**3GPP TSG-RAN WG2 Meeting #124 *R2-231xxxx***

**Chicago, USA, 13 – 17 November 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **37.340** | **CR** | **-** | **rev** | **-** | **Current version:** | **17.6.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Introduction of QoE enhancement for NR-DC |
|  |  |
| ***Source to WG:*** | Nokia, Nokia Shanghai Bell |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_QoE\_enh-Core |  | ***Date:*** | 2023-11 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Introduction of the R18 WI: enhancement on NR QoE management and optimizations for diverse services, to support QoE in NR-DC. |
|  |  |
| ***Summary of change:*** | The CR captures the agreements on support of QoE measurements for NR-DC made since RAN2#119bis meeting. The CR adds the RAN3 endorsed stage 2 CR R2-2313992/R3-238102. |
|  |  |
| ***Consequences if not approved:*** | QoE enhancement not supported in NR-DC. |
|  |  |
| ***Clauses affected:*** | 3.1, 3.2, 4.2.1, 7.6, 10.2.2,10.3.2,10.5.2,10.7.2,13.x |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.331 CRxxxxTS 38.300 CRxxxxTS 38.423 CR1069 |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1] and TS 36.300 [2].

**Child node**: IAB-DU's or IAB-donor-DU's next hop neighbour IAB-node.

**Conditional PSCell Addition:** a PSCell addition procedure that is executed only when PSCell addition execution condition is met.

**Conditional PSCell Change:** a PSCell change procedure that is executed only when PSCell change execution condition is met.

**En-gNB:** node providing NR user plane and control plane protocol terminations towards the UE, and acting as Secondary Node in EN-DC.

**Fast MCG link recovery:** in MR-DC, an RRC procedure where the UE sends an MCG Failure Information message to the MN via the SCG upon the detection of a radio link failure on the MCG.

**IAB-donor:** gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-MT:** IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise.

**IAB-node:** RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via E-UTRA.

**Master Cell Group**: in MR-DC, a group of serving cells associated with the Master Node, comprising of the SpCell (PCell) and optionally one or more SCells.

**Master node**: in MR-DC, the radio access node that provides the control plane connection to the core network. It may be a Master eNB (in EN-DC), a Master ng-eNB (in NGEN-DC) or a Master gNB (in NR-DC and NE-DC).

**MCG bearer**: in MR-DC, a radio bearer with an RLC bearer (or two RLC bearers, in case of CA packet duplication in an E-UTRAN cell group, or up to four RLC bearers in case of CA packet duplication in a NR cell group) only in the MCG.

**MN terminated bearer:** in MR-DC, a radio bearer for which PDCP is located in the MN.

**MCG SRB**: in MR-DC, a direct SRB between the MN and the UE.

**Multi-Radio Dual Connectivity:** Dual Connectivity between E-UTRA and NR nodes, or between two NR nodes.

**Ng-eNB**: as defined in TS 38.300 [3].

**NR sidelink communication**: AS functionality enabling at least V2X Communication as defined in TS 23.287 [18] and ProSe Communication (including ProSe UE-to-Network Relay and non-Relay communication) as defined in TS 23.304 [24], between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink discovery**: AS functionality enabling ProSe non-Relay Discovery and ProSe UE-to-Network Relay discovery for Proximity based Services as defined in TS 23.304 [24] between two or more nearby UEs, using NR technology but not traversing any network node.

**Parent node:** IAB-MT's next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU.

**PCell**: SpCell of a master cell group.

**PSCell**: SpCell of a secondary cell group.

**RLC bearer:** RLC and MAC logical channel configuration of a radio bearer in one cell group.

**Secondary Cell Group**: in MR-DC, a group of serving cells associated with the Secondary Node, comprising of the SpCell (PSCell) and optionally one or more SCells.

**Secondary node**: in MR-DC, the radio access node, with no control plane connection to the core network, providing additional resources to the UE. It may be an en-gNB (in EN-DC), a Secondary ng-eNB (in NE-DC) or a Secondary gNB (in NR-DC and NGEN-DC).

**SCG bearer**: in MR-DC, a radio bearer with an RLC bearer (or two RLC bearers, in case of CA packet duplication in an E-UTRAN cell group, or up to four RLC bearers in case of CA packet duplication in a NR cell group) only in the SCG.

**SN terminated bearer:** in MR-DC, a radio bearer for which PDCP is located in the SN.

**SpCell**: primary cell of a master or secondary cell group.

**SRB3**: in EN-DC, NGEN-DC and NR-DC, a direct SRB between the SN and the UE.

**SRB5:** in NR-DC, a direct SRB between the SN and the UE dedicated for sending application layer measurement report information.

**Split bearer:** in MR-DC, a radio bearer with RLC bearers both in MCG and SCG.

**Split PDU Session (or PDU Session split):** a PDU Session whose QoS Flows are served by more than one SDAP entities in the NG-RAN.

**Split SRB**: in MR-DC, a SRB between the MN and the UE with RLC bearers both in MCG and SCG.

**User plane resource configuration:** in MR-DC with 5GC, encompasses radio network resources and radio access resources related to either one or more PDU sessions, one or more QoS flows, one or more DRBs, or any combination thereof.

**V2X sidelink communication**: AS functionality enabling V2X Communication as defined in TS 23.285 [19], between nearby UEs, using E-UTRA technology but not traversing any network node.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1], TS 36.300 [2] and TS 38.300 [3].

BFD Beam Failure Detection

CHO Conditional Handover

CLI Cross Link Interference

CPA Conditional PSCell Addition

CPAC Conditional PSCell Addition or Change

CPC Conditional PSCell Change

DAPS Dual Active Protocol Stack

DC Intra-E-UTRA Dual Connectivity

DCP DCI with CRC scrambled by PS-RNTI

EN-DC E-UTRA-NR Dual Connectivity

IAB Integrated Access and Backhaul

MCG Master Cell Group

MN Master Node

MR-DC Multi-Radio Dual Connectivity

NE-DC NR-E-UTRA Dual Connectivity

NGEN-DC NG-RAN E-UTRA-NR Dual Connectivity

NR-DC NR-NR Dual Connectivity

QMC QoE Measurement Collection

QoE Quality of Experience

RLM Radio Link Monitoring

SCG Secondary Cell Group

SMTC SS/PBCH block Measurement Timing Configuration

SN Secondary Node

V2X Vehicle-to-Everything

# 4 Multi-Radio Dual Connectivity

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## 4.2 Radio Protocol Architecture

### 4.2.1 Control Plane

In MR-DC, the UE has a single RRC state, based on the MN RRC and a single C-plane connection towards the Core Network. Figure 4.2.1-1 illustrates the Control plane architecture for MR-DC. Each radio node has its own RRC entity (E-UTRA version if the node is an eNB or NR version if the node is a gNB) which can generate RRC PDUs to be sent to the UE.

RRC PDUs generated by the SN can be transported via the MN to the UE. The MN always sends the initial SN RRC configuration via MCG SRB (SRB1), but subsequent reconfigurations may be transported via MN or SN. When transporting RRC PDU from the SN, the MN does not modify the UE configuration provided by the SN.

In E-UTRA connected to EPC, at initial connection establishment SRB1 uses E-UTRA PDCP. If the UE supports EN-DC, regardless whether EN-DC is configured or not, after initial connection establishment, MCG SRBs (SRB1 and SRB2) can be configured by the network to use either E-UTRA PDCP or NR PDCP (either SRB1 and SRB2 are both configured with E-UTRA PDCP, or they are both configured with NR PDCP). Change from E-UTRA PDCP to NR PDCP (or vice-versa) is supported via a handover procedure (reconfiguration with mobility) or, for the initial change of SRB1 from E-UTRA PDCP to NR PDCP, with a reconfiguration without mobility before the initial security activation.

If the SN is a gNB (i.e. for EN-DC, NGEN-DC and NR-DC), the UE can be configured to establish a SRB with the SN (SRB3) to enable RRC PDUs for the SN to be sent directly between the UE and the SN. RRC PDUs for the SN can only be transported directly to the UE for SN RRC reconfiguration not requiring any coordination with the MN. Measurement reporting for mobility within the SN can be done directly from the UE to the SN if SRB3 is configured.

In NR-DC, the UE can be configured to establish a SRB with the SN (SRB5) to enable RRC messages which include application layer measurement report information to be sent directly between the UE and the SN. The application measurement report can be sent directly from the UE to the SN if SRB5 is configured and indicated by the network for the application measurement reporting.

Split SRB is supported for all MR-DC options, allowing duplication of RRC PDUs generated by the MN, via the direct path and via the SN. Split SRB uses NR PDCP. This version of the specification does not support the duplication of RRC PDUs generated by the SN via the MN and SN paths.

In EN-DC, the SCG configuration is kept in the UE during suspension. During connection resumption, if the UE supports resuming with EN-DC, the UE can be configured to release, restore, or reconfigure the SCG configuration. Otherwise, the UE releases the SCG configuration (but not the radio bearer configuration) during resumption initiation.

In MR-DC with 5GC, the UE stores the PDCP/SDAP configuration and the SCG configuration when moving to RRC Inactive. During connection resumption, if the UE supports resuming with MR-DC, the UE can be configured to release, restore, or reconfigure the SCG configuration. Otherwise, it releases the SCG configuration.

 

Figure 4.2.1-1: Control plane architecture for EN-DC (left) and MR-DC with 5GC (right).

# 7 RRC related aspects

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## 7.6 Split SRB

Split SRB is supported for both SRB1 and SRB2 (split SRB is not supported for SRB0, SRB3, SRB4 and SRB5) in all MR-DC cases. RRC PDUs on split SRB are ciphered and integrity protected using NR PDCP.

Split SRB can be configured by the MN in Secondary Node Addition and/or Modification procedure, with SN configuration part provided by the SN. A UE can be configured with both split SRB and SRB3 simultaneously. SRB3 and the SCG leg of split SRB can be independently configured.

For the split SRB, the selection of transmission path in downlink depends on network implementation. For uplink, the UE is configured via MN RRC signalling whether to use MCG path or duplicate the transmission on both MCG and SCG.

# 10 Multi-Connectivity operation related aspects

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### 10.2.2 MR-DC with 5GC

The Secondary Node (SN) Addition procedure is initiated by the MN and is used to establish a UE context at the SN in order to provide resources from the SN to the UE. For bearers requiring SCG radio resources, this procedure is used to add at least the initial SCG serving cell of the SCG. This procedure can also be used to configure an SN terminated MCG bearer (where no SCG configuration is needed). In case of CPA, the Conditional Secondary Node Addition procedure can be used for CPA configuration and CPA execution. This procedure can also be used to support coordination between the MN and the SN for managing the configuration and reporting of QoE measurements and/or RAN visible QoE measurements in NR-DC.

**Secondary Node Addition**

Figure 10.2.2-1 shows the SN Addition procedure.



Figure 10.2.2-1: SN Addition procedure

1. The MN decides to request the target SN to allocate resources for one or more specific PDU Sessions/QoS Flows, indicating QoS Flows characteristics (QoS Flow Level QoS parameters, PDU session level TNL address information, and PDU session level Network Slice info). In addition, for bearers requiring SCG radio resources, MN indicates the requested SCG configuration information, including the entire UE capabilities and the UE capability coordination result. In this case, the MN also provides the latest measurement results for SN to choose and configure the SCG cell(s). The MN may request the SN to allocate radio resources for split SRB operation. In NGEN-DC and NR-DC, the MN always provides all the needed security information to the SN (even if no SN terminated bearers are setup) to enable SRB3 to be setup based on SN decision. The MN may request the SCG to be activated or deactivated.

 For MN terminated bearer options that require Xn-U resources between the MN and the SN, the MN provides Xn-U UL TNL address information. For SN terminated bearers, the MN provides a list of available DRB IDs. The S-NG-RAN node shall store this information and use it when establishing SN terminated bearers. The SN may reject the request.

 For SN terminated bearer options that require Xn-U resources between the MN and the SN, the MN provides in step 1 a list of QoS flows per PDU Sessions for which SCG resources are requested to be setup upon which the SN decides how to map QoS flows to DRB.

 In case of coordination between the MN and the SN on QoE and RAN visible QoE measurement configuration and reporting, the *SN Addition Request* message may contain the *QMC Coordination Request* IE.

NOTE 1: For split bearers, MCG and SCG resources may be requested of such an amount, that the QoS for the respective QoS Flow is guaranteed by the exact sum of resources provided by the MCG and the SCG together, or even more. For MN terminated split bearers, the MN decision is reflected in step 1 by the QoS Flow parameters signalled to the SN, which may differ from QoS Flow parameters received over NG.

NOTE 2: For a specific QoS flow, the MN may request the direct establishment of SCG and/or split bearers, i.e. without first having to establish MCG bearers. It is also allowed that all QoS flows can be mapped to SN terminated bearers, i.e. there is no QoS flow mapped to an MN terminated bearer.

2. If the RRM entity in the SN is able to admit the resource request, it allocates respective radio resources and, dependent on the bearer type options, respective transport network resources. For bearers requiring SCG radio resources the SN triggers UE Random Access so that synchronisation of the SN radio resource configuration can be performed. The SN decides for the PSCell and other SCG SCells and provides the new SCG radio resource configuration to the MN within an SN RRC configuration message contained in the *SN Addition Request Acknowledge* message. If the MN requested the SCG to be deactivated, the SN may keep the SCG activated. If the MN requests the SCG to be activated, the SN shall keep the SCG activated. In case of bearer options that require Xn-U resources between the MN and the SN, the SN provides Xn-U TNL address information for the respective DRB, Xn-U UL TNL address information for SN terminated bearers, Xn-U DL TNL address information for MN terminated bearers. For SN terminated bearers, the SN provides the NG-U DL TNL address information for the respective PDU Session and security algorithm. If SCG radio resources have been requested, the SCG radio resource configuration is provided.

In case of coordination between the MN and the SN on QoE and RAN visible QoE measurement configuration and reporting, the *SN Addition Request* *Acknowledge* message may contain the *QMC Coordination Response* IE.

NOTE 3: In case of MN terminated bearers, transmission of user plane data may take place after step 2.

NOTE 4: In case of SN terminated bearers, data forwarding and the SN Status Transfer may take place after step 2.

NOTE 5: For MN terminated bearers for which PDCP duplication with CA is configured in NR SCG side, the MN allocates up to 4 separate Xn-U bearers and the SN provides a logical channel ID for primary or split secondary path to the MN.

 For SN terminated bearers for which PDCP duplication with CA is configured in NR MCG side, the SN allocates up to 4 separate Xn-U bearers and the MN provides a logical channel ID for primary or split secondary path to the SN via an additional MN-initiated SN modification procedure.

2a. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message.

3. The MN sends the MN RRC reconfiguration message to the UE including the SN RRC configuration message, without modifying it. Within the MN RRC reconfiguration message, the MN can indicate the SCG is deactivated.

4. The UE applies the new configuration and replies to MN with MN RRC reconfiguration complete message, including an SN RRC response message for SN, if needed. In case the UE is unable to comply with (part of) the configuration included in the MN RRC reconfiguration message, it performs the reconfiguration failure procedure.

5. The MN informs the SN that the UE has completed the reconfiguration procedure successfully via *SN Reconfiguration Complete* message, including the SN RRC response message, if received from the UE.

6. If configured with bearers requiring SCG radio resources and the SCG is not deactivated, the UE performs synchronisation towards the PSCell configured by the SN. The order the UE sends the MN RRC reconfiguration complete message and performs the Random Access procedure towards the SCG is not defined. The successful RA procedure towards the SCG is not required for a successful completion of the RRC Connection Reconfiguration procedure.

7. If PDCP termination point is changed to the SN for bearers using RLC AM, and when RRC full configuration is not used, the MN sends the *SN Status Transfer* message.

8. For SN terminated bearers or QoS flows moved from the MN, dependent on the characteristics of the respective bearer or QoS flow, the MN may take actions to minimise service interruption due to activation of MR-DC (Data forwarding).

9-12. If applicable, the update of the UP path towards the 5GC is performed via a PDU Session Path Update procedure*.*

**Conditional Secondary Node Addition**

Figure 10.2.2-2 shows the Conditional SN Addition procedure.



Figure 10.2.2-2: Conditional Secondary Node Addition procedure

1. The MN decides to configure CPA for the UE. The MN requests the candidate SN(s) to allocate resources for one or more specific PDU Sessions/QoS Flows, indicating QoS Flows characteristics (QoS Flow Level QoS parameters, PDU session level TNL address information, and PDU session level Network Slice info), indicating that the request is for CPA and providing the upper limit for the number of PSCells that can be prepared by the candidate SN. In addition, for bearers requiring SCG radio resources, the MN indicates the requested SCG configuration information, including the entire UE capabilities and the UE capability coordination result. In this case, the MN also provides the candidate cells recommended by MN via the latest measurement results for the candidate SN to choose and configure the SCG cell(s). The MN may request the candidate SN to allocate radio resources for split SRB operation. In NR-DC, the MN always provides all the needed security information to the candidate SN (even if no SN terminated bearers are setup) to enable SRB3 to be setup based on SN decision.

 For MN terminated bearer options that require Xn-U resources between the MN and the candidate SN, the MN provides Xn-U UL TNL address information. For SN terminated bearers, the MN provides a list of available DRB IDs. The candidate SN shall store this information and use it when establishing SN terminated bearers. The candidate SN may reject the addition request.

 For SN terminated bearer options that require Xn-U resources between the MN and the candidate SN, the MN provides in step 1 a list of QoS flows per PDU Sessions for which SCG resources are requested to be setup upon which the candidate SN decides how to map QoS flows to DRB.

NOTE 6: For split bearers, MCG and SCG resources may be requested of such an amount, that the QoS for the respective QoS Flow is guaranteed by the exact sum of resources provided by the MCG and the SCG together, or even more. For MN terminated split bearers, the MN decision is reflected in step 1 by the QoS Flow parameters signalled to the candidate SN, which may differ from QoS Flow parameters received over NG.

NOTE 7: For a specific QoS flow, the MN may request the direct establishment of SCG and/or split bearers, i.e. without first having to establish MCG bearers. It is also allowed that all QoS flows can be mapped to SN terminated bearers, i.e. there is no QoS flow mapped to an MN terminated bearer.

2. If the RRM entity in the candidate SN is able to admit the resource request, it allocates respective radio resources and, dependent on the bearer type options, respective transport network resources, and provides the prepared PSCell ID(s) to the MN. For bearers requiring SCG radio resources the candidate SN configures Random Access so that synchronisation of the SN radio resource configuration can be performed at the CPA execution. Fromthe list of cells indicated within the measurement results provided by the MN, the candidate SN decides the list of PSCell(s) to prepare (considering the maximum number indicated by the MN) and, for each prepared PSCell, the candidate SN decides other SCG SCells and provides the new corresponding SCG radio resource configuration to the MN in an NR *RRCReconfiguration\*\** message, contained in the *SN Addition Request Acknowledge* message. The candidate SN can either accept or reject each of the candidate cells listed within the measurement results indicated by the MN, i.e. it cannot configure any alternative candidates. In case of bearer options that require Xn-U resources between the MN and the candidate SN, the candidate SN provides Xn-U TNL address information for the respective DRB, Xn-U UL TNL address information for SN terminated bearers, Xn-U DL TNL address information for MN terminated bearers. For SN terminated bearers, the candidate SN provides the NG-U DL TNL address information for the respective PDU Session and security algorithm. If SCG radio resources have been requested, the SCG radio resource configuration is provided.

NOTE 8: For MN terminated bearers for which PDCP duplication with CA is configured in NR SCG side, the MN allocates up to 4 separate Xn-U bearers and the candidate SN provides a logical channel ID for primary or split secondary path to the MN.

 For SN terminated bearers for which PDCP duplication with CA is configured in NR MCG side, the candidate SN allocates up to 4 separate Xn-U bearers and the MN provides a logical channel ID for primary or split secondary path to the candidate SN via an additional MN-initiated SN modification procedure.

NOTE 9: In case of SN terminated bearers, early data forwarding may take place after step 2. For the early data forwarding of SN terminated bearers, the MN forwards the PDCP SDU to the candidate SN. For the early transmission of MN terminated split/SCG bearers, the MN forwards the PDCP PDU to the candidate SN.

2a. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message. In case of early data forwarding in CPA, the MN sends the *Early Status Transfer* message to the candidate SN.

3. The MN sends to the UE an *RRCReconfiguration* message including the CPA configuration, i.e. a list of *RRCReconfiguration\** messagesand associated execution conditions. Each *RRCReconfiguration\** messagecontains the SCG configuration in the *RRCReconfiguration\*\** received from the candidate SN in step 2 and possibly an MCG configuration. Besides, the *RRCReconfiguration* messagecan also include an updated MCG configuration. e.g. to configure the required conditional measurements.

4. The UE applies the *RRCReconfiguration* message received in step 3, stores the CPA configurationand replies to the MN with an *RRCReconfigurationComplete* message. In case the UE is unable to comply with (part of) the configuration included in the *RRCReconfiguration* message, it performs the reconfiguration failure procedure.

4a. The UE starts evaluating the execution conditions. If the execution conditionof one candidate PSCell is satisfied, the UE applies *RRCReconfiguration\** message corresponding to the selected candidate PSCell, and sends an MN *RRCReconfigurationComplete\** message, including an *RRCReconfigurationComplete\*\** message for the selected candidate PSCell, and information enabling the MN to identify the SN of the selected candidate PSCell.

5a-5c. The MN informs the SN of the selected candidate PSCell that the UE has completed the reconfiguration procedure successfully via *SN Reconfiguration Complete* message, including the *RRCReconfigurationComplete\*\** message. The MN sends the *SN Release Request* message(s) to cancel CPA in the other candidate SN(s), if configured. The other candidate SN(s) acknowledges the release request.

6. The UE performs synchronisation towards the PSCell indicated in the *RRCReconfiguration\** message applied in step 4a. The order the UE sends the MN *RRCReconfigurationComplete\** message and performs the Random Access procedure towards the SCG is not defined. The successful RA procedure towards the SCG is not required for a successful completion of the RRC Connection Reconfiguration procedure.

7. If PDCP termination point is changed to the SN for bearers using RLC AM, and when RRC full configuration is not used, the MN sends the *SN Status Transfer* message.

8. For SN terminated bearers or QoS flows moved from the MN, dependent on the characteristics of the respective bearer or QoS flow, the MN may take actions to minimise service interruption due to activation of MR-DC (Data forwarding).

9-12. If applicable, the update of the UP path towards the 5GC is performed via a PDU Session Path Update procedure*.*

## 10.3 Secondary Node Modification (MN/SN initiated)

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### 10.3.2 MR-DC with 5GC

The SN Modification procedure may be initiated either by the MN or by the SN and be used to modify the current user plane resource configuration (e.g. related to PDU session, QoS flow or DRB) or to modify other properties of the UE context within the same SN. It may also be used to transfer an RRC message from the SN to the UE via the MN and the response from the UE via MN to the SN (e.g. when SRB3 is not used). In NGEN-DC and NR-DC, the RRC message is an NR message (i.e., *RRCReconfiguration*) whereas in NE-DC it is an E-UTRA message (i.e., *RRCConnectionReconfiguration*). In case of CPA or inter-SN CPC, this procedure is used to modify CPA or inter-SN CPC configuration within the same candidate SN. In case of CPA or inter-SN CPC, this procedure may also be triggered by the candidate SN to add some prepared PSCells from the suggested list or cancel part of the prepared PSCells. In case of intra-SN CPC, this procedure is used to configure, modify or release intra-SN CPC configuration. This procedure may be initiated by the MN or SN to request the SN or MN to activate or deactivate the SCG. This procedure can also be used to support coordination between the MN and the SN for managing the configuration and reporting of QoE measurements and/or RAN visible QoE measurements in NR-DC.

The SN modification procedure does not necessarily need to involve signalling towards the UE.

**MN initiated SN Modification**



Figure 10.3.2-1: SN Modification procedure - MN initiated

The MN uses the procedure to initiate configuration changes of the SCG within the same SN, including addition, modification or release of the user plane resource configuration. The MN uses this procedure to perform handover within the same MN while keeping the SN, when the SN needs to be involved (i.e. in NGEN-DC). The MN also uses the procedure to query the current SCG configuration, e.g. when delta configuration is applied in an MN initiated SN change. The MN also uses the procedure to provide the S-RLF related information to the SN or to provide additional available DRB IDs to be used for SN terminated bearers. The MN also uses this procedure to activate or deactivate the SCG. The MN may not use the procedure to initiate the addition, modification or release of SCG SCells. The SN may reject the request, except if it concerns the release of the user plane resource configuration, or if it is used to perform handover within the same MN while keeping the SN. Figure 10.3.2-1 shows an example signalling flow for an MN initiated SN Modification procedure.

1. The MN sends the *SN Modification Request* message, which may contain user plane resource configuration related or other UE context related information, PDU session level Network Slice info and the requested SCG configuration information, including the UE capabilities coordination result to be used as basis for the reconfiguration by the SN. In case a security key update in the SN is required, a new *SN Security Key* is included. In case the PDCP data recovery in the SN is required, the *PDCP Change* *Indication* is included which indicates that PDCP data recovery is required in SN. In case of coordination between the MN and the SN on QoE and RAN visible QoE measurement configuration and reporting, the *SN Modification Request* message may contain the *QMC Coordination Request* IE.

2. The SN responds with the *SN Modification Request Acknowledge* message, which may contain new SCG radio configuration information within an SN RRC reconfiguration message*,* and data forwarding address information (if applicable). If the MN requested the SCG to be activated or deactivated, the SN indicates whether the SCG is activated or deactivated. In case of coordination between the MN and the SN on QoE and RAN visible QoE measurement configuration and reporting, the *SN Modification Request* *Acknowledge* message may contain the *QMC Coordination Response* IE.

NOTE 1: For MN terminated bearers to be setup for which PDCP duplication with CA is configured in NR SCG side, the MN allocates up to 4 separate Xn-U bearers and the SN provides a logical channel ID for primary or split secondary path to the MN.

 For SN terminated bearers to be setup for which PDCP duplication with CA is configured in NR MCG side, the SN allocates up to 4 separate Xn-U bearers and the MN provides a logical channel ID for primary or split secondary path to the SN via an additional MN-initiated SN modification procedure.

2a. When applicable, the MN provides data forwarding address information to the SN. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message.

3/4. The MN initiates the RRC reconfiguration procedure, including an SN RRC reconfiguration message. The UE applies the new configuration, synchronizes to the MN (if instructed, in case of intra-MN handover) and replies with MN RRC reconfiguration complete message,including an SN RRC response message, if needed. In case the UE is unable to comply with (part of) the configuration included in the MN RRC reconfiguration message, it performs the reconfiguration failure procedure.

5. Upon successful completion of the reconfiguration, the success of the procedure is indicated in the *SN Reconfiguration Complete* message.

6. If instructed, the UE performs synchronisation towards the PSCell of the SN as described in SN addition procedure. Otherwise, the UE may perform UL transmission after having applied the new configuration.

7. If PDCP termination point is changed for bearers using RLC AM, and when RRC full configuration is not used, the SN Status Transfer takes place between the MN and the SN (Figure 10.3.2-1 depicts the case where a bearer context is transferred from the MN to the SN).

8. If applicable, data forwarding between MN and the SN takes place (Figure 10.3.2-1 depicts the case where a user plane resource configuration related context is transferred from the MN to the SN).

9. The SN sends the *Secondary RAT Data Usage Report* message to the MN and includes the data volumes delivered to and received from the UE as described in clause 10.11.2.

NOTE 2: The order the SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN is not defined. The SN may send the report when the transmission of the related QoS flow is stopped.

10. If applicable, a PDU Session path update procedure is performed.

**SN initiated SN Modification with MN involvement**



Figure 10.3.2-2: SN Modification procedure - SN initiated with MN involvement

The SN uses the procedure to perform configuration changes of the SCG within the same SN, e.g. to trigger the modification/release of the user plane resource configuration, to trigger the release of SCG resources (e.g., release SCG lower layer resources but keep SN), and to trigger PSCell changes (e.g. when a new security key is required or when the MN needs to perform PDCP data recovery). The MN cannot reject the release request of PDU session/QoS flows and the release request of SCG resources. The SN also uses the procedure to request the MN to provide more DRB IDs to be used for SN terminated bearers or to return DRB IDs used for SN terminated bearers that are not needed any longer. The SN also uses this procedure to activate or deactivate the SCG. Figure 10.3.2-2 shows an example signalling flow for SN initiated SN Modification procedure.

1. The SN sends the *SN Modification Required* message including an SN RRC reconfiguration message, which may contain user plane resource configuration related context, other UE context related information and the new radio resource configuration of SCG. The SN may request the SCG to be activated or deactivated. In case of change of security key, the *PDCP Change* *Indication* indicates that an SN security key update is required. In case the MN needs to perform PDCP data recovery, the *PDCP Change* *Indication* indicates that PDCP data recovery is required. In case of coordination between the MN and the SN on QoE and RAN visible QoE measurement configuration and reporting, the *SN Modification Required* message may contain the *QMC Coordination Request* IE.

 The SN can decide whether the change of security key is required.

NOTE 3a: In case that a MN initiated conditional reconfiguration (e.g. CHO or MN initiated inter-SN CPC) is prepared, and if any execution of a prepared SN initiated intra-SN CPC procedure or reconfiguration of the SCG, the SN notifies to the MN via the *SN Modification Required* message. In this case, the steps 2 and 3 are skipped.

NOTE 3b: In case of SN initiated inter-SN CPC and in case that a candidate SN triggered the SN Initiated SN Modification procedure to include some prepared PSCells (within the candidate cells suggested by the source SN in SN initiated inter-SN CPC) or to remove some prepared PSCells, the MN may decide to trigger the step 2 towards the source SN.

2/3. The MN initiated SN Modification procedure may be triggered by *SN Modification Required* message, e.g. when an SN security key change needs to be applied.

NOTE 3: For SN terminated bearers to be setup for which PDCP duplication with CA is configured in NR MCG side, the SN allocates up to 4 separate Xn-U bearers and the MN provides a logical channel ID for primary or split secondary path to the SN via the nested MN-initiated SN modification procedure.

4. The MN sends the MN RRC reconfiguration message to the UE including the SN RRC reconfiguration message with the new SCG radio resource configuration.

5. The UE applies the new configuration and sends the MN RRC reconfiguration complete message, including an SN RRC response message, if needed. In case the UE is unable to comply with (part of) the configuration included in the MN RRC reconfiguration message, it performs the reconfiguration failure procedure.

6. Upon successful completion of the reconfiguration, the success of the procedure is indicated in the *SN Modification Confirm* message including the SN RRC response message, if received from the UE. In case of coordination between the MN and the SN on QoE and RAN visible QoE measurement configuration and reporting, the *SN Modification Confirm* message may contain the *QMC Coordination Response* IE.

7. If instructed, the UE performs synchronisation towards the PSCell configured by the SN as described in SN Addition procedure. Otherwise, the UE may perform UL transmission directly after having applied the new configuration.

8. If PDCP termination point is changed for bearers using RLC AM, and when RRC full configuration is not used, the SN Status Transfer takes place between the MN and the SN (Figure 10.3.2-2 depicts the case where a bearer context is transferred from the SN to the MN).

9. If applicable, data forwarding between MN and the SN takes place (Figure 10.3.2-2 depicts the case where a user plane resource configuration related context is transferred from the SN to the MN).

10. The SN sends the *Secondary RAT Data Usage Report* message to the MN and includes the data volumes delivered to and received from the UE as described in clause 10.11.2.

NOTE 4: The order the SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN is not defined. The SN may send the report when the transmission of the related QoS flow is stopped.

11. If applicable, a PDU Session path update procedure is performed.

**SN initiated SN Modification without MN involvement**

This procedure is not supported for NE-DC.



Figure 10.3.2-3: SN Modification – SN initiated without MN involvement

The SN initiated SN modification procedure without MN involvement is used to modify the configuration within SN in case no coordination with MN is required, including the addition/modification/release of SCG SCell and PSCell change (e.g. when the security key does not need to be changed and the MN does not need to be involved in PDCP recovery). The SN may initiate the procedure to configure, modify or release intra-SN CPC configuration within the same SN. Figure 10.3.2-3 shows an example signalling flow for SN initiated SN modification procedure without MN involvement. The SN can decide whether the Random Access procedure is required.

1. The SN sends the SN RRC reconfiguration message to the UE through SRB3.

2. The UE applies the new configuration and replies with the SN RRC reconfiguration complete message. In case the UE is unable to comply with (part of) the configuration included in the SN RRC reconfiguration message, it performs the reconfiguration failure procedure.

3. If instructed, the UE performs synchronisation towards the PSCell of the SN as described in SN Addition procedure. Otherwise the UE may perform UL transmission after having applied the new configuration.

**SN initiated Conditional SN Modification without MN involvement (SRB3 is used)**

This procedure is not supported for NE-DC and NGEN-DC.



Figure 10.3.2-3a: SN Modification – SN-initiated without MN involvement and SRB3 is used to configure intra-SN CPC.

The SN initiates the procedure when it needs to transfer an NR RRC message to the UE and SRB3 is used to configure intra-SN CPC.

1. The SN sends the SN RRC reconfiguration including CPC configuration to the UE through SRB3.

2. The UE applies the new configuration. In case the UE is unable to comply with (part of) the configuration included in the SN RRC reconfiguration message, it performs the reconfiguration failure procedure. The UE starts evaluating the CPC execution conditions for the candidate PSCell(s). The UE maintains connection with the source PSCell and replies with the *RRCReconfigurationComplete* message to the SN via SRB3.

3. If at least one CPC candidate PSCell satisfies the corresponding CPC execution condition, the UE detaches from the source PSCell, applies the stored configuration corresponding to the selected candidate PSCell and synchronises to the candidate PSCell.

4. The UE completes the CPC execution procedure by sending an *RRCReconfigurationComplete* message to the new PSCell.

**Transfer of an NR RRC message to/from the UE (when SRB3 is not used)**

This procedure is supported for all the MR-DC options.



Figure 10.3.2-4: Transfer of an NR RRC message to/from the UE

The SN initiates the procedure when it needs to transfer an NR RRC message to the UE and SRB3 is not used.

1. The SN initiates the procedure by sending the *SN Modification Required* to the MN including the SN RRC reconfiguration message.

2. The MN forwards the SN RRC reconfiguration message to the UE including it in the RRC reconfigurationmessage.

3. The UE applies the new configuration and replies with the RRC reconfiguration complete message by including the SN RRC reconfiguration complete message. In case the UE is unable to comply with (part of) the configuration included in the SN RRC reconfiguration message, it performs the reconfiguration failure procedure.

4. The MN forwards the SN RRC response message, if received from the UE, to the SN by including it in the *SN Modification Confirm* message.

5. If instructed, the UE performs synchronisation towards the PSCell of the SN as described in SN Addition procedure. Otherwise the UE may perform UL transmission after having applied the new configuration.

**SN initiated Conditional SN Modification without MN involvement (SRB3 is not used)**

This procedure is not supported for NE-DC and NGEN-DC.



Figure 10.3.2-5: SN Modification – SN-initiated without MN involvement and SRB3 is not used to configure intra-SN CPC

The SN initiates the procedure when it needs to transfer an NR RRC message to the UE and SRB3 is not used to configure intra-SN CPC.

1. The SN initiates the procedure by sending the *SN Modification Required* to the MN including the SN RRC reconfiguration message with CPC configuration.

2. The MN forwards the SN RRC reconfiguration message to the UE including it in the *RRCReconfiguration* message.

3. The UE replies with the *RRCReconfigurationComplete* message by including the SN RRC reconfiguration complete message. In case the UE is unable to comply with (part of) the configuration included in the SN RRC reconfiguration message, it performs the reconfiguration failure procedure. The UE maintains connection with source PSCell after receiving CPC configuration, and starts evaluating the CPC execution conditions for the candidate PSCell(s).

4. The MN forwards the SN RRC response message, if received from the UE, to the SN by including it in the *SN Modification Confirm* message.

5. If at least one CPC candidate PSCell satisfies the corresponding CPC execution condition, the UE completes the CPC execution procedure by an *ULInformationTransferMRDC* message to the MN which includes an embedded *RRCReconfigurationComplete* message to the selected target PSCell.

6. The *RRCReconfigurationComplete* message is forwarded to the SN embedded in *RRC Transfer* message.

7. The UE detaches from the source PSCell, applies the stored corresponding configuration and synchronises to the selected candidate PSCell.

## 10.5 Secondary Node Change (MN/SN initiated)

<unchanged text omitted>

### 10.5.2 MR-DC with 5GC

**MN initiated SN Change**

The MN initiated SN change procedure is used to transfer a UE context from the source SN to a target SN and to change the SCG configuration in UE from one SN to another.

The Secondary Node Change procedure always involves signalling over MCG SRB towards the UE.



Figure 10.5.2-1: SN change procedure - MN initiated

Figure 10.5.2-1 shows an example signalling flow for the SN Change initiated by the MN:

1/2. The MN initiates the SN change by requesting the target SN to allocate resources for the UE by means of the SN Addition procedure. The MN may include measurement results related to the target SN. If data forwarding is needed, the target SN provides data forwarding addresses to the MN. The target SN includes the indication of the full or delta RRC configuration.

NOTE 1: The MN may trigger the MN-initiated SN Modification procedure (to the source SN) to retrieve the current SCG configuration and SN-associated QMC configuration information, and to allow provision of data forwarding related information before step 1.

2a. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message.

3. If the allocation of target SN resources was successful, the MN initiates the release of the source SN resources including a Cause indicating SCG mobility. The Source SN may reject the release. If data forwarding is needed the MN provides data forwarding addresses to the source SN. If direct data forwarding is used for SN terminated bearers, the MN provides data forwarding addresses as received from the target SN to source SN. Reception of the *SN Release Request* message triggers the source SN to stop providing user data to the UE.

4/5. The MNtriggers the UE to apply the new configuration. The MN indicates the new configuration to the UE in the MN RRC reconfiguration message including the target SN RRC reconfiguration message. The UE applies the new configuration and sends the MN RRC reconfiguration complete message, including the SN RRC response message for the target SN, if needed. In case the UE is unable to comply with (part of) the configuration included in the MN RRC reconfiguration message, it performs the reconfiguration failure procedure.

6. If the RRC connection reconfiguration procedure was successful, the MN informs the target SN via *SN Reconfiguration Complete* message with the included SN RRC response message for the target SN, if received from the UE.

7. If configured with bearers requiring SCG radio resources the UE synchronizes to the target SN.

8. If PDCP termination point is changed for bearers using RLC AM, the source SN sends the *SN Status Transfer* message, which the MN sends then to the target SN, if needed.

9. If applicable, data forwarding from the source SN takes place. It may be initiated as early as the source SN receives the *SN Release Request* message from the MN.

10. The source SN sends the *Secondary RAT Data Usage Report* message to the MN and includes the data volumes delivered to and received from the UE as described in clause 10.11.2.

NOTE 2: The order the SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN is not defined. The SN may send the report when the transmission of the related QoS flow is stopped.

11-15. If applicable, a PDU Session path update procedure is triggered by the MN.

16. Upon reception of the *UE Context Release* message, the source SN releases radio and C-plane related resources associated to the UE context. Any ongoing data forwarding may continue

**SN initiated SN Change**

The SN initiated SN change procedure is used to transfer a UE context from the source SN to a target SN and to change the SCG configuration in UE from one SN to another.



Figure 10.5.2-2: SN change procedure - SN initiated

Figure 10.5.2-2 shows an example signalling flow for the SN Change initiated by the SN:

1. The source SN initiates the SN change procedure by sending the *SN Change Required* message, which contains a candidate target node ID and may include the SCG configuration (to support delta configuration) and measurement results related to the target SN. For supporting QMC continuity during mobility, the *SN Change Required* message may contain the information about the QMC configurations at the source SN.

2/3. The MN requests the target SN to allocate resources for the UE by means of the SN Addition procedure, including the measurement results related to the target SN received from the source SN. If data forwarding is needed, the target SN provides data forwarding addresses to the MN. The target SN includes the indication of the full or delta RRC configuration.

3a. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message.

4/5. The MN triggers the UE to apply the new configuration. The MN indicates the new configuration to the UE in the MN RRC reconfiguration message including the SN RRC reconfiguration message generated by the target SN. The UE applies the new configuration and sends the MN RRC reconfiguration complete message, including the SN RRC response message for the target SN, if needed. In case the UE is unable to comply with (part of) the configuration included in the MN RRC reconfiguration message, it performs the reconfiguration failure procedure.

6. If the allocation of target SN resources was successful, the MN confirms the change of the source SN. If data forwarding is needed the MN provides data forwarding addresses to the source SN. If direct data forwarding is used for SN terminated bearers, the MN provides data forwarding addresses as received from the target SN to source SN. Reception of the *SN Change Confirm* message triggers the source SN to stop providing user data to the UE and, if applicable, to start data forwarding.

7. If the RRC connection reconfiguration procedure was successful, the MN informs the target SN via *SN Reconfiguration Complete* message with the included SN RRC response message for the target SN, if received from the UE.

8. The UE synchronizes to the target SN.

9. If PDCP termination point is changed for bearers using RLC AM, the source SN sends the *SN Status Transfer* message, which the MN sends then to the target SN, if needed.

10. If applicable, data forwarding from the source SN takes place. It may be initiated as early as the source SN receives the *SN Change Confirm* message from the MN.

11. The source SN sends the *Secondary RAT Data Usage Report* message to the MN and includes the data volumes delivered to and received from the UE as described in clause 10.11.2.

NOTE 3: The order the SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN/target SN is not defined. The SN may send the report when the transmission of the related QoS flow is stopped.

12-16. If applicable, a PDU Session path update procedure is triggered by the MN.

17. Upon reception of the *UE Context Release* message, the source SN releases radio and C-plane related resources associated to the UE context. Any ongoing data forwarding may continue.

**MN initiated conditional SN Change**

The Conditional Secondary Node Change procedure is initiated by the MN for inter-SN CPC configuration and inter-SN CPC execution.



Figure 10.5.2-3: Conditional SN change procedure - MN initiated

Figure 10.5.2-3 shows an example signalling flow for the conditional SN Change initiated by the MN:

1/2. The MN initiates the conditional SN change by requesting the candidate SN(s) to allocate resources for the UE by means of the SN Addition procedure, indicating that the request is for CPAC. The MN also provides the candidate cells recommended by MN via the latest measurement results for the candidate SN(s) to choose and configure the SCG cell(s), provides the upper limit for the number of PSCells that can be prepared by the candidate SN. Within the list of cells as indicated within the measurement results indicated by the MN, the candidate SN decides the list of PSCell(s) to prepare (considering the maximum number indicated by the MN) and, for each prepared PSCell, the candidate SN decides other SCG SCells and provides the new corresponding SCG radio resource configuration to the MN in an NR *RRCReconfiguration*\*\* message contained in the *SN Addition Request Acknowledge* message with the prepared PSCell ID(s). If data forwarding is needed, the candidate SN provides data forwarding addresses to the MN. The candidate SN includes the indication of the full or delta RRC configuration. The candidate SN can either accept or reject each of the candidate cells listed within the measurement results indicated by the MN, i.e. it cannot configure any alternative candidates.

NOTE 4: The MN may trigger the MN-initiated SN Modification procedure (to the source SN) to retrieve the current SCG configuration and to allow provision of data forwarding related information before step 1.

2a. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message to the candidate SN(s).

3. The MN sends to the UE an *RRCReconfiguration* messageincluding the CPC configuration, i.e. a list of *RRCReconfiguration\** messagesand associated execution conditions, in which each *RRCReconfiguration\** messagecontains the SCG configuration in the *RRCReconfiguration\*\** messagereceived from the candidate SN in step 2 and possibly an MCG configuration. Besides, the *RRCReconfiguration* message can also include an updated MCG configuration, e.g., to configure the required conditional measurements.

4. The UE applies the *RRCReconfiguration* message received in step 3, stores the CPC configurationand replies to the MN with an *RRCReconfigurationComplete* message. In case the UE is unable to comply with (part of) the configuration included in the *RRCReconfiguration* message, it performs the reconfiguration failure procedure.

4a. Upon receiving the MN *RRCReconfigurationComplete* message from the UE, the MN informs the source SN that the CPC has been configured via Xn-U Address Indication procedure, the source SN, if applicable, together with the Early Status Transfer procedure, starts early data forwarding. The PDCP SDU forwarding may take place during early data forwarding.

NOTE 4a: Separate Xn-U Address Indication procedures may be invoked to provide different forwarding addresses of the prepared candidate target SNs. In this case, it is up to the MN and the source SN implementations to make sure that the EARLY STATUS TRANSFER message(s) from the source SN, if any, is forwarded to the right target destination. The Xn-U Address Indication procedure may further be invoked to indicate to the source SN to stop already initiated early data forwarding for some SN-terminated bearers if they are no longer subject to data forwarding due to the modification or cancellation of the prepared conditional SN change procedures.

NOTE 4b: For the early transmission of MN terminated split/SCG bearers, the MN forwads the PDCP PDU to the candidate SN(s).

5. The UE starts evaluating the execution conditions. If the execution conditionof one candidate PSCell is satisfied, the UE applies *RRCReconfiguration\** message corresponding to the selected candidate PSCell, and sends an MN *RRCReconfigurationComplete\** message, including an NR *RRCReconfigurationComplete*\*\* message for the selected candidate PSCell, and information enabling the MN to identify the SN of the selected candidate PSCell.

6a-6c. The MN triggers the MN initiated SN Release procedure to inform the source SN to stop providing user data to the UE, and if applicable, triggers the Xn-U Address Indication procedure to inform the source SN the address of the SN of the selected candidate PSCell, to start late data forwarding.

7a-7c. If the RRC connection reconfiguration procedure was successful, the MN informs the SN of the selected candidate PSCell via *SN Reconfiguration Complete* message, including the SN *RRCReconfigurationComplete\*\** message. The MN sends the *SN Release Request* message(s) to cancel CPC in the other candidate SN(s), if configured. The other candidate SN(s) acknowledges the release request.

8. The UE synchronizes to the PSCell indicated in the *RRCReconfiguration\** message applied in step 5.

9a-9b. If PDCP termination point is changed for bearers using RLC AM, the source SN sends the message, which the MN sends then to the SN of the selected candidate PSCell, if needed.

10. If applicable, data forwarding from the source SN takes place. It may be initiated as early as the source SN receives the early data forwarding address in step 4a.

11. The source SN sends the *Secondary RAT Data Usage Report* message to the MN and includes the data volumes delivered to and received from the UE as described in clause 10.11.2.

NOTE 5: The order the SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN is not defined. The SN may send the report when the transmission of the related QoS flow is stopped.

12-16. If applicable, a PDU Session path update procedure is triggered by the MN.

17. Upon reception of the *UE Context Release* message, the source SN releases radio and C-plane related resources associated to the UE context. Any ongoing data forwarding may continue.

**SN initiated conditional SN Change**

The SN initiated conditional SN change procedure is used for inter-SN CPC configuration and inter-SN CPC execution.

The SN initiated conditional SN change procedure may also be initiated by the source SN, to modify the existing SN initiated inter-SN CPC configuration, or to trigger the release of the candidate SN by cancellation of all the prepared PSCells at the candidate SN and releasing the CPC related UE context at the candidate SN.

NOTE 5a0: To modify or release an existing intra-SN CPC configuration, the source SN triggers an SN initiated Conditional SN Modification (with or without SRB3) without MN involvement, as specified in 10.3.



Figure 10.5.2-4: Conditional SN change procedure - SN initiated

Figure 10.5.2-4 shows an example signalling flow for the conditional SN Change initiated by the SN:

1. The source SN initiates the conditional SN change procedure by sending the *SN Change Required* message, which contains a CPC initiation indication. The message also contains candidate node ID(s) and may include the SCG configuration (to support delta configuration), and contains the measurements results which may include cells that are not CPC candidates. The message also includes a list of proposed PSCell candidates recommended by the source SN, including execution conditions, the upper limit for the number of PSCells that can be prepared by each candidate SN, and may also include the SCG measurement configurations for CPC (e.g. measurement ID(s) to be used for CPC).

2/3. The MN requests each candidate SN(s) to allocate resources for the UE by means of the SN Addition procedure(s), indicating the request is for CPAC, and the measurements results which may include cells that are not CPC candidates received from the source SN to the candidate SN, and indicating a list of proposed PSCell candidates received from the source SN, but not including execution conditions. Within the list of PSCells suggested by the source SN, the candidate SN decides the list of PSCell(s) to prepare (considering the maximum number indicated by the MN) and, for each prepared PSCell, the candidate SN decides SCG SCells and provides the new corresponding SCG radio resource configuration to the MN in an NR *RRCReconfiguration\*\** message contained in the *SgNB Addition Request Acknowledge* message. If data forwarding is needed, the candidate SN provides data forwarding addresses to the MN. The candidate SN includes the indication of full or delta RRC configuration, and the list of prepared PSCell IDs to the MN. The candidate SN can either accept or reject each of the candidate cells suggested by the source SN, i.e., it cannot configure any alternative candidates.

3a. For SN terminated bearers using MCG resources, the MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message to the candidate SN(s).

4/5. The MN may indicate the candidate PSCells accepted by each candidate SN to the source SN via *SN Modification Request* message before it configures the UE, e.g., when not all candidate PSCells were accepted by the candidate SN(s). If the MN does not send such indication, step 4 and 5 are skipped. If requested, the source SN sends an *SN Modification Request Acknowledge* message and if needed, provides an updated measurement configurations and/or the execution conditions to the MN.

6. The MN sends to the UE an *RRCReconfiguration* message including the CPC configuration, i.e. a list of *RRCReconfiguration\** messagesand associated execution conditions, in which each *RRCReconfiguration\** messagecontains the SCG configuration in the *RRCReconfiguration\*\** message received from the candidate SN in step 3 and possibly an MCG configuration. Besides, the *RRCReconfiguration* messagecan also include an updated MCG configuration, as well as the NR *RRCReconfiguration\*\**\* message generated by the source SN, e.g., to configure the required conditional measurements.

7. The UE applies the *RRCReconfiguration* message received in step 6, stores the CPC configurationand replies to the MN with an *RRCReconfigurationComplete* message, which can include an NR *RRCReconfigurationComplete\*\*\** message. In case the UE is unable to comply with (part of) the configuration included in the *RRCReconfiguration* message, it performs the reconfiguration failure procedure.

8. If an SN RRC response message is included, the MN informs the source SN with the SN *RRCReconfigurationComplete\*\*\** message via *SN Change Confirm* message. If step 4 and 5 are skipped, the MN will indicate the candidate PSCells accepted by each candidate SN to the source SN in the *SN Change Confirm* message.

The MN sends the *SN Change Confirm* message towards the source SN to indicate that CPC is prepared, and in such case the source SN continues providing user data to the UE. If early data forwarding is applied, the MN informs the source SN the data forwarding addresses as received from the candidate SN(s), the source SN, if applicable, together with the Early Status Transfer procedure, starts early data forwarding. The PDCP SDU forwarding may take place during early data forwarding. In case multiple candidate SNs are prepared, the MN includes a list of Target SN ID and list of data forwarding addresses to the source SN.

NOTE 5a: The Xn-U Address Indication procedure may further be invoked to indicate to the source SN to stop already initiated early data forwarding for some PDCP SDUs if they are no longer subject to data forwarding due to the modification or cancellation of the prepared conditional PSCell change.

NOTE 5b: For the early transmission of MN terminated split/SCG bearers, the MN forwads the PDCP PDU to the candidate SN(s).

9a-9d. The source SN may send the *SN Modification Required* message to trigger an update of CPC execution condition and/or corresponding SCG measurement configuration for CPC. In such case in step 9b, the MN reconfigures the UE and in step 9c the UE responds with *RRCReconfigurationComplete*, similarly as in steps 6 and 7.

10. The UE starts evaluating the execution conditions. If the execution conditionof one candidate PSCell is satisfied, the UE applies *RRCReconfiguration\** message corresponding to the selected candidate PSCell, and sends an *RRCReconfigurationComplete\** message, including an *RRCReconfigurationComplete\*\** message for the selected candidate PSCell, and information enabling the MN to identify the SN of the selected candidate PSCell.

11a-11c. The MN triggers the MN initiated SN Release procedure to inform the source SN to stop providing user data to the UE, and triggers the Xn-U Address Indication procedure to inform the source SN the address of the SN of the selected candidate PSCell and if applicable, starts late data forwarding.

12a-12c. If the RRC connection reconfiguration procedure was successful, the MN informs the SN of the selected candidate PSCell via *SN Reconfiguration Complete* message, including the SN *RRCReconfigurationComplete\*\** message. The MN sends the *SN Release Request* message(s) to cancel CPC in the other candidate SN(s), if configured. The other candidate SN(s) acknowledges the release request.

13. The UE synchronizes to the PSCell indicated in the *RRCReconfiguration\** message applied in step 10.

14. If PDCP termination point is changed for bearers using RLC AM, the source SN sends the *SN Status Transfer* message, which the MN sends then to the SN of the selected candidate PSCell, if needed.

15. If applicable, data forwarding from the source SN takes place. It may be initiated as early as the source SN receives the data forwarding address related information from the MN.

16. The source SN sends the *Secondary RAT Data Usage Report* message to the MN and includes the data volumes delivered to and received from the UE as described in clause 10.11.2.

NOTE 6: The order the SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN/target SN is not defined. The SN may send the report when the transmission of the related QoS flow is stopped.

17-21. If applicable, a PDU Session path update procedure is triggered by the MN.

22. Upon reception of the *UE Context Release* message, the source SN releases radio and C-plane related resources associated to the UE context. Any ongoing data forwarding may continue.

## 10.7 Inter-Master Node handover with/without Secondary Node change

<unchanged text omitted>

### 10.7.2 MR-DC with 5GC

Inter-MN handover with/without MN initiated SN change is used to transfer UE context data from a source MN to a target MN while the UE context at the SN is kept or moved to another SN. During an Inter-Master Node handover, the target MN decides whether to keep or change the SN (or release the SN, as described in clause 10.8). Only intra-RAT Inter-Master node handover with/without SN change is supported (e.g. no transition from NGEN-DC to NR-DC).



Figure 10.7.2-1: Inter-MN handover with/without MN initiated SN change procedure

Figure 10.7.2-1 shows an example signalling flow for inter-MN handover with or without MN initiated SN change:

NOTE 1: For an Inter-Master Node handover without Secondary Node change, the source SN and the target SN shown in Figure 10.7.2-1 are the same node.

1. The source MN starts the handover procedure by initiating the Xn Handover Preparation procedure including both MCG and SCG configuration. The source MN includes the source SN UE XnAP ID, SN ID and the UE context in the source SN in the *Handover Request* message.

NOTE 2: The source MN may trigger the MN-initiated SN Modification procedure (to the source SN) to retrieve the current SCG configuration and SN-associated QMC configuration information and to allow provision of data forwarding related information before step 1.

2. If the target MN decides to keep the UE context in source SN, the target MN sends *SN Addition Request* to the SN including the SN UE XnAP ID as a reference to the UE context in the SN that was established by the source MN. If the target MN decides to change the SN allowing delta configuration, the target MN sends the *SN Addition Request* to the target SN including the UE context in the source SN that was established by the source MN. Otherwise, the target MN may send the *SN Addition Request* to the target SN including neither the SN UE XnAP ID nor the UE context in the source SN that was established by the source MN.

3. The (target) SN replies with *SN Addition Request Acknowledge*. The (target) SN may include the indication of the full or delta RRC configuration.

NOTE 2a0: Void.

3a. For SN terminated bearers using MCG resources, the target MN provides Xn-U DL TNL address information in the *Xn-U Address Indication* message.

4. The target MN includes within the *Handover Request Acknowledge* message the MN RRC reconfiguration message to be sent to the UE in order to perform the handover, and may also provide forwarding addresses to the source MN. If PDU session split is performed in the target side during handover procedure, more than one data forwarding addresses corresponding to each node are included in the *Handover Request Acknowledge* message. The target MN indicates to the source MN that the UE context in the SN is kept if the target MN and the SN decided to keep the UE context in the SN in step 2 and step 3.

5a/5b. The source MN sends *SN Release Request* message to the (source) SN including a Cause indicating MCG mobility. The (source) SN acknowledges the release request. The source MN indicates to the (source) SN that the UE context in SN is kept, if it receives the indication from the target MN. If the indication as the UE context kept in SN is included, the SN keeps the UE context.

5c. The source MN sends XN-U Address Indication message to the (source) SN to transfer data forwarding information. More than one data forwarding addresses may be provided if the PDU session is split in the target side.

6. The source MN triggers the UE to perform handover and apply the new configuration.

7/8. The UE synchronizes to the target MN and replies with MN RRC reconfiguration *complete* message.

9. If configured with bearers requiring SCG radio resources, the UE synchronizes to the (target) SN.

NOTE 2a1: The order the UE performs Random Access towards the MN (step 7) and performs the Random Access procedure towards the SN (step 9) is not defined.

10. If the RRC connection reconfiguration procedure was successful, the target MN informs the (target) SN via *SN Reconfiguration Complete* message.

11a. The source SN sends the *Secondary RAT* *Data Usage Report* message to the source MN and includes the data volumes delivered to and received from the UE over the NR/E-UTRA radio as described in clause 10.11.2.

NOTE 2a2: The order the source SN sends the *Secondary RAT Data Usage Report* message and performs data forwarding with MN/target SN is not defined. The SN may send the report when the transmission of the related QoS is stopped.

11b. The source MN sends the *Secondary RAT Report* message to AMF to provide information on the used NR/E-UTRA resource.

12. For bearers using RLC AM, the source MN sends the *SN Status Transfer* message to the target MN, including, if needed, SN Status received from the source SN. The target forwards the SN Status to the target SN, if needed.

13. If applicable, data forwarding takes place from the source side. If the SN is kept, data forwarding may be omitted for SN terminated bearers or QoS flows kept in the SN.

14-17. The target MN initiates the Path Switch procedure*.* If the target MN includes multiple DL TEIDs for one PDU session in the *Path Switch Request* message, multiple UL TEID of the UPF for the PDU session should be included in the *Path Switch Ack* message in case there is TEID update in UPF.

NOTE 3: If new UL TEIDs of the UPF for SN are included, the target MN performs MN initiated SN Modification procedure to provide them to the SN.

18. The target MN initiates the UE Context Release procedure towards the source MN.

19. Upon reception of the *UE Context Release* message from source MN, the (source) SN releases C-plane related resources associated to the UE context towards the source MN. Any ongoing data forwarding may continue. The SN shall not release the UE context associated with the target MN if the UE contest kept indication was included in the *SN Release Request* message in step 5.

# 13 Other aspects

## 13.1 Interference avoidance for in-device coexistence

In-Device Coexistence (IDC) solution as described in TS 36.300 [2] is extended to address EN-DC operation. Only FDM solution, where the list of NR carriers suffering from IDC problems is signalled in IDC indication, is supported in this version of the specifications. The requirement on RRM/RLM/CSI measurements in different phases of IDC interference defined in TS 36.300 [2] is applicable except that for NR serving cell, the requirements in TS 38.133 [8] and TS 38.101-1 [12], TS 38.101-2 [13], TS 38.101-3 [14] apply.

## 13.2 Sidelink

NR Sidelink Communication, V2X Sidelink Communication and NR Sidelink Discovery cannot be configured in MR-DC in this release.

## 13.3 SCG UE history information

The MN stores and correlates the UE History Information from MN and SN(s) as long as the UE stays in MR-DC, forwards UE History Information and optional UE History Information from the UE to its connected SNs. The resulting information is then used by SN for dual-connectivity operation. The SN is in charge of collecting SCG UE history information and providing the collected information to the MN.

If the UE stays in a PSCell for a duration exceeding the maximum value of the Time Stay parameter, the SN may store the PSCell information with consecutive entries using the same PSCell identity. The total stay time in this PSCell is the sum of stay time for all consecutive PSCell with the same identity.

The SN shall provide the collected SCG UE history information, if available, to the MN in the following procedures:

- the SN Release, and SN initiated SN Change procedures

- the MN initiated SN Modification procedure if requested by the MN in this procedure

- the SN initiated SN modification procedure upon PSCell change if subscribed in the SN Addition procedure

When the target NG-RAN node receives the SCG UHI from the source NG-RAN node via Handover Request message for CHO, the target NG-RAN node updates the time UE stayed in cell of the latest PSCell entry (i.e. the source PSCell) when the UE successfully accesses to a candidate cell of the target NG-RAN node. The updated value of the time UE stayed in the source PSCell is equal to the value received from the source NG-RAN node during the Handover Preparation plus the time from receiving Handover Request message from the source NG-RAN node to receiving RRC Reconfiguration Complete message from the UE.

## 13.x Application Layer Measurement Collection

### 13.x.1 Overview

The QoE Measurement Collection function as described in TS 38.300 [3] is extended to address the NR-DC operation. The requirements on the gNB provided in TS 38.300 [3] apply to the MN, together with additional requirements on the MN and the SN provided in following sub-clauses.

### 13.x.2 SRB5

SRB5 is supported in NR-DC, but not in EN-DC, NGEN-DC and NE-DC.

The decision to establish SRB5 is taken by the SN, which provides the SRB5 configuration using an SN RRC message. SRB5 establishment and release can be done at Secondary Node Addition and Secondary Node Change. SRB5 reconfiguration can be done at Secondary Node Modification procedure.

SRB5 is used to send RRC messages (i.e., *MeasurementReportAppLayer* message) including application layer measurement report information directly to the SN.

SRB5 is modelled as one of the SRBs defined in TS 38.331 [4] and uses the NR-DCCH logical channel type.

When the SCG is released, SRB5 is released.

### 13.x.3 QoE Measurement Configuration

#### 13.x.3.1 QoE Measurement Collection Activation and Reporting in NR-DC

For a UE in NR-DC, either the MN or the SN can generate QoE configuration(s) and transmit the configuration to the UE. If both the MN and the SN send QoE configurations to the UE, the MN and the SN do not use the same set of application layer measurement configuration identities, which means there is a unique ID for QoE configurations across MN and SN.

For a UE in NR-DC, the MN and the SN may coordinate QoE measurement collection activation and reporting as follows:

For management-based QoE activation, the MN:

- Allocates the application layer measurement configuration ID, and indicates it to the SN if needed;

- Determines whether the MN or the SN sends the QoE configuration to the UE, in case the SN inquires the MN.

For management-based QoE measurement configurations received directly by the SN from OAM, the SN may perform UE selection. For a selected UE, the SN indicates to the MN the QoE reference of the management-based QoE session and, separately for the QoE reports and RAN visible QoE reports, the SN indicates whether it is going to receive the corresponding reports via the MN (using SRB4) or using SRB5. Upon receiving the request, the MN can decide and notify the SN whether the MN sends the QoE and RAN Visible QoE configuration to the UE, or whether the SN should send the configuration(s) to the UE. The SN can send a QoE and a RAN Visible QoE measurement configuration directly to the UE via SRB3, or in a transparent container to the MN, which then sends the configuration to the UE via SRB1.

For management-based QoE configurations received from OAM and for signalling-based QoE configurations, the MN can only send the configuration to the UE via SRB1, and the UE can send the QoE reports via SRB4 or SRB5.

For a UE in NR-DC, both SRB4 and SRB5 can be configured simultaneously for QoE reporting. The network explicitly indicates to the UE whether to send QoE reports via SRB4 or SRB5, per QoE reference, separately for QoE reports and RAN visible QoE reports. The SRB for QoE reporting can be changed during the application session. The command for changing the SRB used for reporting may be sent to the UE by the node that configured that specific QoE configuration. The node that currently receives the QoE reports via the Uu interface can request from the peer node that the QoE reporting leg is switched to the peer node per QoE Reference. The leg switch for QoE reporting needs to be approved by both nodes serving the UE. RAN visible QoE reports can be sent via the same SRB as the QoE reports pertaining to the same QoE reference, or via a different SRB.

RAN visible QoE reports can be sent to the SN directly via SRB5, or via the MN using SRB4.

If encapsulated QoE reports cannot be sent because the SRB configured for the encapsulated QoE reporting is not available, the UE continues to store the reports until the SRB is available or the QoE configuration is released. If RAN visible QoE reports cannot be sent because the SRB configured for RAN visible QoE measurement reporting is not available, the UE discards the RAN visible QoE report.

The MN should inform the SN that a UE is configured with a management-based QoE/RAN visible QoE measurement configuration.

If the MN has configured the UE with QoE measurements, and if the UE is configured to send the QoE reports to the SN, then, if the MN decides that the SN forwards the reports directly to the MCE, the MN should indicate to the SN the QoE reference, the MCE IP address and the application layer measurement configuration ID.

If the SN has configured the UE with QoE measurements, and if the UE is configured to send the QoE reports to the MN, then, if the SN decides that the MN forwards the reports directly to the MCE, the SN should indicate to the MN the QoE reference and the MCE IP address.

If the SN has released a QoE configuration towards a UE, the SN should inform the MN.

When SCG is deactivated, for QoE configurations configured to use SRB5 for QoE reporting, it is up to network implementation to reconfigure the reporting leg to SRB4, release the QoE configuration or pause the QoE reporting. For UL data arrival on SRB5 while the SCG is deactivated, the UE does not indicate to the MN that it has QoE report to transmit over SRB5 for the purpose of SCG activation.

When the SCG is released, the UE releases all the QoE measurements configured by the SCG and discards the unsent QoE reports configured to be reported via SRB5.

In order to allow the transmission of application layer measurement reports which exceed the maximum PDCP SDU size, the network can inform the UE whether the MN allows RRC segmentation of *MeasurementReportAppLayer* message via SRB4 and whether the SN allows RRC segmentation of *MeasurementReportAppLayer* message via SRB5.

#### 13.x.3.2 RAN Overload Handling

In NR-DC, when RAN overload happens in the node which receives the QoE reports from the UE, the node may coordinate with its peer node to reconfigure the QoE reporting path, by sending the QoE Reporting Path Request in the *QMC Coordination Request* IE, via the SN modification procedure.

When neither the MN nor the SN is able to receive the QoE reports due to RAN overload, the network can indicate to the UE to pause QoE reporting, as specified in TS 38.300 [3].

### 13.x.4 QoE Measurement Continuity for Mobility

For ongoing sessions, QoE measurement continuity is ensured during mobility in NR-DC, e.g., during inter-MN handover (with/without SN change) and SN change scenarios.

To ensure QoE measurement continuity during SN change, the SN-initiated SN modification procedure and/or the MN-initiated SN modification procedure can be used to provide the information about the SN-associated QMC configurations to the MN. The MN can then transfer this information to the new SN during the SN Addition procedure.

To ensure QoE measurement continuity during inter-MN handover with SN change, the source SN should provide the information about the SN-associated QMC configurations to the source MN. During the handover procedure, the target MN is provided with all the information that the source MN has about the SN-associated QMC configuration.

If the MN configured the UE with QoE measurements, every subsequent MN serving the UE can configure and release the RAN visible QoE measurements.