

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Source: MCC Support

Title: Draft Report of 3GPP TSG RAN WG1 #86bisbis v0.1.0
(Lisbon, Portugal, 10th – 14th October 2016)

Document for: Comments



Table of contents

1	Opening of the meeting	7
1.1	Call for IPR.....	7
1.2	Competition law statement.....	7
1.3	Network usage conditions	7
2	Approval of Agenda	7
3	Approval of Minutes from previous meeting.....	8
4	Highlights from RAN Plenary.....	8
5	Incoming Liaison Statements	8
6	UTRA.....	12
6.1	Maintenance of UTRA Releases 4 – 13.....	12
6.2	Multi-Carrier enhancements for UMTS - WID in RP-161259.....	12
6.2.1	TTI switching	12
6.2.2	Power scaling.....	12
6.2.3	Other	13
6.3	DTX/DRX enhancements in CELL_FACH - WID in RP-160185.....	13
6.3.1	DRX improvements.....	13
6.3.2	DTX improvements.....	13
7	E-UTRA.....	13
7.1	Maintenance of E-UTRA Releases 8 – 14.....	13
7.1.1	Maintenance of E-UTRA Release 8 – 12	13
7.1.2	Maintenance of Release 13 LTE carrier aggregation enhancement beyond 5 carriers	13
7.1.3	Maintenance of Release 13 licensed-assisted access to unlicensed spectrum	13
7.1.4	Maintenance of Release 13 elevation beamforming/full-dimension MIMO for LTE.....	14
7.1.5	Maintenance of Release 13 further LTE physical layer enhancements for MTC	14
7.1.6	Maintenance of Release 13 NB-IoT	16
7.1.7	Maintenance of Release 14 Enhanced Licensed-Assisted Access to Unlicensed Spectrum.....	17
7.1.8	Maintenance of Release 14 V2V services based on LTE sidelink.....	19
7.1.9	Other	21
7.2	LTE Release 14	21
7.2.1	LTE-based V2X Services - WID in RP-161894.....	21
7.2.1.1	Enhancement to UL and SL SPS	22
7.2.1.1.1	DCI design to support multiple SPS configurations	22
7.2.1.1.2	Other.....	23
7.2.1.2	Resource selection for pedestrian Ues	23
7.2.1.2.1	Details of random selection by pedestrian UEs	23
7.2.1.2.2	Details of resource selection using partial sensing by pedestrian Ues	24
7.2.1.2.3	Other.....	24
7.2.1.3	Long-term basis co-channel coexistence between DSRC/IEEE 802.11p and LTE PC5 for V2V operating over the same frequency channels.....	24
7.2.1.4	Support of inter-PLMN for Uu and PC5.....	25
7.2.1.5	Aspects transferred from WI LTE SL V2V-Core.....	25
7.2.1.5.1	Congestion control for PC5-based V2X.....	25
7.2.1.5.2	Simultaneous Uu and PC5 operations in different carriers.....	26
7.2.1.5.3	Remaining enhancement to sidelink synchronization	26
7.2.1.5.4	Handle multiplexing V2V with other signals/channels	28
7.2.1.5.5	Support for traffic with smaller periodicity on PC5 based V2V using shorter resource reservation period.....	28
7.2.1.5.6	Prioritization of SL TX for V2X over WAN TX under eNB management	28
7.2.1.5.7	Other.....	29
7.2.2	Enhancements on Full-Dimension (FD) MIMO for LTE - WID in RP-160623.....	29
7.2.2.1	CSI enhancements	29
7.2.2.1.1	Advanced CSI.....	29
7.2.2.1.2	Interference measurement.....	31
7.2.2.1.3	Feedback mechanism enhancement	31
7.2.2.1.4	Non-coded CSI-RS codebook for 20 – 32 ports	31
7.2.2.2	Open-loop and Semi-open-loop	32
7.2.2.3	UL DMRS.....	33
7.2.2.4	Non-coded CSI-RS.....	35
7.2.2.5	Other remaining issues	37
7.2.2.5.1	Aperiodic and frequency domain reduced overhead CSI-RS.....	37
7.2.2.5.2	Hybrid CSI.....	39
7.2.3	Downlink Multiuser Superposition Transmission for LTE - WID in RP-161019.....	40
7.2.3.1	Superposition transmissions	40

7.2.3.2	Mechanisms for efficient operation	41
7.2.3.3	Evaluation for MUST using up to 8Tx	42
7.2.4	eMBMS enhancements for LTE - <i>WID in RP-161297</i>	42
7.2.4.1	Longer cyclic prefix for MBSFN subframe.....	42
7.2.4.2	MBSFN-RS pattern for longer cyclic prefix.....	42
7.2.4.3	Synchronization and acquisition of system information	43
7.2.4.4	Other	44
7.2.5	SRS Carrier Based Switching for LTE - <i>WID in RP-160935</i>	44
7.2.5.1	Procedures and configurations for SRS/RACH switching and transmission	44
7.2.5.2	DCI design	46
7.2.5.3	Details of collision handling	46
7.2.5.4	Other	47
7.2.6	Further Indoor Positioning enhancements for UTRA and LTE - <i>WID in RP-161850</i>	47
7.2.6.1	Remaining issues for OTDOA enhancements	47
7.2.6.2	PRS-based beacons.....	47
7.2.6.3	E-CID enhancements.....	48
7.2.6.4	Other	48
7.2.7	Uplink Capacity Enhancements for LTE - <i>WID in RP-160664</i>	48
7.2.8	Further Enhanced MTC for LTE - <i>WID in RP-161464</i>	50
7.2.8.1	Higher data rates.....	50
7.2.8.1.1	Larger max PDSCH/PUSCH TBS	51
7.2.8.1.2	Larger max PDSCH/PUSCH channel bandwidth.....	51
7.2.8.1.3	HARQ-ACK bundling in HD-FDD	52
7.2.8.1.4	Number of DL processes in FD-FDD	53
7.2.8.2	Multicast support	53
7.2.8.3	OTDOA enhancements	54
7.2.8.4	VoLTE enhancements	54
7.2.8.5	Other	55
7.2.9	Enhancements of NB-IoT - <i>WID in RP-161901</i>	55
7.2.9.1	Positioning	55
7.2.9.1.1	Design of narrowband OTDOA positioning	55
7.2.9.1.2	Evaluation of narrowband OTDOA positioning	56
7.2.9.1.3	Evaluation of narrowband UTDOA positioning using an existing NB-IoT transmission.....	57
7.2.9.2	Multicast support	57
7.2.9.3	Non-anchor PRB enhancements	59
7.2.9.4	Power consumption and latency reduction	59
7.2.9.5	Other	60
7.2.10	Shortened TTI and processing time for LTE - <i>WID in RP-161922</i>	60
7.2.10.1	Shortened processing time for 1ms TTI.....	60
7.2.10.2	Shortened TTI length together with shortened processing time.....	61
7.2.10.2.1	Design of sTTI for DL and UL.....	61
7.2.10.2.2	Processing time	66
7.2.10.3	Other	66
7.2.11	Performance enhancements for high speed scenario - <i>WID in RP-152263</i>	66
7.2.12	Voice and Video enhancement for LTE - <i>WID in RP-161856</i>	67
7.2.13	Study on Further enhancements to Coordinated Multi-Point Operation - <i>SID in RP-160954</i>	67
7.2.13.1	Initial evaluation results and enhancements for non-coherent joint transmission	67
7.2.13.2	Initial evaluation results and enhancements for coordinated scheduling/beamforming with FD-MIMO.....	68
8	NR	69
8.1	Study on New Radio Access Technology - <i>SID in RP-161596</i>	69
8.1.1	Waveform and multiple access schemes for new radio interface	69
8.1.1.1	Waveform	69
8.1.1.2	Multiple access scheme	70
8.1.2	Numerology and frame structure for new radio interface	74
8.1.2.1	Numerology	74
8.1.2.2	Frame structure.....	80
8.1.3	Channel coding and modulation for new radio interface	85
8.1.3.1	Channel coding.....	85
8.1.3.2	Modulation.....	92
8.1.4	Multi-antenna scheme for new radio interface	93
8.1.4.1	Beam management	93
8.1.4.2	Multi-antenna scheme	97
8.1.4.3	CSI acquisition	102
8.1.4.4	Reference signal design and QCL.....	108

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

8.1.4.5	Other	115
8.1.5	Aspects related to initial access and mobility	116
8.1.5.1	Synchronization signal and DL broadcast signal/channel	116
8.1.5.2	RACH procedure	122
8.1.5.3	Mobility	125
8.1.5.4	Other	127
8.1.6	Duplexing	127
8.1.6.1	Resource assignment and interference handling	128
8.1.6.2	Performance evaluation study	128
8.1.7	Scheduling/HARQ aspects	129
8.1.7.1	L1/L2 control channel design	129
8.1.7.2	Scheduling/HARQ mechanism	135
8.1.7.2	Other	138
8.1.8	Other	138
8.2	Other	140
9	Closing of the meeting	141
Annex A:	List of Tdocs at RAN1 #86bis	142
Annex B:	List of CRs agreed at RAN1 #86bis	143
Annex C-1:	List of Outgoing LSs from RAN1 #86bis	148
Annex C-2:	List of Incoming LSs from RAN1 #86bis	150
Annex D:	List of Approved updated WIDs	152
Annex E:	List of draft TSs/TRs agreed at RAN1 #86bis	153
Annex F:	List of actions	154
Annex G:	List of participants at RAN1 #86bis	158
Annex H:	TSG RAN WG1 meetings in 2016 – 2017	159

Main facts summary

3GPP TSG WG RAN1 #86bisbis meeting, hosted by the European Friends of 3GPP, was held at the ALTIS GRAND HOTEL, Lisbon, Portugal.

The meeting started at 9:05 on Monday 10th October and finished at 17:07 on Friday 14th October 2016.

The number of attending delegates, having confirmed their participation through the electronic check-in application, was **337**.

Note that the number of registered was 511.

The schedule of the week was as follows:

- Monday: Common session on Agenda items 1, 2, 3, 4, 5, 7.1.2 (Maintenance of Release 13 LTE carrier aggregation enhancement beyond 5 carriers), 7.1.3 (Maintenance of Release 13 LAA) and 7.1.4 (Maintenance of Release 13 EB/FD-MIMO) followed by Study on Latency reduction techniques (AI 7.3.10.1 on Evaluation results, AI 7.3.10.2 on Channel design for shortened TTI)
- Monday afternoon (LTE)
 - Session on NB-IoT (AI 7.2.1) chaired by Matthew Baker.
- Tuesday (NR): chaired by Satoshi Nagata
- Tuesday (LTE session1): chaired by Matthew Baker
 - eMBMS enhancements for LTE (AI 7.3.5), SRS Carrier Based Switching for LTE (AI 7.3.6) and Enhancements on Full-Dimension (FD) MIMO for LTE (AI 7.3.3).
- Tuesday (LTE session2): chaired by Wanshi Chen
 - Rel-13 eMTC CRs (and possibly other CRs (e.g., LAA, MIMO, eCA), Further Indoor Positioning enhancements for UTRA and LTE (AI 7.3.7), Enhanced Licensed-Assisted Access Using LTE (AI 7.3.1) and Support for V2V services based on LTE sidelink (AI 7.3.2).
- Tuesday (LTE session3):
 - Study on channel model for frequency spectrum above 6 GHz (AI 8.2) chaired by Tuomo Säynäjäkangas from Nokia followed by session on NB-IoT (AI 7.2.1) chaired by Brian Classon from Huawei.
- Tuesday (HSPA): Multi-Carrier enhancements for UMTS (AI 6.2) chaired by Carmela Cozzo from Huawei.
- Wednesday (NR): chaired by Satoshi Nagata
- Wednesday (LTE session1): chaired by Matthew Baker
 - Rel-13 CRs Maintenance (AI 7.1), Uplink Capacity Enhancements for LTE (AI 7.3.8), Study on Latency reduction techniques (AI 7.3.10) and Enhancements on Full-Dimension (FD) MIMO for LTE (AI 7.3.3).
- Wednesday (LTE session2): chaired by Wanshi Chen
 - Support for V2V services based on LTE sidelink (AI 7.3.2), Study on LTE-based V2X Services (AI 7.3.9) and Enhanced Licensed-Assisted Access Using LTE (AI 7.3.1).
- Wednesday (LTE session3):
 - Study on channel model for frequency spectrum above 6 GHz (AI 8.2) chaired by Tuomo Säynäjäkangas from Nokia followed by session on NB-IoT (AI 7.2.1) chaired by Brian Classon from Huawei.
- Wednesday (HSPA): DTX/DRX enhancements in CELL_FACH (AI 6.3) chaired by Florent Munier from Ericsson followed by Maintenance.
- Thursday (NR): chaired by Satoshi Nagata
- Thursday (LTE session1): chaired by Matthew Baker
 - Rel-13 CRs Maintenance (AI 7.1), Enhanced Licensed-Assisted Access Using LTE (AI 7.3.1), Study on Latency reduction techniques (AI 7.3.10), Enhancements on Full-Dimension (FD) MIMO for LTE (AI 7.3.3) and Downlink Multiuser Superposition Transmission for LTE (AI 7.3.4).
- Thursday (LTE session2): chaired by Wanshi Chen
 - Rel-13 eMTC CRs (AI 7.1.5), Downlink Multiuser Superposition Transmission for LTE (AI 7.3.4), Study on LTE-based V2X Services (AI 7.3.9), Enhanced Licensed-Assisted Access Using LTE (AI 7.3.1) and Support for V2V services based on LTE sidelink (AI 7.3.2).
- Thursday (LTE session3):
 - Study on channel model for frequency spectrum above 6 GHz (AI 8.2) chaired by Tuomo Säynäjäkangas from Nokia and session on NB-IoT (AI 7.2.1) chaired by Brian Classon from Huawei.
- Friday: Revisions. Continued offline in the morning (eLAA,...).

The list of action points that required RAN1 close follow-up is listed in Annex F (end of document).

The number of contributions for this meeting was xxxx, and those documents were categorized as followed.

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Agenda Item	Input Document	Treated Document
All		

Note: The amount of documents includes those discussed during the email discussion session post meeting.

	Contribution is agreed/approved
	Further discussion is required – come-back needed
	Working assumption
	Specific action needed from MCC
	Contribution is for email discussion/approval

1 Opening of the meeting

Mr Satoshi Nagata (RAN1 Chairman) welcomed the participants of the RAN WG1 86 meeting and opened the meeting at 09:05. Mr Shin Horng Wong from Sony welcomed the delegates on behalf of the European Friends of 3GPP, Alcatel-Lucent, Apple, BlackBerry, Deutsche Telekom, Ericsson, Huawei, Intel, KPN, Motorola, Nokia, Orange, Qualcomm, SIMAlliance, Sony, TeliaSonera, Telefonica, TIM, Telenor, Vodafone and detailed the domestic arrangements for the full week.

1.1 Call for IPR

The attention of the members of this Technical Specification Group was drawn to the fact that 3GPP Individual Members have the obligation under the IPR Policies of their respective Organizational Partners to inform their respective Organizational Partners of Essential IPRs they become aware of.

The members take note that they are hereby invited:

- to investigate whether their organization or any other organization owns IPRs which were, or were likely to become Essential in respect of the work of 3GPP.
- to notify their respective Organizational Partners of all potential IPRs, e.g., for ETSI, by means of the IPR Information Statement and the Licensing declaration forms (e.g. see the ETSI IPR forms <http://webapp.etsi.org/Ipr/>).

1.2 Competition law statement

The Chairman also drew Member's attention to the fact that 3GPP activities are subject to antitrust and competition laws and that compliance with said laws is therefore required of any participant of this WG meeting including the Chairman and Vice Chairmen. In case of question, please contact your legal counsel.

The present meeting will be conducted with strict impartiality and in the interests of 3GPP.

Furthermore, the Chairman reminded Members that timely submission of work items/contributions in advance of WG meetings is important to allow for full and fair consideration of such matters.

1.3 Network usage conditions

The PCG has laid down the following network usage conditions:

Users shall not use the network to engage in illegal activities. This includes activities such as copyright violation, hacking, espionage or any other activity that may be prohibited by local laws.

Users shall not engage in non-work related activities that consume excessive bandwidth or cause significant degradation of the performance of the network.

Since the **network is a shared resource**, users should exercise some basic etiquette when using the 3GPP network at a meeting. It is understood that high bandwidth applications such as downloading large files or video streaming might be required for business purposes, but delegates should be strongly discouraged in performing these activities for personal use. Downloading a movie or doing something in an interactive environment for personal use essentially wastes bandwidth that others need to make the meeting effective. The meeting chairman should remind end users that the network is a shared resource; the more one user grabs, the less there is for another. Email and its attachments already take up significant bandwidth (certain email programs are not very bandwidth efficient). In case of need the chair can ask the delegates to restrict IT usage to things that are essential for the meeting itself.

1. **DON'T place your WiFi device in ad-hoc mode**
2. **DON'T set up a personal hotspot in the meeting room**
3. **DO try 802.11a if your WiFi device supports it**
4. **DON'T manually allocate an IP address**
5. **DON'T be a bandwidth hog by streaming video, playing online games, or downloading huge files**
6. **DON'T use packet probing software which clogs the local network (e.g., packet sniffers or port scanners)**

2 Approval of Agenda

[R1-1610440](#) Draft Agenda of RAN1#86bis meeting RAN1 Chair ([R1-1608561](#))

Satoshi Nagata (Chairman) proposed the agenda for the meeting, as well the schedule of the week.

Discussion: No comment.

Decision: The agenda is approved.

3 Approval of Minutes from previous meeting

[R1-1608562](#) Final Report of 3GPP TSG RAN1 #86 v1.0.0 ETSI

The document was presented by Patrick Mérias (ETSI Mobile Competence Center) and provides the outcomes of last meeting in Sweden.

Discussion: MCC → recalled a rather simple working rule when CR needs to be revised (increment revision each time a formal CR is revised)

Decision: The document is approved.

4 Highlights from RAN Plenary

[R1-1608563](#) Selected highlights from RAN#73 of relevance to RAN1 RAN1 Chair

The document was presented by RAN1 Chair and feedbacks the decisions made by RAN#72, relevant to RAN1.

Discussion: Chair → regarding the additional ad-hoc meetings for NR, current view is as follows:

- January 2017 – 5days meeting – in the US (exact location still to be defined)
- June 2017 – 4days meeting – in China (exact location still to be defined)
- September 2017 - 4days meeting – location TBD, likely in Asia (Japan, India)

Decision: The document is noted.

5 Incoming Liaison Statements

[R1-1608565](#) LS on Support of CAT 9/10 and CAT 13 RAN2, Intel

The document was presented by ... from Intel. RAN2 agreed to use existing IEs i.e the UE indicates both ue-Category-v1170 (= Category 9/10) and ue-CategoryDL-r12 (= Category 13) when it supports both Category 9/10 and Category 13. RAN2 confirms that there is no backward compatibility issue when the UE sends both UE category IEs.

Decision: The document is noted.

[R1-1608571](#) LS on introduction of new UL categories in Rel-13 RAN2, Qualcomm

The document was presented by ... from Qualcomm. Based on the LS from RAN1 on introduction of new UL categories in Rel-13 (R1-168459), RAN2 endorsed the attached CRs to TS36.306 and TS36.331 to be sent to RAN for decision.

Discussion: No action to RAN1.

Decision: The document is noted.

LAA related

[R1-1608572](#) LS on CSI measurement ambiguity in LAA RAN4, LGE

The document was already treated in RAN1#86 (R1-167928).

Decision: The document is noted.

[R1-1609168](#) Discussion on RAN4 LS on CSI measurement ambiguity in LAA LG Electronics

- Proposal 1. Agree with the proposed text and introduce a corresponding Rel-13 CR (drafted in [[R1-1609170](#)]), where it should be decided first whether the yellow-highlighted text should be introduced as well or not. Then, inform RAN4.
- Proposal 2: Agree on the draft CR for Rel-13 LAA in [[R1-1609169](#)] which reflects previous RAN1 agreement on the CSI reference resource definition. Then, answer the issue 2 in RAN4 LS with information on the agreed CR.

Discussion: Intel is also supporting the proposal.

Decision: The document is treated under AI 7.1.3.

[R1-1609934](#) Draft LS response to 802.11 regarding LAA Qualcomm Incorporated

Discussion: Chair → already discussed in last meeting, can we agree it as baseline?

Ericsson/Huawei: ok to take it as a baseline but more discussion required for wording improvement

Decision: The document is noted. Continue offline discussion until Friday – (Qualcomm)

Friday: Response LS has been agreed in the CR maintenance session (see [R1-1611031](#) under 7.1.7) – it covers partially the topics of the original LS from IEEE.

[R1-1608567](#) LS on Timing reference for LAA SCell RAN2, LGE

In order to handle the TA of LAA SCells without RA, as one solution, RAN2 suggests configuring a TAG including only LAA SCells and use N_{TA} for that TAG as zero. Considering that a timing reference cell within an sTAG is an activated SCell in that sTAG, if we allow configuring a TAG including only LAA SCells, an LAA SCell should be used as a timing reference cell for that TAG. Question to RAN4 Under which conditions the UE can consider that the LAA SCell is a reliable timing reference cell for UL transmissions?

Discussion: No action to RAN1.

Decision: The document is noted.

[R1-1608570](#) Reply LS on ECID positioning for TDD RAN2, CATT

The document was presented by ... from CATT and confirms that RAN1 and RAN4 agreements on ECID TDD related measurements have been taken into account, and based on the assumptions that E-SMLCs will be upgraded to new LPP and new UEs will only use behaviour 1, RAN2 approved three CRs: 36.355 CR (R2-165956), 36.331 CR (R2-165954), 36.306 CR (R2-165955)

Decision: The document is noted.

R1-1608579 LS for definition of SSTD measurement RAN4, CATT

The document was presented by ... from CATT and asks RAN1 to modify the definition of SFN and subframe timing difference (SSTD) measurement as proposed.

Decision: The document is noted.

R1-1608580 LS on on UCG parameters for eMTC RAN4, Intel

The document was presented by ... from Intel. RAN4 has discussed frequency synchronization during continuous transmissions by HD-FDD eMTC UEs and has concluded the following:

1. Frequency error requirement for Cat-M1 UE is relaxed to 0.2 ppm for $f < 1$ GHz
2. For UEs that need uplink compensation gaps (UCG) the gap period (X) is 256 ms and gap length (Y) is 40 ms
3. The UEs that don't need UCG shall be enabled to operate without UCG implementation
4. UCG is not needed for any PRACH configuration

Decision: The document is noted.

R1-1608581 LS on LTE Rel-13 UE feature list RAN4, Qualcomm, Intel

The document was presented by ... from Qualcomm and asks RAN2 to develop the capability signalling for Rel-13 UEs taking this UE feature list into account.

Discussion: No action to RAN1.

Decision: The document is noted.

V2X related

R1-1608564 LS Response on QoS requirements for V2X RAN2, Intel

The document was presented by Alexey Khoryaev from Intel and reports following RAN2 agreements and assumptions.

- RAN2 does not expect V2X PC5 resources to be shared with other non-V2X applications.
- For mode 1, RAN2 agrees that PPPP and other QoS parameters provided by higher layers will be used.
- For mode 2, RAN2 assumes that PPPP can be used to ensure QoS for PC5 V2V.
- For proposed QCI characteristics in S2-162662, RAN2 confirms two new QCIs and observation that two QCI values with different PDB can be assigned with the same priority.

Discussion: No action to RAN1.

Decision: The document is noted.

R1-1608566 LS on Exceptional Pool Handling for V2XRAN2, OPPO

The document was presented by ... from OPPO. The RRC specification will include the exceptional pool in SIB21 (for the non-handover cases like idle-to-connected, RLF, RRCReconfiguration, etc.), and pre-sensing on the exceptional pool is used for exceptional pool provided by serving cell. For handover case, an "exceptional" pool is provided by the target cell. The UE uses random selection on this pool based on the concern that sensing may cause latency issue in the transition states.

RAN1 is asked to feedback if there is any concern with this solution, in particular with the use of random selection on the exceptional pool for handover case.

Decision: The document is noted.

R1-1608582 Reply LS on QoS requirements for V2X SA2, LGE

The document was presented by ... from LGE and provides the following feedback to RAN2:

- A1) SA2 confirms that enforcing UE-PC5-AMBR is not necessary for mode 2 operation. This is because the network is not expected to control the amount of resources consumed when the UE operates in mode 2.
- A2) SA2 considers the PDB as the latency requirement from the application layer (i.e. 20ms or 100ms as defined in TS 22.185). The latency can be derived from PPPP by the AS layer, which is based on the mapping between the PPPP and latency provided by configuration to be defined in SA2.
- A3) SA2 assumes that the V2X UE in limited service state shall follow the similar principles for the ProSe Direct Communication specified for ProSe-enabled Public Safety UEs set forth in clause 4.5.6 of TS 23.303. However, final confirmation needs to be made by SA1 from service perspective.

Discussion: No action to RAN1.

Decision: The document is noted.

R1-1608569 LS on RAN2 agreements on FeMBMS RAN2, Qualcomm

The document was presented by ... from Qualcomm and reports RAN2 conclusions:

- Working Assumption: For non-standalone case, Rel-14 FeMBMS carrier broadcasts MIB and all SI needed to receive FeMBMS transmission in Idle mode. Which of the necessary SI and contents are FFS.
- Agreements:

- The Rel-14 FeMBMS carrier does not support paging functionality for mobile terminating calls.
- For non-standalone case, from RAN2 point of view, subframes 0, 4, 5, 9 (FS1) and 0, 1, 5, 6 (FS2) can be used as MBSFN subframes for FS1 (FS2) in an eMBMS carrier. It is understood that 100% MBSFN subframe allocation allows for subframes to be set aside, for example, for cell search and broadcasting of necessary system information.

Decision: The document is noted.

R1-1608575 Reply LS on blind detection evaluations RAN4, MediaTek

The document was presented by ... from MediaTek and reports RAN4 conclusions:

- MUST Case 1 and Case 2 : For NOMA near UE
 - Blind detection on interference existence is not feasible
 - The degradation due to existence detection error is significant for either OMA to NOMA or NOMA to OMA
 - Practical blind detection algorithms cannot achieve acceptable detection rate for both 1-layer and 2-layer in CRS-based TMs
 - Blind detection on power ratio is not feasible
- MUST Case 3: Unequal power allocation between spatial layers in CRS-based TMs is not feasible in terms of UE blind detection complexity

Decision: The document is noted.

R1-1608577 Reply LS on SRS carrier switching interruption time RAN4, Huawei

The document was presented by Weimin Xiao from Huawei and states:

Given that the RF switching time may have some dependency on the CA scenarios and UE implementation, RAN4 agrees that the RF switching time can be defined in the following values:

- 0 us / 30 us / 100 us / 200 us / 300 us / 500 us / 900 us
- Any values equal to or larger than 1ms are not considered because it may negate the potential gains of enabling SRS switching in the first place. Note that this RF switching time does not include UL transmit timing difference between two TAGs, which is up to 32.47us, or any channel access delay caused by LBT in the case of LAA operation.

Depending on UE implementation, network configuration, CA scenarios, and RAN1 design, DL reception of PCell or SCells may be impacted due to SRS switching.

Decision: The document is noted.

mobility enhancements

R1-1608568 LS on further mobility enhancements RAN2, ZTE

The document was presented by Zhisong Zuo from ZTE. RAN2 agreements regarding

- the RACH-less solution:
 - 1) The asynchronous RACH-less solution is excluded.
 - 2) Only the RACH-less solution that the TA value of the source cell is reused for the targeted cell, or TA=0 will be further considered.
 - 3) The subframe allocation and uplink grant format can be configured by RRC message. If the subframe allocation and uplink grant format is configured, the starting subframe of the configured uplink grant is provided by the target eNB in RRC message. If UE doesn't receive UL grant in RRC message, it will monitor PDCCH of the target eNB for UL grant. UE doesn't need to know the SFN of the target eNB.
 - 4) RACH-less solution can be used for SCG change and handover scenarios.
- the make-before-break solution:
 - 1) The "make before break handover solution" means the UE continues downlink and uplink with the source cell until the UE performs the first transmission through PUSCH or PRACH to the target eNB.
 - 2) The solution is applicable for intra frequency handover and SCG change. Inter frequency case is FFS.
 - 3) Consider RACH-less solution and "maintaining a connection to the source eNB" as two independent mechanisms, activation of which is up to the network decision. Two solutions can be activated simultaneously.

Discussion: No action to RAN1.

Decision: The document is noted.

R1-1609936 On RAN2 LS on further mobility enhancements Qualcomm Incorporated

- Observation 1: From the LS description, the timing and the duration of the grant provided via RRC are unclear.
- Observation 2: The benefit of defining a new grant type and transmitting via RRC instead of using legacy PDCCH scheduling is not justified.
- Observation 3: Without a power control mechanism for PUSCH transmission when RACH is skipped, the uplink transmissions will fail and UE power and uplink resources will be wasted.
- Observation 4: Using the existing dynamic grant and TPC mechanism, the eNB can control uplink power. If upper layer grant is used, this is not possible.
- Proposal: RAN1 to respond to RAN2 LS by recommending not to define a new upper layer grant and instead use the existing PUSCH scheduling procedure when RACH is skipped during E-UTRA handover.

Decision: The document is noted. Continue offline discussion until Friday – Peter (Qualcomm)

Friday: Not much progress achieved. Discussion postponed to next meeting.

R1-1608576 Reply LS on the feasibility of mobility enhancement solutions RAN4, Ericsson, ZTE

The document was presented by ... from Ericsson and provides the following clarifications:

- The legacy accuracy requirements for uplink timing alignment, i.e. the accuracy of TA for initial uplink transmission, cannot be met by UE calculated TA scheme in either synchronous or asynchronous network. The TA calculation error comes from TA error of source cell, UE reception time difference, BS transmission time alignment error, and uplink/downlink imbalance.
- If it is feasible to start PUCCH/PUSCH/SRS transmission directly is up to RAN1. RAN4 would like to point out that without PRACH power ramping step the transmission power accuracy could be impacted.
- The feasibility and accuracy of network based timing offset estimation in asynchronous case is within the domain of RAN3 to evaluate. From a RAN4 perspective, any error in the estimated timing offset between source and target eNBs will cause doubled error in the calculated TA value.

Discussion: No action to RAN1.

Decision: The document is noted.

R1-1608578 LS on Measurement gap enhancement RAN4, Ericsson, Intel

The document was presented by ... from Ericsson and asks RAN WG2 to start to consider the signalling necessary to introduce the gap enhancements described in the liaison statement.

Discussion: No action to RAN1.

Decision: The document is noted.

NR related

R1-1608573 Response LS on Modelling and simulation of IMT networks for use in sharing and compatibility studies RAN4, Ericsson

The document was presented by ... from Ericsson and asks RAN to approve and forward the LS to ITU-R WP5D.

Discussion: No action to RAN1.

Decision: The document is noted.

R1-1608574 LS on Characteristics of terrestrial IMT systems for frequency sharing/interference analysis in the frequency range between 24.25 GHz and 86 GHz RAN4, Nokia

The document was presented by ... from Nokia and asks RAN to approve and forward the LS to ITU-R WP5D in advance of the ITU-R WP5D meeting in October 2016.

Decision: The document is noted.

R1-1608583 Reply LS on NR requirements RAN, ZTE

The document was presented by ... from ZTE and provides the following guidance:

- There are two types of latency requirements in TR38.913: latency-only (sec. 7.5, where no value for eV2X is defined) and latency + reliability (sec. 7.9, applicable to URLLC and eV2X). Both are to be considered best case targets.
 - There are no exact latency requirements for URLLC and eV2X during successful mobility events, but it can be assumed that in the ideal scenario they are close to the corresponding latency + reliability requirements.
 - For failure cases, RAN2 should aim at minimizing interruption times.
- For the latency-only target (not defined for eV2X), some radio error rate may be considered (e.g. HARQ Retransmission), but likely no UE speed assumption. For the latency + reliability requirement, RAN1 will define separate UE speed and error rate assumptions for URLLC and eV2X as part of their work on the evaluation environments and methodology for URLLC and eV2X services. For eV2X, the maximum UE speed is currently set to 250 km/h but could be further modified after further SA1 input.
- The latency requirements in TR 38.913 apply to the 5G radio network, and there needs to be a way for the 5G radio network to meet the requirements. Not all possible configurations and options need to meet all the requirements. In the context of the NR Study Item, the control plane latency requirement applies for the case when NR is the anchor.
- The latency requirements in TR 38.913 apply to the 5G radio network, and there needs to be a way for the 5G radio network to meet the requirements. Not all possible configurations and options need to meet all the requirements. In the context of the NR Study Item, the user plane latency requirement applies for the cases when NR or LTE is the anchor and user plane data transmission only happens through the NR node.

Discussion: No action to RAN1.

Decision: The document is noted.

The following set of LS was received in the course of the meeting week:

R1-1610565 LS on Multi-carrier enhancements for UMTS RAN2, Ericsson

R1-1610680 LS on TTI switching for MC enhancements RAN2, Huawei

R1-1610765 LS on RAN2 agreements on FeMBMS RAN2, Ericsson

Decision: The document is noted. The LS was treated under AI 7.2.4.

[R1-1610766](#) LS to RAN1 on V2V agreements RAN2, LGE

6 UTRA

[R1-1610573](#) Report of the UMTS sessions UMTS Session Chairman's Notes (Carmela Cozzo, Huawei)
The document was presented by Gerardo Medina from Ericsson on behalf of Carmela Cozzo.

Decision: The document is endorsed and content incorporated below.

6.1 Maintenance of UTRA Releases 4 – 13

None.

6.2 Multi-Carrier enhancements for UMTS - WID in [RP-161259](#).

6.2.1 TTI switching

[R1-1610194](#) HS-SCCH order design for TTI switching Huawei, HiSilicon

[R1-1610233](#) On introducing the HS-SCCH orders for enabling TTI Switching in Multicarrier Enhancements in UMTS Ericsson

Agreement on HS-SCCH orders for TTI switching:

Table 14B.3A: Orders for switching the E-DCH TTI for single cell E-DCH

Extended Order Type	Order Type	Order Mapping			Interpretation
Xeodt,1, Xeodt,2	Xodt,1, Xodt,2, Xodt,3	Xord,1	Xord,2	Xord,3	
11	011	0	0	0	TTI switch order from 2ms to 10ms
		0	0	1	TTI switch order from 10ms to 2ms
		0	1	0	Unused (Reserved single cell E-DCH)
		0	1	1	Unused (Reserved single cell E-DCH)
		1	0	0	Unused (Reserved single cell E-DCH)
		1	0	1	Unused (Reserved single cell E-DCH)
		1	1	0	Unused (Reserved single cell E-DCH)
		1	1	1	Unused (Reserved single cell E-DCH)

Table 14B.3B: Orders for switching the E-DCH TTI for dual cell E-DCH

Extended Order Type	Order Type	Order Mapping			Interpretation
Xeodt,1, Xeodt,2	Xodt,1, Xodt,2, Xodt,3	Xord,1	Xord,2	Xord,3	
11	011	0	0	0	Unused (Reserved dual cell E-DCH)
		0	0	1	Unused (Reserved dual cell E-DCH)
		0	1	0	TTI switch order to 2ms+2ms
		0	1	1	TTI switch order to 2ms+10ms
		1	0	0	TTI switch order to 10ms+2ms
		1	0	1	TTI switch order to 10ms+10ms
		1	1	0	Unused (Reserved dual cell E-DCH)
		1	1	1	Unused (Reserved dual cell E-DCH)

Note 1 (Table 14B.3B): For the TTI switch orders the TTI length displayed on the left hand side applies to the primary uplink frequency, while the TTI length displayed on the right hand side applies to the secondary uplink frequency.

Note 2 (Table 14B.3B): The TTI switch orders also apply if the secondary uplink frequency is deactivated, but it becomes effective on the secondary uplink frequency upon its re-activation.

[R1-1610572](#) LS to RAN2/3 on the agreements on TTI switching RAN1

6.2.2 Power scaling

[R1-1610193](#) Considerations on power scaling rules for 2ms+10ms configurations

Huawei, HiSilicon

[R1-1610234](#) On Power Scaling and Multicarrier Enhancements for UMTS

Ericsson

Conclusion: For proposal in [R1-1610193](#), it is encouraged to show use cases (throughput) for next meeting.

6.2.3 Other

[R1-1610195](#) Response to RAN2 LS on MC enhancements Huawei, HiSilicon
[R1-1610196](#) Configuration of physical layer parameters for MC enhancements Huawei, HiSilicon
[R1-1610235](#) On the “Response LS” related to the configuration of DTX along with the Rel-14 Multicarrier Enhancements for UMTS Ericsson

[R1-1610571](#) LS to RAN2/3 Response LS RAN1

[R1-1610236](#) Primary Carrier Switching for Multicarrier Enhancements in UMTS Ericsson

Conclusion: continue discussing the proposal in [R1-1610236](#)

6.3 DTX/DRX enhancements in CELL_FACH - WID in [RP-160185](#).

6.3.1 DRX improvements

[R1-1609782](#) Introduction of HS-SCCH Order for HS-SCCH DRx feature in enhanced Cell Fach Qualcomm Europe Inc.(France)

Decision: CR0344 to 25.2.12 (Rel-14) is agreed.

[R1-1609784](#) UE Procedures for HS-SCCH DRx feature in enhanced Cell Fach Qualcomm Europe Inc.(France)

Decision: CR0758 to 25.2.14 (Rel-14) is agreed.

6.3.2 DTX improvements

[R1-1610237](#) An assessment on the potential gains in cell throughput derived from fully applying DTX on the stand alone UL DPCH transmissions in CELL_FACH Ericsson

7 E-UTRA

7.1 Maintenance of E-UTRA Releases 8 – 14

Only essential corrections.

Note that individual companies can submit draft CRs to this agenda item for Rel-13 items.

[R1-1610882](#) Chairman's notes of AI 7.1 on CRs Ad-Hoc chair (Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Discussion: Ad-hoc chair → Typo needs to be fixed ([R1-1609173](#) should be read as [R1-1610773](#))

Decision: The document is endorsed and content incorporated below.

7.1.1 Maintenance of E-UTRA Release 8 – 12

Friday: Following contribution deals with the benefits of introducing new TBS values for DL 256QAM, and is a follow-up of RAN's decision requesting to discuss further this issue in the Working Groups.

[R1-1610413](#) Introduction of new Transport Block Size for DL 256QAM Qualcomm

Decision: The document is noted for email approval until Oct.27th – (Qualcomm)

7.1.2 Maintenance of Release 13 LTE carrier aggregation enhancement beyond 5 carriers

[R1-1610094](#) Clarification on a few PUCCH format 4 and 5 related issues in eCA Qualcomm Incorporated

Conclusion:

- For the 3 issues discussed in [R1-1610094](#),
 - The 1st and 3rd issues are for email discuss till 10/21 (Peter, Qualcomm)
 - The proposals for the 2nd issue is aligned with RAN1 understanding (i.e., $N_{ID}^{csh-DMRS}$, if configured by higher layers for PUSCH, is also applicable to PUCCH format 4 and 5). CR to be prepared for the next RAN1 meeting.

[R1-1610852](#) Correction on PDCCH candidate configuration LG Electronics

Decision: Email approval of [R1-1610852](#) till 10/21 – Seonwook (LG Electronics)

7.1.3 Maintenance of Release 13 licensed-assisted access to unlicensed spectrum

[R1-1609168](#) Discussion on RAN4 LS on CSI measurement ambiguity in LAA LG Electronics

[R1-1609169](#) Correction on CSI reference resource definition in LAA LG Electronics

Decision: Draft CR in [R1-1609169](#) is endorsed. Final CRs to be prepared.

Friday: CR0780 to 36.213 (Rel-13) is agreed in [R1-161027](#) and shadow CR0781 to 36.213 (Rel-14) is agreed in [R1-161028](#).

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Post-meeting: **MCC to change category F to A in R1-1611028.**

R1-1610773 Correction on CSI measurement in LAA LG Electronics (R1-1609170)

Decision: Draft CR in R1-1610773 is endorsed. Final CRs to be prepared.

Friday: CR0782 to 36.213 (Rel-13) is agreed in R1-1611029 and shadow CR0783 to 36.213 (Rel-14) is agreed in R1-1611030.

Post-meeting: **MCC to change category F to A in R1-1611030.**

R1-1610841 [Draft] Reply LS on CSI measurement ambiguity in LAA LGE

Decision: The document is noted and final LS is approved in R1-1611026.

R1-1609937 Discussion on periodic and aperiodic CSI reporting in LAA Qualcomm Incorporated

R1-1609938 Draft CR on aperiodic CSI reporting in LAA Qualcomm Incorporated

R1-1609368 Draft CR on energy detection threshold for DL multi-carrier operation for LAA in 36.213 Huawei,

HiSilicon

R1-1610462 Draft CR on energy detection threshold for DL multi-carrier operation for LAA in 36.213 Huawei,

HiSilicon

R1-1610197 Correction on CWp adjustment on Type B1 multi-carrier access procedure for Rel-13 LAA WILUS Inc.

Decision: CR0754 to 36.213 (Rel-13) is agreed in R1-1610450.

7.1.4 Maintenance of Release 13 elevation beamforming/full-dimension MIMO for LTE

R1-1609171 Correction on NZP CSI-RS aggregation for Class A LG Electronics

Decision: CR0296 to 36.211 (Rel-13) is agreed in R1-1610451.

R1-1609449 Correction on periodic CSI reporting mode 2-1 for Class B FD-MIMO Intel Corporation, ZTE, ZTE
Microelectronics

R1-1610428 Correction on periodic CSI reporting mode 2-1 for Class B FD-MIMO Intel Corporation, ZTE
Corporation, ZTE Microelectronics

Decision: CR0755 to 36.213 (Rel-13) is agreed in R1-1610452 Correction to PUCCH reporting mode 2-1

Prepare Rel-14 CR within Monday – Alexei (Intel)

Decision: CR0757 to 36.213 (Rel-14) is agreed in R1-1610454

R1-1609450 Correction on periodic CSI reporting mode 1-1 for Class B FD-MIMO Intel Corporation, ZTE, ZTE
Microelectronics

Decision: CR0756 to 36.213 (Rel-13) is agreed in R1-1610453 Correction to PUCCH reporting mode 1-1

Prepare Rel-14 CR within Monday – Alexei (Intel)

Decision: CR0758 to 36.213 (Rel-14) is agreed in R1-1610455

7.1.5 Maintenance of Release 13 further LTE physical layer enhancements for MTC

R1-1610439 Correction of typos due to wrong implementation of CR0283 “Clarification of valid subframe in eMTC”

MCC

Decision: CR0295 to 36.211 (Rel-13) is agreed.

R1-1611020 Correction of typos due to wrong implementation of CR0283 “Clarification of valid subframe in eMTC”

MCC

Decision: CR0308 to 36.211 (Rel-14) is agreed.

PRACH

R1-1610447 Correction of PRACH starting subframes for eMTC Intel Corporation (Revision of R1-
1609451)

Decision: The CR is endorsed. Final CRs to be prepared.

CR0303 to 36.211 (Rel-13) is agreed in R1-1610914 and shadow CR0304 to 36.211 (Rel-14) is agreed in R1-1610915.

MPDCCH

R1-1609605 Correction to DMRS for MPDCCH associated with P-RNTI Virtuosys Limited, Qualcomm
Incorporated, Intel Corporation

Decision: CR0289 to 36.211 (Rel-13) is agreed. Also to prepare a shadow CR for Rel-14 (Mark, Virtuosys).

R1-1610504 Correction to DMRS for MPDCCH associated with P-RNTI Virtuosys Limited, Qualcomm
Incorporated, Intel Corporation

Decision: CR0298 to 36.211 (Rel-14) is agreed.

R1-1609941 CR for clarification on i_0 value Qualcomm Incorporated

[R1-1610208](#) Draft CR for correction on MPDCCH hopping Qualcomm Incorporated
[R1-1610742](#) CR for clarification on i_0 value Qualcomm Incorporated

Decision: The CR is endorsed. Final CRs to be prepared.

CR0301 to 36.211 (Rel-13) is [agreed in R1-1610911](#) and shadow CR0302 to 36.211 (Rel-14) is [agreed in R1-1610912](#).

[R1-1610474](#) Correction on equation for MPDCCH search space and starting subframe position NTT DOCOMO, INC., Panasonic (Revision of [R1-1610028](#))

Decision: The draft CR in R1-1610474 is endorsed. Prepare final CR, including Rel-14 shadow CR (Naoto, DCM). CRs are provided in [R1-1610497](#) and [R1-1610501](#). Prepare updated CRs with 'ME' box checked (Naoto, DCM).

[R1-1610726](#) Correction on equation for MPDCCH search space and starting subframe position NTT DOCOMO, Panasonic

Decision: CR0767r1 to 36.213 (Rel-13) is [agreed](#).

[R1-1610797](#) Correction on equation for MPDCCH search space and starting subframe position NTT DOCOMO, Panasonic

Decision: CR0768r1 to 36.213 (Rel-14) is [agreed](#).

[R1-1610308](#) DraftCR: 36.213 Clarification on the reference subframe k in ECCE determination in a MPDCCH search space Sony

[R1-1610408](#) DraftCR: 36.213 Clarification on the reference subframe k in ECCE determination in a MPDCCH search space Sony Europe Limited

Decision: The CRs in [R1-1610308](#) and [R1-1610408](#) are not necessary.

[R1-1610369](#) Correction on MPDCCH monitoring in special subframes Huawei, HiSilicon

Decision: The CR in [R1-1610369](#) is not necessary

[R1-1610370](#) Correction on MPDCCH transmission without repetition Huawei, HiSilicon

Decision: Continue discussion offline (Huawei)

[R1-1610778](#) Correction on MPDCCH transmission without repetition Huawei, HiSilicon

Decision: CR0291 to 36.211 (Rel-13) is agreed. Prepare Rel-14 shadow CR (Zheng, Huawei)

[R1-1610926](#) Correction on MPDCCH transmission without repetition Huawei, HiSilicon

Decision: CR0307 to 36.211 (Rel-14) is agreed.

CSI

[R1-1609939](#) Draft CR clarification on spectral efficiency Qualcomm Incorporated

Decision: The draft CR in [R1-1609939](#) is [endorsed](#). Prepare final CR, including Rel-14 shadow CR (Alberto, Qualcomm)

Final decision: CR0763 to 36.213 (Rel-13) is [agreed in R1-1610493](#) and CR0765 to 36.213 (Rel-14) is [agreed in R1-1610495](#)

[R1-1609942](#) CR for clarification on A-CSI without hopping Qualcomm Incorporated, Samsung

Decision: The draft CR in [R1-1609942](#) is [endorsed](#) (to fix the indentation). Prepare final CR, including Rel-14 shadow CR (Alberto, Qualcomm)

CRs are provided in [R1-1610494](#) and [R1-1610496](#). Prepare updated CRs to fix the spacing and the date (Alberto, Qualcomm)

CRs are provided in [R1-1610837](#) and [R1-1610838](#). Prepare updated CRs to fix the indentation (Alberto, Qualcomm)

Final decision: CR0764r2 to 36.213 (Rel-13) is [agreed in R1-1610944](#) and CR0766r2 to 36.213 (Rel-14) is [agreed in R1-1610945](#)

PUSCH

[R1-1609940](#) Draft CR clarification on PUSCH repetition levels Qualcomm Incorporated

Decision: The CR in [R1-1609940](#) is not necessary

PUCCH/SRS

[R1-1609826](#) Clarification of number of repetitions of PUCCH ZTE

Continue discussion offline (Huiying, ZTE)

Decision: CR0769 to 36.213 (Rel-13) is [agreed in R1-1610648](#) and CR0771 to 36.213 (Rel-14) is [agreed in R1-1610656](#)

[R1-1610382](#) Clarification of PUCCH and SRS not belonging to any narrowband for BL/CE UE Ericsson

[R1-1610749](#) WF on PUCCH and SRS not belonging to any narrowband for BL-CE UE Ericsson, Intel, Qualcomm, Sequans, Sony, ZTE

[R1-1610919](#) WF on PUCCH and SRS not belonging to any narrowband for BL-CE UE Ericsson, Alcatel-Lucent Shanghai Bell, AT&T, Intel, Nokia, NTT DoCoMo, Orange, Qualcomm, Sequans, Sony, Sierra Wireless, Virtuosys, ZTE, ZTE Microelectronics

- BL/CE UE can transmit PUCCH in any PRB.

- BL/CE UE drops SRS transmission in subframe n when PUCCH transmission occurs in subframe n or $n+1$ in a PRB not belonging to a narrowband.

Note: No specification change is required from the above proposals.

Decision: The document is noted. Also supported by Verizon

Conclusion:

- It is RAN1 understanding that BL/CE UE can transmit PUCCH in any PRB.
- It is RAN1 understanding that BL/CE UE drops SRS transmission in subframe n when PUCCH transmission occurs in subframe n or $n+1$ in a PRB not belonging to a narrowband.
- It is RAN1 understanding that BL/CE UE may need retune to/from transmitting PUCCH in a PRB not belonging to a narrowband when necessary
- Note: No specification change is required from the above proposals.

7.1.6 Maintenance of Release 13 NB-IoT

PDSCH

[R1-1608706](#) CR on 36.211 NB-IoT PDSCH symbol mapping Ericsson

[R1-1610409](#) CR on 36.211 NB-IoT PDSCH symbol mapping Ericsson

Both CRs are not pursued.

NPDCCH

[R1-1608707](#) CR on 36.213 NB-IoT Type1 and Type 2 search space definition Ericsson

Decision: The CR is **endorsed** in principle.

[R1-1610733](#) CR on 36.213 NB-IoT Type1 and Type 2 search space definition Ericsson

[R1-1610734](#) CR on 36.213 NB-IoT Type1 and Type 2 search space definition Ericsson

Decision: CR0751r1 to 36.213 (Rel-13) is **agreed in [R1-1610733](#)** and CR0752r1 to 36.213 (Rel-14) is **agreed in [R1-1610734](#)**

[R1-1609403](#) Correction on the determination of NPDCCH candidates ITRI

[R1-1609404](#) Correction on the determination of NPDCCH candidates ITRI

Decision: CR0746 to 36.213 (Rel-13) is **agreed in [R1-1609403](#)** and CR0747 to 36.213 (Rel-14) is **agreed in [R1-1609404](#)**

NPRACH

[R1-1609452](#) Correction of NPRACH frequency hopping Intel Corporation

Decision: The CR in [R1-1609452](#) is **endorsed** in principle.

[R1-1610756](#) Correction of NPRACH frequency hopping Intel Corporation

Decision: CR0305 to 36.211 (Rel-13) is **agreed in [R1-1610916](#)** and CR0306 to 36.211 (Rel-14) is **agreed in [R1-1610917](#)**

[R1-1609680](#) Clarifications about NPRACH configuration parameters Nokia, Alcatel-Lucent Shanghai Bell

[R1-1609679](#) Clarifications about NPRACH configuration parameters Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610412](#) Clarifications about NPRACH configuration parameters Nokia, Alcatel-Lucent Shanghai Bell
Note: For 240 msec period values, an overlap with the next HSFN occurs for 32 repetitions

[R1-1610018](#) Clarification on power ramping for NPRACH MediaTek Inc.

[R1-1610770](#) WF on Clarification of NPRACH for single/multi-tone MSG 3 Mediatek

- If there is no resource reserved for multi-tone MSG 3 in a coverage level, UE supports multi-tone MSG 3 can use the NPRACH resources for single-tone MSG 3 in the coverage level.
- If there is no resource for single-tone MSG 3 in a coverage level,
 - For Rel-13, no additional CR for current specs. This means,
 - If all the PRACH resources are for multi-tone MSG 3 in a coverage level, multi-tone MSG 3 incapable UE cannot transmit NPRACH if the UE belongs to that coverage level.
 - If there is no NPRACH resources for single-tone MSG 3 in the next coverage level, multi-tone MSG 3 incapable UE stays in current level.
 - Further study for Rel-14 if UE support single tone MSG 3 transmission can use other coverage level and the need of additional power ramping.

Decision: The document is noted

Conclusion:

- RAN1 concludes that random access resource selection procedure in MAC specification may need some clarification at least for multi-tone-message-3 capable UEs. Companies may bring CRs to RAN2

NRS

[R1-1609827](#) Clarification on nrs-Power related description ZTE

Decision: The CR in [R1-1609827](#) is **endorsed** in principle.

[R1-1610649](#) Clarification on nrs-Power related description ZTE

R1-1610657 Clarification on nrs-Power related description ZTE
Decision: CR0770 to 36.213 (Rel-13) is **agreed in R1-1610649** and CR0772 to 36.213 (Rel-14) is **agreed in R1-1610657**

Collision Handling

R1-1610471 CR for clarification on NPRACH and NPUSCH collision Qualcomm Incorporated (Revision of [R1-1609943](#))

Decision: The CR in [R1-1610471](#) is endorsed. Final CRs to be prepared (including Rel-14 shadow CR)

Decision: CR0299 to 36.211 (Rel-13) is **agreed in R1-1610505** and CR0300 to 36.211 (Rel-14) is **agreed in R1-1610506**.

7.1.7 Maintenance of Release 14 Enhanced Licensed-Assisted Access to Unlicensed Spectrum

R1-1608980 Draft CR on start timing of PUSCH Samsung

Decision: The CR0297 to 36.211 (Rel-14) is **agreed in R1-1610475**

R1-1609174 Correction on UL grant reception in ending partial subframe LG Electronics

Decision: The CR0759 to 36.213 (Rel-14) is **agreed in R1-1610456**

R1-1609175 Correction on UL burst scheduling LG Electronics

R1-1610775 Correction on UL burst scheduling LG Electronics

Decision: The CR is **endorsed**. Final CR to be prepared.

Final decision: The CR0760 to 36.213 (Rel-14) is **agreed in R1-1610457**

R1-1609367 Draft CR on PHICH operation for eLAA in 36.213 Huawei, HiSilicon

Decision: The CR0761 to 36.213 (Rel-14) is **agreed in R1-1610458**

R1-1609569 [Draft 36.212 CR] Corrections to RV in eLAA DCI definitions Nokia, Alcatel-Lucent Shanghai Bell

Decision: The CR0221 to 36.212 (Rel-14) is **agreed in R1-1610459**

R1-1609576 Draft CR on DCI formats related with LAA in TS 36.212 ETRI

R1-1610463 Draft CR on DCI formats related with LAA in TS 36.212 ETRI

Decision: The CR0222 to 36.212 (Rel-14) is **agreed in R1-1610476** with following update (deletion of text):

Else10463(212), 10464(213),

R1-1610464 Draft CR on UL duration and offset field in TS 36.213 ETRI

Decision: The CR is **endorsed**. Final CR to be prepared.

Final decision: The CR0774 to 36.213 (Rel-14) is **agreed in R1-1610896**

R1-1609577 Draft CR on timing offset field in TS 36.213 ETRI

R1-1610198 Correction on PUSCH RE mapping in case of multiple subframe scheduling WILUS Inc.

R1-1610199 Correction on handling UL LBT procedure under UE power limited case WILUS Inc.

Final decision: The draft is agreed as CR0762 to 36.213 (Rel-14) **in R1-1610460 with following update**

If the beginning of UE transmission in subframe $n + 1$ immediately follows the end of UE transmission in subframe n , the UE is not expected to be indicated with different channel access types for the transmissions in those subframes.

If the UE is scheduled to transmit in subframes $n_0, n_1, \dots, n_{w-1}$ using Type 1 or Type 2 channel access procedure using a PDCCH DCI Format 0B/4B, and if the UE has stopped transmitting during or before subframe

R1-1610200 Clarification on channel access priority class according to UL LBT type indication in eLAA DCI WILUS Inc.

R1-1610653 Correction on channel access priority class according to UL LBT type indication in eLAA WILUS Inc.

Decision: The CR is **endorsed** with the following update: moving the change right after the paragraph starting with "The eNB shall schedule UL transmissions...". Final CR to be prepared.

Final decision: The CR0775 to 36.213 (Rel-14) is **agreed in R1-1610900**.

PUSCH design

R1-1608981 PHR reporting for two-step scheduling Samsung

R1-1608982 CCA slot and tx-rx/tx-tx switching time Samsung

R1-1609172 Discussion on (E)PDCCH candidate configuration LG Electronics

R1-1610853 Correction on PDCCH candidate configuration LG Electronics

Decision: Email approval of [R1-1610853](#) till 10/21 – Seonwook (LG Electronics)

R1-1609944 Discussion on UL resource allocation for 10MHz eLAA Qualcomm Incorporated

R1-1609945 Draft 212 CR on UL resource allocation for 10MHz eLAA Qualcomm Incorporated

R1-1609946 Draft 213 CR on UL resource allocation for 10MHz eLAA Qualcomm Incorporated

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

Decision: Discuss the second and third bullets in [R1-1609944](#) till next meeting

[R1-1609953](#) **Frame structure and maximum timing advance for eLAA** Qualcomm Incorporated
Continue discussion next meeting

[R1-1609947](#) **Discussion on trigger monitoring timeline for two stage triggered grants in eLAA** Qualcomm Incorporated

[R1-1609948](#) **Draft CR on trigger monitoring timeline for triggered grants in eLAA** Qualcomm Incorporated

[R1-1611021](#) **Draft CR on trigger monitoring timeline for triggered grants in eLAA** Qualcomm

[R1-1611025](#) **CR on trigger monitoring timeline for triggered grants in eLAA** Qualcomm

Final decision: The CR0779 to 36.213 (Rel-14) is **agreed**.

SRS design

[R1-1609950](#) **Draft CR on SRS dropping rules for eLAA** Qualcomm Incorporated
Continue discussion next meeting

UCI

[R1-1608978](#) **Periodic CSI reporting for eLAA** Samsung

[R1-1608979](#) **Draft CR on Periodic CSI report** Samsung

[R1-1609173](#) **Discussion on periodic CSI transmission** LG Electronics

[R1-1610774](#) **Correction on periodic CSI transmission** LG Electronics

Decision: The CR is **agreed in principle**, further discussion offline to refine wording. Final CR to be prepared.

[R1-1610908](#) **Correction on periodic CSI transmission** LG Electronics

Decision: The wording to be further refine. Finally **agreed as CR0776r1 to 36.213 (Rel-14) in [R1-1611007](#)**

[R1-1609949](#) **Discussion on simultaneous transmission on the non-LAA and LAA Scells** Qualcomm Incorporated
Continue discussion next meeting

[R1-1609951](#) **Discussion on RI transmission on PUSCH for LAA Scells** Qualcomm Incorporated

[R1-1609952](#) **Draft CR for RI transmission on PUSCH for LAA Scells** Qualcomm Incorporated

Conclusion:

- The CR in [R1-1609952](#) is endorsed in principle, with the following updates:
 - Add change marks to the two new tables
 - Add references to the two new tables
- Final CR to prepared. **Agreed as CR0224 to 36.212 (Rel-14) in [R1-1610998](#)**

Post meeting: MCC to correct CR number by replacing 0777 to 0224 before submission to plenary.

[R1-1610209](#) **On simultaneous transmission of periodic and aperiodic CSI in eLAA** Qualcomm Incorporated

[R1-1610210](#) **Draft CR on simultaneous transmission of periodic and aperiodic CSI in eLAA** Qualcomm Incorporated

[R1-1610858](#) **Draft CR on using 25us LBT for UEs on carriers without eNB Cat 4 LBT** Qualcomm Incorporated

Continue discussion next meeting

Channel access

[R1-1608659](#) **Discussion on UL CWS adjustment for eLAA** Huawei, HiSilicon

[R1-1610996](#) **Draft CR on UL CWS adjustment for eLAA in 36.213** Huawei, HiSilicon, Qualcomm, Broadcom, LGE, Ericsson, Intel (Revision of [R1-1609366](#))

Decision: The CR is **endorsed** (also check ME in the cover page). Final CR to be prepared.

Decision: **Agreed as CR0778 to 36.213 (Rel-14) in [R1-1611022](#)**

[R1-1609777](#) **Draft CR on eLAA UL Multicarrier channel access** BROADCOM LIMITED

Continue discussion next meeting

[R1-1609954](#) **On UE assumptions for UL LBT and start of UL transmission** Qualcomm Incorporated

Continue discussion next meeting

[R1-1610201](#) **Discussion on UL Multi-carrier Transmission for eLAA** WILUS Inc.

Continue discussion next meeting

[R1-1610202](#) **Discussion on Handling UL Multicarrier Transmission under UE power limited case** WILUS Inc.

[R1-1610421](#) **Removal of LAA DRS channel access from UL Type 2 Channel Access description** Nokia, Alcatel-

Lucent Shanghai Bell

Decision: The CR is **endorsed**. Final CR to be prepared.

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

Decision: Agreed as CR0773 to 36.213 (Rel-14) in [R1-1610884](#)

[R1-1610859](#) Draft CR on clarification of PUSCH start position for eLAA Panasonic, Qualcomm Incorporated

Decision: The CR is endorsed. Final CR to be prepared.

Decision: Agreed as CR0223 to 36.212 (Rel-14) in [R1-1610886](#)

Friday

[R1-1609934](#) Response LS to IEEE 802.11 regarding LAA Qualcomm

[R1-1611031](#) Response LS to IEEE 802.11 regarding LAA Qualcomm

7.1.8 Maintenance of Release 14 V2V services based on LTE sidelink

CR submission is only allowed by specification editors.

Note that proponent can submit discussion contribution to this A.I. which contains a possible TP.

DMRS randomization

[R1-1609453](#) Proposal to align DMRS cyclic shift for PSCCH and PSSCH (Correction to V2V CR - 36.211)

Intel Corporation

Decision: Agreed proposal 1

- Editors to check whether clarification is needed for MSB and LSB of CRC field in SCI format 1.

[R1-1610465](#) WF on DMRS randomization Samsung

[R1-1608715](#) Discussion on randomization on DMRS CATT

Decision:

Agreements:

- DMRS randomization of a PSSCH follows the CRC of the SA in the same subframe as the PSSCH
- Discuss in RAN1#87 whether additional mechanism is needed for PSSCH DM RS randomization focusing on the single-subframe transmission case.

[R1-1609455](#) Clarification on V2V Resource Selection Procedure (Correction to V2V CR - 36.213) Intel Corporation

[R1-1608983](#) Further randomization on DMRS and scrambling code Samsung

[R1-1609179](#) Corrections on randomizing PSSCH DM-RSLG Electronics

[R1-1609817](#) TP on random selection of PSCCH cyclic shift ZTE

Resource size for PSCCH and PSSCH

[R1-1609955](#) Remaining issues for V2V Qualcomm Incorporated

Proposals 3 and 9 only

Decision: Agreed proposals 3 and 9

[R1-1609363](#) Discussion on resource pool for PC5 based V2V Huawei, HiSilicon

Proposal 1 only

PSCCH and PSSCH transmission in the same subframe

[R1-1609373](#) Discussion on the remaining issues for sidelink power control Huawei, HiSilicon

Conclusion:

- P₀ can be preconfigured for out-coverage V2V UEs as in Rel-12 D2D
 - This will not have specification impact

[R1-1609812](#) Discussion on PSD offset with PSCCH and PSSCH ZTE

[R1-1609955](#) Remaining issues for V2V Qualcomm Incorporated

Proposals 1, 2, and 4 only

Decision: Agreed proposals 1 and 4

- Proposal 2 in [R1-1609955](#) is agreed in principle.

[R1-1609177](#) Discussion on power offset for PSCCH LG Electronics

Background sensing

[R1-1610039](#) Discussion on background sensing NTT DOCOMO, INC.

[R1-1610302](#) Discussion on the issue of transmission during the sensing window Panasonic

[R1-1609360](#) Discussion on sensing procedure for PC5 based V2V Huawei, HiSilicon

[R1-1609178](#) Corrections on excluding resources within selection window LG Electronics

[R1-1608984](#) On resource (re)selection in 36.213 Samsung

Agreements:

- In order to handle the skipped subframe#k in the resource exclusion procedure, the UE shall exclude the subframe#y within its own selection window if the subframe#(y+P*j) can be overlapped with subframe#(k+100*i), where P is the resource reservation interval of the UE, j is 0, 1, ..., C_resel-1, i are any (available) elements in the set restricted by carrier-specific network (pre)configuration.
- Continue discussion on the proposal “For a received SA, if initial transmission is before subframe n while retransmission is after subframe n, UE can measure PSSCH-RSRP on initial transmission resource and do resource exclusion by the retransmission resource.”

20% rule in resource selection

[R1-1609955](#) **Remaining issues for V2V** **Qualcomm Incorporated**

Proposal 5 only

Conclusion:

- Continue discussion on proposal 5 in [R1-1609955](#) till next meeting, especially more evaluation results

Reserved subframes

[R1-1609955](#) **Remaining issues for V2V** **Qualcomm Incorporated**

Proposal 6 only

[R1-1609729](#) Outstanding issues for mode-4 resource allocation Ericsson

[R1-1608716](#) **Discussion on details of resource reselection** **CATT**

Decision: Continue discussion of proposal 2 next meeting

[R1-1609180](#) Corrections on the set of reserved subframes in SL TM 4 LG Electronics

[R1-1608986](#) Remaining issues on resource reservation Samsung

Conclusion:

- For clarification of C_resel, FFS till next meeting

UE decoding capability

[R1-1609751](#) **Discussion on UE decoding capabilities** **Ericsson**

[R1-1609361](#) Discussion on UE capability in decoding PSSCH and PSCCH Huawei, HiSilicon

Conclusion:

- A UE is not expected to try to decode more than N1 RBs in a subframe
 - Further discussion the value of N1 (e.g., 100, 138 or 150)
- A UE is not expected to try to decode more than N2 PSCCHs in a subframe
 - Further discussion the value of N2 (e.g., 10 or 20)
- Further discussion this week whether or not to introduce the specific rule(s) to ensure that transmissions from a given UE are not systematically dropped, and if so, the rule(s)

For the further discussion parts above, continue discussion next meeting

Others

[R1-1610461](#) **PSSCH/PSBCH decoding issue** **CATT** (Revision of [R1-1608714](#))

Continue discussion of proposals 2 and 3 till next meeting

[R1-1608985](#) **Remaining issues on resource exclusion in Step 2** **Samsung**

[R1-1609176](#) Discussion on minimum portion of remaining resources for PSSCH LG Electronics

[R1-1609362](#) **Discussion on sensing window range for PC5 based V2V** **Huawei, HiSilicon**

Agreements:

- Change the sensing window range to subframes n-1000, n-999, n-998 ..., n-1

[R1-1609363](#) **Discussion on resource pool for PC5 based V2V** **Huawei, HiSilicon**

Proposal 2 only

Conclusion:

- No change is needed regarding proposal 2 in [R1-1609363](#)

[R1-1609454](#) **Clarification on Resource Selection Procedure (Correction to V2V CR - 36.213)** **Intel Corporation**

Conclusion:

- Align the name of the field “Frequency resource location” and “Frequency resource location of the initial transmission and retransmission” across technical specification TS 36.212 and TS 36.213 respectively.

[R1-1609811](#) TP on PSBCH ZTE

[R1-1609955](#) **Remaining issues for V2V** **Qualcomm Incorporated**

Proposal 10 only

Agreements:

- Send LS response to R2-165962 with the following contents:

- RAN1 has not introduced random resource selection for V-UEs and RAN1 has concerns on increased resource collision probability caused by random resource selection. RAN1 notes that random selection for V-UE is not among the list of the objectives transferred from V2V WI.
- LS draft by Ricardo – Ericsson.

R1-1610920 [Draft] LS response on Exceptional Pool Handling for V2X Ericsson

Decision: Final LS is agreed in **R1-1610930**

R1-1610935 Outcome offline discussion on V2V maintenance LGE

R1-1610977 WF on V2V support for TDD Intel, CATT

Decision: Further discussion next meeting

Not treated.

R1-1610477 Way Forward on UE background sensing NTT DOCOMO, Panasonic

R1-1610507 Way Forward on Resource Reservation Samsung

R1-1610769 Way Forward on resource reselection Samsung, CATT, Huawei, HiSilicon, ZTE

7.1.9 Other

R1-1609552 Introduction of RACHless handover for Further mobility enhancement in LTE ZTE Corporation

Decision: CR0748 to 36.213 (Rel-14) is for email approval until October 20th – (ZTE)

R1-1608717 Correction on SST definition CATT

Decision: CR0039 to 36.214 (Rel-13) is agreed.

R1-1609824 Correction on SST definition CATT

Decision: Shadow CR0040 to 36.214 (Rel-14) is agreed.

R1-1610106 Discussion on power allocation for SC-PTM TD Tech, Huawei

R1-1610901 Correction on downlink power allocation for SC-PTM TD Tech, Huawei (**R1-1610110**)

Further revised in **R1-1611045**.

R1-1611045 Correction on downlink power allocation for SC-PTM TD Tech, Huawei

Decision: CR0749r2 to 36.213 (Rel-13) is agreed.

Agreement:

- SC-MCCH uses a fixed modulation of QPSK.
 - No signaling of PA and PB for SC-MCCH.
- RAN1 recommends that for each SC-MTCH, there is a higher layer parameter “PA” for configuring ρ_A for the PDSCH carrying the SC-MTCH.
 - If “PA” is not signaled by high layer, the UE may assume that “PA” is equal to 0 dB.
- RAN1 recommends that for each cell supporting SC-PTM, there is a higher layer parameter “PB” for configuring ρ_B / ρ_A for any SC-MTCH in the cell.

$$\rho_B / \rho_A = 1$$

- If “PB” is not signaled by high layer, the UE may assume that

R1-1610748 [DRAFT] LS on power allocation for SC-PTM Huawei

Agreed in **R1-1610780**

7.2 LTE Release 14

Friday

For MUST, Further indoor positioning enh., SRS carrier based switching, Performance enhancements for high speed:

- Rapporteurs will provide list of agreements, including WA until Oct. 17th.
- Spec editors (36.201, 36.211, 36.212, 36.213, 36.214) shall provide draft CRs based on above lists until Nov. 10th
- All proponents are invited checking the draft CRs until next meeting

7.2.1 LTE-based V2X Services - WID in RP-161894

R1-1610864 Chairman's notes of AI 7.2.1 on LTE-based V2X Services Ad-Hoc chair (Nokia, LGE)

The document was presented by Hanbyul Seo from LGE.

Decision: The document is endorsed and content incorporated below.

Friday

[R1-1611061](#) [Draft] LS on RAN1 agreements potentially related to RAN2/4 in LTE-based V2X LG Electronics

Decision: The document is noted and final LS is [agreed in R1-1611066](#).

[R1-1610936](#) Outcome offline discussion on V2X LG Electronics

[R1-1609932](#) SC-PTM Enhancements for V2X MediaTek Inc.

[R1-1609933](#) On suitability of Uu transport and PC5 transport for V2X Solutions MediaTek Inc.

Agreement:

- Send an LS response to [R1-1610798](#) with the following starting point:
 - RAN1 has no concern because the network configuration for this offset can be aligned with the offset in the pre-configuration.

[R1-1610847](#) [Draft] LS response on DFN offset [RAN WG1], Ericsson

Final version [agreed](#) in [R1-1610929](#) with correcting the WI code to “LTE_V2X-Core.”

Agreements:

- From RAN1 viewpoint, the following three cases can be supported regarding the capability of LTE V2X devices on the simultaneous transmission of UL and SL.
 - Case 1: UL TX and SL TX use separate TX chains and separate power budget
 - Case 2: UL TX and SL TX use separate TX chains but sharing power budget
 - Case 3: UL TX and SL TX share TX chains and power budget
 - It is noted that the most suitable case may be dependent of the V2X use case.
- RAN WGs to identify solution(s) that takes into account the minimum performance of SL TX at least for some important SL TX. RAN WGs needs to reduce possible degradation of Uu operation performance in identifying such solution(s).
 - For case 1, RAN1 assumes no physical layer solution is needed.
- Send LS to RAN2/4 to inform this understanding and to ask them to reflect this in the UE capability discussion.
 - LS draft by Yi – Huawei

[R1-1610966](#) [Draft] LS on V2X UE transmission chain Huawei, [RAN1]

Final version [agreed](#) in [R1-1611000](#).

7.2.1.1 Enhancement to UL and SL SPS

7.2.1.1.1 DCI design to support multiple SPS configurations

Including details of SPS RNTI for V2X, indicator(s) in DCI to differentiate SPS configurations

DCI contents

[R1-1608718](#) DCI design to support multiple SPS configurations CATT

Revised to [R1-1610556](#)

[R1-1610037](#) Multiple SPS support for sidelink and uplink V2X NTT DOCOMO, INC.

[R1-1608650](#) DCI design for sidelink SPS scheduling Huawei, HiSilicon

[R1-1608988](#) Remaining details on DCI design for Mode 3 Samsung

[R1-1609182](#) Remaining details of (E)PDCCH design of sidelink and uplink SPS LG Electronics

[R1-1609290](#) Discussion on SL-SPS DCI and cross carrier scheduling CMCC

[R1-1609732](#) SL-SPS and DCI design for V2X Ericsson

[R1-1609888](#) Details of multiple SPS configurations for V2X over Uu Potevio

[R1-1609956](#) Uplink SPS enhancements for V2X Qualcomm Incorporated

RNTI and search space

[R1-1609570](#) Signalling design on supporting SPS for sidelink transmission mode 3 Panasonic

[R1-1609401](#) Discussion on DCI design to support multiple SPS configurations Lenovo

[R1-1608595](#) SPS enhancement for V2V mode 1 Huawei, HiSilicon

[R1-1608987](#) Support of multiple UL SPS configurations Samsung

[R1-1609732](#) SL-SPS and DCI design for V2X Ericsson

[R1-1609752](#) UL-SPS and DCI design for V2X Ericsson

Others

[R1-1608596](#) SPS enhancement for V2X on Uu interface Huawei, HiSilicon

[R1-1609804](#) Scheduling of V2X SPS resources ZTE

[R1-1610776](#) WF on reliable sidelink SPS NTT DOCOMO, CMCC, LG Electronics

Proposed agreements:

- At least one of the following mechanism is supported for sidelink SPS controlled by eNB
 - A/N feedback mechanism on the reception of DCI indicating SL SPS activation/release
 - ◆ FFS on details.
 - Automatic release after a counter is expired
 - ◆ Further detail is up to RAN2
 - When a SPS configuration is activated for an SPS process, previously configured SPS process is released
 - ◆ UE identifies a SPS process associated to a DCI based on the contents of the DCI, for example,
 - Option 1: One-to-one mapping between SPS configuration index and SPS process
 - Option 2: Semi-static (higher layer configured) association between SPS configuration index and SPS process. Multiple SPS configurations can be associated to a SPS process.
 - Option 3: Dynamic indication (explicitly or implicitly) of SPS process associated to a SPS DCI
 - ◆ Further detail is FFS

Agreement:

- Activation of one SPS configuration releases the previous allocation for the same SPS configuration.

[R1-1610813](#) WF on DCI design for SL SPS LG Electronics, ZTE, Samsung, CATT, Huawei, HiSilicon

Agreement:

- An SL SPS RNTI different from SL dynamic scheduling RNTI is defined.
- The following two fields are additionally included in the existing dynamic scheduling DCI (i.e., DCI 5A).
 - **Working assumption:**
 - ◆ SL SPS configuration index : 3 bits
 - ◆ Activation/release indication : 1 bit
- Each SL SPS DCI contains a single SPS configuration index.
- If the number of information bits in SL SPS DCI format mapped onto a given search space is less than the payload size of DCI format 0 mapped onto the same search space, zeros shall be appended to SL SPS DCI format until the payload size equals that of DCI format 0 including any padding bits appended to DCI format 0.
 - FFS whether the size of SL SPS DCI format can be larger than the size of DCI format 0 on the same search space.

[R1-1610812](#) WF on DCI design for V2X UL SPS LG Electronics, Samsung, ZTE, NTT DOCOMO, Huawei, HiSilicon

Agreements:

- **Working assumption:** A V2X UL SPS RNTI different from the legacy SPS C-RNTI is defined.
- The following existing field in DCI 0 (for the legacy UL SPS activation/release) is reused to indicate V2X UL SPS configuration index.
 - **Working assumption:** Cyclic shift DM RS (3bits)
 - ◆ TPC command (2 bits) can be considered as an alternative if this working assumption is not confirmed.
- Each UL SPS DCI contains a single SPS configuration index.

7.2.1.1.2 Other

Including explicit release and implicit release mechanism for SPS

[R1-1609181](#) Remaining details of UE procedure for sidelink and uplink SPS LG Electronics

[R1-1609719](#) Mechanisms for releasing V2X SPS Ericsson

7.2.1.2 Resource selection for pedestrian UEs

[R1-1609727](#) Pools for V2X Ericsson LM

7.2.1.2.1 Details of random selection by pedestrian UEs

Resource pool

[R1-1609805](#) Details of random selection by pedestrian UEs ZTE

[R1-1609865](#) Random Resource Selection for Pedestrian UEs Sharp

[R1-1609786](#) Comments on Pool Configuration with Random Resource Selection Nokia, Alcatel-Lucent Shanghai Bell

Issues related to TX/RX capability

[R1-1609787](#) On resource selection for V2P communication Nokia, Alcatel-Lucent Shanghai Bell

[R1-1609456](#) Random resource selection by pedestrian UEs for V2V communication Intel Corporation

[R1-1609183](#) Details of random resource selection for P-UE LG Electronics

[R1-1610212](#) On random resource selection for V2P Ericsson
[R1-1609402](#) Discussion on random selection by pedestrian UEs Lenovo

7.2.1.2.2 Details of resource selection using partial sensing by pedestrian Ues

[R1-1608947](#) Discussion on details of partial sensing for pedestrian UEs Sony
[R1-1608989](#) Partial sensing for pedestrian UE Samsung
[R1-1609457](#) Partial sensing for P2V communication Intel Corporation
[R1-1608899](#) Details of partial sensing by pedestrian UEs Sequans Communications
[R1-1609681](#) Discussion on partial sensing of pedestrian UEs Beijing Xinwei Telecom Techn.
[R1-1609724](#) Partial sensing for V2P Ericsson

[R1-1608719](#) Discussion on P-UE resource selection CATT
[R1-1608911](#) Discussion on resource sensing and selection for pedestrian UEs Spreadtrum Communications
[R1-1609184](#) Discussion on partial sensing for P-UEs LG Electronics
[R1-1608649](#) Discussion on the P-UE resource selection Huawei, HiSilicon
[R1-1609806](#) Details of resource selection using partial sensing by P-UEs ZTE
[R1-1609866](#) Further Discussions on Power Efficient Sensing for P-UEs Sharp
[R1-1609957](#) Sensing based resource selection for V2P Qualcomm Incorporated
[R1-1610035](#) Discussion on details of pedestrian UE partial sensing NTT DOCOMO, INC.

[R1-1610739](#) WF on P-UE sensing timeline in partial sensing Huawei, HiSilicon, NTT Docomo
[R1-1611016](#) WF on P-UE sensing timeline in partial sensing Huawei, HiSilicon, Sequans, ZTE, Sony

Agreement:

- The following aspects needs to be addressed to define resource selection based on partial sensing
 - How to determine the subset of subframes in which UE performs sensing
 - How to determine the subset of subframes for the candidates of resource selection
 - How to relate these two subsets
- Study the above aspects in terms of PRR and energy consumption:

7.2.1.2.3 Other

[R1-1608658](#) Discussion on the necessity of differentiating P-UE and V-UE Huawei, HiSilicon

7.2.1.3 Long-term basis co-channel coexistence between DSRC/IEEE 802.11p and LTE PC5 for V2V operating over the same frequency channels

Target is to complete this by RAN#74. Solution(s) to be specified should avoid negative impact on the performance of LTE PC5. Possible solutions identified during the study item are "Geo-location and database," "Time sharing between systems based on GNSS timing," and "Sensing-based vacate/switching approaches with or without transmission of a predetermined signal(s)."

[R1-1608594](#) Coexistence of 802.11p and V2V services Huawei, HiSilicon
[R1-1609185](#) Considerations on the co-channel coexistence of multiple RATs for V2X LG Electronics
[R1-1609458](#) Design considerations on LTE-V2V coexistence with DSRC technology Intel Corporation
[R1-1609710](#) Discussion on Coexistence Between Different Technologies for ITS Services Ericsson
[R1-1609711](#) Detection Sequence in LTE-ITS Sidelink for Coexistence with Other Access Technologies Ericsson
[R1-1609807](#) Co-channel coexistence between DSRC and LTE V2V on same channel ZTE
[R1-1609958](#) Co-channel coexistence for DSRC and LTE-V2V Qualcomm Incorporated

Revised to [R1-1610418](#)

[R1-1610728](#) WF on ITS Coexistence Mechanisms Ericsson, Huawei, HiSilicon

Agreements:

- The following two aspects need to be discussed with regard to the usefulness of an detection option
 - Usefulness when IEEE802.11p detects LTE
 - Usefulness when LTE detects IEEE802.11p
- Study until the next meeting on the usefulness of the following options
 - Option 1: Detecting the pattern of LTE CP
 - Option 2: Detecting a sequence of LTE transmitted within the last symbol of a subframe
 - Option 3: Detecting periodically transmitted LTE signal (e.g., SLSS)
 - Option 4: Measuring energy

7.2.1.4 Support of inter-PLMN for Uu and PC5

R1-1609186	Discussion on support of inter-PLMN for Uu and PC5	LG Electronics
R1-1609346	Inter-PLMN operation on PC5	Huawei, HiSilicon
R1-1609409	Coordinated and uncoordinated operation in inter-PLMN for V2X scenario	ITRI
R1-1609959	Inter-PLMN support for PC5 and Uu	Qualcomm Incorporated
R1-1610301	Discussion on inter-PLMN V2X over Uu and PC5	Ericsson

7.2.1.5 Aspects transferred from WI LTE SL_V2V-Core

7.2.1.5.1 Congestion control for PC5-based V2X

Including load balancing across multiple carriers

Congestion level measurement metric definition

R1-1609709	Radio measurements for congestion control for V2X	Ericsson
R1-1608990	Discussion on congestion control	Samsung

Section 3

R1-1608720	Measurement metric for the congestion level in V2X	CATT
R1-1608592	Congestion control for V2V	Huawei, HiSilicon

Section 3

R1-1609141	Discussion on congestion control in distributed scheduling mode	NEC
----------------------------	---	-----

Section 2.2

R1-1609187	Discussion on congestion control for PC5-based V2X	LG Electronics
----------------------------	--	----------------

Section 2.1

R1-1609459	Sidelink congestion control for V2X services	Intel Corporation
----------------------------	--	-------------------

Section 4

R1-1609808	Discussion on congestion control of PC5 carrier	ZTE
----------------------------	---	-----

Section 2

Congestion control mechanism

R1-1609960	Congestion control for V2V	Qualcomm Incorporated
R1-1609459	Sidelink congestion control for V2X services	Intel Corporation

Sections 3, 5, 6

R1-1609187	Discussion on congestion control for PC5-based V2X	LG Electronics
----------------------------	--	----------------

Section 2.2, 2.3

R1-1609712	Congestion Control Framework for V2V	Ericsson
R1-1608592	Congestion control for V2V	Huawei, HiSilicon

Sections 3, 5, 6

R1-1608909	UE measurement based congestion control	Guangdong OPPO Mobile Telecom.
R1-1608948	Discussion on details of congestion control	Sony
R1-1608990	Discussion on congestion control	Samsung

Sections 4, 5

R1-1609141	Discussion on congestion control in distributed scheduling mode	NEC
R1-1609142	Discussion on congestion control in eNB scheduling mode	NEC
R1-1609571	Discussion on channel busy ratio measurement in V2X	Panasonic
R1-1609788	On congestion control for PC5-based V2X	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609808	Discussion on congestion control of PC5 carrier	ZTE

Section 3

Physical layer format

R1-1609699	Outstanding Physical Layer Structure Details and Receiver Behavior for Sidelink V2V	Ericsson
R1-1609707	Autonomous Resource allocation for multiple retransmissions	Ericsson

[R1-1610753](#) WF on congestion control Huawei, HiSilicon, Ericsson, OPPO, Nokia
Also supported by NEC

Agreements:

- Channel busy ratio (CBR) is defined for the congestion measurement over PC5 in V-UEs
 - CBR is the portion of sub-channels whose S-RSSI exceed a (pre-)configured threshold observed during (working assumption: 100 ms).
 - ◆ Only the sub-channels included in the resource pool are used for the measurement.
 - ◆ FFS whether additional separated measurement is needed for SA pool.
 - For a UE in Mode 3, the eNB indicates a set of resources on which the UE perform this measurement

- For a UE in Mode 4, the measurement is pool-specific.
 - ◆ A UE measures at least on its current TX pool(s).
 - FFS whether a UE measures on a pool which is not its current transmission pool.
 - ◆ RAN1 will not optimize this measurement to address the case of multiple TX pools
- UE Reporting of CBR to eNB is supported
 - Details up to RAN2 including any possible additional averaging at higher layer
- Send LS to RAN2/4 to inform this agreement.

7.2.1.5.2 Simultaneous Uu and PC5 operations in different carriers

- [R1-1609188](#) Discussion on power control for simultaneous SL TX and WAN TX in different carriers LG Electronics
- [R1-1609347](#) Timing alignment for cross-carrier operation Huawei, HiSilicon

7.2.1.5.3 Remaining enhancement to sidelink synchronization

Including SLSS-based synchronization and offset to shift the DFN #0 w.r.t the reference timing derived from GNSS.

- [R1-1608651](#) Discussion on sync priority and SLSS ID set definition Huawei, HiSilicon
- [R1-1608652](#) Discussion on PSBCH contents and SLSS transmission procedure Huawei, HiSilicon
- [R1-1608657](#) Sidelink synchronization enhancement for V2X communication Huawei, HiSilicon
- [R1-1608721](#) Synchronization enhancements in PC5-based V2V CATT
- [R1-1608910](#) Discussion on the GNSS based synchronization Guangdong OPPO Mobile Telecom.
- [R1-1608991](#) Discussion on SLSS based Sidelink synchronization Samsung
- [R1-1609143](#) Discussion on determining timing of sidelink synchronization signals for V2X NEC
- [R1-1609189](#) Remaining issues on synchronization enhancements for V2X LG Electronics
- [R1-1609410](#) Discussion prioritization of multiple synchronization sources on sidelink synchronization protocol for V2V communication ITRI
- [R1-1609411](#) Enhancement to sidelink synchronization among multiple synchronization sources for V2X communications ITRI
- [R1-1609460](#) Discussion on V2V synchronization procedure Intel Corporation
- [R1-1609461](#) On PSBCH physical layer design for V2V communication Intel Corporation
- [R1-1609717](#) Distributed Synchronization Procedure for V2X over PC5 Ericsson
- [R1-1609720](#) Receiver Timing Assumptions for V2V SL Operation Ericsson

Agreements:

- Reuse Rel-12 D2D mechanism of indicating synchronization of each RX pool with the following change:
 - GNSS can be added or can replace the cell ID.
- It is RAN1's understanding that a single FFT per carrier can be used to receive these Sidelink processes (note that this does not imply anything about whether the UE is expected to receive on more than one carrier simultaneously).
- RAN1 understanding is an IE similar to the current SL-SyncConfig can be reused for the case where GNSS is among the synchronization reference of a pool. Details are up to RAN2.
- UE selects only one transmission synchronization reference at a time based on the synchronization reference selection procedure.
- The TX pool (pre-)configuration includes the type(s) of sync reference that is allowed in using each pool.
 - For a pool, specification supports any combination of the following:
 - ◆ SyncRef directly or indirectly derived from eNB
 - This includes UE's own timing and SLSS originated from a stand-alone UE
 - ◆ SyncRef directly or indirectly derived from GNSS

- [R1-1609721](#) Outstanding details of PSBCH for V2V over PC5 Ericsson
- [R1-1609731](#) V2V Signals Transmission Dropping for SLSS Reception Ericsson
- [R1-1609733](#) SLSS/PSBCH and Transmitter Behavior under Congestion Control Restrictions Ericsson
- [R1-1609789](#) Enhancements to sidelink synchronization Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609809](#) Remaining enhancement to sidelink synchronization ZTE
- [R1-1609961](#) Synchronization Procedure for V2V Qualcomm Incorporated
- [R1-1610038](#) SLSS Enhancements for GNSS based Synchronization NTT DOCOMO, INC.

[R1-1610672](#) Way Forward on the SLSS Transmission Huawei, HiSilicon, Qualcomm, LG Electronics, Ericsson, Samsung, CATT, ITRI, NTT DOCOMO, OPPO, Nokia, ASB

Agreements:

- If the vehicle UE has selected the GNSS as syncRef,
 - For the OOC case:
 - ◆ The UE transmits SLSS and PSBCH every synchronization period when the SLSS resource is pre-configured and the UE is capable of SLSS/PSBCH transmission;

- FFS whether any SLSS/PSBCH dropping behaviour is specified, e.g., for congestion control.
- For the InC case:
 - ◆ Rel-12 D2D mechanism is reused, i.e.:
 - RSRP threshold or dedicated signaling to determine the SLSS transmission
- When GNSS is the highest priority, the UE is not expected to read SLSS from other UEs.
- UE capability of SLSS transmission/reception will be discussed later.

Friday:

Ericsson→ comment to the following WA adding the statement “UE indirectly synchronized to GNSS”

LGE (rapporteur)→ suggested to add it as FFS note

Agreement is modified as shown below and RAN1 chair tasked rapporteur to prepare an LS to RAN2/RAN4 (see [R1-1611061](#))

Agreements:

- Rel-12 mechanism is re-used to determine the subframe used for transmissions of SLSS/PSBCH from out-coverage UEs synchronized to SLSS, i.e., two SLSS resources are pre-configured for an out-coverage UE, one is used for SLSS of UE's syncRef and the other is used for SLSS transmission of the UE.
- **Working assumption:** An out-coverage UE directly synchronized to GNSS transmits SLSS/PSBCH on the pre-configured sync resource which is one of the two preconfigured sync resources.
 - FFS: Out-coverage UE indirectly synchronized to GNSS
 - In the other resource, the UE receives PSBCH potentially transmitted from an in-coverage UE.
- FFS whether a UE that selected SLSS ID = 0 as its sync reference transmits SLSS = X (FFS 0 or 168) and PSBCH in a different resource.
 - FFS PSBCH content if transmits

[R1-1610673](#) Way Forward on Sync Priority for OOC Huawei, HiSilicon, LG Electronics, Qualcomm, ZTE, ITRI, DCM, Xinwei, Samsung, NEC, CATT, Ericsson, Nokia, ASB

Agreements:

- If the UE detects no eNB in a carrier which is (pre-)configured as the carrier which potentially includes eNBs used as sync reference, the following priority rules should be applied:
 - P1: GNSS
 - P2: the following UE has the same priority:
 - ◆ UE directly synchronized to GNSS
 - ◆ UE directly synchronized to eNB
 - P3: the following UE has the same priority:
 - ◆ UE indirectly synchronized to GNSS (if RAN1 decides to differentiate between direct and indirect synchronization to GNSS)
 - ◆ UE indirectly synchronized to eNB
 - P4: the remaining UEs have the lowest priority.
- The priority order between P1 and P2 can be (pre-)configured.
 - Note: It is RAN1 understanding that P1 will be prioritized over P2 if the eNB prioritizes GNSS over eNB timing.

Agreements:

- If the UE detects an eNB in a carrier which is (pre-)configured as the carrier which potentially includes eNBs used as sync reference,
 - If GNSS is prioritized over eNB by eNB configuration, UE directly or indirectly synchronized to GNSS has a higher priority than eNB.

[R1-1610711](#) Way Forward on the pre-defined SLSS IDs for the GNSS timing Huawei, HiSilicon, ZTE, Samsung, ITRI, CATT, LG Electronics, NTT DOCOMO, Qualcomm, Nokia, ASB

Agreements:

- For the V2V PC5 SLSS
 - If the vehicle UE has selected the GNSS as syncRef and acts as a synchronization source, SLSS ID is set to 0 for SLSS transmissions.

[R1-1610740](#) Way Forward on V2V PC5 SLSS transmission Huawei, HiSilicon, OPPO, ITRI

Proposed agreements:

- When a UE loses GNSS, the UE still transmits the synchronization signal based on its previous GNSS timing for a certain time duration (timer definition and duration up to RAN2/RAN4)
- Send LS to RAN2 and RAN4

Agreement:

- PSBCH contains 48 bits

- DM RS OCC of PSBCH

Orthogonal sequence	$[w^{\lambda}(\cdot)]$	$\begin{bmatrix} +1 & +1 \\ +1 & -1 \end{bmatrix}$ if $N_{ID}^{SL} \bmod 2 = 0$ $\begin{bmatrix} +1 & +1 \\ +1 & -1 \end{bmatrix}$ if $N_{ID}^{SL} \bmod 2 = 1$	$\begin{bmatrix} +1, +1, +1 \\ +1, -1, +1 \end{bmatrix}$ if $N_{ID}^{SL} \bmod 2 = 0$ $\begin{bmatrix} +1, +1, +1 \\ +1, -1, +1 \end{bmatrix}$ if $N_{ID}^{SL} \bmod 2 = 1$
---------------------	------------------------	--	--

7.2.1.5.4 Handle multiplexing V2V with other signals/channels

E.g., handling the case where the bitmap for V2V subframes does not repeat an integer number of times within the DFN period

R1-1608722	Multiplexing V2V with other signals/channels	CATT
R1-1608992	Remaining details on resource pool configuration	Samsung
R1-1609190	Time domain multiplexing of V2V subframes and other signals/channels	LG Electronics
R1-1609726	Pool design for V2V	Ericsson
R1-1610220	Considerations on handling wrap-around issue in subframe pool configuration for V2V	Innovative Technology Lab Co.
R1-1610363	Discussion on subframe bitmap for V2V communication	Intel Corporation

[R1-1610708](#) WF on handling multiplexing V2V with other signals/channels LG Electronics, Samsung, Intel

Agreements:

- A pool is configured with a number of reserved subframes such that the bitmap is repeated in an integer number within the DFN range.
 - V2V logical subframe index is not allocated to a reserved subframe.
 - The location of the reserved subframes is indicated by an implicit way (details FFS until next meeting).

7.2.1.5.5 Support for traffic with smaller periodicity on PC5 based V2V using shorter resource reservation period

R1-1609191	Discussion on support of small periodicity resource reservation	LG Electronics
R1-1609365	Details for supporting traffic with smaller periodicity on PC5 based V2V	Huawei, HiSilicon
R1-1609462	Sidelink enhancements to support V2V traffic with smaller periodicity	Intel Corporation
R1-1609734	Support for smaller resource reservation periods in V2X	Ericsson
R1-1609810	Discussion on smaller periodicity	ZTE
R1-1609962	Low latency support for V2V	Qualcomm Incorporated

[R1-1610713](#) WF on supporting traffic with small periodicity for LTE-V2X Huawei, HiSilicon, LG Electronics, Qualcomm, Ericsson

Agreements:

- Support i as 1/5, 1/2 (Pstep fixed at 100) with resource-pool specific configuration of the set of allowed i
 - No change to sensing window and selection window
- Use undefined states of the 4-bit resource reservation field in SCI format 1 to indicate shorter periodicity.
- FFS the following aspects till the next meeting
 - Scale the SL_RESOURCE_RESELECTION_COUNTER to 2(for 50ms period) or 5 (for 20 ms period)
 - S-RSSI measurement interval is (select one of the options at the next meeting)
 - 100 ms interval is kept
 - set to the minimum allowed i
 - set to the resource reservation interval used for transmission of the UE
 - Combination of allowed intervals {20, 50, 100} with shortened averaging duration
 - In step2, reselection UE scales the number of reservations of other UE within selection window by $1/i$ when $0 < i < 1$.

[R1-1610913](#) WF on enhancement in step 2 for supporting shorter periodicity LG Electronics, CATT

[R1-1610932](#) WF on supporting 50ms periodicity CATT

7.2.1.5.6 Prioritization of SL TX for V2X over WAN TX under eNB management

E.g., SL gap

R1-1608591	Resource allocation in partial coverage	Huawei, HiSilicon
R1-1608593	Coexistence of cellular and V2V services	Huawei, HiSilicon
R1-1608723	On Prioritization of SL TX for V2X under eNB management	CATT
R1-1608993	Coexistence of PC5-based V2V operation and legacy Uu operation	Samsung
R1-1609192	Discussion on prioritizing SL TX over WAN TX	LG Electronics
R1-1609364	Coexistence of cellular and V2V services in partial network coverage	Huawei, HiSilicon
R1-1609718	On the Need for V2V Gaps	Ericsson
R1-1609790	On Prioritization of V2V Sidelink TX over WAN UL TX	Nokia, Alcatel-Lucent Shanghai Bell

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1609963](#) Sidelink gap for V2V transmission Qualcomm Incorporated
[R1-1610036](#) Discussion on eNB management of prioritizing V2x SL Tx over WAN Tx NTT DOCOMO, INC.

[R1-1610709](#) WF on prioritization of SL TX over UL TX LG Electronics, NTT DOCOMO, ZTE, NOKIA, Alcatel-Lucent Shanghai Bell, CATT, Samsung
Also supported by Qualcomm

Proposed agreements:

- From RAN1 viewpoint, the following three cases can be supported regarding simultaneous operation of UL TX and SL TX.
 - Case 1: UL TX and SL TX use separate TX chains and separate power budget
 - Case 2: UL TX and SL TX use separate TX chains but sharing power budget
 - Case 3: UL TX and SL TX share TX chains and power budget
- Send LS to RAN2/4 to inform this understanding and to ask it to be reflected in the UE capability discussion.
- When UL TX overlaps in time domain with SL TX then SL TX is prioritized over UL TX if the PPPP of SL packet is above a (pre)configured PPPP threshold.
 - In case of overlapping in the same carrier frequency, the UE shall drop the UL TX.
 - In case of overlapping in different carrier frequency, the UE shall allocate power to the SL TX first.
 - ◆ UL TX power is up to UE implementation (including dropping UL TX).
- Send LS to RAN2/4.

[R1-1610973](#) Way forward on prioritizing V2x SL Tx over WAN Tx NTT DOCOMO, LGE, ZTE, NOKIA, Alcatel-Lucent Shanghai Bell, CATT, Samsung, Qualcomm

Agreement:

- ◆ When UL TX overlaps in time domain with SL TX in the shared (or same) carrier frequency,
 - the UE shall drop the UL TX if the PPPP of SL packet is above a (pre)configured PPPP threshold, otherwise SL TX is dropped

7.2.1.5.7 Other

[R1-1609412](#) Discussion measurement metric and report for zone based resource management in V2V service ITRI
[R1-1609730](#) Resource allocation for exceptional pools Ericsson
[R1-1609750](#) Support for TDM mode Ericsson

Agreement:

- Include the following previous RAN1 agreement in the LS which will be sent to RAN WGs to inform all the agreements made in RAN1#86bis
 - QPSK and 16QAM are supported in SL-based V2X.

7.2.2 Enhancements on Full-Dimension (FD) MIMO for LTE - *WID in RP-160623*

[R1-1610865](#) Chairman's notes of AI 7.2.2 on Enhancements on Full-Dimension (FD) MIMO for LTE Ad-Hoc chair (Nokia)

The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

[R1-1610425](#) Updated work plan Rapporteurs (Samsung, Nokia, CATT)

[R1-1610938](#) Outcome of Friday Offline Session on eFD-MIMO Samsung

7.2.2.1 CSI enhancements

7.2.2.1.1 Advanced CSI

Including reduced space representation, enhancements of Rel-8-13 dual-stage codebook and high resolution codebooks

[R1-1608597](#) Overview of advanced CSI feedback for LTE Huawei, HiSilicon
[R1-1609921](#) Design and performance evaluation for advanced CSI feedback Huawei, HiSilicon
[R1-1609854](#) Orthogonal vs. non-orthogonal basis for advanced CSI reporting Ericsson
[R1-1609012](#) Linear combination W1 codebook Samsung
[R1-1609964](#) Discussion on advanced CSI reporting for eFD-MIMO Qualcomm Incorporated

[R1-1608682](#) Discussion on design of linear combination codebook ZTE, ZTE Microelectronics
[R1-1608724](#) Considerations on advanced CSI reporting CATT

R1-1608726	Codebook design for advanced CSI reporting	CATT
R1-1609013	Linear combination W2 codebook	Samsung
R1-1609014	Rank 2 linear combination codebook	Samsung
R1-1609193	Performance evaluation on linear combination based CSI	LG Electronics
R1-1609440	Analysis on orthogonal/non-orthogonal basis for advanced CSI feedback	Huawei, HiSilicon
R1-1609463	On beam combining codebook for Class B FD-MIMO	Intel Corporation
R1-1609464	Discussion on advanced CSI feedback	Intel Corporation
R1-1609855	Phase and amplitude vs. phase only beam combining for advanced CSI reporting	Ericsson
R1-1609856	Performance of Advanced CSI with 4 & 8 Tx Antennas	Ericsson
R1-1609857	Support of advanced CSI for CLASS B	Ericsson
R1-1609922	Advanced CSI feedback for Class B	Huawei, HiSilicon
R1-1610101	Performance evaluation of explicit CSI feedback	InterDigital Communications

[R1-1610761](#) WF on Number of Ports Supported in Advanced CSI Huawei, HiSilicon, MediaTek, ZTE, ZTE Microelectronics, Nokia, ASB, Deutsche Telekom, Samsung, Intel, CATT, Xinwei, InterDigital, Oppo, AT&T, China Unicom, ITRI

Working Assumption:

- {4,8,12,16,20,24,28,32} CSI-RS ports are supported in advanced CSI
- Aim for a unified structure, with a single common CSI reporting mechanism which is dimensioned or scalable to support all the numbers of ports
- If it turns out that a particular number of ports is not smoothly supportable, then it can be removed from the list

[R1-1610636](#) WF on Advanced CSI Codebook for eFD-MIMO Samsung, NTT DOCOMO, KT Corporation, AT&T, Mitsubishi Electric, Straight Path, NEC

Proposal:

Rank-1

- $\mathbf{W}_1$: Rel. 13 Class A rank 1 $\mathbf{W}_1$ codebook for Codebook-Config = 2, 3, and 4.
- $\mathbf{W}_2$:
 - Beam selection: L out of 4 beam selection, where L = 2,4
 - Co-phasing per beam: from QPSK $\{1, j, -1, -j\}$ for $l=0,1,\dots,L-1$
 - Coefficient: from QPSK $\{1, j, -1, -j\}$ for $l=1,\dots,L-1$
 - Overhead:
 - i_1 or $(i_{1,1}, i_{1,2})$: Same as Rel. 13 Class A rank 1 codebook
 - FFS: overhead for i_2

Rank-2

- $\mathbf{W}_1$: Rel. 13 Class A $\mathbf{W}_1$ codebook for Codebook-Config = 2, 3, and 4.
 - Alt 0: Class A rank 1 $\mathbf{W}_1$ based
 - Alt 1: Class A rank > 2 $\mathbf{W}_1$ based
 - FFS: down selection between Alt 0 and Alt 1 (and which rank(s) are used)
- $\mathbf{W}_2$:
 - Beam selection: L out of 4 beam selection, where L = 2, 4
 - Co-phase: from QPSK $\{1, j, -1, -j\}$ for $l=0,1,\dots,L-1$ and for layer $r=0,1$
 - Coefficient: from QPSK $\{1, j, -1, -j\}$ for $l=1,\dots,L-1$ and for layer $r=0,1$
 - Design goal: i_2 reporting overhead should be at most equal to that for rank 1

[R1-1610772](#) Way Forward for Quantized Advanced CSI Feedback Structure Ericsson, Huawei, HiSi, ZTE, ZTE Microelectronics

Also supported by CATT

Proposal:

- Reduced space basis (eigenvectors)/ $\mathbf{W}_1$ is constructed based on selecting orthogonal 2D DFT beams
 - TBD: if polarization cophasing is in $\mathbf{W}_1$
 - Basis has rotation with oversampling corresponding to at least $O1=O2=4$
 - Downselect from:
 - Unconstrained selection of N beams
 - Constrained selection using a beam group / beam groups
- Phase and amplitude weighting is applied to combine selected beams from $\mathbf{W}_1$
 - Phase weighting is subband, downselect from:
 - Separate weighting for each layer, with [2 or 3] bits quantization per beam per layer
 - Joint encoding of weighting across layers, with [3] bits quantization per beam
 - Downselect amplitude quantization from:
 - Frequency granularity:
 - Wideband using [1 - 3] bits
 - Differential using [1] bits / subband

- Absolute using [1-3] bits / subband
- Layer granularity:
 - Same amplitude for all layers
 - Different amplitude for each layer
- TBD: if quantization granularity/bits vary per layer and/or per beam
- TBD: if amplitude and phase are jointly encoded

Updated version in: [R1-1611018](#)

Conclusion: More discussion is needed. Email discussion considering the above two proposals and any possible refinement/updates/merging (including [R1-1611018](#)), moderator Hoondong (Samsung), until 27th October

7.2.2.1.2 Interference measurement

R1-1610029	MU interference measurement and MU-CQI enhancement	NTT DOCOMO, INC.
R1-1609291	Enhancing interference measurement for MU transmissions	CMCC
R1-1608725	Aperiodic CSI-IM for interference measurement enhancement	CATT
R1-1609965	Discussion on interference measurement enhancements	Qualcomm Incorporated
R1-1609860	On need of interference measurement enhancement in Rel-14	Ericsson

Conclusions:

- Companies that have provided simulation results have shown benefits from a variety of interference measurement enhancements; no consensus on the size of the benefits of interference measurement enhancements, or on which enhancements might be worth considering further.
- No interference measurement enhancements will be specified in Release 14, unless consensus emerges on a proposal that can be agreed with less than 5 minutes of online meeting time.
- Companies are encouraged to discuss the following WFs offline for possible future consideration in a later Release:

R1-1610771	WF on Interference Measurement Enhancements	CATT, Samsung, CATR, ITRI, InterDigital, KT, KDDI, LG Electronics, ZTE, Xinwei
R1-1610603	WF on MU-CQI Enhancement	NTT DOCOMO, Qualcomm, Samsung, NEC, Xinwei
R1-1610763	WF on NZP CSI-RS based interference measurement	Huawei, HiSilicon

R1-1608598	Interference measurement enhancement in LTE Rel-14	Huawei, HiSilicon
R1-1608683	Discussion on interference measurement for MU-CSI	ZTE, ZTE Microelectronics
R1-1609015	Discussions on enhanced interference measurement based on NZP CSI-RS	Samsung
R1-1609016	Discussion on enhanced MU interference measurement based on DMRS	Samsung
R1-1609017	Discussions on enhanced interference measurement based on aperiodic IMR	Samsung
R1-1609547	Interference measurement and reporting for MU transmission in FD-MIMO	ASTRI, TCL

7.2.2.1.3 Feedback mechanism enhancement

Including analog feedback, use of PUCCH format 3, and others

R1-1608599	Uplink channel design for quantized/un-quantized channel representation	Huawei, HiSilicon
R1-1608684	Feedback mechanism for linear combination based CSI	ZTE, ZTE Microelectronics
R1-1609018	Discussions on periodic CSI reporting for class A in eFD-MIMO	Samsung
R1-1609194	Discussion on feedback mechanism enhancement for advanced CSI	LG Electronics
R1-1609858	Feedback Mechanisms for Advanced CSI	Ericsson
R1-1609859	Draft LS on Support for Advanced CSI Reporting in Higher Layer Signaling	Ericsson
R1-1609966	Discussion on analog CSI feedback	Qualcomm Incorporated
R1-1610030	On feedback enhancements to support advanced CSI	NTT DOCOMO, INC.

7.2.2.1.4 Non-precoded CSI-RS codebook for 20 – 32 ports

R1-1609851	Email summary: [86-14] FD-MIMO Port Layouts and Oversampling Factors	Ericsson
----------------------------	--	----------

Strive to conclude on (N1,N2,O1,O2) combinations for Class A reporting in RAN1#86b, starting from the proposal of R1-168511. Further discuss the following, addressing if and how complexity is impacted and considering performance:

1. The necessity of 3 oversampling factors

2. Why we need both $N_1 \geq N_2$ and $N_2 \geq N_1$ combinations

[R1-1610560](#) Way Forward on Antenna Port Layouts and Oversampling Factors Ericsson, Sprint, Verizon, DOCOMO, Deutsche Telekom, ATT, Samsung

Agreement:

- Agree on all (N_1, N_2) combinations on slide 4 of R1-1010560
- Agree on the following table for (O_1, O_2) combinations (Alt1 of the left table on slide 4 of [R1-1610560](#))

Number of CSI-RS antenna ports, P	(N_1, N_2)	(O_1, O_2) :
20	(2,5)	(8,4)
	(5,2)	(4,4)
	(10,1)	(4,-)
24	(2,6)	(8,4)
	(3,4)	(8,4)
	(4,3)	(4,4)
	(6,2)	(4,4)
	(12,1)	(4,-)
28	(2,7)	(8,4)
	(7,2)	(4,4)
	(14,1)	(4,-)
32	(2,8)	(8,4)
	(4,4)	(8,4)
	(8,2)	(4,4)
	(16,1)	(4,-)

[R1-1610942](#) WF on A codebook enhancements Qualcomm, LG Electronics, Xinwei
Conclusion: no consensus on WF proposed in [R1-1610942](#)

Conclusions:

- The need for extending design principles of Rel.13 Class A codebooks with $\{20, 24, 28, 32\}$ ports is to be decided in RAN1#87.

[R1-1609852](#) Performance comparison of different antenna port layouts Ericsson
[R1-1609926](#) Codebook design for up to 32 CSI-RS ports Huawei, HiSilicon
[R1-1608685](#) Port layout and Class A codebook design for 20-32 ports ZTE, ZTE Microelectronics
[R1-1609019](#) Class A codebook extension and enhancement Samsung
[R1-1608926](#) Codebook Design for Class A CSI Reporting up to 32 Ports Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609967](#) Non-precoded CSI-RS Codebooks for 20-32 ports Qualcomm Incorporated

[R1-1608727](#) Non-precoded CSI-RS codebook for 20-32 ports CATT
[R1-1609195](#) Discussion on Class A codebook for eFD-MIMO LG Electronics
[R1-1609465](#) Beam broadening for more than 16 antenna ports Intel Corporation

7.2.2.2 Open-loop and Semi-open-loop

[R1-1610303](#) Evaluations on DMRS based open and semi-open loop MIMO schemes CEWiT
[R1-1608927](#) DMRS-based Semi-open Loop Schemes for Rank 1 Transmission Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609020](#) Discussions on semi-open-loop transmission in eFD-MIMO Samsung
[R1-1609021](#) Simulation results for precoder cycling based on semi-open-loop transmission Samsung
[R1-1609968](#) DMRS based semi-OL Transmission schemes and CSI reporting Qualcomm Incorporated
[R1-1609196](#) Discussion on OL and Semi-OL MIMO LG Electronics
[R1-1609862](#) Semi-Open Loop Transmission Scheme Ericsson
[R1-1609928](#) DMRS based semi-open loop transmission Huawei, HiSilicon

[R1-1609466](#) Discussion on open loop and semi-open loop Intel Corporation
[R1-1608728](#) CSI feedback and PDSCH transmission for open-loop MIMO CATT
[R1-1608686](#) Enhancements for DMRS-based Semi-Open-Loop Transmission ZTE, ZTE Microelectronics

[R1-1609861](#) Details of Semi-Open Loop Transmission Ericsson
[R1-1610031](#) Semi-open-loop MIMO with beamformed CSI-RS NTT DOCOMO, INC.

[R1-1610592](#) WF on transmission scheme for semi-open loop CATT, Samsung, Nokia, Alcatel-Lucent Shanghai Bell, Intel

Revised in [R1-1610598](#).

Agreements:

- Denote the modulation symbol index as i , RE-level PDSCH processing for semi-open-loop MIMO is based on DMRS ports 7/8
 - Rank-1: Tx diversity
 - $$\begin{bmatrix} y^{(7)}(2i) \\ y^{(7)}(2i) \\ y^{(8)}(2i+1) \\ y^{(8)}(2i+1) \end{bmatrix} = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 0 & j & 0 \\ 0 & -1 & 0 & j \\ 0 & 1 & 0 & j \\ 1 & 0 & -j & 0 \end{bmatrix} \begin{bmatrix} \text{Re}(x^{(0)}(i)) \\ \text{Re}(x^{(1)}(i)) \\ \text{Im}(x^{(0)}(i)) \\ \text{Im}(x^{(1)}(i)) \end{bmatrix}$$
 - Rank-2: co-phasing cycling
 - $$\begin{bmatrix} y^{(7)}(i) \\ y^{(8)}(i) \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ \varphi_n & -\varphi_n \end{bmatrix} \begin{bmatrix} x^{(0)}(i) \\ x^{(1)}(i) \end{bmatrix}, \varphi_n = e^{j\pi \text{mod}(i,2)/2}$$
- For the purpose of CSI feedback, UE assumes the following beamforming on port 7/8 (to N CSI-RS ports)
 - Dual-stage codebook: $W(j) = W1W2(j)$
 - W1: wideband i1 (e.g. grid of beams) of rank-2
 - Rank-1 (options to be downselected at RAN1#87):
 - Option 0: SFBC without defined cycling pattern (e.g. codebook subset restriction applicable to i2, and/or hybrid A+B CSI (with second eMIMO type associated with single-stage codebook), and/or Class B)
 - Option 1: SFBC only + fixed beam selection
 - Option 2: SFBC + per-N-PRB-pair cycling with defined cycling pattern
 - W2(j): pre-determined set of beam selection matrices of rank-2
 - W2(j) cycling per PRG, where PRG comprises N consecutive PRB pairs
 - value of N FFS
 - size/order of beam selection matrices for cycling FFS
 - Rank-2 (options to be downselected at RAN1#87)
 - Option 0: without defined cycling pattern (e.g. codebook subset restriction applicable to i2, and/or hybrid A+B CSI (with second eMIMO type associated with single-stage codebook), and/or Class B)
 - Option 1: fixed beam selection
 - Option 2: per-N-PRB-pair cycling with defined cycling pattern
 - W2(j): pre-determined set of beam selection matrices of rank-2
 - W2(j) cycling per PRG, where PRG comprises N consecutive PRB pairs
 - value of N FFS
 - size/order of beam selection matrices for cycling FFS
 - If the CQI reporting is configured to be based on the Single-stage codebook: $W(j)$
 - 2 CSI-RS ports: identify matrix (i.e. no PMI feedback)
 - 4 CSI-ports: Per-PRB-pair cycling of $W(j)$, where $W(j) = C_k, k = \text{mod}(j,4)+12$, C_k denotes the rank-2 precoding matrix of index k
 - NOTE: j denotes PRB pair index
 - FFS rank-3/4

[R1-1610613](#) WF on CSI feedback for DMRS open loop transmission Huawei, HiSilicon, CATT

Proposal:

- For Class A in case of semi-open-loop operation, two CSI reporting types for dual stage codebook are supported including
 - Type A: i1, CQI, RI
 - Type B: i1, CQI, RI and subsampled i2,
 - FFS: detailed i2 subsampling
 - Type A or Type B is configured by RRC signalling

Conclusion: No consensus.

7.2.2.3 UL DMRS

[R1-1609197](#) Remaining details on UL DMRS enhancement LG Electronics
[R1-1609467](#) Discussion on UL DM-RS with IFDMA structure Intel Corporation
[R1-1609849](#) On RPF, Control Signalling, and Power Boosting for UL DMRS Ericsson
[R1-1608928](#) Remaining details of UL DMRS Base Sequences with IFDMA Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609850](#) On new UL DMRS sequences of lengths 6, 18 and 30 Ericsson
[R1-1609925](#) Discussion on DMRS sequence design Huawei, HiSilicon

[R1-1609848](#) On Cyclic Shifts for UL DMRS with IFDMA Ericsson
[R1-1609148](#) Discussion on backward compatibility for IFDMA based scheme NEC

[R1-1610591](#) WF on UL DMRS Nokia, Alcatel-Lucent Shanghai Bell, NEC

Agreements:

- IFDMA details
 - IFDMA DMRS with RPF=2 only will be supported in Rel-14
 - Lengths of 6, 18 and 30 DMRS based sequences are supported for RPF=2
 - Length-30 base sequence is FFS until RAN1#87 (e.g. Table 6 in [R1-1609850](#))
 - Length-18 base sequences design refer Table 3 in [R1-1608928](#)
 - Length-6 base sequence design refer to Table 4 in [R1-1609850](#)
 - Additional 3dB power boosting is used for IFDMA DMRS with RPF=2
 - Cyclic Shift of UL IFDMA DMRS Generation:
 - If IFDMA is activated according to control signaling,
 - reference signal sequence on even subcarriers is $r_{u,v}^{(\alpha)}(n) = e^{j\alpha n} \bar{r}_{u,v}(n)$, $0 \leq n < M_{sc}^{RS}$
 - reference signal sequence on odd subcarriers is $r_{u,v}^{(\alpha)}(n) = e^{j\frac{\alpha}{2}n} e^{j\alpha n} \bar{r}_{u,v}(n)$, $0 \leq n < M_{sc}^{RS}$
- where $M_{sc}^{RS} = mN_{sc}^{RB} / 2$ is the length of the reference signal sequence, where $1 \leq m \leq N_{RB}^{\max, UL}$ and $n_{cs,\lambda} = (n_{DMRS}^{(1)} + n_{DMRS,\lambda}^{(2)} + 2n_{PN}(n_s)) \bmod 12$.

FFS until RAN1#87:

- Comb hopping is supported including inter-slot hopping and inter-subframe hopping
 - Inter-slot comb hopping is dynamically indicated by UL DCI.
 - FFS on details of signalling design.
 - Inter-subframe comb hopping, applying to initial transmissions and retransmissions and SPS, can be semi-statically configured by RRC signalling
 - Support of both inter-slot and inter-subframe comb hopping is not precluded
- Companies are encouraged to bring system level simulations to RAN1#87 to show the gain of comb hopping.

Conclusion:

CS/OCC/IFDMA Mapping Table:

- Down-select at RAN1#87 one solution from the two candidates on slides 6 & 7 in [R1-1610591](#), or the table below Proposal 3 in [R1-1608603](#), for joint CS/OCC/IFDMA indication
 - o Note: if intra-subframe Comb hopping is supported, comb id or IFDMA configuration in the tables refers to comb id in slot #0 for two slots of a subframe. FFS comb id in the slot #1.

[R1-1610611](#) WF on RPF4 support for UL DMRS Huawei, HiSilicon, Nokia, ASB

[R1-1610570](#) WF on IFDMA DMRS Intel, Qualcomm

[R1-1610612](#) WF on sequence collision for UL DMRS Huawei, HiSilicon

Proposal:

- Root sequence index for DMRS with RPF=2 is determined with $4*q$, wherein, q is the root sequence index of legacy DMRS sequence in the cell.

Conclusion: no consensus.

[R1-1608603](#) Downlink control signaling design to support IFDMA based DMRS Huawei, HiSilicon

[R1-1608929](#) Control Signaling Design for UL DMRS with IFDMA Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610597](#) WF on DL control signalling for IFDMA based DMRS

[R1-1608687](#) Discussion on UL DMRS enhancement for eFD-MIMO ZTE, ZTE Microelectronics
[R1-1608729](#) Consideration on UL DMRS enhancements CATT
[R1-1608602](#) On IFDMA based DMRS design Huawei, HiSilicon
[R1-1609022](#) Further discussion on UL DMRS enhancement for eFDMIMO Samsung
[R1-1609969](#) Remaining details on uplink DMRS enhancements for FD-MIMO Qualcomm Incorporated

7.2.2.4 Non-precoded CSI-RS

[R1-1609970](#) Non-precoded CSI-RS design for up to 32 ports Qualcomm Incorporated
[R1-1608600](#) Discussion on non-precoded CSI-RS up to 32 CSI-RS ports Huawei, HiSilicon
[R1-1609842](#) Remaining details on aggregation of CSI-RS configurations Ericsson
[R1-1608930](#) Considerations of Non-precoded CSI-RS for Class A Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609023](#) Discussions on non-precoded CSI-RS port numbering Samsung
[R1-1609024](#) Discussions on CDM-4/-8 for non-precoded CSI-RS Samsung

[R1-1609843](#) CDM-8 for NZP CSI-RS Ericsson
[R1-1608730](#) Enhanced non-precoded CSI-RS with CDM-8 CATT

[R1-1609150](#) Proposals for CSI-RS with CDM8 NEC

[R1-1610595](#) WF on N_k and M_k for 20 and 28 port CSI-RS Samsung, LGE, CATT, Nokia, ASB, InterDigital, Intel

Agreement:

- For {20, 28} ports, $\sum_k M_k \in \{20, 28\}$, $M_k = 4$, where M_k is the same for all k
 - At least for CDM-4

Qualcomm and ZTE note that this agreement implies that port sharing with Rel-12/13 UEs is not supported.

[R1-1610593](#) WF on aggregation for non-precoded CSI-RS ZTE, ZTE Microelectronics, Qualcomm
 Proposal:

- For {20, 28} ports, $\sum_k M_k \in \{20, 28\}$, $M_k \in \{4, 8\}$, where M_k can be different for different k at least for CDM-4
 - FFS port indexing

[R1-1610596](#) WF on CSI-RS design for CDM 4 and CDM 8 LG Electronics, Ericsson, Qualcomm, CATT

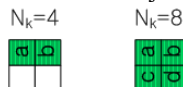
Agreement:

Working Assumption is confirmed that CDM8 is supported for {24,32} port CSI-RS

R1-1610741

Agreements:

- For 20-, 24-, 28-, and 32-port CSI-RS, when CDM-4 OCC applies in the CDM group comprising 4 REs within k-th CSI-RS configuration, according to the table below.
 - For $N_k=4$, 4REs mapping to legacy 4-port CSI-RS comprises a CDM group.
 - For $N_k=8$, 8 REs mapping to legacy 8-port CSI-RS are partitioned into two groups of 4 REs, and each group of 4 REs located adjacently comprises a CDM group:



–

OCC index	OCC on REs [a b c d]
0	[1 1 1 1]

1	[1 -1 1 -1]
2	[1 1 -1 -1]
3	[1 -1 -1 1]

- FFS on additional CDM-4 pattern(s) at least for 28- and 32-port to support full power utilization within a single PRB.
- CDM-8 design for {24, 32} ports:
 - At least for 32-port CSI-RS, at least one CDM-8 pattern exists which uses REs from more than 2 OFDM symbols
 - FFS until RAN1#87:
 - which CDM-8 patterns are useful, and
 - downselection between:
 - Alt 1: CDM-8 patterns are configured by aggregation of CDM-2/4 patterns
 - Alt 2: CDM-8 patterns are defined in the specifications without explicit aggregation
 - Overhead reduction for CDM-8 is FFS
 - Note: CDM-8 can be supported in both normal and special subframes

[R1-1608732](#) Density reduction for class A CSI-RS with 20-32 ports CATT
[R1-1609840](#) Frequency domain measurement restriction for reduced overhead NZP CSI-RS Ericsson
[R1-1609841](#) On Supported CSI-RS Density Values for Class A in eFD-MIMO Ericsson
[R1-1610032](#) Low-density CSI-RS and port sharing NTT DOCOMO, INC.

[R1-1609885](#) Non-coded CSI-RS design for eFD-MIMO Potevio
[R1-1608688](#) Further discussion on non-coded CSI-RS design for eFD-MIMO ZTE, ZTE Microelectronics
[R1-1608731](#) Enhanced non-coded CSI-RS with CDM-2/4 CATT
[R1-1609149](#) Proposals for CSI-RS with CDM4 NEC
[R1-1608689](#) Aperiodic CSI-RS for non-coded CSI-RS ZTE, ZTE Microelectronics
[R1-1609198](#) Remaining details on Non-coded CSI-RS LG Electronics
[R1-1609468](#) Remaining details on NZP CSI-RS for Class A FD-MIMO Intel Corporation

[R1-1610623](#) WF on CSI-RS density values for Class A Ericsson, LG

Agreement:

- For Class A eFD-MIMO, a CSI-RS density value of 1/3 is supported in addition to already agreed values of 1 and 1/2
- No other values of CSI-RS density are supported in this Release.

[R1-1610624](#) WF on CSI-RS overhead reduction for Class A Ericsson, Samsung

Agreement:

- For Class A, CSI-RS overhead reduction is supported by Comb-like transmission, allowing PDSCH transmission in the REs in PRBs with no CSI-RS ports
 - UE measures channel in REs in PRBs with CSI-RS ports and expects PDSCH in PRBs with no CSI-RS ports
 -

[R1-1610594](#) WF on signalling details for CSI-RS overhead reduction Samsung, ZTE, Ericsson, DoCoMo, InterDigital
 Revised in [R1-1610602](#)

Agreements:

- For Class B NZP CSI-RS:
 - Support CSI-RS density of $d \in \{1, 1/2\}$ RE/RB/port
 - Additional values of $d=1/3$ and/or $1/8$ are not precluded for Class B if significant benefit can be shown at RAN1#87.
- Transmission and/or measurement comb offsets are $0..1/d-1$
 - For $d=1/2$ (i.e. for Class A & Class B), comb offsets $\in \{0, 1\}$ can be configured for CSI-RS transmission and/or measurement in the n-th PRB, where $n \bmod 2 = \text{comb offset}$
 - For $d=1/3$ (i.e. at least for Class A), comb offsets $\in \{0, 1, 2\}$ can be configured for CSI-RS transmission and/or measurement in the n-th PRB, where $n \bmod 3 = \text{comb offset}$
- Working Assumption: For Class A NZP CSI-RS with more than 16 CSI-RS port, in a given CSI-RS resource all CSI-RS configurations have the same values of d
 - Will be confirmed automatically at RAN1#87 unless there is consensus to support different values of d per CSI-RS configuration

- For Class A NZP CSI-RS with more than 16 CSI-RS ports each CSI-RS configuration can have different values of comb offset
- FFS the detailed signalling design

R1-1610718 WF on the overhead reduction for Class B CSI-RS Intel

Proposal:

- For Class-B eMIMO type and CSI-RS resource with two or more antenna ports with *alternativeCodebookEnabledCLASSB_K1=True*, the channel measurements obtained from CSI-RS antenna ports are renumbered for CSI calculation according to the following equation:

$$p = \begin{cases} 15 + i & \text{for } p' \in \{15, \dots, 15 + 2i\} \\ 15 + i + \frac{N_{\text{ports}}^{\text{CSI}}}{2} & \text{for } p' \in \{16, \dots, 15 + 2i + 1\} \end{cases}$$

$$i = \{0, 1, \dots, \frac{N_{\text{ports}}^{\text{CSI}}}{2} - 1\}$$

- CSI-RS antenna ports of CSI-RS resource can be transmitted in different PRBs
- Signalling details of PRB density and PRB offsets for antenna ports are FFS

7.2.2.5 Other remaining issues

7.2.2.5.1 Aperiodic and frequency domain reduced overhead CSI-RS

Activation/release mechanism

R1-1610635 WF on Aperiodic CSI-RS for eFD-MIMO Samsung, CATT, LG Electronics, Nokia, Alcatel-Lucent Shanghai Bell, ZTE, ZTE Microelectronics, InterDigital, Xinwei, Huawei, HiSilicon, KT Corporation, AT&T, Mitsubishi Electric, Straight Path, Qualcomm

Agreements:

- For activation/release mechanism:
 - MAC CE is used to signal the choice of N out of K RRC-configured CSI-RS resources
 - The value of N is configurable via higher-layer signalling and upper bounded by a UE capability parameter N_{max}
 - N_{max} for aperiodic and multi-shot periodic CSI-RS can be different.
 - When $K \leq 2$, $N=K$; else (when $K > 2$) $N = \{1, 2, \dots, \min(4, K)\}$
 - Note: If the above value of N exceeds N_{max} , $N = N_{\text{max}}$ is used instead.
 - Note: Activation/release mechanism is skipped for aperiodic CSI-RS when $K = 1$ or N
- The above MAC-CE-based activation/release mechanism is used for both aperiodic and “multi-shot” CSI-RS.

R1-1610941 WF on MAC CE based activation/release mechanism Qualcomm

Agreements:

- Down select the value for X/Y for MAC CE based activation/release mechanism from (RAN1#87)
 - Alt1. $X=Y=4$ ms
 - Alt2. $X=Y=8$ ms
 - Note: For both aperiodic and “multi-shot” CSI-RS

R1-1610615 WF on supporting aperiodic CSI-RS with one resource Huawei/HiSi

QCL

R1-1610732 WF on QCL issue for aperiodic CSIRS LG Electronics, Samsung

Proposal:

- For QCL indication on DMRS to aperiodic CSIRS or multi-shot CSIRS,
 - UE is not expected that aperiodic CSIRS is indicated in PQI for QCL purpose with DMRS
 - Multi-shot CSIRS can be indicated in PQI for QCL purpose, and follow legacy QCL assumption.

Conclusion: More discussion is needed. Email discussion, moderator Jonghyun (LG), until 20th October

Rate Matching

[R1-1610924](#) WF on remaining details on PDSCH rate matching LG Electronics, InterDigital, Qualcomm, ZTE, ZTE Microelectronics

Proposal:

- For PDSCH rate matching on aperiodic CSI-RS and multi-shot CSI-RS, X-bit (X=1 or 2) aperiodic ZP CSI-RS resource signaling field is introduced in DL-related DCIs for all TMs
 - AP ZP CSIRS resource configuration is defined without subframe_config
 - UE conducts PDSCH rate matching on AP ZP CSIRS at the subframe when the DCI is signaled.
 - If X=1 and only AP ZP CSI-RS resource configuration is configured by RRC, AP ZP CSI-RS resource signaling field descriptions are
 - State '0': No configured AP ZP CSIRS is indicated.
 - State '1': The 1st RRC-configured AP ZP CSIRS is indicated to be applied.
 - If X=1 and more than 1 AP ZP CSI-RS resource configurations are configured by RRC, the above State '1' description is given/activated via MAC CE, choosing one out of the configured AP ZP CSI-RS resource configurations.
 - If X=2 and up to 3 AP ZP CSI-RS resource configurations are configured by RRC, AP ZP CSI-RS resource signaling field descriptions are
 - State '0': No configured AP ZP CSIRS is indicated.
 - State '1': The 1st RRC-configured AP ZP CSIRS is indicated to be applied.
 - State '2': The 2nd RRC-configured AP ZP CSIRS is indicated to be applied.
 - State '3': The 3rd RRC-configured AP ZP CSIRS is indicated to be applied.
 - If X=2 and more than 3 AP ZP CSI-RS resource configurations are configured by RRC, the above 3 non-zero state descriptions are given/activated via MAC CE, each choosing one out of the configured AP ZP CSI-RS resource configurations.
- ZP CSI-RS resource configuration with 1ms periodicity is configured for EPDCCH by higher layer, and considered as EPDCCH available REs and punctured.

Conclusion: More discussion is needed. [Email discussion, moderator Jonghyun \(LG\), until 20th October](#)

DCI signalling

[R1-1610815](#) WF on aperiodic CSI-RS selection Ericsson, NTT DOCOMO

Conclusion:

- 3 alternatives are identified:
 - Alt1 Reuse A-CSI request field and add more bit(s) if necessary
 - Alt2 Reuse CS field (see [R1-1610815](#), [R1-1610816](#))
 - Alt3 Add ceil(log2(N))-bit or 2-bit DCI field
- Decide between the above 3 alternatives. [Email discussion, moderator Siva \(Ericsson\), until 27th October](#)

R1-1609199	Remaining details on beamformed CSI-RS enhancement	LG Electronics
R1-1608601	Enhancement on rate matching for different transmission modes	Huawei, HiSilicon
R1-1608690	Remaining issues on aperiodic CSI-RS	ZTE, ZTE Microelectronics
R1-1608733	Remaining issues on aperiodic CSI-RS	CATT
R1-1608734	PDSCH rate-matching for aperiodic CSI-RS	CATT
R1-1608735	Density reduction for beamformed CSI-RS	CATT
R1-1608736	On QCL for aperiodic CSI-RS	CATT
R1-1608931	Remaining Details of aperiodic CSI-RS and overhead Reduction	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609025	Discussions on remaining details of rate matching and QCL for aperiodic and multi-shot CSI-RS	Samsung
R1-1609026	Completing aperiodic and "multi-shot" CSI-RS for Rel.14	Samsung
R1-1609407	Discussion on frequency domain reduced overhead CSI-RS	ITRI
R1-1609469	Remaining details on overhead reduction for Class B CSI-RS	Intel Corporation
R1-1609844	Mechanism for Class B overhead reduction	Ericsson
R1-1609845	Remaining details of Aperiodic and Multi-shot CSI-RS	Ericsson
R1-1609846	On Rate Matching for Beamformed CSI-RS	Ericsson
R1-1609847	QCL for Multi-Shot or Aperiodic CSI-RS	Ericsson
R1-1609923	Support of multi-shot CSI-RS	Huawei, HiSilicon
R1-1609924	Support of aperiodic CSI-RS	Huawei, HiSilicon
R1-1609971	Discussion on activation and release mechanism for beamformed CSI-RS	Qualcomm Incorporated

R1-1609972	Remaining details on aperiodic CSI-RS	Qualcomm Incorporated
R1-1610033	Discussion on Resource Sharing of Beamformed CSI-RS	NTT DOCOMO, INC.
R1-1610102	CSI-RS overhead reduction	InterDigital Communications
R1-1610104	A-CSI-RS Impacts on EPDCCH	InterDigital Communications
R1-1610105	PDSCH rate-matching for A-CSI-RS	InterDigital Communications
R1-1610365	Discussion multi-shot CSI-RS	Intel Corporation
R1-1610632	WF on PDSCH rate matching for supporting aperiodic A-CSI-RS	LG, InterDigital, Qualcomm, Samsung

7.2.2.5.2 Hybrid CSI

Finalizing mechanism 1

R1-1610759	WF on Remaining Issues for Hybrid CSI	Samsung
R1-1610731	WF on PUSCH CSI reporting for hybrid CSIRS mechanism 1	LG Electronics, Samsung, Qualcomm

Mechanism “2”?

R1-1610786	Way Forward on Hybrid CSI Mechanism	ZTE, ZTE Microelectronics, NTT DOCOMO, Ericsson, Intel
----------------------------	-------------------------------------	--

Proposal:

- For hybrid CSI in one CSI process, support CLASS B with $K > 1$ CSI-RS resources for the 1st eMIMO-Type and CLASS B with $K = 1$ CSI-RS resource for the 2nd eMIMO-Type
 - For the 1st eMIMO-Type
 - CRI (without CQI/PMI/RI) is reported
 - For the 2nd eMIMO-Type
 - CQI/PMI/RI are reported
 - Different CSI-RS resources and/or eMIMO-Types can be used for PUCCH and PUSCH
 - UE calculates one CSI report for only one eMIMO-Type of a pair at a time

Conclusion: More discussion is needed. [Email discussion, moderator Yuichi \(Docomo\), until 20th October](#)

R1-1611013	WF on Remaining Issues for Hybrid CSI	Samsung, Ericsson
----------------------------	---------------------------------------	-------------------

Agreements:

- Confirm working assumption for mechanism 1:
 - No inter-dependence between CSI calculations across two eMIMO-Types
 - Note: ZTE has a concern on this.

Conclusions: More discussion is needed on the proposal below. If the use of PF-3 (e.g. the proposal below) cannot be agreed by RAN1#87 (Reno), the use of PF-2 will be agreed.

- Use PUCCH format 3 (PF-3) for CSI reporting of 1st eMIMO-Type
 - A PF-3 resource is allocated for CSI reporting and/or A/N
- PF resource usage follows legacy-like procedures as follows:
 - For $N \geq 1$ CC(s):
 - CSI-only reporting: Use PF-3 resource allocated for CSI
 - A/N-only: If A/N is for Pcell only, use PF-1A/1B resource allocated for A/N. Otherwise use PF-3 resource allocated for A/N
 - CSI and A/N collision: multiplex CSI and A/N using PF-3 resource allocated for A/N
 - For TDD scenario, the DAI is set to be 1 (i.e. PF-1A/B is used only if for PCell and DAI in DCI format is the first DAI with value 1 that the UE detects)

R1-1610731	WF on PUSCH CSI reporting for hybrid CSIRS mechanism 1	LG Electronics, Samsung, Qualcomm
----------------------------	--	-----------------------------------

Conclusions: More discussion is needed to choose between the following two alternatives. [Email discussion, moderator Youngwoo \(Samsung\), until 27th October](#)

Alt1. Proposal in [R1-1610731](#)

- For aperiodic CSI reporting for hybrid CSIRS mechanism 1
 - Either one of CSI for 1st eMIMO-Type (i.e., 1st CSI) and CSI for 2nd eMIMO-Type (i.e., 2nd CSI) is triggered for aperiodic CSI reporting

- CSI request field in UL grant DCI is used to indicate either one of the two. FFS whether additional bit(s) are needed
 - For 1st eMIMO-Type, encoding mechanism/mapping on PUSCH is FFS.
 - For 2nd eMIMO-Type, legacy CSI encoding/mapping on PUSCH is reused.
- Alt2. Report both eMIMO-Types, but the UE is only required to update one of the two eMIMO-Types
- Example a: A method analogous to Rel.13 CSI relaxation
 - Example b: cf. [R1-1609853](#) section 2.2.2. For this solution, the reference resource definition for the 1st eMIMO-Type needs to be changed. There might be some impact on UE behaviors.
 - [\[R1-1609853\]](#) “When periodic CSI is not configured for the first eMIMO-Type, its reference resource is in the subframe containing its most recent CSI-RS resource
 - Otherwise, the reference resource for the first eMIMO-Type is that set by periodic CSI”

Conclusions: [Email discussion on the proposal below, moderator Hao, until 27th Oct.](#)

- Regardless of which alternative is chosen, 1st and 2nd eMIMO-Types can be configured for PUCCH and PUSCH, respectively.

R1-1610764	WF on extra scheme supported in Hybrid CSI	Huawei, HiSilicon
R1-1608691	Remaining issues on Hybrid CSI	ZTE, ZTE Microelectronics
R1-1608737	On remaining issues on hybrid CSI-RS	CATT
R1-1608932	Remaining Details of Hybrid CSI Reporting	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609027	Partial port hybrid CSI reporting	Samsung
R1-1609028	Completing mechanism 1 of hybrid CSI for Rel.14	Samsung
R1-1609200	Remaining details on Hybrid CSI-RS	LG Electronics
R1-1609853	Generalized Hybrid CSI Reporting	Ericsson
R1-1609927	Discussion on Hybrid CSI reporting	Huawei, HiSilicon
R1-1609973	Remaining details on CSI reporting for hybrid CSI-RS	Qualcomm Incorporated
R1-1610034	CSI Reporting for Hybrid CSI-RS	NTT DOCOMO, INC.
R1-1610364	Discussion on CSI reporting for hybrid CSI	Intel Corporation

7.2.3 Downlink Multiuser Superposition Transmission for LTE - *WID in RP-161019*

[R1-1610866](#) Chairman's notes of AI 7.2.3 on Downlink Multiuser Superposition Transmission for LTE Ad-Hoc chair (Qualcomm, MediaTek)

The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

7.2.3.1 Superposition transmissions

Power ratios

R1-1610802	Discussion on power ratios for MUST Case 1&2	Huawei, HiSilicon
Revision of R1-1608604		
R1-1610304	Super-constellation based power ratios and gray mapping for MUST	KT Corp.
R1-1609615	On the set of power ratios for MUST Case 1 and 2	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610724	Way Forward on Power Ratio in MUST Cases 1 and 2	MediaTek, ZTE, ZTE Microelectronics

Agreements

- For MUST Cases 1 and 2, the number of power ratios is
 - 3 for MOD combination of QPSK (MUST-near) + QPSK (MUST-far)
 - 3 for MOD combination of 16QAM (MUST-near) + QPSK (MUST-far)

Working assumption

- 3 for MOD combination of 64QAM (MUST-near) + QPSK (MUST-far)

R1-1610714	Way Forward on Principle Generating Power Ratio	ZTE, ZTE Microelectronics, LG Electronics
R1-1610803	Way Forward on downlink power allocation for MUST Case 1&2	Huawei, HiSilicon, NTT DOCOMO

Agreements:

- In case of MUST Case 1 operation, when MUST near UE is rank2 and MUST far UE is rank1 transmission, the two layers of MUST near UE have the same transmission power

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1610804](#) Way Forward on Power Ratios for Case 1 &2 Huawei, HiSilicon, Qualcomm
[R1-1610948](#) Way Forward on Power Ratios for Case 1 &2 Huawei, HiSilicon, Qualcomm, Nokia, ASB

Agreements

- The power ratios for different modulation combination are
 { 8/10, 50/58, 264.5/289} for QPSK+QPSK
 { 32/42, 144.5/167, 128/138} for 16QAM+QPSK
 {128/170, 40.5/51, 288/330} for 64QAM+QPSK
- Up to editor to how to capture the values in the specification

[R1-1608678](#) MUST system performances with different power ratio choices ZTE
[R1-1609201](#) Discussion on power ratio and modulation order LG Electronics
[R1-1609292](#) Views on MUST power ratio signaling CMCC
[R1-1609975](#) Power ratio set considerations for MUST Qualcomm Incorporated
[R1-1610040](#) Discussion on power ratios for MUST scheme NTT DOCOMO, INC.

Gray mapping

[R1-1608679](#) Specification for Gray mapped composite constellation for MUST ZTE
[R1-1609616](#) On standardization of the composite constellations for MUST Case 1 and 2 Nokia, Alcatel-Lucent
Shanghai Bell

[R1-1610723](#) Way Forward on Gray Mapped Composite Constellation in MUST MediaTek, Qualcomm, Nokia, ASB, ITRI
[R1-1610754](#) Way Forward on Definition of Gray Mapped Composite Constellation ZTE, ZTE Microelectronics, LG Electronic
[R1-1610805](#) Way Forward on Gray Conversion for MUST Case 1&2 Huawei, HiSilicon, ZTE, ZTE Microelectronics
[R1-1610715](#) Way Forward on the Gray conversion LG Electronics, ZTE, ZTE Microelectronics

Agreement

- For MUST case 1 and case 2, specify the text to achieve Gray-mapped composite constellation for superposed users and it's up to editor to choose from the following references for specification
 - [R1-1610723](#)
 - [R1-1610805](#)

[R1-1609202](#) Discussion on Gray mapping for superposed constellation LG Electronics
[R1-1609353](#) Discussion on Gray conversion for MUST Case 1&2 Huawei, HiSilicon
[R1-1609600](#) Gray mapped composite constellation of MUST MediaTek Inc.

Power allocation

[R1-1609601](#) Power allocation for CRS based transmission schemes in MUST MediaTek Inc.
[R1-1609930](#) Discussion on power allocation issue for MUST Case 1&2 Huawei, HiSilicon
[R1-1610041](#) Discussion on remaining issues and signaling design for DL MUST NTT DOCOMO, INC.
Section 2.2 only

[R1-1609974](#) Superposition transmissions Qualcomm Incorporated

7.2.3.2 Mechanisms for efficient operation

Related RRC signaling, DCI, UE assumptions, etc.

[R1-1609203](#) Discussion on Signaling Assistance Information and remaining issues LG Electronics
[R1-1609293](#) On signaling design for MUST case 3 CMCC
[R1-1609566](#) DCI design for MUST Case 1 and Case 2 China Telecommunications
[R1-1609617](#) On signaling for MUST CASE1/2/3 Nokia, Alcatel-Lucent Shanghai Bell
[R1-1610041](#) Discussion on remaining issues and signaling design for DL MUST NTT DOCOMO, INC.

Contents except section 2.2

[R1-1610725](#) Way Forward on DMRS based Transmission Scheme of MUST Case 3 MediaTek, ZTE, ZTE Microelectronics, CMCC
Continue offline till next meeting

[R1-1610726](#) Way Forward on PDSCH Starting Symbol in MUST MediaTek, ZTE, ZTE Microelectronics, Nokia, ASB, ITRI, CMCC
Also supported by Huawei

Agreements

- To cancel or suppress interfering PDSCH, MUST UE assumes the same starting OFDM symbol of interfering PDSCH as its own PDSCH

[R1-1610729](#) WF on PDSCH starting symbol LG Electronics, Qualcomm
[R1-1610830](#) WF on MUST control operation Nokia, ASB, QC
[R1-1610947](#) WF on MUST control operation Nokia, ASB, NEC
[R1-1610730](#) WF on new DCI design LG Electronics, LG Uplus, MediaTek, ZTE, ZTE Microelectronics, Huawei, HiSilicon
Also supported by Sharp, Sony

Agreements:

- MUST operation with RA alignment of interference within near-UE allocation is supported for cases 1 and 2
 - single DCI by adding bits of wideband power ratio and interference presence in the self DCI is supported
- FFS case 3
- FFS MUST operation without RA alignment of interference within near-UE allocation is supported
 - two DCIs are supported
 - FFS on content of two DCIs
 - Aim for minimizing specification impact and reducing complexity

[R1-1610809](#) Way Forward on MUST UE multiplexing Huawei, HiSilicon
Further check whether [R1-1610809](#) is already covered by [R1-1610723](#), [R1-1610805](#) and RP-160680 or not till next meeting

[R1-1608605](#) DCI design for MUST Case 1&2 Huawei, HiSilicon
[R1-1608680](#) Signaling design for MUST ZTE
[R1-1608738](#) Support of downlink superposition transmission CATT
[R1-1609144](#) New DCI design consideration for MUST NEC
[R1-1609345](#) MUST UE multiplexing and resource allocation Huawei, HiSilicon
[R1-1609381](#) Discussion on DCI options for providing MUST-near UE co-schedule information Sony
[R1-1609602](#) On scheduling restrictions of MUST MediaTek Inc.
[R1-1609603](#) Fallback transmission mode of MUST MediaTek Inc.
[R1-1609976](#) Mechanisms for efficient operation Qualcomm Incorporated
[R1-1609977](#) MUST UE pairing with existing CQI feedback Qualcomm Incorporated

7.2.3.3 Evaluation for MUST using up to 8Tx

Focusing on Case 3 using up to 4Tx CRS-based TMs

[R1-1608681](#) Discussion and evaluation for MUST Case 3 ZTE
[R1-1609604](#) System-level evaluation and design requirements for MUST Case 3 MediaTek Inc.
[R1-1609931](#) Simulation results for MUST Case 3 Huawei, HiSilicon
[R1-1610806](#) Way Forward on CRS-based MUST Case 3 Huawei, HiSilicon, LG Electronics

Conclusion

- There is no consensus in RAN1 to support Case 3 for CRS-based TMs

7.2.4 eMBMS enhancements for LTE - WID in RP-161297

[R1-1610867](#) Chairman's notes of AI 7.2.4 on eMBMS enhancements for LTE Ad-Hoc chair (Ericsson)
The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

[R1-1610765](#) LS on RAN2 agreements on FeMBMS

7.2.4.1 Longer cyclic prefix for MBSFN subframe

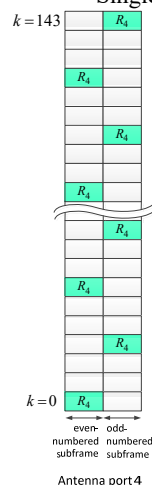
[R1-1609978](#) Design options for longer cyclic prefix and link level simulation results Qualcomm Incorporated

7.2.4.2 MBSFN-RS pattern for longer cyclic prefix

[R1-1609676](#) MBSFN reference signal design Ericsson
[R1-1609979](#) RS pattern for longer CP Qualcomm Incorporated
[R1-1610310](#) eMBMS RS Design Considerations Nokia, Alcatel-Lucent Shanghai Bell

Agreement:

- Confirm the working assumption from RAN1#86: CP length is 200us and core symbol duration of 800us
- Single RS pattern for this numerology:



Note for minutes: Huawei has a strong concern that this limits flexibility for MBSFN subframe configuration and has poor support for mobility.

Agreement:

- There is a set of 8 MBSFN RS pseudo-random sequences for the Rel-14 longer-CP subframes.

7.2.4.3 Synchronization and acquisition of system information

R1-1609348

Considerations on increased number of MBSFN subframes Huawei, HiSilicon

R1-1609677

Synchronization and acquisition of system information for FeMBMS carrier Ericsson

R1-1609980

Initial acquisition and system information for eMBMS Qualcomm Incorporated

R1-1610311

eMBMS PSS/SSS/PBCH and SIB1 transmission Nokia, Alcatel-Lucent Shanghai Bell

R1-1610358

System Information modification indication for FeMBMS carrier Ericsson

R1-1610927

Way Forward on eMBMS enhancement Ericsson, Qualcomm, BBC, Nokia, ASB, Intel, EBU, IRT, Dish

Agreements:

For synchronization and acquisition of system information on FeMBMS carrier:

- For <100% MBSFN subframes the legacy sync and SI acquisition procedures are reused based on subframe #0 and #5

Working Assumption:

For synchronization and acquisition of system information on FeMBMS carrier:

- For 100% MBSFN subframe allocation FeMBMS carrier transmits a periodic subframe, CAS Cell Acquisition Subframe
 - To be confirmed or revisited at RAN1#87, including:
 - CAS performance (including synchronization performance and link level performance of PDCCH and PDSCH), and capacity analysis, based on the definitions below should be evaluated to the next meeting; details of SI transmission in different system bandwidths should also be provided.
 - Consideration of FDM as an additional mode of operation if all the details (i.e. design, guard band size, specification impact, UE implementation impact analysis) and evaluations showing clear performance benefit (considering the performance targets) are presented at the next meeting
- CAS supports PSS, SSS, CRS, PBCH, PDCCH, PDSCH (SI)
- CAS is always transmitted in subframe #0 with a period of 40ms
- MIB is provided by PBCH in every CAS
- The MIB transmitted in SFN mod 4 = 0 and can change only in SFN mod 16 = 0 and contains systemFrameNumber equal to the 6 most significant bits of the SFN
- SI is provided by PDSCH in CAS

- A first SI that may also contains scheduling of further SI is transmitted in SFN mod 8 = 0 and can change only in SFN mod 16 = 0
- This first SI may be a combination of SIBs, up to RAN2 agreements.
- MCCH change notification and SI modification notification are sent in PDCCH region of the CAS.
- FFS if from RAN1 perspective, it is feasible to transmit multiple SI messages in the same subframe by using different RNTIs. RAN2 may consider if this may be used.
- Inform RAN2 that SI modification notification can be conveyed to the UE with Direct Indication signalling.
- FFS enhancements on DCI to indicate larger allocation

Note that this Working Assumption is not based on complete performance evaluations. Complete performance evaluations are to be used in deciding whether to confirm or modify the working assumption at RAN1#87.

LS to be sent to RAN2 to inform them of the above agreements and Working Assumption - [R1-1610605](#) - Alberto

[R1-1610605](#) [DRAFT] LS regarding agreements for FeMBMS Qualcomm
Agreed in [R1-161051](#)

[R1-1609471](#) PBCH coverage enhancements for further enhanced MBMS carriers Intel Corporation
[R1-1610312](#) Considerations on PBCH coverage enhancement Nokia, Alcatel-Lucent Shanghai Bell

7.2.4.4 Other

This includes potential CRS reductions in FeMBMS carrier with less than 100% MBSFN subframes

[R1-1609981](#) MBSFN subframes without a unicast control region and cell-specific reference signals Qualcomm
Incorporated

[R1-1609470](#) Potential CRS reductions for further enhanced MBMS carriers Intel Corporation
[R1-1609678](#) CRS reductions in FeMBMS carrier with less than 100% MBSFN subframes Ericsson
[R1-1609982](#) Considerations on further CRS reduction Qualcomm Incorporated

[R1-1610357](#) Unicast control region for FeMBMS carrier Ericsson

7.2.5 SRS Carrier Based Switching for LTE - WID in RP-160935

[R1-1610868](#) Chairman's notes of AI 7.2.5 on SRS Carrier Based Switching for LTE Ad-Hoc chair (Huawei)

The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

[R1-1610647](#) Way Forward on SRS Carrier-based Switching Huawei, HiSilicon, Softbank

Agreement:

- Send LS with agreements and RRC parameters to RAN2 and RAN4.
 - o Content of LS and RRC parameters to be discussed.

[R1-1611009](#) Draft LS for SRS Carrier-Based Switching Agreements Huawei

Agreed in [R1-161039](#)

[R1-1611042](#) Draft LS on L1 parameters for SRS Carrier-Based Switching Huawei

Agreed in [R1-161050](#)

7.2.5.1 Procedures and configurations for SRS/RACH switching and transmission

Including details for selection of switching-from CC, maximum supported RF retuning time, and PHR

[R1-1608586](#) Other considerations on SRS switching Huawei, HiSilicon
[R1-1609472](#) On SRS transmission without PUSCH Intel Corporation
[R1-1609683](#) Parameters for transmission of SRS in carrier based switching Ericsson

Agreement:

- Switching-from CC for a PUSCH-less CC
 - Option 1: rule(s) defined
 - E.g., descending order of CC index, but a CC with higher index may be more tightly coupled with the PCell
 - Option 2: RRC configuration
 - Agreed on option 2.

Note:

- UE is not expected to switch to a deactivated CC.
- For dual connectivity case, only switching within a cell group (MCG or SCG).

Agreement:

- UE may report RF retuning time no longer than X us
 - Option 1: X = 200
 - Option 2: X = 300
 - Option 3: X = 500
 - Option 4: X = 900
- Adopt Option 3

Agreement:

- Switching for RACH
 - Switching-from CC: same as SRS and no additional configuration
 - Switching-to CC: based on PDCCH order

Agreement:

- PC parameter further clarifications: (remove subscript of SRS from f(i))
 - $P_{SRS,c}(i) = \min[P_{CMAX,c}(i), \{10\log_{10}(M_{SRS,c}) + P_{O_SRS,c}(m) + \alpha_{SRS,c} \cdot PL_c + f_{SRS,c}(i)\}]$ [dB]
 - $m=0$ for P-SRS and $m=1$ for A-SRS on a PUSCH-less CC

Agreement:

- PHR
 - If SRS transmitted:
 $PH_{SRS,c}(i) = P_{CMAX,c}(i) - \{10\log_{10}(M_{SRS,c}) + P_{O_SRS,c}(m) + \alpha_{SRS,c} \cdot PL_c + f_{SRS,c}(i)\}$ [dB]
 - Else:
 $PH_{SRS,c}(i) = \tilde{P}_{CMAX,c}(i) - \{P_{O_SRS,c}(1) + \alpha_{SRS,c} \cdot PL_c + f_{SRS,c}(i)\}$ [dB]
- SRS
 - Through RRC configuration, allow SRS transmissions on more than 2 UpPTS symbols in the same subframe for the same UE, for A-SRS and P-SRS
 - On the same CC or multiple CCs
 - Allow more than one SRS configurations for the subframe, for A-SRS and P-SRS
 - Reuse existing SRS configurations (1 or 2 UpPTS symbols per SRS configuration)

Agreement:

- PRACH
 - No autonomous Re-Tx of PRACH if UE does not receive RAR
 - Re-transmission is achieved by monitoring PDCCH order
 - Power ramping up follows the current procedure

[R1-1608585](#)
[R1-1608587](#)

Details on SRS switching-from CC and switching-to CC Huawei, HiSilicon
Power headroom report for SRS switching Huawei, HiSilicon

R1-1609029	Configurations for SRS/RACH switching	Samsung	
R1-1609344	Details on timing advance for SRS on TDD CCs without PUSCH		Huawei, HiSilicon
R1-1609684	UE reporting of interruption time for SRS in carrier based switching	Ericsson	
R1-1609983	Details for SRS and PRACH switching and transmission		Qualcomm Incorporated

7.2.5.2 DCI design

Including details for group DCI design (jointly for TPC and A-SRS trigger), DL DCI design (for A-SRS trigger)

R1-1608588	DCI design for SRS switching	Huawei, HiSilicon
R1-1609030	DCI for SRS Triggering and Power Control	Samsung

Agreement:

- Group DCI for SRS switching
 - Payload same as 0/1A/3/3A
 - With 1 or more configured group RNTI for the newly introduced group DCI
 - A UE can be triggered for multiple CCs within one group DCI
 - Type A: A single field is used to trigger a group of (one or multiple) CCs if the UE is configured with more than 5 CCs without PUSCH
 - For all the CCs that are triggered by this field, each have a TPC field in this group DCI and the number of bits reserved is decided by the maximum group size among the configured groups
 - Maximum number of CCs of a group: 8
 - Type B: N fields are used to trigger up to N CCs if the UE is configured with less than or equal to 5 CCs without PUSCH
 - TPC field for each of the N CCs is also in this group DCI
 - Number of bits:
 - Trigger field:
 - 2 bits for triggering a group of CCs (type A)
 - For triggering only single CC (type B),
 - 1 bit for single UL Tx antenna without antenna switching,
 - 2 bits for multiple UL Tx antenna including antenna switching
 - Per UE configured size
 - TPC: UE specifically configured 1 bit or 2 bits
 - Search space
 - Common search space in Pcell
 - Name of the new group DCI format: leave to the editor
 - Also support TPC-only group DCI by not configuring the triggering field
 - UE is not expected to be configured with both TPC-only group DCI and the joint TPC and A-SRS trigger group DCI
- DL DCI formats for trigger
 - Reuse current DL DCI formats with SRS request field (currently 1A/2B/2C/2D)
 - 1 bit in DL DCI for SRS request

R1-1609473	Remaining details of SRS triggering with CC switching	Intel Corporation
R1-1609685	Power control for SRS carrier based switching	Ericsson
R1-1609882	Joint group DCI for SRS switching	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609984	DCI design	Qualcomm Incorporated

7.2.5.3 Details of collision handling

Including details for priority/dropping rules, mechanisms to mitigate the impact of collision (shortened PUSCH), and approaches to help avoid collision

Agreement:

- RRC signalling for HARQ reference configuration same (from RAN1 perspective) as in eIMTA (but not associated with eIMTA)
- **Working assumption:** RRC configure whether SRS flexible timing applies. No timing ambiguity between eNB and UE for SRS transmission is allowed. Details FFS.

R1-1609985	Collision Handling	Qualcomm Incorporated
R1-1608589	Details on collision handling for SRS switching	Huawei, HiSilicon
R1-1609031	SRS Collisions due to Carrier Switching	Samsung
R1-1609474	Collision handling for SRS CC-based switching	Intel Corporation
R1-1609686	General principles for handling interruptions with SRS carrier based switching	Ericsson
R1-1609687	PUCCH in SRS carrier switching	Ericsson
R1-1609688	PUSCH in SRS carrier switching	Ericsson
R1-1609689	SRS switching within the Special subframe	Ericsson

7.2.5.4 Other

Including details for SRS from each of the multiple antennas with carrier switching

R1-1609032	SRS Switching for UE with Multiple Antennas	Samsung
R1-1609986	Support of multiple antennas for SRS switching	Qualcomm Incorporated
R1-1608590	Details on SRS switching for UEs with multiple antennas	Huawei, HiSilicon
R1-1608739	On SRS carrier switching with antenna switching	CATT

7.2.6 Further Indoor Positioning enhancements for UTRA and LTE - *WID in RP-161850*

[R1-1610869](#) Chairman's notes of AI 7.2.6 on Further Indoor Positioning enhancements for UTRA and LTE Ad-Hoc chair (Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Discussion:

Decision: The document is endorsed and content incorporated below.

7.2.6.1 Remaining issues for OTDOA enhancements

R1-1609475	CRS Usage together with PRS	Intel Corporation
R1-1609987	Introduction of UE inter-frequency RSTD calibration accuracy reporting	Qualcomm Incorporated
R1-1610215	RSTD Reporting Enhancement in OTDOA	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610383	Multipath RSTD reporting per cell for enhanced indoor positioning	Ericsson, Nokia
R1-1610384	On combining of CRS and PRS for enhanced indoor positioning	Ericsson
R1-1610909	WF on Multipath RSTD	Ericsson, Nokia, Qualcomm, Acorn Technology

Agreements:

- RAN1 decides to prioritize the following for the OTDOA enhancement
 - Support Multipath RSTD reporting by UE to E-SMLC
 - Multipath RSTD includes relative timing difference information of up to two additional peaks (i.e., 0, 1 or 2) relative the reference peak for each cell (reference or neighbor).
 - The reference peak of a cell (reference and neighbor) is the peak used for the current RSTD reporting determined by the UE to be the most likely.
 - Based on a maximum relative timing difference of 4 μ s and a resolution of 0.5Ts, each relative timing difference is represented by an integer in the range [-256...255].
 - TOA reporting and optional uncertainty reporting from UE should be explicitly defined in the LS
 - Note: there will not be new measurement definition intended for 36.214
 - Send LS to RAN2 and cc RAN3 RAN4.

[R1-1610527](#) Way forward on CRS usage together with PRS Intel Corporation, Acorn Technologies, Huawei, HiSilicon, Sony

Agreements:

- Support the use of CRS together with PRS for OTDOA enhancement
 - If CRS usage together with PRS is configured,
 - Signal CP information for CRS if PRS is present.
 - Note: this CP information signaling is additional one to the existing CP signaling for PRS.
 - Quasi-collocation between PRS and CRS is assumed.
 - FFS signaling of CRS presence (e.g., due to MBSFN subframes)
 - Send the LS for the above to RAN2 and cc RAN3 RAN4 to be captured for their works.

[R1-1610972](#) [DRAFT] LS on Multipath RSTD reporting and CRS usage together with PRS Ericsson, Intel

Agreed in [R1-1610527](#)

7.2.6.2 PRS-based beacons

[R1-1609988](#) Draft CR 36.211: Additional PRS configuration indices for PRS-based Terrestrial Beacon Systems Qualcomm Incorporated

[R1-1609989](#) Draft CR 36.213: Introduction of PRS-only transmission points for PRS-based Terrestrial Beacon Systems
Qualcomm Incorporated

[R1-1609990](#) PRS CP length in MBSFN subframes Qualcomm Incorporated

[R1-1610216](#) Discussion of PRS-Based Beacon for Indoor Positioning Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610385](#) PRS patterns for PRS-based TBS for enhanced indoor positioning Ericsson

[R1-1610928](#) WF on PRS-Based RSRP/RSRQ Measurement and Reporting for PRS-Based Beacon Nokia, Alcatel-Lucent
Shanghai Bell

Proposals:

- Support PRS-based RSRP/RSRQ measurement and reporting
 - Interface/protocol
 - **FFS Alt. 1: PRS-based RSRP/RSRQ measurement configuration and reporting by RRC signalling**
 - Alt. 2: PRS-based RSRP/RSRQ measurement configuration and reporting by LPP
 - Number of PRS-based beacons for RSRP/RSRQ measurement and reporting
 - Up to 9 PRS-based beacons per UE for RSRP/RSRQ
 - Value range
 - The value range of PRS-based RSRP: INTEGER (0...97) [Same as RSRP value range in LPP]
 - The value range of PRS-based RSRQ: INTEGER (0...34) [Same as RSRQ value range in LPP]
 - Reporting Mode
 - Alt. 1: Periodic: 120ms, 240ms, 480ms, 640ms, 1024ms, 2048ms, 5120ms, 10240ms, 1min, 6min, 12min, 30min, 60min [Same as E-CID measurement periodicity in LPP]
 - Alt. 2: Aperiodic
 - Alt. 3: Event triggered, for example PRS resource becomes better than absolute threshold

Further discussion until next meeting, especially in relation to an alternative proposal to use CSI-RS for RSRP/RSRQ measurement and reporting in E-CID enhancements

7.2.6.3 E-CID enhancements

[R1-1609351](#) Further discussion on the same PCI case for E-CID enhancements Huawei, HiSilicon

[R1-1609352](#) Further discussion on the UE Rx-Tx measurement over multiple serving cells Huawei, HiSilicon

[R1-1610386](#) On CSI-RSRP reporting support to E-SMLC for enhanced indoor positioning Ericsson

7.2.6.4 Other

[R1-1610387](#) Defining indoor/outdoor classification for enhanced indoor positioning Ericsson

7.2.7 Uplink Capacity Enhancements for LTE - WID in RP-160664

Specification of PUSCH in special subframe, with focus on the design of HARQ timing, TBS determination, UL DM-RS, TTI bundling, related signalling and procedure

[R1-1610870](#) **Chairman's notes of AI 7.2.7 on Uplink Capacity Enhancements for LTE** Ad-Hoc chair (Ericsson)
The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

[R1-1608607](#) Further Discussion on Scheduling and HARQ Timing for PUSCH on UpPTS Huawei, HiSilicon

[R1-1608740](#) Remaining issues for PUSCH support in UpPTS CATT

[R1-1609991](#) PUSCH in UpPTS Qualcomm Incorporated

[R1-1609297](#) Discussion on HARQ timing design for PUSCH in UpPTS CMCC

[R1-1609883](#) HARQ timing for PUSCH transmission in special subframe Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608608](#) Transmission of PUSCH on UpPTS Huawei, HiSilicon

[R1-1609295](#) Discussion on TBS scaling design for PUSCH in UpPTS CMCC

[R1-1609296](#) Discussion on TTI bundling for PUSCH in UpPTS CMCC

[R1-1609354](#) Discussion on UCI in PUSCH on UpPTS Huawei, HiSilicon

[R1-1609294](#) Discussion on DMRS design for PUSCH in UpPTS CMCC

[R1-1609884](#) HARQ timing for TTI bundling for PUSCH transmission in special subframe Nokia, Alcatel-Lucent
Shanghai Bell

[R1-1610695](#) WF on HARQ timing for PUSCH in UpPTS CMCC

[R1-1610696](#) WF on DMRS for PUSCH in UpPTS CMCC

Agreement:

- For TDD UL/DL configuration 1~5

- Support adaptive HARQ transmission, and specify the timing from PUSCH to PUSCH retransmission grant according to the following table

TDD DL/UL config.	UL subframe index n									
	0	1	2	3	4	5	6	7	8	9
1		4	4	6			4	4	6	
2		5	6				5	6		
3		6	6	6	6					
4		6	6	6						
5		6	6							

- Support non-adaptive HARQ transmission
FFS the timing from PUSCH to its ACK/NACK feedback in PHICH

Agreement:

- For TDD UL/DL configuration 6, support the following timing design from UL grant to PUSCH
 - Introduce two bits for UL index field in DCI for UL grant in UE specific search space
 - The UL index is interpreted as
 - When MSB=1 and LSB=0: UE shall upon detection of a PDCCH with DCI format 0/4 in subframe n intended for the UE, adjust the corresponding PUSCH transmission in subframe n+k, with the value of k in the following table
 - When MSB=0 and LSB=1: UE shall adjust the corresponding PUSCH transmission in subframe n+6
 - When MSB=1 and LSB=1: UE shall adjust the corresponding PUSCH transmission in both subframes n+k and n+6, with the value of k in the following table

TDD UL/DL Config	DL subframe index n									
	0	1	2	3	4	5	6	7	8	9
6	7	7				7	7			5

Agreement:

- For TDD UL/DL configuration 0 and 6
 - Support both adaptive and non-adaptive HARQ transmission, and specify the timing from PUSCH to its ACK/NACK feedback in PHICH or UL grant for retransmission according to the following table

TDD UL/DL Config	subframe index n									
	0	1	2	3	4	5	6	7	8	9
0		5	4	7	6		5	4	7	6
6		4	4	6	6		4	4	7	

Agreement:

- DMRS for PUSCH in UpPTS is transmitted in the UpPTS
 - **Working assumption:** DMRS is transmitted in the symbol index $l=3$ for normal CP, and the symbol index $l=2$ for extended CP
 - FFS: Support additionally the following alternative by RRC configuration for DMRS transmission for PUSCH in UpPTS:
 - DMRS for PUSCH in UpPTS is transmitted in the following UL subframe, and reuse the legacy DMRS pattern in normal UL subframe

Working assumption:

- For TDD UL/DL configuration 0
 - Support the following for timing from UL grant to PUSCH
 - Change the interpretation of UL index field

- 1)MSB=1, LSB=0: UE shall upon detection of a PDCCH with DCI format 0 in subframe n intended for the UE, adjust the corresponding PUSCH transmission in subframe n+k, with k given in the following table.
- 2)MSB=0, LSB=1: UE shall adjust the corresponding PUSCH transmission in subframe n+7
- 3)MSB=1, LSB=1: UE shall adjust the corresponding PUSCH transmission in both subframes n+ k and n+7, with k in the following table

TDD UL/DL Config	DL subframe index n									
	0	1	2	3	4	5	6	7	8	9
0	4	5				4	5			

7.2.8 Further Enhanced MTC for LTE - *WID in RP-161464*

[R1-1610871](#) Chairman's notes of AI 7.2.8 on Further Enhanced MTC for LTE Ad-Hoc chair (Nokia, Ericsson)

The document was presented by Johan Bergman from Ericsson.

Discussion:

Decision: The document is endorsed and content incorporated below.

7.2.8.1 Higher data rates

Contributions relevant for more than one sub-topic (e.g. joint DCI design) are submitted to this agenda item

[R1-1608623](#) Considerations on the control channel of supporting wider bandwidth in FeMTC Huawei, HiSilicon

[R1-1608624](#) DCI design on supporting wider bandwidth in FeMTC Huawei, HiSilicon

[R1-1609204](#) Fallback operation for FeMTC LG Electronics

[R1-1609397](#) Discussion on Higher Data Rate for Further eMTC Lenovo

[R1-1609476](#) Overall DCI design options for higher data rates for FeMTC Intel Corporation

[R1-1610661](#) **WF on DCI for higher data rates in FeMTC** Ericsson, Qualcomm, Sony, NTT DoCoMo, Intel, Kyocera, KT Corp., Sierra Wireless

Agreement:

- FeMTC UEs use Rel-13 DCI formats for MPDCCH Type-0/1/2 CSS transmissions.

Proposal:

- FeMTC UEs use Rel-13 or Rel-14 DCI formats for MPDCCH USS transmissions.
 - It is FFS whether the Rel-14 DCI formats are backwards compatible with the same size as the Rel-13 DCI formats or whether they can have a different size.

[R1-1610630](#) **WF on RRC reconfiguration for FeMTC features** Qualcomm, Ericsson, Sony, Sequans, DOCOMO, Virtuosys, Sierra Wireless, Kyocera

Also supported by Intel and ZTE and Nokia.

Agreement:

- The following FeMTC features:
 1. HARQ-ACK bundling
 2. Larger maximum TBS for 1.4MHz operation
 3. Larger maximum TBS for 5MHz operation
 4. Support of larger bandwidth
 5. 10 HARQ processes for downlink

are enabled as follows:

- The UE reports capability to support a given feature
 - FFS: The eNB enables the larger bandwidth and larger TBS by RRC reconfiguration
 - The eNB enables the other features by RRC reconfiguration
- FFS: dependency between different features
 - E.g. a UE that supports 5MHz operation shall support larger maximum TBS.

[R1-1609156](#) Retuning Symbols for FeMTC in Rel-14 NEC

[R1-1610662](#) **WF on retuning symbols in FeMTC**

Ericsson, NEC, Sequans, Sierra Wireless

Agreement:

- Rel-14 UE supporting CE mode A and/or B can indicate how many narrowband retuning symbols it needs.
 - Range: {0, 1, 2} symbols
 - Default value: 2 symbols
- FFS: If the UE indicates it needs 1 symbol for retuning, then:
 - When retuning between two PUSCH narrowbands, the guard period is the last SC-FDMA symbol in the previous UL subframe
 - When retuning between two PUCCH narrowbands, the guard period is the last SC-FDMA symbol in the previous UL subframe
 - When retuning from a PUSCH narrowband to a PUCCH narrowband, the guard period is the last SC-FDMA symbol in the previous UL subframe
 - When retuning from a PUCCH narrowband to a PUSCH narrowband, the guard period is the first SC-FDMA symbol in the next UL subframe
- It is up to eNB whether and how to take the UE capability into account.

7.2.8.1.1 Larger max PDSCH/PUSCH TBS

[R1-1608626](#) On supporting larger TBS for UEs with maximum 1.4 MHz bandwidth in TDD/HD-FDD Huawei, HiSilicon

[R1-1608627](#) On supporting larger TBS for UEs with larger bandwidth Huawei, HiSilicon

[R1-1608890](#) Maximum TBS for FeMTC Nokia, Alcatel-Lucent Shanghai Bell

[R1-1609477](#) Support of larger max TBS for DL and UL Intel Corporation

[R1-1609992](#) Support of higher data rates Qualcomm Incorporated

[R1-1610388](#) Larger max TBS for MTC Ericsson

[R1-1610407](#) Design for larger maximum TBS Kyocera Corporation

[R1-1610663](#) **WF on TBS for FeMTC Ericsson, Qualcomm, Sony**

Agreement:

- Supported modulation schemes for Rel-14 BL/CE UEs:
 - PDSCH: QPSK, 16QAM
 - PUSCH: QPSK, 16QAM

Agreement:

- Max TBS for 5-MHz Rel-14 BL/CE UEs:
 - PDSCH: 4008 bits
 - PUSCH: 4008 bits

Agreement:

- Soft buffer size for 5-MHz Rel-14 BL UEs:
 - Option 1: $N \cdot 96 \cdot \lceil (X+28)/32 \rceil$ where N = max number of DL HARQ processes and X = max DL TBS
 - Option 2: a smaller value than in Option 1
- Option 2 is agreed
 - Details are FFS

Agreement:

- Max UL TBS in CE mode A for 1.4-MHz Rel-14 BL FD-FDD UE:
 - Option A: 1000 bits (same as Rel-13 Cat-M1)
 - Option B: 2984 bits (same as 1.4-MHz FeMTC TDD/HD-FDD UE)
- Option B is agreed

[R1-1610817](#) **WF on TBS indication for 1.4 MHz feMTC UEs Huawei, HiSilicon, Qualcomm**

Agreement:

- TBS for 1.4-MHz UE in CE mode A is indicated by using the existing TBS table
 - Introduce UE capability signaling for the larger TBS
 - The use of larger TBS is RRC configured by eNB

[R1-1610861](#) **WF on TBS indication for 1.4 MHz feMTC UEs Huawei, HiSilicon, Nokia, Qualcomm, Sierra Wireless**

Agreement: The tables in [R1-1610861](#) are agreed.

7.2.8.1.2 Larger max PDSCH/PUSCH channel bandwidth

[R1-1608622](#) On enabling and disabling of wider bandwidth in FeMTC Huawei, HiSilicon

[R1-1608625](#) On supporting larger channel bandwidth for Rel-14 non-BL UEs in CE mode A Huawei, HiSilicon
[R1-1608891](#) Consideration on supporting larger channel bandwidth for FeMTC Nokia, Alcatel-Lucent Shanghai Bell
[R1-1608937](#) Resource Allocation in wide bandwidth FeMTC Sony
[R1-1609154](#) Larger maximum PDSCH/PUSCH channel bandwidth in CE mode A NEC
[R1-1609205](#) Larger channel bandwidth for FeMTC LG Electronics
[R1-1609478](#) Support of larger max channel bandwidth for PDSCH/PUSCH Intel Corporation
[R1-1609828](#) Discussion on support of larger PDSCH/PUSCH bandwidth for MTC ZTE
[R1-1609829](#) Resource allocation for larger PDSCH/PUSCH bandwidth for MTC ZTE
[R1-1609993](#) Support of larger data channel bandwidth Qualcomm Incorporated
[R1-1610389](#) Larger max channel bandwidth for MTC Ericsson
[R1-1610406](#) Design for larger max PDSCH/PUSCH channel bandwidth Kyocera Corporation

[R1-1610650](#) WF on support of larger PDSCH/PUSCH channel bandwidth for MTC ZTE, ZTE Microelectronics

Agreement:

- Rel-14 non-BL UE can support CE mode A in connected mode with a maximum PDSCH/PUSCH channel bandwidth of either 5 or 20 MHz.
 - Rel-14 capability signaling is introduced to differentiate non-BL UEs with respect to maximum UE channel BW support in CE.
- Rel-14 non-BL UE may also support Rel-13 CE mode A and CE mode B.
- A Rel-14 non-BL UE supporting CE mode A operation with 20-MHz maximum PDSCH/PUSCH channel bandwidth also supports CE mode A operation with 5-MHz maximum channel bandwidth.
- Strive for commonality in the DCI design for the 5-MHz and 20-MHz cases without introducing unnecessary overhead for the 5-MHz case.
- FFS whether to support frequency hopping for PDSCH/PUSCH channel bandwidths >5 MHz

[R1-1610684](#) WF on supporting larger channel bandwidth for Rel-14 non-BL UEs Huawei, HiSilicon,

Qualcomm

Agreement:

- The larger maximum UE channel BW for PDSCH is supported for both CE mode A and CE mode B.
- The larger maximum UE channel BW for PUSCH is not supported for CE mode B.
- For the 5-MHz BL UE,
 - The maximum reception bandwidth is 25 PRBs.
 - The maximum allocatable PDSCH channel bandwidth is [FFS between 24 or 25] PRBs.
 - The maximum transmission bandwidth is 25 PRBs.
 - The maximum allocatable PUSCH channel bandwidth is [FFS between 24 or 25] PRBs.

7.2.8.1.3 HARQ-ACK bundling in HD-FDD

[R1-1608630](#) HARQ-ACK bundling in HD-FDD Huawei, HiSilicon
[R1-1608797](#) Design of HARQ-ACK bundling for HD-FDD Sequans Communications
[R1-1608892](#) ACK/NACK Bundling in FeMTC Nokia, Alcatel-Lucent Shanghai Bell
[R1-1608938](#) Considerations on HARQ-ACK Bundling in HD-FDD Sony
[R1-1609155](#) Different Options for HARQ-ACK bundling in CE mode A for HD-FDD NEC
[R1-1609819](#) Ack Bundling Design Considerations Sierra Wireless, S.A.
[R1-1609830](#) Support of HARQ-ACK bundling for MTC ZTE
[R1-1609994](#) Support of HARQ-ACK bundling in HD-FDD Qualcomm Incorporated
[R1-1610025](#) HARQ bundling design for HD-FDD in Rel-14 MTC NTT DOCOMO, INC.
[R1-1610390](#) HARQ-ACK bundling for MTC Ericsson

[R1-1610651](#) WF on HARQ bundling in HD-FDD for MTC ZTE, ZTE Microelectronics, Sony, Lenovo, NTT Docomo, Sierra Wireless, Sequans

Also supported by Qualcomm

Agreement:

- HARQ-ACK bundling is supported in CE Mode A in HD-FDD.
- HARQ-ACK bundling is not supported in CE Mode B.
- FFS whether HARQ-ACK bundling is supported in CE Mode A in FD-FDD.
- FFS whether HARQ-ACK bundling is supported for PUCCH repetition case.
- FFS whether HARQ-ACK bundling is supported for PDSCH repetition case.
- FFS whether HARQ-ACK bundling is supported for MPDCCH repetition case.

[R1-1610824](#) WF on bundle size and bundle number in HD-FDD for MTC ZTE, ZTE Microelectronics, Sierra Wireless, Ericsson, Lenovo, Sony

Agreement:

- One or multiple HARQ-ACK bundles can be supported for PDSCH scheduling before switching to UL.
 - HARQ-ACK bundle size is defined as the number of PDSCH transmissions (corresponding to different HARQ processes) with a joint HARQ-ACK feedback.
 - The maximum HARQ-ACK bundle size is 4.
 - FFS: maximum number of HARQ-ACK bundles before switching to UL

7.2.8.1.4 Number of DL processes in FD-FDD

R1-1608629	Analysis on increasing DL HARQ processes in CE mode A for FD-FDD	Huawei, HiSilicon
R1-1608798	On supporting 10 DL HARQ processes	Sequans Communications
R1-1608893	Increasing the number of HARQ processes in FeMTC	Nokia, Alcatel-Lucent Shanghai Bell
R1-1608939	Considerations on HARQ Processes in FD-FDD	Sony
R1-1609831	Discussion on Number of DL processes in FD-FDD for MTC	ZTE
R1-1610026	Indication of up to 10 HARQ process number for FD-FDD in Rel-14 MTC	NTT DOCOMO, INC.
R1-1610391	Number of DL HARQ processes for MTC	Ericsson

[R1-1610670](#) WF on supporting 10 HARQ processes Sequans, Intel, Sony, Ericsson

Also supported by Sierra Wireless and Qualcomm

Agreement:

- For HD-FDD and FD-FDD,
 - Support for max 10 DL HARQ processes in CE mode A is introduced for Rel-14 BL UEs
 - A 1.4-MHz BL UE supporting max 10 DL HARQ processes has the same required soft buffer size as Rel-13 Cat-M1 UE

7.2.8.2 Multicast support

R1-1608628	Consideration on SC-PTM transmission for FeMTC	Huawei, HiSilicon
R1-1608894	SPS Design Considerations	Nokia, Alcatel-Lucent Shanghai Bell
R1-1608895	SC-PTM Search Space Considerations	Nokia, Alcatel-Lucent Shanghai Bell
R1-1608940	Multicast Support for feMTC	Sony
R1-1609206	Multicast support for FeMTC	LG Electronics
R1-1609358	Control channel design on supporting SC-PTM in FeMTC	Huawei, HiSilicon
R1-1609479	SC-PTM for FeMTC	Intel Corporation
R1-1609606	on supporting multicast with large TBS	Sequans Communications
R1-1609832	Discussion on multicast support for MTC	ZTE
R1-1609867	Further discussion on the change notification of SC-PTM for FeMTC	Sharp
R1-1609995	Support of multicast	Qualcomm Incorporated
R1-1610392	Collision handling for multicast support for MTC	Ericsson
R1-1610393	L1 configuration for multicast support for MTC	Ericsson

[R1-1610820](#) WF on FeMTC SC-PTM scheduling Ericsson, ITL, Nokia, ASB

Agreement:

- Max channel bandwidth and max TBS for **SC-MTCH** PDSCH transmission to BL/CE UEs:
 - **Option 1:** According to Rel-13 Cat-M1 limitations (i.e. 6 PRBs and 1000 bits)
 - **Option 2:** Configurable per SC-MTCH (with minimum maximum values of 6 PRBs and 1000 bits)
- Max channel bandwidth and max TBS for **SC-MCCH** PDSCH transmission to BL/CE UEs:
 - **Option A:** According to Rel-13 Cat-M1 limitations (i.e. 6 PRBs and 1000 bits)
 - **Option B:** Configurable per SC-MCCH (with minimum maximum values of 6 PRBs and 1000 bits)
- From physical layer point of view,
 - All four options are feasible.
 - Option 2 may have performance benefits over Option 1.
- Ask RAN2 to confirm feasibility and usefulness from higher layer point of view.

Agreement:

- The maximum number of on-going SC-MTCHs supported by SC-MCCH is reduced compared to LTE.
- Send LS to RAN2 to
 - Inform RAN2 that RAN1 assumes the maximum number of on-going SC-MTCHs supported by SC-MCCH is reduced compared to LTE
 - Request RAN2 to inform RAN1 of the maximum number of on-going SC-MTCHs supported by SC-MCCH in FeMTC.
 - Request RAN2 to inform RAN1 whether and how segmentation of SC-MCCH will be supported in Rel-14.
- For the search space scheduling SC-MCCH
 - UE monitoring of blind decoding candidates is based on FFS: Type1-CSS or Type2-CSS for MPDCCH
 - Rmax, and G values are configured per SC-MCCH by higher layers

- FFS the configuration of other parameters, e.g., narrowband.

Cover FeMTC and NB-IoT in the same LS to RAN2 (Huawei)

[R1-1610666](#) **WF on FeMTC SC-MTCH transmission** Ericsson, Nokia, ASB

Agreement:

- Frequency hopping is supported in multicast to BL/CE UEs at least for max PDSCH channel bandwidth of 6 PRBs.
 - FFS whether the frequency hopping is controlled by the same SIB parameters as other DL transmissions or by separate SIB parameters and/or DCI

Proposal:

- The possibility of combining of multicast transmissions of the same UDP/IP packet can be studied till the next meeting.

[R1-1610665](#) WF on FeMTC multicast collision handling Ericsson

[R1-1610706](#) WF on DCI for SC-PTM Huawei, ...

[R1-1610707](#) WF on SC-PTM configuration and scheduling Huawei, ...

7.2.8.3 OTDOA enhancements

Consider improvements of accuracy, UE complexity and power consumption

[R1-1608896](#) **OTDOA enhancements for FeMTC** Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608950](#) OTDoA enhancements for feMTC Sony

[R1-1609359](#) Discussion on the OTDOA enhancements for FeMTC Huawei, HiSilicon

[R1-1609370](#) Evaluations of feMTC OTDOA Huawei, HiSilicon

[R1-1609839](#) Discussion on OTDOA support for eMTC ZTE

[R1-1609996](#) OTDOA enhancements Qualcomm Incorporated

[R1-1610394](#) OTDOA enhancements for MTC Ericsson

[R1-1610934](#) **WF on OTDOA for feMTC** ZTE , ZTE Microelectronics, Ericsson, Qualcomm

Agreement:

- For Rel-14 feMTC OTDOA positioning reference signal, enhancements to the legacy LTE PRS patterns and sequences can be considered but need to be justified by significant performance improvement compared to legacy
 - Strive for the possibility for the legacy PRS REs to overlap with the Rel-14 PRS REs
- Rel-14 PRS configuration includes
 - All legacy parameters, i.e., bandwidth, periodicity, subframe offset, number of consecutive subframes, etc.
 - FFS transmission in invalid subframes
 - Sets of values of the parameters are FFS
 - Determination of frequency location remains FFS
 - Details of Rel-14 PRS configuration parameter settings are FFS
 - Details of Rel-14 PRS muting pattern are FFS
 - FFS how many Rel-14 PRS configurations are needed per cell
 - FFS how many Rel-14 PRS configurations are needed per UE
- RSTD measurement of PRS in different sets of PRBs in the frequency domain is supported
 - FFS details

[R1-1610621](#) **WF on PRS Frequency Hopping for OTDOA** Sony, ZTE, Ericsson, Virtuosys

Agreement:

- Frequency hopping of PRS in OTDOA is supported.
 - Configurations and details are FFS

7.2.8.4 VoLTE enhancements

Increase VoLTE coverage for half-duplex FDD/TDD through techniques to reduce DL repetitions, new repetition factors, and adjusted scheduling delays

[R1-1608655](#) SRS enhancement to supporting higher data rates Huawei, HiSilicon

[R1-1608799](#) VoLTE coverage enhancements Sequans Communications

[R1-1608897](#) VoLTE performance for Cat-M1 UE Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608898](#) VoLTE enhancements for FeMTC Nokia, Alcatel-Lucent Shanghai Bell

[R1-1609369](#) On half duplex enhancements for VoLTE Huawei, HiSilicon

[R1-1609480](#) VoLTE enhancements for HD-FDD and TDD UEs Intel Corporation

[R1-1609997](#) VoLTE enhancements for eMTC Qualcomm Incorporated

[R1-1610395](#) VoLTE enhancements for CE mode A Ericsson

[R1-1610922](#) WF on FeMTC eVoLTE Huawei, HiSilicon, Ericsson, Qualcomm, Sequans

Agreement:

- RAN1 design will assume delay budget relaxation for UL voice packets

- Prioritize consideration of the following in VoLTE enhancements in FeMTC for BL/CE UE considering overall system impacts:
 - New number(s) of repetitions for PUSCH
 - Adjusted scheduling relationships between physical channels
 - SRS coverage enhancement
 - Discontinuous PUSCH transmission
- SPS and non-SPS cases should both be considered
- Ask RAN2+RAN4: What can be assumed regarding need for intra- and inter-frequency measurement gaps, in synchronized and non-synchronized networks
- Ask RAN2: For feedback on what delay budget relaxation can be assumed

Provide LS to RAN2 and RAN4 (Matthew, Huawei)

Friday

[R1-1611017](#) [DRAFT]LS on FeMTC VoLTE enhancements Huawei

Decision: The document is noted and final LS agreed in [R1-1611053](#)

7.2.8.5 Other

[R1-1609998](#) Paging channel enhancements Qualcomm Incorporated

[R1-1609999](#) Power consumption reduction techniques for eMTC Qualcomm Incorporated

7.2.9 Enhancements of NB-IoT - WID in RP-161901.

The objectives apply to the in-band, guard-band, and standalone operation modes and the same coverage enhancement targets as defined in the Rel-13 NB-IoT work item.

[R1-1610872](#) Chairman's notes of AI 7.2.9 on Enhancements of NB-IoT Ad-Hoc chair (Huawei)

The document was presented by Matthew Webb from Huawei.

Discussion:

Decision: The document is endorsed and content incorporated below.

7.2.9.1 Positioning

7.2.9.1.1 Design of narrowband OTDOA positioning

Re-use of existing signals

[R1-1608617](#) On reusing existing downlink signals for NB-IoT downlink positioning Huawei, HiSilicon

[R1-1608881](#) Existing Downlink Signals for OTDOA Positioning in NB-IoT Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608698](#) OTDOA performance for NB-IoT Ericsson

Agreement:

- Introduce a new positioning reference signal for OTDOA in NB-IoT
 - Not based on existing Rel-13 NB-IoT signal and not based on LTE CRS.

[R1-1610346](#) On the use of existing NB-IoT signals for OTDOA Ericsson

New designs for NPRS

[R1-1608618](#) Design of new downlink positioning reference signal for NB-IoT Huawei, HiSilicon

[R1-1610000](#) Downlink-based narrowband positioning Qualcomm Incorporated

Configurations

[R1-1608619](#) Configuration of downlink positioning reference signal for NB-IoT Huawei, HiSilicon

[R1-1608882](#) NPRS Design for OTDOA Positioning in NB-IoT Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608697](#) OTDOA design for NB-IoT Ericsson

[R1-1609207](#) OTDOA design for eNB-IoT LG Electronics

Working assumptions:

- NB-IoT positioning reference signal resource pattern in one subframe is at least LTE PRS in 1 PRB
 - FFS: With additional REs in guard-band and standalone operation modes
 - FFS: Increased density per cell according to coverage
 - NB-IoT PRS do not occur in a subframe containing
 - NPDCCH
 - NPDSCH
 - NPBCH

- NPSS/NSSS

[R1-1609835](#) OTDOA positioning for NB-IoT ZTE
[R1-1610221](#) Support of OTDOA in NB-IoT Innovative Technology Lab Co.

[R1-1609377](#) RSTD measurement and reporting in NB-IoT Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608699](#) A new system simulator for NB-IoT positioning Ericsson

[R1-1610639](#) WF on configurations of time resources for NPRS Huawei, HiSilicon

Agreement:

- The subframes which contain NPRS are configured by higher-layers
 - Per NB-IoT carrier, it is possible to configure the subframes used NPRS transmission such that NPRS do not occur in subframes containing transmissions to Rel-13 UEs in the cell of:
 - NPDCCH
 - NPDSCH
 - NPBCH
 - NPSS/NSSS

Agreement:

- Configuration of time resources for NPRS
 - Indication of exact subframes is by
 - Alt. 4:
 - Part A: A bitmap on subframes which are not NB-IoT DL subframes (i.e. invalid DL subframes)
 - Alt. 4.A1: Bitmap is a fixed length of 10 bits
 - Alt. 4.A2: Bitmap is a the same length as valid subframe configuration, i.e. 10 bits or 40 bits
 - Alt. 4.A3: Bitmap is a fixed length of x bits (e.g., $x = 20$)
 - FFS which until RAN1#87
 - Part B: Indicated with one start subframe, one periodicity, and one number of repetitions for the occasions
 - On an anchor carrier, Part A and/or Part B
 - On a non-anchor carrier, Part A and/or Part B

Agreement:

- Indication of NPRS muting patterns is
 - Alt. 2: Indicated with a periodic NPRS muting sequence
 - Details are FFS

[R1-1610640](#) WF on configuration of NPRS transmission on multiple NB-IoT carriers Huawei, HiSilicon

[R1-1610641](#) WF on configuration of NPRS power for NB-IoT downlink positioning Huawei, HiSilicon

• Send LS to RAN4

- Referencing the 36.104 section on PSD boosting
- Include the working assumption on NPRS resource pattern
- Asking if PSD boosting of REs used in NPRS relative to NRS can be supported, for in-band, guard-band and standalone operation, and for anchor and non-anchor carriers where NRS are transmitted.
 - Note that it is FFS in RAN1 if NRS is present on a non-anchor carrier on which NPRS are transmitted
- Asking if PSD boosting of REs used in NPRS relative to anchor carrier NRS can be supported, for in-band, guard-band and standalone operation, and for non-anchor carriers where NRS are not transmitted.
- Asking what is an appropriate limit and granularity of PSD boosting in the above cases.

[R1-1611006](#) **[DRAFT]**LS on on configuration of NPRS power for NB-IoT downlink positioning
The LS is **endorsed**, with “respectively” replaced by “respectfully”. Final LS in [R1-1611032](#)

7.2.9.1.2 Evaluation of narrowband OTDOA positioning

[R1-1608620](#) Evaluation of downlink positioning accuracy for NB-IoT Huawei, HiSilicon

[R1-1610381](#) On OTDOA Positioning for NB-IOT Fraunhofer IIS

[R1-1608621](#) Analysis of power consumption and complexity for NB-IoT downlink positioning Huawei, HiSilicon

7.2.9.1.3 Evaluation of narrowband UTDOA positioning using an existing NB-IoT transmission

R1-1608647	On reusing existing uplink signals for NB-IoT uplink positioning	Huawei, HiSilicon
R1-1609836	UTDOA positioning for NB-IoT	ZTE
R1-1608880	UTDOA positioning in NB-IoT	Nokia, Alcatel-Lucent Shanghai Bell
R1-1608700	On modelling of NPRACH based UTDOA performance	Ericsson
R1-1608701	On NPRACH based UTDOA impact on NB-IOT performance	Ericsson
R1-1608702	On NPRACH based UTDOA capacity	Ericsson
R1-1610001	Uplink-based narrowband positioning	Qualcomm Incorporated
R1-1610905	WF on positioning reference signal design for NB-IoT UTDOA	ZTE , ZTE Microelectronics

Conclusions:

- Rel-13 NPRACH preamble is the best candidate and can be used as a signal for NB-IoT UTDOA in some scenarios.
 - Whether it is feasible in a given network deployment depends on issues including network coordination, interference handling, power control, in-band emissions, capacity impacts, etc.
 - Companies are encouraged to identify in RAN1#87 scenarios where it is and is not feasible.

7.2.9.2 Multicast support

Extend Rel-13 SC-PTM to support multicast downlink transmission

SC-MCCH

R1-1608884	SC-MCCH transmission for NB-IoT	Nokia, Alcatel-Lucent Shanghai Bell
R1-1608612	Discussion on configuration of SC-MTCH in NB-IoT	Huawei, HiSilicon
R1-1608703	L1 configuration for multicast support for NB-IoT	Ericsson
R1-1610002	Support of multicast	Qualcomm Incorporated

[R1-1610643](#) WF on SC-MCCH transmission for NB-IoT SC-PTM Huawei, HiSilicon
Also supported by ITL

Agreements:

- The maximum number of on-going SC-MTCHs supported by SC-MCCH is reduced compared to LTE.
- Send LS to RAN2 to
 - Inform RAN2 that RAN1 assumes the maximum number of on-going SC-MTCHs supported by SC-MCCH is reduced compared to LTE
 - Request RAN2 to inform RAN1 of the maximum number of on-going SC-MTCHs supported by SC-MCCH in NB-IoT.
 - Also include the larger maximum TBS value (if agreed this week)
 - Request RAN2 to inform RAN1 whether and how segmentation of SC-MCCH will be supported in Rel-14.

[R1-1610969](#) **[DRAFT]**LS on SC-MCCH transmission in NB-IoT

The LS is **endorsed**, with the following update. Final LS is in [R1-1610033](#)

- ~~{~~The larger maximum TBS value in downlink in Rel-14 is **1352 bits**~~}~~ for NB-IoT, and **4008 bits**~~}~~ for feMTC~~}~~

[R1-1610551](#) WF on NB IoT SC-PTM scheduling Ericsson

Agreements:

- Transmission of a given SC-MCCH is restricted to one NB-IoT carrier
- Transmission of a given SC-MTCH is restricted to one NB-IoT carrier

[R1-1610469](#) WF on SC-PTM configuration for eNB-IoT LG Electronics, ITL

[R1-1610027](#) Discussion on multicast support for Rel-14 NB-IoT NTT DOCOMO, INC.
[R1-1610222](#) On support of SC-PTM in NB-IoT Innovative Technology Lab Co., KT Corp.

SC-MTCH

R1-1608941	Multicast Support for eNB-IoT	Sony
R1-1608885	SC-MTCH transmission for NB-IoT	Nokia, Alcatel-Lucent Shanghai Bell

[R1-1608613](#) Discussion on SC-MTCH transmission in NB-IoT Huawei, HiSilicon

[R1-1610552](#) Draft WF on NB IoT SC-MTCH transmission Ericsson

[R1-1610642](#) WF on SC-MTCH transmission for NB-IoT SC-PTM Huawei, HiSilicon

Agreements:

- Different SC-MTCHs can be transmitted over different NB-IoT carriers, while one SC-MTCH is sent on one NB-IoT carrier

Search spaces and DCIs

[R1-1608614](#) Discussion on NPDCCH search space for multicast in NB-IoT Huawei, HiSilicon

[R1-1609833](#) Considerations on multicast support for NB-IoT ZTE

[R1-1608883](#) SC-PTM search space design for NB-IoT Nokia, Alcatel-Lucent Shanghai Bell

[R1-1609481](#) Multicast support for NB-IoT Intel Corporation

[R1-1609868](#) Further discussion on change notification of SC-PTM for NB-IoT Sharp

[R1-1610644](#) WF on search space design for SC-PTM in NB-IoT Huawei, HiSilicon

Agreements:

- For the search space scheduling SC-MCCH (called Type1-MSS for RAN1 purposes)
 - ✓ UE monitoring of blind decoding candidates is based on FFS: Type1-CSS or Type2-CSS
 - ✓ α , R_{max} , and G values for Type1-MSS are configured per SC-MCCH by higher layers

[R1-1610968](#) WF on search space for NB-IoT SC-PTM Huawei, HiSilicon, ZTE

Agreements:

- For the search space scheduling SC-MTCH (called Type2-MSS for RAN1 purposes)
 - UE monitoring of blind decoding candidates is based on FFS: Type1-CSS or Type2-CSS
 - α , R_{max} , and G values for Type2-MSS are configured per SC-MTCH in SC-MCCH
- UE is not required to simultaneously monitor Type1-MSS and Type2-MSS
- UE is not required to monitor Type2-MSS while receiving NPDSCH carrying SC-MTCH

Collision handling

[R1-1610019](#) Discussion on SC-PTM for NB-IoT MediaTek Inc.

[R1-1608615](#) Discussion on collision handling for multicast in NB-IoT Huawei, HiSilicon

[R1-1610347](#) NB-IoT Collision handling in Multicast Ericsson

[R1-1609208](#) Multicast support for eNB-IoT LG Electronics

Section 2

[R1-1609682](#) Considerations on SC-PTM in NB-IoT Beijing Xinwei Telecom Techn.

[R1-1610468](#) WF on collision issue on SC-PTM for eNB-IoT LG Electronics, ITL

[R1-1610553](#) WF on NB IoT multicast collision handling Ericsson

Agreement

- Prepare a LS to RAN2, RAN3, SA2
 - There may be cases where the UE cannot monitor NPDCCH search spaces and/or receive NPDSCH transmissions for both paging and SC-PTM simultaneously

[R1-1610970](#) **[DRAFT]**LS on collisions between SC-PTM and Paging in NB-IoT

The LS is **endorsed** with the following update. Final LS in [R1-1611034](#)

RAN1 respectfully ask RAN2, RAN3 and SA2 to take the above into consideration in their work. ~~that the reliability of SC-PTM would be impacted if SC-PTM transmissions are dropped when collision happens between SC-PTM and paging.~~

Other

[R1-1608616](#) Discussion on acknowledgement of SC-MTCH transmission in NB-IoT Huawei, HiSilicon

7.2.9.3 Non-anchor PRB enhancements

Transmission of paging on non-anchor PRBs

[R1-1608704](#) NB-IoT Paging on non-anchor PRBs Ericsson
[R1-1608705](#) NB-IoT Paging Capacity Ericsson
[R1-1608886](#) Random access on non-anchor PRB for NB-IoT Nokia, Alcatel-Lucent Shanghai Bell
[R1-1608887](#) Paging on non-anchor PRB for NB-IoT Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609209](#) Non-anchor PRB enhancements for eNB-IoT LG Electronics
[R1-1609289](#) Considerations on multiple anchor PRBs for NB-IoT Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609357](#) On non-anchor carrier paging Huawei, HiSilicon
[R1-1609482](#) Enhancements to paging on non-anchor PRBs Intel Corporation
[R1-1609838](#) Remaining issues on multiple PRB support for NB-IoT ZTE
[R1-1610003](#) Non-anchor PRB enhancements Qualcomm Incorporated
[R1-1610206](#) Paging Transmission on Non-Anchor PRB III

[R1-1610554](#) WF on the Presence of NRS on Non-anchor PRBs Ericsson, Nokia/Alcatel-Lucent Shanghai Bell
[R1-1610470](#) WF on paging PRB configuration for eNB-IoT LG Electronics

7.2.9.4 Power consumption and latency reduction

Support in DL and UL for 2 HARQ processes and larger maximum TBS

[R1-1608648](#) On 2 HARQ processes for enhancement of NB-IoT Huawei, HiSilicon
[R1-1610020](#) Discussion on two HARQ process MediaTek Inc.
[R1-1610430](#) Power consumption and latency reduction by increasing the maximum NPDSCH transport block sizes and using two HARQ Ericsson
Revision of [R1-1610348](#) Power consumption and latency reduction by increasing the maximum NPDSCH transport block sizes and using two HARQ Ericsson
[R1-1610431](#) Power consumption and latency reduction by increasing the maximum NPUSCH transport block size and using two HARQ Ericsson
Revision of [R1-1610349](#) Power consumption and latency reduction by increasing the maximum NPUSCH transport block size and using two HARQ Ericsson

[R1-1610645](#) WF on timing relationships of 2 HARQ processes for NB-IoT enhancement Huawei, HiSilicon

[R1-1610994](#) WF on timing relationships of 2 HARQ processes for NB-IoT enhancement Huawei, HiSilicon, Deutsche Telekom, Vodafone, China Unicom, IITH, CEWIT, IITM, Tejas Networks, Reliance Jio, Ericsson, ITL, Lenovo, Neul, Potevio, ublox, Sony
Also supported by: Intel

Friday

[R1-1611019](#) WF on timing relationship for 2 HARQ processes for Rel-14 NB-IoT MediaTek, Qualcomm, DoCoMo, AT&T, Softbank, ITRI, Sharp, MTI, APT, Xinwei, ZTE, ZTE Microelectronics, KDDI
Discussion: Concern from Intel/Huawei on the cost impact
Vodafone → support Huawei's view – would like to keep complexity level to the Rel-13 level
RAN1 chair: different views from other operators
MediaTek suggested having an email discussion how to evaluate the cost impact
Huawei: objection
MediaTek → can interested companies bring up analysis related to cost impact for both alternatives on the table ([R1-1610994](#) & [R1-1611019](#))? - Objective: cross compare the results between companies
Decision: Continue discussions about [R1-1610994](#) and [R1-1611019](#) until the next meeting.

[R1-1608888](#) Supporting 2 HARQ processes for NB-IoT Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609372](#) DCI formats for enhancement of NB-IoT Huawei, HiSilicon

[R1-1610004](#) Support of larger TBS and 2 HARQ processes Qualcomm Incorporated
[R1-1609483](#) Support of two DL and UL processes and larger max TBS values Intel Corporation

[R1-1610432](#) Power consumption and latency reduction by increasing the maximum NPDSCH transport block sizes Ericsson

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

Revision of [R1-1610398](#) Power consumption and latency reduction by increasing the maximum NPDSCH transport block sizes
Ericsson
[R1-1610433](#) Power consumption and latency reduction by increasing the maximum NPUSCH transport block size
Ericsson
[R1-1610399](#) Power consumption and latency reduction by increasing the maximum NPUSCH transport block size
Ericsson
[R1-1610021](#) Support of larger Max TBS MediaTek Inc.

Agreement:

- Maximum DL TBS is 1352 bits
- Maximum UL TBS is 1800 bits
- The same values of N_SF and N_RU and I_TBS are used as in Rel-13

Email discussion to agree TBS/N_SF and TBS/N_RU tables until Friday 21 October (Olof, Ericsson).

[R1-1608889](#) Larger maximum TBS for NB-IoT Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609371](#) On larger TBS for enhancement of NB-IoT Huawei, HiSilicon
[R1-1609834](#) Considerations on power consumption and latency reduction ZTE
Parts on larger TBS only

7.2.9.5 Other

[R1-1609210](#) Low power UE support for eNB-IoT LG Electronics
[R1-1609837](#) Discussion for aspects of supporting Low Power class UE for NB-IoT ZTE

7.2.10 Shortened TTI and processing time for LTE - WID in RP-161922.

[R1-1610873](#) Chairman's notes of AI 7.2.10 on Shortened TTI and processing time for LTE Ad-Hoc chair
(Ericsson)

The document was presented by Daniel Larsson from Ericsson.

Discussion:

Decision: The document is endorsed and content incorporated below.

Friday

[R1-1610584](#) [DRAFT] LS on Shortened TTI and processing time for LTE Ericsson

Decision: The document is noted and final LS is agreed in [R1-1610555](#).

7.2.10.1 Shortened processing time for 1ms TTI

[R1-1608644](#) Design on shortened processing time for 1ms TTI Huawei, HiSilicon
[R1-1608996](#) Fall-back mode operation for processing time reduction with 1ms TTI Samsung
[R1-1608997](#) Discussion on processing time reduction with 1ms TTI Samsung
[R1-1609315](#) On maximum TA and EPDCCH support for n+3 timing Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609317](#) Dynamic fall-back and required scheduling restrictions for 1ms TTI with different processing times
Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609484](#) On reducing processing time for 1ms TTI Intel Corporation
[R1-1609821](#) Considerations on processing time reduction for legacy TTIs Mediatek Inc.
[R1-1610005](#) Shortened processing time for 1ms TTI for DL Qualcomm Incorporated
[R1-1610006](#) Shortened processing time for 1ms TTI for UL Qualcomm Incorporated
[R1-1610042](#) Views on shortened processing time for 1ms TTI NTT DOCOMO, INC.

[R1-1610543](#) WF on not supporting N+2 in 1ms TTI processing time reduction Qualcomm, CATT, Samsung, Huawei, HiSilicon, Intel, MTK, ZTE, ZTE Microelectronics
Also supported by: LGE

[R1-1610557](#) WF on supporting n+2 minimum timing for shortened processing time in 1ms TTI Nokia, Alcatel-Lucent Shanghai Bell, Ericsson, NTT DoCom, Sharp

Also supported by: Spreadtrum, Interdigital

Support a minimum timing of n+2 TTIs for FS1/2/3 for UL grant to UL data and for DL data to DL HARQ as a UE capability

- For n+2 timing, the maximum TA is reduced to 0.33ms
- PDCCH USS scheduling for n+2 timing is supported
 - FSS if EPDCCH scheduling is supported as an additional UE capability
- The supported DL peak data rate with n+2 timing is a UE capability
 - The peak data rate are given by DL UE category is scaled by Z

- $Z = (0.5, 0.75, 1)$
- For PUCCH on FS1 cell, support a dynamic indication of n+2 and n+3 timing
 - Signaling details of indicating the different processing time for 1ms TTI is FFS
 - FFS support for PUCCH on FS2 cell
- FFS: For n+2 UL grant to PUSCH timing, the UL-SCH interleaving over all PUSCH SC-OFDMA symbols is removed

Conclusion

No consensus to support a minimum processing time of n+2

- [R1-1610542](#) WF on maximum TA restriction for 1ms TTI processing time reduction Qualcomm, Mediatek
- [R1-1610561](#) WF on fallback mechanism for shortened processing time in 1ms TTI LG Electronics, Ericsson, Intel, Qualcomm, Huawei, HiSilicon
- [R1-1610341](#) HARQ and UL scheduling timings for 1ms TTI and reduced processing time Ericsson
- [R1-1608645](#) Performance evaluation of short TTI vs. 1ms TTI with processing time reduction Huawei, HiSilicon
- [R1-1609160](#) Latency Reduction for FS2 with 1-ms TTI Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609212](#) Discussion on shortened processing time for FS2 LG Electronics
- [R1-1610562](#) WF on UL scheduling timing for FS2 with shortened processing time in 1 ms TTI LG Electronics, NTT DOCOMO, Ericsson, ZTE Corp, ZTE Microelectronics, Intel
- [R1-1610568](#) WF on DL HARQ-ACK timing for FS2 Samsung
- [R1-1608741](#) HARQ and scheduling timing design for LTE processing timing reduction with 1ms TTI CATT
- [R1-1608912](#) Considerations for shortened processing time Spreadtrum Communications
- [R1-1608994](#) Overall operations for processing time reduction with 1ms TTI Samsung
- [R1-1608995](#) DCI for processing time reduction with 1ms TTI Samsung
- [R1-1608999](#) TDD DL HARQ-ACK feedback procedure for processing time reduction with 1ms TTI Samsung
- [R1-1609211](#) Remaining issues on shortened processing time for 1ms TTI LG Electronics
- [R1-1609316](#) On support of n+2 timing for 1ms TTI Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609318](#) On DCI details for 1ms TTI UL asynchronous HARQ Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609319](#) Interaction between synchronous and asynchronous UL HARQ for 1ms TTI Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609320](#) On processing time reduction between PDSCH transmission and DL HARQ feedback Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609321](#) On processing time reduction between UL grant and UL data transmission Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609339](#) Some issues in 1ms TTI with shortened processing time ZTE, ZTE Microelectronics
- [R1-1609340](#) HARQ with shortened processing time for 1ms TTI ZTE, ZTE Microelectronics
- [R1-1609869](#) Shortened processing time operation for 1ms TTI Sharp
- [R1-1609870](#) HARQ-ACK feedback for 1ms TTI with reduced processing time Sharp
- [R1-1610043](#) HARQ/Scheduling for shortened processing time for 1ms TTI NTT DOCOMO, INC.
- [R1-1610339](#) Reduced processing for 1ms TTI Ericsson
- [R1-1610342](#) PUCCH collisions with reduced processing time for 1ms TTI Ericsson
- [R1-1610343](#) Asynchronous HARQ for PUSCH Ericsson
- [R1-1608654](#) Processing time reduction and related HARQ timings with 1ms TTI for FS2 Huawei, HiSilicon
- [R1-1608998](#) CSI measurement and reporting for processing time reduction with 1ms TTI Samsung
- [R1-1609213](#) Discussion on CSI feedback for 1ms TTI with shortened processing time LG Electronics
- [R1-1610340](#) Fast CSI for 1ms TTI Ericsson
- [R1-1610044](#) Views on CSI feedback for 1ms TTI with shortened processing time NTT DOCOMO, INC.

7.2.10.2 Shortened TTI length together with shortened processing time

- [R1-1609820](#) Considerations on short TTI design Mediatek Inc.
- [R1-1609822](#) UL RS design for short TTI Mediatek Inc.
- [R1-1609823](#) DL DMRS and DCI design for short TTI Mediatek Inc.

7.2.10.2.1 Design of sTTI for DL and UL

- [R1-1609161](#) Considerations on Asymmetric DL&UL sTTI Length Operations Nokia, Alcatel-Lucent Shanghai Bell
- [R1-1609006](#) sPUSCH for 2-symbol, 4-symbol, 1-slot sTTI Samsung
- [R1-1609008](#) Coexistence between 1ms TTI and sTTI operations for DL/UL Samsung

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1608745](#) DL/UL sTTI partition CATT
[R1-1608631](#) Discussion on sTTI structure Huawei, HiSilicon

Proposed agreements:

- In DL no sTTI spans over slot boundary
- In DL TTI can span over slot boundary
- In UL no sTTI spans over slot boundary
- In UL TTI can span over slot boundary

Agreement:

- Short TTI is not configured with extended CP.

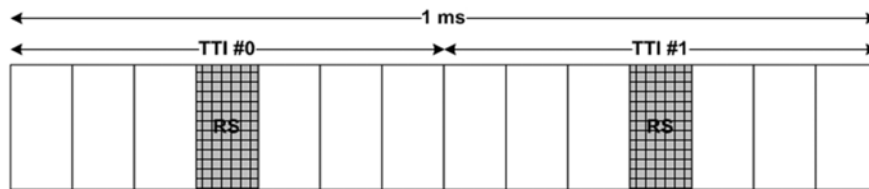
[R1-1609219](#) Discussion on sTTI designs for UL LG Electronics
[R1-1610331](#) On the operation with different TTI lengths Ericsson

[R1-1608633](#) Discussion on DMRS-based sPDCCH Huawei, HiSilicon
[R1-1609322](#) On DL control channel design for shorter TTI operation Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610563](#) WF on short TTI structure LG Electronics, Huawei, HiSilicon

Agreement:

- For 7-symbol TTI, the following sTTI structure is supported for UL



[R1-1610833](#) WF on UL short TTI structure LG Electronics, Huawei, HiSilicon, Ericsson, Nokia, Alcatel-Lucent Shanghai Bell, Samsung, NTT DOCOMO, Sharp, ZTE, ZTE Microelectronics, Intel, Qualcomm

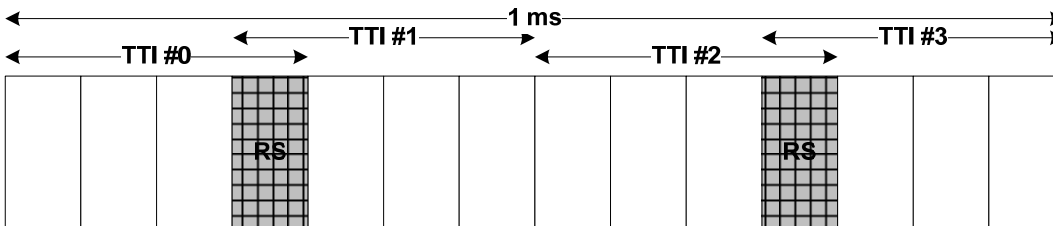
Agreement:

- For 2-symbol TTI, RAN1 will down-select UL sTTI structure among the following options:
 - Option 1: fixed sTTI structure
 - The data symbol(s) for sPUSCH are confined within a sTTI. Note that the DMRS for one sTTI may be placed within or outside the sTTI.
 - Option 1a: without spanning over slot boundary
 - The presence (if any) and the position of the UL DMRS is given by the UL grant,
 - If the UL DMRS is present it can be positioned before, within or after the sTTI
 - Considered sTTI patterns in OFDM symbols per subframe
 - Alt1: (2, 2, 3, 2, 2, 3)
 - Alt2: (3, 2, 2, 2, 2, 3)
 - Alt3: (3, 2, 2, 3, 2, 2)
 - Option 1b: a sTTI can span over slot boundary
 - Considered sTTI patterns in OFDM symbols per subframe
 - Alt1: (2, 2, 2, 2, 2, 2, 2)
 - Option 2: fixed nominal sTTI starting points and a possibility to delay the start of the transmission by N symbols with an indication in the UL grant
 - The presence (if any) and the position of the UL DMRS is given by the UL grant,
 - If the UL DMRS is present it can be positioned before, within or after the sTTI
 - The nominal sTTI starting point is determined by n+k processing time and DL sTTI structure

[R1-1610834](#) WF on UL short TTI structure for 4-symbol sTTI LG Electronics, Samsung, Ericsson, CATT, NTT DOCOMO, ZTE, ZTE Microelectronics, Huawei, HiSilicon, Panasonic

Agreement:

- If 4-symbol UL sTTI is supported, the following sTTI structure is adopted:



[R1-1610856](#) WF on sTTI length for DL Samsung, Ericsson, Sharp, NTT DOCOMO, Huawei, HiSilicon, Intel, CATT, ZTE, ZTE Microelectronics, LG Electronics

Agreement:

- The DL sTTI length of a UE is configured by RRC signaling.
 - FFS on whether different DL sTTI lengths for a given UE can be configured for different serving cells or not.

[R1-1610827](#) WF on DL sTTI pattern Huawei, HiSilicon, NTT DOCOMO, Intel, Qualcomm, Ericsson, LGE

Conclusion

- Aspects to consider when downselecting between the 2OS DL sTTI in [R1-1610827](#)
 - Orphan symbol sTTI
 - Support of distributed resource block allocation together with sTTI operation
 - Slot based sTTI operation together with 2 symbol sTTI operation
 - CSI-IM
 - Varying number of shortened TTI within a subframe
 - PCFICH detection error
 - HARQ timing
 - Achievable minimum HARQ/scheduling timing with varying sTTI length
 - UL sTTI structure
 - Other aspects can also be considered

[R1-1610855](#) WF on the combination of sTTI length for DL and UL Samsung, Qualcomm

Agreement:

- For the combination of sTTI for DL and UL, RAN1 chooses one to be supported among the following alternatives.
 - Alt 1. {2,2}, {7,7}
 - Alt 2. {2,2}, {2,4}, {7,7}
 - Alt 3. {2,2}, {2,7}, {7,7}
 - Alt 4. {2,2}, {2,4}, {2,7}, {7,7}
 - Note: {a,b} denotes {DL sTTI length, UL sTTI length}.
 - Note: DL sTTI length is used for sPDCCH and sPDSCH.
 - Note: UL sTTI length is used for sPUSCH and sPUCCH corresponding to sPDCCH and sPDSCH, respectively.
- RAN1 study the necessity of {2,14} and/or {7,14}

[R1-1608634](#) Details of two-level DCI schemes for short TTI Huawei, HiSilicon

[R1-1609001](#) sDCI for sTTI operation Samsung

[R1-1609323](#) On two-level DL control channel design and subframe structure for shorter TTI operation Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610007](#) DI design for shortened TTI Qualcomm Incorporated

[R1-1610583](#) Way Forward on sTTI scheduling options Ericsson, Huawei, HiSilicon

Revision of [R1-1610582](#)

Agreement

- Select a sTTI scheduling scheme among the following candidates for each sTTI length
 - Single level DCI
 - RRC configuration of sPDCCH search space and/or sPDCCH frequency region
 - UE-specific information in sDCI related to sPDSCH/sPUSCH
 - Two level DCI
 - RRC configuration may or may not at least partially indicate sPDCCH frequency region/search space for some of the variants described below

- variant 1
 - Slow DCI: non UE-specific information in PDCCH
 - Fast DCI: UE-specific information in sDCI
 - variant 2
 - Slow DCI: UE-specific information in PDCCH
 - Fast DCI: UE-specific information in sDCI
 - variant 3
 - Slow DCI: UE-specific information in PDCCH and/or sPDCCH
 - Fast DCI: UE-specific information in sDCI
- Note: the sTTI scheduling scheme may be the same or different for different sTTI length
- FFS how to reduce the payload of sDCI/DCI messages for sTTI operation
 - FFS support of multi-sTTI scheduling
 - Additional L1 signaling related to sTTI operation can be considered

[R1-1608640](#) Handling collision between sTTI and 1ms TTI Huawei, HiSilicon
[R1-1608748](#) On efficient multiplexing of normal TTI and sTTI CATT

[R1-1610836](#) Way Forward on handling of PDSCH/sPDSCH assignments for the same subframe and carrier Ericsson, Huawei, HiSilicon, Qualcomm, NTT DOCOMO, LG Electronics

[R1-1610581](#) Way Forward on handling of PUSCH and sPUSCH grants for the same subframe and carrier Ericsson, Huawei, HiSilicon

[R1-1608636](#) Discussion on sPDSCH design Huawei, HiSilicon

[R1-1609215](#) Discussions on sPDSCH for latency reduction LG Electronics

[R1-1610325](#) Design aspects of sPDSCH Ericsson

[R1-1610787](#) WF on transmission modes for sTTI Huawei, HiSilicon, CMCC, Softbank, Qualcomm, Intel, CATT

Agreement

- For DL transmission for sTTI
 - TM1, 2, 3, 4, 6, 9, 10 are supported for FS1.
 - TM1, 2, 3, 4, 6, 8, 9, 10 are supported for slot based sTTI for FS2.
 - Note: For 2 symbol sTTI design TM8 is not supported in this WI
- For UL transmission for sTTI
 - TM1 and TM2 are supported

[R1-1608749](#) Discussion on UL sTTI operation CATT

[R1-1610337](#) UL power-related aspects for sTTI Ericsson

[R1-1610338](#) Draft LS on UL power control related aspects Ericsson

Friday

[R1-1610585](#) [DRAFT] LS on implication of sTTI operation on UL ON/OFF time mask Ericsson

Decision: The document is noted and final LS is agreed in [R1-1611054](#).

[R1-1608632](#) Discussion on CRS based sPDCCH Huawei, HiSilicon

[R1-1608635](#) Discussion on DCI design for short TTI Huawei, HiSilicon

[R1-1608637](#) Discussion on sPUCCH design Huawei, HiSilicon

[R1-1608638](#) Discussion on sPUSCH design Huawei, HiSilicon

[R1-1608639](#) UCI on sPUSCH Huawei, HiSilicon

[R1-1608641](#) Discussion on UL RS for short TTI Huawei, HiSilicon

[R1-1608653](#) Discussion on CA issues for shortened TTI operation Huawei, HiSilicon

[R1-1608656](#) Discussion on sPUCCH resource for shortened TTI Huawei, HiSilicon

[R1-1608742](#) On sDCI design CATT

[R1-1608743](#) Design of sPDCCH structure CATT

[R1-1608744](#) Other issues for sPDCCH design CATT

[R1-1608746](#) DMRS design for sPUSCH CATT

[R1-1608747](#) DMRS design for DL sTTI CATT

[R1-1608750](#) sPUCCH design for sTTI CATT

[R1-1608751](#) Discussion on the simultaneous transmissions of (s)PUCCH and (s)PUSCH CATT

[R1-1608752](#) UCI transmission for LTE sTTI CATT

[R1-1608913](#) Discussion on sPDCCH design for sTTI Spreadtrum Communications

[R1-1608914](#) Discussion on sPUSCH design for sTTI Spreadtrum Communications

[R1-1608915](#) Discussion on DL RS design for sTTI Spreadtrum Communications
[R1-1608946](#) Discussion on sPDCCH for shortened TTI Sony
[R1-1609000](#) Overview of sTTI operations Samsung
[R1-1609002](#) sPDCCH for 2-symbol sTTI Samsung
[R1-1609003](#) sPDCCH for 1-slot sTTI Samsung
[R1-1609004](#) sPDSCH for 2-symbol/1-slot sTTI Samsung
[R1-1609005](#) sPUCCH for 2-symbol, 4-symbol, 1-slot sTTI Samsung
[R1-1609007](#) TDD-specific issues on sTTI operation Samsung
[R1-1609157](#) sPDSCH/sPDCCH with 2-symbol sTTI and 1-slot sTTI NEC
[R1-1609162](#) Simultaneous Transmissions of UL Signals for Shortened TTI Operation Nokia, Alcatel-Lucent
Shanghai Bell
[R1-1609163](#) On signaling details for flexible DMRS in UL shorter TTI Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609164](#) sPUCCH Design for shortened TTI Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609165](#) Considerations of slot-level sTTI for FS2 Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609214](#) Discussions on sPDCCH for latency reduction LG Electronics
[R1-1609216](#) sPUCCH for HARQ-ACK in shortened TTI LG Electronics
[R1-1609217](#) sPUCCH for CSI in shortened TTI LG Electronics
[R1-1609218](#) Discussion on CA operations for latency reduction LG Electronics
[R1-1609298](#) Discussion on HARQ timing for shortened TTI in TDD CMCC
[R1-1609324](#) On design of search space for short PDCCH Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609325](#) On details of flexible DMRS design for DL shorter TTI Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609341](#) Discussion on sPDCCH for sTTI ZTE, ZTE Microelectronics
[R1-1609342](#) Discussion on PUCCH design for sTTI ZTE, ZTE Microelectronics
[R1-1609343](#) Study on PDSCH transmission in sTTI ZTE, ZTE Microelectronics
[R1-1609374](#) Study on PUSCH transmission in sTTI ZTE, ZTE Microelectronics
[R1-1609375](#) Simultaneous transmission and reception in sTTI ZTE, ZTE Microelectronics
[R1-1609485](#) DCI formats for shorten TTI Intel Corporation
[R1-1609486](#) On sPDCCH design for shoten TTI Intel Corporation
[R1-1609487](#) UL design aspects of TTI shortening Intel Corporation
[R1-1609572](#) Discussion on reference signal design for shortened TTI Panasonic
[R1-1609573](#) Discussion on multiplexing between sTTI and TTI in the same subframe Panasonic
[R1-1609574](#) UL simultaneous transmission between sTTI and TTI Panasonic
[R1-1609575](#) Discussion on single level DCI and two-level DCI Panasonic
[R1-1609908](#) Considerations on DCI design for shortened TTI Beijing Xiaomi Mobile Software
[R1-1609914](#) Shortened TTI design Motorola Mobility
[R1-1609915](#) Multiplexing of Regular TTI and shortened TTI Motorola Mobility
[R1-1609916](#) CSI aspects of shortened TTI operation Motorola Mobility
[R1-1610008](#) UL design for shortened TTI Qualcomm Incorporated
[R1-1610045](#) s(E)PDCCH for shortened TTI NTT DOCOMO, INC.
[R1-1610046](#) sPDSCH for shortened TTI NTT DOCOMO, INC.
[R1-1610047](#) sPUCCH for shortened TTI NTT DOCOMO, INC.
[R1-1610048](#) sPUSCH for shortened TTI NTT DOCOMO, INC.
[R1-1610093](#) sPDCCH design for short TTI HTC Corporation
[R1-1610096](#) On sPDCCH Design InterDigital Communications
[R1-1610097](#) On sPDSCH Design InterDigital Communications
[R1-1610098](#) On sPUCCH Design InterDigital Communications
[R1-1610099](#) On sPUSCH Design InterDigital Communications
[R1-1610230](#) Discussion on HARQ Process for Slot-based TTI ASUSTEK COMPUTER (SHANGHAI)
[R1-1610305](#) Design aspects of short PUSCH KT Corp.
[R1-1610321](#) DL DMRS design for TTI shortening Ericsson
[R1-1610322](#) sPDCCH search space design Ericsson
[R1-1610323](#) Design aspects of sPDCCH Ericsson
[R1-1610324](#) DL control for short TTI Ericsson
[R1-1610326](#) Design aspects of sPUSCH Ericsson
[R1-1610327](#) sPUSCH sTTI operation Ericsson
[R1-1610328](#) UCI on sPUSCH with short TTI Ericsson
[R1-1610329](#) Design aspects of sPUCCH Ericsson
[R1-1610332](#) TDD aspects of short TTI Ericsson
[R1-1610333](#) sTTI lengths combination in case of CA Ericsson
[R1-1610334](#) Asynchronous HARQ for UL retransmissions with short TTI Ericsson
[R1-1610335](#) Handling overlapping allocations with short and 1 ms TTI Ericsson
[R1-1610336](#) Puncturing sTTI in legacy TTI Ericsson
[R1-1610344](#) TBS scaling for short TTI Ericsson
[R1-1610619](#) WF on sPUCCH formats Huawei, HiSilicon, Ericsson, Qualcomm, CATT

[R1-1610814](#) WF on DMRS-based sPDCCH ZTE, ZTE Microelectronics

7.2.10.2.2 Processing time

Including maximum TA, CSI processing and minimum data processing time

[R1-1608642](#) Discussion on CSI feedback for short TTI Huawei, HiSilicon
[R1-1608643](#) Processing time reduction and related procedures for short TTTHuawei, HiSilicon
[R1-1608646](#) TDD-specific design for short TTI Huawei, HiSilicon
[R1-1608753](#) Implicit HARQ and scheduling timing design for LTE sTTI CATT
[R1-1608754](#) Explicit HARQ and scheduling timing design for LTE shorten TTI CATT
[R1-1609009](#) Processing time reduction for sTTI operation Samsung
[R1-1609220](#) Shortened processing time for shortened TTI length LG Electronics
[R1-1609221](#) HARQ timing in shortened TTI LG Electronics
[R1-1609376](#) Processing time reduction and related procedures ZTE, ZTE Microelectronics
[R1-1609488](#) On the processing time reduction for latency reduction Intel Corporation
[R1-1609871](#) Association timing for sTTI with different UL and DL lengths Sharp
[R1-1609872](#) Processing time reduction for TDD with 1-slot sTTI Sharp
[R1-1610009](#) Processing time reduction and related procedures for DL Qualcomm Incorporated
[R1-1610010](#) Processing time reduction and related procedures for UL Qualcomm Incorporated
[R1-1610011](#) TDD-specific design for shortened TTI Qualcomm Incorporated
[R1-1610049](#) Views on processing time reduction and related procedures NTT DOCOMO, INC.
[R1-1610050](#) Views on CSI feedback for shortened TTI with reduced processing time NTT DOCOMO, INC.
[R1-1610100](#) Processing Time Reduction for sTTI InterDigital Communications
[R1-1610330](#) On reduced processing time for short TTI Ericsson

7.2.10.3 Other

[R1-1609405](#) On the carrier aggregation system supporting shortened TTI operation ITRI
[R1-1609406](#) Discussion on the power headroom reporting for shortened TTI operation ITRI
[R1-1610012](#) Link evaluation of DL data transmission under symbol-dependent impact Qualcomm Incorporated

7.2.11 Performance enhancements for high speed scenario - WID in RP-152263.

[R1-1610874](#) Chairman's notes of AI 7.2.11 on Performance enhancements for high speed scenario Ad-Hoc
chair (Qualcomm)

The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

[R1-1609349](#) Restricted sets of cyclic shifts for PRACH in high speed scenario Huawei
[R1-1609350](#) On the support for legacy UEs in high speed cells Huawei
[R1-1609929](#) Introduction of PRACH enhancement for high speed scenario Huawei
[R1-1610013](#) PRACH enhancements Qualcomm Incorporated
[R1-1610223](#) PRACH for very high speed scenario Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610903](#) WF on Performance enhancements for high speed scenario Huawei, HiSilicon, Nokia, ASB, NTT
DOCOMO

Agreements:

- Set 3 in [R1-1609349](#) is selected as the new restricted set of cyclic shifts for PRACH in the new Rel-14 high speed scenario.
- Two sets of PRACH resources are configured for a cell that supports the new Rel-14 high speed scenario:
 - One set optimized for new Rel-14 high speed scenario and signaled to Rel-14 UEs. RAN1 recommends that this set is configured by the following new RRC parameters:
 - highSpeedFlag-r14
 - zeroCorrelationZoneConfig-r14
 - rootSequenceIndex-r14
 - The other set signaled to Rel-8 – Rel-13 UEs.

[R1-1610985](#) [DRAFT] Reply LS on A New PRACH Cyclic Shift Restriction Set Huawei
Agreed in [R1-1610956](#)

7.2.12 Voice and Video enhancement for LTE - WID in RP-161856

VoLTE coverage enhancement

[R1-1610875](#) Chairman's notes of AI 7.2.12 on Study on Enhancement of VoLTEAd-Hoc chair (Qualcomm)

The document was presented by ... from ...

Discussion:

Decision: The document is endorsed and content incorporated below.

R1-1609565	Specification impact of VoLTE/ViLTE coverage enhancements	China Telecommunications
R1-1610396	PUSCH coverage enhancement for VoLTE	Ericsson
R1-1608606	Discussion on VoLTE coverage enhancement	Huawei, HiSilicon
R1-1609723	VoLTE coverage enhancement	Nokia, Alcatel-Lucent Shanghai Bell

Companies are encouraged to check:

- what aspects of quality are to be enhanced
- what maximum transport block size is envisaged
- why ViLTE is not included in the coverage enhancement part of the WID.

[R1-1610921](#) WF on VoLTE and ViLTE enhancement Huawei, HiSilicon, China Telecommunications
Also supported by CMCC

Agreements:

- HARQ process ID of PUSCH is indicated in DCI
- Re-use the eMTC repetition scheme, i.e.:
 - o Support numbers of repetitions for PUSCH not larger than X
 - FFS the value of X considering the relaxed delay budget, and X may be different from the largest value in eMTC
 - o A set of [4 or 8 (TBD)] numbers of repetitions are configured by RRC signalling of the maximum number of repetitions
 - o The number of repetitions of PUSCH is indicated in DCI
- Re-use eMTC frequency hopping scheme, i.e.:
 - o The frequency domain hopping offset and the time domain hopping interval are cell specific
 - o The time domain hopping interval is configured as one of
 - {1, 2, 4, 8} subframes for FDD
 - {1, 5, 10, Y} subframes for TDD, where Y is TBD after deciding the value of X
 - o FFS: values of frequency domain hopping offset

[R1-1610606](#) Draft LS for Voice and Video enhancement for LTE Huawei
Agreed in [R1-1611057](#)

[R1-1610014](#) Coverage enhancement techniques Qualcomm Incorporated

7.2.13 Study on Further enhancements to Coordinated Multi-Point Operation - SID in RP-160954

[R1-1610876](#) Chairman's notes of AI 7.2.13 on Study on Further enhancements to Coordinated Multi-Point Operation
Ad-Hoc chair (Intel)

The document was presented by Alexey Davydov from Intel.

Discussion:

Decision: The document is endorsed and content incorporated below.

R1-1608609	TP for 36.741 on definition and classification of non-coherent JT	Huawei, HiSilicon
R1-1610299	TP on TR 36.741 Study on FeCoMP	ZTE, ZTE Microelectronics

Agreement:

- Endorse TP in [R1-1610299](#)

7.2.13.1 Initial evaluation results and enhancements for non-coherent joint transmission

R1-1608610	Potential enhancements and specification impact analysis of non-coherent JT	Huawei, HiSilicon
R1-1608692	Potential Enhancement on the Non-coherent JT	ZTE, ZTE Microelectronics
R1-1608694	Initial evaluation results of non-coherent JT	ZTE, ZTE Microelectronics

R1-1608933	Discussion and Preliminary Simulation Results of NCJT Case 1 of FeCoMP Nokia, Alcatel-Lucent	
Shanghai Bell		
R1-1609010	Initial evaluation results and enhancements for non-coherent JT	Samsung
R1-1609355	Simulation results of non-coherent JT	Huawei, HiSilicon
R1-1609489	CSI feedback enhancements for non coherent JT	Intel Corporation
R1-1609490	Control signalling enhancements for non coherent JT	Intel Corporation
R1-1609491	System level evaluation results for non coherent JT Intel Corporation	
R1-1609715	QCL Issues of Joint Transmission	ZTE, ASTRI
R1-1609863	Non-Coherent JT Enhancements Ericsson	
R1-1610016	Enhancements for non-coherent JT	Qualcomm Incorporated
R1-1610819	WF on potential enhancements for non-coherent joint transmission , ZTE, ZTE Microelectronics, Intel, ASTRI, Huawei, HiSilicon, Nokia, ASB	

Agreements:

- At least the following enhancements should be studied for NCJT:
 - Enhancement to QCL assumptions for DM-RS antenna ports
 - e.g., non co-located DM-RS antenna ports
 - Control signalling enhancements
 - e.g., One DCI or multiple DCIs to support CW-specific resource allocation / MCS assignment / PDSCH RE mapping, more than one CSI-RS resource for QCL/ CW-to-layer mapping
 - CSI enhancements
 - e.g., CSI calculation for multiple CSI processes with dependency among CSI processes
 - e.g., CSI calculation for single CSI process with codebook enhancement
 - e.g., CSI calculation for single CSI process with dependency among K CSI-RS resource in Class B FD-MIMO
 - e.g., Support of the CSI for advanced receivers
 - Enhancement to channel/interference measurements
 - e.g., interference measurements based on NZP CSI-RS
 - e.g., aperiodic CSI-IM
 - e.g., measurement restriction in the frequency domain

7.2.13.2 Initial evaluation results and enhancements for coordinated scheduling/beamforming with FD-MIMO

R1-1608611	Potential enhancements and specification impacts for CS/CB with FD-MIMO Huawei, HiSilicon	
R1-1608695	Initial evaluation results for CS/CB	ZTE, ZTE Microelectronics
R1-1608696	Potential enhancements for CS/CB with FD-MIMO	ZTE, ZTE Microelectronics
R1-1609011	Initial evaluation results and enhancements for CS/CB with FDMIMO Samsung	
R1-1609356	Simulation results of CS/CB with FD-MIMO	Huawei, HiSilicon
R1-1609492	Enhancements and system level evaluation of CS/CB CoMP for FD-MIMO	Intel Corporation
R1-1609864	Further results on CS/CB in indoor scenario Ericsson	
R1-1610017	Enhancements for coordinated scheduling/beamforming with FD-MIMO	Qualcomm Incorporated
R1-1610782	WF on enhancement of CS/CB with FD-MIMO Huawei, HiSilicon, Intel, SoftBank Corp, ZTE, ZTE Microelectronics, Samsung	

Agreements:

- At least the following enhancements should be studied for CS/CB enhancement:
 - CSI feedback enhancement
 - e.g. CSI feedback reflect different interference beamforming hypothesis from coordinated TPs .
 - e.g. CSI feedback considering power adjustment
 - e.g. only CSIs regarding TPs with strong interference are reported
 - Interference measurement enhancements
 - e.g. NZP CSI-RS used for measuring interference from coordinated TP.
 - e.g. aperiodic CSI-IM
 - e.g. measurement restriction in the frequency domain
 - Enhancement to non ideal backhaul
 - e.g. PMI/CRI signalling between eNBs
 - Enhancement to reference signals
 - e.g. support of orthogonal DM-RS ports for multi-point MU-MIMO
 - e.g. SRS configuration signalling between eNBs
 - e.g. Multiplexing of CSI-RS resources with IC
 - e.g. Resource pool sharing for channel and interference measurement
 - QCL enhancement
 - e.g. non co-located CSI-RS resources in Class B FD-MIMO
 - Enhancement to SRS:

- e.g. enable eNB to measure the SRS from interfering UE(s).

8 NR

Friday morning: “Funny” debate on the definition and content of the wording “study”

Background came from Ericsson commenting that they would like to avoid ending-up to a situation where company(ies) say(s) “this topic has not been studied” and consequently SI is not completed and needs to be postponed.

Nokia also agreed to Ericsson’s comment

Chair→ Study does not necessarily have to reach a conclusion

RAN1 chair agreed with Ericsson/Nokia views and would like to avoid having the same kind of issue raised at the plenary.

8.1 Study on New Radio Access Technology - SID in [RP-161596](#)

Additional RAN guidance in [RP-161914](#)

Wednesday

[R1-1610053](#) Draft TR 38.802 Study on New Radio (NR) Access Technology - Physical Layer Aspects NTT
DOCOMO, INC.

The document was presented by Kazuaki Takeda from NTT DOCOMO.

Discussion: Huawei couldn’t check whether remarks sent on the reflector have been captured

Decision: The document is noted. All proponents are encouraged to check it until Thursday morning.

Thursday

[R1-1610843](#) Draft TR 38.802 Study on New Radio (NR) Access Technology - Physical Layer Aspects NTT
DOCOMO, INC.

Decision: The document (TR38.802 v0.2.1) is noted and endorsed as version 0.3.0 in [R1-1610843](#) as basis for future updates.

The document was presented by ... from ...

Discussion:

Decision: The document is noted.

[R1-1610052](#) Workplan for Study on NR Access Technology NTT DOCOMO, INC.

8.1.1 Waveform and multiple access schemes for new radio interface

[R1-1610877](#) Chairman's notes of AI 8.1.1 on waveform and multiple access schemes for NR Ad-Hoc chair
(Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Decision: The document is endorsed and content incorporated below.

8.1.1.1 Waveform

Summarize the waveform study including conclusions of Phase I

[R1-1608709](#) Optimized PAPR/CM SC-CPS Waveform and Further Results Idaho National Laboratory
[R1-1608829](#) Uplink coverage performance of OFDM with PAPR reduction for below 6 GHz Huawei, HiSilicon
[R1-1609034](#) Evaluation results of Low PAPR waveform Samsung
[R1-1609222](#) Discussion on DFT-s-OFDM and CP-OFDM for Uplink LG Electronics
[R1-1609299](#) Discussion and evaluation of UL Waveforms CMCC
[R1-1609378](#) A New DFTS-OFDM Compatible Low PAPR Technique for NR Uplink Waveforms MediaTek
[R1-1609384](#) Network Assisted Waveform Selection for NR AT&T GNS Belgium SPRL
[R1-1609390](#) Low PAPR Waveform Design for NR IITH
[R1-1609567](#) On UL Waveforms below 40 GHz Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609813](#) Uplink waveform evaluations and proposals for NR Phase 1 Panasonic Corporation
[R1-1610054](#) Views on UL waveform for NR NTT DOCOMO, INC.
[R1-1610113](#) Coverage analysis of DFT-s-OFDM and OFDM with low PAPR techniques Qualcomm Incorporated
[R1-1610224](#) Coexistence of DFTsOFDM and OFDM in UL below 40GHz Mitsubishi Electric RCE
[R1-1610446](#) OTFS PAPR Analysis Cohere Technologies

Revision of [R1-1610397](#)

[R1-1610485](#) WF on Waveform for NR Uplink Qualcomm, Orange, OPPO, ZTE, ZTE Microelectronics, InterDigital, MediaTek, LGE, IITH, Idaho National Lab, Mitsubishi, Panasonic, Vivo, Tejas Networks, IITM, CEWIT, Straight Path, NTU, Kyocera, Samsung, Spreadtrum, Reliance-jio, Sharp, AT&T, Xiaomi, Sony, NEC, Motorola, Lenovo, National Instrument, Apple
Also supported by Dish Network

Agreement:

- NR Support DFT-S-OFDM based waveform complementary to CP-OFDM waveform, at least for eMBB uplink for up to 40GHz
 - FFS additional low PAPR techniques

- CP-OFDM waveform can be used for a single-stream and multi-stream (i.e. MIMO) transmissions, while DFT-S-OFDM based waveform is limited to a single stream transmissions (targeting for link budget limited cases)
- Network can decide and communicate to the UE which one of CP-OFDM and DFT-S-OFDM based waveforms to use
 - Note: both CP-OFDM and DFT-S-OFDM based waveforms are mandatory for UEs
- RAN1 should target for a common framework in designing CP-OFDM and DFT-S-OFDM based waveforms (without compromising CP-OFDM performance/complexity), e.g., control channels, RS, etc.
- Discuss further offline for possible refined evaluation assumptions/methodology for waveform evaluations

R1-1608708	Optimized PAPR/CM SC-CPS Waveform and Further Results Idaho National Laboratory
Withdrawn	
R1-1608800	Discussion on real domain OFDM for mMTC Fujitsu
R1-1608825	Low-complexity filter implementation for f-OFDM Huawei, HiSilicon
R1-1608826	Delay analysis for f-OFDM Huawei, HiSilicon
R1-1608827	Analysis of guard band for FDM of different numerologies in a NR carrier Huawei, HiSilicon
R1-1608828	Overview of PAPR reduction techniques Huawei, HiSilicon
R1-1608868	Analysis of spectral utilization in a NR carrier Huawei, HiSilicon
R1-1608916	Further considerations on waveform configuration Spreadtrum Communications
R1-1609033	Discussion on Low PAPR waveform for UL Samsung
R1-1609035	Evaluation results of guard-band supporting methods Samsung
R1-1609383	Summary of Link level analysis of candidate waveforms for NR AT&T GNS Belgium SPRL
R1-1609419	In-band Tx requirements for FDM of different numerologies in a NR carrier Huawei, HiSilicon
R1-1609420	In-band Rx requirements for FDM of different numerologies in a NR carrier Huawei, HiSilicon
R1-1609493	Single carrier based waveform for high frequency bands above 40 GHz Intel Corporation
R1-1609494	Further discussion on GI-DFT-s-OFDM for high frequency bands above 40 GHz Intel Corporation
R1-1609495	Views on multiple NR waveform proposals for high bands Intel Corporation
R1-1609496	Considerations on NR waveform with improved spectral containment Intel Corporation
R1-1609564	Implementation-specific UF-OFDM for New Radio Nokia, Alcatel-Lucent Shanghai Bell
R1-1609568	Out of band emissions, in-band emissions and EVM requirement considerations for NR Nokia, Alcatel-Lucent
Shanghai Bell	
R1-1609596	Waveform Simulation Results for Above 40 GHz Nokia, Alcatel-Lucent Shanghai Bell
R1-1609597	Waveform proposal for carrier frequencies beyond 40 GHz Nokia, Alcatel-Lucent Shanghai Bell
R1-1609598	Potential for system level gains for low-PAPR waveforms Nokia, Alcatel-Lucent Shanghai Bell
R1-1609599	Way forward waveform for carrier frequencies beyond 40 GHz Nokia, Alcatel-Lucent Shanghai Bell,
Mitsubishi Electric, InterDigital Communications	
R1-1609643	On UL waveform - discussion Ericsson
R1-1609644	On UL waveform - evaluation Ericsson
R1-1609778	Further discussions on FB-OFDM ZTE, ZTE Microelectronics
R1-1609779	Further evaluations on FB-OFDM ZTE, ZTE Microelectronics
R1-1609780	Text Proposal on TR38.802 for NR waveform ZTE, ZTE Microelectronics
R1-1609792	mmWave UW DFTsOFDM link level evaluation Mitsubishi Electric
R1-1609825	OTFS Performance in High Doppler with Varying Subcarrier Spacing Cohere Technologies
R1-1609887	Coexistence of CP OFDM and CP DFT-s-OFDM for NR UL InterDigital Communications
R1-1609889	Waveform design considerations for carrier frequencies above 40 GHz InterDigital Communications
R1-1610015	Specification impact of DFTs-OFDM vs OFDM Qualcomm Incorporated
R1-1610107	Precoder flexibility and forward compatibility of CPS-OFDM waveform National Taiwan University
R1-1610108	Evaluation results of CPS-OFDM waveform National Taiwan University
R1-1610111	Phase I Waveform proposal: CP-OFDM plus DFT-s-OFDM Qualcomm Incorporated
R1-1610112	On the impact of beamforming to link budget comparison of DFTs-OFDM and OFDM Qualcomm
Incorporated	
R1-1610114	User Multiplexing of DFTs-OFDM and OFDM in uplink Qualcomm Incorporated
R1-1610116	UL waveform considerations for mmW Qualcomm Incorporated
R1-1610117	Common PAPR reduction techniques for OFDM / DFT-s-OFDM Qualcomm Incorporated
R1-1610238	FC-OFDM discussion based on RAN1#86 agreement ORANGE
R1-1610309	flexi-OFDMA, a new waveform for NR CEWiT, IIT-H, IIT-M, Reliance Jio, Tejas Networks
R1-1610403	Waveform Simulation Results for Above 40 GH Nokia, Alcatel-Lucent Shanghai Bell
R1-1610404	FC-OFDM discussion based on RAN1#86 waveform agreements ORANGE
Withdrawn	

8.1.1.2 Multiple access scheme

Summarize the multiple access scheme study and preliminary conclusions of Phase I

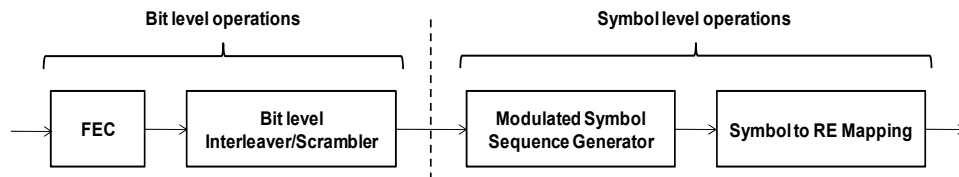
[R1-1608802](#) DM-RS considerations for UL non-orthogonal multiple access Fujitsu

[R1-1608869](#) Grant-free Non-orthogonal MA for uplink URLLC Huawei, HiSilicon
[R1-1608919](#) Considerations on pre-configured resource for grant-free based UL non-orthogonal MA Spreadtrum Communications
[R1-1608954](#) Physical layer abstraction method for MMSE-SIC type receiver ZTE
[R1-1609039](#) Support of HARQ in grant-free based multiple access Samsung
[R1-1609228](#) General procedures on grant-free/grant-based MA LG Electronics
[R1-1609334](#) System level evaluation result on RDMA MediaTek Inc.
[R1-1609398](#) Uplink Grant-free Access for 5G mMTC Lenovo
[R1-1609497](#) Link-level analysis of UL NOMA schemes Intel Corporation
[R1-1609549](#) Comparison of OFDMA vs LSSA system level UL performance ETRI
[R1-1609581](#) Initial system level simulation results of new multiple access scheme CATR
[R1-1609783](#) Transmission Options for the mMTC Grant-Free Uplink Nokia, Alcatel-Lucent Shanghai Bell
[R1-1610120](#) System level simulation results for proposed multiple access scheme Qualcomm Incorporated
[R1-1610213](#) On Low Latency UL Multiple Access in NR Ericsson

[R1-1608956](#) Summary of [86-18] email discussion on categorization for NR MA schemes ZTE
[R1-1610801](#) WF on Observation of MA Signature ZTE, ZTE Microelectronics, Huawei, HiSilicon, ETRI
[R1-1610956](#) WF on Common Features and General Framework of MA Schemes Huawei, HiSilicon, CATR, CATT, CMCC, Samsung, ETRI, MediaTek
Also supported by DCM

Agreements:

- Capture the following observations in the TR
 - All proposed non-orthogonal MA schemes for UL transmission share the following common features:
 - At the transmitter side: using MA signature(s)
 - At the receiver side: allowing multi-user detector
 - All proposed non-orthogonal MA schemes for UL transmission on a high level follow the following basic diagram. Note that the basic diagram is not intended to capture all the details or to be a complete diagram.



[R1-1610528](#) WF on support of UL non-orthogonal multiple access Huawei, HiSilicon, Convida Wireless, Interdigital
[R1-1610529](#) WF on support of UL grant-free Huawei, HiSilicon, CATT, Convida Wireless, Interdigital

[R1-1610625](#) WF on TP Structure for NR Multiple Access in TR 38.802 ZTE, ZTE Microelectronics, Qualcomm Inc

Agreements:

- To add Section 8.1.3 for multiple access scheme for UL concept
 - Details subsections/contents/descriptions to be discussed offline

[R1-1610626](#) WF on PHY abstraction method for MMSE-SIC/PIC receiver ZTE, ZTE Microelectronics

Agreements:

- For calibration purpose ONLY, The PHY abstraction method described in slides 5-7 of [R1-1610626](#) can be used for SLS of some MA schemes that use MMSE-SIC/PIC receiver.
 - Companies are encouraged to provide link level simulation results for different combinations of MCS and # of UEs for further verification

[R1-1610686](#) WF on TR Structure for NR Multiple Access Nokia, ASB

Conclusion:

- Rapporteur to propose the detailed subsections for 8.1.3 based on agreements made and to be made in RAN1, e.g.:
 - Agreed observations, agreed PHY abstraction, etc.

[R1-1610743](#) WF on UL grant-free workplan Huawei, HiSilicon, CMCC

[R1-1610744](#) WF on non-orthogonal MA workplan Huawei, HiSilicon, CMCC

[R1-1610745](#) WF on summary of UL non-orthogonal MA progress Huawei, HiSilicon

Agreements:

- Capture the observations on page 4, and slides 7-10 into TR 38.802, with the following updates:
 - Non-orthogonal MA schemes using an advanced receiver (e.g. SCMA, MUSA, IGMA) have little or no performance loss due to MA signature (except RS) collision.
 - Some Non-orthogonal MA results combined with narrowband and/or repetition operations can potentially reach

- Non-orthogonal MA, in some of the evaluated scenarios, provides significant gain in terms of UL link-level sum throughput and overloading capability with ideal and realistic channel estimation in the evaluated scenarios
- Slides 9-10 are to be updated based on updated simulation results submitted to this meeting

R1-1610793 WF on SLS observations of non-orthogonal MA Huawei, HiSilicon, ZTE
Agreements:

- The observations on slide 3, along with appendix on slides 5 and 6, are agreed, with the following update:
 - All simulated non-orthogonal MA schemes with grant-free with advanced receivers (some with ideal channel estimation while others with realistic channel estimation) provides significant
 - compared to a respective grant-free reference scheme assumed based on OFDMA with grant-free by each company
 - Add a note to the appendix:
 - Note: the empty entries in the table are due to absence of simulation data
 - Add two rows in the tables in the Appendix listing the receive type(s) and HARQ combining used by each company
 - For the columns in the tables in the appendix with both ideal and realistic channel estimation, split each column into two columns capturing results with ideal and realistic channel estimation separately
 - slides 5-6 are to be updated based on updated simulation results submitted within this meeting

R1-1610746 WF on summary of grant-free progress Huawei, HiSilicon
R1-1610794 WF on UL grant-free technical aspects Huawei, HiSilicon
R1-1610818 WF on PHY abstraction method for MA SLS ZTE, ZTE Microelectronics, Huawei, HiSilicon
Agreements:

- The physical layer abstraction methods in R1-168076 and slides 5-7 of R1-1610626 can be used for MA system-level evaluation with individual verification by each company
- The candidate PHY abstraction methods should be referred in TR 38.802 by using the two reference documents (R1-168076 and R1-1610626)

R1-1610957 WF on Further Summary of LLS Results Huawei, HiSilicon
Agreements:

- Further capture the LLS results in the tables on Page 4, 5, 6, and 7 of R1-1610957 into TR 38.802, with the following updates:
 - The results are to be updated based on updated simulation results submitted to this meeting
 - Note: the empty entries in the table are due to absence of simulation data
 - Change “SE” in the relevant places of the tables to “bits/RE”
 - Add a note whether or not CRC is included in determining “bits/RE” in each result of the corresponding tables
 - Add references to the MA schemes in the tables
- Also add receiver assumptions in the assumption table
- In addition, provide a reference to the spreadsheet capturing all LLS results
 - Note: CRC is excluded in coding rate determination
 - This is only a clarification, not to be captured in the TR

R1-1610826 WF on summary of grant-free progress Huawei, HiSilicon
Also supported by Convida wireless

R1-1610958 WF on Grant-free URRLC Performance Evaluations Huawei, HiSilicon

R1-1611065 To capture LLS and SLS simulation results for NR MA Huawei, HiSilicon
• Email approval for capturing LLS and SLS simulation results for NR MA submitted to RAN1#86bis meeting until 21st October – Wang Yi (Huawei)
• Companies are encouraged to provide input with the following to be captured into TR:

- For LLS
 - MA signature setting [fixed/random]
 - To replace “overloading” by “number of supported UEs”
- For SLS
 - BS antenna configuration
 - MA signature setting [fixed/random]

- The results in the attachment are a starting point.

R1-1608755 LLS results of PDMA with realistic channel estimation CATT
R1-1608756 SLS results of PDMA CATT

R1-1608757	Consideration on grant-free transmission	CATT	
R1-1608758	Discussion on MA for URLLC	CATT	
R1-1608801	Further LLS results for UL non-orthogonal multiple access	Fujitsu	
R1-1608803	Discussion on grant-free transmission for UL multiple access	Fujitsu	
R1-1608852	Categorization and analysis of MA schemes	Huawei, HiSilicon	
R1-1608853	Further UL LLS Results	Huawei, HiSilicon	
R1-1608854	Further UL SLS Results	Huawei, HiSilicon	
R1-1608855	Advanced multi-user detectors for grant-free transmissions	Huawei, HiSilicon	
R1-1608858	Discussion on grant-free versus grant-based transmissions for infrequent small packets	Huawei, HiSilicon	
R1-1608859	The retransmission and HARQ schemes for grant-free	Huawei, HiSilicon	
R1-1608860	Solutions for collisions of MA signatures	Huawei, HiSilicon	
R1-1608861	Resource allocation and management for grant-free UL	Huawei, HiSilicon	
R1-1608917	Considerations on random resource selection	Spreadtrum Communications	
R1-1608918	Multiple access schemes with considering different UE requirements	Spreadtrum Communications	
R1-1608943	Interleaver based non-orthogonal multiple access	Sony	
R1-1608952	System level performance evaluation for MUSA	ZTE	
R1-1608953	Link level performance evaluation for MUSA	ZTE	
R1-1608955	Considerations on the Preamble design for grant-free non-orthogonal MA	ZTE	
R1-1609036	Discussion on low PAPR non-orthogonal multiple access	Samsung	
R1-1609037	Discussion on grant-free based multiple access	Samsung	
R1-1609038	Collision analysis of grant-free based multiple access	Samsung	
R1-1609040	Basic channel structure for grant-free based multiple access	Samsung	
R1-1609041	Link level evaluation results for IGMA	Samsung	
R1-1609042	System level evaluation results for IGMA	Samsung	
R1-1609043	Discussion on IGMA under multi-cell environments	Samsung	
Withdrawn			
R1-1609223	Further evaluation results of NCMA in UL LLS	LG Electronics	
R1-1609224	SLS evaluation results for the NR MA	LG Electronics	
R1-1609225	Discussion on the MA evaluations and further considerations	LG Electronics	
R1-1609226	Discussion on feedback signaling for grant-free MA	LG Electronics	
R1-1609227	On MA resource and MA signature configurations	LG Electronics	
R1-1609229	NoMA scheme based on NCMA	LG Electronics	
R1-1609230	Discussion on Non-orthogonal Spreading Sequence and codebooks for NoMA	LG Electronics	
R1-1609300	Discussion on multiple access schemes for URLLC	CMCC	
R1-1609332	LLS results for GOCA schemes	MediaTek Inc.	
R1-1609333	LLS results for RDMA schemes	MediaTek Inc.	
R1-1609335	System level evaluation result on GOCA	MediaTek Inc.	
R1-1609399	Discussion on grant-free based UL transmission	Lenovo	
R1-1609400	Discussion on retransmission design for grant-free based UL transmission	Lenovo	
R1-1609441	Text Proposal of PHY abstraction method for NR MA	Huawei, HiSilicon	
R1-1609442	Summary of email discussion thread 86-15 and 86-17 on SLS calibration for NR MA	Huawei, HiSilicon	
R1-1609443	Summary of preliminary LLS results	Huawei, HiSilicon	
R1-1609444	Summary of preliminary SLS results	Huawei, HiSilicon	
R1-1609446	Reference signal design for UL grant-free transmission	Huawei, HiSilicon	
R1-1609498	System-level analysis of UL NOMA schemes	Intel Corporation	
R1-1609499	Grant-free UL transmissions in NR	Intel Corporation	
R1-1609500	On spreading-based NOMA schemes	Intel Corporation	
R1-1609501	DM-RS design and channel estimation for UL NOMA	Intel Corporation	
R1-1609502	Retransmissions and repetitions for UL grant-free NOMA schemes	Intel Corporation	
R1-1609548	DMRS design for non-orthogonal UL multiple access user channel estimation	ETRI	
R1-1609553	Discussion on non-orthogonal MA for eMBB	CATT	
R1-1609580	Discussion on non-orthogonal multiple access for URLLC usage scenario	CATR	
R1-1609612	Discussion on usage scenarios for non-orthogonal multiple access	MediaTek Inc.	
R1-1609613	Benchmark with NB-IoT with non-orthogonal multiple access	MediaTek Inc.	
R1-1609646	Summarizing the MA findings in the TR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609647	On MA resources for grant-free transmission	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609648	Collision handling for grant-free	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609649	Grant-free retransmission with diversity and combining for NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609650	Receiver considerations on UL MA	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609651	Non-orthogonal coded access (NOCA)	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609652	Calibration results for UL grant-free transmission	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609653	Preamble transmission procedures for the mMTC uplink	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609654	Link adaptation for grant-free transmissions	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609655	Relationship between grant-free and grant-based transmission	Nokia, Alcatel-Lucent Shanghai Bell	

R1-1609814	Multiple access schemes for NR phase 1	Panasonic Corporation
R1-1609873	Supporting URLLC in NR: Views and Recommendations	Sharp
R1-1609891	Interleaved-based MA in Fading and Asynchronous environments	InterDigital Communications
R1-1609892	On the Performance of Interleaved-based Multiple Access Schemes	InterDigital Communications
R1-1609893	Considerations on UL grant-free transmissions for mMTC	InterDigital Communications
R1-1610076	Discussion on multiple access for uplink eMBB	NTT DOCOMO, INC.
R1-1610077	SLS evaluation on uplink multiple access	NTT DOCOMO, INC.
R1-1610078	LLS evaluation on uplink multiple access	NTT DOCOMO, INC.
R1-1610118	Link level simulation results for RSMA vs OMA	Qualcomm Incorporated
R1-1610119	System level simulation results for calibration	Qualcomm Incorporated
R1-1610121	Battery life analysis for grant-free transmission	Qualcomm Incorporated
R1-1610122	Mixed grant-free and grant based multiple access	Qualcomm Incorporated
R1-1610214	On Synchronization Requirements for Grant-free MA	Ericsson
R1-1610298	System design considerations for UL NoMA	MediaTek Inc.
R1-1610374	Support of link adaptation for UL grant-free NOMA schemes	Intel Corporation
R1-1610375	Coverage performance for UL NOMA schemes	Intel Corporation
R1-1610376	Summary of current studies on NR Multiple Access	Intel Corporation

8.1.2 Numerology and frame structure for new radio interface

8.1.2.1 Numerology

[R1-1610125](#) NR RB Size Design: 12 vs 16 Qualcomm Incorporated

The document was presented by Jing Jiang from Qualcomm.

Proposal: NR adopts 16 REs per PRB for both UL and DL at least for sub-6 eMBB.

Decision: The document is noted.

[R1-1608963](#) About RB grid definition and handling inter-numerology interference in NR ZTE

The document was presented by Thorsten Schier from ZTE.

- Observation 1: The RB grid shall be the same for FDM and TDM
- Observation 2: A nested RB grid structure for FDM ensures RB alignment among different eNBs
- Observation 3: The alternative option to use the RB grid derived from the 15 kHz SCS even for numerologies with wider RBs can lead to RB-misalignment across multiple cells.
- Observation 4: Also for FDM, the nested RB grid does not waste resources
- Proposal 1: Adopt RB grid for FDM as it is agreed in TDM
- Proposal 2: Two methods to handle inter-numerology interference between two adjacent numerologies may be considered. We prefer the first one.
 - A configurable guard band with a granularity in sub-carriers. This is especially beneficial when different numerology are multiplexed in a dynamic manner
 - In scenarios of lower load or when numerologies are multiplexed semi-statically, a guard band may not be needed. The two numerologies could be placed directly adjacently to each other and different schemes to lower the MCS may be employed.
- Proposal 3: GB configuration mechanisms should be considered, a)semi-static; b)dynamic; c)scheduling; or some combination of above approaches.
- Proposal 4: RAN1 should study the impact of introducing a guard band on the signal design and corresponding techniques to handle it.

Decision: The document is noted.

[R1-1610055](#) Wider BW operation for NR NTT DOCOMO, INC.

The document was presented by Kazuaki Takeda from NTT DOCOMO.

- Proposal: Study an efficient mechanism to achieve a wider BW of around 1GHz and the corresponding feasibilities from both NW and UE perspectives.
- Observation: It would be desired that UE with different BW capability can have flexibility to access to the NR carriers regardless of NW channel BW and the number of NR carriers.

Discussion: Ericsson→Maximum supportable BW is a RAN4 issue and their feedback is needed.

Decision: The document is noted.

[R1-1610124](#) 60kHz vs. 120kHz vs. 240kHz performance; impact to PN Qualcomm Incorporated

The document was presented by ... from Qualcomm.

- Observation 1: From most artifacts of the millimeter wave link, two are directly affected by tone spacing, if the CP overhead is kept constant. These are the phase noise and intersymbol interference caused by channel delay spread exceeding the CP length.

- Observation 2: Increasing the tonespacing from 60kHz to 120kHz causes a noticeable improvement in many cases and in the worst category the performance remains the same.
- Observation3: Increasing the tone spacing to 240kHz is only advantageous for the “normal delay” category and a further increase to 480kHz reduce performance for all categories.
- Proposal 1: Prioritize a tone spacing of 120 kHz for millimeter wave airlinks.

Decision: The document is noted.

R1-1609050 Numerology for URLLC Samsung

The document was presented by Youngbum Kim from Samsung.

- **Error! Reference source not found.**
- **Error! Reference source not found.**
- **Error! Reference source not found.**

Decision: The document is noted.

R1-1609048 Time Alignment Among Different Numerologies for Same CP Overhead Samsung

The document was presented by Youngbum Kim from Samsung.

Proposal: RAN1 should consider the proposed alternatives (summarized in Table 1) for supporting time alignment among different numerologies with same CP overhead.

Decision: The document is noted.

R1-1609232 Details on symbol-level alignment LG Electronics

The document was presented by Yunjung Yi from LGE.

Proposal 1: There are two cases: inband and outband multiplexing different numerologies defined. If symbol level alignment is considered, it is restricted to inband cases.

Proposal 2: For NCP family, adopt Option 3 for symbol level alignment.

- *Option 3: Reserve 0.51us, and utilize the same CP for all OFDM symbols*

Decision: The document is noted.

R1-1609427 Evaluation and discussion on CP types for above 6GHz Huawei, HiSilicon

The document was presented by ... from Huawei.

Proposal 1: NR should support ECP for 120kHz below 40GHz band.

Proposal 2: NR should support ECP for 960kHz above 40GHz band.

Decision: The document is noted.

R1-1609894 System level evaluations for multiple CP lengths InterDigital Communications

The document was presented by Shahrokh Nayeb Nazari from InterDigital.

Proposal: NR design should support Zero-CP length for a given subcarrier spacing.

Decision: The document is noted.

R1-1610300 CP length for NR VODAFONE Group Plc

The document was presented by Razieh Razavi from Vodafone.

- Observation 1: The most optimal cyclic prefix to set for the radio interface may depend very much on the specific environment of the UE. Being able to adapt the CP to suit the actual delay spread observed, this could help the link performance, and improve the end user experience.
- Observation 2: Several values of CP per numerology, i.e., Reduced CP, Normal CP and Extended CP, may help to optimize the CP overhead with respect to the UE experienced delay spread and service.
- It is proposed that:
- Proposal 1: NR should support ECP for eMBB and low latency usecases. The representative value of the delay spread related to the aforementioned scenarios should be investigated in order to select the appropriate ECP values per numerology in phase 1.
- Proposal 2: Multiple CP lengths per numerology should be defined for eMBB and URLLC use cases to support different scenarios and delay spread in phase 1 (and later phases).
- Proposal 3: More than one CP lengths can be operated within a cell in both uplink and downlink for eMBB and URLLC use cases in phase 1 (and later phases).

Decision: The document is noted.

R1-1609313 Numerologies for different carrier frequencies KT Corp.

The document was presented by ... from KT and provides a study on subcarrier spacing values that are required for each use case in target frequency bands.

Decision: The document is noted.

R1-1610488 Way Forward on wider BW operation for NR NTT DOCOMO, AT&T

The document was presented by Kazuaki Takeda from NTT DOCOMO.

- Study the following mechanisms from RAN1 perspective to support the wider bandwidth of around 1GHz and the corresponding feasibilities from both NW and UE perspectives
 - Carrier Aggregation/Dual Connectivity (Multi-carrier approach)
 - Details are FFS
 - Single carrier operation
 - Details are FFS
 - Maximum channel BW continues to be studied in RAN1/4
- Send an LS to ask RAN4 to take into account the above proposals

Decision: The document is noted, modified and agreed as follows:

Agreements

- At least for Phase 1, study mechanisms to support operation over e.g. around 1GHz contiguous spectrum from both NW and UE perspectives including the maximum single carrier bandwidth of at least 80 MHz
 - Carrier Aggregation/Dual Connectivity (Multi-carrier approach)
 - Details are FFS
 - FFS: non-contiguous spectrum case
 - Single carrier operation
 - Details are FFS
 - Maximum channel bandwidth continues to be studied in RAN1/4
 - Maximum bandwidth supported by some UE capabilities/categories may be less than channel bandwidth of serving single carrier
 - Note that some UE capabilities/categories may support channel bandwidth of serving single carrier
- Send an LS to ask RAN4 to study the feasibility of the above mechanisms from both NW and UE perspectives

Prepare draft LS to RAN4 until Tuesday morning – Kazuaki (DOCOMO)

Tuesday:

[R1-1610508](#) [Draft] LS on wider bandwidth operation for NR NTT DOCOMO

Decision: The document is noted and final LS is **approved in [R1-1610655](#)**, with following update:

RAN1 discussed how to support operation over, e.g., around 1 GHz contiguous spectrum and reached the following agreements.

[R1-1610503](#) Way Forward on Alignments among different numerologies in frequency domain LG Electronics

The document was presented by Yunjung Yi from LGE.

- For a given numerology/subcarrier spacing, a UE is indicated implicitly and/or explicitly on the start and end frequency
 - Start and end frequency location can be aligned with RB boundary based on reference numerology
- A UE forms RB for the given numerology from the starting frequency location per each numerology/subcarrier spacing
- Note: Depending on the start/end frequency configuration, RB grid of different numerologies can be formed in a nested manner or RB grid can be formed to maximize resource utilization

Decision: The document is noted. Continue discussion – (LGE)

- The number of subcarriers per PRB is:
 - Alt.1: 12 supported by CATT, Huawei, HiSilicon, Nokia, InterDigital, ETRI, Intel, Ericsson, Panasonic
 - Alt.2: 16 supported by Qualcomm (can agree on Alt 1 but would like to clarify that common understanding is that there are performance issue for small packet size).

Agreement: The number of subcarriers per PRB is 12.

- Adopt RB grid for FDM as it was agreed in TDM (ZTE: similar proposal in [R1-1610483](#)) – supported by ZTE, ZTE Microelectronics, Ericsson, Qualcomm, Nokia, Alcatel-Lucent Shanghai Bell, Panasonic, Convida Wireless, Intel, CATT, InterDigital, Samsung, MediaTek, ETRI
- NR carrier shall support UEs with bandwidth support smaller than the carrier bandwidth
- FFS: Fractional RB support

[R1-1610483](#) Way Forward on RB grid definition for mixed numerologies - FDM ZTE, ZTE Microelectronics, Ericsson, Qualcomm, Nokia, Alcatel-Lucent Shanghai Bell, Panasonic, Convida Wireless

Decision: The document is noted.

Working assumption: Adopt RB grid for FDM as it was agreed in TDM

Possible Working assumption:

- In the DL transmission to a UE, the subcarrier overlapping with the DC subcarrier of the receiving UE is modulated in the same way as other subcarriers of the same PRB
 - UE may puncture the DC subcarrier

Continue offline discussion within Monday – (Ericsson)

Possible working assumption (Monday evening):

- For transmitter side, in a DL transmission to a UE, the subcarrier overlapping with the DC subcarrier of the receiving UE is modulated in the same way as other subcarriers of the same PRB
- For receiver side, UE may puncture the DC subcarrier
- DC handling in the receiver side will not be specified

Continue offline discussion until Tuesday – Stefan (Ericsson)

Tuesday

R1-1610622 Way Forward on DC subcarrier Ericsson

- Transmitter side
 - No special handling of the DC subcarrier(s) (if present) on the transmitter side is specified in RAN1
 - Consequence of previous agreement “No explicit DC subcarrier is reserved both for DL and UL”
- Receiver side
 - No special handling of the DC subcarrier(s) (if present) on the receiver side is specified in RAN1
 - Behavior left to implementation, the receiver may for example puncture data received on the DC subcarrier

Decision: The document is noted.

Possible working assumption:

- Transmitter side
 - No special handling of the DC subcarrier(s) on the transmitter side is specified in RAN1

Continue offline discussion until Wednesday – Stefan (Ericsson)

Agreements:

- Receiver side
 - No special handling of the DC subcarrier(s) on the receiver side is specified in RAN1
 - Behavior left to implementation, the receiver may for example puncture data received on the DC subcarrier

Wednesday: Qualcomm’ comment→ was not present when above agreement has been made, is ok to keep the agreement but would like to understand what transmitter/receiver sides mean? DC subcarriers (if present or not) imply 4 cases being considered.

Agreements:

- Regarding DC present within the transmitter,
 - DC Handling of DC subcarrier in transmitter side is specified
 - Receiver knows where DC subcarrier is or is informed (e.g., by specification or signaling) of where DC subcarrier is or if DC subcarrier is not present within receiver bandwidth
 - When receiver is informed DC subcarrier is present, FFS: transmitter DC subcarrier is punctured, rate matched, modulated, or EVM is not specified
 - When DC subcarrier is not present, all subcarriers within the receiver bandwidth are transmitted

R1-1610521 Way Forward on Subframe duration ZTE, ZTE Microelectronics, Ericsson, NTT Docomo, Nokia, Qualcomm, Panasonic, CATT, Mediatek, Convida Wireless

Decision: The document is noted.

Agreements:

- Sub-frame duration is fixed to 1ms
- Reference numerology for defining subframe duration is 15 kHz

R1-1610540 Way Forward on slot NTT DOCOMO, INC., Ericsson, Panasonic, Nokia, Alcatel-Lucent Shanghai Bell, Qualcomm, Huawei, HiSilicon

Decision: The document is noted.

Agreements:

- For SCS of up to 60kHz with NCP, $y = 7$ and 14
 - FFS: whether/which to down select for certain SCS(s)
- For SCS of higher than 60kHz with NCP, $y = 14$

R1-1610500 Way Forward on Numerology for forward compatibility InterDigital, Mitsubishi, Nokia, Alcatel-Lucent Shanghai Bell, Intel

- Numerology and frame structure decisions in NR should consider zero-length CP overhead for above 40 GHz

Decision: The document is noted. Also supported by KDDI. Continue discussion

Agreement: RAN1 has not so far identified any forward compatibility issues for the potential introduction of new waveforms including zero-length CP in the future.

Tuesday

R1-1610652 Way Forward on Symbol Level Alignments LG Electronics, NTT DOCOMO, Ericsson, Panasonic, Qualcomm, ZTE (R1-1610502)

- Confirm WA in the background
- For normal CP family, the following is adopted
 - For $F_s = 15 \text{ kHz} * 2^n$ (n is a positive integer),
 - Each symbol length (including CP) of 15 kHz equals the sum of the corresponding 2^n symbols of F_s
 - Other than the first OS in every 0.5msec, all OFDM symbols within 0.5msec have the same size
 - The first OS in 0.5msec has longer CP of 16 Ts (assuming 15 kHz and FFT size of 2048) compared to other OSs
 - For $F_s = 15 \text{ kHz} * 2^n$ (n is a negative integer)
 - Each symbol length (including CP) of F_s equals the sum of the corresponding 2^n symbols of 15 kHz

Decision: The document is noted.

Agreement:

- Alignment within a subframe
 - Symbol level alignment across different subcarrier spacings with the same CP overhead is assumed within a subframe duration in a NR carrier
 - FFS: Unlicensed spectrum case

(Agreement):

- For normal CP family, the following is adopted
 - For $F_s = 15 \text{ kHz} * 2^n$ (n is non-negative integer),
 - Each symbol length (including CP) of 15 kHz equals the sum of the corresponding 2^n symbols of F_s
 - Other than the first OS in every 0.5msec, all OFDM symbols within 0.5msec have the same size
 - FFS: The first OS in 0.5msec has longer CP of 16 Ts (assuming 15 kHz and FFT size of 2048) compared to other OSs
 - FFS: For $F_s = 15 \text{ kHz} * 2^n$ (n is a negative integer)
 - Each symbol length (including CP) of F_s equals the sum of the corresponding 2^{-n} symbols of 15 kHz

Discuss further on above FFS

Wednesday: Above agreement is modified as follows:

Agreement:

- For normal CP family, the following is adopted
 - For $F_s = 15 \text{ kHz} * 2^n$ (n is non-negative integer),
 - Each symbol length (including CP) of 15 kHz equals the sum of the corresponding 2^n symbols of F_s
 - Other than the first OS in every 0.5msec, all OFDM symbols within 0.5msec have the same size
 - The first OS in 0.5msec is longer by 16 Ts (assuming 15 kHz and FFT size of 2048) compared to other OSs
 - **FFS: How to utilize this 16 Ts**
 - For $F_s = 15 \text{ kHz} * 2^n$ (n is a negative integer)
 - Each symbol length (including CP and 16 Ts) of F_s equals the sum of the corresponding 2^{-n} symbols of 15 kHz

Thursday: Above FFS is replaced by:

- 16 Ts is used for CP for the first symbol

Thursday session

R1-1610126 Scaled CP vs ECP: delay spread, Doppler and SNR tradeoff study Qualcomm Incorporated

- Proposal 1: Design of an additional scaled numerology family with ECP (large CP overhead) should happen only if strong use cases or deployments scenarios are identified, where the normal CP scaled numerology family cannot provide an acceptable performance.
- Proposal 2: The NCP scalable numerology family can be adapted for different delay and Doppler scenarios dynamically or semi-statically.
- Proposal 3: Evaluation of different CP families should happen in conjunction with pilot pattern design.

Decision: The document is noted.

The document was presented by ... from ...

Discussion:

Decision: The document is noted.

[R1-1610142](#) URLLC Channel Coding Qualcomm

[R1-1610810](#) Way forward on CP Huawei, HiSilicon, Sony, OPPO, CATT, Vodafone, Ericsson, ZTE, Intel , Mediatek, NTT DOCOMO, CATR

Agreements:

- From Phase 1, physical layer design should support an extended CP
 - Extended CP will be only one in given subcarrier spacing
- FFS: Exact for the services/scenarios for extended CP

[R1-1610791](#) WF on Fractional RB usage Samsung, ZTE, ZTE Microelectronics, Panasonic, KDDI, IITH, IITM, Tejas Networks, CEWiT, Nokia
Also supported by ASB, Reliance jio
Continue discussions

[R1-1610949](#) WF on forward compatibility for NR Samsung, LG Electronics, Nokia, ASB, Ericsson, Huawei, HiSilicon, Qualcomm, AT&T, Panasonic

Agreements:

- Explicit signaling to NR UEs can indicate reserved resources
 - The details on signaling information and transmission are FFS
 - e.g. granularity for blank resource indication
 - e.g. RRC signaling and/or L1 signaling (including DL control information)
 - e.g. broadcast and/or unicast signaling
 - e.g., whether this signaling is applicable to UE UL operation and/or DL operation and/or sidelink operation
 - FFS: combination of above signaling
 - FFS: time and frequency granularity

[R1-1610953](#) WF on carrier aggregation Huawei, HiSilicon, Nokia, Alcatel-Lucent Shanghai Bell, NTT DOCOMO, Qualcomm, ZTE

Agreements:

- Study at least the following aspects for NR carrier aggregation / dual connectivity
 - Intra-TRP and inter-TRP with ideal and non-ideal backhaul scenarios
 - Number of carriers
 - The need for certain channels, e.g. downlink control channel, uplink control channel or PBCH for some carriers
 - Cross-carrier scheduling and joint UCI feedback, e.g. HARQ-ACK feedback
 - TB mapping, i.e., per carrier or across carriers
 - Carrier on/off switching mechanism
 - Power control
 - Different numerologies between different/same carrier(s) for a given UE
 - FFS: whether/if different numerologies are multiplexed on one carrier for one UE is called carrier aggregation / dual connectivity

R1-1608759	NR numerology	CATT	
R1-1608760	NR CP length for different numerologies	CATT	
R1-1608761	NR symbol alignment and operation in unlicensed spectrum	CATT	
R1-1608833	Discussion on time alignment with different CP overhead	Huawei, HiSilicon	
R1-1608834	Discussion on time alignment with the same CP overhead	Huawei, HiSilicon	
R1-1608835	Evaluation on CP types for 60kHz subcarrier	Huawei, HiSilicon	
R1-1608844	Support of URLLC in DL	Huawei, HiSilicon	
R1-1608900	Subcarrier spacing design for data and reference signal	Guangdong OPPO Mobile Telecom.	
R1-1608901	Discussion of the UE support of multiple numerologies	Guangdong OPPO Mobile Telecom.	
R1-1608920	Discussion on numerology of NR	Spreadtrum Communications	
R1-1608945	Discussion on longer CP lengths	Sony	
R1-1608961	Reference numerology for NR	ZTE	
R1-1608962	About the support of multiple CP families for NR	ZTE	
R1-1609044	Discussion on guard-band supporting methods	Samsung	
R1-1609045	RB grid for mixed numerology	Samsung	
R1-1609046	Number of subcarriers per PRB	Samsung	
R1-1609047	Support of Different Numerologies for Same Vertical	Samsung	
R1-1609049	Time Alignment Among Different Numerologies for Different CP Overhead	Samsung	
R1-1609051	Consideration on UE capability to process multiple numerologies	Samsung	
R1-1609052	Numerology for URLLC	Samsung	
R1-1609153	Discussion on PSS/SSS/PBCH in numerology multiplexing	NEC	
R1-1609159	On Number of subcarriers per PRB for NR	NEC	
R1-1609231	Discussion on 60kHz CP options	LG Electronics	
R1-1609233	Discussion on time-alignment between different CP families	LG Electronics	
R1-1609301	Discussion on phase noise modeling	CMCC	
R1-1609302	Discussion on High Mobility Numerology and RS design	CMCC	
R1-1609303	Discussion and evaluation of CP design for NR	CMCC	
R1-1609425	Discussion on UE behavior on mixed numerology carrier	Huawei, HiSilicon	
R1-1609426	Evaluation on subcarrier spacing and CP types for UL transmission	Huawei, HiSilicon	
R1-1609428	Numerology for 70 GHz and above	Huawei, HiSilicon	
R1-1609430	On multiple carrier operation	Huawei, HiSilicon	
R1-1609503	Reference numerology and time alignment	Intel Corporation	
R1-1609504	Slot and mini-slot numerology and alignment	Intel Corporation	
R1-1609505	Capability to support multiple numerologies	Intel Corporation	
R1-1609607	Numerology design and link-level simulation results for high speed scenario	ETRI	
R1-1609608	Discussion on the subcarrier spacing selection for NR	ETRI	
R1-1609625	On RB structure for mixed numerologies	Ericsson	
R1-1609626	On RB size	Ericsson	
R1-1609627	On supported numerologies	Ericsson	
R1-1609635	On symbol alignment	Ericsson	
R1-1609642	On extended CP	Ericsson	
R1-1609645	On half-subcarrier shift in NR UL	Ericsson	
R1-1609656	On the symbol level alignment across different subcarrier spacings	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609657	On the number of subcarriers per PRB	Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless	
R1-1609658	Supported numerologies for NR Phase I	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609659	Guard band arrangement supporting mixed numerology	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609660	Intra-carrier sub-band for mixed numerology	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609661	Comparison of ECP and NCP link performance with 60 kHz subcarrier spacing	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609698	Remaining numerology related aspects	Panasonic Corporation	
R1-1609728	Study of PN Models for above 6 GHz with experimental data	National Instruments Corp.	
R1-1609791	Proposals for frame format supporting different CP families	Mitsubishi Electric	
R1-1610022	UE support for multiple numerologies for NR	INTERDIGITAL COMMUNICATIONS	
R1-1610080	Remaining numerology aspects	NTT DOCOMO, INC.	
R1-1610123	URLLC numerology and frame structure design	Qualcomm Incorporated	
R1-1610127	Numerology tradeoff case study	Qualcomm Incorporated	
R1-1610297	Evaluation of UW DFT-s-OFDM as a CPless waveform for high speed train scenario	Mitsubishi Electric Co.	

8.1.2.2 Frame structure

Summarize the frame structure study

Note that detailed signal/channel design can be studied in other sub-agendas

R1-1610129	Summary of [86-19] Discussion on Slot Structure Use Cases	Qualcomm Incorporated
----------------------------	---	-----------------------

The document was presented by Joseph Soriaga from Qualcomm.

Proposal 1: *For the slot duration y , at least the following should be supported*

- *Configurations supporting slot $y=7$ and 14 symbols*

Proposal 2: *For transmission durations of EMBB, at least the following should be supported*

- *Ability to define transmission duration through the aggregation of slots*
 - *Configuration may be through semi-static RRC signaling or dynamic L1 indication*
 - *FFS: if any aspects of aggregation or related control should be captured in specification*
- *Ability to configure the minimum transmission duration of more than 14 symbols at higher SCS*
 - *FFS: how to define the minimum*
 - *Option 1. Minimum value of SCS (e.g., 120kHz needs 28 symbols)*
 - *Option 2. Minimum transmission duration of [0.125ms]*
 - *Option 1: Configuration of y to be larger than 14*
 - *Option 2: Aggregation of slots to achieve*

Proposal 3: *The NR frame structure should support both slots and mini-slots.*

- *FFS: Timeline granularity for monitoring control of the mini-slot*

Proposal 4: *The NR frame structure should at least support the following*

- *Periodicities for downlink and uplink control equal to 250us, 500us, and 1ms*
- *Longer intervals or aperiodicity resulting from e.g., semistatic or dynamic slot aggregation*

Proposal 5: *Define a subframe duration as 1 ms with a reference numerology 14-symbols at 15 kHz SCS.*

Decision: The document is noted.

Working assumption/Possible agreements:

- The NR frame structure should support both slots and mini-slots
 - FFS: Timeline granularity for monitoring control of the mini-slot
 - FFS: Terminologies of mini-slot

Continue discussion.

Tuesday: Huawei → no progress on mini-slots structure so far, cannot get it agreed – working assumption can be a step forward

Tuesday

Possible agreements:

- Multiple slots can be aggregated in NR
 - Aggregation may be through semi-static RRC signaling and/or dynamic L1 indication and/or pre-determined by specification
 - Multiple-slot aggregation is supported at least for the following use cases in NR
 - One DL/UL assignment over one or multiple slots in the aggregated slots

Agreements:

- Slot aggregation is supported
- Data transmission can be scheduled to span one or multiple slots

Possible agreements:

- For slot based transmission, the NR frame structure should at least support the following
 - Periodicities for possible downlink and uplink control transmission equal to or approximately 125us, 250us, 500us, and 1ms
 - Longer intervals or aperiodicity resulting from e.g., semistatic or dynamic slot aggregation

Continue offline discussion until Wednesday

R1-1609630 On UE-specific DC subcarrier in NR Ericsson

Observation: Ignoring the information transmitted on the DC subcarrier slightly increases the effective code rate. The code rate increase is worst for a single PRB allocation and gets smaller for wider allocation.

Proposal: In a DL transmission to a UE, the subcarrier overlapping with the DC subcarrier of the receiving UE is modulated in the same way as other subcarriers of the same PRB.

Decision: The document is noted.

R1-1609510 Discussion on mini-slot structure for URLLC Intel Corporation

The document was presented by ... from Intel.

Proposal 1

- *A set of URLLC transmission durations (mini-slots) is configured to a UE.*
- *The sets of URLLC transmission durations for DL and for UL may be independently configured.*
- *Flexible URLLC transmission durations are realized by aggregation of mini-slots.*

Proposal 2

- *URLLC resource access granularity is equal to or shorter than the minimum configured URLLC TTI duration.*
 - *FFS the performance benefits vs complexity tradeoffs for symbol level resource access granularity for URLLC services.*

Decision: The document is noted.

R1-1608710 Frame Structure for Ultra-Low Latency Scheduled-based UL Access Idaho National Laboratory

The document was presented by Ramon Khalona from INL.

- Observation: To enable a schedule-based UL access with dynamic eMBB/URLCC multiplexing in dynamic TDD deployments requires an ultra-fast scheduling-request signal.
- Observation: Zero-wait-time scheduling request transmitted as an underlay signal reduces the average wait time to almost zero, eliminates the delay uncertainty and provides scheduling flexibility to the eNB to adapt and dynamically allocate resources for UL transmissions meeting the most stringent URLLC latency requirements.
- Observation: Underlay SR signals transmissions have the same numerology as the data channel.
- Proposal: NR should support shorter SR transmissions lasting n symbols located at those regions indicated in Figure 3, where $0 < n < (N - N_{DCI} - N_{UCI} - N_{GP})$ and N , N_{DCI} , N_{UCI} , and N_{GP} are the maximum number of symbols, number of DCI symbols, number of UCI symbols and the switching-gap duration in a subframe, respectively.

Decision: The document is noted.

**R1-1608903 Discussion of the UE processing time on the support of multiple numerologies and frame structures
Guangdong OPPO Mobile Telecom.**

The document was presented by ... from OPPO.

- Proposal 1: NR should not assume fixed UE processing time
- Proposal 2: UE processing time is divided into different level/class and UE reports its supported level/class.

Decision: The document is noted.

R1-1609145 Discussion on numerology multiplexing for supporting different service requirements NEC

The document was presented by Rajitha Palipana from NEC.

- Proposal 1: Support configuration of a waveform of a selected numerology that is optimum for one selected service applied for the entire carrier BW and last for a period of time.
- Proposal 2: Support configuration of multiple waveforms of different numerologies frequency multiplexed within the carrier BW to simultaneously and optimally serve different services.
- Proposal 3: Not to support dynamic configuration of multiple numerologies to support fast change of waveform to adapt to instantaneous demand.
- Observation 1: It is observed that UE-specific numerology handling on subframe basis may need further study on resource block and subframe design strategies for seamless co-existence of UEs having different numerologies.

Decision: The document is noted.

R1-1608942 Multiplexing eMBB and URLLC Transmissions Sony

The document was presented by Martin Beale from Sony.

- Observation 1: TDM does not efficiently utilises the resources in multiplexing eMBB and URLLC.
- Observation 2: It may not be beneficial to FDM eMBB and URLLC.
- Observation 3: It is beneficial that the UE receiving eMBB transmission is aware that this transmission is corrupted by an overlapping URLLC transmission.
- Proposal 1: Introduce a downlink control channel at the end of an eMBB transmission frame structure to provide repair information on any overlapping URLLC transmission.

Decision: The document is noted.

R1-1609609 Discussion on time domain frame structure for high speed train scenario with relay for NR ETRI

The document was presented by ... from ETRI.

- Observation 1: The probability of Random Access (RA) collision is very low in HST scenario with relay, and in most of the cases there is only one active relay sending network access request.
- Observation 2: Because the RA collision in HST scenario with relay is not severe and it can be avoided simply, preamble and TA related transmission/reception and processing are no more necessary.
- Proposal 1: The advanced frame structure, which is applicable for the fixed DL transmission and dynamic UL reception in time domain, should be supported at least for the HST scenario with relay for NR.
- Proposal 2: The methods for finding the boundary of UL part during reception by BBU (BS) is FFS.

Decision: The document is noted.

R1-1609919 Flexible frame structure and control signalling for NR Motorola Mobility

The document was presented by ... from MotM and proposes:

- slots and mini-slots
 - Slot duration is $y=7$ OFDM symbols in the numerology used for transmission.

- UE can be configured with a mini-slot.
 - mini-slot duration is $y' = 1$ OFDM symbol in the numerology used for transmission.
 - It is preferable to support only 1 OFDM symbol mini-slot length. However, if multiple mini-slot lengths are defined, the UE can be configured with only one mini-slot length at any given time.
 - mini-slot configuration should be supported at least for subcarrier spacing ≤ 30 kHz
- DL control signalling
 - DL control signalling can be sent to the UE once every slot duration
 - If the UE is configured with a mini-slot, DL control signalling can be sent to the UE once every mini-slot
 - If start of every slot does not align with a mini-slot (e.g. for 2 symbol mini-slot) DL control signalling can be sent to the UE once every mini-slot and once every slot.
- Resource allocation granularity
 - UE can be assigned DL/UL resources in multiples of Time resource units (TRUs).
 - 1TRU corresponds to all available OFDM symbols within one slot
 - UE can also be configured to receive mini-TRU based DL/UL resource assignments.
 - 1 mini-TRU corresponds to one OFDM symbol in the numerology used for transmission

Decision: The document is noted.

The document was presented by ... from ...

Discussion:

Decision: The document is noted.

[R1-1610546](#) Way Forward on bandwidth adaptation in NR MediaTek, Acer, CHTTL, III, Panasonic, Ericsson,
AT&T, Nokia, ASB, Qualcomm
[R1-1611041](#) Way Forward on bandwidth adaptation in NR MediaTek, Acer, CHTTL, III, Panasonic, Ericsson, Nokia,
ASB, Samsung, LG, Intel

Agreements:

- At least for single carrier operation, NR should allow a UE to operate in a way where it receives at least downlink control information in a first RF bandwidth and where the UE is not expected to receive in a second RF bandwidth that is larger than the first RF bandwidth within less than $X \mu s$ (FFS: value of X)
 - FFS the first RF bandwidth is within the second RF bandwidth
 - FFS the first RF bandwidth is at the center of the second RF bandwidth
 - FFS the maximal ratio of the first RF bandwidth over the second RF bandwidth
 - FFS detailed mechanism
- FFS RF bandwidth adaptation for RRM measurement

[R1-1610902](#) WF on Multiplexing eMBB and URLLC in DL Samsung, Panasonic, ZTE, ZTE Microelectronics, ETRI,
Ericsson, CATT, Huawei, NTT DOCOMO, LGE, CMCC, Convida wireless, InterDigital, Sony, Fujitsu
Also supported by Sharp, HiSilicon

Agreements:

- From network perspective, multiplexing of transmissions with different latency and/or reliability requirements for eMBB/URLLC in DL is supported by
 - Using the same sub-carrier spacing with the same CP overhead
 - FFS: different CP overhead
 - Using different sub-carrier spacing
 - FFS: CP overhead
 - NR supports both approaches by specification
- NR should support dynamic resource sharing between different latency and/or reliability requirements for eMBB/URLLC in DL

[R1-1610712](#) Dynamic resource sharing between eMBB and URLLC in DL Huawei
[R1-1610995](#) WF on dynamic resource sharing between eMBB and URLLC in DL Huawei, HiSilicon, CATR, Potevio,
Samsung
[R1-1610952](#) Semi-static resource sharing between eMBB and URLLC LG Electronics, Panasonic

Agreements:

- Consider further the tradeoffs for meeting URLLC requirements for the following.
 - Semi-static resource allocation for UL data transmission.
 - Dynamic indication of available resource (e.g., by broadcast DCI) for UL data transmission.
 - Normal SR-based transmission

- Other solutions are not precluded

R1-1608762	Way Forward on UE-specific slot configuration	CATT	
R1-1608763	NR Time domain structure: subframe, slot and mini-slot and time interval		CATT
R1-1608764	NR frame structure for multiplexing of URLLC and eMBB traffic	CATT	
R1-1608765	NR frequency domain structure: PRB	CATT	
R1-1608766	Configurable DL control channel monitoring in NR system design	CATT	
R1-1608767	On-demand access for UE power saving in NR system design	CATT	
R1-1608804	NR Frame structure considerations for low latency TDD operation	Fujitsu	
R1-1608805	Discussion on flexible/dynamic TDD	Fujitsu	
R1-1608806	Guard period setting in TDD based NR frame structure	Fujitsu	
R1-1608807	TDD frame structure with mixed numerology	Fujitsu	
R1-1608808	Discussion on subframe design with symbol level alignment	Fujitsu	
R1-1608836	Discussion on time domain structures	Huawei, HiSilicon	
R1-1608837	Discussion on slot and mini-slot	Huawei, HiSilicon	
R1-1608841	Support of flexible bandwidth	Huawei, HiSilicon	
R1-1608842	Discussion on blank resources	Huawei, HiSilicon	
R1-1608902	Discussion on subframe structure for NR	Guangdong OPPO Mobile Telecom.	
R1-1608904	Effects of channel reciprocity-based MIMO on frame structure design	Guangdong OPPO Mobile Telecom.	
R1-1608957	Multiplexing of eMBB and URLLC	ZTE	
R1-1608964	About slot structure and scheduling units for NR	ZTE	
R1-1609053	Time domain structure design	Samsung	
R1-1609054	FDM for eMBB and URLLC	Samsung	
R1-1609055	Forward compatibility considerations for joint operation of wireless backhaul and access	Samsung	
R1-1609057	Evaluation results of eMBB with HARQ retransmission in case of multiplexing eMBB and URLLC		
Samsung			
R1-1609058	Evaluation results of superposition scheme in case of multiplexing eMBB and URLLC	Samsung	
R1-1609059	Multiplexing URLLC and eMBB in DL	Samsung	
R1-1609060	Impact on eMBB PDSCH BLER by eMBB puncturing to support URLLC		Samsung
R1-1609061	User plane latency evaluation results for URLLC in FDD NR	Samsung	
R1-1609062	User plane latency evaluation results for URLLC in TDD NR	Samsung	
R1-1609151	Proposals for frame structure	NEC	
R1-1609234	Discussion on frequency-alignment and resource block structure for different numerologies		LG
Electronics			
R1-1609235	Discussion on subframe/slot/mini-slot	LG Electronics	
R1-1609236	On multiplexing between eMBB and URLLC	LG Electronics	
R1-1609238	Discussion on multi-carrier operation between LTE and NR	LG Electronics	
R1-1609304	Discussion on guard period in NR frame structure	CMCC	
R1-1609386	NR Frame Structure Design Requirements	AT&T GNS Belgium SPRL	
R1-1609391	Frequency domain NR frame structure	ETRI	
R1-1609392	Multiplexing of eMBB and URLLC transmissions	ETRI	
R1-1609393	Discussion on the slot structure in time domain	ETRI	
R1-1609433	Discussion on DC handling for downlink and uplink	Huawei, HiSilicon	
R1-1609506	NR physical resource block definition	Intel Corporation	
R1-1609507	Further details on NR slots	Intel Corporation	
R1-1609508	Frame Structure for NR unlicensed operation	Intel Corporation	
R1-1609509	NR frame structure for forward compatibility	Intel Corporation	
R1-1609550	On the PRB definition: subcarrier number analysis	MediaTek Inc.	
R1-1609554	Views on remaining issues for NR frame structure	MediaTek Inc.	
R1-1609555	Discussion on slot structure and channel format	MediaTek Inc.	
R1-1609556	Cross slot scheduling in NR	MediaTek Inc.	
R1-1609618	On slots and mini-slots	Ericsson	
R1-1609621	On carrier bandwidth	Ericsson	
R1-1609629	On subframes	Ericsson	
R1-1609662	On the subframe and slot structures in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609663	On the mini-slot structures in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609664	Comparison of slot and mini-slot based approaches for URLLC	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609665	On bandwidth extension solutions in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609666	On the indication of forward compatibility resources	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609667	On the unlicensed band operation in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1609700	Remaining frame structure discussion	Panasonic Corporation	
R1-1609800	On unified NR frame structure for different spectrum types	ZTE	

R1-1609815	Discussion on frequency domain frame structure for NR	Panasonic Corporation
R1-1609874	Supporting URLLC in NR: Views and Recommendations	Sharp
R1-1609886	Discussion on flexible slot structure with different numerologies	Potevio
R1-1610023	Frame structure for NR	INTERDIGITAL COMMUNICATIONS
R1-1610024	On the number of subcarriers per PRB for NR	INTERDIGITAL COMMUNICATIONS
R1-1610051	On PRB alignment for different NR numerologies	INTERDIGITAL COMMUNICATIONS
R1-1610061	Frequency-domain aspects of frame structure	NTT DOCOMO, INC.
R1-1610081	Time-domain aspects of frame structure	NTT DOCOMO, INC.
R1-1610088	On time alignment between numerologies of different CP overhead	INTERDIGITAL COMMUNICATIONS
R1-1610128	Slot structure, control intervals and scheduling intervals	Qualcomm Incorporated
R1-1610130	Scalable Numerology Control Design for NR	Qualcomm Incorporated
R1-1610131	NR numerology scaling and alignment	Qualcomm Incorporated
R1-1610132	Advanced frame structure	Qualcomm Incorporated
R1-1610133	Multi-TTI and size of slot/minislot and impact to mmW	Qualcomm Incorporated
R1-1610134	Methodology for UE DOU analysis	Qualcomm Incorporated
R1-1610135	Evaluation of frame structure design for UE power consumption	Qualcomm Incorporated
R1-1610217	Resource assignment for mixed numerologies	Panasonic
R1-1610228	Discussion on time domain structure for CP length	KDDI Corporation
R1-1610307	Views on time domain structure for NR	KT Corp.

8.1.3 Channel coding and modulation for new radio interface

[R1-1610878](#) Chairman's notes of AI 8.1.3 on channel coding and modulation for NR Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Discussion: Rapporteur (Nokia)→ very tough sessions with both Wednesday & Thursday night sessions (finished around 1:00AM)

Huawei→ no issues to be reported but the notes are going to be endorsed without having all relevant delegates being present due to late ending time.

RAN1 Chair: agreed to come-back before meeting is over.

Decision: The document is finally endorsed and content incorporated below.

8.1.3.1 Channel coding

Includes choosing at least eMBB data channel coding scheme(s) and summarize observations that lead to the selection

Comparisons

[R1-1610423](#) Summary of Channel Coding Simulation Data Sharing InterDigital Communications

Revision of [R1-1609895](#)

Companies are invited to check the results and provide any updates if available.

Further updated in [R1-1610600](#).

[R1-1610541](#) Performance Evaluation for NR Channel Coding Huawei, HiSilicon

Revision of [R1-1608864](#)

[R1-1608867](#) Considerations on performance and spectrum efficiency Huawei, HiSilicon

[R1-1608922](#) Performance analysis of channel coding schemes for NR Spreadtrum Communications

[R1-1609439](#) Further results on channel coding schemes for NR Huawei, HiSilicon

[R1-1609583](#) Update on eMBB coding performance Nokia, Alcatel-Lucent Shanghai Bell

[R1-1609578](#) Some simulation results for eMBB CATR

[R1-1610059](#) Evaluation of LDPC codes for eMBB NTT DOCOMO, INC.

[R1-1610138](#) Performance of EMBB channel codes with fading Qualcomm Incorporated

[R1-1608770](#) Flexibility evaluation of channel coding schemes for NR CATT

[R1-1608584](#) Complementary turbo and LDPC codes for NR, motivated by a survey of over 100 ASICs
AccelerComm Ltd

[R1-1608878](#) Updated Survey of Channel Coding Implementations Ericsson

[R1-1608879](#) Implementation Consideration of Channel Coding Options for NR Ericsson

[R1-1610419](#) UE considerations on coding combination for NR data channels MediaTek Inc.

Revision of [R1-1609336](#)

[R1-1610139](#) Efficient channel coding implementations for EMBB Qualcomm Incorporated

[R1-1608972](#) Consideration on channel coding candidates for NR eMBB ZTE

[R1-1609240](#) Comparison of complexity for turbo and LDPC codes LG Electronics

[R1-1609241](#) Consideration on implementation of flexible channel decoder LG Electronics

[R1-1609073](#) Discussion on latency of channel codes for NR Samsung

[R1-1609063](#) Summary of Channel Coding for NR Samsung

[R1-1609070](#) Analysis on Trade-off between Performance and Complexity Samsung

[R1-1609243](#) Channel coding selection of eMBB scenario LG Electronics

[R1-1609389](#) On the channel coding scheme for NR NEC

[R1-1609582](#) Selection of eMBB coding scheme Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless

[R1-1610544](#) Observations on channel codes for NR eMBB data AccelerComm, Ericsson, Orange, IMT, LG, NEC, Sony
Proposed observations:

- LDPC codes are **proven, mature and capable**, at least when focusing on achieving **high throughputs**
- LDPC codes can deliver acceptable BLER, **throughput**, latency, area-efficiency and energy-efficiency for NR, at least at **medium to high coding rates**
- Turbo codes are **proven, mature and capable**, at least when focusing on achieving **flexibility and HARQ**
- The LTE turbo code and enhanced LTE turbo codes can deliver acceptable BLER, **flexibility, HARQ**, latency, area-efficiency and energy-efficiency for NR, at least at **medium to low coding rates**.
- Polar codes are **less mature, at least for larger list sizes**.
- Polar....?
- Polar codes require **list decoding** to meet the BLER requirements of NR, which degrades the throughput, latency, area-efficiency and energy-efficiency of polar decoders.
- Turbo codes will be a **necessary part** of NR devices supporting non-standalone operation and/or legacy LTE connectivity
- In some circumstances LDPC codes are more favourable than turbo codes. In other circumstances, turbo codes are more favourable than LDPC codes.
- LDPC and turbo codes are complementary, since they have different advantages and disadvantages.

[R1-1610667](#) Way Forward on Channel Coding Observations Huawei, HiSilicon

Proposed observations:

Performance:

- Polar vs. LDPC
 - For list 32 decoder for Polar, Polar has better BLER performance compared to LDPC for the evaluated info block lengths [Huawei [R1-1608864](#), ZTE R1-166411, Spreadtrum [R1-1608922](#)]
 - For list 8 decoder for Polar, Polar has better BLER performance compared to LDPC for the evaluated info block lengths/code rates except for high coding rates and large info block size [Huawei [R1-1608864](#)]
 - For list 4 decoder for Polar, Polar has better BLER performance compared to LDPC for small info block [Nokia [R1-1609583](#)]
- Polar vs. LTE Turbo
 - For list 32 decoder for Polar, Polar has better BLER performance compared to Turbo for the evaluated info block lengths [Huawei [R1-1608864](#), Huawei R1-164377, QC R1-164700, ZTE R1-166411, Spreadtrum [R1-1608922](#), DCM [R1-1610060](#), CATR [R1-1609578](#)]
 - For list 8 decoder for Polar, Polar has better BLER performance compared to Turbo for the evaluated info block lengths and coding rates except rate 1/3 [Huawei [R1-1608864](#), DCM [R1-1610060](#)]
 - For list 4 decoder for Polar, Polar has better BLER performance compared to Turbo for small info block [Nokia [R1-1609583](#)]
- Polar vs. TBCC
 - For list 32 decoder for Polar, Polar has better BLER performance compared to TBCC for info block lengths up to 200 bits [Huawei [R1-1608863](#), ZTE [R1-1608973](#), CATT [R1-1608771](#), Intel R1-167703, CATR [R1-1609579](#)]
 - For list 4 decoder for Polar, Polar has better BLER performance compared to TBCC for info block [Nokia [R1-1609589](#), Nokia [R1-1609594](#)]

Flexibility:

- For Polar, 1-bit granularity can be achieved for all coding rates and for full range of block size
 - [Huawei R1-167209],[Intel R1-164184]
- For LDPC, 1-bit granularity cannot be achieved with reasonable implementation complexity, due to multiple PCMs needed to support all coding rates with a complex switch network
 - [Samsung R1-166771],[Qualcomm [R1-1610137](#)],[Nokia [R1-1609584](#)],[Samsung [R1-1609067](#)]
- For Turbo, 1-bit granularity is feasible for all coding rates and for full range of block size

Implementation complexity:

- For polar, list 8 decoder is deemed implementable for all info block size and list 32 is deemed implementable for small info block size
 - [Huawei [R1-1608865](#)] [MediaTek [R1-1609336](#)]
- For LDPC, LOMS/LNMS decoder with iterations up to 25 is deemed implementable for info block granularity coarser than LTE
 - [Qualcomm [R1-1610139](#)],[MediaTek [R1-1609337](#)],[Nokia [R1-1609584](#)],[Samsung [R1-1609067](#)]

- For Turbo, decoder complexity is impractical for large info block size
- Latency:
- For Polar
 - with list 8 decoder, a decoding latency of 16us can be met for all info block length
 - [Huawei [R1-1608865](#)]
 - with list 32 decoder, a decoding latency of 1.7us can be met for small info block length (80bit)
 - [Huawei [R1-1608865](#)]
 - For LDPC, a latency of 16us can be met for all info block length
 - [Qualcomm R1-166372]
 - For Turbo, a latency of 16us can be met for small info block length

[R1-1610690](#) Way forward on observations for eMBB data channel coding Samsung, Qualcomm Incorporated, Nokia, ASB, KT Corporation, Intel Corporation

Proposed observations:

Summary:

- LDPC codes can efficiently support the whole range of eMBB data channel rates, block lengths, and IR HARQ with fine granularity
- LDPC codes can provide better area and energy efficiency than other coding schemes, especially for high throughput
- LDPC codes are amenable to parallelization and can provide better decoding latency

Rate flexibility:

- LDPC code can support multiple codes rates, and HARQ, including IR-HARQ by extension of parity check matrix
 - Multiple LDPC code families can be compactly and efficiently described
 - Decoder does not need to carry complexity of mother code on early transmissions, and performance is comparable to Turbo codes

Length flexibility:

- Shortening together with lifting and rate-matching allows LDPC code support information block size and codeword length flexibility with 1-bit granularity
 - The additional HW complexity for supporting a flexible LDPC code with arbitrary sub-block size is not a problem, as compared with that of inflexible LDPC codes.

Implementation:

- LDPC implementation complexity can be better than other codes when LDPC can support flexibility
 - The energy and area efficiencies of a flexible LDPC decoder is better than those of LTE turbo codes.
- Implementation complexity point of view, LDPC is better than other coding schemes especially for high throughput

Performance:

- LDPC codes can support stable performance for various MCS with fine granularity, comparable or better to other codes with similar decoding complexity

Observations:

- Performance
 - The performance of LDPC, Polar and Turbo codes is captured in [R1-1610600](#) (update of [R1-1610423](#)).
 - It has not yet been possible to draw conclusions directly from these captured results, owing to different views on the implementation complexities and possible enhancements which are discussed in more detail below.
- Flexibility for code rate and code block size support
 - LDPC, Polar and Turbo codes can all deliver acceptable flexibility.
- Chase- and IR-HARQ support
 - The proponents of LDPC and Polar have shown schemes for support of both CC- and IR-HARQ in their respective codes
 - Some companies have concerns on the incremental freezing method of HARQ support for Polar codes
 - One company has concerns on the complexity of IR-HARQ for LDPC codes
 - The ability of Turbo codes to support both CC- and IR-HARQ is well known
- Implementation complexity
 - LDPC:
 - LDPC codes are widely implemented in commercial hardware supporting several Gbps throughput and attractive area and energy efficiency with some flexibility, but with flexibility and features that are more limited than required for NR; in relation to NR, there are concerns summarised below.
 - The area efficiency reduces for lower coding rates
 - The complexity of LDPC increases with increasing flexibility
 - Proponents consider LDPC codes with limited flexibility to provide the most attractive area and energy efficiency, and that the characteristics of LDPC codes in area and energy efficiency remain advantageous even when supporting full flexibility, while some other companies consider the applicable flexibility to be limited, for example because a flexible switched network (if used) has an impact on increasing the power, area and latency

- LDPC codes are amenable to parallelisation which can provide better decoding latency
 - Depending on the parity check matrix design, some of this parallelism may not be exploited for all code block lengths for NR, and some companies have a concern with this and its impact on energy and area efficiency
- Some variants of min-sum based iterative decoders are considered implementable, and allow a trade-off between complexity and performance
- Two proponents consider quasi-ML decoders (e.g. list 32, ordered stochastic decoding) implementable for codeword sizes up to 1k
- BP and sum-product decoders are not considered implementable for NR by some companies
- For LDPC there are concerns that implementation with attractive area and energy efficiency may be challenging when simultaneously targeting the peak throughput and flexibility requirements of NR
- Polar:
 - Polar codes are implementable, although there are currently no commercial implementations, and in relation to NR, there are some concerns as summarised below.
 - The area efficiency reduces for shorter block lengths and lower coding rates
 - For list decoders, the implementation complexity increases with increasing list size, especially with larger block sizes
 - Some companies consider that a List 32 decoder is implementable up to a codeword size N of at least 1k (with larger codeword sizes requiring a segmented design), although some other companies have concerns on the achievable performance (including area efficiency, hardware throughput)
 - Some companies consider that a List 8 decoder is implementable for codeword sizes N up to 4k (with larger codeword sizes requiring a segmented design)
 - List 4 decoder is considered implementable for codeword sizes N up to at least 2k, with some companies considering it implementable up to 8k (with larger codeword sizes requiring a segmented design)
 - List 1 is considered implementable
 - For decoding hardware that can achieve acceptable latency, performance and flexibility, there are some concerns about the area efficiency and energy efficiency that are achievable with polar codes
- Turbo:
 - Turbo codes are widely implemented in commercial hardware, supporting HARQ and flexibility similar to what is required for NR, but not at the high data rates or low latencies required for NR; in relation to NR, there are concerns summarised below.
 - Proponents consider some implementations of turbo codes to meet the flexibility requirements of NR with the most attractive area and energy efficiency except at higher throughputs, and particularly at lower code rates and lower block lengths
 - Other companies consider that the latency and area and energy efficiency are not adequate for NR, and that the area and energy efficiency reduces at lower block lengths
 - Only two of the proponents of turbo codes propose turbo codes for the higher throughputs for NR
 - In some implementations suitable for lower throughputs, the area and energy efficiency is constant when varying the puncturing and repetition rate.
 - Otherwise, this is not the case, e.g. in some implementations designed for higher data rates
 - The decoding complexity increases linearly with the information block size for a given mother code rate
 - The decoding complexity increases as the constraint length increases, and to a lesser extent as the mother code rate reduces
 - For turbo codes, there are concerns that implementation with attractive area and energy efficiency is challenging when targeting the higher throughput requirements of NR
 - Some advanced turbo decoders are considered implementable, and allow a tradeoff between complexity and performance.
 - Some companies consider quasi-ML decoders are implementable for shorter information block lengths and codeword sizes up to 1k
 - The proponents consider that a turbo decoder could be designed that would be capable of decoding both LTE and at least small information block sizes ($K \leq 6144$) of NR
 - Other companies consider that such reuse would be subject to multiple concerns or would not be possible
- Latency
 - The proponents of all three coding families consider that their respective codes can fulfil the NR latency requirements
 - Latency-wise, highly-parallelised decoders, as applicable for LDPC, and turbo according to some proponents, can help to reduce latency
 - Although polar codes are not highly parallelisable, proponents consider that there are other design techniques that can help to reduce latency for polar decoders

- Some companies consider that polar codes may be able to achieve lower latency for decoding of small (around 1000 bits) blocks if capability of decoding large blocks is not considered; however, some other companies consider that polar decoders incurs longer latency than turbo decoders
- Other considerations
 - Turbo and LDPC are similarly well established, while Polar is less well established, being the newest among the three. All of the code families require effort at least in specification design, in order to meet the NR requirements. Some companies consider that less well established technologies require more effort.

[R1-1610981](#) WF on observations of eMBB data channel coding for short block length IDC
[R1-1610993](#) WF on observations of eMBB data channel coding for large block length IDC
[R1-1610931](#) WF on channel coding observations for short block size IMT, Orange, AccelerComm, Ericsson, LG, NEC

[R1-1610604](#) WF on channel codes for NR eMBB data AccelerComm, Ericsson, Orange, IMT, LG, NEC, Sony

Revision of [R1-1610545](#)

Proposal:

- Adopt LDPC code and turbo code, to mitigate the concerns associated with the implementation of flexible LDPC

[R1-1610767](#) Way forward on eMBB data channel coding Samsung, Qualcomm Incorporated, Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless, KT Corporation, KDDI, ETRI, IITH, IITM, CEWiT, Reliance Jio, Tejas Network, Xilinx, Sony, SK Telecom, Intel Corporation, Sharp, MTI, National Instrument, Motorola Mobility, Lenovo, Cohere Technologies, Acorn Technologies, CableLabs, WILUS Inc, NextNav, ASUSTEK, ITL

Revision of [R1-1610689](#)

Also acceptable to Ericsson

Proposal:

- Adopt LDPC code for eMBB data channel as single coding scheme

[R1-1610850](#) WF on channel codes Huawei, HiSilicon, Acer, Bell, CATR, China Unicom, China Telecom, CHTTL, Coolpad, Deutsche Telekom, Etisalat, InterDigital, III, ITRI, MediaTek, Nubia Technology, Nuel, OPPO, Potevio, Spreadtrum, TD Tech, Telus, Vivo, Xiaomi, Xinwei, ZTE, ZTE Microelectronics

Revision of [R1-1610668](#)

Also acceptable to CATT

Proposal:

- Polar code is supported as a channel coding scheme for NR eMBB data channel

[R1-1610607](#) Way Forward on Channel Coding ZTE, ZTE Microelectronics, Acer, Bell, CATR, China Unicom, China Telecom, CHTTL, Coolpad, Deutsche Telekom, Etisalat, Huawei, HiSilicon, InterDigital, III, ITRI, MediaTek, Nubia Technology, Neul, OPPO, Potevio, Shanghai Tejet, Spreadtrum, TD Tech, Telus, Vivo, Xiaomi, Xinwei, IITH, IITM, CEWiT, Reliance Jio, Tejas Network

Question: How many channel coding schemes should be specified for the NR eMBB data channel:

- 1:
 - LDPC: Ericsson, Sony, Sharp, Nokia, ASB, Samsung, Intel, QC, VzW, KT, IITH, IITM, Fujitsu, MotM, Lenovo, KDDI
 - Polar: HW
- >1:
 - T+L Accelercomm, IMT, LG, NEC, Fujitsu, Orange
 - L+P ZTE, Etisalat, Mediatek, Nubia, Xiaomi, Coolpad, Neul, HW devices, OPPO, CATR, TDTech, Spreadtrum, Potevio, ITRI, IDC, DT, NTU

Note that the above questions give an approximate picture, though not necessarily complete.

Possible Agreements:

Alt 1:

- The channel coding scheme for eMBB data is LDPC

No: HW, IDC, HiSi, DT, NEC, CMCC, LG, Spreadtrum, Neul, CATR, Xinwei, TDTech, OPPO, Coolpad, Xiaomi, HW Devices, ITRI, Mediatek, Accelercomm, Nubia, IMT, Orange, ZTE, ZTE Microelectronics

Alt 2:

- The channel coding scheme for eMBB data is LDPC, at least for blocks larger than X
- Polar coding is supported for eMBB data for blocks smaller than X

3GPP TSG RAN WG1 Meeting #87

Reno, USA, 14th – 18th November 2016

R1-16xxxxx

No: Sams, NEC, Intel, QC, LG, Nokia, ASB, MotM, Lenovo, KT, Ericsson, CableLabs, IITL, Sequans, Acorn, Asustek, Mitsubishi, KDDI, Wilus, Accelercom, IMT, Orange, Sony, Sharp, Fujitsu, VzW, Docomo

Alt 3:

- The channel coding scheme for eMBB data is LDPC, at least for blocks larger than X
- Turbo coding is supported for eMBB data for blocks smaller than X

No: HW, IDC, HiSi, Sams, Nok, ASB, KT, QC, Asustek, Spreadtrum, Mitusbishi, CATR, Xinwei, TDTech, OPPO, Intel, Coolpad, Neul, Wilus, Xiaomi, ITRI, Mediatek, Nubia, ZTE, ZTE Microelectronics, HW Devices, CableLabs, IITL, DT, VzW, KDDI, Acorn, Docomo

Agreement:

- The channel coding scheme for eMBB data is LDPC, at least for information block size > X
- FFS until RAN1#87 one of Polar, LDPC, Turbo is supported for information block size of eMBB data <= X
 - The selection will focus on all categories of observation, including overall implementation complexity, regardless of the number of coding schemes in the resulting solution (except if other factors are generally roughly equal)
- The value of X is FFS until RAN1#87, 128 <= X <= 1024 bits, taking complexity into account
- The channel coding scheme(s) for URLLC, mMTC and control channels are FFS

~~Huawei has a concern on the upper value of the range of X to be considered.~~

Friday:

Huawei asked adding a note “RAN1 needs to conclude on performance observations of channel coding”

Samsung: why are we re-opening an already endorsed report of the session

Intel: same view – object touching the conclusions again

Sharp: there is no reason to formalize this – there are already a lot of results provided by companies

Ericsson/Fujitsu: RAN1 knows what to do till the next meeting, just let's do it – all we have is sufficient to let the work continue and progress

ZTE support Huawei's view

Qualcomm: a lot of time was spent during the long sessions on channel coding w.r.t performance analysis – there is still time for contributions to be proposed

Nokia: clearly drawing conclusion on the observations was very difficult – let's now focus on the technical work & design

CATT: would like not to forget about the conclusion – support Huawei

Nokia (rapporteur of the session): suggested adding the following sentence “RAN1 is still encouraged to strive to draw additional conclusions on the performance of channel coding”

Samsung: OK with the above statement but recalled that companies had a lot of time to comment during the online session

Fujitsu: also Ok but suggested that such statement should be included in the overall agreement

Ericsson: “conclusions” means all characteristics including complexity/ latency/... - would like to replace that wording by “observations” only

Finally the note “Huawei has a concern on the upper value of the range of X to be considered.” is withdrawn and RAN1 chair concluded as follows:

Conclusion: RAN1 is still encouraged to strive to draw additional observations and conclusions on the performance of channel coding

LDPC details

R1-1610137	LDPC rate compatible design overview	Qualcomm Incorporated
R1-1608875	LDPC Code Design for NR	Ericsson
R1-1608866	Evaluation of LDPC performance	Huawei, HiSilicon
R1-1609064	IR-HARQ Performance of Rate-Compatible Quasi-Cyclic LDPC Codes	Samsung
R1-1609588	False alarm rate of LDPC decoding and CRC requirement	Nokia, Alcatel-Lucent Shanghai Bell
R1-1608772	LDPC codes design for eMBB	CATT
R1-1608876	LDPC Code Performance with Rate Matching	Ericsson
R1-1608877	On Achieving Low Code Rate with LDPC Codes	Ericsson
R1-1608921	Code segmentation and CRC issues for LDPC codes	Spreadtrum Communications
R1-1608971	Consideration on the flexibility of LDPC codes for NR	ZTE
R1-1608974	Consideration on LDPC design for NR	ZTE
R1-1609065	Length-Compatible Quasi-Cyclic LDPC Codes	Samsung
R1-1609066	Decoder Architecture for Length-Compatible Quasi-Cyclic LDPC Codes	Samsung
R1-1609067	Evaluation of HW Complexity for Flexible Quasi-Cyclic LDPC Codes	Samsung
R1-1609071	Cross check results of LDPC code proposal	Samsung

R1-1609239	HARQ of LDPC code for NR	LG Electronics
R1-1609242	Length flexibility of QC-LDPC	LG Electronics
R1-1609337	Implementation considerations on flexible and efficient LDPC decoders	MediaTek Inc.
R1-1609511	Discussion on Data channel coding for NR	Intel Corporation
R1-1609584	LDPC link design for eMBB	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609585	IR HARQ schemes for LDPC	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609708	Discussion of QC-LDPC code design with regular degree-3 for NR	National Taiwan University
R1-1609897	Updated LDPC Simulation Data Sharing	InterDigital Communications
R1-1610136	LDPC for EMBB and URLLC	Qualcomm Incorporated
R1-1610140	LDPC decoding with adjusted min-sum	Qualcomm Incorporated
R1-1610377	Channel Coding scheme for EMBB	Intel Corporation
R1-1610472	Evaluation of adjusted min-sum LDPC decoder and complexity aspects of permutation networks	Huawei
R1-1610693	WF on basics of LDPC design	Ericsson

Polar details

R1-1608862	Polar Code Construction for NR	Huawei, HiSilicon
R1-1610420	Resolving Polar code memory complexity issue	MediaTek Inc.
Revision of R1-1609338		
R1-1609587	Design and performance of polar codes for eMBB	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610060	Evaluation of polar codes for eMBB	NTT DOCOMO, INC.
R1-1608977	On the maturity of polar decoders, based on a survey of over 150 hardware implementations	AccelerComm Ltd

R1-1608865	Design aspects of Polar Code/LDPC for NR	Huawei, HiSilicon
R1-1608975	Consideration on polar codes for NR	ZTE
R1-1609586	Discussion on the IR-HARQ support of polar codes	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609898	Performance Evaluation of Puncturing Schemes for Polar Codes	InterDigital Communications
R1-1609899	Interleaver for Polar Codes	InterDigital Communications
R1-1610687	Clarification of IF-HARQ for PC-Polar	Huawei

Turbo details

R1-1608768	Performance of Turbo codes with high speed decoding algorithm for NR	CATT
R1-1609246	Turbo code enhancement	LG Electronics
R1-1608769	Discussion on implementation of high speed Turbo decoder for NR	CATT

Control channel and short block coding

R1-1608771	Evaluation of channel coding schemes for NR control channels	CATT
R1-1608863	Evaluation of channel coding schemes for control channel	Huawei, HiSilicon
R1-1608871	On TBCC Generator Polynomials	Ericsson
R1-1608872	Study of LDPC Codes for Control Channel of NR	Ericsson
R1-1608873	Study of Polar Codes for Control Channel of NR	Ericsson
R1-1608874	Performance Comparison of Channel Coding Candidates for Short Block Lengths	Ericsson
R1-1608973	Evaluation on channel coding candidates for eMBB control channel	ZTE
R1-1609069	Design of Short-Length LDPC Codes	Samsung
R1-1609072	Performance of Short-Length Polar Codes	Samsung
R1-1609244	Control channel coding scheme evaluation	LG Electronics
R1-1609245	Multiple CRC for TBCC list decoding	LG Electronics
R1-1609385	Link level analysis for channel coding schemes for control channel	AT&T GNS Belgium SPRL
R1-1609512	Discussion on Control channel coding for NR	Intel Corporation
R1-1609579	Simulation results for control channel	CATR
R1-1609589	Performance of coding candidates for control channels	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609590	Polar codes for control channels	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609591	Reed-Muller and BCH codes for control channels	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609592	LDPC codes for control channels	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609614	NR DL Control Channel Coding Selection from UE Perspectives	MediaTek Inc.
R1-1609896	Performance Evaluation of Channel Codes for eMBB Control Channel	InterDigital Communications
R1-1610141	Short blocklength design	Qualcomm Incorporated
R1-1610314	FEC performance comparison for short frame sizes for NR	IMT, ORANGE

[R1-1610692](#) WF on further evaluation assumptions for control channel Ericsson

URLLC & mMTC

[R1-1609382](#) Evaluation on channel coding candidates for uRLLC and mMTC ZTE
[R1-1609593](#) Evaluation criteria for URLLC/mMTC coding scheme Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609594](#) Performance of mMTC and URLLC channel coding candidates Nokia, Alcatel-Lucent Shanghai Bell
[R1-1610411](#) URLLC channel coding Qualcomm Incorporated
Revision of [R1-1610142](#)
[R1-1610350](#) Latency consideration of channel coding candidates for URLLC National Taiwan University

Outer coding

[R1-1608976](#) Consideration on outer codes for NR ZTE
[R1-1610143](#) Erasure coding and HARQ design Qualcomm Incorporated

Other

[R1-1609068](#) Discussion on Maximum Code Block Size Samsung

R1-1611059 Way Forward on Data Sharing Qualcomm

Discussion:

Sony: concern regarding the kind of QAM going to be addressed

Huawei: failed to understand the purpose as all 3GPP contributions are publicly available – would be ok agreeing on the spreadsheet

ZTE: why do we need a new process?

Nokia: nothing new but an update of the existing process, with a formal folder where data can be stored and shared amongst interested – email could be useful

Decision: The document is noted and for **email discussion until October 20th – (Qualcomm)**

8.1.3.2 Modulation

[R1-1610904](#) Way Forward on Low PAPR Modulation in NR Samsung, Qualcomm, Intel, Vodafone, AT&T, MediaTek, KDDI, InterDigital, IITH, IITM, Tejas Networks, Reliance-Jio, CEWiT, National Instruments

[R1-1610799](#) WF on Modulation for NR InterDigital, Qualcomm, Mediatek, Sony, Orange, Huawei, HiSilicon

[R1-1608870](#) Advanced modulation for NR Huawei, HiSilicon
[R1-1608935](#) Evaluation of NU-QAM for NR Sony
[R1-1608936](#) Signal Space Diversity Use in NR Sony
[R1-1609074](#) Evaluation Assumptions for NR Modulation Schemes Samsung
[R1-1609075](#) Discussion on modulation for MIMO Samsung
[R1-1609076](#) Modulation scheme for interference management in NR Samsung
[R1-1609077](#) Performance evaluation of MLC with natural mapping for MIMO Samsung
[R1-1609078](#) Low PAPR modulation and waveform Samsung
[R1-1609513](#) Modulation schemes for New RAT Intel Corporation
[R1-1609595](#) Digital Modulation for 5G New Radio Nokia, Alcatel-Lucent Shanghai Bell
[R1-1609632](#) On modulation schemes for NR Ericsson
[R1-1609900](#) Performance Evaluation of Dual Carrier Modulation for New Radio InterDigital Communications
[R1-1609901](#) Evaluation of Spatial Modulation with Spatial Correlation and Imperfect Channel Estimation InterDigital Communications
[R1-1609902](#) On Fractional N-ary Modulation for NR InterDigital Communications
[R1-1610144](#) Evaluation assumptions for NR modulation schemes Qualcomm Incorporated
[R1-1610211](#) Way Forward on modulation for NR Nokia, Alcatel-Lucent Shanghai Bell

Agreements:

- The same constellation mapping as used in LTE (i.e. QPSK, 16QAM, 64QAM and 256QAM) is introduced, while not precluding other constellation mappings
 - Note that there might be possibility to exclude some of above constellation mapping based on the further study
- Enhancement modulation schemes for further study include
 - Higher order modulation in conjunction with MIMO
 - Constellation mapping among subcarriers
 - Other constellations (e.g., non-uniform QAM)
 - Coded modulations
 - Spatial modulation

- Mappings of bits to symbol(s)
- Rotated-QAM up to BPSK, QPSK
 - $k\pi$ -QAM ($0 < k \leq 1$)
 - FFS k (e.g., $k = 0.5$ for BPSK, 0.25 for QPSK)
- Constellation Interpolation
- Note: Other modulation schemes or combinations of the above schemes are not precluded
- Note: Proponents should describe the details of the receivers

8.1.4 Multi-antenna scheme for new radio interface

R1-1608660	Unified MIMO framework for NR above and below 6GHz	ZTE, ZTE Microelectronics
R1-1609690	Views on Framework of NR MIMO and Beam Management	Beijing Xinwei Telecom Techn.
R1-1609904	Impact of UE Calibration in a Reciprocity-based UL MIMO Transmission	InterDigital Communications

8.1.4.1 Beam management

[R1-1609248](#) On the impact of UE rotation LG Electronics

The document was presented by ... from LGE.

Proposal 1: UE triggering based beam management should be supported in NR.

Proposal 2: Consider omni-directional single or cross-pol antenna for UE above 6 GHz.

Proposal 3: (Semi) OL MIMO techniques can be taken into consideration when UE rotates.

Proposal 4: UE centric MCS back-off mechanisms should be studied for NR.

Decision: The document is noted.

[R1-1609395](#) Discussion of DL hybrid beamforming procedure Lenovo

The document was presented by ... from Lenovo.

Proposal 1: RSRP-based beam measurement and feedback scheme should be considered for beam selection and refinement.

Proposal 2: Spatial multiplexing at the TRP should be supported by the beam measurement and feedback scheme.

Proposal 3: The standard impact of UE RX beam selection and refinement should be minimized, provided a UE is provided sufficient RS resource to tune its RX beam.

Proposal 4: CSI-RS and feedback can be used for CSI acquisition for given analog beams.

Proposal 5: The interaction between analog beamforming and digital beamforming should be studied.

Decision: The document is noted.

[R1-1609754](#) Beam management principles Ericsson

The document was presented by Mattias Frenne from Ericsson.

- Proposal 1: Handle beam management within the CSI framework in NR (i.e. the framework used for link adaptation of data transmission).
- Proposal 2: Use CSI-RS for beam management measurements
- Proposal 3: In the beam management procedures, one or multiple beam pair links (BPLs) are monitored by the network using uplink measurements by the TRPs and/or downlink measurements from the UE.
- Proposal 4: Support a configurable (time multiplexed, frequency multiplexed or both) sweep of CSI-RS in a slot or subframe for beam management measurements
- Proposal 5: Study which different types of frequency allocations that should be supported for CSI-RS used for beam management measurements
- Proposal 6: When triggering a sweep of K CSI-RS transmissions (K beams), it is also indicated to the UE whether it may assume that the same beam is used for the K transmissions or not as to distinguish between P-1/P-2 and P-3 procedure.

Decision: The document is noted.

[R1-1610487](#) Way Forward on beam management Ericsson, Intel, CATT, InterDigital Communications

The document was presented by Mattias Frenne from Ericsson.

- At least CSI-RS can be used for measurements to support the beam management processes P1, P2, P3
 - When used for P1/P2/P3, the CSI-RS signal structure can be specifically optimized for this purpose (as opposed to e.g. link adaptation)
 - Additional RS could also be considered such as DMRS and synchronization signals

Decision: The document is noted.

Possible agreements:

- At least CSI-RS can be used for measurements to support the beam management processes P1, P2, P3
 - When used for P1/P2/P3, optimization of the CSI-RS signal structure can be considered for this purpose (as opposed to e.g. link adaptation)
 - Additional RS could also be considered such as DMRS and synchronization signals

R1-1610516 Way Forward on Beam management RS Samsung, Intel, Verizon Wireless

The document was presented by Young Han Nam from Samsung.

- NR supports two types of RS for beam management procedures (P-1, P-2 and P-3) :
 - Beam reference signals (BRS):
 - BRS is cell-specifically configured and periodically transmitted.
 - FFS: BRS is also used for L3 mobility
 - CSI-RS:
 - CSI-RS is UE-specifically configured.
 - The signal structure for CSI-RS can be specifically optimized based on whether the CSI-RS is used for P1, P2 or P3
 - Note: CSI-RS is also used for CSI acquisition

Decision: The document is noted.

Possible agreements:

- NR supports two types of RS for beam management procedures :
 - Beam reference signals (BRS) at least in P-1:
 - BRS is periodically transmitted
 - FFS: Cell-specific configuration or UE-specific configuration
 - FFS: BRS is also used for L3 mobility
 - CSI-RS in P-2, and P-3:
 - CSI-RS is UE-specifically configured.
 - The signal structure for CSI-RS can be specifically optimized based on whether the CSI-RS is used for P1, P2 or P3
 - Note: CSI-RS is also used for CSI acquisition
 - Additional RS could also be considered such as DMRS and synchronization signals

Possible agreements:

- NR supports at least CSI-RS for beam management procedures (P-1, P-2 and P-3) :
 - CSI-RS is UE-specifically configured.
 - The signal structure for CSI-RS can be specifically optimized based on whether the CSI-RS is used for P1, P2 or P3
 - Note: CSI-RS is also used for CSI acquisition

Continue offline discussions about the necessity to support Beam reference signals (BRS) – Young Han (Samsung)

Continue offline discussion until Tuesday – Mattias (Ericsson), Young Han (Samsung)

Tuesday

R1-1610658 Way Forward on beam management Ericsson, Samsung, Intel

- Beam management procedures can utilize at least the following two RS types:
 - RS used for mobility, at least for P-1:
 - Note: This RS can be used for P-1 when beam sweeping of mobility signal is used
 - CSI-RS, for P-1, P-2, and P-3:
 - CSI-RS is UE-specifically configured.
 - Multiple UE may be configured with the same CSI-RS
 - The signal structure for CSI-RS can be specifically optimized based on whether the CSI-RS is used for P1, P2 or P3
 - Note: CSI-RS can also be used for CSI acquisition
 - Note: The CSI-RS can be used for P-1 in case mobility signal is single beam or when SFN transmission is used, e.g. across multi-TRP/Panel
- Additional RS could also be considered such as DMRS and synchronization signals

Decision: The document is noted. Also supported by Interdigital, CATT.

Working assumptions:

- Beam management procedures can utilize at least the following RS type(s):
 - RS defined for mobility purpose at least in connected mode
 - FFS: RS can be NR-SS or CSI-RS or newly designed RS
 - Others are not precluded
 - CSI-RS:
 - CSI-RS is UE-specifically configured
 - Multiple UE may be configured with the same CSI-RS
 - The signal structure for CSI-RS can be specifically optimized for the particular procedure
 - Note: CSI-RS can also be used for CSI acquisition
- Other RS could also be considered for beam management such as DMRS and synchronization signals

Wednesday session

R1-1610512 Way Forward on Group-based beam management ZTE, ZTE Microelectronics

- Definition of beam grouping:
 - Beam grouping = for TRP(s) or UE to group multiple Tx/Rx beam(s) or beam pair(s) into one subset of beams sharing similar channel properties
- Group based beam management is supported at least in the following aspects:
 - Beam-group based RSRP/CSI reporting
 - e.g. Beam grouping is done on Tx beams sharing similar channel properties, like angles of arrival and departure, QCL and TA. UE reports RSRP/CSI with the best beam in each of the M beam groups
 - Beam-group based indication for beam measurement, beam-based transmission or beam switching
 - e.g. TRP indicates beam group which conveys the information on how UE should receive the beam e.g. which Rx beam is used
 - e.g. TRP/UE indicates intra-group beam measurement. Beam switching on one side within a group, if any, is agnostic to the other side.
 - e.g. TRP/UE indicates inter-group beam measurement. Beam group switching on one side, if any, is informed to the other side.

Decision: The document is noted. Revised in:

R1-1610891 WF on Group-based Beam Management ZTE, ZTE Microelectronics, ASTRI, Nokia, ASB, CATT

Decision: The document is noted. Continue offline.

Agreements:

- Group based beam management is to be further studied:
 - Definition of beam grouping:
 - Beam grouping = for TRP(s) or UE to group multiple Tx and/or Rx beam(s) and/or beam pair(s) into one subset of beams
 - FFS detailed mechanisms for beam grouping, reporting, beam-group based indication for beam measurement, beam-based transmission or beam switching, etc.
 - Some examples can be found in [R1-1610891](#) and [R1-1609414](#)

R1-1610825 WF on Beam management CATT, CATR, CMCC, Xinwei

Decision: The document is noted. Continue offline.

Agreements:

- For downlink, NR supports beam management with and without beam-related indication
 - When beam-related indication is provided, information pertaining to UE-side beamforming/receiving procedure used for data reception can be indicated through QCL to UE
 - FFS: Information other than QCL
 - FFS: When beam-related indication is provided, information pertaining to the Tx beam used for data transmission is indicated to UE
- For downlink, based on RS (used for beam management) transmitted by TRP, UE reports information associated with N selected Tx beams
 - Study how the N Tx beams can be selected
 - Study the case where N comprises of all Tx beams
 - Study UE reporting information
 - Note: N can be equal to 1

R1-1610510 Way Forward on Beam reporting for NR LG Electronics, Intel

- Support both network initiated and UE initiated aperiodic beam reporting.
 - Aperiodic beam reporting can be associated with P-1, P-2, and P-3.
 - UE request message can be transmitted on a reserved/dedicated uplink channel (e.g. physical random access channel, physical uplink control channel).
- Further study is needed whether network/UE initiated semi-persistent/periodic beam reporting is needed.

Decision: The document is noted.

Possible agreements:

- Support at least network initiated aperiodic beam reporting
 - Aperiodic beam reporting can be associated with P-1, P-2, and P-3.
 - FFS: UE request message can be transmitted on a reserved/dedicated uplink channel (e.g. physical random access channel, physical uplink control channel)
 - FFS: UE initiated aperiodic beam reporting case

• Further study is needed whether network/UE initiated semi-persistent/periodic beam reporting is needed.
Continue offline.

R1-1610923 WF on Beam Reporting for NR LG Electronics, Intel, NTT DOCOMO, MediaTek,
Agreements:

- Support at least network triggered aperiodic beam reporting:
 - Aperiodic beam reporting is supported under P-1, P-2, and P-3 related operations
 - FFS beam reporting details
 - FFS: UE assisted/initiated aperiodic beam reporting
 - FFS: In case of UE assisted/initiated aperiodic beam reporting, UE request message can be transmitted on a reserved/dedicated/common uplink channel (e.g. physical random access channel, physical uplink control channel).
- Further study is needed whether semi-persistent/periodic/event-triggered beam (network triggered or UE assisted/initiated) reporting is needed

R1-1610511 WF on Beam Management for DL Control Channel ZTE, ZTE Microelectronics, Intel, Xinwei
Agreements:

- Support using same or different beams on control channel and the corresponding data channel transmissions
 - FFS the antenna ports for control channel and the corresponding data channel (e.g., sharing some ports or not)
- Study detailed aspects related to beams/beam pairs indication/reporting involving usage of control and data channels and involving one or more TRPs

R1-1610971 WF on definition of Beam reciprocity Samsung, Qualcomm, InterDigital, Intel, IITM, IITH, CeWIT, Tejas Networks, KT, MediaTek, AT&T, Verizon, Motorola Mobility, Reliance Jio
Working assumption:

- The followings are defined as Tx/Rx beam correspondence at TRP and UE :
 - Tx/Rx beam correspondence at TRP holds if at least one of the following is satisfied:
 - TRP is able to determine a TRP Rx beam for the uplink reception based on UE's downlink measurement on TRP's one or more Tx beams.
 - TRP is able to determine a TRP Tx beam for the downlink transmission based on TRP's uplink measurement on TRP's one or more Rx beams
 - Tx/Rx beam correspondence at UE holds if at least one of the following is satisfied:
 - UE is able to determine a UE Tx beam for the uplink transmission based on UE's downlink measurement on UE's one or more Rx beams.
 - UE is able to determine a UE Rx beam for the downlink reception based on TRP's indication based on uplink measurement on UE's one or more Tx beams.
 - More refined definition can still be discussed

R1-1610894 UL beam management Samsung, Huawei, Intel
Agreements:

- UL beam management is to be further studied in NR
 - Similar procedures can be defined as DL beam management with details FFS, e.g.:
 - U-1: is used to enable TRP measurement on different UE Tx beams to support selection of UE Tx beams/TRP Rx beam(s)
 - Note: this is not necessarily useful in all cases
 - U-2: is used to enable TRP measurement on different TRP Rx beams to possibly change/select inter/intra-TRP Rx beam(s)
 - U-3: is used to enable TRP measurement on the same TRP Rx beam to change UE Tx beam in the case UE uses beamforming
- FFS Indication of information related to Tx/Rx beam correspondence is supported
- Study UL beam management based on:
 - PRACH
 - SRS
 - DM-RS
 - Other channels and reference signals are not precluded
- Study uplink beam management procedure by considering the Tx/Rx beam correspondence
 - For the case of TRP and UE have Tx/Rx beam correspondence
 - For the case of TRP has no Tx/Rx beam correspondence and/or UE has no Tx/Rx beam correspondence

R1-1610964 WF on Beam recovery Samsung, Qualcomm, Intel, KT, LGE, Ericsson

Also supported by Nokia

Agreements:

- NR supports mechanism(s) in the case of link failure and/or blockage for NR
 - Whether to use new procedure is FFS
- Study at least the following aspects:
 - Whether or not an DL or UL signal transmission for this mechanism is needed
 - E.g., RACH preamble sequence, DL/UL reference signal, control channel, etc.
 - If needed, resource allocation for this mechanisms
 - E.g., RACH resource corresponding mechanism, etc.

R1-1611014	WF on Beam management	CATT, CATR, CMCC, Xinwei, Samsung
R1-1608664	High level views on beam management for NR MIMO	ZTE, ZTE Microelectronics
R1-1608665	Beam grouping for beam management	ZTE, ZTE Microelectronics
R1-1608666	Discussion on beamforming procedure considering high frequency channel characteristics	ZTE, ZTE Microelectronics
R1-1608667	Discussion on methods of determining Tx and Rx beams for NR MIMO	ZTE, ZTE Microelectronics
R1-1608773	On beam management procedures	CATT
R1-1608774	Design of beam training	CATT
R1-1608810	Discussion on Paging in NR	Fujitsu
R1-1608934	Views on beam management for NR	Sony
R1-1609079	Discussion on beam management RS	Samsung
R1-1609080	Overview on beam management	Samsung
R1-1609081	Discussion on beam recovery	Samsung
R1-1609082	Impact of beam/channel reciprocity for NR	Samsung
R1-1609083	Discussion on beam switching	Samsung
R1-1609247	Views on NR beam management	LG Electronics
R1-1609326	Unified Framework for Beam Management and RRM for NR	MediaTek Inc.
R1-1609379	Discussion on Beam Training Procedure of NR MIMO	Sony
R1-1609408	Discussion on beam management procedure	ITRI
R1-1609414	Discussion on beam management aspects for DL MIMO	Huawei, HiSilicon
R1-1609415	Discussion on beam management aspects for UL MIMO	Huawei, HiSilicon
R1-1609514	Reference Signal and Procedure for UE Beam Refinement (BM P-3)	Intel Corporation
R1-1609515	On network beam switching and refinement (BM P-2)	Intel Corporation
R1-1609516	Beam management for initial and candidate beam discovery (BM P-1)	Intel Corporation
R1-1609517	UL beam management	Intel Corporation
R1-1609691	Beam Management Views and Designs	Beijing Xinwei Telecom Techn.
R1-1609692	Initial Simulation Results of Beam Search	Beijing Xinwei Telecom Techn.
R1-1609878	Beam Management for Control Channel	ZTE, ZTE Microelectronics
R1-1610062	General Views on Beam Management for NR	NTT DOCOMO, INC.
R1-1610063	Discussion on beam management for reciprocity based operation	NTT DOCOMO, INC.
R1-1610145	Beam management for NR	Qualcomm Incorporated
R1-1610239	On beam management in NR - procedures	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610240	Beam management - DCI monitoring	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610241	Beam management - reciprocity issues	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610243	On procedures for beam selection and feedback signalling	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610244	On beam training based on periodic DL signals	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610245	Beam training based on aperiodic DL signals	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610246	Increasing beam management robustness at both BS and UE	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610247	Multi-Beam Common Control Plane Design	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610248	DRX and Beam Management	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610249	Initial results on beam management	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610319	Beam-based design framework for New Radio	INTERDIGITAL COMMUNICATIONS
R1-1610345	Robust and Efficient Beam Management for NR	InterDigital Communications
R1-1610405	DRX and Beam Management	Nokia, Alcatel-Lucent Shanghai Bell

8.1.4.2 Multi-antenna scheme

High-level MIMO design including Open-loop/Close-loop MIMO, Transmission diversity, SU/MU-MIMO, Multi-TRP transmission

[R1-1608809](#) Over the air calibration for channel reciprocity in NR MIMO Fujitsu
The document was presented by ... from Fujitsu.

- Observation 1: Performance of DL multi-point MU-MIMO degrades due to Tx/Rx RF circuit response mismatch at BS in TDD.
- Observation 2: Over the air calibration is necessary to calibrate spatially distributed antennas/TRPs.
- Proposal: Clarify whether intra-BS over the air calibration can be implemented without RAN1 specification.

Decision: The document is noted.

R1-1609519 Discussion on Beamforming for NR PDCCH Intel Corporation

The document was presented by Alexey Khoryaev from Intel.

- Observation 1. Different resource allocation for data and control may cause different beamforming for data and control. In this case, the beamwidth of control channel may be broader than that of data channel. The broad beam is not limited to a physical broad beam but it covers logical broad beam (e.g. multiple beams with different beam pointing angles).
- Observation 2. Different transmission strategy of data and control channel may require different beamforming strategy including different beam directions (or different number of beams).
- Observation 3. At least one beam may be shared by data and control or same beam for data and control may be used.
- Observation 4: A single beam performs better when there is no blockage.
- Observation 5: Multiple beams shows more robust performance when there is blockage on the main path.
- Observation 6: Using multiple beams in control channel provides more flexible beam operation.
- Proposal 1. A default assumption is that data and control channel beamforming is different while using same beam for data and control (at least one beam) is also allowed.
- Proposal 2: Study multiple beam operation in control channel.

Decision: The document is noted.

R1-1609903 Partial reciprocity based UL MIMO schemes InterDigital Communications

The document was presented by ... from InterDigital.

- Proposal 1: RAN1 considers study on the effect of interference asymmetry on the use of channel reciprocity for uplink MIMO.
- Proposal 2: RAN1 considers further study on dual precoder design based on combined use of reported- and reciprocity-based CSI for uplink MIMO.
- Proposal 3: RAN1 considers enhanced uplink MU-MIMO operation by relying on reciprocity-based CSI and interference feedback.
- Observation 1: Reciprocity-based precoding even with significant calibration errors outperforms codebook based precoding.
- Observation 2: As the dimension of the system grows the gap between the reciprocity-based and ideal CSI-based precoding widens.

Decision: The document is noted.

R1-1610229 Performance comparison of nonlinear precoding schemes for NR MU-MIMO Mitsubishi Electric Co.

The document was presented by ... from Mitsubishi.

- Observation 1: Link level evaluation is used to evaluate performance of the nonlinear precoding schemes
- Observation 2: The nonlinear precoding scheme exhibits clear throughput performance gain compared to the linear precoding scheme in crowded environments
- Observation 3: From the CDF of throughput, NLP offers stable throughput in both case A and B, where case A and B are illustrated in Figure 5 and 6, respectively.
- Proposal: Consider nonlinear precoding as a potential spatial multiplexing candidate technology

Decision: The document is noted.

R1-1610484 Way Forward on coordinated transmission schemes in NR LG Electronics, Intel Corporation, Samsung

- At least, followings are supported for coordinated transmission schemes for NR
 - Tx schemes for a single site
 - Intra-site (e.g., across TRPs) coordinated transmission schemes including DPS, CS/CB, and JT
 - Tx schemes for multiple sites with ideal backhaul
 - Inter-site coordinated transmission schemes including DPS, CS/CB, and JT, assuming ideal backhaul links among the coordinating TRPs

Decision: The document is noted. Continue the discussion.

R1-1610380 Discussion on Dynamic Switching of Transmission Modes Convida Wireless LLC

Proposal 1: The NR system should support dynamic switching between transmission modes that does not rely on RRC signaling, and the number of transmission modes should be less than the number of transmission modes in LTE.

Proposal 2: The NR system may support transmission mode configuration through the downlink control channel.

Proposal 3: Beam based transmit diversity should be supported in the NR system, and the single/multiple TRP transmit diversity scheme may be transparent to the UE.

Proposal 4: NR need to evaluate the redundancy caused by designing a unified DCI format to support all transmission modes. The design of UE's search space need to be studied.

Decision: The document is noted.

Wednesday session

[R1-1610523](#) Way Forward on coordination schemes in NR Huawei

[R1-1610537](#) **Way Forward on Network Coordination Framework** Samsung

- NR network coordination should support different types of network coordination within a common CSI framework
- For NR network coordination, study sufficient level of flexibility in 'reference signal', 'measurement', and 'reporting' settings
 - Allow a network to configure multiple combinations of 'reference signal', 'measurement', and 'reporting' settings
 - Allow a network to independently configure 'reference signal', 'measurement', and 'reporting' settings
 - Allow a network to dynamically and/or semi-statically choose between multiple combinations of 'reference signal', 'measurement', and 'reporting' settings
 - Allow 'reporting' based on actual interference measurement and emulated interference assessment
- Support signaling of QCL information which is linked to 'reference signal' and 'measurement' setting
 - For QCL parameter estimation at least CSI-RS, beam RS, phase noise RS can be considered
 - Other RSs or signals are not precluded
 - The QCL information should support signaling of RS for QCL parameter estimation and the DMRS ports scheduled to a UE where each RS for QCL parameter estimation is mapped to a non-overlapping subset of DMRS ports
- Study the need of information exchanges between gNB-UE for different types of interference suppression (e.g. inter user, inter cell interference) and cancellation based on advanced receivers
 - If needed, the information at least includes side information on interfering UE(s) for efficient interference suppression and cancellation at UE side
 - As a baseline, consider the receivers structures studied in LTE

Decision: The document is noted.

[R1-1610898](#) **WF on coordinated transmission in NR** LG Electronics, Huawei, HiSilicon, Samsung

- At least, followings are supported for coordinated transmission schemes for NR
 - Tx schemes for a single site
 - Intra-site (e.g., across TRPs) coordinated transmission schemes including DPS, CS/CB, and JT
 - Tx schemes for multiple sites with ideal backhaul
 - Inter-site coordinated transmission schemes including DPS, CS/CB, and JT, assuming ideal backhaul links among the coordinating TRPs
 - Semi-dynamic configuration of UE-transparent TRP cooperation sets
 - FFS other configurations
 - Study coordination techniques with non-ideal backhaul
 - Note: Non-ideal backhaul has less stringent requirements on synchronization and/or coordination information exchange between geographically separated antenna panels.

Decision: The document is noted.

Agreements:

- For coordinated transmission schemes for NR, both the case of co-located TRPs and the case of non-co-located TRPs are considered
 - FFS the assumptions about latency/bandwidth
 - FFS detailed schemes
 - Note: the classification of co-located vs. non-co-located may not capture all aspects, e.g., synchronization among TRPs, etc.

Agreements:

- For coordinated transmission schemes for NR:
 - Support different types of coordinated transmission schemes for NR
 - Strive for commonality in supporting the different types of coordinated transmission schemes for NR
- Study the need of network assistance and coordination for different types of interference suppression (e.g. inter user, inter-TRP interference) and cancellation based on advanced receivers
 - Consider information related to interfering signals for interference suppression and cancellation at UE side
 - As a baseline, consider NAICs receivers structures in LTE

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1610536](#)

Evaluation Assumptions for NR Network Coordination

Samsung, Intel, ZTE, ZTE Microelectronics

[R1-1611010](#)

Evaluation Assumptions for NR Network Coordination

Samsung, Intel, ZTE, ZTE Microelectronics,

Huawei

Agreements:

- For NR network coordination schemes, following three deployment scenarios are encouraged to be evaluated in phase 1
 - Indoor hotspot, dense urban, urban macro
- Use the simulation assumptions in TR 38.802 as baseline
 - Adopt at least the FeCoMP (TR 36.741) methodology in terms of coordination
 - E.g. Coordination cluster size, backhaul latencies, traffic loads, etc.
 - The parameterization from the agreements on email discussion for NR MIMO calibration [86-20] could be considered

[R1-1610519](#)

MIMO transmission based on multiple antenna panels

Huawei

[R1-1610893](#)

MIMO transmission based on multiple antenna panels

Huawei, HiSilicon, Xinwei, NEC

Agreements:

- Study at least the following different multi-panel structures at both TRP and UE
 - Uniform array: antenna elements with the same polarization from multiple panels are uniformly distributed in horizontal and vertical dimensions respectively (see Fig.1(a) in [R1-1610893](#) as an example)
 - Non-uniform array: antenna elements with same polarization from multiple panels are not uniformly distributed in horizontal or vertical dimension (see Fig.1(b) in [R1-1610893](#) as an example)
- Study the coherent/non-coherent MIMO transmission based on uniform/non-uniform array structure at TRP or UE
 - E.g., Codebook design, calibration accuracy, interference measurement, advanced receiver design, interference hypothesis

[R1-1610685](#)

WF on NR UL MIMO CATT, Samsung, LG, InterDigital

Agreements:

- If UE capabilities are known, FFS UL SU-MIMO schemes should be designed agnostic to UE antenna configuration or not
- Support at least a maximum of 4 layers uplink SU-MIMO transmission
 - FFS whether or not to support 5-8 layers

[R1-1610983](#)

WF on SRS-based UL link adaptation

LG Electronics, CATT, Huawei, HiSilicon, Samsung

Agreements:

- At least one of precoded and non-precoded SRS based UL link adaptation procedure should be supported in NR, with at least following different procedures:
 - UL data scheduling (MCS/precoder/rank) is based on non-precoded SRS transmission by UE
 - Configurable number of SRS ports are 1, 2, 4, or [8]. Other possible numbers FFS.
 - FFS on precoder/codebook
 - UL data scheduling (MCS/precoder/rank) is based on precoded SRS(s) transmission by UE
 - Configurable number of SRS ports are 1, 2, or 4. Other possible numbers FFS.
 - Multiple precoded SRS resources (if supported) can be configured.
 - At least one of the following is supported
 - Precoder for SRS can be determined by UE based on measurement on DL RS and
 - Precoder for SRS can be indicated by gNB
 - FFS on precoder/codebook
 - UL data scheduling (MCS/precoder/rank) is based on a combination of non-precoded and precoded SRS transmission by UE
 - Note: Some parts of above procedures might be transparent to UE
 - FFS: UE may select a subset of SRS ports for SRS transmission

[R1-1610694](#)

WF on NR UL MIMO precoding

Intel Corporation, NTT DoCoMo, Fujitsu, Samsung

Companies are encouraged to check the examples in [R1-1610694](#), further discussion next meeting

[R1-1610486](#)

Non-linear precoding Mitsubishi

[R1-1610831](#)

WF on Spatial Multiplexing Schemes for MU-MIMO Mitsubishi Electric, InterDigital, Samsung, NTT

DOCOMO, IITH, IITM, Tejas Networks, CEWIT, KDDI

Also supported by AT&T, Reliance jio, Huawei, HiSilicon

[R1-1610895](#)

WF on DL MIMO Transmission

Huawei, HiSilicon, CATT, ...

[R1-1610633](#)

WF on phase continuity of DL precoding

Qualcomm, InterDigital, Xinwei, Huawei, HiSilicon

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1611037](#) WF on phase continuity of DL/UL precoding
ZTE Microelectronics, Intel
Also supported by Interdigital

Qualcomm, Huawei, HiSilicon, Xinwei, Ericsson, ZTE,

Agreements:

- At least for DL, study PRB bundling with configurable PRG sizes, at least including following aspects
 - The size of PRG may or may not be fixed
 - The size of PRG may or may not be system bandwidth dependent
 - PRG may consist of all scheduled PRBs

[R1-1610735](#) Way Forward on Network Coordination for Advanced Receivers
Vodafone, IITH, Tejas Networks, IITM, KDDI, CeWiT, Reliance Jio

Samsung, Intel, MediaTek, Orange,

[R1-1611047](#) Way Forward on Network Coordination for Advanced Receivers
Vodafone, IITH, Tejas Networks, IITM, KDDI, CeWiT, Reliance Jio

Samsung, Intel, MediaTek, Orange,

[R1-1611064](#) Way Forward on Network Coordination for Advanced Receivers
Orange, Vodafone, IITH, Tejas Networks, IITM, KDDI, CeWiT, Reliance Jio

Samsung, Intel, MediaTek, AT&T,

Agreements:

- RAN1 to study the following aspects :
 - Codeword-to-layer mapping
 - Number of codewords on a “NR-PDSCH”
 - Other techniques not precluded
- This RAN1 study should consider advanced receivers for interference mitigation
 - In the case of network coordination: the following can also be studied
 - Rank and modulation order
 - Modulation mapping
 - Other techniques not precluded
- FFS: For this RAN1 study, the following performance metrics for non-full-buffer system level evaluation can be considered:
 - Average UPT
 - [5%,50%,95%]-tile UPT

[R1-1610967](#) WF on MIMO transmission techniques in NR

LG Electronics, Qualcomm, KT

Agreements:

- DL and UL transmission techniques should be studied to provide robustness against imperfect CSI and mobility
 - e.g.) The techniques using a subset of beams/precoders may include beam cycling, beam broadening, etc.
 - e.g.) In case of DL and FDD, this technical scope may include semi-open-loop MIMO technique being discussed in LTE eFD-MIMO.

[R1-1611044](#) WF on DL MIMO Transmission Huawei, HiSilicon, Ericsson, CATT

Agreements:

- Support downlink transmission scheme(s) achieving diversity gain at least for some control information transmission
 - Exact scheme is for further study.
 - Specification support for such transmission schemes, i.e., the scheme(s) may or may not be implemented in spec-transparent manner
 - Note: The data/control channel transmission is at least based on DM-RS for demodulation.

[R1-1608668](#) Discussion on interference issues in NR ZTE, ZTE Microelectronics

[R1-1608669](#) Discussion on UL MIMO transmission for NR ZTE, ZTE Microelectronics

[R1-1608670](#) Discussion on DL MIMO transmission for NR ZTE, ZTE Microelectronics

[R1-1608775](#) MIMO transmission schemes for NR CATT

[R1-1608776](#) Discussion on UL MIMO for NR CATT

[R1-1608819](#) Discussion on DL MIMO transmission Huawei, HiSilicon

[R1-1608820](#) Discussion on UL MIMO transmission Huawei, HiSilicon

[R1-1608851](#) Antenna Structure Impacts on MIMO transmission and codebook design Huawei, HiSilicon

[R1-1608905](#) Discussion on Multi-antenna Scheme Guangdong OPPO Mobile Telecom.

[R1-1609084](#) DMRS-based spatial multiplexing for DL NR MIMO Samsung

[R1-1609085](#) DMRS-based spatial multiplexing for UL NR MIMO Samsung

[R1-1609086](#) Discussion on transmission schemes, transmission modes and control signaling Samsung

[R1-1609101](#) Discussions on NR network coordination Samsung

[R1-1609102](#) Evaluation assumptions for NR network coordination Samsung

[R1-1609103](#) Coordinated interference cancellation for NR Samsung

[R1-1609104](#) Evaluation assumptions for NR coordinated interference cancellation based on advanced receivers Samsung

[R1-1609249](#) Views on NR DL MIMO LG Electronics

[R1-1609250](#) Views on NR UL MIMO LG Electronics

[R1-1609251](#) Discussion on semi-OL MIMO for NR LG Electronics

R1-1609252	Discussion on interference management for NR	LG Electronics
R1-1609305	Updated System Level Evaluation for NR MIMO	CMCC
R1-1609306	General Requirements on NR MIMO	CMCC
R1-1609417	Overview of coordination schemes and interference management techniques in NR	Huawei, HiSilicon
R1-1609518	Discussion on NR MIMO Transmission Schemes and Transmission Modes	Intel Corporation
R1-1609520	UL subband precoding for NR	Intel Corporation
R1-1609693	Views on NR MIMO Transmission Schemes	Beijing Xinwei Telecom Techn.
R1-1609755	On codewords and layer mapping	Ericsson
R1-1609756	On NR MIMO below 6 GHz	Ericsson
R1-1609757	UL MIMO in NR	Ericsson
R1-1609905	MIMO transmission schemes for NR	InterDigital Communications
R1-1610064	Hybrid Beamforming for NR	NTT DOCOMO, INC.
R1-1610065	High order MU-MIMO with TDD channel reciprocity	NTT DOCOMO, INC.
R1-1610066	Discussion on frequency selective precoding for Uplink MIMO transmission	NTT DOCOMO, INC.
R1-1610095	Discussion on DL multi-antenna transmission schemes	CHTTL
R1-1610146	Continuous beamforming and initial evaluation results	Qualcomm Incorporated
R1-1610147	DL open-loop MIMO transmission schemes	Qualcomm Incorporated
R1-1610148	Uplink MIMO transmission schemes	Qualcomm Incorporated
R1-1610227	Nonlinear precoding schemes for NR MU-MIMO and their specification impact	Mitsubishi Electric Co.
R1-1610250	Scalability of MIMO operation across NR carrier frequencies	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610251	On simultaneous reception of single-beam and multi-beam uplink	Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless
R1-1610252	Unified MIMO transmission mode for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610253	Decoupled Control and Data for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610254	High-level principles for beam coordination and Link Adaptation in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610255	Non-coherent Multi-node Transmission for URLLC in the 5G New Radio	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610256	On the support of transmit diversity in NR for data and control channels	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610257	UL MIMO transmission in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610258	On the support for frequency selective precoding in UL MIMO	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610259	SU-MIMO Performance Characteristics in UMa 30GHz	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610260	MU-MIMO Performance Characteristics in UMa 30GHz	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610261	Uplink SU-MIMO Performance Characteristics in 5G-UMa 4GHz	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610262	Coverage Enhancement Opportunities at High Carrier Frequencies	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610263	Network Coordination to support advanced receivers	Nokia, Alcatel-Lucent Shanghai Bell

8.1.4.3 CSI acquisition

[R1-1609254](#) Discussion on interference measurement for NR LG Electronics

The document was presented by ... from LGE.

- Observation 1: IMR based interference power measurement seems to be still preferable in NR. Interference channel estimation approach can also be considered and may have benefit in the case of large number of interference hypotheses but with small number of antenna ports.
- Observation 2: Interference feedback methods seems to be needed for multiple interference hypotheses in NR. Required amount of feedback and CSI computation should however be taken into account.
- Proposal 1: Inter-beam, MU, and inter-TRP interference should be considered in NR
- Proposal 2: Interference measurement structure is desired to be agnostic to interference type.
- Proposal 3: Consider aperiodic/periodic/semi-persistent resource for interference measurement.
- Proposal 4: Consider independent configuration of resources/signals for interference measurement and CSI measurement.

Decision: The document is noted.

[R1-1609694](#) Views on NR CSI Acquisition and Report Beijing Xinwei Telecom Techn.

The document was presented by Peng Sun from Xinwei.

- Proposal 1: NR MIMO CSI measurement and report framework could be based on the framework of FD-MIMO CSI measurement and report, with refinement on beam combination codebook design, CoMP and streamlining of transmission modes and CSI report classes.
- Proposal 2: CSI report in NR MIMO framework mainly consists of beam index, PMI, RI, CQI and a novel index indicating whether or which TRPs could be used for simultaneous transmission.
- Proposal 3: Without legacy design, with fewer reporting modes, and with higher uplink control payload ability, NR should avoid the many kinds of UCI reports in LTE.
- Proposal 4: Nested property and constant modulus is still the design principle of beam combination codebook. Householder codebook is a good starting point.

- Proposal 5: NR MIMO supports in UCI novel index of whether or which TRPs in the large amount of candidates could be selected for simultaneous transmission.
- Proposal 6: For NR TDD, beam information related to analog beam selection is still acquired from DL beam training reference signal. For beam combination and multiple TRP cooperation, channel reciprocity could be triggered.
- Proposal 7: All UL CSI is acquired through measurement of dynamically configured and triggered SRS. It is possible for UE to transmit multiple SRS simultaneously through different panels/TxRUs. Multiple TRPs should be able to receive the same SRS simultaneously.

Decision: The document is noted.

R1-1610265 Explicit feedback options in NR Nokia, Alcatel-Lucent Shanghai Bell

The document was presented by Mihai Enescu from Nokia.

- Proposal 1: Study the use of high resolution CSI feedback for operation with a hybrid array (i.e., a relatively few ports used in the data transmission) and for operation with a full digital array (i.e., relatively large number of ports used in the data transmission).
- Proposal 2: Study the various mechanisms for high resolution CSI feedback and explore the tradeoffs in performance and required level of feedback.

Decision: The document is noted.

R1-1610517 Way Forward on CSI measurement and reporting Huawei, HiSilicon, Ericsson, Qualcomm

- Support explicit CSI feedback in NR
 - e.g. channel covariance matrix feedback, eigenvector feedback, etc.
- Support the following schemes of NR CSI reporting
 - Semi-persistent CSI reporting
 - Aperiodic CSI reporting
 - FFS: Periodic CSI reporting
- The feasibility of CSI-RS transmission and CSI reporting in a self-contained structure (e.g., subframe) should be studied, considering UE implementation complexity.
 - Possible constraints: CSI reporting includes CQI and/or interference level only
- Interference measurement under different interference hypothesis should be supported in NR.
 - Note: analogous to CSI-IM and interference hypothesis in LTE
- Interference measurement based on a hybrid of ZP CSI-RS and NZP CSI-RS should be studied.

Decision: The document is noted.

R1-1610509 Way Forward on CSI-RS and CSI reporting in NR LG Electronics, Ericsson, Intel

- NR supports CSI-RS at least for CSI measurement and reporting.
 - FFS: Use of DL DMRS for CSI measurement and reporting
- NR supports both aperiodic and semi-persistent transmission of CSI-RS.
 - FFS: periodic transmission of CSI-RS
 - Note: periodic RS means ‘always-on’ RS analogous to LTE CRS
 - FFS: mechanisms (e.g. protocol layer) for dynamic control of activation/deactivation for semi-persistent CSI-RS
 - FFS: mechanisms to provide reliable activation/deactivation for semi-persistent CSI-RS
- With regard to relating CSI-RS transmission and CSI reporting, following combinations are supported at least.
 - Aperiodic CSI reporting with aperiodic CSI-RS
 - Aperiodic CSI reporting with semi-persistent CSI-RS
 - Semi-persistent CSI reporting with semi-persistent CSI-RS
- To support combinations above more flexibly, NR should allow independent control of CSI-RS indication and CSI reporting indication.
 - ‘indication’ above may refer to triggering, activation, and deactivation depending on type of RS/reporting.
 - Further study is needed how to guarantee appropriate time gap between CSI-RS and CSI reporting.
 - Note: This does not preclude joint control of CSI-RS indication and CSI reporting indication.

Decision: The document is noted.

R1-1610515 Way Forward on CSI reporting for NR Samsung, Intel, Ericsson, Xinwei

- Support aperiodic CSI reporting for NR
- Support at least one of following CSI reporting schemes for NR:
 - Periodic CSI reporting
 - Semi-persistent CSI reporting
- Study periodic/semi-persistent CSI reporting by using other signals than CSI-RS
 - FFS on necessary configurations, conditions, situations and use cases

Decision: The document is noted.

Tuesday session

R1-1610716 Way Forward on CSI-RS and CSI reporting in NR

LG Electronics, Ericsson, Intel, Samsung

Decision: The document is noted, modified and agreed as follows:

Agreements:

- At least for CSI acquisition, NR supports CSI-RS, SRS
 - FFS: Use of DL DMRS for CSI measurement
- NR supports aperiodic transmission of CSI-RS
- For CSI-RS transmission, NR supports at least one of following:
 - Semi-persistent transmission
 - Preconfigured CSI-RS resources can be activated or de-activated
 - FFS: Activation/De-activation mechanism
 - Periodic transmission
 - Periodic CSI-RS can be configured by higher layer
 - FFS: mechanisms (e.g. protocol layer) for dynamic control of activation/deactivation for semi-persistent CSI-RS
 - FFS: mechanisms to provide reliable activation/deactivation for semi-persistent CSI-RS
- NR supports aperiodic CSI reporting
- NR supports at least one of following:
 - Periodic CSI reporting
 - It can be configured by higher layer
 - Semi-persistent CSI reporting
 - Configuration of CSI reporting can be activated or de-activated
 - FFS: Activation and de-activation mechanism
- Study periodic/aperiodic/semi-persistent CSI reporting by using CSI-RS
 - FFS using other RSs
 - FFS on necessary configurations, conditions, situations and use cases
- With regard to relating CSI-RS transmission and CSI reporting, following combinations are supported at least
 - Aperiodic CSI reporting with aperiodic CSI-RS
 - Aperiodic CSI reporting with semi-persistent/periodic CSI-RS
 - Semi-persistent/periodic CSI reporting with semi-persistent/periodic CSI-RS
- To support combinations above more flexibly, NR should allow independent control of CSI-RS indication and CSI reporting indication timings.
 - 'indication' above may refer to triggering, activation, and deactivation depending on type of RS/reporting.
 - Further study is needed how to guarantee appropriate time gap between indication of CSI-RS transmission and CSI-RS
 - Further study is needed how to guarantee appropriate time gap between CSI-RS and CSI reporting
 - Note: This does not preclude joint control of CSI-RS indication and CSI reporting indication.

Wednesday session

R1-1610637 Way Forward on CSI Framework for NR Samsung, Ericsson, AT&T, KT Corporation, CATT

(R1-1610533)

- CSI-related settings consisting of:
 - CSI reporting settings
 - Each CSI parameter is independently configured, e.g. time and/or frequency granularity, ON/OFF
 - FFS: Details of configurability
 - CSI parameters include at least RI, PMI, CQI, and CSI-RS resource indicator (CRI)
 - RS (at least for CSI measurement) settings, e.g. CSI-RS (CSI-IM as a special case)
 - FFS: Other RS for CSI measurement
 - CSI measurement settings
 - To configure which RS setting is used for a particular CSI reporting setting
- A UE can be configured with:
 - *N* CSI reporting settings
 - *M* RS (for CSI measurement) settings
 - CSI measurement setting configures mapping/linkage between *N* CSI reporting and *M* RS settings
- Transmission scheme is configured separately
 - Examples of transmission scheme: DMRS-based precoding, Tx diversity, ...
 - Examples of use case for study:
 - Linking/combining multiple PMI components (e.g. i1, i2 in LTE) with multiple RS settings

Decision: The document is noted, modified as follows:

Agreements:

- CSI-related settings consisting of:
 - CSI reporting settings
 - CSI parameter can be independently configured, e.g. time and/or frequency granularity, FFS: ON/OFF
 - FFS: Details of configurability
 - Definition of CSI parameters (e.g., CQI, PMI, RI) is FFS
 - RS (at least for CSI measurement) settings, e.g. CSI-RS (CSI-IM as a special case)
 - FFS: Other RS for CSI measurement
 - CSI measurement settings
 - To configure which RS setting is used for a particular CSI reporting setting
- Study the case where a UE can be configured with:
 - N CSI reporting settings
 - M RS (for CSI measurement) settings
 - CSI measurement setting configures mapping/linkage between N CSI reporting and M RS settings

R1-1610638 Way Forward on PMI Reporting for NR Samsung, AT&T, Ericsson, NTT DOCOMO (R1-1610534)

- NR CSI reporting supports PMI with two levels of spatial resolution:
 - Normal-resolution, e.g. analogous to LTE PMI (“implicit” feedback)
 - High-resolution, e.g. quantized channel, eigenvector, or covariance matrix
 - PMI per subband as well as wideband PMI is supported
- The supported PMI associated with each of the two levels is derived from a codebook
 - Working assumption: The codebook is scalable with different numbers of CSI-RS ports (including at least the ones supported in LTE Rel.14)
- Study at least the following codebook design aspects:
 - “Dual-stage” PMI definition analogous to i_1 and i_2 in LTE, e.g.
 - Precoder basis associated with i_1
 - Precoder selection and/or combining associated with i_2
 - Frequency granularity of i_1 and i_2 (e.g. wideband, subband, subband size)
 - “Multi-stage” feedback analogous to i_1 and i_2 in LTE but with more stages
 - The overall precoder being a function of the feedback for each of these stages
 - Unified and scalable design for both normal- and high-resolutions

Decision: The document is noted, modified as follows:

Possible agreements:

- NR supports CSI reporting with two types of spatial information feedback
 - Type I feedback
 - Type II feedback
 - Note: Type II feedback is higher resolution compared to Type I feedback
- For Type I and II, CSI feedback per subband as well as wideband feedback are supported
- Type I and II are designed for different use cases and/or functionalities
 - Only one scheme is supported for Type I
 - Only one scheme is supported for Type II
- Study following design examples as candidates for Type I
 - PMI-based scheme analogous to LTE Rel-13/14 beam selection codebook (“implicit” feedback) including CRI based feedback
 - Other schemes are not precluded
- Study following design examples as candidates for Type II:
 - PMI-based scheme using beam combination codebook
 - “Explicit” feedback such as quantized channel, channel eigenvector(s) or channel covariance matrix, analog feedback
 - Other schemes are not precluded
- Also study the following design examples:
 - “Dual-stage” PMI definition analogous to i_1 and i_2 in LTE, e.g.
 - Precoder basis associated with i_1
 - Precoder selection and/or combining associated with i_2
 - Frequency granularity of i_1 and i_2 (e.g. wideband, subband, subband size)
 - “Multi-stage” feedback analogous to i_1 and i_2 in LTE but with more stages
 - The overall precoder being a function of the feedback for each of these stages
 - Beam broadening function

- Hermitian matrix based covariance matrix codebook
- Downloadable codebook
- Other designs are not precluded

Agreements:

- NR supports CSI reporting with two types of spatial information feedback
 - Type I feedback: Normal
 - Codebook-based PMI feedback with normal spatial resolution
 - Type II feedback: Enhanced
 - “Explicit” feedback and/or codebook-based feedback with higher spatial resolution
- For Type I and II, CSI feedback per subband as well as wideband feedback are supported
- For Type I and II, beam-related feedback can be included

R1-1610907 WF on CSI-RS resource pooling Ericsson, Samsung, LG, Nokia (R1-1610705)

- A CSI-RS resource set should be supported whereby CSI-RS resources within the set may be dynamically shared amongst users
- CSI-RS resources are configured in 2 steps
 - Step 1: Pre-configure a set of K CSI-RS resources for a group of users through RRC configuration
 - Step 2: For a given user, dynamically indicate N out of K (where $N \geq 1$) of the CSI-RS resources from the set to enable CSI measurement in a given time window
 - Study the following alternatives
 - Alt 1: Dynamic signaling through DCI
 - Alt 2: Dynamic signaling through MAC CE
 - The CSI-RS transmissions can be dynamically indicated as one shot or multi-shot within the window

Decision: The document is noted, modified as follows:

Agreements:

- A CSI-RS resource set should be studied whereby CSI-RS resources within the set may be dynamically shared amongst users
- Study CSI-RS resources configuration in 2 steps
 - Step 1: Pre-configure a set of K CSI-RS resources for one or more users through UE-specific RRC configuration
 - Step 2: For a given user, dynamically indicate N out of K (where $N \geq 1$) of the CSI-RS resources from the set to enable CSI measurement in a given time window
 - Study the following alternatives
 - Alt 1: Dynamic signaling through DCI
 - Alt 2: Dynamic signaling through MAC CE
 - The CSI-RS transmissions can be dynamically indicated as one shot or multi-shot within the window
 - The configured CSI-RS resource pool can be used for channel/interference measurement
 - Configure multi sets of CSI-RS resources for one UE

R1-1610517 Way Forward on CSI measurement and reporting Huawei, HiSilicon, Ericsson, Qualcomm

Agreements:

- The feasibility of CSI-RS transmission and CSI reporting in a self-contained structure (e.g., subframe) should be studied, considering UE implementation complexity
 - FFS: DM-RS based CSI reporting
- Interference measurement under different interference hypothesis should be supported in NR
 - Definition of interference hypothesis and mechanism of interference measurement is FFS

R1-1610899 Way Forward on CSI feedback framework for hybrid beamforming in NR CMCC, CATT, Xinwei, Samsung, Ericsson, Huawei, HiSilicon, Qualcomm (R1-1610727)

- For hybrid beamforming, at least the following steps for CSI/RSRP acquisition should be studied:
 - Step 1: Beam-based CSI/ and/or RSRP (e.g., based on beam management procedures)
 - To determine at least analog beam
 - Using UE feedback and/or beam-based reciprocity
 - With beam-based reciprocity, TRP/UE can obtain DL/UL Tx beam from its Rx beam by multi-beam reception
 - Step 2: Port-based CSI
 - To determine the precoder for all or part of TXRUs (narrow digital beam) given the reported analog beam

- Using UE feedback and/or port-based reciprocity
 - With port-based reciprocity, TRP/UE can obtain DL/UL CSI based on UL SRS/DL RS
- Step 3: CQI
 - To determine CQI for data transmission given the reported analog and digital beam
 - Based on UE-specific beamformed CSI-RS transmission
- Further optimization of the procedure for reciprocity/non-reciprocity can be considered
- Note: Certain steps may be merged/reordered/repeated
- Study the association between UL and DL RS in/among the above steps:
 - E.g. When channel reciprocity holds, UL/DL RS port/resource may be selected/precoded based on DL/UL RS measurement results
- CSI/RSRP acquisition or full digital or full analog beamforming can be a special case of the above framework
 - For single-beam based approach, step 1 doesn't apply

Decision: The document is noted, modified as follows:

Agreements:

- For hybrid beamforming, at least the following steps for CSI/RSRP acquisition should be studied:
 - Step 1: Beam-based CSI/ and/or RSRP (e.g., based on beam management procedures)
 - To determine at least analog beam
 - Using UE feedback and/or beam-based reciprocity
 - With beam-based reciprocity, TRP/UE can obtain DL/UL Tx beam from its Rx beam by multi-beam reception
 - Step 2: Port-based CSI
 - To determine the precoder for digital beam based on the reported analog beam(s)
 - Using UE feedback and/or port-based reciprocity
 - With port-based reciprocity, TRP/UE can obtain DL/UL CSI based on UL SRS/DL RS
 - Step 3: CQI
 - To determine CQI for data transmission given the reported analog and digital beam
 - Based on UE-specific CSI-RS transmission
 - Further optimization of the procedure for reciprocity/non-reciprocity can be considered
 - Note: Certain steps may be merged/reordered/repeated
- Study the association between UL and DL RS in/among the above steps
- Note: CSI/RSRP acquisition for full digital or full analog beamforming can be a special case of the above framework
 - For single-beam based approach, step 1 may not apply

R1-1610906 WF on channel and interference measurements for NR Samsung, Intel, Qualcomm...

Agreements:

- For channel and interference measurement in NR,
 - For interference measurement, support at least one of following schemes:
 - Measurement subsets in both time and frequency domain
 - Interference measurement restriction in both time and frequency domain
 - FFS on channel measurement
 - FFS on the details (including whether measurement subset is equivalent to measurement restriction in the freq. domain)
 - Study CSI reporting which is optimized for each use case
 - E.g. CQI which is targeted to high reliability

R1-1610950 WF on interference measurement for CSI acquisition Qualcomm, Huawei, HiSilicon, Samsung

Agreements:

- For DL data transmission, study following interference measurement options for CSI acquisition.
 - Dynamically assigned (e.g., pre-committed/pre-scheduled) interference measurement resource
 - In-scheduled interference measurement resource
 - NZP CSI-RS based interference measurement
 - DM-RS based interference measurement
 - Combination of above options
 - Other options are not precluded
- Above study should assume non-full buffer traffic model assumption

R1-1610937 WF on CSI Parameters for NR Samsung, Nokia, ASB, AT&T, CATT, NTT DOCOMO, Ericsson, Intel, LG Electronics, InterDigital

Agreements:

- For Type I feedback, NR supports at least the following (DL) CSI reporting parameters
 - Resource selection indicator (Examples for further study are reference signal resource, port, reference signal sequence, beam)
 - RI (rank indicator)
 - PMI (precoding matrix indicator)
 - Channel quality feedback

R1-1608671	Beam selection and CSI acquisition for NR MIMO	ZTE, ZTE Microelectronics	
R1-1608672	Advanced CSI measurement and reporting framework for NR MIMO	ZTE, ZTE Microelectronics	
R1-1608693	Aperiodic CSI for NR MIMO	ZTE, ZTE Microelectronics	
R1-1608777	High-level views on CSI acquisition for NR	CATT	
R1-1608811	Discussion on CSI Acquisition for Massive MIMO in NR	Fujitsu	
R1-1608949	CSI feedback for channel reciprocity operation	Sony	
R1-1609087	CSI acquisition for DL NR MIMO	Samsung	
R1-1609088	CSI acquisition for UL NR MIMO	Samsung	
R1-1609089	Advanced CSI feedback for NR	Samsung	
R1-1609090	Simulation results for explicit CSI reporting for NR MIMO	Samsung	
R1-1609091	Discussions on periodic CSI reporting for NR	Samsung	
R1-1609092	Discussions on aperiodic CSI reporting for NR	Samsung	
R1-1609093	Discussions on channel and interference measurements for NR	Samsung	
R1-1609253	Views on CSI acquisition for NR	LG Electronics	
R1-1609255	Discussion on channel reciprocity for NR MIMO	LG Electronics	
R1-1609307	Considerations on DL CSI acquisition framework of massive MIMO for new radio		CMCC
R1-1609327	CSI framework for multi-beam operation	MediaTek Inc.	
R1-1609380	Massive MIMO: Channel State Information (CSI) Acquisition in Angular Domain		Sony
R1-1609416	Discussion on CSI measurement and reporting	Huawei, HiSilicon	
R1-1609521	Discussion on NR CSI framework	Intel Corporation	
R1-1609522	Discussion on NR CSI configuration	Intel Corporation	
R1-1609523	Discussion on NR CSI contents	Intel Corporation	
R1-1609758	Overview of CSI framework for NR	Ericsson	
R1-1609759	On CSI reporting methods in NR	Ericsson	
R1-1609760	Decoupled CSI framework for NR	Ericsson	
R1-1609761	Details on the unified CSI framework for NR	Ericsson	
R1-1609762	Port combining codebook for NR	Ericsson	
R1-1609763	Aperiodic CSI and CSI-RS resource pooling	Ericsson	
R1-1609906	CSI acquisition for NR MIMO	InterDigital Communications	
R1-1609907	Consideration of Short Block-length for CQI Feedback for NR	InterDigital Communications	
R1-1610067	CSI Acquisition Schemes for NR	NTT DOCOMO, INC.	
R1-1610068	Codebook design requirement for NR	NTT DOCOMO, INC.	
R1-1610069	Discussion on CSI acquisition scheme for Uplink MIMO transmission	NTT DOCOMO, INC.	
R1-1610149	Discussion on CSI acquisition	Qualcomm Incorporated	
R1-1610150	Beam reciprocity aspects	Qualcomm Incorporated	
R1-1610264	CSI feedback types in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610266	On the CSI reporting in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610267	On the CSI timing relationships	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610268	On the channel and interference estimation in NR	Nokia, Alcatel-Lucent Shanghai Bell	

8.1.4.4 Reference signal design and QCL

[R1-1608675](#) **On Quasi-Co-Location/Beam for NR MIMO** ZTE, ZTE Microelectronics

The document was presented by Ruyue Li from ZTE.

- Observation 1: Delay offset among different beam-based channel is significant.
- Observation 2: Similar channel properties can be observed when the beam-pairs point to the adjacent direction.
- Proposal 1: Introducing a new set of “Quasi-Co-beam” parameters e.g. angle of arrival, angular spread to QCL parameters. Grouping of antenna ports according to quasi-co-beam properties is fed back by the UE.
- Proposal 2: Support flexible configuration of the QCL parameters for different applications
- Proposal 3: Support QCL association of UL ports to DL ports considering channel reciprocity

Decision: The document is noted.

[R1-1608822](#) **Reference signal design for phase noise compensation in HF** Huawei, HiSilicon

The document was presented by ... from Huawei.

Observation 1: Phase noise compensation is needed in certain scenarios, depending on at least the scheduled MCS and number of RBs.

Observation 2: Whether the reference signal carrying phase noise compensation functionality is UE-specific or non-UE-specific needs to be studied.

Observation 3: The methods of multiplexing multiple reference signals enabling phase noise compensation for multiple users/streams needs to be studied, including at least FDM and CDM methods.

Observation 4: To reduce overhead and complexity, potential sharing of reference signal for phase noise compensation across streams should be studied.

Proposal 1: The reference signal design in NR should facilitate phase noise compensation when it is needed, especially for frequency bands above 6 GHz.

Proposal 2: The reference signal in NR carrying the phase noise compensation functionality should be continuously mapped in the time domain, i.e., on each data symbol.

Proposal 3: NR should be able to configure the reference signal carrying phase noise compensation functionality (e.g., to map or not), independent of front-loaded RS.

Decision: The document is noted.

R1-1609261 Discussion on Common Phase Error Compensation for Above 6GHz LG Electronics

The document was presented by ... from LGE.

- Observation 1: BLER performance gap according to PTRS frequency density is much higher as TRB size is larger.
- Observation 2: 4 or 8 PTRS is enough for CPE estimation regardless of # of TRB.
- Observation 3: BLER performance gap according to PTRS time density is much higher as TRB size is larger.
- Observation 4: For 4 TRBs, non CPE compensation has better spectral efficiency than CPE compensation.
- Observation 5: For 64 TRBs, CPE compensation except for 1 PTRS has better spectral efficiency than non CPE compensation.
- Observation 6: For 4 TRBs, PTRS time interval 2 achieves higher spectral efficiency than time interval 1. In contrast, for 64 TRBs, PTRS time interval 1 achieves higher spectral efficiency than time interval 2.
- Observation 7: Codeblock spreading in the time domain reduces phase noise impact even for CPE compensation.
- Proposal 1: The trade-off between performance gain from CPE compensation and PTRS overhead should be considered.
- Proposal 2: PTRS time interval should be designed flexibly according to TRB size.
- Proposal 3: Codeblock spreading in the time domain would be considered.

Decision: The document is noted.

R1-1609388 Generalized CSI feedback framework for NR MIMO AT&T GNS Belgium SPRL

The document was presented by Arun Ghosh from AT&T.

- Proposal 1: No need to define transmission mode in NR MIMO. Instead, allow configuration on transmission scheme, RS and CSI measurement/report and downlink control format separately.
- Proposal 2: If needed, dependency or coupling between functions can be introduced during the configurations procedure.
- Proposal 3: The NR CSI feedback framework should support codebook based CSI plus at least one advanced CSI feedback scheme.
- Proposal 4: The NR CSI feedback framework should describe MIMO channel by multiple CSI components, we suggest to describe channel using components in Horizontal, Vertical and Uncorrelated domain separately.
- Proposal 5: The CSI measurement for each CSI component can be based on independent configured CSI-RS.
- Proposal 6: Both network and UE should be involved in deciding the feedback payload bits and CSI granularity (frequency, time, spatial domain) for each CSI component.
- Proposal 7: Study the need of CSI feedback for control channel, and if needed, strive for one generic CSI feedback framework to support both data and control channel.

Decision: The document is noted.

R1-1610524 Way Forward on NR RS definition Huawei, HiSilicon

- The following RSs are supported for NR downlink
 - NR DL CSI-RS: a family of reference signals with main functionalities of CSI acquisition, beam management, and RRM measurement
 - NR DL DM-RS: a family of reference signals with main functionalities of data and control demodulation;
 - FFS: additional reference signal for phase tracking;
- The following RSs are introduced for NR uplink
 - NR UL SRS: a family of reference signals with main functionalities of CSI acquisition, beam management, and RRM measurement;
 - NR UL DM-RS: a family of reference signals with main functionalities of data and control demodulation;
 - FFS: additional reference signal for phase tracking;

Decision: The document is noted. Continue offline.

Agreements:

- At least the following RSs are supported for NR downlink

- CSI-RS: Reference signal with main functionalities of CSI acquisition, beam management
 - FFS: RRM measurement
- DM-RS: Reference signal with main functionalities of data and control demodulation
 - FFS: channel state information estimation and interference estimation
 - FFS: beam management
- Reference signal for phase tracking
 - FFS: Whether DM-RS extension can be applied or not
 - FFS whether new RS or RS for other functionalities can be used
- Reference signal for time/freq. tracking
 - FFS whether new RS or RS for other functionalities can be used
- Reference signal for Radio link monitoring
 - FFS whether new RS or RS for other functionalities can be used
- RS for RRM measurement
 - FFS whether new RS or RS for other functionalities can be used
- At least the following RSs are supported for NR uplink
 - SRS: Reference signal with main functionalities of CSI acquisition, beam management
 - FFS: RRM measurement
 - DM-RS: Reference signal with main functionalities of data and control demodulation
 - FFS: beam management
 - Reference signal for phase tracking
 - FFS: Whether DM-RS extension can be applied or not
 - FFS whether new RS or RS for other functionalities can be used
 - FFS: Reference signal for RRM measurement
 - FFS whether new RS or RS for other functionalities can be used

R1-1610490 Way Forward on NR CSI-RS Huawei, HiSilicon

- Support the following functionalities in NR CSI-RS design
 - CSI measurement
 - Beam measurement
 - RRM measurement
- Support NR CSI-RS pattern with at least the following properties:
 - CSI-RS mapped in one or multiple consecutive symbols
 - At least CSI-RS located at the earlier part of a slot
 - FFS: before or after the DM RS agreed to study in RAN1#85
 - FFS: CSI-RS located at other part of a slot
 - Configurable density of CSI-RS in frequency domain
 - FFS: CSI-RS for NR should support up to at least 32 ports
- Support at least following configurations of NR CSI-RS
 - UE-specific configuration to support
 - Wideband CSI-RS, i.e. the full bandwidth the UE is configured to operate with
 - Subband CSI-RS, i.e. part of the bandwidth the UE is configured to operate with

Decision: The document is noted, modified as follows:

Agreements:

- Support NR CSI-RS pattern with at least the following properties:
 - CSI-RS mapped in one or multiple [consecutive] symbols
 - FFS: At least CSI-RS located at the earlier part of a slot in some cases
 - FFS: before or after the DM-RS agreed to study in RAN1#85
 - FFS: CSI-RS located at other part of a slot
 - **Working assumption:** Configurable density of CSI-RS in frequency and/or time domain by UE-specific manner
 - **Working assumption:** CSI-RS for NR should support up to 32 ports
 - FFS: whether or not to have 32 ports codebook
- Support at least following configurations of NR CSI-RS
 - UE-specific configuration to support
 - Wideband CSI-RS, i.e. from UE perspective, the full bandwidth the UE is configured to operate with
 - Partial-band CSI-RS, i.e. from UE perspective, part of the bandwidth the UE is configured to operate with
 - FFS: Different patterns may be used for wideband and subband CSI-RSs

R1-1610492 Way Forward on the CSI-RS configuration for NR Intel, Samsung, Ericsson

- CSI-RS configuration for NR includes at least ‘number of antenna ports’

- The number of CSI-RS antenna ports can be differently configured for periodic/semi-persistent CSI reporting and aperiodic CSI reporting
- The number of antenna ports supported for CSI-RS configuration includes at least the following values
 - 1,2,4,8,12,16,20,24,28,32

Decision: The document is noted.

Agreements:

- CSI-RS configuration for NR includes at least ‘number of antenna ports’
 - Configuration can be explicit or implicit
- The number of CSI-RS antenna ports can be independently configured for periodic/semi-persistent CSI reporting and aperiodic CSI reporting

Possible working assumption:

- The number of antenna ports supported for CSI-RS configuration includes at least the following values
 - 1,2,4,8,12,16,20,24,28,32

Continue offline discussion until Thursday

Thursday

Working assumption:

- The number of antenna ports supported for CSI-RS configuration includes at least the following values
 - 1,2,4,8,[12],16,[20],[24],[28],32
- RAN1 will update/remove above bracket parts in the next meeting
 - Study e.g., performance, scenario, RS overhead, RS pattern considering the frame structure, reuse of hardware between NR and LTE

R1-1610514 Way Forward on Reference Signal for Demodulation ZTE Corporation, ZTE Microelectronics

- Support variable/configurable RS pattern for demodulation
 - For both control and data channel
- Study multi-level RS for demodulation
 - The first level is front-loaded (i.e. loaded in the front of RB) which meets minimum requirements for demodulation
 - Other level(s) can be configured for different motivations, e.g. higher frequency/time density, Rx beam detection, RSRP/CSI-reporting, phase noise compensation

Decision: The document is noted. Also supported by Ericsson, Samsung

Possible agreements:

- Support variable/configurable RS pattern for demodulation
 - For data channel
 - FFS for control channel
 - At least density can be configured
 - FFS: other configurability
- Support multi-level RS for demodulation
 - The first level is front-loaded (i.e. loaded in the front of RB) which meets minimum requirements for demodulation
 - Other level(s) can be configured for different motivations, e.g. higher frequency/time density, Rx beam detection, RSRP/CSI-reporting, phase noise compensation

Continue offline discussion until Wednesday

Agreements:

- Study variable/configurable DL/UL RS pattern for demodulation
 - For data channel and control channel
 - At least density can be configurable
 - FFS: other configurability
 - The applicable scenarios need to be studied
- Study multi-set DL/UL RS for control and/or data demodulation
 - The first set is front-loaded (i.e. loaded in the front of RB)
 - Other set(s) can be configured for different purposes
 - Details FFS (e.g. higher frequency/time density, Rx beam detection, RSRP/CSI-reporting, phase noise compensation)

R1-1610491 Way Forward on NR DMRS Huawei, HiSilicon

- Separate design of demodulation RS for broadcast channel, control channel and data channel
- Studies on design of demodulation RS for data channel at least include

- The same principle for UL and DL RS pattern design
- DM RS mapped in one or a few consecutive symbols
- Additional RS located at middle part of a slot
- Up to 16 orthogonal DL DMRS ports for MU-MIMO scheduling

Discussion: Chair→ strive for more supporting companies

Decision: The document is noted.

Agreements:

- Study design of demodulation RS for broadcast channel, control channel and data channel
 - Separate vs. joint design
- Study on design of demodulation RS for data channel
 - Whether or not the same principle for UL and DL RS pattern design
 - How to map DM RS in symbols of a slot
 - Max # of orthogonal DL DMRS ports for SU/MU-MIMO scheduling

R1-1610520 Way Forward on the QCL for NR Intel, LGE, Ericsson, NTT DOCOMO, Samsung

- QCL framework in NR is extended with new spatial QCL parameter(s) to support UE side beamforming
 - FFS channel parameters for QCL
 - Option A: Receive angle of arrival (exact wording is FFS)
 - Option B: Spatial correlation
- NR supports at least two QCL assumptions for DM-RS antenna ports
 - All ports are QCL-ed
 - Not all ports are QCL-ed
 - FFS on details
- FFS
 - QCL between antenna ports transmitted on different CCs
 - QCL between CSI-RS antenna ports within one CSI-RS resource
 - All ports are QCL-ed
 - Not all ports are QCL-ed
 - QCL of a DM-RS antenna port with other RS types

Decision: The document is noted. Continue offline discussion until Wednesday

Agreements:

- QCL framework in NR is extended with new spatial QCL parameter(s) to support UE side beamforming/receiving procedure
 - FFS details (e.g., receive angle of arrival, transmit angle of departure, spatial correlation of receiver antennas, Rx/Tx beamforming, etc.)
- For DM-RS antenna ports, NR supports:
 - All ports are QCL-ed
 - Not all ports are QCL-ed
 - FFS on details
- FFS, e.g.:
 - QCL between antenna ports transmitted on different CCs
 - QCL between CSI-RS antenna ports within one CSI-RS resource
 - All ports are QCL-ed
 - Not all ports are QCL-ed
 - QCL between CSI-RS antenna ports within two or more CSI-RS resources
 - All ports are QCL-ed
 - Not all ports are QCL-ed
 - QCL of a DM-RS antenna port with other RS types
 - QCL considering channel reciprocity

R1-1610513 Way Forward on QCL for NR ZTE Corporation, ZTE Microelectronics

- Additional parameters should be included into the definition of QCL in NR:
 - Angle of arrival/departure, angular spread
- Flexible configuration/indication of the QCL assumption should be studied in NR:
 - Possible grouping of the QCL parameters should be studied:
 - e.g., average gain, average delay
 - e.g., angle of arrival/ departure, delay spread, Doppler spread
 - The configurations of QCL assumption could be conducted in two ways:
 - TRP centric
 - e.g., according to transmission mode

- e.g., according to antenna structure
- e.g., according to channel reciprocity
- e.g., according to UE feedback
- UE centric
 - e.g., according to UE measurement
 - e.g., according to channel reciprocity

Decision: The document is noted. Also supported by Qualcomm

Agreements:

- Flexible configuration/indication of the QCL assumption should be studied in NR:
 - Possible grouping of the QCL parameters should be studied:
 - e.g., average gain, average delay
 - e.g., angle of arrival/ departure, delay spread, Doppler spread

R1-1610747 Way Forward on RS for Phase Tracking for CP-OFDM Huawei, HiSilicon, LG Electronics, Samsung, NTT DOCOMO, INC., Intel

- For CP-OFDM waveform, for the RS enabling phase tracking, the following should be studied:
 - Time domain pattern
 - Alt-1: Continuous mapping, i.e., on every OFDM symbol
 - Alt-2: Non-continuous mapping, e.g., every other OFDM symbol
 - Switching between Alt-1 and Alt-2 can also be considered
 - Frequency domain pattern
 - Alt-A: Shared and across full carrier bandwidth with fixed density/spacing
 - Alt-B: Within each UE's scheduled bandwidth and with configurable density/spacing
 - Other patterns are not precluded
 - Other properties
 - UE-specific and/or non-UE-specific
 - Port multiplexing such as FDM/TDM/CDM
 - Potential sharing across users/streams
 - On-off configuration

Decision: The document is agreed.

R1-1610719 Way Forward on evaluation assumptions for Compensation of Phase Rotation and Frequency Offset LG Electronics, InterDigital, KT, Huawei

Decision: The document is noted. Continue offline discussion until Wednesday

R1-1610829 WF on evaluation assumptions for tracking of phase rotation and/or frequency offset LG Electronics, Nokia, Huawei, Samsung, Qualcomm, InterDigital, KT

R1-1611017 WF on evaluation assumptions for tracking of phase rotation and/or frequency offset LG Electronics, Nokia, Huawei, Samsung, Qualcomm, InterDigital, KT, ZTE

R1-1611046 WF on SRS transmission CATT, Nokia, ASB

Agreements:

- NR supports configurable SRS bandwidth
 - Partial-band size can be configured
 - ✧ Partial-band is smaller than the largest transmission bandwidth supported by the UE
 - ✧ Within a partial-band the PRBs for SRS transmission can at least be consecutive in the freq. domain
 - FFS: Size of partial band
 - FFS: Non-consecutive within partial band
 - ✧ FFS: Multiple partial-bands transmitted simultaneously considering impact with OFDM and DFT-S-OFDM waveforms
 - FFS: Simultaneous transmission can be from multiple panels.
 - ✧ FFS: Frequency hopping of partial bands
 - Full band size can be configured
 - ✧ Equal to the largest transmission bandwidth supported by the UE
- NR supports aperiodic SRS transmission triggered by the network
 - FFS on other trigger mechanism, e.g. event triggered
 - FFS on multi-shot SRS transmission, e.g. the UE transmits SRS multiple times with single trigger from network
- FFS: NR supports at least one of followings
 - Periodic SRS transmission
 - Semi-persistent SRS transmission
- FFS: NR supports multiple numerologies for SRS transmission from one UE

R1-1609100	On the support of compensation of phase rotation in NR	Samsung
R1-1610151	Views on RS for CSI acquisition	Qualcomm Incorporated
R1-1608673	Discussion on demodulation reference signal for NR MIMO	ZTE, ZTE Microelectronics
R1-1608674	Discussion on measurement related reference signal for NR-MIMO	ZTE, ZTE Microelectronics
R1-1608778	DMRS design for NR	CATT
R1-1608779	Consideration on SRS transmission for NR	CATT
R1-1608780	Consideration on CSI-RS transmission for NR	CATT
R1-1608781	Discussion on phase noise compensation RS for NR	CATT
R1-1608816	Principles for DL Reference Signal Design and QCL Assumptions	Huawei, HiSilicon
R1-1608817	DL RS design for NR CSI acquisition and beam management	Huawei, HiSilicon
R1-1608818	Reference signal design for demodulation in NR	Huawei, HiSilicon
R1-1608923	Discussion on UL sounding RS design	Spreadtrum Communications
R1-1609094	DMRS Design Aspects for NR	Samsung
R1-1609095	DMRS Design Dependence on numerology	Samsung
R1-1609096	UL CSI-RS (SRS) design for NR	Samsung
R1-1609097	Further discussions on QCL in NR	Samsung
R1-1609098	Discussions on CSI-RS design for NR MIMO	Samsung
R1-1609256	Discussion on beam coordination and QCL for NR	LG Electronics
R1-1609257	Design considerations on NR CSI-RS	LG Electronics
R1-1609258	Discussion on UL sounding signal design for NR	LG Electronics
R1-1609259	Issues on NR DMRS Design	LG Electronics
R1-1609260	Discussion on NR DMRS Pattern	LG Electronics
R1-1609413	Reference Signal design for UL based measurement, CSI acquisition, and beam management	Huawei, HiSilicon
R1-1609418	DL RS design for downlink-based RRM measurement and TRP/beam discovery	Huawei, HiSilicon
R1-1609524	Study on QCL of DM-RS antenna ports	Intel Corporation
R1-1609525	On QCL to support UE beam management	Intel Corporation
R1-1609526	On the need of QCL for NR	Intel Corporation
R1-1609527	Discussion on DM-RS design for NR	Intel Corporation
R1-1609528	Discussion on CSI-RS design for NR	Intel Corporation
R1-1609529	Study of phase noise tracking	Intel Corporation
R1-1609551	Reference signal design consideration	MediaTek Inc.
R1-1609610	Discussion on the additional RS for NR	ETRI
R1-1609695	Views on NR Reference Signal for Beam and CSI measurement	Beijing Xinwei Telecom Techn.
R1-1609764	On UL RS for CSI measurements	Ericsson
R1-1609765	CSI-RS Design	Ericsson
R1-1609766	Discussion on QCL	Ericsson
R1-1609767	Demodulation reference signal design principles	Ericsson
R1-1609768	Frame structure and DMRS positions	Ericsson
R1-1609769	DMRS density configurations in the time domain	Ericsson
R1-1609770	DMRS placement configurations	Ericsson
R1-1609771	On PRB bundling for NR	Ericsson
R1-1609772	Concatenated block RS design	Ericsson
R1-1609773	IC friendliness vs configurable DMRS	Ericsson
R1-1609909	Considerations on demodulation RS design for NR	InterDigital Communications
R1-1609910	Considerations on measurement RS design for NR	InterDigital Communications
R1-1609911	On the need of phase noise correction reference signal	InterDigital Communications
R1-1610070	CSI-RS design for NR	NTT DOCOMO, INC.
R1-1610079	Views on RS for demodulation and tracking	NTT DOCOMO, INC.
R1-1610115	UL reference signal design for eMBB with CP-OFDM and DFT-s-OFDM	Qualcomm Incorporated
R1-1610152	Views on DL DMRS	Qualcomm Incorporated
R1-1610153	Views on RS for control and tracking	Qualcomm Incorporated
R1-1610226	CSI acquisition frameworks for NR MU-MIMO	Mitsubishi Electric Co.
R1-1610269	Reference symbols supporting CSI acquisition framework	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610270	Flexible CSI-RS configuration for CSI measurement	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610271	On the DMRS structure for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610272	On the number of antenna ports to be supported in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610273	UL SRS design considerations in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610274	On QCL Configurations in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610275	Extended framework for QCL assumptions	Nokia, Alcatel-Lucent Shanghai Bell

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1610276](#) On PCRS Design for NR Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless
[R1-1610277](#) On the evaluation of PN model Nokia, Alcatel-Lucent Shanghai Bell
[R1-1610317](#) On the DM-RS structure Ericsson

8.1.4.5 Other

Including phase 1 calibration results and MIMO calibration related assumptions

[R1-1608661](#) Summary of [86-20] email discussion on MIMO calibration for NR ZTE, ZTE Microelectronics
Continue offline discussion about MIMO calibration until Thursday – Ruyue (ZTE)

[R1-1610888](#) **WF on NR MIMO calibration ZTE, ZTE Microelectronics, Nokia, ASB, CATT, MediaTek, Xinwei, Huawei, Hisilicon, Intel, Ericsson, Mitsubishi Electric, Samsung**

- Companies are encouraged to provide/update results for Phase 1 NR MIMO calibration in RAN1#87, including link level and system level simulations
 - Extend the email discussion for further clarification on simulation assumptions and metrics, if needed
- Start the email discussion on simulation assumptions and metrics for Phase 2 NR MIMO calibration, including link level and system level simulations

Decision: The document is agreed. Further revised as follows:

Agreements:

- Companies are encouraged to provide/update results for Phase 1 NR MIMO calibration in RAN1#87, including link level and system level simulations
 - Extend the email discussion for further clarification on simulation assumptions and metrics, if needed
- Email discussion about the calibration work until 28th October – Ruyue (ZTE)
- Including discussions on simulation assumptions and metrics for Phase 2 NR MIMO calibration, including link level and system level simulations

[R1-1610889](#) WF on Phase 1 link-level calibration for NR-MIMO with simplified antenna configuration ZTE, ZTE Microelectronics, CATT, MediaTek, Xinwei, Huawei, Hisilicon, Intel, Ericsson, Nokia, ASB, Mitsubishi Electric, NTT DOCOMO, Samsung

[R1-1610890](#) Further clarification on assumptions for Phase 1 NR-MIMO calibration ZTE
All proponents are recommended to have calibration work considering clarifications in [R1-1610890](#)

[R1-1610999](#) WF on UL Power Control Huawei, HiSilicon, Intel

Agreements:

- The following aspects should be considered for UL PC design:
 - No LTE-like cell-specific reference signal for path loss estimate
 - Beam-based transmissions/receptions
 - Analog beamforming at eNB/UE
 - Multi-beam / multi-stream transmissions
 - Multiple numerologies
 - Inter-TRP information exchange
 - FFS: Dynamic TDD
 - Other aspects are not precluded
- The following design of UL PC as starting point for study:
 - Fractional power control in LTE as framework
 - DL RS for path loss measurement
 - e.g. RS in DL beam management P-1, P-2 and P-3 for multi-beam scenario or single-beam scenario
 - Separate PC settings for UL control and data channel
- FFS: the following design of UL PC
 - Numerology-specific parameter setting
 - Separate PC settings for multi-beam / multi-stream UL

[R1-1608662](#) Phase 1 calibration results for NR MIMO ZTE, ZTE Microelectronics
[R1-1608663](#) Calibration and evaluation assumptions for NR MIMO ZTE, ZTE Microelectronics
[R1-1608782](#) Phase1 calibration for NR MIMO CATT
[R1-1608821](#) UL power control for NR MIMO Huawei, HiSilicon
[R1-1609099](#) MIMO LLS calibration results for NR on 30GHz frequency band Samsung
[R1-1609166](#) MIMO SLS calibration results for NR on 30GHz frequency band Samsung Electronics Co., Ltd
[R1-1609262](#) Phase 1 system level calibration results for NR MIMO LG Electronics
[R1-1609263](#) Phase 1 link level calibration results for NR MIMO LG Electronics

R1-1609288	MIMO LLS calibration results for NR on 30GHz frequency band	Samsung Electronics Co., Ltd
R1-1609445	Discussion on MIMO calibration	Huawei, HiSilicon
R1-1609530	Evaluation results of NR below 6GHz	Intel Corporation
R1-1609531	Discussion on UL Power Control	Intel Corporation
R1-1609532	Evaluation results of NR above 6GHz	Intel Corporation
R1-1609725	Over The Air Calibration For Reciprocity Based MIMO	National Instruments Corp.
R1-1610071	Initial investigation of the impact of UE movement	NTT DOCOMO, INC.
R1-1610072	Phase-1 MIMO calibration results	NTT DOCOMO, INC.
R1-1610103	Initial NR MIMO Calibration Results	Beijing Xinwei Telecom Techn.
R1-1610154	Phase 1 calibration results for sub6GHz and Phase 2 calibration assumptions	Qualcomm Incorporated
R1-1610155	Phase 1 calibration results for above 6GHz and Phase 2 calibration assumptions	Qualcomm Incorporated
R1-1610231	Initial results for Phase 1 link level MIMO calibration for NR	Mitsubishi Electric Co.
R1-1610232	UL power control in multi-beam based approaches	ASUSTEK COMPUTER (SHANGHAI)
R1-1610278	On-demand power boost and cell muting for URLLC in the 5G New Radio	Nokia, Alcatel-Lucent
Shanghai Bell		
R1-1610279	Latency assumptions for network-based coordination studies	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610280	Interference Aware Inter Cell Rank Coordination	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610281	UL Interference Coordination and Power Control	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610282	Dynamic TDD DL-to-UL Interference Cancellation using Packet Exchange in NR	Nokia, Alcatel-Lucent
Shanghai Bell		
R1-1610283	Power control for MIMO	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610284	MIMO link level calibration results	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610285	MIMO system level calibration results	Nokia, Alcatel-Lucent Shanghai Bell

8.1.5 Aspects related to initial access and mobility

Discuss PHY layer aspects related to initial access and mobility, considering beamforming aspects, for standalone and non-standalone operation

R1-1608823	Unified single/multiple beam-based initial access procedure in NR	Huawei, HiSilicon
R1-1609387	Initial Access and Mobility Requirements for NR	AT&T GNS Belgium SPRL
R1-1609722	New Radio MIMO Access Procedures	National Instruments Corp.

8.1.5.1 Synchronization signal and DL broadcast signal/channel

[R1-1608924](#) Discussion on Synchronization signal design Spreadtrum Communications

The document was presented by Arto Lehti from Spreadtrum.

Observation 1: A truncated sequence from a pseudo-random sequence could keep the auto-/cross-correlation properties, while the one from a ZC sequence would lose the auto-/cross-correlation properties thereof.

Proposal 1: The pseudo-random sequence could be as the base sequence for NR synchronization signal or broadcasted signal.

Proposal 2: To enable narrowband UEs and wideband UEs to decode the same synchronization signal or broadcasted signal with no prior knowledge about wideband UEs at narrowband UEs, the base sequence could be shifted circularly to guarantee the narrowband UEs' synchronization signal or broadcasted signal to start from the front part of the base sequence.

Decision: The document is noted.

[R1-1610435](#) Link level simulation results for NR initial synchronization and cell search MediaTek Inc. ([R1-1609330](#))

The document was presented by ... from MediaTek.

Proposal: The NR downlink synchronization signals should be transmitted less frequently than LTE to minimize the transmission of always-on signals for better forward compatibility. To reduce initial access latency, the signals should be designed in a way such that it can be detected and accurately synchronized to in a single observation with high probability.

Decision: The document is noted.

[R1-1609436](#) Support of multiple numerologies in synchronization signal design Huawei, HiSilicon

The document was presented by David Mazzarese from Huawei.

Observation 1: It is implementation efficient that NR synchronization signal is based on subcarrier spacing(s) supported for a given frequency band.

Observation 2: Single subcarrier spacing for all frequency ranges is not implementation efficient.

Proposal 1: The synchronization signal is common at the receiver side regardless of the subcarrier spacing used in a NR carrier for a given frequency range.

Proposal 2: The common synchronization signal is defined using a pre-defined subcarrier spacing for a given frequency range.

Proposal 3: The common synchronization signal has X repetitions. The repetition factor X is the ratio of two subcarrier spacing values defined for synchronization signals.

Decision: The document is noted.

R1-1610156 Single beam SYNC design Qualcomm Incorporated

The document was presented by Tingfang Ji from Qualcomm.

- *Observation 1: An efficient frequency scan procedure should be investigated for NR*
- *Observation 2: Designing NR synchronization signals should take into account the known issues in LTE synchronization signals*
- *Proposal 1: NR synchronization raster is a multiple of least common multiples of channel raster and reference NR subcarrier spacing.*
- *Proposal 2: NR synchronization signal bandwidth should depend on the synchronization raster and the minimum channel bandwidth.*
- *Proposal 3: NR Sub6 synchronization signal bandwidth is at most 5MHz.*
- *Proposal 4: RAN1 should consider the Alt 1 for selecting synchronization numerology and use 30kHz as synchronization signal numerology for Sub6.*
- *Proposal 5: The periodicity of the synchronization signals is proposed to be 5ms.*
- *Proposal 6: The synchronization signals are mapped into the downlink regular burst of the downlink-centric subframe.*
- *Proposal 7: Consider the single synchronization channel and dual synchronization channel design options to support both uplink-based and downlink-based mobility when designing the synchronization signals*

Decision: The document is noted.

R1-1610159 Multi-beam SYNC design Qualcomm Incorporated

Proposal 1: The design should allow base stations to sweep beams during synchronization and random access period.

Proposal 2: The transmission of sync signals is limited to the minimum supportable bandwidth. The value of the minimum supportable bandwidth is FFS (example: 40MHz).

Proposal 3: No data/control channel is frequency-multiplexed with the sync transmission.

Proposal 4: Every X msec, Y msec worth of resources are allocated for the transmission of a synchronization burst. Each synchronization burst consists of N nominal sync signals. The exact values of X , Y and N are FFS (example: $X=5$, $Y=0.25$, $N=14$).

Proposal 5: The max sync (beam sweep) periodicity Z is known by the UEs. The exact value of Z is FFS (example: sync periodicity = sync resource periodicity: $Z=X=5$ [msec]).

Proposal 6: BS needs to convey alongside the sync signals the OFDM symbol index (or another suitable notion of transmission time) of the transmission.

Proposal 7: The directional PSS, SSS and PBCH signals are TDMed within a nominal sync symbol, and are transmitted using the same beam.

Proposal 8: The design of the primary sync signal is based on a Zadoff-Chu sequence with a prime length L , and three different root indices. L is proposed to be 127, and exact choice of the root indices is FFS.

Proposal 9: The design of the secondary sync signal is based on a base m -sequence, repeated and interleaved in frequency domain. The transmission of SSS signal from different antenna ports may be pre-coded to provide channel estimation for 2-layer PBCH decoding.

Proposal 10: The design should support PBCH transmit diversity with upto P ports. $P=2$ is supported. Whether $P>2$ is FFS.

Proposal 11: The design should permit combining of PBCH from multiple transmissions within a burst.

Decision: The document is noted.

**R1-1610498 Way Forward on NR initial access signals/channels
Qualcomm, InterDigital**

NTT DOCOMO, Intel Corporation, Ericsson,

The document was presented by Hiroki Harada from NTT DOCOMO.

Decision: The document is noted and modified as follows:

Agreements:

- NR defines at least two types of synchronization signals
 - NR-PSS at least for initial symbol boundary synchronization to the NR cell
 - FFS other functionality provided by NR-PSS, e.g., part of NR cell ID, serving as DMRS for NR-SSS, detection of subcarrier spacing
 - NR-SSS for detection of NR cell ID or at least part of NR cell ID
 - Number of NR cell IDs is targeted to be at least 504
 - FFS: larger than that in LTE
 - FFS number of NR cell IDs

- NR-SSS detection is based on the fixed time/freq. relationship with NR-PSS resource position irrespective of duplex mode and beam operation type at least within a given frequency range and CP overhead
 - FFS FDM or TDM
- FFS other functionality provided by NR-SSS, e.g., demodulation of broadcast channel, RRM measurement, deriving subframe index, deriving symbol index
- NR defines at least one broadcast channel: NR-PBCH
 - NR-PBCH decoding is based on the fixed relationship with NR-PSS and/or NR-SSS resource position irrespective of duplex mode and beam operation type at least within a given frequency range and CP overhead
 - FFS: Unlicensed spectrum case
 - FFS relationship between NR-PBCH subcarrier spacing and NR-PSS and/or SSS subcarrier spacing
 - Following broadcasting schemes to carry essential system information can be considered
 - Option 1: NR-PBCH carries a part of essential system information for initial access including information necessary for UE to receive channel carrying remaining essential system information
 - Option 2: NR-PBCH carries minimum information necessary for UE to perform initial UL transmission (not limited to NR-PRACH) in addition to information in Option 1
 - Option 3: NR-PBCH carries all essential system information for initial access
 - Other options are not precluded

Possible agreements:

- Wider transmission bandwidth for NR-PSS/SSS/PBCH than that for LTE-PSS/SSS/PBCH is supported at least for a subcarrier spacing larger than 15kHz
 - Below 6 GHz, transmission bandwidth containing NR-PSS/SSS/PBCH is not more than [5] MHz
 - Below 40 GHz, transmission bandwidth containing NR-PSS/SSS/PBCH is not more than [40] MHz

Continue offline discussion until Tuesday – Hiroki (NTT DOCOMO)

Tuesday

Working assumption:

- Wider transmission bandwidth for NR-PSS/SSS and/or PBCH than that for LTE-PSS/SSS/PBCH is supported at least for a subcarrier spacing larger than 15kHz
 - Below 6 GHz, transmission bandwidth containing NR-PSS/SSS/PBCH is not more than [5 or 20] MHz
 - Below 40 GHz, transmission bandwidth containing NR-PSS/SSS/PBCH is not more than [40 or 80] MHz

Tuesday session

[R1-1610522](#) Way Forward on unified structure of DL sync signal Intel Corporation, NTT DOCOMO, ZTE, ZTE Microelectronics, ETRI, InterDigital

- PSS, SSS and/or PBCH can be transmitted within a ‘SS block’
 - FFS: details how to compose PSS, SSS and/or PBCH
- One or multiple ‘SS block(s)’ compose an ‘SS burst’
 - FFS: Number of ‘SS block(s)’ (defined as duration of ‘SS burst’)
 - FFS: whether or not ‘SS block(s)’ are consecutive
- One or multiple ‘SS burst(s)’ compose an ‘SS burst series’
 - FFS: Periodicity and number of ‘SS burst’
 - FFS: Transmission instances of ‘SS burst series’

Decision: The document is noted and modified as follows:

(Agreements):

- PSS, SSS and/or PBCH can be transmitted within a ‘SS block’
 - FFS: details how to compose PSS, SSS and/or PBCH
 - Multiplexing other signals are not precluded within a ‘SS block’
- One or multiple ‘SS block(s)’ compose an ‘SS burst’
 - FFS: Number of ‘SS block(s)’ (defined as duration of ‘SS burst’)
 - FFS: whether or not ‘SS block(s)’ are consecutive
 - FFS: whether or not ‘SS block(s)’ within a ‘SS burst’ are the same
- FFS: One or multiple ‘SS burst(s)’ compose a ‘SS burst series’
 - FFS: Periodicity and number of ‘SS burst’
 - FFS: Transmission instances of ‘SS burst series’ and number of ‘SS burst series’

Continue discussion on FFS until Wednesday – Seunghee (Intel)

Wednesday: Above agreement is modified as follows:

Agreements:

- PSS, SSS and/or PBCH can be transmitted within a ‘SS block’

- FFS: details how to compose PSS, SSS and/or PBCH
- Multiplexing other signals are not precluded within a 'SS block'
- One or multiple 'SS block(s)' compose an 'SS burst'
 - FFS: Number of 'SS block(s)' (defined as duration of 'SS burst')
 - FFS: whether or not 'SS block(s)' are consecutive
 - FFS: whether or not 'SS block(s)' within a 'SS burst' are the same
- One or multiple 'SS burst(s)' compose a 'SS burst set'
 - FFS: Periodicity and the number of 'SS burst' within a SS burst set
 - Number of SS bursts within a SS burst set is finite.
 - FFS: Transmission instances of 'SS burst set'
 - E.g., periodic/aperiodic transmission of SS burst sets.

R1-1610538 Way forward on SYNC periodicity Qualcomm Incorporated

- Proposal:
 - Network should have the flexibility of configuring different SYNC periodicity
 - UE should assume 5ms SYNC periodicity for acquisition unless assisted by network
- Expected UE behavior
 - Assisted search: Deployment with network assistance on frequency and timing could be configured with large SYNC periodicity and maintain high detection probability with low latency
 - Blind search:
 - Frequency layers with 5ms SYNC leads to high detection probability with low latency;
 - Frequency layers with long SYNC periodicity will have reduced UE detection probability
 - Network could configure some layers/cells to have

Discussion: Ericsson would like to see more analysis done, at this point in time could not agree the 5ms Sync figure

Decision: The document is noted. Continue discussion until Thursday – Tingfang (Qualcomm)

R1-1610722 WF on SYNC Periodicity Qualcomm

Agreements:

- From RAN1 specification perspective, NR air interface defines at least one periodicity of SS burst set
 - FFS: whether or not to define common periodicity range for SS burst set across NR carriers
 - Values of the periodicities of SS burst set is for further study
 - E.g., 5ms, 40ms, 100ms
 - The lowest value of the periodicity of SS burst set is X ms, e.g., 5ms, 40ms, 80ms
 - Note: Interval of SS burst can be the same as interval of SS burst set in some cases, e.g., single beam operation
 - Note: the main bullet can be applied to PSS, SSS and/or PBCH
- FFS: networks is allowed to transmit SS burst set at least at the defined periodicities
- FFS: UE is allowed or informed to adapt acquisition procedure based on periodicities of SS burst set
- FFS: For example, if multiple periodicities of SS burst set are defined for initial blind acquisition, UE assumes X ms of an NR carrier as periodicity of SS burst set for dwell time on a freq

R1-1610567 Way Forward on multiplexing of sync signal Samsung

- NR supports the following multiplexing methods for nrSS and nrPBCH.
 - TDM at least for below 6 GHz with single-beam and multi-beam SFN transmissions of these signals
 - FDM at least for above 6 GHz with multi-beam sweeping transmissions of these signals

Decision: The document is noted.

R1-1610550 Way Forward on multiplexing of Sync and Broadcast signals Qualcomm Incorporated, CATT

- NR supports the time division multiplexing of PSSS, SSS and PBCH signals in both sub-6 GHz and over-6 GHz band

Decision: The document is noted. Continue study until the next meeting.

R1-1610558 WF on Synchronization Signal for NR Initial Access Huawei, HiSilicon

- SS for initial access is a predefined subcarrier spacing according to the spectrum range
- SS for initial access can be transmitted in predefined frequency locations other than the centre of a carrier
- For SS with multiple beams, at least TDM of the SS over different beams is supported;
 - FDM and CDM in addition to TDM of the SS are not precluded

Decision: The document is noted.

Agreements:

- At least one subcarrier spacing for each synchronization signal (e.g. NR PSS,SSS, PBCH) is predefined in the specification for a given frequency range
 - FFS: Subcarrier spacings for NR PSS, SSS and PBCH can be same or different.
 - Note that there are more than one frequency ranges
 - FFS: for the case when the frequency ranges are overlapped.
 - FFS: whether or not to define a single numerology or multiple numerology for frequency range
 - RAN1 should study the number of subcarrier spacings in a given frequency range and strive for minimizing the number of subcarrier spacings

[R1-1610844](#) Offline discussion summary of initial access for NR NTT DOCOMO

[R1-1610839](#) WF on Updated Link Level Evaluation Assumptions for Initial Access in NR Qualcomm
Continue offline discussion until Thursday

[R1-1611015](#) WF on Assumptions for Comparing Different SYNC Multiplexing Techniques Qualcomm

Agreements:

- Companies are encourage to provide evaluations for different multiplexing techniques for initial access
 - Use the link level parameters that got agreed in [R1-1610987](#) and [R1-1610991](#)

[R1-1610991](#) WF on Updated System Level Evaluation Assumptions for Initial Access in NR Qualcomm,

Agreements:

- Agree on [R1-1610991](#) with the following modification and note in [R1-1611038](#)
 - “seven sites” should be modified as “one or two cellular tiers”
 - Note: Company reports which value for the number (i.e., 1 or 2) of cellular tiers to choose for the evaluation

[R1-1610959](#) WF on Updated Link Level Evaluation Assumptions for Initial Access in NR Qualcomm, NTT Docomo,
Samsung, Intel

[R1-1610987](#) WF on Updated Link Level Evaluation Assumptions for Initial Access in NR Qualcomm, NTT Docomo,
Samsung, Intel

[R1-1610954](#) WF on synchronization and carrier rasters Huawei, HiSilicon, Ericsson, NTT Docomo, Fujitsu

[R1-1611035](#) WF on synchronization and carrier rasters Huawei, HiSilicon

- Email discussion on whether there is a need to support scenarios where synchronization signal(s) of neighbour cells may not be on the same center frequency
- For intra/inter frequency DL measurement, the two options below are discussed:
 - The network can signal a reduced set of frequency locations of the sync signal(s)
 - including the case where synchronizations signal(s) of neighbour cells are at the same frequency location as the synchronizations signal(s) of the UE’s serving cell
 - The UE may always assume the same frequency location of the synchronization signal(s) among neighbour cells
- Email discussion on the proposal,
 - The candidate frequency locations of synchronization signal(s) are sparser than the possible frequency locations of the center of NR carrier bandwidth.
 - The spacing (Hz) between the candidate frequency locations of synchronization signal(s) may depends on the frequency bands.
 - This does not preclude that for certain bands, the candidate frequency locations of synchronization signals and the possible frequency locations of center of NR carrier bandwidth may be the same
 - A UE should not assume a fixed frequency separation between the frequency location of synchronization signal(s) and the center of NR carrier bandwidth.
- Above email discussion deadline is until 7th November – David (Huawei)
 - All proponents should focus on at least the above 3rd main bullet ant potential standard impact

[R1-1611024](#) Offline Thursday dicussion summary of initial access for NR NTT DOCOMO, INC.

[R1-1609107](#) Discussion on beam sweeping for initial access signals Samsung

[R1-1610073](#) Discussion on initial access design for NR NTT DOCOMO, INC.

[R1-1610378](#) Preliminary performance evaluation of different beamforming options for NR synchronization signals Intel Corporation

[R1-1608711](#) Common signal/information allocation for initial access and mobility Mitsubishi Electric Corp

[R1-1608783](#) NR Numerology Agnostic Synchronization Channel Design CATT

[R1-1608784](#) NR System Bandwidth Agnostic Synchronization Channel Design CATT

3GPP TSG RAN WG1 Meeting #87 Reno, USA, 14th – 18th November 2016

R1-16xxxxx

R1-1608785	NR Multi-stage Synchronization Channel Design	CATT	
R1-1608786	QCL assumption of NR Synchronization Signals and DM RS of Broadcast Channel	CATT	
R1-1608812	Discussion on initial access in NR	Fujitsu	
R1-1608846	Synchronization signal design in NR	Huawei, HiSilicon	
R1-1608847	Channel raster and synchronization signal locations	Huawei, HiSilicon	
R1-1608906	Discussion on multi-beam based synchronization signal and DL broadcast channel for NR		Guangdong OPPO Mobile Telecom.
R1-1608944	Consideration on NR synchronization signal design	Sony	
R1-1608951	Sub-carrier spacing considerations for NR DL Synchronization	Sony	
R1-1608966	Considerations on sweeping time interval in NR	ZTE	
R1-1608967	Frequency and Channel Raster Issue in NR	ZTE	
R1-1609105	Overview on system information delivery and beam alignment/association		Samsung
R1-1609106	Discussion on minimum bandwidth for NR	Samsung	
R1-1609108	Time domain mapping of initial access signals for the multi-beam case	Samsung	
R1-1609109	Discussion on SI delivery for multi-beam before RACH	Samsung	
R1-1609110	Initial access design consideration for unified framework	Samsung	
R1-1609111	Multiplexing of synchronization signals and system information delivery channels for below 6 GHz and above 6 GHz		Samsung
R1-1609112	Numerology for synchronization signal	Samsung	
R1-1609113	Overview on issues on NR downlink synchronization	Samsung	
R1-1609114	Carrier raster and synchronization signal transmission	Samsung	
R1-1609115	Discussion on NR paging design	Samsung	
R1-1609146	Discussion on numerology of synchronisation signals	NEC	
R1-1609147	Discussion on NR synchronization signal and essential system information mapping		NEC
R1-1609152	Proposals for beamformed synchronization signals	NEC	
R1-1609264	Issues on NR Initial Access	LG Electronics	
R1-1609265	Numerology for NR Synchronization Signal	LG Electronics	
R1-1609308	Beam Sweeping using Multi-width Beams	CMCC	
R1-1609314	Initial timing and beam acquisition for multi-beam based approach	KT Corp.	
R1-1609328	Definition of a Downlink Basic Beacon Unit in the Unified Framework for NR Initial Access		MediaTek Inc.
R1-1609329	Synchronization Signal Design in CP-OFDM Based on Time-Frequency Hopping Patterns		MediaTek Inc.
R1-1609331	System level simulation results for NR initial synchronization and cell search		MediaTek Inc.
R1-1609394	Design of synchronization signal for supporting different numerologies in NR	ETRI	
R1-1609438	Initial evaluation results for initial access	Huawei, HiSilicon	
R1-1609562	Consideration on narrowband anchor based access	MediaTek Inc.	
R1-1609668	NR Synchronization signals for idle and connected mode mobility	Ericsson	
R1-1609669	Overview of synchronization signal design for NR initial access	Ericsson	
R1-1609697	Discussion of NR Initial Access	Beijing Xinwei Telecom Techn.	
R1-1609701	NR synchronization signal and DL broadcast signal	Panasonic Corporation	
R1-1609818	NR PSS Design for Wideband and Narrowband UEs	Sierra Wireless, S.A.	
R1-1609875	Numerology for DL synchronization in NR	Sharp	
R1-1609879	Discussion on the design for synchronization signal	Shenzhen Coolpad Technologies	
R1-1609917	Synchronisation signal in NR	Motorola Mobility	
R1-1609920	Considerations for Initial Synchronization in NR	InterDigital Communications	
R1-1610074	Performance evaluation results on NR synchronization signals	NTT DOCOMO, INC.	
R1-1610157	Single beam PBCH design	Qualcomm Incorporated	
R1-1610158	Revised simulation assumptions and metrics for SYNC evaluation		Qualcomm Incorporated
R1-1610160	Multi-beam PBCH design	Qualcomm Incorporated	
R1-1610161	Multi-beam SYNC evaluation	Qualcomm Incorporated	
R1-1610162	System Information transmission considering different UE BWs		Qualcomm Incorporated
R1-1610203	Synchronization in NR considering beam sweeping	ASUSTEK COMPUTER (SHANGHAI)	
R1-1610204	Impact of multiplexing multiple numerologies on initial access	ASUSTEK COMPUTER (SHANGHAI)	
R1-1610207	Discussion on System Information Delivery in NR	III	
R1-1610242	Frame structure support for DL and UL sweeping subframes	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610286	Numerology for NR Synchronization Signals	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610287	On the synchronization signal design principle in NR	Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless	
R1-1610288	Beam management in initial access	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610289	Downlink Discovery Signal for NR	Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless	
R1-1610290	Initial Synch Signal Performance Results	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610291	Physical Layer Cell Identity in Initial Access	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610292	DL Signals for Mobility Measurements in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1610293	Cell Identification in NR	Nokia, Alcatel-Lucent Shanghai Bell	

R1-1610294	On scalable and band agnostic single-beam and multi-beam initial access	Nokia, Alcatel-Lucent
Shanghai Bell		
R1-1610318	Open Items in Synchronization Signal Design	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610351	A framework for initial access for NR	INTERDIGITAL COMMUNICATIONS
R1-1610353	Long Network DTX in NR	Ericsson
R1-1610354	System information acquisition principle for NR	Ericsson
R1-1610356	Considerations for DL Broadcast Channel	InterDigital Communications
R1-1610371	Discussion on Sync Signal Design for NR	Convida Wireless LLC
R1-1610372	Synchronization on Beamforming Initial Access Operations	Convida Wireless LLC
R1-1610400	On NR DL synchronization	Intel Corporation

8.1.5.2 RACH procedure

[R1-1608968](#) Unified Random Access in NR ZTE

The document was presented by ... from ZTE.

Proposal 1: NR random access makes use of Rx/Tx reciprocity, when available at TRP and/or UE, to reduce the need for beam sweeping.

Proposal 2: NR initial access should support random access also without Tx/Rx reciprocity within the same framework as with Tx/Rx reciprocity.

Proposal 3: TRP should provide information to assist UE to determine UL SB(s) for preamble transmission, e.g. in SI.

Proposal 4: NR should support multiple preamble transmission before RAR is received

Proposal 5: Open loop, closed loop and hybrid schemes for RAR transmission should be studied by RAN1.

Proposal 6: The RAR should indicate to which UL SB and UL STI it corresponds.

Proposal 7: RAN1 should study random access for connected mode UEs, based on RS for connected mode mobility.

Proposal 8: The group of preambles available to idle mode UEs should be configurable, with at least the same level of flexibility as in LTE.

Decision: The document is noted.

[R1-1609672](#) NR PRACH preamble evaluations Ericsson

The document was presented by Asbjorn Grovlen from Ericsson.

- Observation 1: The PRACH preamble detector can be configured with varying number of non-coherent intervals (Nnc) when the preamble is constructed by repeating one short sequence
- Observation 2: The PRACH preamble detection performance can be improved as compared to LTE release 8, with a PRACH preamble format which enables non-coherent accumulations in the detector.

Decision: The document is noted.

[R1-1609735](#) Zero-Header Zero-Tail Random Access Preambles for New Radio Nokia, Alcatel-Lucent Shanghai Bell

The document was presented by ... from Nokia.

Proposal 1: ZHRT PRACH preambles should be further studied as an option for the random access of 5G New Radio.

Decision: The document is noted.

[R1-1609533](#) Time Advance derivation for non-reciprocal UE Intel Corporation

The document was presented by Yuan Zhu from Intel.

- Observation 1: UE beamforming gain can be leveraged to improve the coverage of downlink beam management P-1 and PRACH transmission.
- Observation 2: Independent downlink/uplink beam sweep may result in large TA range.
- Observation 3: The additional TA range Δt caused by independent DL/UL beam sweep can be comparable to CP length.

Decision: The document is noted.

[R1-1610056](#) Design for RACH preamble for NR NTT DOCOMO, INC.

The document was presented by Kazuaki Takeda from NTT DOCOMO.

- Proposal 1: The RACH preamble format(s) in LTE should be considered as the basic RACH preamble.
- Proposal 2:
- Scalable numerologies are applied to the basic RACH preamble.
 - Scaling factor of 2^n is considered.
- Observation:
- The MCL for RACH preamble is degraded when larger subcarrier spacing/BW. However, larger subcarrier spacing is robust against higher Doppler frequency.
- Scalable RACH preamble would be applicable to higher carrier frequency and multi-beam operation.

Decision: The document is noted.

Tuesday session

R1-1610489 Way Forward on RACH procedure for multi-beam operation NTT DOCOMO, ETRI, Qualcomm, Nokia, Alcatel-Lucent Shanghai-Bell, ZTE

When Tx/Rx reciprocity is available at both gNB and UE, the following RACH procedure is considered for at least UE in idle mode

- Association between one or multiple occasions for DL broadcast channel/signal and a subset of RACH occasions is partially or fully informed by broadcast system information (e.g., PBCH)
 - Signaling of “non-association” can be also included
 - Detailed design for RACH preamble should be further studied
- Based on the DL Tx beam measurement and the corresponding association, UE selects the subset of RACH occasions
- At gNB, the DL Tx beam for the UE is obtained based on the detected RACH preamble and would be also applied to Message 2
 - UL grant in message 2 may indicate the transmission timing of message 3.

For the cases with and without Tx/Rx reciprocity, the common random access procedure should be strived.

When Tx/Rx reciprocity is not available, the the following could be further considered for at least UE in idle mode

- Whether or how to report DL Tx beam to gNB, e.g.,
 - RACH preamble
 - Msg. 3
- Whether or how to indicate UL Tx beam to the UE, e.g.,
 - RAR

Decision: The document is noted, modified and agreed as follows:

Agreements:

- When Tx/Rx reciprocity is available at gNB at least for multiple beams operation, the following RACH procedure is considered for at least UE in idle mode
 - Association between one or multiple occasions for DL broadcast channel/signal and a subset of RACH occasions is informed to UE by broadcast system information or known to UE
 - FFS: Signaling of “non-association”
 - Detailed design for RACH preamble should be further studied
 - Based on the DL measurement and the corresponding association, UE selects the subset of RACH occasions
 - FFS: Tx beam selection for RACH preamble transmission
 - At gNB, the DL Tx beam for the UE can be obtained based on the detected RACH preamble and would be also applied to Message 2
 - UL grant in message 2 may indicate the transmission timing of message 3
- For the cases with and without Tx/Rx reciprocity, the common random access procedure should be strived
- When Tx/Rx reciprocity is not available, the the following could be further considered for at least UE in idle mode
 - Whether or how to report DL Tx beam to gNB, e.g.,
 - RACH preamble/resource
 - Msg. 3
 - Whether or how to indicate UL Tx beam to the UE, e.g.,
 - RAR

R1-1610854 WF on NR RACH Procedure Huawei, HiSilicon, Qualcomm, ETRI **(R1-1610846)**

- RAN1 is currently studying to see potential benefits of a simplified RA procedure consisting of two main steps (Msg1 and Msg2) for UEs
 - Use of a UE identity in Msg 1
 - Msg 2: RA response is addressed to the UE identity in Msg 1
 - FFS on the definition and choice of the UE identity

Decision: The document is noted. **Continue offline discussion until Thursday**

R1-1610978 WF on NR RACH Procedure Huawei, HiSilicon, NTT Docomo, Qualcomm, ETRI, Intel, Nokia

Agreements:

- RAN1 is studying and some companies see potential benefits of a simplified RACH procedure consisting of two main steps (Msg1 and Msg2) for UEs
- RAN1 has discussed the following:
 - The use of a UE identity in Msg 1
 - Msg 2: RA response that is addressed to the UE identity in Msg 1
 - FFS on the definition and choice of the UE identity
 - FFS on the applicability scenarios of simplified RACH procedure
- RAN1 to send LS to RAN2
- RAN1 is aware that RAN2 is also studying the RACH procedure and RAN1 would like to inform RAN2 to take the above into considerations and would like to request any feedback on UE identities and associated procedure and also ask the corresponding applicable scenarios

[R1-1610990](#) [Draft] LS on NR RACH Procedure Huawei
Agreed in [R1-1610992](#)

[R1-1610783](#) WF on RACH Procedure for Multi-beam without gNB reciprocity ZTE, ZTE Microelectronics, Nokia, NTT DOCOMO

- RACH occasion:
 - A time-frequency resource and a subset of preambles.
- Subset of RACH occasions:
 - One or more RACH occasions
- Multiple/repeated UE preamble transmission within a subset of RACH occasions is informed by broadcast system information
 - To cover gNB RX beam sweeping in case of NO Tx/Rx reciprocity at the gNB

Decision: The document is noted and modified as follows:

Agreements:

- RACH resource:
 - A time-frequency resource to send RACH preamble
- Whether UE needs to transmit one or multiple/repeated preamble within a subset of RACH resources can be informed by broadcast system information
 - For example, to cover gNB RX beam sweeping in case of NO Tx/Rx reciprocity at the gNB

[R1-1610849](#) WF on definition of Beam reciprocity Samsung

- The followings are defined for Tx/Rx beam reciprocity at TRP and UE :
 - **Tx/Rx beam reciprocity at TRP:**
 - TRP is able to determine a TRP Rx beam for the uplink reception based on UE's downlink measurement report on TRP's Tx beam.
 - TRP is able to determine a TRP Tx beam for the downlink transmission based on TRP's uplink measurement on TRP's Rx beams
 - **Tx/Rx beam reciprocity at UE:**
 - UE is able to determine a UE Tx beam for the uplink transmission based on UE's downlink measurement on UE's Rx beams.
 - UE is able to determine a UE Rx beam for the downlink reception based TRP uplink measurement on UE's Tx beam.

Decision: The document is noted. Also supported by Qualcomm. **Continue offline discussion until Thursday.**

[R1-1610962](#) WF on Unified RACH Procedure ZTE, ZTE Microelectronics, NTT DOCOMO, Nokia, Alcatel-Lucent Shanghai Bell, Sharp, Intel

[R1-1610960](#) WF on RACH Preamble NTT DOCOMO, Intel, Sharp, ZTE,

Agreements:

- NR supports multiple RACH preamble formats, including at least
 - RACH preamble format with longer preamble length
 - RACH preamble format with shorter preamble length
 - FFS how many signatures (e.g. number of RACH sequences, payload size, etc.)
- Multiple/repeated RACH preambles in a RACH resource is supported
 - FFS: How to support single-beam and/or multi-beam operation
 - FFS: Preamble could be the same or different
- Numerology for RACH preamble can be different depending on frequency ranges
 - FFS: How many numerologies will be supported per frequency range
- Numerology for RACH preamble can be different or the same from that for the other UL data/control channels

[R1-1610976](#) WF on Updated Link Level Evaluation Assumptions for RACH Preamble Qualcomm

[R1-1610986](#) WF on Updated Link Level Evaluation Assumptions for RACH Preamble Qualcomm

[R1-1611011](#) WF on RACH Preamble Evaluation Assumption Nokia, Alcatel-Lucent Shanghai Bell, DOCOMO

Agreements:

- In the evaluation for RACH preamble transmission and RACH resource selection, companies report the following assumptions
 - Support of Rx beam sweeping at the base station
 - Support of coverage, e.g., the values defined in TR38.913

R1-1608712	RACH preamble transmission	Mitsubishi Electric Corp
R1-1608787	NR RACH Procedure	CATT
R1-1608788	NR RACH Preamble Design Consideration	CATT
R1-1608813	Discussion on PRACH configuration in NR	Fujitsu
R1-1608824	RACH preamble and procedures for unified single/multiple beam based access	Huawei, HiSilicon
R1-1608850	Views on access procedures for NR Huawei, HiSilicon	
R1-1608969	On 2-step Random Access Procedure	ZTE
R1-1609116	RACH procedure considering flexible UE bandwidth	Samsung
R1-1609117	Discussion on RA procedure	Samsung
R1-1609118	RACH design with and without beam reciprocity	Samsung
R1-1609119	RACH preamble design for NR	Samsung
R1-1609266	Discussion on PRACH Preamble Design for NR	LG Electronics
R1-1609267	Consideration on RACH Procedure in NR	LG Electronics
R1-1609309	RACH in Gradual UE-Specific (GUS) initial access	CMCC
R1-1609396	Discussion RACH procedure in beamformed scenarios	Lenovo
R1-1609611	Discussion on RACH procedure for high speed train scenario with relay for NR	ETRI
R1-1609670	NR random access procedure	Ericsson
R1-1609671	NR PRACH preamble design	Ericsson
R1-1609673	NR random-access response design	Ericsson
R1-1609674	NR random-access response signal format	Ericsson
R1-1609736	Cyclic delay-Doppler shifted M-Sequences for New Radio PRACH	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609737	Random Access Principles for New Radio	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609738	RACH resource configuration for single-beam and multi-beam operation	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609876	Numerology for PRACH preamble in NR	Sharp
R1-1609918	Random access in NR	Motorola Mobility
R1-1610057	Design for RACH procedure for NR	NTT DOCOMO, INC.
R1-1610163	Single beam RACH design	Qualcomm Incorporated
R1-1610164	Multi-beam RACH design and evaluation	Qualcomm Incorporated
R1-1610165	Multi-beam RACH procedure aspects	Qualcomm Incorporated
R1-1610320	Random access aspects for beam-based NR initial access	INTERDIGITAL COMMUNICATIONS
R1-1610352	Random access and support for multiple numerologies for NR	INTERDIGITAL COMMUNICATIONS
R1-1610401	On NR RACH procedure	Intel Corporation

8.1.5.3 Mobility

[R1-1610828](#) Way Forward on DL measurement for L3 mobility LG Electronics, Samsung, NTT DOCOMO

- NR supports cell-level mobility based on DL cell-level measurement (e.g. RSRP for each cell) in IDLE mode UE.
 - Study the following DL signals for IDLE mode RRM measurement
 - Option 1: Synchronization signal (i.e. NR-SSS)
 - Option 2: DM-RS for broadcast channel.
 - Option 3: (Beam) Measurement RS which is carrying cell-ID.
 - Other options are not precluded
- For L3 mobility based on DL measurement in CONNECTED mode UE:
 - Non-UE-specific DL signals are used for CONNECTED mode RRM measurement
 - Study the following DL signals for CONNECTED mode RRM measurement
 - Option 1: Cell related RS which is carrying Cell-ID (e.g. NR-SSS)
 - Option 2: (Beam) Measurement RS which is carrying beam-ID and/or Cell-ID
 - Option 3: both option 1 and 2
 - Other options are not precluded
 - At least one of cell-level and beam-level measurement quantities (e.g. RSRP/RSRQ for each cell and/or each beams) is supported for RRM reporting.
 - Study the following options for RSRP/RSRQ to be reported for L3 mobility
 - Option 1: RSRP/RSRQ is derived per cell with averaging multiple beam measurements
 - Option 2: RSRP/RSRQ is derived per beam
 - Option 3: both option 1 and 2
 - Other options are not precluded

Decision: The document is noted. **Continue offline discussion until Thursday**

[R1-1610975](#) WF on DL measurement for L3 mobility Samsung, LG Electronics, NTT DOCOMO, AT&T, Ericsson, Intel Agreements.

- Note: In this WF, IDLE mode refers to a UE state similar to LTE IDLE state, whose exact definition is up to RAN2

- Note: In this WF, CONNECTED mode refers to a UE state similar to LTE CONNECTED state, whose exact definition is up to RAN2
- Note: In this WF, cell refers to NR cell which is tied to a same ID carried by NR-SS.
 - Detailed definition of NR cell FFS
- NR supports cell-level mobility based on DL cell-level measurement (e.g. RSRP for each cell) in IDLE mode UE
 - Study the following DL signals for IDLE mode RRM measurement
 - Option 1: Synchronization signal (e.g., NR-PSS, NR-SSS)
 - Option 2: RS for demodulating broadcast channel
 - Option 3: RS for mobility
 - FFS if and how to associate the cell ID with this RS
 - FFS this RS is for multi-beam and/or single-beam
 - Option 4: Any combinations of above
 - Other options are not precluded
 - FFS: QCL definition for DL signal for IDLE mode RRM measurement
- FFS whether NR cell is defined only for “IDLE mode” or for both IDLE and CONNECTED mode

Agreements:

- For L3 mobility based on DL measurement in CONNECTED mode UE:
 - At least non-UE-specific DL signals can be used for CONNECTED mode RRM measurement
 - FFS UE-specific DL signals for this purpose
 - Study the following DL signals for CONNECTED mode RRM measurement
 - Option 1: Cell related RS which is carrying Cell-ID (e.g. NR-PSS, NR-SSS)
 - Option 2: RS for mobility
 - FFS how to associate it with beam-ID and/or Cell-ID
 - Option 3: RS for demodulating broadcast channel
 - Option 4: A combination of option 1 and 2
 - Other options are not precluded
 - At least one of cell-level and beam-level measurement quantities is supported for RRM reporting.
 - FFS which RRM measurement quantities to define, e.g., RSRP, RSRQ
 - Study the following options for RRM measurement quantities to be reported for L3 mobility:
 - Option 1: derived per cell (e.g., if multi-beam, as a function of multi-beam measurements)
 - Option 2: derived per beam
 - Option 3: A combination of option 1 and 2
 - Other options are not precluded
- FFS for other UE states (if introduced by RAN2)

R1-1610845 Way Forward on NR UL-based RRM measurement Huawei, HiSilicon

- NR shall target to support UL-based RRM measurement and mobility at least in the following cases:
 - New RAN Controlled State with low activity
 - Active state L3 based NR handover
 - Active state L1/2 based NR mobility

Decision: The document is noted. Continue offline discussion until Thursday.

Thursday: Continue until next meeting

R1-1609437 Scenarios and initial evaluation for UL-based RRM measurement and mobility Huawei, HiSilicon

Observation 1: UL based measurements enable the TRP(s) selection within the NR cell.

Observation 2: Configuring UL based measurement in dense network deployment result in efficient reduction on signalling overhead and UE power consumption.

Observation 3: UL based measurement can alleviate the mobility interruption time and reduce the paging signalling overhead and HO failure rate, especially for high speed mobility and beam based operation scenarios.

Observation 4: In RAN controlled state of low-frequency dense urban scenario, UL based RRM has better or close paging performance than DL based RRM with dynamic tracking area.

Observation 5: DL based measurement should be support for L1/L2 beam management, and NR cell reselection for idle UE.

Proposal 1: NR shall support UL based RRM measurement and mobility at least in dense urban, high speed mobility and beam based scenarios.

Decision: The document is noted.

R1-1609167 Evaluation scenarios and assumptions for DL mobility at above 6GHz Samsung Electronics Co., Ltd

Observation 1: UL based mobility is not feasible at higher carrier frequencies where UE/TRX uses directional transmission/reception instead of omni-directional.

Proposal 1: Only DL based mobility is assumed for the evaluation of mobility at higher carrier frequencies (e.g. 30GHz).

Proposal 2: Evaluation for mobility like SLS should be performed in RAN2 for at least higher carrier frequencies.

Proposal 3: For LLS evaluation assumptions, adopt the Table 1. And the performance metrics for link-level simulations are given by

- *Signal detection error performance (misdetection, false alarm)*
- *Measurement accuracy (signal level)*
- *Other metrics (e.g., PAPR) are not precluded*

Decision: The document is noted.

R1-1610167 Comparative Power Analysis between UL and DL-based Mobility Qualcomm Incorporated

Observation: In mobility challenging scenario, to achieve the same paging reliability, UL based mobility can reduce the UE power consumption compared to DL based mobility

Proposal: NR should study supporting both DL and UL based mobility

Decision: The document is noted.

R1-1610590 WF on Evaluation scenarios and assumptions for DL mobility at above-6GHz Samsung, Intel, Qualcomm

Agreements:

- Companies are encouraged to provide link simulation results for DL based mobility at above-6GHz
 - Evaluation assumptions are used in Table A.1.5-1 (TR38.802 V0.2.1)
 - LLS performance metrics to be considered
 - Measurement accuracy (signal level)
 - Difference between actual received power and estimated received power
 - Temporal tracking of beam strength

R1-1608789	NR RRM measurements and mobility management	CATT
R1-1608848	UL based RRM measurement and mobility	Huawei, HiSilicon
R1-1608849	DL based measurement and mobility	Huawei, HiSilicon
R1-1608970	Idle and connected mode mobility in NR	ZTE
R1-1609120	NR mobility in idle mode	Samsung
R1-1609121	NR mobility in connected-active mode	Samsung
R1-1609122	Discussion on RS for supporting mobility	Samsung
R1-1609123	Discussion on hierarchical beam sweeping	Samsung
R1-1609124	Discussion on RS resource mapping for beam measurement	Samsung
R1-1609268	Measurement for Mobility and Beam Procedure in NR	LG Electronics
R1-1609310	On multi-beam-based mobility management	CMCC
R1-1609563	DL Based RRM Measurement for NR	MediaTek Inc.
R1-1609675	NR DL mobility measurement signal design	Ericsson
R1-1609702	Discussion on the NR mobility	Panasonic Corporation
R1-1610075	Discussion on mobility measurement design for NR	NTT DOCOMO, INC.
R1-1610166	Updated evaluation results for high speed rural	Qualcomm Incorporated
R1-1610168	DL based mobility DL channels	Qualcomm Incorporated
R1-1610169	DL based mobility UL channels	Qualcomm Incorporated
R1-1610170	UL based mobility DL channels	Qualcomm Incorporated
R1-1610171	UL based mobility UL channels	Qualcomm Incorporated
R1-1610172	DL mobility in above 6 GHz bands	Qualcomm Incorporated
R1-1610173	NR DL/UL mobility for active and inactive states	Qualcomm Incorporated
R1-1610295	High speed mobility in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610296	On RRM for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610355	NR IDLE mode operation	Ericsson
R1-1610402	On NR initial access and mobility	Intel Corporation

8.1.5.4 Other

R1-1608832	On Support of Aggregation of Carrier on Different Levels	Huawei, HiSilicon
R1-1609448	Low frequency assisted high frequency operation on initial access	Huawei, HiSilicon
R1-1609696	Initial NR MIMO Calibration Results	Beijing Xinwei Telecom Techn.

8.1.6 Duplexing

R1-1610879 Chairman's notes of AI 8.1.6 on duplexing for NR Ad-Hoc chair (Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Decision: The document is endorsed and content incorporated below.

[R1-1609421](#) General discussion on flexible duplex Huawei, HiSilicon

8.1.6.1 Resource assignment and interference handling

[R1-1608790](#) Interference management for dynamic TDD and flexible duplex CATT
[R1-1608925](#) Discussion on duplexing modes in NR Fujitsu
[R1-1609126](#) Dynamic TDD for latency reduction Samsung
[R1-1610415](#) Discussion on flexible duplex operations in NR design LG Electronics
Revision of [R1-1609269](#)
[R1-1609716](#) On Resource Assignment and Interference Handling for Flexible TDD ZTE, ZTE Microelectronics
[R1-1610176](#) Signaling requirements for dynamic TDD Qualcomm Incorporated
[R1-1610219](#) On Flexible Duplexing and Associated Interference Management Techniques Ericsson
[R1-1610306](#) Forward compatible reference signal design requirement for interference mitigation CEWiT

Conclusion:

- Continue study considering some or all of the following aspects:
 - Deployment scenarios/bands, same-/cross-operator considerations
 - Resource assignments and rate adaptations
 - Frame structure and HARQ/scheduling timing
 - Measurements for cross-link interference management
 - Signalling (e.g., OTA, backhaul, UE capability, etc.)
 - Cross-link interference management (IC/IS, power control, etc.)
 - Centralized vs. distributed interference/resource management
 - Beamforming/MIMO
 - Duplex modes (e.g., FDD/TDD, FDM/TDM, etc.)
 - Latency reduction
 - Whether or not LTE interference/resource management can be used as a starting point (as applicable)
 - Sensing
 - RS design
 - Advanced receiver
 - Timing alignment between DL and UL

[R1-1610669](#) Way Forward on flexible duplex Huawei, HiSilicon

Agreements:

- Strive for a common framework for cross-link interference mitigation schemes for both paired and unpaired spectra

[R1-1610627](#) WF on technique(s) to handle cross-link interference in flexible duplex LG Electronics, Panasonic, Huawei, HiSilicon

[R1-1608830](#) Discussion on TRP-to-TRP interference mitigation schemes Huawei, HiSilicon
[R1-1608831](#) Discussion on UE-to-UE interference mitigation schemes Huawei, HiSilicon
[R1-1608838](#) Discussion on TDD operation on an unpaired spectrum Huawei, HiSilicon
[R1-1609056](#) Multiplexing UL URLLC and eMBB Samsung
[R1-1609125](#) Inter-cell Interference Management for Uncoordinated TDD Samsung
[R1-1609127](#) Signaling of Slot Structure Samsung
[R1-1609270](#) Semi-static DL/UL configuration for inter-cell interference coordination/handling LG Electronics
[R1-1609271](#) Interference coordination for flexible duplex operation LG Electronics
[R1-1609628](#) On dynamic TDD Ericsson
[R1-1609704](#) Discussion on NR duplexing Panasonic Corporation
[R1-1610085](#) Mechanisms for dynamic TDD NTT DOCOMO, INC.
[R1-1610174](#) Dynamic TDD control interference considerations Qualcomm Incorporated
[R1-1610175](#) Dynamic TDD data interference considerations Qualcomm Incorporated
[R1-1610192](#) Resource assignment and interference handling in TDD NR RAN Intel Corporation
[R1-1610205](#) Discussion on resource assignment and interference handling in TDD NR RAN Intel Corporation

8.1.6.2 Performance evaluation study

Revision of [R1-1609423](#)

[R1-1610087](#) Initial evaluation results of dynamic TDD NTT DOCOMO, INC.

[R1-1610717](#) WF on additional offset in path-loss model for flexible duplex LG Electronics, Huawei, HiSilicon

[R1-1609272](#) Remaining issues on evaluation assumptions for flexible duplex LG Electronics

[R1-1609422](#) Evaluation of flexible duplex in indoor hotspot scenario Huawei, HiSilicon
[R1-1609424](#) Evaluation of flexible duplex in urban macro scenario Huawei, HiSilicon
[R1-1610086](#) Dynamic TDD in dense urban scenario NTT DOCOMO, INC.

8.1.7 Scheduling/HARQ aspects

[R1-1611039](#) Offline outcome of Thursday afternoon on 8.1.7 NTT DOCOMO

Agreements:

- For UL control channel in short duration,
 - 1 symbol duration of a slot is supported.
 - FFS: a few symbol duration of a slot is supported.
- Mechanism enabling frequency-diversity is supported.

Agreements:

- In frequency-domain, a PRB (or multiple PRBs) is the minimum resource unit size for UL control channel.

Agreements:

- UE-specific RS is used for PUCCH transmission

[R1-1610946](#) WF on URLLC HARQ Intel

Agreements:

- Study how to meet RAN requirements on latency and reliability using at least one HARQ retransmission for DL data and UL data
 - Further study TTI duration and achievable latency based on at least one retransmission
 - Further study details of HARQ operation in DL and UL taking into account reliability of overall HARQ signaling procedure (control, data and feedback channels)
- This does not preclude studying single transmission to meet the RAN requirements on latency and reliability

Email discussion about DL L1/L2 control channel design until 7th November (including [R1-1610671](#)) – Stefan (Ericsson)
Email discussion about UL L1/L2 control channel design until 7th November – Stefan (Ericsson)

8.1.7.1 L1/L2 control channel design

Including DL/UL control channel structures and DCI/UCI contents

[R1-1609741](#) Input to control channel design from a scheduler perspective Nokia, Alcatel-Lucent Shanghai Bell

The document was presented by Sigen Ye from Nokia.

- Proposal #1: Adopt a user-centric design principle, where the downlink control channel and data channel are time multiplexed on a per user basis while still limited to distinct physical resource sets. For downlink data transmissions, the downlink control channel transmission only appears in the start of the TTI.
- Proposal #2: It should be possible to configure UEs with a time-frequency domain control channel monitoring pattern, such that UEs are not mandated to always monitor for control channel grants over the full bandwidth at all possible time occasions, say at the start of every slot, mini-slot, or subframe.

Decision: The document is noted.

[R1-1609539](#) On the NR physical control channel Intel Corporation

The document was presented by ... from Intel.

- Proposal 1: NR PDCCH should support the scheduling of common and dedicated data transmissions.
- Proposal 2: NR PDCCH should support in-carrier scheduling of common data transmission in low frequency band as well as dedicated data transmissions in both low and high frequency band.
- Proposal 3: NR PDCCH should support variable TTIs, and blind decoding computation burden thereof shall be kept in a reasonable level.
- Proposal 4: NR should support localized control and data transmission, a.k.a. in-resource control scheduling, whereby control signaling and scheduled data are transmitted in a confined time-frequency resource grid, and can be multiplexed in hybrid time-frequency domain.
- Proposal 5: NR PDCCH should support distributed transmission in frequency domain to benefit from frequency diversity, especially when localized beamforming transmission is not possible or feasible.
- Proposal 6: The coverage of NR PDCCH at low and high frequency should be further studied by taking into account relevant deployment scenarios and appropriate beamforming gain assumption.
- Proposal 7: Both DMRS and shared reference signal should be studied for NR PDCCH demodulation.

Decision: The document is noted.

R1-1609128 DL Control Channel Design Samsung

The document was presented by Aris Papasakellariou from Samsung.

Proposal 1: A resource block is the frequency resource unit for both PDCCH and PDSCH transmissions.

Proposal 2: A CCE includes a predetermined number of RBs. The RB interleaving is based on the REG interleaving in LTE.

Proposal 3: The duration of PDCCH transmissions is determined per transmission slot.

Proposal 4: A PDCCH transmission can span multiple symbols.

Proposal 5: A UE is signaled RBs of a system bandwidth and the transmission slots for monitoring PDCCH transmissions.

Decision: The document is noted.

R1-1610177 DL control channels overview Qualcomm Incorporated

The document was presented by Jing Jiang from Qualcomm.

Proposal 1: Agree on the need of PSFICH for NR.

Proposal 2: RS for PDCCH is transmitted on the 1st symbol in DL control region in each slot.

Proposal 3: Consider the multi-part PDCCH structure.

Proposal 4: Consider 2 symbol DL control region or 1 symbol DL control region with additional control channel in the data region.

Proposal 5: Do not consider dynamically configurable number of control symbols.

Proposal 6: Consider 2 port SFBC and CDD as a candidate diversity scheme for PDCCH.

Proposal 7: NR shall allow a smaller BW UE to operate in the system. Minimum UE BW can be [5] MHz.

Proposal 8: Introduce the subband concept for PDCCH search space with the above attributes per subband:

- UE specific search space / Common search space
 - CCE can be localized/distributed within a subband.
- Omni / Beamformed
 - For omni subband, UE can have a wideband RS processing over the subband.
 - For beamformed subband, UE should have per REG/CCE level RS processing.
- Single / Multi-part control

Proposal 9: Consider fewer hypotheses for PDCCH blind decoding based on the presented ways.

- Limit the DCI length options via quantized DCI length
- Use nested search space for each subband (example shown in Figure 1)
- Reduce the number of options for each aggregation level compared to LTE

Proposal 10: Consider flexible DCI multiplexing PDCCH for multiple UEs.

Proposal 11: Introduce pre-indication / cross slot scheduling (UL/DL) PDCCH.

Proposal 12: Introduce dynamic BW switching.

Decision: The document is noted.

R1-1609273 Overall structure of DL control transmission for NR LG Electronics

The document was presented by ... from LGE.

Proposal #1: In NR system, the following two types of DL control region are to be considered.

- DL control region A
 - Non-configurable in terms of time/frequency resource and numerology
- DL control region B
 - Configurable in terms of time/frequency resource and numerology

Proposal #2: In NR system, the following two types of search space are to be considered.

- Search space A
 - DCI monitoring for broadcast data and unicast data associated with fall back operation
 - Non-configurable in terms of CCE mapping, TX scheme, and DM-RS scrambling
- Search space B
 - DCI monitoring for normal unicast data
 - Configurable in terms of CCE mapping, TX scheme, and DM-RS scrambling

Proposal #3: In DL control design for NR system, the following options need to be studied.

- Option 1
 - Search space A is located in DL control region A
 - Search space B is located in DL control region B
- Option 2
 - Search space A is located in both DL control region A and B
 - Search space B is located in DL control region B

Decision: The document is noted.

R1-1609435 Control channel design for URLLC Huawei, HiSilicon

The document was presented by David Mazzaresse from Huawei.

Observation 1: The DL assignment is needed for URLLC DL transmission considering the UE complexity, power consumption and processing delay due to data channel blind detection.

Observation 2: Both A/N-based and A/N-less operation can be considered for URLLC DL transmission.

Observation 3: CSI reporting should be studied for URLLC DL transmission considering the sporadic traffic characteristics and latency requirement.

Observation 4: The scheduling request and UL grant are not needed for URLLC UL transmission if grant-free based scheme is adopted.

Observation 5: Both A/N-based and A/N-less operation can be considered for URLLC UL transmission.

Observation 6: The DL control channel reliability requirement depends on the number of possible transmissions within the latency bound, which is determined by the scheduling interval and interval between initial transmission and retransmission.

Observation 7: With a limited number of possible transmissions, the DL control channel reliability needs to be increased compared to LTE requirement (1%).

Observation 8: The NACK to ACK error for control channel carrying HARQ-ACK feedback should be studied for URLLC in order to guarantee the overall reliability requirement.

Proposal 1: A compact DCI format can be considered targeting URLLC where only limited scheduling information is conveyed.

Discussion: Qualcomm → overhead issue to be considered

Decision: The document is noted.

R1-1610083 Initial views on UL control channel design NTT DOCOMO, INC.

The document was presented by Fred Takeda from NTT DOCOMO.

Proposal 1:

- NR UL control channel(s) should support at least scheduling request, HARQ-ACK feedback, and CSI feedback.
- NR UL control channel(s) should be designed with the following high-level requirements:
 - High reliability
 - At least for lower carrier frequencies (e.g., below 6GHz), NR UL control channel(s) should be comparable with PUCCH for LTE, in terms of BLER/coverage performances.
 - For higher carrier frequencies (e.g., above 6GHz), NR UL control channel(s) have sufficient BLER/coverage performances, which could overcome the high carrier frequency specific problems.
 - High efficiency
 - NR UL control channel(s) should be efficiently multiplexed with DL data and/or UL data.
 - High flexibility
 - NR UL control channel(s) should be friendly to flexible dynamic TDD operation.
 - Scalability
 - NR UL control channel(s) should be designed for various SCSs and scheduling unit duration.

Proposal 2: NR UL control channel(s) should be designed such that required reliability can be properly achieved.

- Both BER/BLER performance evaluation and link-budget analysis would be essential.

Decision: The document is noted.

R1-1610683 Discussion points on Downlink Control Signaling Ericsson

The document was presented by Stefan Parkvall from Ericsson. Comprehensive list (non exhaustive) of questions for RAN1 to look at.

Discussion: Chair → intention is not trying to answer them right now but more to clarify the questions and revisit later in the week.

Decision: The document is noted. Continue offline discussion until Wednesday.

Wednesday

R1-1610736 Summary of offline discussion on downlink control channels Ericsson

Agreements: NR should support

- UE/PDCCH-specific DM-RS for PDCCH reception. At least for beamforming, UE may assume same precoding operation for PDCCH and associated DM-RS for PDCCH.
 - FFS: DM-RS is PDCCH-specific and/or UE-specific
- Shared/Common RS for PDCCH reception
 - Whether this sharing will be transparent to UE is FFS
 - FFS: Whether UE may assume the same precoding operation between RS and PDCCH
- FFS: QCL between antenna ports for PDCCH demodulation
- Tx diversity supported. Which scheme/how FFS

Agreements: For the frequency-domain aspects:

- A UE monitors for downlink control information in one or more “control subband”
 - This does not preclude that UE may receive additional control information elsewhere within or outside the control subband in the same or different OFDM symbol(s)
 - FFS: One DCI message is transmitted within one control subband.
- A “control subband” is smaller than or equal to the carrier bandwidth (up to a certain limit)

- FFS if a “control subband” is non-contiguous and/or contiguous in the frequency domain.
- A “control subband” consists of an integer number of RBs/PRBs in the frequency domain
- FFS: multiplexing of multiple control channels in a subband

Agreements:

- From gNB perspective, DL control signalling can be located at the first OFDM symbol(s) in a slot and/or mini-slot
- FFS: From gNB perspective, DL control signalling can be located over the slot and/or mini-slot

Possible agreements:

- NR supports same-slot and/or same-mini-slot scheduling for both DL and UL
- NR supports cross-slot and/or cross-mini-slot scheduling for both DL and UL

Agreement:

- NR supports at least same-slot and cross-slot scheduling for DL.
 - Note: it is already agreed that NR supports same-slot and cross-slot scheduling for UL.

R1-1610566 Way Forward on NR UL control channel Samsung, Qualcomm, Intel, Panasonic, InterDigital, Sony, Ericsson, NTT DOCOMO, Fujitsu

- At least two formats are supported for NR UL control channel assuming “slot” is defined
 - Short UL control channel can be
 - transmitted in the last UL symbol(s) of a slot
 - FFS: transmitted in the first UL symbol(s) of a slot
 - TDMed and/or FDMed with UL data channel within a slot
 - TDMed with DL data/control channel within a slot
 - Long UL control channel can be
 - transmitted over multiple UL symbols to improve coverage
 - FDMed with UL data channel within a slot
 - TDMed with DL control channel within a slot
 - FFS how to multiplex with SRS
 - The frequency resource and hopping, if hopping is used, should not spread over whole bandwidth for a given UL control channel

Decision: The document is noted. Continue discussion.

Wednesday session

R1-1610808 Way Forward on NR UL control channel Samsung, Qualcomm, Intel, Panasonic, InterDigital, Sony, Ericsson, NTT DOCOMO, Fujitsu, OPPO, CATT, CMCC

- At least two ways of transmissions are supported for NR UL control channel
 - UL control channel can be transmitted in short duration
 - around the last UL symbol(s) of a slot
 - FFS: in the other positions, e.g., the first UL symbol(s) of a slot
 - TDMed and/or FDMed with UL data channel within a slot
 - UL control channel can be transmitted in long duration
 - over multiple UL symbols to improve coverage
 - FDMed with UL data channel within a slot
 - FFS how to multiplex with SRS
 - The frequency resource and hopping, if hopping is used, may not spread over the carrier bandwidth

Decision: The document is noted, modified as follows:

Agreements:

- At least two ways of transmissions are supported for NR UL control channel
 - UL control channel can be transmitted in short duration
 - around the last transmitted UL symbol(s) of a slot
 - FFS: How to define and treat the potential gap at the end of the slot
 - FFS: in the other positions, e.g., the first UL symbol(s) of a slot
 - TDMed and/or FDMed with UL data channel within a slot
 - UL control channel can be transmitted in long duration
 - over multiple UL symbols to improve coverage
 - FDMed with UL data channel within a slot
 - FFS how to multiplex with SRS
 - The frequency resource and hopping, if hopping is used, may not spread over the carrier bandwidth

R1-1610671 Way Forward on NR DL Control ZTE, ZTE Microelectronics, Ericsson, Qualcomm, InterDigital

- For PDCCH with UE/PDCCH-specific DM-RS
 - UE/PDCCH-specific DM-RS should be mapped within the resources for each PDCCH transmission
 - A PDCCH transmission should be able to demodulated by DM-RS within its resource

Decision: The document is noted. Continue discussion.

R1-1610789 Scale numerology for DL control Qualcomm, ZTE

- Study the slot structure with scaled numerology for DL control portion, relative to data portion
 - Split a control OFDM symbol to half/quarter symbols
 - FFS: Control channel performance under different numerologies, Overhead saving, Control channel capacity; Quantify timeline saving.

Decision: The document is noted.

R1-1610883 WF on Using Scaled Numerology for Control Transmission Qualcomm, ZTE, Ericsson

- Study impact and benefits of allowing the transmission of DL control information and data transmission to a UE within the same slot interval using different numerologies
- Study impact and benefits of allowing the transmission of uplink control information and data transmission from a UE within the same slot interval using different numerologies
 - The associated DMRS for data transmission still uses the same numerology as the data transmission
 - Eg. Split a control OFDM symbol to half/quarter symbols with 2/4 times SCS
 - FFS: Control channel performance under different numerologies, Overhead saving, Control channel capacity; Quantify timeline saving.

Decision: The document is noted.

Agreements:

- NR should support both data and control with the same numerology
- Study impact and benefits of allowing the transmission of DL control information and data transmission to a UE within the same slot interval using different numerologies in TDM or FDM manner
 - Above may apply both slot and mini-slot
- Study impact and benefits of allowing the transmission of uplink control information and data transmission from a UE within the same slot interval using different numerologies in TDM or FDM manner
 - Above may apply both slot and mini-slot
- Followings applies both DL and UL
 - The associated DM-RS for data/control transmission still uses the same numerology as the data/control transmission
 - FFS: Control channel performance under different numerologies, Overhead saving, Control channel capacity; Quantify timeline saving, UE complexity

Thursday session

R1-1610943 Offline outcome of Wednesday evening on 8.1.7.1 NTT DOCOMO

Decision: The document is noted. The following offline consensus are agreed:

Agreements:

- NR should support at least the following.
 - In frequency-domain, a PRB (or a multiple of PRBs) is the resource unit size (may or may not including DM-RS) for control channel
 - This is at least for the case where the DL control region consists of one or a few OFDM symbol(s) of a slot or a mini-slot
 - FFS: whether a PRB or a multiple PRBs is the resource unit size
 - FFS: If multiple PRBs is the resource unit size, the multiple PRBs are contiguous
 - FFS: whether the resource unit size for a DL control channel is called as NR-REG or not

Agreements:

- NR should support at least the following
 - A DL control channel can be mapped on one or more NR-CCEs
 - This is at least for the case where the DL control region consists of one or a few OFDM symbol(s) of a slot or a mini-slot
 - A NR-CCE includes an FFS a positive integer number of PRBs (FFS: exact value)
 - FFS: whether a NR-CCE contains contiguous PRBs
 - FFS: whether multiple NR-CCEs may share one or more PRBs

- FFS: whether NR-CCE is mapped on frequency-domain only or on both frequency and time-domain.

R1-1610784 DL control channel Huawei, HiSilicon, Qualcomm, ZTE, InterDigital, Convida Wireless

- Study one step and two (or multiple) steps control channel designs
 - One step control channel design
 - DL control channel located at the first OFDM symbol(s) in a slot
 - Two (or multiple) steps control channel design
 - A first level DL control channel located at the first OFDM symbol in a slot, which can indicate at least the time and frequency resource for the data channel
 - The second level control channel has two options
 - Opt 1: The second level control channel embedded in the associated downlink data region
 - » FFS if the demodulation RS for the second level control can be shared with the associated data channel
 - Opt 2: The second level control channel located in the later OFDM symbol(s) of the control region (not later than starting of the data region)
 - FFS: Support for first level and second level DL control channel in different slots/mini-slots

Decision: The document is noted. Continue discussion.

R1-1611036 WF on DL control channel design Huawei, HiSilicon

Email discussion until 7th November – David (Huawei)

R1-1610676 Way Forward on UCI transmission for NR LG Electronics, Intel

- For NR system, it is supported that UCI feedback is transmitted via UL data channel.
 - The UCI feedback in above at least includes the HARQ-ACK response corresponding to DL data reception
 - FFS on the details (e.g., how to enable this operation, how to map the UCI on UL data channel)

Decision: The document is noted. Continue discussion.

R1-1611005 Way forward on UCI transmission for NR LG Electronics, Intel, Panasonic

Agreements:

- Study at least the following operations to be supported in NR, from a single UE perspective
 - Case 1: UL data and UCI are FDMed where the resource for UCI is not a part of the resource allocated for UL data
 - Case 2: UL data and UCI are TDMed where the resource for UCI is not a part of the resource allocated for UL data
 - Case 3: UL data and UCI are multiplexed where the resource for UCI is a part of the resource allocated for UL data
- FFS: how different types of UCI are handled
- Further study on other possibilities is not precluded

R1-1610677 DL common control channel LG

- Should be discussed as part of initial access at the next meeting.

R1-1609913 On Non-orthogonal Control Channel Design for NR InterDigital Communications

R1-1608676	Discussion on Control Channel Design for NR	ZTE, ZTE Microelectronics
R1-1608677	Discussion on Common Control Channel for NR	ZTE, ZTE Microelectronics
R1-1608791	NR DL control channel design considerations	CATT
R1-1608792	NR UL control channel design considerations	CATT
R1-1608793	Principle of DL DCI formats design	CATT
R1-1608794	Principle of UL DCI formats design	CATT
R1-1608814	DL control channel related to multiplexing eMBB and URLLC	Fujitsu
R1-1608840	Discussion on uplink control channel design in NR	Huawei, HiSilicon
R1-1608907	DL PHY procedure issues for multi-beam based approaches	Guangdong OPPO Mobile Telecom.
R1-1609129	UL Control Channel Design	Samsung
R1-1609130	Common Control Signaling	Samsung
R1-1609131	DCI Formats and Contents for NR	Samsung
R1-1609132	UCI Contents for NR	Samsung
R1-1609158	Principles of L1/L2 Control Channel Design for NR	NEC
R1-1609237	Discussion on control and data transmission of URLLC	LG Electronics
R1-1609274	Discussion on DL control channel design for NR	LG Electronics
R1-1609275	Discussion on common control signaling for NR	LG Electronics
R1-1609276	Structure of control and data multiplexing for NR	LG Electronics
R1-1609277	Discussion on UL control channel design for NR	LG Electronics
R1-1609278	Discussion on support of CA operation in NR	LG Electronics
R1-1609311	Discussion on uplink control channel design for NR	CMCC

R1-1609432	Discussion on downlink control channel design	Huawei, HiSilicon
R1-1609534	UL control channel mapping in time	Intel Corporation
R1-1609535	UCI embedding onto UL shared channel	Intel Corporation
R1-1609536	UCI contents and UL control channel formats	Intel Corporation
R1-1609537	UL control coverage enhancement	Intel Corporation
R1-1609538	Resource allocation for NR uplink control channel	Intel Corporation
R1-1609540	Reference signal design for NR control channel	Intel Corporation
R1-1609541	On the transmission schemes of NR physical control channel	Intel Corporation
R1-1609557	On techniques for enhanced UE power efficiency	MediaTek Inc.
R1-1609558	Consideration on NR-PDCCH design	MediaTek Inc.
R1-1609559	Discussion on UL control channel design	MediaTek Inc.
R1-1609560	Preconfigured decoding or transmission candidates in NR	MediaTek Inc.
R1-1609619	On downlink control channels	Ericsson
R1-1609622	On DL HARQ feedback transmission in UL	Ericsson
R1-1609623	On fast DL HARQ feedback transmission in UL	Ericsson
R1-1609624	On scheduled DL HARQ feedback transmission in UL	Ericsson
R1-1609631	On timing of downlink control signaling	Ericsson
R1-1609705	Overview on DL control channel design	Panasonic Corporation
R1-1609739	On the DL control channel structure for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609740	On the UL control channel structure for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609816	Discussion on uplink control channel for NR	Panasonic Corporation
R1-1609880	Discussion on the DL control channel design	Shenzhen Coolpad Technologies
R1-1609912	Unified Control Channel Design for NR	InterDigital Communications
R1-1610058	Initial views on DL control channel design	NTT DOCOMO, INC.
R1-1610089	DL control channel framework for NR	INTERDIGITAL COMMUNICATIONS
R1-1610178	UL control channels overview	Qualcomm Incorporated
R1-1610179	UCI content	Qualcomm Incorporated
R1-1610191	Scheduling request design for NR	Intel Corporation
R1-1610379	On Downlink Control Channel Design for New Radio	Convida Wireless LLC

8.1.7.2 Scheduling/HARQ mechanism

Including procedures for scheduling/HARQ operation

[R1-1609431](#) Discussion on short processing delay Huawei, HiSilicon

The document was presented by David Mazzaresse from Huawei.

Proposal 1: NR should evaluate the potential performance loss due to applying the processing time reduction methods and identify the use case of these methods.

Decision: The document is noted.

[R1-1610180](#) Number of HARQ processes Qualcomm Incorporated

The document was presented by Jing Jiang from Qualcomm.

- Proposal 1: NR should target to single interlace self-contained HARQ process at least for some UEs and base stations in TDD mode.
- Proposal 2: NR should also target to support one (more than one FFS) multiple HARQ process mode for UE and eNBs in TDD mode.
- Proposal 3: The need of fully dynamic HARQ Ack timeline need to be investigated very carefully and justified by sufficient performance benefit.

Decision: The document is noted.

[R1-1609744](#) HARQ operation for large transport block sizes Nokia, Alcatel-Lucent Shanghai Bell

The document was presented by Sigen Ye from Nokia.

- Observation 1: 5G new radio is expected to support increasingly larger transport block sizes as compared to LTE. This will result in a larger number of code block segments per transport block.
- Observation 2: Using a configurable multi-bit feedback, HARQ process can perform more efficiently by skipping the correctly decoded segments of the transport block in the retransmission.
- Observation 3: Depending on the CRC check of the code blocks the most useful information to be reported back to the transmitter may include e.g., index(es) of failed code block(s), index(es) of failed PRB('s), decoder state information, etc.
- Observation 4: The number of available bits for HARQ feedback is expected to increase by increasing carrier bandwidth. Moreover, multi-bit HARQ feedback can potentially use more bits by transport block size increasing, in order to report e.g. indexes of the failed CB's.
- Proposal 1: Requirements and benefits of configurable multi-bit HARQ feedback shall be investigated for 5G new radio.

- Proposal 2: 5G new radio shall enable partly-retransmission of transport blocks through skipping the successfully decoded segments of the transport block. Furthermore, it should allow for multiplexing of initial transmission and/or HARQ retransmission of two –or more— transport blocks.
- Proposal 3: The content of a multi-bit feedback shall be configurable in order to capture the most useful information that can fit the limited available number of feedback bits.
- Proposal 4: The size of a multi-bit HARQ feedback shall be configurable e.g., semi-statically for each UE or dynamically based on transport block size, available control signaling resources, etc.

Decision: The document is noted.

R1-1609543 On HARQ support for URLLC Intel Corporation

The document was presented by ... from Intel.

- The HARQ support is considered for URLLC services.
- Further study impact from different error sources on URLLC UEs with enabled HARQ operation.

Decision: The document is noted.

Wednesday session

R1-1610631 Way forward on NR HARQ Intel, Nokia, ASB, AT&T, OPPO, MediaTek

- Timing relationship between DL data reception and corresponding acknowledgement can be dynamically indicated in the DCI
 - FFS: minimum interval
- Timing relationship between UL assignment and corresponding UL data transmission can be dynamically indicated in the DCI
 - FFS: minimum interval
- Timing relationship between DL data reception and corresponding acknowledgement can be semi-statically indicated to a UE via higher layer signaling.
 - FFS: minimum interval
- Timing relationship between UL assignment and corresponding UL data transmission can be semi-statically indicated to a UE via higher layer signaling.
 - FFS: minimum interval
- Support at least multiple DL HARQ processes to support consecutive DL transmissions for eMBB.
- Support at least multiple UL HARQ processes to support consecutive UL transmissions for eMBB.

Decision: The document is noted.

Agreements:

- NR supports operation of more than one DL HARQ processes for a given UE
- NR supports operation of more than one UL HARQ processes for a given UE
- FFS: URLLC case

Agreements:

- NR supports operation of one DL HARQ process for some UEs
- NR supports operation of one UL HARQ process for some UEs
- FFS: Conditions on supporting above 2 bullets
- Note: This does not mean the gNB has to schedule back-to-back
- Note: This does not mean the UE has to support K1=0 and/or K2 = 0

Thursday

Agreements:

- Timing relationship between DL data reception and corresponding acknowledgement can be (one or more of, FFS which ones)
 - dynamically indicated by L1 signaling (e.g., DCI)
 - semi-statically indicated to a UE via higher layer
 - a combination of indication by higher layers and dynamic L1 signaling (e.g., DCI)
- FFS: minimum interval between DL data reception and corresponding acknowledgement
- FFS: common channels (e.g. random access)

Agreements:

- Timing relationship between UL assignment and corresponding UL data transmission can be (one or more of, FFS which ones)
 - dynamically indicated by L1 signaling (e.g., DCI)
 - semi-statically indicated to a UE via higher layer
 - a combination of indication by higher layers and dynamic L1 signaling (e.g., DCI)
- FFS: minimum interval between UL assignment and corresponding UL data transmission
- FFS: common channels (e.g. random access)

[R1-1610760](#) Clarification on timing relationship in NR HARQ Qualcomm

[R1-1610547](#) Way Forward on timing relationship for NR MediaTek, III, Samsung, NTT Docomo, Nokia, ASB, Qualcomm, Ericsson, Huawei, HiSilicon, Sony

- For per-slot scheduling, NR specification should support the following
 - DL data reception in slot N and corresponding acknowledgment in slot N+K1
 - All UEs should support $K1 \geq 1$ with exact values for K1 FFS
 - Some UEs may support $K1=0$ (FFS conditions)
 - UL assignment in slot N and corresponding uplink data transmission in slot N+K2
 - All UEs should support $K2 \geq 1$ with exact values for K2 FFS
 - Some UEs may support $K2=0$ (FFS conditions)

Decision: The document is noted and modified as follows:

Agreements:

- For slot-based scheduling, NR specification should support the following
 - DL data reception in slot N and corresponding acknowledgment in slot N+K1
 - All UEs should support $K1 \geq 1$ with exact values for K1 FFS
 - Some UEs may support $K1=0$ (FFS conditions)
 - UL assignment in slot N and corresponding uplink data transmission in slot N+K2
 - All UEs should support $K2 \geq 1$ with exact values for K2 FFS
 - Some UEs may support $K2=0$ (FFS conditions)

[R1-1610752](#) Way forward on NR DCI monitoring Intel, CATT, Ericsson, Panasonic, ETRI

- DCI monitoring occasions can be configured by higher layers

Decision: The document is noted, modified and agreed as follows:

Agreement: UE-specific DL control information monitoring occasions at least in time domain can be configured

[R1-1610750](#) WF on HARQ feedback for eMBB MediaTek

Agreements:

- At least asynchronous and adaptive HARQ is supported for eMBB.
- NR supports at least UL transmission of at least single HARQ-ACK bit.
- Consider whether/how to support more than one HARQ-ACK bits per TB.
- Consider whether/how to support single HARQ-ACK bit per multiple TBs, e.g., HARQ-ACK bundling.

The document was presented by ... from ...

Discussion:

Decision: The document is noted.

R1-1608795	NR Scheduling procedure	CATT
R1-1608796	NR HARQ operation	CATT
R1-1608815	Scheduling and CQI feedback for URLLC	Fujitsu
R1-1608839	Discussion on timing relations for NR	Huawei, HiSilicon
R1-1608908	On DL HARQ for NR	Guangdong OPPO Mobile Telecom.
R1-1608958	On indicating HARQ timing and PUCCH	ZTE
R1-1608959	Fast scheduling and transmission for NR	ZTE
R1-1609133	Support of Flexible Scheduling Timing	Samsung
R1-1609134	Number of HARQ Processes	Samsung
R1-1609280	Discussion on HARQ timing and resource for NR	LG Electronics
R1-1609281	Discussion on scheduling in time domain for NR	LG Electronics
R1-1609282	Discussion on HARQ latency reduction for NR	LG Electronics
R1-1609283	Discussion on potential HARQ operation in NR	LG Electronics
R1-1609284	Discussion on minimum HARQ-ACK and retransmission timing	LG Electronics
R1-1609429	Discussion on resource block for NR	Huawei, HiSilicon
R1-1609542	NR HARQ and scheduling timing	Intel Corporation
R1-1609561	Consideration on HARQ mechanism in NR	MediaTek Inc.
R1-1609706	Timing relation dependency to slots transmission direction indication method	Panasonic Corporation
R1-1609742	On HARQ/scheduling timing and self-contained operation	Nokia, Alcatel-Lucent Shanghai Bell

R1-1609743	Enhanced redundancy matching for HARQ transmission	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609745	Early Hybrid ARQ Feedback for the 5G New Radio	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609746	HARQ Pooling for Carrier Aggregation in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609747	Punctured Scheduling for Low Latency Transmissions	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609748	Semi-persistent scheduling for 5G new radio URLLC	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609749	Pause-Resume Scheduling for Low Latency Transmissions	Nokia, Alcatel-Lucent Shanghai Bell
R1-1609801	Discussion on grant-free transmission based on sensing	ZTE
R1-1609877	DL HARQ and UL scheduling timing in NR	Sharp
R1-1610082	Multiplexing mechanism for eMBB and URLLC	NTT DOCOMO, INC.
R1-1610084	HARQ and scheduling operation for NR	NTT DOCOMO, INC.
R1-1610090	Scheduling and support of service multiplexing	INTERDIGITAL COMMUNICATIONS
R1-1610092	Reduced HARQ timing for NR	HTC Corporation
R1-1610181	DL processing time consideration	Qualcomm Incorporated
R1-1610182	UL processing time consideration	Qualcomm Incorporated
R1-1610218	Some Considerations on HARQ Feedback Mechanism	ZTE

8.1.7.2 Other

R1-1609135	Discussion on UE power consumption reduction	Samsung
R1-1609136	Signaling of Resources for forward compatibility	Samsung
R1-1609279	Discussion on UL power control procedure for NR	LG Electronics

8.1.8 Other

Including remaining evaluation assumptions

Including forward compatibility not covered by above agenda items

[R1-1610880](#) Chairman's notes of AI 8.1.8 Ad-Hoc chair (Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Decision: The document is endorsed and content incorporated below.

R1-1608857	Remaining issues on panel modeling	Huawei, HiSilicon
----------------------------	------------------------------------	-------------------

Agreements:

- Phase offset of non-calibrated panel (either TRP or UE side) is modeled as a uniform distributed random variable between $(-\pi, \pi)$.
- Adopt the accumulated phase offset of non-calibrated panel pair in channel coefficients equation (7.21) and (7.26) in TR 38.900.

R1-1608965	Initial Link Level Simulation Results for URLLC	ZTE
----------------------------	---	-----

R1-1609140	Remaining evaluation assumption for dense urban macro with 30GHz frequency	Samsung
----------------------------	--	---------

Agreements:

- When deploying macro TRP at above 6GHz in dense urban scenario,
 - 40dBm PA scaled down with simulation BW when system BW is higher than simulation BW.

R1-1609312	Remaining evaluation details of High Speed Train Scenario	CMCC
----------------------------	---	------

Agreements:

- For High speed train scenario
 - The baseline BS antenna configuration at 4GHz in high speed train scenario is $(M,N,P,M_g,N_g)=(8,8,2,1,1)$, where the radiation pattern of antenna elements follows TR 36.873 according to the current agreements. Other antenna configurations are not precluded.
 - For geometry evaluation, the users are uniformly distributed along the railway track. Companies provide geometry results to determine the azimuth beam direction using the beam formed by two elements with weighting values $[1, 1]$ assuming no power loss and elevation downtilt angle using the DFT beam formed by all vertical elements for cell association.
 - Adopt the penetration loss model in Table 1 of [R1-1609312](#) for high speed train scenario.

R1-1609545	Remaining details of URLLC system level evaluation assumptions	Intel Corporation
----------------------------	--	-------------------

R1-1610720	WF on URLLC System Level Evaluation Methodology	Intel, Qualcomm, ZTE, ZTE Microelectronics
----------------------------	---	--

Agreements:

- Slide 3 and slide 4 in [R1-1610720](#) are agreed with the following updates:
 - Option 1 for UE distribution on slide 4 is for DL only, optional, and 1 eMBB UE in the other 56 sectors is of the same traffic model as the eMBB UEs in the center sector
 - Unidirectional and bidirectional (DL or UL) ~~is evaluated as baseline.~~
~~Bidirectional DL and UL traffic is evaluated as a second priority.~~

- URLLC: Both FTP Model 3 (with Poisson arrival) and periodic packet arrivals with packet size 32, 50, 200 bytes.
- URLLC: ~~Poisson~~ packet arrival with arrival rate λ to achieve URLLC capacity
- For “Simulation bandwidth”
 - Add “other bandwidths are not precluded”
- For eMBB UE of FTP model 3, add that the packet size is 0.1Mbytes and 0.5Mbytes
- Companies are encouraged to report the power control parameters (e.g., open-loop, etc.) for UL URLLC evaluations

[R1-1609546](#) On eMBB and URLLC multiplexing Intel Corporation

[R1-1610436](#) Path loss model for evaluation of mMTC Ericsson

Revision of [R1-1609775](#)

[R1-1610183](#) Updated mMTC battery life evaluation assumptions Qualcomm Incorporated

[R1-1610359](#) On the utilization of Advanced Receivers in NR Nokia, Alcatel-Lucent Shanghai Bell

[R1-1610681](#) WF on coexistence between NR and LTE LG Electronics, AT&T

[R1-1610800](#) WF on coexistence between NR and LTE LG Electronics, AT&T, Ericsson

Agreements:

- To support the efficient coexistence between NR and LTE operating in the same licensed frequency band,
 - At least legacy LTE features should be considered in the NR study, e.g.:
 - MBSFN configuration (for LTE Rel-8 and beyond)
 - TDD UL subframe (for LTE Rel-8 and beyond)
 - SCell activation/deactivation (for LTE Rel-10 and beyond)
 - TDD UL subframe configured by eIMTA feature (for LTE Rel-12 and beyond)
 - NR should study the following candidate mechanisms for coexistence:
 - Resource indication (e.g., blank resources, available resources, etc.) of time/frequency resources
 - Reconfiguring channel bandwidth/carriers monitored by UEs
 - Any other mechanisms are not precluded.
 - For non co-located LTE/NR case, backhaul signaling between LTE and NR can be studied to mitigate inter-cell interference.
 - FFS on which information can be conveyed on the backhaul signaling
 - Over-the-air listening at the gNB can also be considered
 - Note: Dynamic switch between NR and LTE can be studied from the perspective of network for co-located LTE/NR case.

[R1-1610951](#) Way Forward on LLS evaluation assumption for control channel evaluation in URLLC Huawei, HiSilicon
The evaluation assumptions for control channel in URLLC are to be discussed under control channel design for URLLC

[R1-1609774](#) Channel model for evaluation of Rural scenario Ericsson

[R1-1610961](#) Way Forward on O2I model for rural scenario Huawei, HiSilicon, CATT, CATR, CMCC

[R1-1610955](#) WF on channel model for Rural macro scenario Ericsson

Also supported by AT&T, DT, Samsung, Intel, Nokia, ASB

Email discussion/approval based on the above two WFs till Oct 21th (Kazuaki, DCM)

[R1-1608843](#) Overview of URLLC support for NR Huawei, HiSilicon

[R1-1608845](#) Support of URLLC in UL Huawei, HiSilicon

[R1-1608856](#) Further discussion on URLLC evaluation Huawei, HiSilicon

[R1-1608960](#) Remaning issue on system level evaluation assumptions for URLLC ZTE

[R1-1609137](#) NR-LTE Coexistence Samsung

[R1-1609138](#) Carrier Aggregation for NR Samsung

[R1-1609139](#) Overview of NR Unlicensed Spectrum Samsung

[R1-1609285](#) Forward compatibility issues considering NR operation in unlicensed spectrum LG Electronics

[R1-1609286](#) On coexistence of NR and LTE LG Electronics

[R1-1609287](#) Forward compatibility issues on mMTC LG Electronics

[R1-1609434](#) Discussion on UE power consumption reduction in NR Huawei, HiSilicon

[R1-1609447](#) WF on Modeling Line-of-Sight Blockage for V2V Huawei, HiSilicon, Volkswagen, Ericsson, General Motors, Vodafone

[R1-1609544](#) LTE/NR coexistence Intel Corporation

[R1-1609620](#) On scrambling Ericsson

[R1-1609633](#) On URLLC characteristics Ericsson

[R1-1609634](#) On URLLC design principles Ericsson

[R1-1609636](#) On NR Operation in the 60 GHz Unlicensed Band Ericsson

[R1-1609637](#) On channel access mechanisms for NR in unlicensed spectrum Ericsson

R1-1609638	Technology components for unlicensed operation	Ericsson
R1-1609639	On autonomous UL transmissions for NR in unlicensed spectrum	Ericsson
R1-1609640	Discussion of multi-antenna and highly directional beam-forming for unlicensed operation	Ericsson
R1-1609641	On Physical Layer Design Policies for Unlicensed Operation of NR	Ericsson
R1-1609703	Antenna pattern at UE/RSU in NR eV2X	Ericsson
R1-1609713	Discussions on simulation scenarios of NR eV2X at 63GHz	Ericsson
R1-1609714	Discussions on traffic model for NR eV2X	Ericsson
R1-1609753	Update to channel models for eV2X evaluation	Ericsson
R1-1609781	Satellite Aspects- Forward Compatibility Consideration	Dish Network
R1-1609802	Operation on high frequency band of unlicensed spectrum in NR	ZTE
R1-1609803	Discussion on NR operation in unlicensed spectrum	ZTE
R1-1609890	Requirements on Future Railway Mobile Communication	ZTE, China Academy of Railway Sciences (CARS), CATR
R1-1610091	In-band full duplexing in NR	HTC Corporation
R1-1610109	NR and LTE coexistence assisted by embedded-GFDM	National Taiwan University
R1-1610184	Summary of email discussion on mMTC evaluation path loss calibration	Qualcomm Incorporated
R1-1610185	Remaining issue for mMTC evaluation assumption	Qualcomm Incorporated
R1-1610186	Updated URLLC SLS evaluation assumptions	Qualcomm Incorporated
R1-1610187	EMBB DL bursty data	Qualcomm Incorporated
R1-1610188	URLLC system capacity and URLLC/eMBB multiplexing efficiency analysis	Qualcomm Incorporated
R1-1610189	Summary of KP evaluation results for MMW scenarios	Qualcomm Incorporated
R1-1610190	Impact of initial access design for access/backhaul relay	Qualcomm Incorporated
R1-1610315	On battery models for mMTC	Ericsson
R1-1610316	On the evolution of mMTC	Ericsson
R1-1610360	On the cross-link interference mitigation	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610361	On network energy efficiency requirement and evaluation for the 5G new radio	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610362	Uplink power control for 5G New Radio	Nokia, Alcatel-Lucent Shanghai Bell
R1-1610366	Discussion on URLLC design aspects	Intel Corporation
R1-1610367	Considerations on eV2X NR design	Intel Corporation
R1-1610368	Preliminary eV2X evaluation analysis	Intel Corporation

8.2 Other

Including channel model for frequency spectrum above 6 GHz

[R1-1610881](#) Chairman's notes of AI 8.2 Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Decision: The document is endorsed and content incorporated below.

Channel model TR38.900

[R1-1609776](#) Correction for O-I modeling for RMA Ericsson

Decision: CR0045 to 38.900 (Rel-14) is agreed.

[R1-1609796](#) TR38.900_CR_Section_7.5 Fraunhofer HHI

Decision: CR0046 to 38.900 (Rel-14) is agreed.

[R1-1610479](#) TR38.900_CR_Section_7.6.2.2 Fraunhofer HHI (Revision of [R1-1609797](#))

Decision: CR0047r1 to 38.900 (Rel-14) is agreed.

[R1-1610313](#) Correction for correlation modelling for multi-frequency simulations Ericsson

Decision: Revisit at RAN1#87. CR0051 to 38.900 (Rel-14) is postponed to next meeting.

[R1-1609798](#) TR38.900_CR_Section_7.7.1 Fraunhofer HHI

Decision: CR0048 to 38.900 (Rel-14) is agreed.

[R1-1610225](#) TR38.900_CR_Section_7.7.5.1 Mitsubishi Electric Co., Fraunhofer HHI

Decision: CR0050 to 38.900 (Rel-14) is agreed.

[R1-1609799](#) TR38.900_CR_Section_8.4 Fraunhofer HHI

Decision: CR0049 to 38.900 (Rel-14) is agreed.

Companies are invited to check the following late CRs before RAN1#87:

[R1-1610699](#) TR38.900_CR_Azimuthal_Angle_Notation Fraunhofer HHI

Decision: CR0053 to 38.900 (Rel-14) is postponed to next meeting.

[R1-1610700](#) TR38.900_CR_Harmonizing_Terminology Fraunhofer HHI

Decision: CR0054 to 38.900 (Rel-14) is postponed to next meeting.

3GPP TSG RAN WG1 Meeting #87 Reno, USA, 14th – 18th November 2016

R1-16xxxxx

[R1-1609785](#) e-mail discussion summary [86-28] on additional feature calibration Samsung
[R1-1610672](#) 38.900CR0052 to capture additional feature calibration results Samsung
Decision: CR0052 to 38.900 (Rel-14) is agreed.

[R1-1610688](#) Full calibration results for channel model above 6GHz Lenovo, Motorola Mobility

Other

[R1-1609793](#) TR25.996_CR_Equation_Numbering Fraunhofer HHI
Decision: CR0002 to 25.996 (Rel-13) is agreed.
[R1-1609794](#) TR36.814_CR_Equation_Numbering Fraunhofer HHI
Decision: CR0001 to 36.814 (Rel-9) is agreed.
[R1-1609795](#) TR36.873_CR_Equation_Numbering Fraunhofer HHI
Decision: CR0005 to 36.873 (Rel-12) is agreed.

Companies are invited to check the following late CRs before RAN1#87:

[R1-1610701](#) TR36.873_CR_Section_7.3 Fraunhofer HHI
Decision: CR0006 to 36.873 (Rel-12) is postponed to next meeting.
[R1-1610702](#) TR36.873_CR_LOS_Probability Fraunhofer HHI
Decision: CR0007 to 36.873 (Rel-12) is postponed to next meeting.
[R1-1610703](#) TR36.814_CR_Section_B.1.2.2.1 Fraunhofer HHI
Decision: CR0002 to 36.814 (Rel-9) is postponed to next meeting.
[R1-1610704](#) TR36.814_CR_LOS_Probability Fraunhofer HHI
Decision: CR0003 to 36.814 (Rel-9) is postponed to next meeting.

9 Closing of the meeting

Mr Chair thanked all for the hard work during the week. Special thanks to Channel coding for NR team who finished Wednesday/Thursday sessions very late (01:30AM).

Thanks also to the European Friends of 3GPP for hosting and organizing meeting room facilities for such big meeting.

Mr Chair thanked Vice chairs and all the rapporteurs who help managing the number of parallel sessions during the course of the week.

Question was raised by Cohere Technologies regarding how Phase 2 for NR will be taken into account.

Mr Chair emphasized that the details remain a RAN plenary decision, and if clarification is needed, this should be discussed by December 2016.

Agenda to next upcoming meetings shall slightly changed compare to the one of RAN1#86bis.

Huawei commented that reviewing the NR TR content during the meeting was made very difficult due to the work load all week long – better to update between meetings – NTT DOCOMO responded that the draft TR was distributed and available one week prior to RAN1#86bis.

Meeting was closed at 17:07.

See you all in Reno.

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex A: List of Tdocs at RAN1 #86bis

Please see excel file attached to this report

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex B: List of CRs agreed at RAN1 #86bis

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

TS	CR	Rev	Rel	Title	Cat	Vsn	@ Mtg	TD#	Source to WG	Work Item
25.212	344	-	Rel-14	Introduction of HS-SCCH Order for HS-SCCH DRx feature in enhanced Cell Fach	B	13.1.0	R1#86b	R1-1609782	Qualcomm Europe Inc.(France)	FACH_DTXDRX-Core
25.214	758	-	Rel-14	UE Procedures for HS-SCCH DRx feature in enhanced Cell Fach	B	13.4.0	R1#86b	R1-1609784	Qualcomm Europe Inc.(France)	FACH_DTXDRX-Core
36.211	289	-	Rel-13	Correction to DMRS for MPDCCH associated with P-RNTI	F	13.3.0	R1#86b	R1-1609605	Virtuosys Ltd, Qualcomm Incorporated, Intel Corporation	LTE_MTCe2_L1-Core
36.211	291	1	Rel-13	Correction on MPDCCH transmission without repetition	F	13.3.0	R1#86b	R1-1610778	Huawei, HiSilicon	LTE_MTCe2_L1-Core
36.211	295	-	Rel-13	Correction of typos due to wrong implementation of CR0283 "Clarification of valid subframe in eMTC"	D	13.3.0	R1#86b	R1-1610439	MCC	LTE_MTCe2_L1-Core
36.211	296	-	Rel-13	Correction on NZP CSI-RS aggregation for Class A	F	13.3.0	R1#86b	R1-1610451	LG Electronics, Samsung	LTE_EBF_FDMIMO-Core
36.211	297	-	Rel-14	Draft CR on start timing of PUSCH	F	14.0.0	R1#86b	R1-1610475	Samsung	LTE_eLAA-Core
36.211	298	-	Rel-14	Correction to DMRS for MPDCCH associated with P-RNTI - Rel-14	A	14.0.0	R1#86b	R1-1610504	Virtuosys Ltd, Qualcomm Incorporated, Intel Corporation	LTE_MTCe2_L1-Core
36.211	299	-	Rel-13	Clarification on NPRACH and NPUSCH collision	F	13.3.0	R1#86b	R1-1610505	Qualcomm Incorporated	NB_IoT-Core
36.211	300	-	Rel-14	Clarification on NPRACH and NPUSCH collision	A	14.0.0	R1#86b	R1-1610506	Qualcomm Incorporated	NB_IoT-Core
36.211	301	-	Rel-13	Clarification on i_0 value	F	13.3.0	R1#86b	R1-1610911	Qualcomm Incorporated	LTE_MTCe2_L1-Core
36.211	302	-	Rel-14	Clarification on i_0 value	A	14.0.0	R1#86b	R1-1610912	Qualcomm Incorporated	LTE_MTCe2_L1-Core
36.211	303	-	Rel-13	Correction of PRACH starting subframes for eMTC	F	13.3.0	R1#86b	R1-1610914	Intel Corporation, Ericsson	LTE_MTCe2_L1-Core
36.211	304	-	Rel-14	Correction of PRACH starting subframes for eMTC	A	14.0.0	R1#86b	R1-1610915	Intel Corporation, Ericsson	LTE_MTCe2_L1-Core
36.211	305	-	Rel-13	Correction of NPRACH frequency hopping	F	13.3.0	R1#86b	R1-1610916	Intel Corporation	NB_IOT-Core
36.211	306	-	Rel-14	Correction of NPRACH frequency hopping	A	14.0.0	R1#86b	R1-1610917	Intel Corporation	NB_IOT-Core
36.211	307	-	Rel-14	Correction on MPDCCH transmission without repetition	A	14.0.0	R1#86b	R1-1610926	Huawei, HiSilicon	LTE_MTCe2_L1-Core
36.211	308	-	Rel-14	Correction of typos due to wrong implementation of CR0283 "Clarification of valid subframe in eMTC"	A	14.0.0	R1#86b	R1-1611020	MCC, Qualcomm	LTE_MTCe2_L1-Core
36.212	221	-	Rel-14	Corrections to RV in eLAA DCI definitions	F	14.0.0	R1#86b	R1-1610459	Nokia, Alcatel-Lucent Shanghai Bell	LTE_eLAA-Core
36.212	222	-	Rel-14	Draft CR on DCI formats related with LAA in TS 36.212	D	14.0.0	R1#86b	R1-1610476	ETRI	LTE_eLAA-Core
36.212	223	-	Rel-14	Clarification of PUSCH start position for eLAA	F	14.0.0	R1#86b	R1-1610886	Panasonic, Qualcomm Incorporated	LTE_eLAA-Core

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

36.212	224	0	Rel-14	Draft CR on RI transmission on PUSCH for LAA SCeLLs	F	14.0.0	R1#86b	R1-1610998	Qualcomm Incorporated	LTE_eLAA-Core
36.213	746	-	Rel-13	Correction on the determination of NPDCCH candidates	F	13.3.0	R1#86b	R1-1609403	ITRI	NB_IoT-Core
36.213	747	-	Rel-14	Correction on the determination of NPDCCH candidates	A	14.0.0	R1#86b	R1-1609404	ITRI	NB_IoT-Core
36.213	749	2	Rel-13	Correction on downlink power allocation for SC-PTM	F	13.3.0	R1#86b	R1-1611045	TD Tech, Huawei	LTE_SC_PTM-Core
36.213	751	1	Rel-13	CR on 36.213 NB-IoT Type1 and Type 2 search space definition	F	13.3.0	R1#86b	R1-1610733	Ericsson	NB_IoT-Core
36.213	752	1	Rel-14	CR on 36.213 NB-IoT Type1 and Type 2 search space definition	A	14.0.0	R1#86b	R1-1610734	Ericsson	NB_IOT-Core
36.213	754		Rel-13	Correction on CWp adjustment on Type B1 multi-carrier access procedure for Rel-13 LAA	F	13.3.0	R1#86b	R1-1610450	WILUS Inc.	LTE_LAA-Core
36.213	755	-	Rel-13	Correction to PUCCH reporting mode 2-1	F	13.3.0	R1#86b	R1-1610452	Intel Corporation, ZTE Corporation, ZTE Microelectronics	LTE_EBF_FDMIMO-Core
36.213	756	-	Rel-13	Correction to PUCCH reporting mode 1-1	F	13.3.0	R1#86b	R1-1610453	Intel Corporation, ZTE Corporation, ZTE Microelectronics	LTE_EBF_FDMIMO-Core
36.213	757	-	Rel-14	Correction to PUCCH reporting mode 2-1	A	14.0.0	R1#86b	R1-1610454	Intel Corporation, ZTE Corporation, ZTE Microelectronics	LTE_EBF_FDMIMO-Core
36.213	758	-	Rel-14	Correction to PUCCH reporting mode 1-1	A	14.0.0	R1#86b	R1-1610455	Intel Corporation, ZTE Corporation, ZTE Microelectronics	LTE_EBF_FDMIMO-Core
36.213	759	–	Rel-14	Correction on UL grant reception in ending partial subframe	F	14.0.0	R1#86b	R1-1610456	LG Electronics	LTE_eLAA-core
36.213	760		Rel-14	Correction on UL burst scheduling	F	14.0.0	R1#86b	R1-1610457	LG Electronics	LTE_eLAA-core
36.213	761	-	Rel-14	Draft CR on PHICH operation for eLAA in 36.213	F	14.0.0	R1#86b	R1-1610458	Huawei, HiSilicon	LTE_LAA-Core
36.213	762		Rel-14	Correction on handling UL LBT procedure under UE power limited case	F	14.0.0	R1#86b	R1-1610460	WILUS Inc.	LTE_eLAA-core
36.213	763	-	Rel-13	Clarification on spectral efficiency	F	13.3.0	R1#86b	R1-1610493	Qualcomm Incorporated	LTE_MTCe2_L1-Core
36.213	764	2	Rel-13	Aperiodic CSI without MPDCCH frequency hopping	F	13.3.0	R1#86b	R1-1610944	Qualcomm Incorporated, Samsung	LTE_MTCe2_L1-Core
36.213	765	-	Rel-14	Clarification on spectral efficiency	A	14.0.0	R1#86b	R1-1610495	Qualcomm Incorporated	LTE_MTCe2_L1-Core
36.213	766	2	Rel-14	Aperiodic CSI without MPDCCH frequency hopping	A	14.0.0	R1#86b	R1-1610945	Qualcomm Incorporated, Samsung	LTE_MTCe2_L1-Core
36.213	767	1	Rel-13	Correction on equation for MPDCCH search space and starting subframe position	F	13.3.0	R1#86b	R1-1610796	NTT DOCOMO, Panasonic	LTE_MTCe2_L1-Core
36.213	768	1	Rel-14	Correction on equation for MPDCCH search space and starting subframe position	A	14.0.0	R1#86b	R1-1610797	NTT DOCOMO, Panasonic	LTE_MTCe2_L1-Core

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

36.213	769	-	Rel-13	Clarification of number of repetitions of PUCCH	F	13.3.0	R1#86b	R1-1610648	ZTE, Rohde & Schwarz	LTE_MTCe2_L1-Core
36.213	770	-	Rel-13	Clarification on nrs-Power related description	F	13.3.0	R1#86b	R1-1610649	ZTE	NB_IoT-Core
36.213	771	-	Rel-14	Clarification of number of repetitions of PUCCH	A	14.0.0	R1#86b	R1-1610656	ZTE, Rohde & Schwarz	LTE_MTCe2_L1-Core
36.213	772	-	Rel-14	Clarification on nrs-Power related description	A	14.0.0	R1#86b	R1-1610657	ZTE	NB_IoT-Core
36.213	773		Rel-14	Removal of LAA DRS channel access from UL Type 2 Channel Access description	F	14.0.0	R1#86b	R1-1610884	Nokia, Alcatel-Lucent Shanghai Bell	LTE_eLAA-core
36.213	774	-	Rel-14	CR on UL duration and offset field in TS 36.213	D	14.0.0	R1#86b	R1-1610896	ETRI	LTE_eLAA-Core
36.213	775		Rel-14	Correction on channel access priority class according to UL LBT type indication in eLAA	F	14.0.0	R1#86b	R1-1610900	WILUS Inc.	LTE_eLAA-core
36.213	776	1	Rel-14	Correction on periodic CSI transmission	F	14.0.0	R1#86b	R1-1611007	LG Electronics	LTE_eLAA-core
36.213	778	-	Rel-14	Draft CR on UL CWS adjustment for eLAA in 36.213	F	14.0.0	R1#86b	R1-1611022	Huawei, HiSilicon, Qualcomm, Broadcom, LGE, Ericsson, Intel,	LTE_eLAA-core
36.213	779	0	Rel-14	CR on trigger monitoring timeline for triggered grants in eLAA	F	14.0.0	R1#86b	R1-1611025	Qualcomm Incorporated	LTE_eLAA-Core
36.213	780	–	Rel-13	Correction on CSI reference resource definition in LAA	F	13.3.0	R1#86b	R1-1611027	LG Electronics	LTE_LAA-Core
36.213	781	–	Rel-14	Correction on CSI reference resource definition in LAA	A	14.0.0	R1#86b	R1-1611028	LG Electronics	LTE_eLAA-core
36.213	782		Rel-13	Correction on CSI measurement in LAA	F	13.3.0	R1#86b	R1-1611029	LG Electronics	LTE_LAA-Core
36.213	783		Rel-14	Correction on CSI measurement in LAA	A	14.0.0	R1#86b	R1-1611030	LG Electronics	LTE_eLAA-core
36.214	39	-	Rel-13	Correction on SSTD definition	F	13.3.0	R1#86b	R1-1608717	CATT	LTE_SC_enh_dualC-Core
36.214	40	-	Rel-14	Correction on SSTD definition	A	14.0.0	R1#86b	R1-1609824	CATT	LTE_SC_enh_dualC-Core

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

TS	CR	Rev	Rel	Title	Cat	Vsn	@ Mtg	TD#	Source to WG	Work Item
25.996	2		Rel-13	TR25.996_CR_Equation_Numbering	D	13.0.0	R1#86b	R1-1609793	Fraunhofer HHI	MIMO
36.814	1		Rel-9	TR36.814_CR_Equation_Numbering	D	9.0.0	R1#86b	R1-1609794	Fraunhofer HHI	FS_RAN_LTEA
36.873	5		Rel-12	TR36.873_CR_Equation_Numbering	D	12.2.0	R1#86b	R1-1609795	Fraunhofer HHI	FS_LTE_3D_channel
38.900	45	-	Rel-14	Correction for O-I modeling for RMa	F	14.1.0	R1#86b	R1-1609776	Ericsson	FS_6GHz_CH_model
38.900	46		Rel-14	TR38.900_CR_Section_7.5	F	14.1.0	R1#86b	R1-1609796	Fraunhofer HHI	FS_6GHz_CH_model
38.900	47	1	Rel-14	TR38.900_CR_Section_7.6.2.2	F	14.1.0	R1#86b	R1-1610479	Fraunhofer HHI, Samsung, Ericsson, Intel, Nokia, InterDigital	FS_6GHz_CH_model
38.900	48		Rel-14	TR38.900_CR_Section_7.7.1	F	14.1.0	R1#86b	R1-1609798	Fraunhofer HHI	FS_6GHz_CH_model
38.900	49		Rel-14	TR38.900_CR_Section_8.4	D	14.1.0	R1#86b	R1-1609799	Fraunhofer HHI	FS_6GHz_CH_model
38.900	50	-	Rel-14	TR38.900_CR_Section_7.7.5.1	F	14.1.0	R1#86b	R1-1610225	Mitsubishi Electric, Fraunhofer HHI	FS_6GHz_CH_model
38.900	52	-	Rel-14	CR to capture additional feature calibration results	F	14.1.0	R1#86b	R1-1610679	Samsung	FS_6GHz_CH_model

3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016

R1-16xxxxx

Annex C-1: List of Outgoing LSs from RAN1 #86bis

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1610571	LS reply on Multi-carrier enhancements for UMTS	RAN1, Ericsson	Rel-14	UTRA_MCe-Core	R1-168089	RAN2, RAN3			
R1-1610572	LS to RAN2/3 on RAN1 progress on MC enhancements	RAN1, Huawei	Rel-14	UTRA_MCe-Core		RAN2, RAN3			
R1-1610655	LS on wider bandwidth operation for NR	RAN1, NTT DOCOMO	Rel-14	FS_NR_newRAT		RAN4	RAN2		
R1-1610780	LS on power allocation for SC-PTM	RAN1, Huawei	Rel-13	LTE_SC_PTM-Core		RAN2			
R1-1610929	LS response on DFN offset	RAN1, Ericsson	Rel-14	LTE_V2X-Core	R1-1610798	RAN2			
R1-1610930	LS response on Exceptional Pool Handling for V2X	RAN1, Ericsson	Rel-14	LTE_SL_V2V-Core	R1-1608566	RAN2			
R1-1610992	LS on NR RACH Procedure	RAN1, Huawei	Rel-14	FS_NR_newRAT		RAN2			
R1-1611000	LS on V2X UE transmission chain	RAN1, Huawei	Rel-14	LTE_V2X-Core		RAN2, RAN4			
R1-1611026	Reply LS on CSI measurement ambiguity in LAA	LG Electronics	Rel-13	LTE_LAA-Perf	R1-1608572	RAN4			
R1-1611031	Response LS to IEEE 802.11 regarding LAA	RAN1, Qualcomm	Rel-13	LTE_LAA-Core	R1-167908	IEEE 802 LAN/MAN Standards Committee	"Wi-Fi Alliance, The City of New York Office of the Mayor, RAN, RAN2, RAN4		
R1-1611032	LS on configuration of NPRS power for NB-IoT downlink positioning	RAN1, Huawei	Rel-14	NB_IOTenh-Core	"				
R1-1611033	LS on SC-MCCH transmission in NB-IoT	RAN1, HiSilicon	Rel-14	NB_IOTenh-Core, LTE_feMTC-Core		RAN4			
R1-1611034	LS on collisions between SC-PTM and Paging in NB-IoT	RAN1, HiSilicon	Rel-14	NB_IOTenh-Core		RAN2			
R1-1611049	LS for SRS Carrier-Based Switching Agreements	RAN1, Huawei	Rel-14	LTE_SRS_switch-Core		RAN2, RAN3, SA2			
R1-1611050	LS on L1 parameters for Carrier-Based Switching	RAN1, Huawei	Rel-14	LTE_SRS_switch-Core		RAN2, RAN4			
R1-1611051	LS regarding agreements for FeMBMS	RAN1, Qualcomm	Rel-14	MBMS_LTE_enh2-Core		RAN2	RAN4		
R1-1611052	LS on Multipath RSTD reporting and CRS usage together with PRS	RAN1, Ericsson, Intel	Rel-14	UTRA_LTE_iPos_enh2-Core		RAN2			
R1-1611053	LS on FeMTC VoLTE enhancements	RAN1, Huawei	Rel-14	LTE_feMTC-Core		RAN2	RAN3, RAN4		
R1-1611054	LS on implication of sTTI operation on UL ON/OFF time mask	RAN1, Ericsson	Rel-15	LTE_sTTIandPT-Core		RAN2, RAN4			

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1611055	LS On Shortened TTI and processing time for LTE	RAN1, Ericsson	Rel-15	LTE_sTTIandPT-Core		RAN4			
R1-1611056	Reply LS on A New PRACH Cyclic Shift Restriction Set	RAN1, Huawei	Rel-14	LTE_high_speed-Core		RAN2, RAN4			
R1-1611057	LS for Voice and Video enhancement for LTE	RAN1, Huawei	Rel-14	LTE_VoLTE_ViLTE_enh-Core	R1-163371	RAN4, RAN2			
R1-1611066	LS on RAN1 agreements potentially related to RAN2/4 in LTE-based V2X services	RAN1, LGE	Rel-14	LTE_V2X-Core		RAN2			

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex C-2: List of Incoming LSs from RAN1 #86bis

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1608564	LS Response on QoS requirements for V2X	RAN2, Intel	Rel-14	LTE_SL_V2V-Core	S2-163081	SA1, SA2	RAN1, RAN3	R2-165773	
R1-1608565	LS on Support of CAT 9/10 and CAT 13	RAN2, Intel	Rel-12	TEI12		RAN1		R2-165924	
R1-1608566	LS on Exceptional Pool Handling for V2X	RAN2, OPPO	Rel-14	LTE_SL_V2V-Core		RAN1		R2-165962	
R1-1608567	LS on Timing reference for LAA SCell	RAN2, LGE	Rel-14	LTE_eLAA-Core		RAN4	RAN1	R2-165965	
R1-1608568	LS on further mobility enhancements	RAN2, ZTE	Rel-14	LTE_eMob-Core		RAN1, RAN3, RAN4		R2-165969	
R1-1608569	LS on RAN2 agreements on FeMBMS	RAN2, Qualcomm	Rel-14	MBMS_LTE_enh2-Core		RAN WG1		R2-165970	
R1-1608570	Reply LS on ECID positioning for TDD	RAN2, CATT	Rel-13	TEI13	R1-161518	RAN1, RAN3, RAN4	RAN5	R2-165974	
R1-1608571	LS on introduction of new UL categories in Rel-13	RAN2, Qualcomm	Rel-13	TEI13		RAN	RAN1	R2-165975	
R1-1608572	LS on CSI measurement ambiguity in LAA	RAN4, LGE	Rel-13	LTE_LAA-Perf		RAN1		R4-165659	
R1-1608573	Response LS on Modelling and simulation of IMT networks for use in sharing and compatibility studies	RAN4, Ericsson	Rel-14	FS_NR_newRAT	LS_EOs_5D_234_temp_125R1	RAN	RAN1	R4-166674	
R1-1608574	LS on Characteristics of terrestrial IMT systems for frequency sharing/interference analysis in the frequency range between 24.25 GHz and 86 GHz	RAN4, Nokia	Rel-14	FS_NR_newRAT	RP-160508	RAN	RAN1	R4-166734	
R1-1608575	Reply LS on blind detection evaluations	RAN4, MediaTek	Rel-14	LTE_MUST		RAN1		R4-166811	
R1-1608576	Reply LS on the feasibility of mobility enhancement solutions	RAN4, Ericsson, ZTE	Rel-14	LTE_eMob-Core	R2-163135, R2-164565	RAN2	RAN1, RAN3	R4-166817	
R1-1608577	Reply LS on SRS carrier switching interruption time	RAN4, Huawei	Rel-14	LTE_SRS_switch-Core	R1-163453	RAN1		R4-166913	
R1-1608578	LS on Measurement gap enhancement	RAN4, Ericsson, Intel	Rel-14	LTE_meas_gap_enh-Core		RAN2	RAN1	R4-167024	
R1-1608579	LS for definition of SSTF measurement	RAN4, CATT	Rel-12	LTE_SC_enh_dualC		RAN1	RAN2, RAN5	R4-167153	
R1-1608580	LS on on UCG parameters for eMTC	RAN4, Intel	Rel-13	LTE_MTCe2_L1-Core		RAN1, RAN2		R4-167198	

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1608581	LS on LTE Rel-13 UE feature list	RAN4, Qualcomm, Intel	Rel-13			RAN2	RAN, RAN1	R4-167200	
R1-1608582	Reply LS on QoS requirements for V2X	SA2, LGE	Rel-14	LTE_SL_V2V-Core	R2-165773	RAN2	SA1, RAN1, RAN3	S2-164913	
R1-1608583	Reply LS on NR requirements	RAN, ZTE	Rel-14	FS_NG_SReq	R2-165967	RAN2	RAN1	RP-161916	
R1-1610565	LS on Multi-carrier enhancements for UMTS	RAN2, Ericsson	Rel-14	UTRA_MCe-Core		RAN4	RAN1	R2-167169	
R1-1610680	LS on TTI switching for MC enhancements	RAN2, Huawei	Rel-14	UTRA_MCe-Core		RAN1, RAN3		R2-167171	
R1-1610765	LS on RAN2 agreements on FeMBMS	RAN2, Ericsson	Rel-14	MBMS_LTE_enh2-Core		RAN1		R2-167204	
R1-1610766	LS to RAN1 on V2V agreements	RAN2, LGE	Rel-14	LTE_SL_V2V-Core		RAN1		R2-167188	
R1-1610798	LS on DFN offset	RAN2, Huawei	Rel-14	LTE_V2X-Core		RAN1		R2-167189	

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex D: List of Approved updated WIDs

None

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex E: List of draft TSs/TRs agreed at RAN1 #86bis

Tdoc Number	Title	Source	Conclusion/Decision

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex F: List of actions

- Outgoing LS.

[86-21] Asbjorn (Ericsson)

LS to RAN2 about NE initial access and mobility

Email approval until 1st September to tell the current RAN1 agreements and WA to RAN2

Done: Final LS is agreed in [R1-168214](#) as per Mr Chair's decision posted on Sept 2nd.

- CR approval

None

- Text proposal for TS and TR

None

- Miscellaneous

[86b-01] Peter (Qualcomm)

[R1-1610413](#) Introduction of new Transport Block Size for DL 256QAMQualcomm

Email approval until Oct. 27th.

Done:

[86b-02] Peter (Qualcomm)

[R1-1610094](#) Clarification on a few PUCCH format 4 and 5 related issues in eCA Qualcomm

The 1st and 3rd issues are for email discuss till 21st Oct.

Done:

[86b-03] Seonwook (LGE)

[R1-1610852](#) Correction on PDCCH candidate configuration LG Electronics 36.213 (Rel-13)

[R1-1610853](#) Correction on PDCCH candidate configuration LG Electronics 36.213 (Rel-14)

Email approval for [R1-1610852](#) and [R1-1610853](#) till 21st Oct.

Done:

[86b-04] Zhisong (ZTE)

[R1-1609552](#) Introduction of RACHless handover for Further mobility enhancement in LTE ZTE Corporation

Email approval until 20th October

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Done:

[86b-05] Editors
MUST CRs

Editors (36.201, 211, 212, 213, 214) will provide draft CRs including agreements and WA until 10th Nov. (Thu)

Rapporteur will provide agreements list until 17th Oct.

All proponents are recommended to check the CRs until the next meeting

Done:

[86b-06] Editors

Further indoor positioning enh. CRs

Editors (36.201, 211, 212, 213, 214) will provide draft CRs including agreements and WA until 10th Nov. (Thu)

Rapporteur will provide agreements list until 17th Oct.

All proponents are recommended to check the CRs until the next meeting

Done:

[86b-07] Editors

SRS carrier based switching CRs

Editors (36.201, 211, 212, 213, 214) will provide draft CRs including agreements and WA until 10th Nov. (Thu)

Rapporteur will provide agreements list until 17th Oct.

All proponents are recommended to check the CRs until the next meeting

Done:

[86b-08] Editors

High speed CRs

Editors (36.201, 211, 212, 213, 214) will provide draft CRs including agreements and WA until 10th Nov. (Thu)

Rapporteur will provide agreements list until 17th Oct.

All proponents are recommended to check the CRs until the next meeting

Done:

[86b-09] Hoondong (Samsung)

Quantized Advanced CSI Feedback Structure for eFD-MIMO

Email discussion considering the two proposals and any possible refinement/updates/merging (including [R1-1611018](#)), until 27th October

Done:

[86b-10] Jonghyun (LGE)

QCL issue for aperiodic CSI-RS for eFD-MIMO

Email discussion until 20th Oct.

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Done:

[86b-11] Jonghyun (LGE)
Remaining details on PDSCH rate matching for eFD-MIMO
Email discussion until 20th Oct.

Done:

[86b-12] Siva (Ericsson)
Aperiodic CSI-RS selection for eFD-MIMO
Email discussion until 27th Oct.

Done:

[86b-13] Yuichi (DOCOMO)
Hybrid CSI Mechanism for eFD-MIMO
Email discussion until 20th Oct.

Done:

[86b-14] Youngwoo (Samsung)
PUSCH CSI reporting for hybrid CSIRS mechanism 1 for eFD-MIMO
Email discussion until 27th Oct.

Done:

[86b-15] Hao
eMIMO-Types for eFD-MIMO
Email discussion until 27th Oct.

Done:

[86b-16] Olof (Ericsson)
TBS/N_{SF} and TBS/N_{RU} tables for eNB-IoT
Email discussion until 21st October

Done:

[86b-17] Wang Yi (Huawei)
LLS and SLS simulation results for NR MA
Email approval until 21st Oct.

Done:

[86b-18] Joseph (Qualcomm)

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

R1-1611059 **Way Forward on Data Sharing** **Qualcomm**
Email discussion until 20th October

Done:

[86b-19] Ruyue (ZTE)
NR MIMO calibration
Email discussion until 28th Oct.

Done:

[86b-20] David (Huawei)
Synchronization and carrier rasters for NR
Email discussion until 7th Nov.

Done:

[86b-21] Stefan (Ericsson)
DL L1/L2 cont. channel design for NR
Email discussion until 7th Nov.

Done:

[86b-22] Stefan (Ericsson)
UL L1/L2 cont. channel design for NR
Email discussion until 7th Nov.

Done:

[86b-23] David (Huawei)
R1-1611036 **WF on DL control channel design** **Huawei, HiSilicon**
Email discussion until 7th Nov.

Done:

[86b-24] Kazuaki (DOCOMO)
Channel model for NR
Email discussion/approval until 21th Oct..

Done:

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex G: List of participants at RAN1 #86bis

Please see excel file attached to this report

**3GPP TSG RAN WG1 Meeting #87
Reno, USA, 14th – 18th November 2016**

R1-16xxxxx

Annex H: TSG RAN WG1 meetings in 2016 – 2017

TITLE	TYPE	DATES	LOCATION	CTRY
<u>3GPPRAN1#87</u>	<u>WG</u>	14 – 18 Nov 2016	Reno	US
<u>3GPPRAN1-NR</u>	<u>AH</u>	16 – 20 Jan 2017	TBD	US
<u>3GPPRAN1#88</u>	<u>WG</u>	13 – 17 Feb 2017	Athens	Greece
<u>3GPPRAN1#88bis</u>	<u>WG</u>	03 – 07 Apr 2017	TBD	US
<u>3GPPRAN1#89</u>	<u>WG</u>	15 – 19 May 2017	TBD	China
<u>3GPPRAN1-NR</u>	<u>AH</u>	27 – 30 Jun 2017	TBD	China
<u>3GPPRAN1#90</u>	<u>WG</u>	21 – 25 Aug 2017	Prague (TBC)	Rep Czech
<u>3GPPRAN1#90bis</u>	<u>WG</u>	09 – 13 Oct 2017	Prague (TBC)	Rep Czech
<u>3GPPRAN1#91</u>	<u>WG</u>	27 Nov – 01 Dec 2017	TBD	US

MEETING TYPES

AH = Ad Hoc

JM = Joint

PM = Preparatory Meeting

RM = Resolution Meeting

ST = Startup Meeting

WG = Working Group

CM = Chairmen's meeting

OR = Ordinary

RG = Rapporteurs Group

SG = Steering Group

TG = Task Group

XO = Extraordinary

End of document