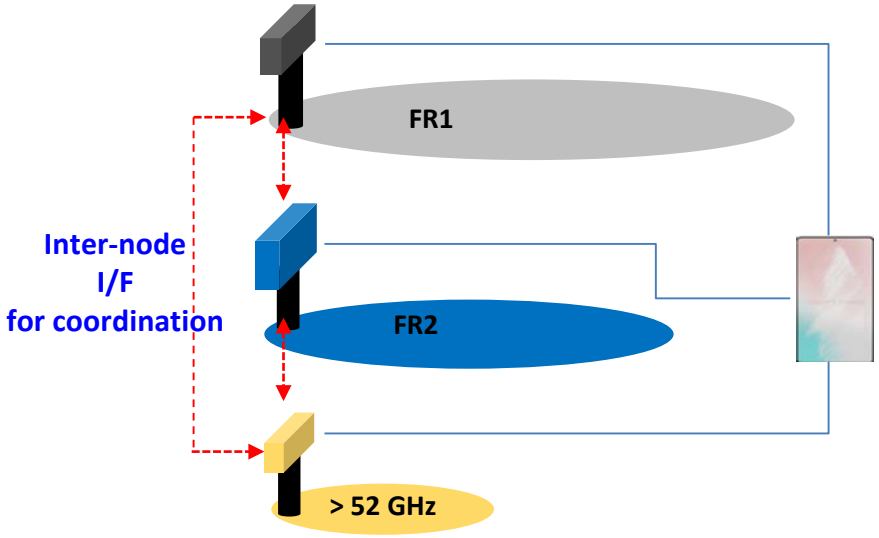


Enhancements on Existing Features: Multi-RAT Multi-Connectivity

- For efficient and flexible utilization of diverse frequency ranges (FR1, FR2, >52GHz) with different coverages, multi-RAT multi-connectivity should be extended to support more than two cell groups.
- We propose to specify the following enhancements
  - Support triple connectivity with at most two active uplink cells
  - Inter-node interface for dynamic scheduling and resource coordination between non-collocated gNBs



Extension of Multi-RAT Multi-Connectivity (MR-MC) in Rel-18



Enhancements on Existing Features

- RedCap enhancement
  - Support of NR wearables should be well specified in Rel-17.
  - Some small details can be enhanced depending on the outcome of Rel-17.
- Enhanced NR support for high speed train scenario in FR2
  - NR support for high speed train scenario in FR2 should be well specified in Rel-17.
  - Some small details can be enhanced depending on the outcome of Rel-17.
- Sidelink enhancement
  - 6 GHz band (5.925 – 7.125 GHz) is now available for unlicensed use to meet the demand for wireless broadband and WiFi Alliance introduced a new Very Low Power (VLP) device for use in that unlicensed band.
  - Device-to-device communication using the 3GPP sidelink can be a good candidate to support such VLP mode.
- Positioning enhancement
  - Evolution of various positioning schemes so far has mainly focused on improving accuracy and reducing latency.
  - For public safety application, we propose to consider the need for specifying a solution to guarantee full availability of location information on top of high performance, regardless whether an infrastructure exists or not.

Enhancements on Existing Features

- Serving node change enhancement in MR-DC
  - In MR-DC, throughput fluctuates due to the transmission interruption during MN (Master Node)/Pscell change and frequent SCG failures.
  - To minimize the interruption, we propose to specify the followings.
    - Keeping the UE connected to both source and target nodes, which is similar to DAPS (Dual Active Protocol Stack) handover.
    - Serving SN (Secondary Node)/Pscell can dynamically change among the pre-configured SNs/Pscells.
- Multi-SIM
  - In Rel-17, paging collision handling and notification of network switching are specified by RAN2.
  - For support of active connection with multiple networks with limited UE capability, L1 enhancements are needed for collision avoidance, dynamic power control, and antenna capability switching.
- Mobile IAB
  - To provide high-data rate services for in-vehicle UEs, an IAB node can be mounted on the vehicle, resulting in the need for support of mobility for IAB nodes.
  - Inter-CU IAB node migration is supported in Rel-17 and can be considered as partial support of mobile IAB.
  - For better support of mobile IAB, the inter-AMF IAB node migration and some additional features, e.g., PCI change of a IAB node cell, should be supported.
- NTN enhancement
  - NTN support in Rel-17 cannot connect satellites to terrestrial networks if they are located in the area where gNBs cannot be deployed, e.g., ocean area.
  - Consider whether a solution on this should be specified taking into account the recent trend of building a mega-constellation (e.g., tens of thousands) of LEO satellites.

Thank you