3GPP TSG RAN Meeting #89-e
14-18 September 2020

RP-201888

Views on RAN4 Rel-17 non-spectrum SI/WI package

Agenda Item: 9.1.2

Source: Intel Corporation

Document for: Discussion

RAN4 REL-17 NR WORK AREAS (NON-SPECTRUM)

Candidate RAN4 Rel-17 NR non-spectrum work areas based on pre-plenary email discussions:

- **RRM**
  - MG Enhancements
  - RRM Enhancements
- **Demodulation**
  - UE Demodulation
  - BS Demodulation
  - Link adaptation throughput requirements (RAN5 topic)
- **RF**
  - FR1 RF (incl. new brand CBW)
  - FR2 RF
- **OTA**
  - SISO FR1 OTA
  - Dynamic FR2 OTA
  - MIMO OTA (Ongoing)
  - FR2 Test Method Enh (Ongoing)
- **Use cases**
  - FR1 HST
  - FR2 HST
  - ATG
- **Other**
  - FR1 DL 1024QAM
  - Smart repeater

RAN4 Rel-17 SI/WI package shall strive to achieve a balance between different work areas

RAN4 REL-17 NR SI/WI PACKAGE CONTENTS

Intel's view on the RAN4 Rel-17 non spectrum package content balancing the needs of the industry and the RAN4 workload constraints

- ✓ NR RRM Enhancements
- ✓ NR MG Enhancements
- ✓ NR UE Demodulation
- ✓ NR BS Demodulation
- ✓ NR FR1 RF
- ✓ NR New Brand CBW
- ✓ NR FR2 RF
- ✓ NR FR1 SISO OTA
- ✓ NR FR1 HST
- ✓ NR FR2 HST
- ✓ NR ATG
- ✓ NR FR1 DL 1024QAM

The potential RAN4 Rel-17 scope is broad and may not fit available TUs for RAN4-led WIs

The scope of RAN4 SI/WIs shall be adjusted to fit the available RAN4 TU budget
(i.e. objectives prioritization and down-scoping is required for all items)

RRM

RRM WORK AREA CANDIDATE OBJECTIVES

A very big amount candidate RRM objectives was identified during pre-plenary email discussion

- ✓ **MG Enhancements objectives:**
  - Network Controlled Small Gap (NCSG)
  - Burst gap patterns
  - **Multiple concurrent and independent MG patterns**
  - **New measurement gap patterns for PRS measurement**
  - On-demand UE-initiated MG request
  - **Pre-configured MG pattern(s) per configured BWP (fast MG configuration)**
  - Per-CC MG configuration
  - **MG sharing enhancement**
  - Enhanced utilization of UL slots before and after measurement gap
  - Measurement gap enhancements for NR-U
- ✓ **General RRM Enhancements objectives:**
  - RRM for UE different RX beam sets in FR2
  - CSI-RS based L3 mobility
  - RRC release with redirection enhancement
  - **RLM enhancement requirement**
  - **SRS antenna port switching**
  - Active TCI-state switch for CSI reporting
  - Gapless measurement
  - Enhanced DCI-based BWP switch in FR2
  - **Inter-RAT NR measurement w/o gaps for EN-DC**
  - BFR based on CBRA
  - RRM Enhancement for larger CC number
  - **PUCCH SCell activation/deactivation**
  - **IDLE mode requirement for SMTC2-LP**
  - **TCI switching enhancement**
- ✓ **General RRM Enhancements objectives (cont.):**
  - Non-simultaneous UL carrier operation in FR2
  - CGI reading enhancements
- ✓ **Leftover topics from R16**
  - R16 NR RRM enhancement
  - CSI-RS L3 measurement
  - NR Positioning
  - NR-U RRM

Proposal 1: Make further prioritization of RRM work area objective based on companies' interests

Proposal 2: Split the Rel-17 work into RRM Enhancements and MG Enhancements WIs

Note: Objectives in bold are prioritized by Intel

NR RRM ENHANCEMENTS

Given a large amount of candidate objectives, it is recommended to focus on objectives that can bring significant gain, as well as the ones which require limited standardization effort (e.g. similar procedure exist in LTE spec)

PUCCH Scell activation/deactivation [RAN4]

- Scell Activation/Deactivation Delay Requirement for Deactivated PUCCH Scell (including valid/invalid TA)
- Scell Activation/Deactivation Delay Requirement for Deactivated PUCCH Scell with Multiple Scells (including valid/invalid TA)

TCI switching enhancement [RAN4, RAN1]

- Study and specify enhancements to maintain the UE reception and transmission during the period (or part of period) of MAC-CE based or RRC-based TCI switching

RLM enhancement requirement [RAN4]

- Specify the second IS/OOS BLER pair for VoNR service

IDLE mode requirement for SMTC2-LP [RAN4]

- RRM requirement for SMTC2-LP in IDLE mode

Inter-RAT NR measurement without gaps for EN-DC [RAN4]

- RRM requirements for inter-RAT measurement without gaps when configured with EN-DC
- RRM requirements for inter-frequency measurement without gaps defined in Rel-16 are used as starting point
- Define related UE capability, if necessary

SRS antenna port switching [RAN4]

- Specify RRM interruption requirement of NR SRS antenna port switching for NR SA, NR-DC, EN-DC and NE-DC.
  - NR SRS antenna port switching impacting LTE CC
  - NR SRS antenna port switching impacting NR CC

NR MG ENHANCEMENTS (1)

Pre-RAN #89 email discussion summary (RRM work area)

- Candidate objectives for NR MG Enhancements
  - **3.1 Network Controlled Small Gap (NCSG) specification**
  - 3.2 Burst gap patterns specification
  - **3.3 Multiple concurrent and independent MG patterns**
  - **3.4 New MG patterns for PRS measurement**
  - 3.5 On-demand UE-initiated MG request
  - **3.6 Pre-configured MG pattern(s) per configured BWP**
  - **3.7 Per-CC MG configuration**
  - 3.8 MG sharing enhancement
  - 3.9 Enhanced utilization of UL slots before and after MG
  - 3.10 MG enhancements for NR-U
- 5 objectives with the largest support in the email discussion are marked in **bold**
- Further RANP discussion is recommended to confirm prioritization

Companies views summary on NR MG Enhancements objectives based on pre-plenary email discussion

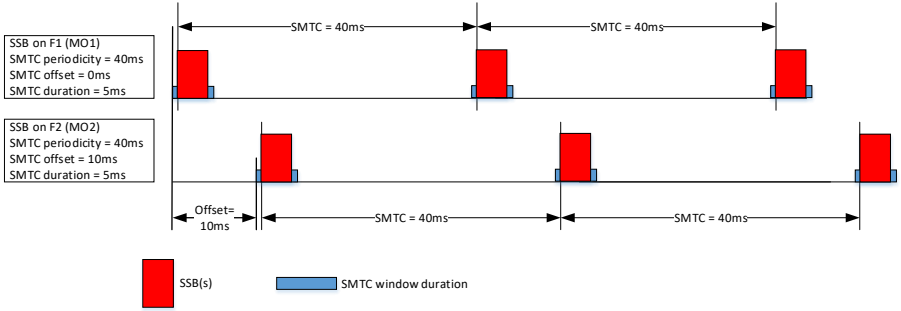
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10
Company 1			✓	✓		✓		✓		
Company 2			✓			✓		✓		
Company 3			✓	✓		✓		✓		
Company 4										
Company 5		✓				✓				✓
Company 6	✓		✓			✓		✓		
Company 7	✓			✓		✓		✓	✓	
Company 8			✓			✓		✓		
Company 9	✓		✓			✓	✓			
Company 10	✓		✓			✓				
Company 11	✓		✓		✓	✓		✓		
Company 12	✓				✓			✓		
Company 13				✓					✓	
Company 14	✓									
Company 15	✓	✓	✓			✓				
Company 16										
Total	8	2	9	4	2	11	1	8	2	1

Proposal 3: Further discuss and down-select NR MG enhancements objectives based on companies' priorities

NR MG ENHANCEMENTS (2)

MG configuration to cover multiple flexible SMTCs

- **Background**
  - In Rel-15/16 a single MG pattern can be configured within one measurement period for single UE (if UE supports per-UE MG only) or single FR (if UE supports per-FR MG).
  - Single MG pattern can't cover multiple SMTC windows for different MOs if the time difference between two SMTCs is not divisible by MGRP.



- **Candidate enhancements**
  - Introduce support of multiple MGs patterns within a single measurement period to improve the mobility performance.
  - Investigate the possibility of using multiple SMTC configurations on a single frequency layer, including both intra-frequency and inter-frequency, with different periodicities or offsets.

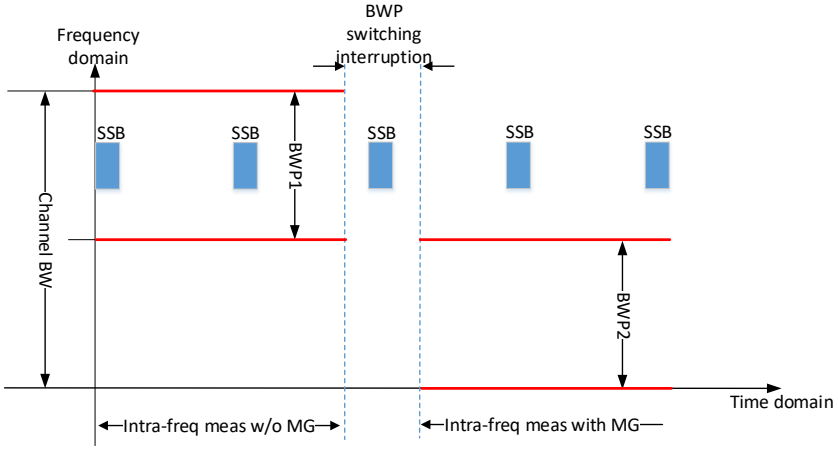
Candidate objective 1:

- ✓ **UE behavior with multiple MG/SMTC patterns [RAN4]**
- ✓ **Applicability of multiple MG patterns within single measurement period [RAN4]**
- ✓ **Applicability of multiple MOs within single measurement gap [RAN4]**
- ✓ **RRM requirement with multiple MG/SMTC patterns [RAN4]**
- ✓ **RRC signaling support of multiple MG/SMTC pattern configuration [RAN2]**

NR MG ENHANCEMENTS (3)

Fast MG configuration during BWP switching

- **Background**
  - In Rel-15/16 SSB based measurement need MG if the active BWP doesn't contain the target SSB.
  - MG/BWP have different configuration time scale
    - MG is configured via RRC signalling
    - BWP switching can be commanded via DCI
    - BWP switching is more dynamic and faster than MG configuration.
- **Candidate enhancements**
  - Introduce a Fast MG configuration mechanism to accommodate the MG configuration to the dynamic situations for SSB based measurement with BWP switching



Candidate objective 2: Introduce fast MG configuration mechanism to meet the demand from measurement type change for SSB based intra-frequency measurement, e.g. due to BWP switching.

NR MG ENHANCEMENTS (4)

MG sharing enhancement

- **Background**
  - Rel-15/16 MG sharing mechanism was designed to coordinate MG resource allocation between intra-frequency MOs and inter-frequency MOs
  - In RAN4 #AH1807 meeting, some operators prefer to further improve the MG sharing mechanism to prioritize some specific RATs, e.g. LTE in EN-DC mode.
  - Current signalling granularity for MG sharing ratio is limited (2 bits) and cannot adequately cover all the prioritization preference from network operators.
    - E.g. 2G/3G is an important option to do the fall-back for voice service while LTE also plays key role in EN-DC operation; so depending on different demands from different network operators, it would be much beneficial if the MG sharing mechanism can allow network to prioritize any RAT measurement it wants.
- **Candidate enhancements**
  - Enhance the MG sharing mechanism and signalling to offer network operators more flexibility on prioritize any RAT measurement.

Candidate objective 3: Enhance the MG sharing mechanism and signalling to offer network operators more flexibility to prioritize any RAT measurement

NR MG ENHANCEMENTS (5)

New MG patterns for PRS measurement

- **Background**
  - Companies showed interest in new MG for PRS measurement
  - Only 2 new MG patterns were agreed in Rel-16 due to tight timelines and potential impact on legacy RRM requirement
- **Candidate enhancements**
  - Study feasibility of new measurement gap patterns for PRS measurement
  - Study the impact on legacy RRM requirement
  - Define RRM requirement based on the outcome of study

Pattern #	MGL (ms)	MGRP (ms)
0	10	80
1	10	160
2	20	80
3	20	160
4	40	320
5	40	640
6	50	320

Candidate objective 4: Study the feasibility and define new MG patterns for PRS measurement and study the impact on legacy RRM requirements

Demodulation

UE DEMODULATION

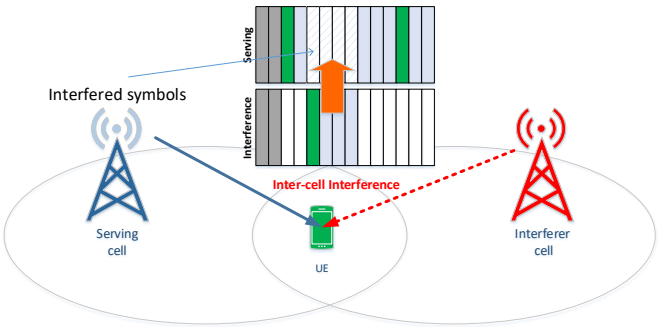
UE Advanced Receivers

Scenario	Intel's views
Inter-cell	✓ LMMSE-IRC receiver (incl. time-selective interference handling) ✓ CRS-IC for LTE-NR co-existence scenarios (focus on 15kHz SCS) ✓ Network assistance shall be studied
SU-MIMO	✓ Low priority. ✓ Limited gains over R-ML expected. ✓ Propose to study performance benefits first.
MU-MIMO	✓ Low priority. ✓ Requires network assistance and RAN1 scope.

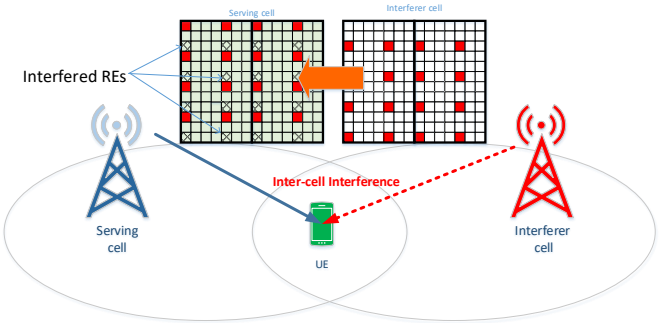
Other prioritized requirements

- Rel-15 Multi-TRP DPS TX scheme
- Rel-16 Multi-TRP URLLC TX schemes

Time-selective NR-NR inter-cell interference



CRS inter-cell interference in LTE-NR coexistence scenario



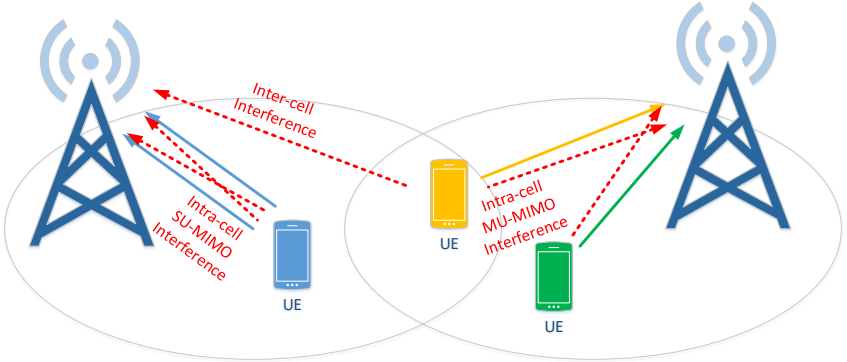
BS DEMODULATION

BS Advanced Receivers

- Inter-cell interference
  - Support defining requirements (WI stage)
  - LMMSE-IRC receiver
  - Prioritize FR1
- Inter-layer interference for SU-MIMO
  - Recommend to study performance benefits and complexity before requirements introduced
- Intra-cell inter-user interference for MU-MIMO
  - Recommend to study performance benefits and complexity before requirements introduced

Scenario	Intel view
Inter-cell	✓ **LMMSE-IRC receiver**
SU-MIMO	✓ FFS (SL-IC receiver)
MU-MIMO	✓ FFS

UL interference scenarios



RF & OTA

FR1 RF

Scope: FR1 RF requirements evolution

- **Efficient utilization of spectrum for Brand new CBW**
  - Support a separate SI or WI in Rel-17
  - Propose to study all identified solutions.
  - Different non-standard CBWs might have different preferred solutions.
  - Prioritize Approach 2 - overlapping UE CBW from network perspective
- **Optimizations on power class fall back**
  - Support to have studies in Rel-17
  - Focus on EN-DC only in Rel-17
  - Aim to minimize RAN1 impacts
- **HPUE for TDD intra-band contiguous CA**
  - Support the work on enabling PC2 for TDD intra-band contiguous CA for in Rel-17
  - Prefer a single umbrella HPUE item to avoid overlapping discussions under multiple WIs.
- **2Tx for SUL/TDD/FDD bands**
  - Support further work on enabling 2Tx for NR bands
  - Basket approach recommended
  - Agree to remove RAN2 restrictions on SUL band UL-MIMO configuration
- **2Tx RF requirements**
  - Support to investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements
- **LTE overlapping CA**
  - PHY layer design impacts are foreseen (e.g. overlapping PDCCH) and should be avoided
  - Introduction of new LTE approach may bring limited benefits since existing UEs/eNBs will not adopt the solutions

FR2 RF

Scope: FR2 RF requirements evolution

- **DL inter-band CA**
  - Continue Rel-16 work on CBM support for CCs within same frequency group (e.g. 28+28GHz)
  - Consider 3 bands inter-band DL CA subject to operators' interest
- **UL inter-band CA**
  - Support UL inter-band CA based on IBM and CBM implementations
  - Do not continue work on NSU (non-simultaneous UL) due to limited benefits of the solution and no progress in Rel-16.
- **MPE enhancements**
  - Study additional enhancements to improve MPE performance
  - Align with RAN1 feMIMO on overlapping objectives (MPE enhancements for beam management purposes)
- **Beam Correspondence enhancements**
  - Further study BC under dynamic conditions incl. high mobility scenarios
- **FR2 UL gap for UE RF self-calibration**
  - Study additional UL gaps to assist UE RF calibration

OTA

SISO NR FR1 OTA requirements

- Scope: TRP/TRS requirements for NR FR1 SA and EN-DC within FR1
- Intel's views
  - Industry-common methodology and requirements are important for 5G success
  - Propose to cover different device types incl. laptops in a fair manner without explicit prioritization of device types
  - Low priority for Tx Diversity and exceptional requirements objectives

FR2 Dynamic Test Environment

- Scope: E2E testing methodology for FR2 NR UEs in a dynamic environment
- Intel's views
  - Support the overall direction, but consider low priority for Rel-17
  - Multiple parallel OTA items increase the risk that some of them may no complete in Rel-17.

Use Cases & Others

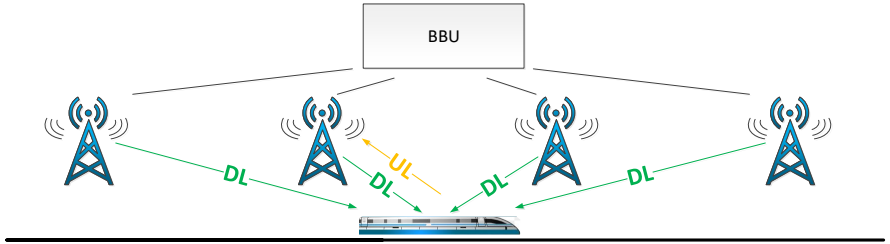
NR HIGH SPEED TRAIN

FR1 HST

- Scope: NR FR1 HST requirements evolution
- Intel's views
  - Support RRM and Demod requirements for CA scenarios
  - Support basic support CSI-RS based mobility
  - UE Demodulation enhancements
    - Define requirements for RAN1 feMIMO WI schemes
    - Study additional enhancements

FR2 HST

- Scope: FR2 support for HST networks with a focus on CPE-like devices
- Intel's views
  - Support further RAN4 work to enable new FR2 use case
  - Strive to reuse existing FR2 RF requirements
  - Conventional FR2 RRM requirements may not work due time-consuming RX beam sweeping
  - Further studies on RRM enhancements are needed (e.g. reduction of number of RX beams)



FR1 DL 1024QAM

Scope (RP-201156)

- DL 1024QAM modulation for PDSCH in FR1

Intel's views

- Keep simple RAN1 scope with a minimum amount of changes
- Keep unchanged DCI overhead for MCS indication
- Reuse 5-bit MCS tables and 4-bit CQI tables
- Reuse LTE 1024QAM entries for MCS and CQI
- Extend to IAB-DU Tx and IAB-MT Rx

Proposed WI objectives

The objective is to specify downlink 1024QAM for NR PDSCH operation in FR1, together with related procedures, signalling and necessary RF requirements. The main objectives are:

- Specify high order modulation for PDSCH [RAN1]
  - Specify 1024QAM constellation as specified in E-UTRA for DL PDSCH
  - Specify corresponding 5-bit MCS table with 1024QAM entries as defined in E-UTRA
    - Note: DCI overhead for MCS indication should be the same as in Rel-15
  - Specify corresponding 4-bit CQI feedback with 1024QAM entries as defined in E-UTRA
- Specify corresponding RRC signalling and UE capabilities [RAN2]
  - Note: DL PDSCH 1024QAM for FR1 should be defined as a per-band UE capability
- Specify corresponding BS, UE, and [IAB] RF requirements [RAN4]

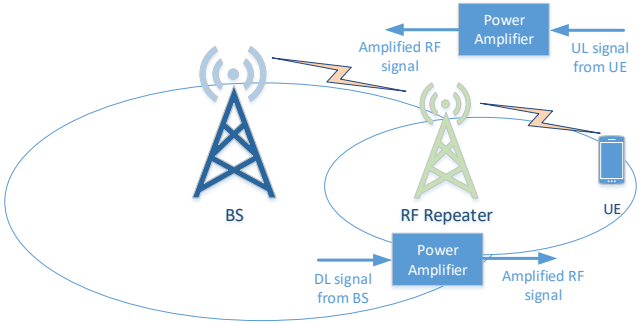
SMART REPEATERS

Scope (RP-201139)

- Network assistance for RF Repeaters with an emphasis on FR2 and TDD (beam management and UL/DL configurations)

Intel's views

- FR2 RF repeaters can provide FR2 coverage extension in a cost-efficient manner and allow faster FR2 technology penetration
- Many of the issues can be handled in an implementation-specific manner (e.g. beam tracking) or via vendor-specific solutions.
- Additional network assistance and L1/L2 support may have impact on RF Repeater cost/complexity and L1/L2 impacts shall be deprioritized
- Prefer to keep at least beam management solutions up to RF repeater implementation



Feature	L2/L3 Relay	RF Repeater	Smart Repeater
Backbone connectivity	No	No	TBD
L1 (FEC, Mod/Demod)	Yes	No	TBD
Latency	Med	Low	Low
Cost	Med	Low	TBD

intel®

experience
what's inside™