**3GPP TSG RAN WG1 #112bis-e R1-2303652**

**e-Meeting, April 17th – April 26th, 2023**

**Agenda Item: 9.17.4**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for NR NCR**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion/approval [112bis-e-R18-UE\_features-01] during RAN1 #112bis-e. According to the Chairman’s Notes:

|  |
| --- |
| [112bis-e-R18-UE\_features-01] Email discussion on UE features for NR NCR by April 26 – Ralf (AT&T)* Check points: April 21, April 26
 |

The following was discussed and/or agreed during RAN1 #112bis-e within the scope of [112bis-e-R18-UE\_features-01]. All proposals are based on the rapporteur input provided in [1].

# Summary of Contributions Submitted to RAN1 #112bis-e

The following is the moderator’s summary of contributions submitted to RAN1 #112bis-e in this agenda item.

|  |  |
| --- | --- |
| Company | Summary |
| Rapporteur (ZTE) [1] |

|  |
| --- |
| **Agreement**The following is supported to deliver the information to characterize the supported physical beam of NCR-Fwd for access link: Option-2: The information is informed to gNB and NCR via OAM* Note-1: In this option, how to characterize the beam information is based on implementation (e.g., declaration from NCR vendor).
* Note-2: In this option, the beam(s) used by NCR-Fwd for access link is configured for gNB and NCR by OAM based on implementation.
	+ The beam index in SCI corresponds to the configured beam(s) sequentially.
 |

According to the agreement above, the information to characterize the physical beams for access link is informed to gNB and NCR via OAM. In addition, ON-OFF behavior of NCR-Fwd is implicitly determined by access link beam indication, therefore, the ON-OFF related capability of NCR-Fwd can also be informed to NCR and gNB via OAM. As for backhaul link beam indication, since the TCI state is selected from the same RRC configured list for NCR-MT, the corresponding capability can be defined for NCR-MT and reported via legacy RRC signalling.In summary, the information exchange/delivering for the NCR-Fwd relevant capabilities including beam and ON-OFF can be delivered via implementation and there’s no need to define UE features for NCR-Fwd reported via RRC signalling.***Proposal 1:*** *No need to define UE features for NCR-Fwd reported via RRC signalling.*New UE features for NCR-MTIn normative phase, the side control information and associated signalling for NCR have been specified, including periodic, semi-persistent and aperiodic beam indication for access link, and dedicated MAC CE signalling for backhaul link, while NCR is ON within the time domain resource indicated in the access link beam indication. From NCR-MT’s perspective, the capabilities for reception of these side control information should be defined.For periodic beam indication, it can be used to forward periodic signals including common and UE specific signals and for aperiodic beam indication, it can be used to forward the dynamically scheduled signals based on UE’s traffic. So, the reception of periodic and aperiodic indication should be defined as mandatory UE features for NCR-MT.For semi-persistent beam indication for access link, it can be used as a supplementary in addition to periodic indication to forward the periodic signals which can be activated or deactivated. Then it can be further studied whether this feature can be mandatory or optional. In addition, it has been agreed that the MAC CE can optionally provide update for the Zy beam index configured in RRC, then the beam index update should be an separate optional capability for NCR-MT.Moreover, in RAN1#110bis-e meeting, the following agreements have been achieved on defining the NCR capabilities for simultaneous UL transmission of C-link and backhaul link, adaptive beam for C-link/backhaul link and new signalling for backhaul link. In addition, corresponding to adaptive beam, the fixed beam for C-link/backhaul link is default capability. It’s also agreed that simultaneous UL transmission of C-link and backhaul link should be NCR capability, and TDMed UL transmission of C-link and backhaul link is default capability.If adaptive beams are adopted for C-link and backhaul link, new signaling via MAC CE can be optionally supported to indicate a beam(s) used for backhaul link from the set of beams for C-link, the new signalling is agreed as an optional NCR capability.

|  |
| --- |
| **Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link

AgreementIf adaptive beams are adopted for C-link and backhaul link, new signaling is supported to indicate a beam(s) used for backhaul link from the set of beams for C-link.* Predefined rule is used to define the beam in case there is no indication via the new signalling
	+ FFS: Details of the predefined rule
	+ FFS: Application of predefined rule for other cases
* Note: The beam(s) used for backhaul link should be from the RRC-configured list of beams for C-link.
* The new signalling, if needed, is an optional NCR capability
 |

For those capabilities agreed for backhaul link and C-link, since it’s more related to the NCR-MT’s behavior, it’s better to define these capabilities as NCR-MT’s UE features informed to gNB via RRC signalling.***Proposal 2:*** *Adopt the following new feature groups for NCR-MT.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Features*** | ***Index*** | ***Feature group*** | ***Components*** | ***Prerequisite feature groups*** | ***Applicable to the capability signalling exchange between UEs (Sidelink WI only)”.*** | ***Need for the gNB to know if the feature is supported*** | ***Consequence if the feature is not supported by the UE*** | ***Type(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)*** | ***Need of FDD/TDD differentiation*** | ***Need of FR1/FR2 differentiation*** | ***Capability interpretation for mixture of FDD/TDD and/or FR1/FR2*** | ***Note*** | ***Mandatory/Optional*** |
| *43. NR\_netcon\_repeater* | *43-1* | *Periodic beam indication for access link* | *1.Support periodic beam indication for access link* |  | *n/a* | *No* | *NCR-MT cannot decode the periodic beam indication* | *Per NCR-MT* | *No* | *No* | *Support* |  | *Mandatory without capability signaling* |
| *43-2* | *Aperiodic beam indication for access link* | *1.Support aperiodic beam indication for access link* |  | *n/a* | *No*  | *NCR-MT cannot decode the aperiodic beam indication* | *Per NCR-MT* | *No*  | *No*  | *Support* |  | *Mandatory without capability signaling* |
| *43-3* | *Semi-persistent beam indication for access link* | *1.Support semi-persistent beam indication for access link* |  | *n/a* | *[Yes/No]*  | *NCR-MT cannot decode the periodic beam indication* | *Per NCR-MT* | *No*  | *No*  | *Support* |  | *[Mandatory without/Optional with] capability signaling* |
| *43-3a* | *Beam index updates for semi-persistent beam indication* | *1.Support to update the beam index(es) in semi-persistent beam indication* | *43-3* | *n/a* | *Yes* | *The semi-persistent beam indication cannot provide updates for the beam index(es).* | *Per NCR-MT* | *No* | *No* | *Support* |  | *Optional with capability signaling* |
| *43-4* | *Adaptive beam for NCR backhaul link/C-link* | 1. *Support adaptive beam for NCR C-link*
2. *Support adaptive beam for NCR backhaul link*
 |  | *n/a* | *Yes* | *The beam for backhaul link and C-link is fixed.* | *Per NCR-MT* | *No* | *No* | *Support* |  | *Optional with capability signaling* |
| *43-5* | *Simultaneous UL transmission of backhaul link and C-link* | *1. Simultaneous UL transmission of backhaul link and C-link* |  | *n/a* | *Yes* | *NCR only supports TDMed UL transmission of C-link and backhaul link* | *Per NCR-MT* | *No* | *No* | *Support* |  | *Optional with capability signaling* |
| *43-6* | *Dedicated signalling for backhaul link beam indication* | *1. Support dedicated signalling for backhaul link beam indication* | *43-4* | *n/a* | *Yes* | *The beam for backhaul link follows predefined rule.* | *Per NCR-MT* | *No* | *No* | *Support* |  | *Optional with capability signaling* |

Furthermore, there is a pending issue on how to define the reference of slot offset for each time resource for aperiodic beam indication, which may have impact on UE features.

|  |
| --- |
| **Agreement**For the aperiodic beam indication, the reference of slot offset for each time resource is defined as the slot n+k where n refers to the slot that NCR-MT receive the DCI carrying the indication and:* Option-2: k refers to the offset value [defined by NCR-MT capability and/or declared by vendor].
	+ Note: This k is different from the parameter used to define the Slot offset for the time resource.
 |

According to the agreement above, down-selection is required to define the offset value k, which can be defined by NCR-MT capability and/or declared by vendor. The offset value k may come from the timing in several parts, e.g., DCI decoding time of NCR-MT, MT to Fwd inter-module delay, potential ON-OFF or beam switching time of NCR-Fwd, it’s difficult to define the offset value as NCR-MT’s capability. Thus it’s more straightforward to go with the other direction, i.e., the offset value k can be declared by vendor by considering all possible impacted factors.***Proposal 3:*** *For the aperiodic beam indication, the reference of slot offset for each time resource is defined as the slot n+k where n refers to the slot that NCR-MT receive the DCI carrying the indication and k refers to the offset value declared by vendor.** *Note: No need to define new capability for the offset value k.*

Existing mandatory UE features for NCR-MT

|  |
| --- |
| RAN1#111AgreementAs optional functionalities for the NCR-MT, at least Rel-15 legacy BFD/BFR/RLM mechanisms are supported* FFS: The behavior of NCR-Fwd when BFR/RLF happen in C link.

Agreement* Legacy Rel-15 initial/random access procedure is supported for NCR-MTs in C link.
	+ Note: No additional enhancement is necessary from RAN1 point of view.
* The CRC bits of the PDCCHs carrying side control information are scrambled by a new dedicated RNTI
	+ Applicable only for NCR-MT

Agreement:For NCR-MT which can support adaptive beams in C link, * Rel-15 beam indication framework can be reused.
* Rel-17 beam indication framework (i.e., the unified TCI) can be reused as well. The gNB can configure the unified TCI for the NCR-MT, if the NCR-MT supports.
 |

Generally, NCR-MT is assumed to have simplified functionalities compared to legacy UE. Also, no additional complexity is expected compared to IAB-MT with the mandatory features defined in section 4. [2]. Meanwhile, BFD/BFR/RLM mechanisms have been agreed as optional functionalities in RAN1#111.Then, the mandatory feature defined in Table 1 seems enough for NCR-MT.

|  |  |  |  |
| --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** |
| 0. Waveform, modulation, subcarrier spacings, and CP | 0-1 | CP-OFDM waveform for DL and UL | 1) CP-OFDM for DL2) CP -OFDM for UL |
| 0-3 | DL modulation scheme | 1) QPSK modulation2) 16QAM modulation3) 64QAM modulation for FR1 |
| 0-4 | UL modulation scheme | 1) QPSK modulation2) 16QAM modulation |
| 1. Initial access and mobility | 1-1 | Basic initial access channels and procedures | 1) RACH preamble format2) SS block based RRM measurement3) Broadcast SIB reception including RMSI/OSI and paging |
| 2. MIMO | 2-1 | Basic PDSCH reception | 1) Data RE mapping2) Single layer transmission3) Support one TCI state |
| 2-5 | Basic downlink DMRS for scheduling type A | 1) Support 1 symbol FL DMRS without additional symbol(s)2) Support 1 symbol FL DMRS and 1 additional DMRS symbol3) Support 1 symbol FL DMRS and 2 additional DMRS symbols for at least one port. |
| 2-6 | Basic downlink DMRSfor scheduling type B | 1) Support 1 symbol FL DMRS without additional symbol(s)2) Support 1 symbol FL DMRS and 1 additional DMRS symbol |
| 2-12 | Basic PUSCH transmission | Data RE mappingSingle layer (single Tx) transmissionSingle port, single resource SRS transmission (SRS set use is configured as for codebook) |
| 2-16 | Basic uplink DMRS (uplink) for scheduling type A | 1) Support 1 symbol FL DMRS without additional symbol(s)2) Support 1 symbol FL DMRS and 1 additional DMRS symbols3) Support 1 symbol FL DMRS and 2 additional DMRS symbols |
| 2-16a | Basic uplink DMRSfor scheduling type B | 1) Support 1 symbol FL DMRS without additional symbol(s)2) Support 1 symbol FL DMRS and 1 additional DMRS symbol |
| 2-32 | Basic CSI feedback | 1) Type I single panel codebook based PMI (further discuss which mode or both to be supported as mandatory)2) 2Tx codebook for FR1 and FR23) 4Tx codebook for FR14) 8Tx codebook for FR1 when configured as wideband CSI report7) a-CSI on PUSCH (at least Z value >= 14 symbols, detail processing time to be discussed separately)further check a-CSI on p-CSI-RS and/or SP-CSI-RS from component-7 |
| 2-50 | Basic TRS | 1) Support of TRS (mandatory)2) All the periodicity are supported. |
| 2-52 | Basic SRS | 1) Support 1 port SRS transmission2) Support periodic/aperiodic SRS transmission |
| 3. DL control channel and procedure | 3-1 | Basic DL control channel | 1) One configured CORESET per BWP per cell in addition to CORESET0- CORESET resource allocation of 6RB bit-map and duration of 1 – 3 OFDM symbols for FR1- For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSSs, CORESET resource allocation of 6RB bit-map and duration 1-3 OFDM symbols for FR2- For type 1 CSS with dedicated RRC configuration and for type 3 CSS, UE specific SS, CORESET resource allocation of 6RB bit-map and duration 1-2 OFDM symbols for FR2- REG-bundle sizes of 2/3 RBs or 6 RBs- Interleaved and non-interleaved CCE-to-REG mapping- Precoder-granularity of REG-bundle size- PDCCH DMRS scrambling determination- TCI state(s) for a CORESET configuration2) CSS and UE-SS configurations for unicast PDCCH transmission per BWP per cell- PDCCH aggregation levels 1, 2, 4, 8, 16- UP to 3 search space sets in a slot for a scheduled SCell per BWPThis search space limit is before applying all dropping rules.- For type 1 CSS with dedicated RRC configuration, type 3 CSS, and UE-SS, the monitoring occasion is within the first 3 OFDM symbols of a slot- For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS, the monitoring occasion can be any OFDM symbol(s) of a slot, with the monitoring occasions for any of Type 1- CSS without dedicated RRC configuration, or Types 0, 0A, or 2 CSS configurations within a single span of three consecutive OFDM symbols within a slot3) Monitoring DCI formats 0\_0, 1\_0, 0\_1, 1\_14) Number of PDCCH blind decodes per slot with a given SCS follows Case 1-1 table5) Processing one unicast DCI scheduling DL and one unicast DCI scheduling UL per slot per scheduled CC for FDD |
| 4. UL control channel and procedure | 4-1 | Basic UL control channel | 1) PUCCH format 0 over 1 OFDM symbols once per slot2) PUCCH format 0 over 2 OFDM symbols once per slot with frequency hopping as "enabled"3) PUCCH format 1 over 4 – 14 OFDM symbols once per slot with intra-slot frequency hopping as "enabled"5) One SR configuration per PUCCH group6) HARQ-ACK transmission once per slot with its resource/timing determined by using the DCI7) SR/HARQ multiplexing once per slot using a PUCCH when SR/HARQ-ACK are supposed to be sent by overlapping PUCCH resources with the same starting symbols in a slot8) HARQ-ACK piggyback on PUSCH with/without aperiodic CSI once per slot when the starting OFDM symbol of the PUSCH is the same as the starting OFDM symbols of the PUCCH resource that HARQ-ACK would have been transmitted on9) Semi-static beta-offset configuration for HARQ-ACK10) Single group of overlapping PUCCH/PUCCH and overlapping PUCCH/PUSCH s per slot per PUCCH cell group for control multiplexing |
| 4-10 | Dynamic HARQ-ACK codebook | Dynamic HARQ-ACK codebook |
| 5. Scheduling/HARQ operation | 5-1 | Basic scheduling/HARQ operation | 1) Frequency-domain resource allocation- RA Type 0 only and Type 1 only for PDSCH without interleaving- RA Type 1 for PUSCH without interleaving2) Time-domain resource allocation- 1-14 OFDM symbols for PUSCH once per slot- One unicast PDSCH per slot- Starting symbol, and duration are determined by using the DCI- PDSCH mapping type A with 7-14 OFDM symbols- PUSCH mapping type A and type B- For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS, PDSCH mapping type A with {4-14} OFDM symbols and type B with {2, 4, 7} OFDM symbols3) TBS determination4) Nominal UE processing time for N1 and N2 (Capability #1)5) HARQ process operation with configurable number of DL HARQ processes of up to 166) Cell specific RRC configured UL/DL assignment for TDD9) In TDD support at most one switch point per slot for actual DL/UL transmission(s)10) DL scheduling slot offset K0=012) UL scheduling slot offset K2<=12For type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS, interleaving for VRB-to-PRB mapping for PDSCH |
| 6. CA/DC, BWP, SUL | 6-1 | Basic BWP operation with restriction | 1) 1 UE-specific RRC configured DL BWP per carrier2) 1 UE-specific RRC configured UL BWP per carrier3) RRC reconfiguration of any parameters related to BWP4) BW of a UE-specific RRC configured BWP includes BW of CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP includes SSB for SCell if there is SSB on SCell |
| 7. Channel coding | 7-1 | Channel coding | 1) LDPC encoding and associated functions for data on DL and UL2) Polar encoding and associated functions for PBCH, DCI, and UCI3) Coding for very small blocks |
| 8. UL TPC | 8-3 | Basic power control operation | 1) Accumulated power control mode for closed loop2) 1 TPC command loop for PUSCH, PUCCH respectively3) One or multiple DL RS configured for pathloss estimation4) One or multiple p0-alpha values configured for open loop PC5) PUSCH power control6) PUCCH power control7) PRACH power control8) SRS power control9) PHR |

***Proposal 4:*** *NCR-MT supports the following layer-1 mandatory UE features defined in TR38.822.** *0-1, 0-3, 0-4, 1-1, 2-1, 2-5, 2-6, 2-12, 2-16, 2-16a, 2-32 (only components 1-4 and 7), 2-50 (only components 1,2), 2-52 (only components 1, 2), 3-1 (only components 1,2,3,4,5), 4-1, 4-10, 5-1 (only components 1/2/3/4/5/6/9/10/12), 6-1, 7-1, 8-3*

Revised existing UE features for NCR-MT

|  |
| --- |
| RAN1#111AgreementAs optional functionalities for the NCR-MT, at least Rel-15 legacy BFD/BFR/RLM mechanisms are supported* FFS: The behavior of NCR-Fwd when BFR/RLF happen in C link.

**Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link
 |

As shown in above agreement, the RLM mechanism is changed to an optional functionality for the NCR-MT, so FG 1-3, 1-7 for SSB/CSI-RS based RLM should be changed to optional.In addition, the existing UE features relevant to beam management can only be supported optionally if adaptive beam is supported, for example, in Rel-15, FG 2-21 periodic and FG 2-22 aperiodic beam report are mandatory features, but those features should be changed to optional since beam report is useless if backhaul/C-link beam is fixed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Prerequisite feature groups** | **Mandatory/Optional** | **Additional information** |
| 1. Initial access and mobility | 1-3 | SS block based RLM | 1-1 | Mandatory with capability signalling which shall be set to '1'Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR. |
| 1-7 | CSI-RS based RLM | 1-1, CSI-RS | Mandatory with capability signallingOptional with capability signalling for NCR | This FG is optional with capability signalling for NCR. |
| 2. MIMO | 2-21 | Periodic beam report | 43-4 for NCR | Mandatory with capability signalling for both FR1 and FR2Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-22 | Aperiodic beam report | 43-4 for NCR | Mandatory with capability signalling for both FR1 and FR2Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-23 | Semi-persistent beam report on PUCCH | 43-4 for NCR | Optional with capability signalling | FG 43-4 should be added in the prerequisite feature group. |
| 2-23a | Semi-persistent beam report on PUSCH | 43-4 for NCR | Optional with capability signalling | FG 43-4 should be added in the prerequisite feature group. |
| 2-24 | SSB/CSI-RS for beam measurement | 2-21, 2-22 or 2-23, 2-23a43-4 for NCR | Mandatory with capability signallingComponent-1, candidate value set for MB\_1 is {0, 8, 16, 32, 64}On FR2, UE is mandated to signal MB\_1 >=8On FR1, MB\_1 >=8 is supported mandatory with capability signalling.Component-2, candidate value set for MC\_1 is {0, 4, 8, 16, 32, 64}For FR1, UE is mandated to report at least 8.Component-3, candidate value set for MB\_2 is {0, 4, 8, 16, 32, 64}Component-4: candidate value set:{"not supported", "1 only", "3 only", "both 1 and 3"}On FR2, UE is mandated to signal either "3 only" or "both 1 and 3"On FR1, either "3 only" or "both 1 and 3" is mandatory with UE capability signalling.Component-5, candidate value set for MD\_2 is {0, 1, 4, 8, 16, 32, 64}For both FR1 and FR2, UE is mandated to report at least 4Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-25 | Beam reporting timing | 2-2443-4 for NCR | Mandatory with capabilitCandidate value sets:X1 is {2, 4, 8}X2 is {4, 8, 14, 28}X3 is {8,14, 28}X4 is{14,28, 56}Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-26 | Receiving beam selection using CSI-RS resource repetition "ON" | 43-4 for NCR | Mandatory with UE capability at least for FR2Componet-2: candidate value set {2, 3, 4, 5, 6, 7, 8}Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-27 | Beam switching | 2-2443-4 for NCR | Optional with capability signallingCandidate value set: {4, 7, 14} | FG 43-4 should be added in the prerequisite feature group. |
| 2-28 | A-CSI-RS beam switching timing | 43-4 for NCR | Optional with capability signallingCandidate values:{14, 28, 48, 224, 336} | FG 43-4 should be added in the prerequisite feature group. |
| 2-29 | Non-group based beam reporting | 43-4 for NCR | Mandatory with capability for both FR1 and FR2candidate value set is {1, 2, 4}Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-29a | Group based beam reporting | 43-4 for NCR | Optional with capability signalling | FG 43-4 should be added in the prerequisite feature group. |
| 2-30 | Uplink beam management | 43-4 for NCR | Optional with capability signalling- Capability signalling shall be set to 1 if 2-20 is set to 0- For the UE meeting the minimum peak EIRP and spherical coverage requirements without the uplink beam sweeping, this feature is optionalComponent-2, candidate value set is {2, 4, 8, 16}Component-3, candidate value set is {from 1 to 8} | FG 43-4 should be added in the prerequisite feature group. |
| 2-31 | Beam failure recovery | 1-7 for CSI-RS based BFD/BFR43-4 for NCR | Mandatory with capability signalling for FR2Optional with capability signalling for FR1Component-1 candidate value set: {from 1 to 16}Component-2 candidate: {from 1 to 16}Component-3:Candidate value set is: {from 1 to 128}UE is mandated to support at least 32 for FR2Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-59 | Configured spatial relations | 43-4 for NCR | Candidate value set: {4, 8, 16, 32, 64, 96}UE is mandated to report 16 or higher values.Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-60 | Active spatial relations | 2-5943-4 for NCR | Mandatory with capability signallingCandidate value set: {1, 2, 4, 8, 14}Optional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-61 | Additional active spatial relation for PUCCH | 2-6043-4 for NCR | Mandatory with capability signallingOptional with capability signalling for NCR | This FG is optional with capability signalling for NCR.FG 43-4 should be added in the prerequisite feature group. |
| 2-62 | Max number of downlink RS resources used for QCL type-D in the active TCI states and active spatial relation info | 2-4, 2-4a and 2-6043-4 for NCR | Optional with capability signallingCandidate value set: {1,2,4,8, 14} | FG 43-4 should be added in the prerequisite feature group. |

Based on above, the following is proposed:***Proposal 5:*** *The beam management related UE features (i.e., FG 2-21~FG 2-31 and FG 2-59~FG 2-62 in Rel-15) as defined in TR38.822 should be revised for NCR-MT as follows:** *The mandatory features for beam management should be changed to optional.*
* *FG 43-4 Adaptive beam for NCR backhaul link/C-link should be added in the prerequisite feature group.*

2.2.4 Not supported UE features for NCR-MT

|  |
| --- |
| AgreementFor the flexible symbol based on the semi-static configuration (e.g., TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated), the default behavior of the NCR-Fwd is expected to be OFF or not forwarding over these symbols* FFS: The behavior over these symbol if dynamic DL/UL operation is supported by NCR-MT and/or NCR-Fwd.

ConclusionFor the flexible symbol based on the semi-static configuration (e.g., TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated), the dynamic DL/UL operation of NCR-MT and NCR-Fwd is not supported in Rel-18. |

As agreed in RAN1#111, the dynamic DL/UL operation of NCR-MT and NCR-Fwd is not supported in Rel-18, therefore, the dynamic DL/UL operation related UE features are not supported for NCR.

| **Features** | **Index** | **Feature group** | **Components** | **Additional information** |
| --- | --- | --- | --- | --- |
| 3. DL control channel and procedure | 3-6 | Dynamic SFI monitoring | Adjust periodic and semi-persistent signal reception and transmission in response to detected dynamic UL/DL configuration | This FG is not supported for NCR. |
| 5. Scheduling/HARQ operation | 5-1 | Basic scheduling/HARQ operation | 7) Dynamic UL/DL determination based on L1 scheduling DCI with/without cell specific RRC configured UL/DL assignment | Component 7 of this FG is not supported for NCR. |
| 5-1a | UE specific RRC configure UL/DL assignment | Dynamic UL/DL determination based on L1 scheduling DCI with cell-specific and UE specific RRC configured UL/DL assignment | This FG is not supported for NCR. |

***Proposal 6:*** *The dynamic DL/UL operation related UE features FG 3-6, FG 5-1a and Component 7 of FG 5-1 are not supported for NCR.* |
| vivo [2] | **NCR-Fwd features** In RAN1, several features were discussed and supported for NCR-Fwd, including beam control, ON-OFF control, TDD, timing, C-link and backhaul link multiplexing and so on. The features should be further categorized and defined as optional or mandatory feature to easy the implementation.**Beam control**For the beam control, both backhaul link (BH) beam control and access link (AL) beam control are supported. For BH beam control, either fixed beam or adaptive beam can be used, where the adaptive BH beam is determined based on either explicit indication or implicit rule. From implementation perspective, only one of the fixed beam and the adaptive beam may be implemented by vendor, thus it is beneficial to support an optional feature for adaptive BH beam determination.**Proposal 1: Support an optional feature for adaptive BH beam determination, including explicit BH beam indication and implicit BH beam determination.**For the AL beam indication, it is straightforward to define a feature group which includes periodic indication, semi-persistent indication and aperiodic indication. Since the AL beam indication controls the ON operation of the NCR (without AL beam indication the NCR is always OFF by default), it is reasonable to define this AL beam indication feature as mandatory feature. **Proposal 2: Support a mandatory feature group for access beam indication, including periodic indication, semi-persistent indication and aperiodic indication.****ON-OFF control**For the ON-OFF control, since no dedicated signaling or procedure is specified for the ON state indication, a feature for the OFF state determination is sufficient and the feature group includes the following functions. * The NCR is off on the time resource where AL beam indication is not applied.
* If BF is detected by C-link, the NCR is off before BF is covered.
* For the symbols semi-statically configured as flexible, the NCR is off on these symbols.

Since the OFF state determination is the basic operation of NCR, it is preferred to define a mandatory feature for the OFF state determination. Considering ON-OFF state as tightly correlated and the ON state determination is based on AL beam indication, it is preferred to define a unified feature for AL beam indication and ON-OFF state determination.**Proposal 3: Support a mandatory feature for OFF state determination, and the feature can be merged to AL beam indication feature group as a unified feature group.****TDD** The determination of TDD configuration can be an optional feature for the NCR-Fwd. The reasons are listed as following* TDD UL-DL configuration is required for the operation on TDD band, while for the operation on FDD band, NCR does not need to know any TDD configuration.
* Even for TDD band, NCR can still acquire TDD configureation via OAM.

**Proposal 4: Support an optional feature for TDD determination of NCR-Fwd.****Timing** The determination of timing is basic function for NCR, thus a mandatory feature should be defined.**Proposal 5: Support a mandatory feature for NCR-Fwd timing determination.****C-link and BH link multiplexing** **110b Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link

In RAN1#110bis meeting, it has been agreed that TDMed UL transmission of C-link and backhaul link is default capability and optionally NCR capability can support simultaneous UL transmission of C-link and backhaul link. To reflect such NCR capability, it is preferred to define an optional feature for this.**Proposal 6: Support an optional feature for simultaneous UL transmission of C-link and backhaul link.****NCR-MT features**Besides the features defined for NCR-Fwd, the features for NCR-MT should be defined. Regarding the NCR-MT features, the NCR-MT should inherit the UE features from a normal UE, and RAN1 should focus on the discussion on which mandatory UE features of a normal UE can be set as optional feature for NCR-MT considering that NCR-MT can be a simplified UE. **Proposal 7: RAN1 should focus on the discussion on which mandatory UE features of a normal UE can be set as optional feature for NCR-MT**Similar as the discussion for IAB-MT features, the Rel-15 mandatory UE feature [1] without capability signaling or mandatory UE feature with capability signaling set as “1” can be the baseline for further discussion to set NCR-MT mandatory feature. **FG 0: Waveform and modulation**For FG 0-1/0-2/0-3/0-4, since these waveform and modulation features are always needed, thus NCR-MT should support these feature as mandatory as well. **FG 1: Initial access and mobility**For FG 1-1/1-3, considering the NCR-MT also supports initial access, FG 1-1 should be mandatory; and considering the NCR-MT also performs radio link monitoring, especially when NCR is deployed with lower elevation and the channel condition varies, FG 1-3 should also be mandatory for NCR-MT. **FG 2: MIMO**For FG 2-1, the feature ensure basic PDSCH reception, which should be mandatory for NCR-MT. For FG 2-5/2-6, since the NCR-MT DL does not requires complicated scheduling scheme considering normal data transmission is not expected in the C-link, only one of the FG 2-5/2-6 is sufficient for DL DMRS. For FG 2-12/FG 2-16/2-16a, the feature ensure basic PUSCH reception which should be mandatory for NCR-MT considering that at least initial access procedure requires PUSCH transmission. Moreover, only one of the FG 2-16/2-16a is sufficient for UL DMRS mapping. For FG 2-32, CSI feedback feature is included in this FG, this FG seems not necessary for NCR-MT, since only control information is transmitted between gNB and NCR-MT and lower MCS can be always used for control signaling transmission. For the same reason as for FG 2-32, FG 2-52 for basic SRS can also be set as optional feature for NCR-MT. For FG 2-50, since TRS is beneficial to improve receiver decoding performance, basic component of 2-50 can be mandatory for NCR-MT, e.g., component 1 of FG 2-50. **Proposal 8: RAN1 should discuss whether CSI feedback and SRS are mandatory or optional for NCR-MT.****FG 3: DL control channel and procedure**For the FG 3-1, the FG enables basic DL control channel reception, which should be supported as mandatory feature. Moreover, DCI format 5-0 is defined to carry side control information, monitoring of DCI format 5-0 should also be mandatory for NCR-MT.**FG 4: UL control channel and procedure**For FG 4-1, the FG enables basic UL control channel reception. Since CSI feedback may be not mandatory for NCR-MT as discussed above, it is reasonable to at least define a subset of components in FG 4-1 as mandatory. In our opinion, at least component 1-6 can be baseline for further discussion to support basic HARQ-ACK feedback and SR functionality. For FG 4-10, RAN1 should further discuss whether codebook based HARQ-ACK feedback is mandatory for NCR-MT or not, since only some control information is transmitted via C-link, such feature may not be popular for NCR-MT.**FG 5: Scheduling and HARQ**For FG 5-1, the FG describes basic scheduling/HARQ operation, considering complicated scheduling scheme may be not required for NCR-MT since only control information is to be transmitted via C-link, only a set of components need to be set as mandatory, e.g., components 1/2/3/4/5/6/7/9/10/12 as for IAB-MT.**Other FG** For FG 6-1, Basic BWP operation should be mandatory for NCR-MT. For FG 7-1, channel coding should be mandatory for NCR-MT. For FG 8-3, basic power control operation should be mandatory for NCR-MT.**Proposal 9: RAN1 at least considers the following FGs for normal UE as NCR-MT mandatory features.*** **FG 0-1, FG 0-2, FG 0-3, FG 0-4**
* **FG 1-1, FG 1-3**
* **FG 2-1, one of the FG 2-5/2-6, FG 2-12, one of FG 2-16/2-16a, FG 2-50 (FFS which components are mandatory)**
* **FG 3-1 including reception of DCI format 5-0**
* **FG 4-1 (FFS which components are mandatory)**
* **FG 5-1 (FFS which components are mandatory)**
* **FG 6-1**
* **FG 7-1**
* **FG 8-3**
 |
| Nokia, Nokia Shanghai Bell [3] | NCR nodes are supposed to be transparent to UEs, and hence no capability signaling from UEs is expected to support NCRs. However, similarly to IAB nodes, it is relevant to capture features supported for communication between NCR-MT and gNB.**Proposal: No UE capabilities are defined for support of NCR, but feature groups for communication between NCR node and gNB are defined in Rel-18.**Based on the agreements made so far in the WI, the following feature groups can be considered as a starting point for discussion:

|  |  |  |
| --- | --- | --- |
| FG | Description | Observations |
| NCR-1 | 1. Fixed beam for C-link/backhaul link
2. TDMed UL transmission of C-link and backhaul link
 | Basic capability for NCRPre-requisites: * RACH procedure and TA adjustment for the NCR-MT
* CSI-RS reception, CSI measurement and reporting by the NCR-MT
* SRS transmission by the NCR-MT
 |
| NCR-2 | Support for simultaneous UL transmission of C-link and backhaul link |  |
| NCR-3 | Support for adaptive beam for C-link/backhaul-link | Candidate values: {Rel15, Rel17, both} |
| NCR-4 | Support for periodic beam indication |  |
| NCR-5 | Support for semi-persistent beam indication |  |
| NCR-6 | 1. Support for aperiodic beam indication
2. Slot offset k
 | FFS Candidate values |
| NCR-7 | Support for explicit indication of backhaul beam | Optional feature |

 |
| Fujitsu [4] | Legacy featuresIn the legacy, a table of Layer-1 mandatory features (i.e. Table 4.2.15.1-1 in [1]) is introduced for IAB-MT. And the features outside the table are optional, unless stated otherwise.In general, the UE features for NCR can be defined in a similar manner to save discussion effort. Otherwise, we may need to go through all features one-by-one, which is inefficient.**Proposal 1: Define a new table of Layer-1 mandatory features for NCR. The features outside the table are optional, unless stated otherwise.**Furthermore, the table defined for IAB (Table 4.2.15.1-1 in [1]) can be the baseline for NCR. It should be changed at least based on some agreements/conclusions for NCR. For example:* Feature group 1-3 (SSB based RLM) should be removed since RLM is optional for NCR as per the agreement below.

|  |
| --- |
| **Agreement**As optional functionalities for the NCR-MT, at least Rel-15 legacy BFD/BFR/RLM mechanisms are supported* FFS: The behaviour of NCR-Fwd when BFR/RLF happen in C link.
 |

* Statements related to CA/DC in component 2) of feature group 3-1 and component 4) of feature group 6-1 should be removed, because it is the common understanding that NCR does not support CA/DC.
* Component 2) of feature group 2-23 should be changed to be “2) 2Tx codebook for FR1 and FR2-1”, because NCR does not support FR2-2 according to [R1-2302113](file:///C%3A%5C%5CUsers%5C%5Cjiangqinyan.G08%5C%5CDocuments%5C%5CWork%5C%5C3GPP%20Meetings%5C%5CRAN1%20Meeting%5C%5CRAN1%23112b-e%5C%5CDocs%5C%5CR1-2302113.zip) as below.

|  |
| --- |
| **Agreement**The RRC parameters and MAC CE parameters in [R1-2302113](file:///C%3A%5C%5CDocs%5C%5CR1-2302113.zip) are agreed. LS to RAN2 is agreed in [R1-2302227](file:///C%3A%5C%5CDocs%5C%5CR1-2302227.zip). |

* Component 7) of feature group 5-1 should be removed due to the following conclusion.

|  |
| --- |
| **Conclusion**For the flexible symbol based on the semi-static configuration (e.g., TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated), the dynamic DL/UL operation of NCR-MT and NCR-Fwd is not supported in Rel-18. |

Moreover, there are some other remaining issues to be clarified so that the final clean table can be defined for NCR.**Issue 1: FDD operation** During the discussion in previous meetings, the basic assumption is TDD. In our view, it is not clear whether NCR can operate in FDD bands or whether FDD is supported for NCR in Rel-18. If the FDD is not supported, component 5) of feature group 3-1 should be updated.**Issue 2: Discussion/check points in the legacy table for IAB**In Table 4.2.15.1-1 in [1] for IAB, there are still some discussion/check points. Whether the discussion/check points should be maintained in the new table for NCR need to be clarified/discussed. **Issue 3: Additional information for feature group 1-1**In Table 4.2.15.1-1 in [1] for IAB, there is additional information for feature group 1-1. However, the meaning of the additional information seems not clear, and NCR has no relevant discussion yet. The additional information should be clarified to check whether it should be maintained for NCR.Based on the discussions above, an example for NCR (with comments) is given in Table 1 in [4].**Proposal 2: For definition of the new table of Layer-1 mandatory features for NCR, take the table defined for IAB (Table 4.2.15.1-1 in [1]) as the baseline.** * **At least changes as below should be made based on previous agreements/conclusions for NCR.**
	+ **Remove feature group 1-3 (SSB based RLM).**
	+ **Remove statements related to CA/DC in component 2) of feature group 3-1 and component 4) of feature group 6-1.**
	+ **Change component 2) of feature group 2-23 to be “2) 2Tx codebook for FR1 and FR2-1”.**
	+ **Remove component 7) of feature group 5-1.**
* **Clarify the following aspects.**
	+ **Whether to support FDD.**
		- **If FDD is not supported for NCR, component 5) of feature group 3-1 should be updated for NCR.**
	+ **Whether to maintain the discussion/check points in Table 4.2.15.1-1 in [1] for NCR.**
	+ **The meaning of the additional information for feature group 1-1 and whether to maintain the information for NCR.**

New featuresC-link and BH-linkFor C-link and BH-link, some agreements which are related to UE feature discussion and corresponding comments are provided below.

|  |  |
| --- | --- |
| **Agreements** | **Comments** |
| **Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link
 | Two features should be defined according to the agreement:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
 |
| **Agreement­**If adaptive beams are adopted for C-link and backhaul link, new signaling is supported to indicate a beam(s) used for backhaul link from the set of beams for C-link.* Predefined rule is used to define the beam in case there is no indication via the new signalling
	+ FFS: Details of the predefined rule
	+ FFS: Application of predefined rule for other cases
* Note: The beam(s) used for backhaul link should be from the RRC-configured list of beams for C-link.
* The new signalling, if needed, is an optional NCR capability

**Agreement**For NCR-MT which can support adaptive beams in C link, * Rel-15 beam indication framework can be reused
* Rel-17 beam indication framework (i.e., the unified TCI) can be reused as well. The gNB can configure the unified TCI for the NCR-MT, if the NCR-MT supports.

**Agreement**The semi-static beam indication for backhaul link is supported as:* If the beam indication framework in Rel-15 is used for NCR-MT
	+ The DL beam is indicated by MAC CE to select one of TCI state ID from the RRC-configured list of beams for C-link
	+ The UL beam is indicated by SRI on C-link via MAC CE.
* If the beam indication framework in Rel-17 is used for NCR-MT
	+ The DL and UL beam are indicated by MAC CE to select one of TCI state ID from the RRC-configured list of beams for C-link
 | 1. Support of adaptive beams for C-link and BH-link is prerequisite condition of support of the new signalling (dedicated BH-link beam indication)2.Two features for the new signalling (i.e. dedicated BH-link beam indication) should be defined respectively for Rel-15/16 and Rel-17 framework (optional for NCR capability).* Dedicated BH-link beam indication when Rel-15/16 beam indication framework is used for C-link
* Dedicated BH-link beam indication when Rel-17 beam indication framework is used for C-link
 |
| **Agreement**For NCR-MT which can support adaptive beams in C link, * Rel-15 beam indication framework can be reused
* Rel-17 beam indication framework (i.e., the unified TCI) can be reused as well. The gNB can configure the unified TCI for the NCR-MT, if the NCR-MT supports.

**Agreement**The following pre-defined rules are applied to determine the beam for backhaul link:* In the time domain resource with simultaneous downlink reception or uplink transmission in C-link and backhaul link, the beam of backhaul link is the same as the beam of C-link regardless whether there is beam indicated by the dedicated signal for backhaul link.
* In the time domain resource without simultaneous downlink reception or uplink transmission in C-link and backhaul link, if the NCR does not support capability with the new signalling for backhaul beam indication or if no beam is indicated for backhaul link by the dedicated signal,
	+ When Rel-15/16 beam indication framework is used for C-link,
		- The beam determined by QCL assumption for CORESET with the lowest ID and spatial relationship for PUCCH with lowest PUCCH resource ID in the C-link is applied for the DL and UL of backhaul link, respectively.
	+ When Rel-17 beam indication framework (i.e., unified TCI framework) is used for C-link, the indicated unified TCI for C-link DL and UL is applied for the DL and UL of backhaul link, respectively.

Otherwise, the beam indicated by the dedicated signalling is applied for backhaul link.**Agreement**In the time domain resource without simultaneous downlink reception or uplink transmission in C-link and backhaul link, if the NCR does not support capability with the new signalling for backhaul beam indication or if no beam is indicated for backhaul link by the dedicated signal, * When Rel-17 beam indication framework is used for C-link,
	+ If no unified TCI is applied for C-link, the beam determined by QCL assumption for CORESET with the lowest ID and spatial relationship for PUCCH with lowest PUCCH resource ID in the C-link is applied for the DL and UL of backhaul link, respectively. (i.e. same as the default beam defined for Rel-15/16 beam indication framework)

If there is unified TCI applied for C-link, the indicated unified TCI for C-link DL and UL is applied for the DL and UL of backhaul link, respectively. | 1. Support of adaptive beams for C-link and BH-link is prerequisite condition of support of BH-link beam determination based on the pre-defined rule.2.Two features for BH-link beam determination based on the pre-defined rule should be defined respectively for Rel-15/16 and Rel-17 framework (optional for NCR capability).* Dedicated BH-link beam indication when Rel-15/16 beam indication framework is used for C-link
* Dedicated BH-link beam indication when Rel-17 beam indication framework is used for C-link
 |

As a summary, we have the following proposal.**Proposal 3: For NCR C-link and BH-link, define the following optional features.*** **Simultaneous UL transmission of C-link and BH-link**
	+ **If it is not supported, TDMed UL transmission of C-link and BH-link is assumed.**
* **Adaptive beam for C-link and BH-link**
	+ **If it is not supported, fixed beam for C-link and BH-link is assumed.**
* **Dedicated BH-link beam indication when Rel-15/16 beam indication framework is used for C-link**
	+ **It is optional only when adaptive beam for C-link and BH-link beam is supported.**
* **Dedicated BH-link beam indication when Rel-17 beam indication framework is used for C-link**
	+ **It is optional only when adaptive beam for C-link and BH-link beam is supported.**
* **BH-link beam determination when Rel-15/16 beam indication framework is used for C-link**
	+ **It is mandatory when adaptive beam for C-link and BH-link beam is supported.**
* **BH-link beam determination when Rel-17 beam indication framework is used for C-link**
	+ **It is mandatory when adaptive beam for C-link and BH-link beam is supported.**

AC-linkFor AC-link, some agreements which are related to UE feature discussion and corresponding comments are provided below.

|  |  |
| --- | --- |
| **Agreements** | **Comments** |
| **Agreement**Update the agreements on ‘ON-OFF’ achieved in RAN1 #111 as follows:

|  |
| --- |
| For FR2, the “ON” state of NCR-Fwd is indicated:* Implicit indication via the AC link beam indication (i.e., if there is an AC link beam indication, the NCR is assumed to be ON over the indicated time domain resource associated with corresponding beam(s))

For FR1, the “ON” state of NCR-Fwd is indicated:* Indication via the AC link beam indication (i.e., if there is an AC link beam indication, the NCR is assumed to be ON over the indicated time domain resource associated with corresponding beam(s))
	+ When there is only one beam, the sole purpose of the AC link beam indication is for indicating “ON” state of NCR-Fwd

Note: Backhaul link is following the AC link in terms of ON/OFF |

 | AC-link beam indication is necessary for NCR’s proper operation, at least with respect to ON-OFF. |
| **Agreement**For each periodic beam indication for access link, one RRC signalling is used including the information defined by the following:* A list of X ($1\leq X\leq X\_{max}$) forwarding resource, each is defined as {Beam index, time resource}
* FFS: The value of $X\_{max}$, other details

Each time resource is defined by {Starting slot defined as the slot offset in one period, starting symbol defined by symbol offset within the slot, duration defined by the number of symbols} with dedicated field.* The periodicity is configured as part of the RRC signaling for periodic beam indication
	+ The same periodicity is assumed for all time resource(s) in one periodic beam indication.
* The reference SCS is configured as part of the RRC signaling for periodic beam indication
	+ The same reference SCS is assumed for all time resource(s) in one periodic beam indication.
 | 1. Three features can be defined for periodic, semi-persistent and aperiodic beam indication for access link, respectively.2. Since AC-link beam indication is necessary for NCR’s proper operation, at least one of periodic, semi-persistent and aperiodic beam indication for access link should be supported or mandatory for NCR.3.For semi-persistent beam indication for access link, support of beam index update via MAC CE can be defined as an optional feature. |
| **Agreement**For semi-persistent beam indication:* Alt-0:
	+ RRC configures $Y$ list of forwarding resource, the $y$th list is consist of $Z\_{y} \left(1\leq Z\_{y}\leq Z\_{max}\right)$ forwarding resources, and each forwarding resource is defined by {beam index, time resource}.
		- The periodicity and reference SCS is configured as part of the RRC signaling for each list of forwarding resource
	+ MAC-CE activate/de-activate one of Y list, and all the $Z\_{y}$ forwarding resources in this list are selected.
	+ MAC-CE can optionally provide update for Zy beam index
* Note: The value of $ Z\_{max}$ ($1\leq Z\leq Z\_{max}$) is 128, where $ Z\_{max}$ refers to the maximum beams indicated in one indication.
 |
| **Agreement**For each aperiodic beam indication for access link, one DCI is used with the information defined by Option-1: * $L\_{max}$ fields are used to indicate the beam information and each field refers to one beam index ;
	+ Note: The bitwidth of this field is determined by the number of beams used for access link.
* $T\_{max}$ fields to indicate the time resource;
	+ Note: A list of time resource is pre-defined by RRC signalling. The bitwidth of this field for time resource indication is determined by the length of list.
* FFS: The value of $T\_{max}$
	+ Down-select between $T\_{max}=1 $or $T\_{max}=L\_{max}$.
* FFS: How to define the association between time indication and beam indication

Each time resource is defined by {Starting slot defined as the slot offset, starting symbol defined by symbol offset within the slot, duration defined by the number of symbols} with dedicated field.**Agreement**The DCI Format 5\_0 carrying the side control information is monitored by the NCR-MT at least in the UE specific search space.Note: The existing configuration of UE specific search space will be reused. |

**Proposal 4: For NCR AC-link, define the following optional features.*** **Periodic AC-link beam indication**
* **Semi-persistent AC-link beam indication**
* **Aperiodic AC-link beam indication**
* **Update of AC-link beam via MAC CE**
	+ **It is optional only when semi-persistent AC-link beam indication is supported.**
* **Note: At least one of periodic, semi-persistent and aperiodic AC-link beam indication is supported or mandatory for NCR.**

ON-OFFFor ON-OFF, some agreements which are related to UE feature discussion and corresponding comments are provided below.

|  |  |
| --- | --- |
| **Agreements** | **Comments** |
| **Agreement**Update the agreements on ‘ON-OFF’ achieved in RAN1 #111 as follows:

|  |
| --- |
| For FR2, the “ON” state of NCR-Fwd is indicated:* Implicit indication via the AC link beam indication (i.e., if there is an AC link beam indication, the NCR is assumed to be ON over the indicated time domain resource associated with corresponding beam(s))

For FR1, the “ON” state of NCR-Fwd is indicated:* Indication via the AC link beam indication (i.e., if there is an AC link beam indication, the NCR is assumed to be ON over the indicated time domain resource associated with corresponding beam(s))
	+ When there is only one beam, the sole purpose of the AC link beam indication is for indicating “ON” state of NCR-Fwd

Note: Backhaul link is following the AC link in terms of ON/OFF |

 | ON-OFF according to AC-link beam indication should be mandatory feature for NCR |
| **Agreement**For the flexible symbol based on the semi-static configuration (e.g., TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated), the default behavior of the NCR-Fwd is expected to be OFF or not forwarding over these symbols* FFS: The behavior over these symbol if dynamic DL/UL operation is supported by NCR-MT and/or NCR-Fwd.

**Conclusion*** For the flexible symbol based on the semi-static configuration (e.g., TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated), the dynamic DL/UL operation of NCR-MT and NCR-Fwd is not supported in Rel-18.
 | ON-OFF according to semi-static UL/DL configuration should be mandatory feature for NCR |
| **Agreement**Once beam failure is detected in C link by NCR-MT, NCR-Fwd is OFF until the beam failure recovery is completed.**Agreement**As optional functionalities for the NCR-MT, at least Rel-15 legacy BFD/BFR/RLM mechanisms are supportedFFS: The behavior of NCR-Fwd when BFR/RLF happen in C link. | ON-OFF according to BFD/BFR should be mandatory feature for NCR supporting BFD/BFR. |
| On NCR-MT RLF:* After RLF is declared by NCR-MT, NCR-MT performs cell selection and trigger RRC re-establishment;
* If NCR-MT enters RRC\_IDLE due to no suitable cell is find, NCR-Fwd is OFF;
* During RRC re-establishment procedure, NCR-Fwd is OFF.

**Agreement**As optional functionalities for the NCR-MT, at least Rel-15 legacy BFD/BFR/RLM mechanisms are supportedFFS: The behavior of NCR-Fwd when BFR/RLF happen in C link. | ON-OFF according to RLF should be mandatory feature for NCR supporting RLM. |
| * WA: RRC\_INACTIVE is optionally supported without any specific enhancements

On NCR-Fwd ON/OFF:* When NCR-MT is in RRC\_CONNECTED mode, the NCR-Fwd can be ON or OFF following the side control information received from the gNB.
* After NCR-MT enters RRC\_INACTIVE mode, the NCR-Fwd can be ON or OFF following the last configuration received from the gNB.
* Release to RRC-IDLE is FFS.
* The NCR-FWD is switched OFF if the NCR-MT in RRC\_INACTIVE state reselects a different cell than the last serving cell on which side control configuration was received.
 | ON-OFF in case when NCR-MT enters RRC\_INACTIVE should be mandatory feature for NCR supporting RRC\_INACTIVE. |

**Proposal 5: For ON/OFF, at least the following optional features considered.*** **ON-OFF according to AC-link beam indication and semi-static TDD configuration**
	+ **It is mandatory for NCR.**
* **forwarding when NCR-MT enters RRC\_INACTIVE**
	+ **It is mandatory when NCR supports RRC\_INACTIVE.**
* **ON-OFF in case of BFD/BFR**
	+ **It is mandatory when NCR supports BFD/BFR.**
* **ON-OFF in case of RLF**
	+ **It is mandatory when NCR supports RLM.**

Based on the discussions above in 2.2, an example for definition of new features is given in Table 2.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Note | Mandatory/Optional |
| X. NR\_NCR | X-Y1 | Simultaneous UL transmission of C-link and BH-link | Support simultaneous UL transmission of C-link and BH-link |  | If not supported, TDMed UL transmission of C-link and BH-link is assumed. | Optional with capability signalling |
| X-Y2 | Adaptive beam for C-link and BH-link | Support adaptive beam for C-link and BH-link |  | If not supported, fixed beam for C-link and BH-link is assumed. | Optional with capability signalling |
| X-Y3a | Dedicated BH-link beam indication | Support MAC CEs for dedicated BH-link beam indication when Rel-15/16 beam indication framework is used for C-link | X-Y2 |  | Optional with capability signalling |
| X-Y3b | Dedicated BH-link beam indication | Support MAC CE for dedicated BH-link beam indication when Rel-17 beam indication framework is used for C-link | X-Y2 | Optional when NCR supports Rel-17 beam indication framework | Optional with capability signalling |
| X-Y4a | BH-link beam determination  | Support BH-link beam determination based on pre-defined rules when Rel-15/16 beam indication framework is used for C-link | X-Y2 | Mandatory when NCR supports X-Y2 | Optional with capability signalling |
|  | X-Y4b | BH-link beam determination  | Support BH-link beam determination based on pre-defined rules when Rel-17 beam indication framework is used for C-link | X-Y2 | Mandatory when NCR supports X-Y2 and Rel-17 beam indication framework | Optional with capability signalling |
|  | X-Y5 | Periodic AC-link beam indication  | Support semi-static configuration/indication of access link beam |  | Support at least one of X-Y5, X-Y6 and X-Y7 | Optional with capability signalling |
|  | X-Y6 | Semi-persistent AC-link beam indication  | Support semi-persistent configuration/indication of access link beam |  | Optional with capability signalling |
|  | X-Y7 | Aperiodic AC-link beam indication  | Support monitoring DCI Format 5\_0 scrambled by NCR-RNTI for indication of access link beam  |  | Optional with capability signalling |
|  | X-Y8 | Update of AC-link beam via MAC CE | Support update of AC-link beam via MAC CE for semi-persistent AC-link beam indication | X-Y6 |  | Optional with capability signalling |
|  | X-Y9a | ON-OFF operation | Support ON-OFF according to AC-link beam indication and semi-static TDD configuration |  |  | Mandatory with capability signalling |
|  | X-Y9b | ON-OFF operation | Support forwarding when NCR-MT enters RRC\_INACTIVE |  | Mandatory when NCR supports RRC\_INACTIVE | Optional with capability signalling |
|  | X-Y9c | ON-OFF operation | Support ON-OFF in case of BFD/BFR |  | Mandatory when NCR supports BFD/BFR | Optional with capability signalling |
|  | X-Y9d | ON-OFF operation | Support ON-OFF in case of RLF |  | Mandatory when NCR supports RLM | Optional with capability signalling |

 |
| Samsung [5] | In previous RAN1 meetings [1-4], agreements related to UE feature for NR NCR are provided as below.

|  |
| --- |
| Agreement (RAN1#110)For the timing of NCR, the following assumption is captured into TR 38.867.* The DL transmitting timing of the NCR-Fwd is delayed after the DL receiving timing of the NCR-MT (or the NCR-Fwd) by the internal delay;
* The UL receiving timing of the NCR-Fwd is advanced before the UL transmitting timing of the NCR-MT (or the NCR-Fwd) by the internal delay.

Agreement (RAN1#110b-e)The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link

Agreement **(**RAN1#110b-e)If adaptive beams are adopted for C-link and backhaul link, new signaling is supported to indicate a beam(s) used for backhaul link from the set of beams for C-link.* Predefined rule is used to define the beam in case there is no indication via the new signalling
	+ FFS: Details of the predefined rule
	+ FFS: Application of predefined rule for other cases
* Note: The beam(s) used for backhaul link should be from the RRC-configured list of beams for C-link.
* The new signalling, if needed, is an optional NCR capability

Agreement (RAN1#111)As optional functionalities for the NCR-MT, at least Rel-15 legacy BFD/BFR/RLM mechanisms are supported* FFS: The behavior of NCR-Fwd when BFR/RLF happen in C link.

Agreement **(**RAN1#112)For the aperiodic beam indication, the reference of slot offset for each time resource is defined as the slot n+k where n refers to the slot that NCR-MT receive the DCI carrying the indication and:* Option-2: k refers to the offset value [defined by NCR-MT capability and/or declared by vendor].
	+ Note: This k is different from the parameter used to define the Slot offset for the time resource.
 |

As agreed in RAN1#110b-e, it is subject to NCR capability to support simultaneous transmission of the UL of C-link and UL of backhaul link. In addition, TDMed UL transmission of C-link and backhaul link was agreed as default capability.**Proposal 1: Introduce a capability for NR NCR to indicate support for simultaneous transmission of the UL of C-link and UL of backhaul link.*** **TDMed UL transmission of C-link and backhaul link is the default capability.**

For an NCR that supports simultaneous transmission of the UL of C-link and UL of backhaul link, an additional capability can be considered to indicate whether the NCR: (i) is not subject to a joint power limit across the C-link and BH-link (e.g., using separate PAs / power resources for the C-link and BH-link), or (ii) is subject to a joint power limit across the C-link and BH-link and supports power sharing when power limited, or (iii) is subject to a joint power limit across the C-link and BH-link and does not supports power sharing when power limited (e.g., transmit only one of C-link or BH-link when power limited). Corresponding NCR behavior can be further discussed.**Proposal 2: For an NR NCR indicating a support for simultaneous transmission of the UL of C-link and UL of backhaul link, introduce an additional capability to indicate support for power allocation and power sharing among the C-link and backhaul link.**As agreed in RAN1#110b-e, it is subject to NCR capability to support adaptive beam for C-link/backhaul-link. In addition, fixed beam for C-link/backhaul link was agreed as default capability.**Proposal 3: Introduce a capability for NR NCR to indicate support for adaptive beam for C-link/backhaul-link.*** **Fixed beam for C-link/backhaul link is the default capability.**

As agreed in RAN1#110b-e, it is subject to NCR capability to support dedicated signaling of beam indication for backhaul link.**Proposal 4: Introduce a capability for NR NCR to indicate support for dedicated signaling of beam indication for backhaul link.**In our view, whether to introduce NCR capability to support aperiodic beam indication for access link can be discussed.**Proposal 5: In terms of UE feature for NR NCR, further discuss the necessity of a capability for aperiodic beam indication for access link.**As agreed in RAN1#112, for the aperiodic beam indication, the reference of slot offset for each time resource is defined as the slot n+k. Here, n refers to the slot that NCR-MT receive the DCI carrying the indication and k refers to the offset value. A further study point is whether k is defined by NCR-MT capability and/or declared by vendor. In our view, k should be subject to NCR-MT capability. A value set for k can be larger than that for a similar UE capability for DCI processing (e.g., parameter N\_pdsch) in order to support simplified implementation of NCR and/or to incorporate beam switching delay of the NCR-Fwd.**Proposal 6: Introduce a capability for NR NCR for defining the offset between the slot that NCR-MT receive the DCI carrying aperiodic beam indication and the reference of slot offset for the time resource for aperiodic beam indication.*** **A value set for NR NCR capability can be larger than that for a UE capability for DCI processing (e.g., parameter N\_pdsch).**

As agreed in RAN1#110, NCR forward DL transmitting timing of the NCR-Fwd is delayed after the DL receiving timing of the NCR-MT (or the NCR-Fwd) by the internal delay; and UL receiving timing of the NCR-Fwd is advanced before the UL transmitting timing of the NCR-MT (or the NCR-Fwd) by the internal delay. A discussion points is the internal delay. In our view, it is beneficial for gNB to acquire the information on DL/UL internal delay of NCR. By knowing the value of DL/UL internal delay, gNB can identify whether a UE is being served by the NCR more accurately. A straightforward option for gNB to get internal delay of NCR is from NCR capability report. Also, same DL internal delay and UL internal delay can be assumed.**Proposal 7: Introduce a capability for the internal delay for NR NCR.*** **DL internal delay and UL internal delay is the same.**

As agreed in RAN1#111, support for BFD/BFR/RLM is an optional capability for NCR-MT, with Rel-15 procedures as baseline.**Proposal 8: Introduce a capability for NR NCR to indicate support for BFD/BFR/RLM.*** **The capability can additionally indicate a supported release (e.g., Rel-15, or Rel-16/17/18) for these procedures. Rel-15 is the default capability.**

Per agreements below from RAN1#110bis-e, legacy mechanisms for CSI measurement and reporting, uplink sounding (SRS), and HARQ-ACK feedback are supported by an NCR-MT, while details of the supported mechanisms are left open. It is reasonable to introduce corresponding UE capabilities to indicate the supported release for such features.**Proposal 9: Introduce capabilities for NR NCR to indicate the supported release for CSI measurement and reporting, uplink sounding (SRS), and HARQ-ACK feedback procedures.*** **As starting point, a value set can consider {Rel-15, or Rel-16/17/18}. Rel-15 is the default capability.**

|  |
| --- |
| **Agreement (RAN1#110bis-e)**To support CSI measurement/reporting mechanisms for NCR-MT in C-link* The necessary legacy mechanism for receiving CSI-RS is reused for NCR-MT.
* The necessary legacy mechanism for reporting CSI is reused for NCR-MT.
* FFS: The details of the necessary mechanisms will be further discussed and decided.
* Note: this does not mean all the legacy procedures for receiving CSI-RS and reporting CSI will be supported.

**Agreement (RAN1#110bis-e)**To support the sounding procedure for NCR-MT in C link, the necessary mechanism of legacy UE sounding procedure is supported.* FFS: The details of the necessary mechanism of legacy UE sounding procedure.
* Note: This does not mean all legacy UE sounding procedure will be supported.

**Agreement (RAN1#110bis-e)**HARQ-ACK feedback for PDSCH carrying the side control information from higher layer (e.g., MAC-CE, RRC) is supported. The legacy HARQ-ACK feedback mechanism is reused.* FFS: Whether HARQ-ACK feedback for PDCCH carrying side control information is supported
* Note: This does not mean all legacy HARQ-ACK feedback mechanism will be supported.
 |

 |
| Comba [6] | **HARQ-ACK feedback for PDCCH**

|  |
| --- |
| **Agreement**HARQ-ACK feedback for PDSCH carrying the side control information from higher layer (e.g., MAC-CE, RRC) is supported. The legacy HARQ-ACK feedback mechanism is reused.* FFS: Whether HARQ-ACK feedback for PDCCH carrying side control information is supported

Note: This does not mean all legacy HARQ-ACK feedback mechanism will be supported. |

In RAN1#110bis-e meeting, HARQ-ACK feedback for PDSCH carrying the side control information was agreed, and the HARQ-ACK feedback for PDCCH was left as an open issue. Our preference is to support the HARQ-ACK feedback for PDCCH, considering the C-link does not always satisfy the performance requirement for PDCCH carrying side control information, when the NCR is deployed in relative low elevation. Consider the diversity of deployment scenarios, the network can control this feature based on the scene. **Proposal 1: HARQ-ACK feedback for PDCCH carrying side control information is supported, and the network can enable/disable this feature as needed.****Capabilities/features of NCR-MT and NCR-Fwd** There are two kinds of NCR capability, the NCR-MT capability and the NCR-Fwd capability. The NCR-MT capability includes capabilities related to beams in C-link, e.g. SSB/CSI-RS for beam measurement, SRS based beam management, et.al, can reuse the legacy capability reporting mechanism. For capabilities only related to NCR-Fwd, e.g. beam related capabilities for NCR-Fwd, mimo related capabilities for NCR-Fwd, the information is informed to gNB and NCR via OAM. **Proposal 2: The NCR-MT capabilities are informed to NW via RRC signalling, and the only NCR-Fwd capabilities are informed to NW via OAM.****Rel-18 NCR feature list**According to the previous agreement for NCR, the following feature list can be considered as a starting point for discussion:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Note** | **Mandotory/****Optional** |
| NCR | 1 |  | Support simultaneous UL transmission of C-link and backhaul link | NCR-MT impact | Optional with capability signaling |
| NCR | 2 |  | Support adaptive beam for C-link/backhaul-link | NCR-MT impact | Optional with capability signaling |
| NCR | 3 |  | Support dynamic beam indication for NCR-Fwd access link | NCR-MT impact | Optional with capability signaling |
| NCR | 4 |  | Support semi-static beam indication for NCR-Fwd access link | NCR-MT impact | Optional with capability signaling |
| NCR | 5 |  | 1. Support the aperiodic beam indication for NCR-Fwd access link
2. Slot offset k
 | NCR-MT impact | Optional with capability signaling |
| NCR | 6 |  | Support ON/OFF information explicit indication | NCR-MT impact | Optional with capability signaling |
| NCR | 7 |  | Support ON/OFF information implicit indication | NCR-MT impact | Optional with capability signaling |
| NCR | 8 |  | Support HARQ-ACK for PDCCH carrying SCI | NCR-MT impact | Optional with capability signaling |

**Proposal 3: Consider Table 1 as the starting point for discussion for Rel-18 NCR feature list.** |
| ETRI [7] | **Rel-16/-17 IAB-MT power control**As captured in Table 1, it is clarified that the IAB-MT configured output power, PCMAX,f,c, is set by rated EIRP, PRated,c,EIRP, as declared by manufacturer.

|  |
| --- |
| **9.2.4 Configured radiated output power****9.2.4.1 IAB-MT configured output power for IAB-MT type 1-H, 1-O and 2-O**The configured maximum output power PCMAX,f,c is set in each slot according to the following equation:PCMAX,f,c = PRated,c,EIRPwhere PRated,c,EIRP is declaredby manufacturer.  |

Furthermore, it is also noted that the typical UE capability signaling on power class is not applicable for IAB-MT as highlighted in Table 2.

| ***powerClass, powerClass-v1610***Indicates power class the UE supports when operating according to this band combination. If the field is absent, the UE supports the default power class. If this power class is higher than the power class that the UE supports on the individual bands of this band combination (*ue-PowerClass* in *BandNR*), the latter determines maximum TX power available in each band. The UE sets the power class parameter only in band combinations that are applicable as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. This capability is not applicable to IAB-MT. | BC | No | N/A | FR1 only |
| --- | --- | --- | --- | --- |
| ***powerClassNRPart-r16***Indicates NR part power class the UE supports when operating according to this band combination.This field only applies for MR-DC BCs containing only single CC or intra-band CA in NR side in this release. | BC | No | N/A | FR1 only |

Consequently, the following aspects are not considered for IAB-MT configured output power calculation:* Power class
* ΔPPowerClass
* MPR/A-MPR
* PHR
* Interband CA
* SUL and SRS related aspects

**Observation 1. The following aspects are not considered for IAB-MT configured output power calculation:*** **Power class**
* **ΔPPowerClass**
* **MPR/A-MPR**
* **PHR**
* **Interband CA**
* **SUL and SRS related aspects**

**Expected NCR power control by following IAB-MT power control**It seems that Rel-17 NR repeater has various types of manufacturer declaration on the output power. For instance, Table 3 shows three examples of manufacturer declarations on rated output power on Rel-17 NR repeater from conducted conformance testing perspective. Table 4 captures another example of manufacturer declarations on rated (beam) EIRP on Rel-17 NR repeater from radiated conformance testing perspective.

|  |  |  |
| --- | --- | --- |
| D.9 | Rated output powerper passband (Prated,p,AC) | Conducted rated output power per passband, per *single band connector* or *multi-band connector.*Declared per supported *passband*, per *antenna connector.* (Note 1) |
| D.10 | R*ated total output power* (Prated,t,AC) | Conducted total rated output power*.*Declared per supported *operating band*, per *antenna connector.*For *multi-band connectors* declared for each supported *operating band* in each supported band combination. (Note 1) |
| D.11 | Rated multi-band total output power, Prated,MB,TABC | Conducted multi-band rated total output power*.*Declared per supported operating band combinations, per *multi-band connector*. (Note 1) |

|  |  |  |
| --- | --- | --- |
| D.9 | Rated beam EIRP | The rated EIRP level per passband (Prated,p,EIRP) at the *beam peak direction* associated with a particular *beam direction pair* for each of the declared maximum steering directions (D.8), as well as the reference *beam direction pair* (D.8). Declared for every beam (D.3).(Note 5, 6, 7) |

Assuming that one of the above rated output power or EIRP of NR repeater replaces the rated EIRP, PRated,c,EIRP, in Table 1, the same observations with IAB-MT would be made for NCR-MT as well, since the declared values are not varied per specific operation mode/scenarios of NCR. In other words, the following aspects will not be considered for NCR-MT configured output power calculation, if the same mechanism with IAB-MT is applied for NCR-MT:* Power class
* ΔPPowerClass
* MPR/A-MPR
* PHR
* Interband CA
* SUL and SRS related aspects
* Simultaneous UL transmission of C-link and backhaul link

**Observation 2. The following aspects may not be considered for NCR-MT configured output power calculation, if the same mechanism with IAB-MT is applied for NCR-MT:*** **Power class**
* **ΔPPowerClass**
* **MPR/A-MPR**
* **PHR**
* **Interband CA**
* **SUL and SRS related aspects**
* **Simultaneous UL transmission of C-link and backhaul link**

It may mean that the clarification on UE power class needs to be revised as highlighted in Table 5 considering NCR-MT.

| ***powerClass, powerClass-v1610***Indicates power class the UE supports when operating according to this band combination. If the field is absent, the UE supports the default power class. If this power class is higher than the power class that the UE supports on the individual bands of this band combination (*ue-PowerClass* in *BandNR*), the latter determines maximum TX power available in each band. The UE sets the power class parameter only in band combinations that are applicable as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. This capability is not applicable to IAB-MT and NCR-MT (NCR control link). | BC | No | N/A | FR1 only |
| --- | --- | --- | --- | --- |
| ***powerClassNRPart-r16***Indicates NR part power class the UE supports when operating according to this band combination.This field only applies for MR-DC BCs containing only single CC or intra-band CA in NR side in this release. | BC | No | N/A | FR1 only |

**Proposals on Rel-18 NCR power control**

|  |
| --- |
| **Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link
 |

As captured by Table 6, it was agreed that simultaneous UL transmission of C-link and backhaul link may be performed according to the NCR capability. Given that some types of NCR may share the same RF chain (i.e., a single set of antenna panels, amplifiers, and filters) the control link and the backhaul link, for these types of NCR the maximum transmission power for either of control link or access/backhaul link would be affected by the multiplexing mode for those links. For instance, as shown in Figure 1, the control link may fully utilize the maximum transmission power of the NCR during the access link OFF duration where the control link transmission and backhaul link transmission are TDMed. On the other hands, it is clear that the control link and backhaul link may share a portion of the maximum transmission power during the access link ON duration where the control link transmission and backhaul link transmission can be FDMed. Taking this into account, it should be noted that higher-layer configuration-based NCR power control can be beneficial for FDMed C-link and backhaul link uplink transmissions and can be introduced in later releases.**Observation 3. Higher-layer configuration-based NCR power control is beneficial for FDMed C-link and backhaul link uplink transmissions.**Given that RAN1 has not had a common understanding on power control enhancements for NCR yet, it is assumed that at least the NCR-MT will follow the legacy power control mechanism, where the maximum transmission power PCMAX is determined by UE power class in Table 7 [6]. On the other hand, individual repeater class has been defined at least for Rel-17 RF repeater in Table 8 [7].

|  |  |
| --- | --- |
| **UE Power class** | **UE type** |
| 1 | Fixed wireless access (FWA) UE |
| 2 | Vehicular UE |
| 3 | Handheld UE |
| 4 | High power non-handheld UE |
| 5 | Fixed wireless access (FWA) UE |
| 6 | High Speed Train Roof-Mounted UE |
| 7 | RedCap UE |
| Note: RedCap variants of non-RedCap UEs are not precluded |

|  |  |  |
| --- | --- | --- |
| **UL repeater class** | **Prated,p,TRP** | **Prated,p,EIRP** |
| Wide Area | (note 1) | (note 1) |
| Local Area | ≤ + 35 + X dBm, Note 3 | ≤ + 55 + X dBm, Note 2 |
| NOTE1: There is no upper limit for the Prated,p,TRP or Prated,p,EIRP of the *repeater type 2-O* UL transmission.NOTE2: X = [10\*log (ceil (*passband* bandwidth/100MHz))] |

As discussed in various agendas including power sharing for CA/DC scenarios, the legacy power control features have considered multiple types of possible PA architectures. And the number of possible PA architectures for NCR will be more than one as well for similar reasons with the multi-carrier scenarios. Figure 2 and Figure 3 shows examples of repeater PA architectures with single PA per TX/RX path and multiple PAs per TX/RX path, respectively. Since the possible combinations of the UE/repeater power class as captured in Table 7 and Table 8 and the PA architecture to support C-link and backhaul link are quite diverging, several ambiguities need to be resolved. In the current specifications, various types of MPR are associated with UE power class and we think that these MPR limitations can be relaxed for repeater applications.With the PA architecture like Figure 2, the uplink transmission power for C-link and backhaul link will be from the same PA for RX (UL) path. In this case, it needs to be clarified that which power class should be applied for C-link and/or backhaul link to determine the maximum transmission power PCMAX. The answer of this question can be different according to the multiplexing scenarios of C-link and backhaul link. For the TDMed C-link and backhaul link uplink transmission, the legacy method (i.e., applying repeater class for backhaul link and assuming UE power class for C-link) may have no issues. For the FDMed C-link and backhaul link uplink transmission, however, the maximum output power of the RX (UL) path PA can be smaller than the sum of the maximum C-link transmission power and the maximum backhaul link transmission power, which are declared by UE power class and repeater class, respectively. In this case, a certain level of transmission power backoff margin may be required. Furthermore, priority rules for power allocation/reduction can be introduced. For instance, repeater may apply higher priority to uplink transmission in backhaul link and the transmission power of C-link can be reduced, accordingly. In this case, the legacy uplink transmission omission by the higher-layer parameter should be applied to the uplink transmission in C-link (i.e., the repeater omits the uplink transmission of C-link, if the reduced transmission power is larger than the value configured by *xScale*).With the PA architecture like Figure 3, the uplink transmission power of a PA can be shared in a certain uplink transmission group. For example, the uplink transmission group could be 1) uplink cells in a same cell group, or 2) uplink transmission in either of C-link or backhaul link. In this case, it needs to be clarified that whether/how to apply the semi-static/dynamic power sharing across the uplink transmission groups. As done by the higher-layer parameter *dualPA-Architecture*, report (from the repeater) and configuration (from the gNB) on the PA architecture also can be beneficial to handle this issue.**Proposal 1. For TDMed C-link and backhaul link transmissions, clarify RAN1 preference among the following options (and send an LS to RAN4):*** **Option 1: Determine PCMAX of TDMed C-link by manufacturer declaration (single value, same as IAB-MT)**
* **Option 2: Determine PCMAX of TDMed C-link by UE/NCR-MT power class**

**Proposal 2. For FDMed C-link and backhaul link transmissions, clarify RAN1 preference among the following options (and send an LS to RAN4):*** **Option 1: Determine PCMAX of FDMed C-link by manufacturer declaration (the same value with TDMed C-link, same as IAB-MT)**
* **Option 2: Determine PCMAX of FDMed C-link by manufacturer declaration (an additional / separated value for FDMed C-link)**
* **Option 3: Determine PCMAX of FDMed C-link by UE/NCR-MT power class**
* **Option 4: Report/define transmission power adjustment value for FDMed cases (similar with Rel-17 eIAB)**

**Proposal 3. For the case that uplink transmissions of C-link and backhaul link share the same PA, support one of the followings:*** **Option 1: The repeater applies higher priority to uplink transmission in backhaul link and the transmission power of C-link can be reduced, accordingly.**
* **Option 2: The repeater applies higher priority to uplink transmission in C-link and the transmission power of backhaul link can be reduced, accordingly.**

**Proposal 4. The repeater omits the uplink transmission of C-link, if the reduced transmission power is larger than the value configured by gNB.** |
| CMCC [8] | Simultaneous UL transmission of C-link and backhaul link

|  |
| --- |
| **RAN1#109****Agreement**Capture the following model of network-controlled repeater in TR 38.867.* The NCR-MT is defined as a function entity to communicate with a gNB via Control link (C-link) to enable the information exchanges (e.g. side control information). The C-link is based on NR Uu interface.
	+ Note: Side control information is at least for the control of NCR-Fwd
* The NCR-Fwd is defined as a function entity to perform the amplify-and-forwarding of UL/DL RF signal between gNB and UE via backhaul link and access link. The behavior of the NCR-Fwd will be controlled according to the received side control information from gNB.

**Agreement**Recommend to capture the following examples of the transmission/reception of C-link and backhaul link by NCR in TR 38.867.* The DL of C-link and DL of backhaul link can be performed simultaneously or in TDM way.
* The UL of C-link and UL of backhaul link can be performed in TDM way
* Note-1: Multiplexing is under the control of gNB with consideration for NCR capability
* Note-2: Simultaneous transmission of the UL of C-link and UL of backhaul link is subject to NCR’s capability

**RAN1#110bis****Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link
 |

According to the agreements above, the simultaneous UL transmission of C-link and Backhaul link is a NCR capability. Whether the simultaneous transmission of the two links should be reported to the gNB. And as noted in the above agreement, the TDMed UL transmission of C-link and BH link is a default UE capability. Considering this feature is highly relevant to NCR’s hardware implementation, the granularity of this feature can be per UE. For NCR support both FR1 and FR2, since two RF chain is assumed for two FR, this capability needs to differentiation between FR1 and FR2. But there is no need to differentiation between TDD and FDD.**Proposal 1:****Simultaneous UL transmission of C-link and backhaul link should be a NCR/UE capability. And a note should be added saying that TDMed UL transmission of C-link and backhaul link is default capability.****Proposal 2:****The granularity of this feature should be per NCR/UE and per FR.****Proposal 3:****No need to differentiation between TDD and FDD for Simultaneous UL transmission of C-link and backhaul link.**Adaptive beam for both C-link and backhaul-link

|  |
| --- |
| **RAN1#109****Agreement**Both fixed beam and adaptive beam can be considered at NCR for both C-link and backhaul-link.* FFS: the mechanism for indication and determination of beam.
* Note: Fixed beam refers to the case that beam at NCR for both C-link and backhaul-link cannot be changed.

**Agreement**As baseline, the same TCI states as C-link are assumed for beam at NCR-Fwd for backhaul link if the NCR-MT’s carrier(s) is within the set of carriers forwarded by the NCR-Fwd.* FFS: additional indication from gNB to determine the beam at NCR-Fwd for backhaul link or implicit determination of the beam at NCR-Fwd for backhaul link

Note: the same assumption of the beam correspondence is applied for DL/UL of the backhaul link at NCR-Fwd as the DL/UL of the C-link at NCR-MT.**RAN1#110bis****Agreement**The following aspects should be NCR capability:* Simultaneous UL transmission of C-link and backhaul link
* Adaptive beam for C-link/backhaul-link
* Note-1: Fixed beam for C-link/backhaul link is default capability
* Note-2: TDMed UL transmission of C-link and backhaul link is default capability.
* FFS: How to define the capability for adaptive beam for C-link/backhaul-link

**RAN1#111****Agreement**The semi-static beam indication for backhaul link is supported as:* If the beam indication framework in Rel-15 is used for NCR-MT
* The DL beam is indicated by MAC CE to select one of TCI state ID from the RRC-configured list of beams for C-link
	+ The UL beam is indicated by SRI on C-link via MAC CE.
* If the beam indication framework in Rel-17 is used for NCR-MT
	+ The DL and UL beam are indicated by MAC CE to select one of TCI state ID from the RRC-configured list of beams for C-link

**Agreement**The following pre-defined rules are applied to determine the beam for backhaul link:* In the time domain resource with simultaneous downlink reception or uplink transmission in C-link and backhaul link, the beam of backhaul link is the same as the beam of C-link regardless whether there is beam indicated by the dedicated signal for backhaul link.
* In the time domain resource without simultaneous downlink reception or uplink transmission in C-link and backhaul link, if the NCR does not support capability with the new signalling for backhaul beam indication or if no beam is indicated for backhaul link by the dedicated signal,
	+ When Rel-15/16 beam indication framework is used for C-link,
		- The beam determined by QCL assumption for CORESET with the lowest ID and spatial relationship for PUCCH with lowest PUCCH resource ID in the C-link is applied for the DL and UL of backhaul link, respectively.
	+ When Rel-17 beam indication framework (i.e., unified TCI framework) is used for C-link, the indicated unified TCI for C-link DL and UL is applied for the DL and UL of backhaul link, respectively.

Otherwise, the beam indicated by the dedicated signalling is applied for backhaul link.**RAN1#112****Agreement**In the time domain resource without simultaneous downlink reception or uplink transmission in C-link and backhaul link, if the NCR does not support capability with the new signalling for backhaul beam indication or if no beam is indicated for backhaul link by the dedicated signal, * When Rel-17 beam indication framework is used for C-link,
	+ If no unified TCI is applied for C-link, the beam determined by QCL assumption for CORESET with the lowest ID and spatial relationship for PUCCH with lowest PUCCH resource ID in the C-link is applied for the DL and UL of backhaul link, respectively. (i.e. same as the default beam defined for Rel-15/16 beam indication framework)
* If there is unified TCI applied for C-link, the indicated unified TCI for C-link DL and UL is applied for the DL and UL of backhaul link, respectively.
 |

For the NCR C-link and BH link, there are different solutions according to different MIMO release assumptions. Both Rel-15/16 TCI framework and Rel-17 unified TCI framework are supported. NCR-MT should report which release it supports. For this part, UE capabilities of MIMO can be reused. Adaptive beam gives gNB more flexibility to handle the channel condition change and avoid NCR’s self interface. In current discussion about MIMO, many enhancements for beam indication have been provided. Since the structure of NCR-MT is highly similar with a normal UE, beam indication defined in MIMO could be reused.**Proposal 4:****Which MIMO framework or the release of MIMO are supported by NCR or NCR MT should be reported. The UE capability of MIMO can be reused for NCR.**Slot offset for the aperiodic beam indication

|  |
| --- |
| **RAN1#112****Agreement**For the aperiodic beam indication, the reference of slot offset for each time resource is defined as the slot n+k where n refers to the slot that NCR-MT receive the DCI carrying the indication and:* Option-2: k refers to the offset value [defined by NCR-MT capability and/or declared by vendor].
	+ Note: This k is different from the parameter used to define the Slot offset for the time resource.
 |

When an NCR-MT receive a DCI carried aperiodic beam indication in slot n, slot n+k is defined as the reference of slot offset for each time resource. The parameter k is a NCR-MT capability, which covers the process time of NCR. The capability of beam is based on the design of the antenna panel, the granularity of this feature should be per UE. For NCR support both FR1 and FR2, since two RF chain is assumed for two FR, this capability needs to differentiation between FR1 and FR2 but not need for TDD and FDD.**Proposal 5:****The parameter k which represents as the process time of NCR should be a capability and reported to gNB.** **Proposal 6:****The granularity of this feature should be per UE and per FR.****Proposal 7:****No need to differentiation between TDD and FDD for slot offset for the aperiodic beam indication.** |
| LG Electronics [9] | **Support of legacy UE features for NCR-MT**In the RAN1#110bis meeting, it was agreed to support CSI measurement/reporting and sounding procedure for NCR-MT in C-link as follows [1]. However, the specific features that NCR-MT supports have not yet been determined.

|  |
| --- |
| **Agreement**To support CSI measurement/reporting mechanisms for NCR-MT in C-link* The necessary legacy mechanism for receiving CSI-RS is reused for NCR-MT.
* The necessary legacy mechanism for reporting CSI is reused for NCR-MT.
* FFS: The details of the necessary mechanisms will be further discussed and decided.
* Note: this does not mean all the legacy procedures for receiving CSI-RS and reporting CSI will be supported.

**Agreement**To support the sounding procedure for NCR-MT in C link, the necessary mechanism of legacy UE sounding procedure is supported.* FFS: The details of the necessary mechanism of legacy UE sounding procedure.
* Note: This does not mean all legacy UE sounding procedure will be supported.
 |

In our view, the basic L1 feature required for the operation of NCR-MT may not be much different from that of IAB-MT. The discussion on the L1 mandatory features to be supported for IAB-MT was conducted in Rel-16 IAB WI, and Table 4.2.15.1-1 of TS38.306 shows the determined L1 mandatory features of the IAB-MT. Table 1 summarizes the feature groups of the L1 mandatory features for IAB-MT.In order to discuss the support of legacy UE features for NCR-MT, we propose to consider these L1 mandatory features of IAB-MT as mandatory features in NCR-MT as a baseline.From this point of view, in the case of CSI measurement/reporting and sounding procedure for NCR-MT, Feature group indices 2-32 (Basic CSI feedback) and 2-52 (Basic SRS) can be supported as mandatory features for NCR-MT.**Table 1. Layer-1 mandatory features for IAB-MT**

| Features | Index | Feature group |
| --- | --- | --- |
| 0. Waveform, modulation, subcarrier spacings, and CP | 0-1 | CP-OFDM waveform for DL and UL |
| 0-3 | DL modulation scheme |
| 0-4 | UL modulation scheme |
| 1. Initial access and mobility | 1-1 | Basic initial access channels and procedures |
| 1-3 | SS block based RLM |
| 2. MIMO | 2-1 | Basic PDSCH reception |
| 2-5 | Basic downlink DMRS for scheduling type A |
| 2-6 | Basic downlink DMRS for scheduling type B |
| 2-12 | Basic PUSCH transmission |
| 2-16 | Basic uplink DMRS (uplink) for scheduling type A |
| 2-16a | Basic uplink DMRS for scheduling type B |
| 2-22 | Aperiodic beam report |
| 2-32 | Basic CSI feedback |
| 2-50 | Basic TRS |
| 2-52 | Basic SRS |
| 3. DL control channel and procedure | 3-1 | Basic DL control channel |
| 4. UL control channel and procedure | 4-1 | Basic UL control channel |
| 4-10 | Dynamic HARQ-ACK codebook |
| 5. Scheduling/HARQ operation | 5-1 | Basic scheduling/HARQ operation |
| 6. CA/DC, BWP, SUL | 6-1 | Basic BWP operation with restriction |
| 7. Channel coding | 7-1 | Channel coding |
| 8. UL TPC | 8-3 | Basic power control operation |

**Proposal 1:** For CSI measurement/reporting procedure for NCR-MT, feature group index 2-32 (Basic CSI feedback) is supported for NCR-MT.**Proposal 2:** For the sounding procedure for NCR-MT, feature group index 2-52 (Basic SRS) is supported for NCR-MT.**Proposal 3:** To support legacy UE features for NCR-MT, L1 mandatory features for IAB-MT are considered mandatory features for NCR-MT.**Rel-18 NCR specific features**This section contains our view on the level of support for the different features introduced for Rel-18 NCR.**UL transmission of C-link and backhaul link**During Rel-18 NCR WI, TDMed UL transmission of C-link and backhaul link is agreed as the default behavior of NCR, and simultaneous UL transmission is agreed to be supported depending on NCR's capability [1]. Therefore, TDMed UL transmission of C-link and backhaul link should be a mandatory feature, and simultaneous UL transmission should be an optional feature depending on the capability.**Proposal 4:** Regarding UL transmission of C-link and backhaul link for Rel-18 NCR, support following features.1. TDMed UL transmission of C-link and backhaul link: *Mandatory without capability signalling*
2. Simultaneous UL transmission of C-link and backhaul link: *Optional with capability signalling*

**C-link/backhaul link beam adaptation**During Rel-18 NCR WI, it was agreed that fixed beam for C-link/backhaul link would be the default behavior of NCR, while adaptive beam could be supported depending on NCR's capability [1]. Therefore, fixed beam for C-link/backhaul link should be a mandatory feature, and adaptive beam for C-link/backhaul link should be an optional feature depending on the UE capability.If adaptive beam is supported for C-link/backhaul link, the backhaul link beam determination based on predefined rules should be supported as a mandatory feature. Additionally, if adaptive beam is supported by NCR, the explicit backhaul link beam indication can be optionally supported.**Proposal 5:** Regarding beam adaptation for C-link/backhaul link for Rel-18 NCR, support following features.1. Fixed beam for C-link/backhaul link: *Mandatory without capability signalling*
2. Adaptive beam for C-link/backhaul link: *Optional with capability signalling*
3. Backhaul link determination by predefined rule: *Mandatory if capability 2-2 is supported*
4. Backhaul link determination by beam indication: *Optional with capability signalling*
	* If UE supports 2-4, UE shall report capability 2-2.

**ON-OFF**In terms of OFF operation of NCR-Fwd, the following behaviors were agreed upon during the SI/WI stage of Rel-18 NCR.* The NCR-Fwd is always expected to be “OFF” unless otherwise explicitly or implicitly indicated by gNB [2].
* For the flexible symbol based on the semi-static configuration (e.g., TDD-UL-DL-ConfigCommon, TDD-UL-DL-ConfigDedicated), the default behavior of the NCR-Fwd is expected to be OFF or not forwarding over these symbols [2].
* Once beam failure is detected in C link by NCR-MT, NCR-Fwd is OFF until the beam failure recovery is completed [3].

To support above NCR-Fwd behaviors, it is natural that ON-OFF operation is supported as a mandatory feature.**Proposal 6:** Regarding ON-OFF operation for Rel-18 NCR, support following features.1. ON-OFF for backhaul link/access link: *Mandatory without capability signalling*

**Access link beam adaptation**NCR-Fwd operates in the ON state on a resource that has received an access link beam indication [3]. Therefore, in order for NCR-Fwd to perform forwarding operations, support for access link beam indication is necessary. To enable NCR-Fwd to operate in the ON state, it is essential to support at least one of the three access link beam indication methods: periodic, semi-persistent, and aperiodic indication. It is necessary to support at least one of these methods. One considerable way to accomplish this is by making all three indication methods optional features, but specifying that at least one of them must be supported. However, the more preferred approach is to make aperiodic indication, the most adaptable indication method, a mandatory feature.Additionally, in the previous meeting, it was agreed to introduce a priority flag to indicate priority to periodic and semi-persistent indications over aperiodic indication [3]. This priority flag can be supported as an optional feature in our view.**Proposal 7:** Regarding access link beam adaptation for Rel-18 NCR, support following features.1. Periodic access link beam indication: *Optional with capability signalling*
2. Semi-persistent access link beam indication: *Optional with capability signalling*
3. Aperiodic access link beam indication: *Mandatory without capability signalling*
4. Priority flag for periodic/semi-persistent indication: *Optional with capability signalling*
 |
| Huawei, HiSilicon [10] | **NCR-MT specific features**The existing UE and IAB-MT capabilities are captured in TS 38.306 [1] and TR 38.822 [2]. Similar to IAB, NCR is a network node and deployed by operator. It should be noted that typically the network node features are not specified since they mainly rely on the negotiation between the operator and the vendor. Nevertheless, there are some features that are rather basic such as waveform, channel coding, random access, DL/UL control signaling which may not be part of the negotiation. In addition, there are some NCR-MT features that are mandatory or optional with capability signaling. In general, they are related to performance enhancement hence can be optional for NCR-MT. The features defined for IAB-MT can be taken as a starting point for discussion. ***Proposal 1****:**RAN1 should identify the mandatory and optional features for NCR-MT, and the features defined for IAB-MT can be a starting point.***NCR-Fwd related features**For NCR, simultaneous UL transmission and adaptive beams of C-link and backhaul link are agreed as optional with capability signaling. Besides, the periodic beam indication including the priority flag, semi-persistent aperiodic beam indications including the priority flag and aperiodic beam indications have been specified can be considered as optional features for providing better tradeoff between latency and signaling overhead. ***Proposal 2****: Simultaneous UL transmission and adaptive beams of* *C-link and backhaul link are optional with NCR-MT capability signaling.****Proposal 3****: Periodic beam indication including the priority flag, semi-persistent beam indication including the priority flag and aperiodic beam indications are three independent optional features with NCR-MT capability signaling.*Moreover, the reference time slot for aperiodic beam indication should be able to cover the time required by NCR-MT for PDCCH processing and access beam switching. The required time is dependent on NCR-MT capability and should be provided to gNB if NCR support aperiodic beam indication. ***Proposal 4****: The reference of slot offset is an optional feature with NCR-MT capability signaling conditional on the NCR supporting aperiodic beam indication.* |
| Ericsson [11] | **NCR-MT’s capability**In this contribution, we discuss the RAN1 capabilities which are needed for the basic operation of the operator deployed Rel-18 NCR, i.e., those features without which the system cannot operate. Specifically, RAN1 should not modify existing UE functionalities that have been carefully developed and specified. As such, we think, a repeater node, similar to an IAB-node, is a stationary node that is planned and deployed by an operator. The planning can be expected to result in a stable control/backhaul link between the controlling gNB and the NCR. Hence, many UE features related to mobility and measurements are not needed for NCR-MTs whereas all features necessary for the NCR to connect to the network are. Additionally, a minimalistic feature set will allow for reduced development costs, essential for the commercial success of the NCR. In relation to independent IAB-nodes, an NCR is merely an extension of the gNB, implying that, if anything, the NCR feature set should be reduced instead of increased relative to the IAB set.As a baseline, the NCR-MT can have the same mandatory features as an IAB-MT agreed in the RAN1#101-e meeting [1] and summarized in Table 1.

|  |
| --- |
| **Agreement (RAN1#101-e)*** Wide-area IAB-MTs support the following Rel. 15 layer-1 mandatory UE features (as defined in TR38.822)
	+ Without capability
		- 0-1, 0-3, 0-4, 1-1 (only 1 preamble for component 1, component 2, component 3 except paging), 2-1, 2-5, 2-6, 2-12, 2-16, 2-16a, 2-32 (only components 1-4 and 7), 2-50 (only components 1,2), 2-52 (only components 1, 2), 3-1 (only components 1,2,3,4,5), 4-1, 5-1 (only components 1/2/3/4/5/6/7/9/10/12), 6-1, 7-1, 8-3
	+ With capability signaling which shall be set to '1'
		- 1-3, 2-22, 4-10
	+ The rest of Rel-15 layer-1 UE features other than the ones as listed above are optional for wide-area IAB-MTs.
* Note: Mandatory MT capabilities are independent from DU capabilities and do not imply a corresponding mandatory DU capability.
* The UE feature list for local-area IAB-MTs is FFS
 |

1. The deployment situation for an IAB-node and NCR is similar, hence the required features for IAB-MT and NCR-MT are similar.

Use the identified and agreed IAB-MT capabilities as a starting point for repeater-MT capabilities.

| Features | Index | Feature group | Mandated components for IAB | Without capability | With capability set to 1 |
| --- | --- | --- | --- | --- | --- |
| 0. Waveform, modulation, subcarrier spacings, and CP | 0-1 | CP-OFDM waveform for DL and UL |  | Yes |  |
| 0-3 | DL modulation scheme |  | Yes |  |
| 0-4 | UL modulation scheme |  | Yes |  |
| 1. Initial access and mobility | 1-1 | Basic initial access channels and procedures | 1 preamble for component 1, component 2, component 3 except paging | Yes |  |
| 1-3 | SS block based RLM |  |  | Yes |
| 2. MIMO | 2-1 | Basic PDSCH reception |  | Yes |  |
| 2-5 | Basic downlink DMRSfor scheduling type A |  | Yes |  |
| 2-6 | Basic downlink DMRSfor scheduling type B |  | Yes |  |
| 2-12 | Basic PUSCH transmission |  | Yes |  |
| 2-16 | Basic uplink DMRS (uplink) for scheduling type A |  | Yes |  |
| 2-16a | Basic uplink DMRSfor scheduling type B |  | Yes |  |
| 2-22 | Aperiodic beam report |  |  | Yes |
| 2-32 | Basic CSI feedback | component 1-4 and 7 | Yes |  |
| 2-50 | Basic TRS | components 1,2 | Yes |  |
| 2-52 | Basic SRS | components 1,2 | Yes |  |
| 3. DL control channel and procedure | 3-1 | Basic DL control channel | components 1,2,3,4,5 | Yes |  |
| 4. UL control channel and procedure | 4-1 | Basic UL control channel |  | Yes |  |
| 4-10 | Dynamic HARQ-ACK codebook |  |  | Yes |
| 5. Scheduling/HARQ operation | 5-1 | Basic scheduling/HARQ operation | components 1,2,3,4,5,6,7,9,10,12 | Yes |  |
| 6. CA/DC, BWP, SUL | 6-1 | Basic BWP operation with restriction |  | Yes |  |
| 7. Channel coding | 7-1 | Channel coding |  | Yes |  |
| 8. UL TPC | 8-3 | Basic power control operation |  | Yes |  |

 |

# Discussion/Approval Items during RAN1 #112bis-e — First Checkpoint

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following topics were identified by the moderator for discussion/approval during RAN1 #112bis-e.

**General comments**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | There is an outstanding issue whether the application time for DCI is a UE feature or configured by OAM. That should be discussed at some point. According to Issue 6 in the summary for MAC CE parameters for NCR, it should be discussed here. |

# Issue 1: Basic NCR feature

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. NR\_netcon\_repeater | 43-1 | Basic NCR support | 1. Fixed beam for C-link/backhaul link2. TDMed UL transmission of C-link and backhaul link |  | N/A | Yes | NCR is not supported  | Per NCR-MT | No | No | Yes | An NCR-MT must support FG 43-1 | Optional with capability signaling |
| 43. NR\_netcon\_repeater | 43-1a | Periodic beam indication for access link | 1.Support periodic beam indication for access link | 43-1 | N/A | Yes | NCR-MT cannot decode the periodic beam indication | Per NCR-MT | No | No | Yes | FFS: whether to merge this FG with 43-1 | Optional with capability signaling |
| 43. NR\_netcon\_repeater | 43-2 | Aperiodic beam indication for access link | 1.Support aperiodic beam indication for access link | 43-1 | N/A | Yes | NCR-MT cannot decode the aperiodic beam indication | Per NCR-MT | No  | No  | Yes | FFS: whether to merge this FG with 43-1 | Optional with capability signaling |
| 43. NR\_netcon\_repeater | 43-3 | Semi-persistent beam indication for access link | 1.Support semi-persistent beam indication for access link | 43-1 | N/A | Yes | NCR-MT cannot decode the semi-persistent beam indication | Per NCR-MT | No  | No  | Yes | FFS: whether to merge this FG with 43-1 | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | 43-1: Better description would be “Basic NCR support for c-link and backhaul link”, and collect c-link and backhaul related features under 43-1, see further comments below.43-1a: Is really orthogonal to 43-1, propose a separate index for it. |
| Intel  | 43-1 is for backhaul/c-link, while 43-1a/2/3 is for access link. We don’t see the need to merge access link feature with backhaul/c-link feature. We share similar view with E/// that better to use a separate index for 43-1a. For 43-2, beam application latency (slot-offset k for reference slot) values should also be reported as UE feature (e.g., considered to be 43-2a). This is to reflect NCR-MT processing capability similar to exiting *timedurationforQCL* with additional delay caused by inter-module latency. |
| Vivo | For 43-1, if An NCR-MT must support FG 43-1, it should be a mandatory feature.NCR-MT must support the AL beam indication, considering that w/o beam indication the NCR is always OFF, we wonder whether one of 43-1a/43-2/43-3 should be a mandatory feature..For 43-2, we share view as Intel that slot-offset k for reference slot (43-2a) should be reported as UE capability |
| LG | 43-1: It appears that it only includes operations related to the C-link and backhaul link. If the intention is to collect all basic features for NCR operation in this FG, it's necessary to add not only basic operations related to the C-link and backhaul link, but also other NCR-related fundamental operations. For example, ON-OFF operation, TDD UL/DL determination, and timing determination of backhaul/access link could be added.43-1a: Share the view with Ericsson. The index should be separated from 43-1.43-2: Among periodic, aperiodic, semi-persistent beam indication for access link, in our view, NCR must support aperiodic beam indication at least. |
| Fujitsu | 43-1a: Should be defined as a mandatory feature, because an NCR can properly operate only if it supports at least one type of beam indication for access link while 43-1a is the simplest one for NCR implementation. 43-2: We share a similar view with Intel that the value of slot-offset k should be reported via capability signaling.  |
| Apple | 43-1: As commented by other companies, this is not an overall basic NR feature, but aa feature for C-link and backhaul link. Can be updated accordingly43-1a: this is not C-link and backhaul link feature, but an access link feature. 43-1a,43-2,43-3 can be indexed together as 43-2a, 43-2b, 43-2c, respectively. Because they are all access link features. Also share similar view as Intel on slot-offset k |
| CMCC | We share similar view that NCR should have at least one of the three beam indication for access link, even the number of beam is one, to indicate NCR ON based on previous agreements. |

# Issue 2: FG 43-3a

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. NR\_netcon\_repeater | 43-3a | Beam index updates for semi-persistent beam indication | 1.Support to update the beam index(es) in semi-persistent beam indication | 43-1, 43-3 | N/A | Yes | The semi-persistent beam indication cannot provide updates for the beam index(es). | Per NCR-MT | No | No | Yes |  | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | We understand this as referring to the temporary override of the RRC configuration. Maybe that should be included in the description? |
| Intel  | OK with this FG  |
| Vivo | OK |
| LG | Support |
| Fujitsu | Support |
| Apple | Support |
| CMCC | Support |

# Issue 3: FG 43-4

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. NR\_netcon\_repeater | 43-4 | Adaptive beam for NCR backhaul link/C-link | 1. Support adaptive beam for NCR C-link

Support adaptive beam for NCR backhaul link | 43-1 | N/A | Yes | The beam for backhaul link and C-link is fixed. | Per NCR-MT | No | No | Yes | Component candidate values: {Rel-15/16, Rel-17, both} | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | We propose to name this 43-1a, since it is related to C-link and backhaul link operation. Additionally, the C-link beam management should be handled as for normal UEs and not be included in the NCR features leaving only the backhaul link in this FG. |
| Intel  | For 43-4, we’d like to clarify, what is the relation between 43-4 and existing UE features for beam operation, e.g., if NCR-MT reports one of existing unified TCI UE capability, does NCR-MT need to also report 43-4 with value ‘Rel-17’ ? |
| vivo | OK |
| LG | Support |
| Fujitsu | We have a question for clarification. Whether “Rel-15/16, Rel-17, both” can be somehow reported by existing capability signaling? |
| ETRI | 1. In case that the NCR-MT reports that 43-4 is not supported, what kind of beam management would be applied for C-link of that NCR-MT? Would the legacy beam (e.g., on TCI, QCL, spatial relation, etc.) capability signaling be valid in such case?
2. We acknowledge that the previous agreements were made as two parts, one for Rel-15/-16 and the other one for Rel-17. However, from UE capability signaling perspective, we think each release can be separated to each other (and we think the latest release can include previous releases, e.g., Rel-15, Rel-15/-16, Rel-15/-16/-17).
 |
| Apple | Share similar view as Ericsson to name this as 43-1a because it is related to C-link/backhaul link |
| CMCC | We’d like to clarify, does this FG indicate capability of adaptive beam for NCR backhaul link and C-link at the same time? If NCR-MT reports a FG like unified TCI, and does not report this 43-4, is it a error case? |

# Issue 4: FG 43-5

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. NR\_netcon\_repeater | 43-5 | Simultaneous UL transmission of backhaul link and C-link | 1. Simultaneous UL transmission of backhaul link and C-link | 43-1 | N/A | Yes | NCR only supports TDMed UL transmission of C-link and backhaul link | Per NCR-MT | No | No | Yes |  | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | Can also be considered to be 43-1b considering it relates to the C-link and backhaul links. |
| Intel  | Fine with E///’s suggestion |
| Vivo | OK |
| LG | Support |
| Fujitsu | OK with the FG. |
| ETRI | Support. |
| Apple | Generally fine, but can also be okay with Ericsson’s suggestion |
| CMCC | OK |

# Issue 5: FG 43-6

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. NR\_netcon\_repeater | 43-6 | Dedicated signalling for backhaul link beam indication | 1. Support dedicated signalling for backhaul link beam indication | 43-1, 43-4 | N/A | Yes | The beam for backhaul link follows predefined rule. | Per NCR-MT | No | No | Yes | Component candidate values: {Rel-15/16, Rel-17, both} | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | For consistency with our previous comments, this should be included in 43-1a as a separate component or renamed to 43-1c. Additionally, implementation of UL and DL may differ causing us to think DL and UL should have separate components. |
| Intel  | OK with this FG |
| Vivo | OK |
| LG | Support |
| Fujitsu | OK with the FG |
| ETRI | We acknowledge that the previous agreements were made as two parts, one for Rel-15/-16 and the other one for Rel-17. However, from UE capability signaling perspective, we think each release can be separated to each other (and we think the latest release can include previous releases, e.g., Rel-15, Rel-15/-16, Rel-15/-16/-17). |
| Apple | OK |
| CMCC | OK |

# Issue 6: FG 43-7

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. NR\_netcon\_repeater | 43-7 | Priority flag | Priority flag for periodic/semi-persistent indication | 43-1, one of 43-1a or 43-3 | N/A | Yes | Priority flag is not supported  | Per NCR-MT | No | No | Yes |  | Optional with capability signaling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | Support |
| Intel  | OK with this FG |
| Vivo | OK |
| LG | Support |
| Fujitsu | OK with the FG |
| ETRI | Support |
| Apple | Support |
| CMCC | Support |

# Issue 7: Dynamic DL/UL operation

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Send LS to RAN2 informing them that dynamic DL/UL operation related UE features FG 3-6, FG 5-1a and Component 7 of FG 5-1 are not supported for NCR.**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | Support |
| Intel  | Support  |
| Vivo | No, NCR-MT is a normal UE, why we prevent a UE from supporting dynamic TDD, it is totally up to vendor. |
| LG | Support |
| Fujitsu | Support |
| ETRI | Support. |
| Apple | Support |

# Issue 8: Optional NCR-MT features

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Send LS to RAN2 informing them that beam management related UE features should be revised for NCR-MT as follows:**

**• The mandatory features for beam management should be changed to optional.**

* **FGs 1-3, 1-7, 2-21, 2-22, 2-23, 2-23a, 2-24, 2-25, 2-26, 2-27, 2-28, 2-29, 2-29a, 2-30, 2-31, 2-59, 2-60, 2-61, 2-62**

**• FG 43-4 Adaptive beam for NCR backhaul link/C-link should be added in the prerequisite feature group.**

* **FGs 2-21, 2-22, 2-23, 2-23a, 2-24, 2-25, 2-26, 2-27, 2-28, 2-29, 2-29a, 2-30, 2-31, 2-59, 2-60, 2-61, 2-62**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | It seems like FGs 1-3 and 2-22 are in conflict since they are included in both Sec. 3.8 and Sec. 3.9. Additionally, it seems redundant (and opens up for misunderstandings) to define both FGs that can be made optional in this section and then discuss which features are mandatory in the next section.We are fine with the FG 43-4 prerequisites. |
| Intel  | Same view with E/// that 1-3 and 2-22 should be optional per RAN1 agreement.  |
| Fujitsu | After the mandatory features are defined as in section 3.9, the features for beam management can be automatically made optional. The 1st bullet here can be removed to avoid conflict and redundancy.  |
| Apple | Share similar view as Ericsson |

# Issue 9: Mandatory NCR-MT features

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Send LS to RAN2 informing them that NCR-MT supports the following layer-1 mandatory UE features:**

**• 0-1, 0-2, 0-3, 0-4, 1-1, 1-3, 2-1, 2-5, 2-6, 2-12, 2-16, 2-16a, 2-22, 2-32 (only components 1-4 and 7), 2-50 (only components 1,2), 2-52 (only components 1, 2), 3-1 (only components 1,2,3,4,5), 4-1, 4-10, 5-1 (only components 1/2/3/4/5/6/9/10/12), 6-1, 7-1, 8-3**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| Ericsson | Support |
| Intel  | Support.  |
|  | Remove the RLM functionality per the agreement, i.e.., FG 1-3We think CSI feedback/SRS related feature should be removed from mandatory feature, since C-link only transmit control information, we assume lowest MCS can be used, i.e., FG 2-22, FG 2-32, FG 2-52 |
| LG | FG 1-3 and 2-22 should be removed from the proposal. |
| Fujitsu | Taking the mandatory features for IAB-MT as the starting point, feature 0-2, which is not a mandatory feature for IAB-MT, should be removed.1-3 and 2-22 should be removed since they are optional according to agreement. |
| Apple | OK and share similar view as others to remove FG 1-3 and FG 2-22 |

# Discussion/Approval Items during RAN1 #112bis-e — Second Checkpoint

Based on the comments/questions/suggestions received by the first checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 3 will not be considered]***

**General comments**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
|  |  |

# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# Discussion/Approval Items during RAN1 #112bis-e — Third Checkpoint

Based on the comments/questions/suggestions received by the second checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 4 will not be considered]***

**General comments**

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
|  |  |

# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #112bis-e by email. There are no tables for comments.

***[All comments must be directly made on the RAN1 email reflector]***

Companies can continue to update their comments in the previous Sections, however, these are no longer monitored by the moderator. Any such comments will be for archival purposes only and will not influence the outcome of this email discussion. Any objection to any of the proposals in this Section must be voiced directly on the RAN1 email reflector.

**Possible Agreement: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# Conclusion

After further discussion on the RAN1 email reflector the following was agreed as part of this email discussion:

# References

1. R1-2303293, Discussion on the UE feature for NCR, Rapporteur (ZTE)
2. R1-2302514, Discussion on UE features for NCR, vivo
3. R1-2302898, Initial views on UE features for Network Controlled Repeaters, Nokia/Nokia Shanghai Bell
4. R1-2302917, Discussion on UE features for NR NCR, Fujitsu
5. R1-2303158, Discussion on UE features for NR NCR, Samsung
6. R1-2303177, Discussion on other aspects of NCR, Comba
7. R1-2303208, Discussion on NCR features, ETRI
8. R1-2303259, Discussion on UE feature of NR NCR, CMCC
9. R1-2303753, Discussion on UE features for NR NCR, LG Electronics
10. R1-2303862, UE features for NCR, Huawei/HiSilicon
11. R1-2303872, Legacy UE features for NCR, Ericsson