3GPP TSG-RAN WG2 Meeting #112 Electronic R2-20xxxxx

Online, 2 – 13 November 2020

**Agenda item: 8.2.3**

**Source: CATT**

**Title: [AT112-e][231][eDCCA] Progressing conditional reconfiguration for SN initiated inter-SN CPC (CATT)**

**WID/SID: LTE\_NR\_DC\_enh2-Core - Release 17**

**Document for: Discussion and Decision**

# 1 Introduction

This is the report for the following email discussion:

[AT112-e][231][eDCCA] Progressing conditional reconfiguration for SN initiated inter-SN CPC (CATT)

Scope: Discuss the option 1 and option 3 details from P4 of email discussion [Post111-e][920][1] to better understand the technical details between the alternatives (e.g. signalling flows, signalling load, etc.)

Intended outcome: Discussion summary in R2-2010734 (by email rapporteur).

Deadlines phase 1: Monday 9th November, UTC 1200. Phase 1 is to gather information for detail of option 1 and option 3 and technical points for comparison.

Deadline phase 2: email discussion report: 2nd week Thu, UTC 1000

Note that the focus of this email discussion is primarily on proposal 4 of email discussion [1]. The two options listed in Proposal 4 is analysed taken in to account the signalling flow, signalling details in order to understand the options. Also pros and cons of each option are discussed with an intention to select the most appropriate option for SN initiated Inter-SN CPC.

# 2 Discussion

For SN initiated Inter-SN CPC, the SN should provide the CPAC trigger condition. Same as in Rel-16 CPC, the trigger condition in this case can be defined by a measurement identity, given by a measurement configuration provided by the SN.

For SN initiated inter-SN conditional PSCell change, [1] discussed different options for generating the conditional configuration message. The following options were selected for further discussion.

**Option 1: The MN generates CPC. The source SN sets the execution condition and communicates it to the MN. The MN generates the conditional reconfiguration message including the execution condition(s) provided by the source SN and RRCReconfiguration provided by the candidate PSCell(s).**

**Option 3: The source SN generates CPC. The source SN sets the execution condition. The source SN communicates with target SN and receives RRCReconfiguration provided by the candidate PSCell(s). The source SN generates the conditional reconfiguration message and provides it to the MN (possibly in a transparent container) for transmission to the UE.**

**2.1 Discussion of Option 1**

***Option 1: The MN generates CPC. The source SN sets the execution condition and communicates it to the MN. The MN generates the conditional reconfiguration message including the execution condition(s) provided by the source SN and RRCReconfiguration provided by the candidate PSCell(s).***

Figure 1 is an illustration of signaling flow for SN initiated Inter-SN CPC based on Option 1. The figure follows the steps used in a conventional SN initiated SN change procedure as shown in Figure 10.5.1-2 of TS37.340. Note that Figure 1 shows the signaling flow up to the signaling of the conditional configuration for SN initiated Inter-SN CPC to the UE. Signaling upon the execution of CPC is not shown in the figure as the main focus of this discussion is on the generation of conditional reconfiguration for SN initiated Inter-SN CPC.

In this solution, the MN generates a CPC configuration, i.e., the IE *ConditionalReconfiguration* as an MN configuration based on reconfiguration per target candidate (denoted RRCReconfiguration\*\* in Figure 1) and the execution condition per candidate cell. Reconfiguration\*\* per target candidate is provided by each target candidate cell in response to a conditional SN Addition Request. The execution condition per candidate cell is provided by the S-SN in the conditional SN Change Required.



**Figure 1: Configuration of SN-initiated CPC based on option 1.**

**Steps 1:** Based on RRC measurement report received from the UE, source SN decides to initiate the CPC procedure. Source SN determines the set of target SNs for the CPC procedure, and the candidate target PSCells for each target SN. For each candidate target PSCell, source SN determines the CPC execution condition. In the SN Change Required message, source SN provides information relevant to CPC configuration to the MN. In addition to the content of conventional SN Change Required message, CPC execution condition for each candidate target PSCell is included in the SN Change Required message.

**Steps 2:** MN initiates the SN Addition procedure with the set of target SNs indicated in SN Change Required. As a base line, the content of SN addition Request is similar to the conventional SN Addition Request message.

**Step 3:**  The target SN generates RRCReconfiguration\*\* for each candidate PSCell and provides it to the MN in SN addition request acknowledgement message. FFS on inclusion of multiple candidate cell configurations.

**Step 4:**  The MN generates an RRCReconfiguration to be provided to the UE including CPC configuration (as an MN configuration), mapping the execution condition configuration to an RRCReconfiguration\*\* provided by the target SN for candidate PSCell.

**Step 5:** the UE provides RRCReconfigurationComplete message to the MN upon reception of RRCReconfiguration message.

**Question 1: Companies are requested to comment whether Figure 1 is a reasonable representation of signalling flow for SN initiated Inter-SN CPC according to Option 1. For SN initiated CPC based on Option 1;**

**A: CPC configuration is generated by the MN.**

**B: SN provides the execution conditions to the MN.**

**C: the message applied upon CPC execution is in MN format.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree/not agree** | **Comments** |
| Qualcomm | Agree |  |
| Lenovo and Motorola Mobility | Agree | The figure looks fine in general. |
| Sharp | Agree |  |
| CATT | Agree | Figure 1 is a good representation of Option 1. |
| OPPO | Agree |  |
| China Telecom | Agree | The signaling flow in Option1 is reasonable. |
| KDDI | Agree |  |
| ITRI | Agree |  |
| Samsung | Partially | Step 1   * We think that the FFS on support of multiple candidates should also extend to step 1 * S-SN typically will reconfigure measConfig (CPC specific measId and reportConfigs), which will be a regular (non-conditional) reconfiguration. This will be included in same message to UE (i.e. 4) and it will result in embedded complete in msg5, forwarded to S-SN (in Msg6, that is missing)   Step 4:   * We think that the configuration to be applied upon CPC to a candidate target PCell concerns an MN generated message i.e. that MN and T-SN configurations are applied at execution time. For the name of this MN generated message it seems appropriate to use Reconfiguration, to also cover LTE MN case   Step 6 (missing)   * Forwarding of complete to S-SN for non-conditional configurations included in the message (i.e. CPC related measConfig, see previous) |
| Huawei | Agree with comments | On step 1, we don't see why the MN needs to store the execution conditions, while it actually has no clue about them. It would be simpler to let the MN forward all information to each target SN, as prepared by the source SN, and let target SNs provide the (execution condition, configuration) for each candidate target PSCell back to the MN. |
| Apple | Agree |  |
| Nokia | Somewhat agree, but with comments | Fine assuming in A ‘CPC configuration’ = the final message to be sent to the UE.  In Step B it is the target SN that decides on the target PSCells (and not the S-SN). The source SN can provide the execution conditions to the MN once it knows the selected target PSCells. Alternatively, the MN can be provided with an execution condition which could be linked to multiple cells.  Step C is not shown in the figure, correct? So is it enough to conclude its format, based on Step4/5?  Should there be a message from MN to S-SN upon Step5 in Figure 1? |
| ZTE | Agree |  |
| Futurewei | Agree with comments | The meaning of “in MN format” in C is not clear. Consider the scenarios of SN initiated CPAC are most likely the inter-RAT, the configurations applied at the CPC execution should be the configurations generated from the target PSCell as well as MN. |

**Summary of Q1:** all companies agreed that Figure 1 is a reasonable representation of signalling flow for SN initiated Inter-SN CPC according to Option 1. Three companies commented on the details of the inter-node messages. the detail of the messages should eb further discussed. however, for the purpose of comparing option 1and option 3, Figure 1 could be considered.

**Observation 1: for the purpose of comparing option 1and option 3, Figure 1 could be considered to illustrate Option 1.**

**2.2 Discussion of Option 3**

***Option 3: The source SN generates CPC. The source SN sets the execution condition. The source SN communicates with target SN and receives RRCReconfiguration provided by the candidate PSCell(s). The source SN generates the conditional reconfiguration message and provides it to the MN (possibly in a transparent container) for transmission to the UE.***

Option 3 requires communication between the source SN and the target SN. There are two methods for enabling communication between the source SN and the target SN [3].

 the communication between S-SN and T-SN is performed directly

 the communication between S-SN and T-SNs occurs via MN

As discussed in [3], there is no direct communication between the source SN and the target SN is supported today. Enabling direct communication between the source SN and the target SN has a significant specification impact, eg. Xn. Therefore [3] argues that a direct communication between the source SN and the target SN should be avoided.

**Question 2: should direct communication be avoided between the source SN and the target SN?**

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| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Qualcomm | Yes | In our view, direct communication between source SN and target SN has significant specification impact and more signaling overhead than Option 1. |
| Lenovo and Motorola Mobility | Yes | Agree with the view in [3] that direct communication between SNs has significant spec impact while the gain is questionable, e.g. for both option 1 and option 3 with direct SN communication, 4 steps of message exchanges are needed to transmit the conditional configuration to UE.   * For option 1: S-SN -> MN, MN-> T-SN, T-SN->MN, MN->UE * For option 3 with direct SN communication: S-SN->T-SN, T-SN ->S-SN, S-SN->MN, MN->UE |
| Sharp | Yes | We see much spec impact to introduce direct communication between S-SN and T-SN. |
| CATT | Yes | Direct communication is not supported between source SN and target SN. And support of direct communication between the source SN and target SN creates a lot of discussion and specification impacts with limited benefits hence should be avoided. |
| OPPO | Yes | Direct communication between two SNs could not be guaranteed. |
| China Telecom | Yes | 1. Too much RAN3 spec impacts: Current RAN3 spec does not allow a direct interface exists between SN nodes. 2. Performance gain is questionable: If the UE needs sk-Counter (currently provided by MN configuration) or the CPC configuration affects the MN bearer configuration, additional signalling should also be introduced. In addition, from the perspective of signalling delay, compared with option 1, the gain is not cquestionable. Therefore, we prefer that the direct communication should be avoided. |
| KDDI |  | No strong preference, but no direct communication seems to be much simpler. If the direct communication is enabled, MN has to negotiate T-SN with understanding of MN full capability and that seems to be complicated somehow |
| ITRI | Yes | Agree with Lenovo. In comparison with Option 1, Option 3 with direct communication between S-SN and T-SN has no clear benefits, but introduces significant specification impact. |
| Samsung | OK to assume this  (but upto RAN3) | We think this is mainly an issue for R3 to conclude. For now it seems appropriate for R2 to assume direct communication is not possible. We note that direct communication can be relevant in other cases also e.g. subsequent modifications potentially affecting T-SN. |
| Huawei | Yes | Share the same view as rapporteur, this will introduce significant RAN3 impact without clear benefit so should be avoided. |
| Apple | Yes | Agree with rapporteur. |
| Nokia |  | We prefer to limit the specification impact in general. However, in this case, the decision is not in the hands of RAN2. This shall be discussed and decided in RAN3, if such direct signaling is found to be beneficial.  One more thing to clarify: is ‘direct’ also applicable to SN-SN communication via MN, but when MN does not comprehend, just forwards? |
| ZTE | Yes | Agree with rapporteur. |
| Futurewei | Yes. | Direct communication between the source SN and target SN should be avoided. The increased complexity and effort is not justified by the benefit. |

**Summary of Q2:** All companies agreed that it could be assumed that direct communication between the source SN and the target SN should be avoided. final decision should be confirmed by RAN3.

**Observation 2: for this discussion on comparing option 1and option 3, it could be assumed that direct communication between the source SN and the target SN should be avoided.**

Figure 2 shows an illustration of signaling flow for SN initiated Inter-SN CPC based on Option 3. It is assumed that there is no direct communication between the Source SN and target SN. In option 3), the source SN generates CPC. The source SN sets the execution condition. The source SN communicates with target SN and receives RRCReconfiguration provided by the candidate PSCell(s). The source SN generates the conditional reconfiguration message and provides it to the MN (possibly in a transparent container) for transmission to the UE. Some assumptions are made regarding the inter-node messages (step 4) in Figure 2 which need to be finally agreed and discussed in RAN3. The source SN sends an S-Node Change Required message. The MN initiates an SN addition procedure to a target candidate SN. The target SN generates RRCReconfigurtaion\*\* for the candidate cell. The target SN sends S-Node Addition Request Ack message including CG-Config and the target generated RRCReconfigurtaion\*\*. In Step 4, the MN sends the CG-Config, including the target generated RRCReconfigurtaion\*\* to the source SN. Note that S-Node Change confirm message is modified to include CG-Config including the target generated RRCReconfigurtaion\*\* (highlighted in red) in the illustration in Figure 2. This should be discussed and agreed in RAN3. The source SN generates an RRCReconfiguration\* including CPC configuration, RRCReconfiguration\*\* generated by the target SN. Steps as in Rel-16 CPC can be used for the delivery of the source SN generated RRCReconfiguration\* message to the UE. In the illustration in Figure 2, SN initiated SN modification procedure is used to signal the source SN generated RRCReconfigurtaion\* message to the UE via the MN (using SRB1).



**Figure 2: Configuration of SN-initiated CPC based on option 3.**

**Steps 1:** Based on RRC measurement report received from the UE, source SN decides to initiate the CPC procedure. Source SN determines the set of target SNs for the CPC procedure, and the candidate target PSCells for each target SN. For each candidate target PSCell, source SN determines the CPC execution condition but the execution condition is not provided to the MN. In the SN Change Required message, source SN provides information relevant to CPC configuration to the MN in a similar way as in conventional SN change required message.

**Steps 2:** MN initiates the SN Addition procedure with the set of target SNs indicated in SN Change Required. As a base line, the content of SN addition Request is similar to the conventional SN Addition Request message.

**Step 3:** the target SN generates RRCReconfiguration\*\* for each candidate PSCell and provides it to the MN in SN addition request acknowledgement message. FFS on inclusion of multiple candidate cell configurations.

**Step 4:** The MN provides the CG-Config, including the target SN generated RRCReconfiguration\*\* received from the target SN in step 3 to the source SN in S-Node Change Confirm message. This message and the content should be discussed in RAN3.

**Step 5-8:** The source SN generates an RRCReconfiguration\* including CPC configuration, RRCReconfiguration\*\* generated by the target SN and execution condition. Steps as in Rel-16 CPC can be used for the delivery of the source SN generated RRCReconfiguration\* message to the UE under the assumption that MN is not involved with the configuration of CPC.

**Question 3: Companies are requested to comment whether Figure 2 is a reasonable representation of signalling flow for SN initiated Inter-SN CPC according to Option 3. For SN initiated CPC based on Option 3;**

**A: CPC configuration is generated by the source SN.**

**B: SN does not provide the execution conditions to other NW nodes.**

**C: the message applied upon CPC execution is in source SN format.**

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| --- | --- | --- |
| **Company** | **Agree/not agree** | **Comments** |
| Qualcomm | Agree |  |
| Lenovo and Motorola Mobility | Agree | It looks fine in general. |
| Sharp | Agree |  |
| CATT | Agree |  |
| OPPO | Agree |  |
| China Telecom | Agree |  |
| KDDI | Agree |  |
| ITRI | Agree |  |
| Samsung | Partially | We were assuming that MN would initiate a new nested procedure towards T-SN. I.e. that:   * Msg4 would be a new MN initiated request with Msg5 being a response to that * ChangeConfirm would not be used for Msg4 but would continue to be used as final message i.e. for Msg8.   Anyhow we think these actual signaling aspects are mainly up to R3 |
| Huawei | Agree |  |
| Apple | Agree |  |
| Nokia | Agree | Regarding A: the MN just forwards in a transparent manner what has been received from the S-SN?  We think SRB3 could be also used, to avoid some processing and signaling delay over Xn. |
| ZTE | Agree |  |
| Futurewei | Agree | Figure 2 is a reasonable illustration of signalling flow for Option 3. |

**Summary of Q3**: most companies agreed that Figure 2 is a reasonable representation of signalling flow for SN initiated Inter-SN CPC according to Option 3. There are slight variations on hoe to generate message towards target SN , which should be discussed in RAN3, if Option 3 is selected.

**Observation 3: for the purpose of comparing option 1and option 3, Figure 2 could be considered to illustrate Option 3.**

**2.3 Comparison of option 1 and option 3**

In this section we discuss the main technical points for the operation of SN-Initiated Inter-SN CPC.

**MN involvement**

MN involvement of the procedure affects the generation and structure of the final CPC configuration message for Inter-SN CPC.

As discussed in [2,6], the UE needs to be provided with the MN generated sk-Counter in order to derive a new secondary KgNB for the operation of SN terminated DRBs and SRB3. Sk-Counter is provided to the UE as in an MN configuration in the conventional SN addition/change procedures. In option 1, MN generates the final conditional configuration, hence it can also provide the sk-Counter in MN configuration following the legacy signalling approach for sk-Counter.

It is questionable how sk-Counter can be provided to the UE in Option 3. Note that provisioning of sk-Counter was not an issue for Rel-16 CPC as security keys do not need to be refreshed for Intra-SN CPC. But for inter-SN CPC, sk-Counter should be provided to the UE.

It is clear how option 1 allows a key refresh upon an SN change triggered by CPC, as Sk counter is an MN/MCG configuration. However it is not clear how to provide sk-Counter for key refresh in Option 3.

**Question 4: Companies are requested comment on how to provide sk-Counter for key refresh in Option 1 and Option 3.**

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| --- | --- | --- | --- |
| **Company** | **Option 1** | **Option 3** | **Comments** |
| Qualcomm | sk-Counter can be added as part of MCG configuration included in the final conditional configuration message generated by MN | Not possible to provide sk-Counter | For **Option 1**, it seems clear that sk-Counter can be added as part of MN configuration included in the final conditional configuration message generated by MN.  Under the assumption in **Option 3** that source SN generates the final conditional configuration message and that MN is not involved in CPC configuration, any part of MCG configuration, e.g., sk-Counter, cannot be added. If MN involvement in CPC configuration is allowed, then it is possible to add sk-Counter as part of MCG configuration, for each target PSCell. |
| Lenovo and Motorola Mobility | Take legacy approach for sk-Counter as the baseline |  |  |
| Sharp | MN can provide the sk-Counter to UE in the CPC configuration when generate the final CPC configuration | New scheme is needed for this | For option 3, it may need to enhance step2~3 to include the sk-Counter in the CPC configuration. |
| CATT | MN can provide the sk-counter in MN configuration. | Not clear how to provide sk-Counter | It is clear how option 1 allows a key refresh upon an SN change triggered by CPC, as Sk counter is an MN/MCG configuration. However it is not clear how to provide sk-Counter for key refresh in Option 3. |
| OPPO | Agree with Qualcomm | Not possible only if MN involvement in CPC configuration is not allowed. | For Option 3, if MN involvement in CPC configuration is allowed, sk-Counter could be added by MN in the SgNB Change Confirm msg or after reception of SN Modification Required msg including RRCReconfiguration\* from source SN. Otherwise, no. |
| China Telecom | MN generates the sk-Counter and provides it to UE in the final conditional configuration | Not possible to provide sk-Counter | Option 1 is a simple and straightforward solution.  Option 3 has too much impact on current network architecture. |
| KDDI | Sk-counter could be provided by MN |  | We are not sure whether option3 is possible at this moment, maybe a new scheme is needed as Sharp comments above |
| ITRI | Sk-Counter can be provided in the MN generated final conditional configuration message |  |  |
| Samsung | Straightforward i.e. no signaling changes required | MN could provide in Msg4  S-SN can include, using additional within condReconfigToAddMod | We agree that provision of MN configuration is much simpler in case of option 1, assuming that configuration to be applied upon CPC to a candidate target PCell concerns an MN generated message |
| Huawei | in legacy way | Not clear | Share the same view as rapporteur, option 1 can follow legacy way, but it seems not so clear for option 3. |
| Apple | MN generates sk-Counter |  |  |
| Nokia | Added when MN compiles the CPC configuration (prior to step 4 in Figure 1) | This is pretty difficult in this option but can be resolved. First a decision to adopt Option 3 could be taken. |  |
| ZTE | sk-Counter can be added as part of MCG configuration included in the final conditional configuration message generated by MN | Not clear |  |
| Futurewei | Can be done with known legacy method. | Not straight forward. |  |

Summary of Q4: all companies agreed that sk-Counter can be added as a part of MCG configuration included in the final conditional configiuration message to the uE in Option 1. Some companies commented that it is not clear how sk-Counter can be signalled to the UE according to Option 3. Some companies commented that it is not possible or it is very difficult to signal sk-Counter to the UE according to Option 3.

**Observation 4: It is clear how option 1 allows a key refresh upon an SN change triggered by CPC, as sk-Counter is an MN/MCG configuration (i.e sk-counter is provided as a part of MCG configuration included in the final conditional configuration message). However it is not clear how to provide sk-Counter for key refresh in Option 3.**

In conventional SN initiated SN change, the Radio bearer configuration could be changed due to that target SN may not be able to admit some of the SN terminated DRBs. As discussed in [2, 4], DRBs which could not be admitted by the target SN is desirable to be configured as MN terminated DRBs. It would be preferable to perform this change at execution time.

Considering final conditional configuration is performed by the MN, it is clear how the bearer configuration (reflecting the change of SN terminated bearer to MN terminated bearer) be signalled in Option 1. However it is not clear how the CPC configuration affecting MN bearer configuration can be signalled in Option 3.

**Question 5: Companies are requested comment on how the bearer configuration (reflecting the change of SN terminated bearer to MN terminated bearer) be signalled in Option 1 and Option 3.**

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| --- | --- | --- | --- |
| **Company** | **Option 1** | **Option 3** | **Comments** |
| Qualcomm | MN can change the MN bearer configuration when it adds the MCG configuration to the final conditional configuration | Not possible to change MN bearer configuration | Similar to response to Question 4.  For **Option 1**, it seems clear that MN can change the MN bearer configuration when it adds the MCG configuration to the final conditional configuration to be sent to the UE. In general, a separate MN bearer configuration may need to be provided for each target PSCell configuration.  For **Option 3**, it is not possible since MN is not involved in CPC configuration. If MN involvement in CPC configuration is allowed, then it is possible to add MN bearer configuration as part of MCG configuration, for each target PSCell. |
| Lenovo and Motorola Mobility | MN modifies the radio bearer configuration if needed when generating the conditional configuration |  |  |
| Sharp | MN can include the bearer configuration in the CPC configuration when generate the final CPC configuration | New scheme is needed for this | For option 3, agree with QC that MN should be involved in the CPC configuration generation steps, e.g. step2~4, so that the MN bearer configuration can be included in the CPC configuration. |
| CATT | MN can provide the bearer configuration in MN configuration. | Not clear | Considering final conditional configuration is performed by the MN, it is clear how the bearer configuration (reflecting the change of SN terminated bearer to MN terminated bearer) be ignaled in Option 1. However it is not clear how the CPC configuration affecting MN bearer configuration can be ignaled in Option 3. |
| OPPO | Agree with Qualcomm | Not possible only if MN involvement in CPC configuration is not allowed. | For Option 3, similar with the previous question, if MN involvement is allowed, radioBearerConfig consisting of PDCP configuration of the MN terminated bearer could be added by MN in the SgNB Change Confirm msg or after reception of SN Modification Required msg including RRCReconfiguration\* from source SN. Otherwise no. |
| China Telecom | MN changes the MN bearer configuration and forms the final CPC configuration. | MN changes the MN bearer configuration and sends it to the source SN. | In **Option 1**, the source SN contains “SN-terminated DRBs for target SN to consider configuring” in the SN Change Required message (step 1) and sends it to MN. The target SN contains the “Radio bearer configuration of SN-terminated RBs of each target PSCell” in the SN Addition Request Acknowledge message (step 3) and sends it to MN. After receiving it, MN configures the DRBs which refused by the target SN as the MN terminated DRBs. And then forms the final CPC configuration and sends it to the UE.  In **Option 3**, after receiving the “SN-terminated DRBs for target SN to consider configuring” from the source SN (step 1) and the “Radio bearer configuration of SN-terminated DRBs” from the target SN (step 3), the MN configures the DRBs that are not admitted by the target SN as MN terminated DRBs, and then sends it to the source SN in step 5. The source SN forms the final CPA configuration and then sends it to UE by MN (possibly as a transparent container). |
| KDDI |  |  | For option3, agree with QC that MN should be involved in the CPC configuration generation steps. Opton1 seems simpler, but we are also fine to explore enhancement for option3 if we have available discussion time |
| ITRI | The bearer configuration can be included by MN in its generated final conditional configuration message |  |  |
| Samsung | Straightforward i.e. no signaling changes required | Not entirely sure | If MN is able to set this information upon receiving Msg3, the same approach may be used as for sk-Counter. If however, MN can only set this upon receiving Msg5 we are not sure how it can be done (no way for MN to provide the info timely to S-SN, that generates the message for the UE) |
| Huawei | In legacy way | Not possible to change MN bearer configuration without MN involvement | Share the same view as rapporteur, option1 can follow legacy way, but it seems not so clear for option3. |
| Apple | Agree with QC |  | Share QC’s views that for Option 3, MN involvement is required. |
| Nokia | MN does that prior to step 4 in Figure 1. | If no MCG reconfiguration is needed, then Option 3 may be especially justified. |  |
| ZTE | MN can change the MN bearer configuration when it adds the MCG configuration to the final conditional configuration | Not clear |  |
| Futurewei | MN can change the MN bearer configuration to the final conditional configuration in a legacy way | New method has to be developed | New method still involving MN should be developed which conflict to the purpose of option 3. |

Summary of Q5: all companies agreed that legacy procedure can be used to add bearer configuiration (reflecting the change of SN terminated bearer to Mn terminated bearer) in Option 1. Most companies commented that it is not clear how the bearer configuration affecting Mn bearer configuration can be signalled to the UE in Option 3. Feasibility of signalling to include MN radio bearer configuration in Option 3 needs further study.

**Observation 5: Considering final conditional configuration is performed by the MN, it is clear how the bearer configuration (reflecting the change of SN terminated bearer to MN terminated bearer) be signalled in Option 1. However it is not clear how the CPC configuration affecting MN bearer configuration can be signalled in Option 3.**

[6] discusses another aspect of MN involvement at CPC, requirement on capability coordination to facilitate Inter SN CPC. Upon change of SN, the MN and Target SN interact may share some of the UE capabilities and that the nodes interact for this (capability coordination) purpose. E.g. the band combination and/ or feature set combination used by MN/ for MCG may need to be adjusted to facilitate configuration of the SCG configuration included in the condRRCConfig. This means that, the MN configuration may need modification to ensure that, together with the SCG configuration applied at execution time, it respects the UE capabilities. It would again be preferable to avoid that MN configuration should be restricted prior to conditional reconfiguration execution. I.e. if application of the MN configuration cannot be delayed until execution, MN has to restrict its configuration such that in conjunction with every conditional CPC candidate, UE capabilities are respected. This would result in performance loss. Hence, it should be possible to delay application of MN generated fields until CPC execution.

With Option 1, it is clear how to provide MN configuration, affecting capability coordination which could be applied at the CPC execution, to the UE. However it is not clear how this can be enable in Option 3.

**Question 6: Companies are requested comment on how to provide MN configuration (affecting capability coordination which could be applied at the CPC execution) to the UE in Option 1 and Option 3.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Option 1** | **Option 3** | **Comments** |
| Qualcomm | Possible following the usual SN Addition procedure | Not possible | In **Option 1** it is possible following the usual SN Addition procedure. |
| Lenovo and Motorola Mobility | Take legacy procedure for SN addition as the baseline |  |  |
| Sharp | Similar to current SN addition procedure | Not clear yet |  |
| CATT | Following legacy SN addition procedure. | Not clear | With Option 1, it is clear how to provide MN configuration, affecting capability coordination which could be applied at the CPC execution, to the UE. However it is not clear how this can be enable in Option 3. |
| OPPO | Following the legacy procedure |  |  |
| China Telecom | MN generates RRCReconfiguration message including the MN configuration and sends it to UE. | Not clear | For **Option 1**, the MN generates RRCReconfiguration message including the MN configuration and sends it to UE. |
| KDDI | The current SN addition procedure can be considered as a baseline | Not clear | Option3 is required to develop a new mechanism which enables S-SN negotiate with T=SN based on the full understanding of MN capabilities, e.g band combination, features set etc |
| ITRI | Take legacy SN addition procedure as the baseline |  |  |
| Samsung | Straightforward i.e. no signaling changes required | Not entirely sure | Same as for Question 5 |
| Huawei | Basically follow legacy way with some differences potentially | Not clear | Share the same view as rapporteur, option1 can follow legacy way, but it seems not so clear for option3. |
| Apple | Follow legacy way | Not clear |  |
| Nokia | When the UE confirms the CPC execution towards a particular cell, the MN can reconfigure UE’s MCG config. However, this may have some drawbacks and be too late. | Assuming there may be scenarios where MN knows beforehand the UE capabilities will not be exceeded, Option 3 could make sense. |  |
| ZTE | Following the legacy SN addition procedure | Not clear |  |
| Futurewei | Following the legacy SN addition as baseline | Not clear | Share the similar view as rapporteur. MN still have to be involved for option 3. |

**Summary of Q6:** all companies agreed that MN configuration, affecting capability coordination could be signalled to the UE using legacy procedure in Option 1. Similar as in Q5, this is not entirely clear for Option 5.

**Observation 6: With Option 1, it is clear how to provide MN configuration, affecting capability coordination which could be applied at the CPC execution, to the UE. However it is not clear how this can be enable in Option 3.**

**Signalling load for inter-node messages**

Limitation in support of multiple candidate cell configurations in single inter-Node message was discussed in [2,5]. Currently, only one PSCell configuration can be provided in a single inter-Node message (RAN3 scope). If multiple candidate PSCell configurations are to be provided in a single inter-node message, RAN3 should be consulted.

The above issue of multiple candidate PSCell configurations occures if target SN requires providing multiple candidate PSCell in the same target SN. The issue of how to provide multiple candidate PSCell configurations by the target SN is seen in both Option 1 (step 3 in Figure 1) and Option 2 (step 3 in Figure 2).

The number of inter-node messages required for Option 3 is more than that of Option 1 as can be seen in Figure 1 and Figure 2, however the content of the messages are different in option 1 and option 3.

Considering that the target candidate PSCell is chosen by target SN, the MN or Source SN can’t perform the mapping of the execution condition and the candidate target SCG configuration until the MN or source SN received the candidate target SCG configuration in option 1 and option 3 respectively. In order to facilitate mapping of the execution condition and the target SCG configuration, Option 1 requires the provision of a list of execution conditions and candidate PSCells to the MN in step 1 of Figure 1. In option 3, provision of execution condition to the MN or target SN is not required. However, the candidate target SCG configuration should be forwarded to Source SN by the MN (step 4/5) in Figure 2.

**Question 7: Considering the number of inter-node messages and signalling content in each message, companies are requested to comment on/compare the overhead of inter-node messages in option 1 and option 3.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Inter-node signaling in Option 1 (High/low)** | **Inter-node signaling in Option 3 (High/low)** | **Comments** |
| Qualcomm | Potentially lower than Option 3 |  | The higher signaling overhead in Option 3 compared to Option 1 is because of the following reasons:  - Step 2 (Option 3) in which target PSCell SCG configurations are forwarded from MN to source SN;  - Step 5 (Option 3) in which source SN forwards the generated conditional configuration to MN.  The overhead here should be higher than the overhead in transmitting the list of execution conditions in Step 1 in Option 1 (Fig 1).  However, the main concerns or disadvantages with Option 3 are the limitations discussed in responses to Questions 3, 4, and 5 above. |
| Lenovo and Motorola Mobility | Low | High | We are not sure about “In option 3, provision of execution condition to the MN or target SN is not required” in above statement, since the execution condition will be carried in the RRCReconfiguration in step 5 option 3.  In our view, step 4 and step 5 in option 3 produce extra overhead compared to option 1. |
| Sharp |  |  | From figures for option 1 and 3, seems signaling overhead for option 3 is higher than that of option 1.  For option 3, at least there more steps are needed to forward target cell CPC configuration to S-SN (step 4) and to forward CPC configuration from S-SN to MN (step 5). |
| CATT | Low | High | - The number of inter-node messages required for Option 3 is more than that of Option 1  - In option 3, the candidate target SCG configuration should be forwarded to Source SN by the MN (step 4/5) in Figure 2. |
| OPPO | Low | High | In the first step of Option 1, both of execution conditions and candidate PSCell IDs should be sent to MN. In the first step of Option 3, only candidate PSCell IDs should be sent to MN.  Same in the second step of Option 1 and 3, only the candidate PSCell IDs should be sent to target SN from the MN.  In the third step of Option 1 and 3, target SN responds with the same thing: target candidate PSCell configuration.  However, in Option 3, MN have to forward the target candidate PSCell configuration to source SN and in turn receives the final RRCReconfiguraiton from the source SN, which is saved in the Option 1. In addition, an SN modification confirm msg needs to be transmitted from MN towards SN after reception of UE confirmation of receiving final RRCReconfiguration.  Overall, the signaling overhead of Option 3 is greater than Option 1. |
| China Telecom | Low | High | Compared to Option1, the different messages in Option3 from Option 1 are as follow:  - Step 4: MN sends the configuration of target PSCells, the radio configuration of SN-terminated DRBs and MN-terminated DRBs, sk-Counter and the MN configuration to the source SN.  - Step 5: The source SN sends the CPC execution condition, sk-Counter, the MN configuration, the radio configuration of SN-terminated DRBs and MN-terminated DRBs to MN.  - Step 6: MN sends the final conditional configuration to UE as a transparent container.  the step 4 and step 5 (maybe step 6) of Option 3 introduce extra signaling overhead. |
| KDDI |  |  | With the assumption there is no direct interface between S-SN and T-SN, option1 seems to have lower overhead. |
| ITRI | Low | High | Option 3 requires at least more steps of inter-node transmissions in comparison with option 1, e.g. steps 4 and 5 in Figure 2. |
| Samsung | Lower (for single candidate) | Higher (for single candidate) | We assume number of messages is more of a concern than actual message size. We think that with option 3 it is probably easier to support handling of multiple candidates by one inter-node message. This may result in lower number of message, both at initial configuration and subsequent reconfigurations affecting RRC configuration of the CPC candidate  (I.e. T-SN may admit a subset of the candidates suggested by S-SN and return RRC configurations for a subset within inter-node message. S-SN can comprehend which candidates were accepted by T-SN and compile an RRCReconfiguration message only including the accepted candidates) |
| Huawei | Low | High | We do not see message size is an issue, but too many rounds of signaling exchange may lead to long latency. |
| Apple | Low | High | We agree signaling overhead for Option 3 should be considered. We also agree with Huawei that the multiple rounds of signaling exchange lead to longer latency. |
| Nokia | Relatively low | Higher than in Option 1 (if no direct S-SN <-> tgt SN signaling is used)  Can be reduced if SRB3 is enabled. |  |
| ZTE | Low | High | Step 4 and step 5 in option 3 shall cause larger signaling overhead and longer latency, compared to option 1. |
| Futurewei | Low | High | Comparing the Figure 1 and Figure 2, option 3 involving more signaling exchanges among the MN, S-SN and T-SN. It introduce more signaling overhead and latency. |

Summary of Q7: almost all companies agreed that Option 1 results in low overhead compare to Option 3 considering the number of inter-node messages and signaling contents.

**Observation 7: Considering the number of inter-node messages and signaling content in each message, Option 1 may result in low signaling overhead than that of Option 3.**

**RAN3 involvement and Specification impact**

The procedure in Option 1 reuses conventional SN change procedure. Even though, additional message content may need to be included in inter-node messages in Option 1 (step 1), option 1 does not require introducing new inter-node messages.

Option 3 uses Rel-16 Intra-SN CPC based signalling. Rel-16 intra-SN CPC only supported scenario where MN is not involved in the CPC configuration. As discussed in section 2.3, the MN involvement is required for Inter-SN CPC in order to provide sk-Counter, affected MN radio bearer configuration, etc. this would require additional modification to the Rel-16 CPC procedure in RAN2. Required modification on inert-node message to support Option 3 should be discussed in RAN3. Especially the message involved in step 4 in Figure 2 needs further discussion in RAN3.

**Question 8: Considering the above discussion points (inter-node message content, enabling MN involvement in CPC configuration), companies are requested to comment on/compare the specification impact (in RAN2 and RAN3) for introduction of Option 1 and Option 3.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Specification impact of Option 1 (High/low)** | **Specification impact of Option 3 (High/low)** | **Comments** |
| Qualcomm | Potentially lower than Option 3 |  | The **specification impact of Option 1**, as per our understanding:  1. Including execution condition per candidate target PSCell in SN Change Required from source SN to MN in Step 1 of the call-flow in Figure 1. Likely RAN2 impact.  2. In Step 3, in case multiple target PSCell configurations are provided in SN Addition Request Acknowledge, the list of target PSCell IDs at the top level of the message so that MN attaches execution conditions to the appropriate target PSCells. Alternative option is to provide this list in the CG-Config container. Likely RAN3 or RAN2 impact depending upon which of the above options is adopted.  The **specification impact of Option 3**, as per our understanding:  1. Including target PSCell SCG configuration in SN Change Confirm in Step 4 of the call-flow in Figure 2. Likely RAN3 impact.  2. In Steps 3 and 4, in case multiple target PSCell configurations are provided in SN Addition Request Acknowledge, the list of target PSCell IDs at the top level of the messages so that source SN attaches execution condition to the appropriate target PSCells. Alternative option is to provide this list in the CG-Config container. Likely RAN3 or RAN2 impact depending upon which of the above options is adopted. |
| Lenovo and Motorola Mobility | Low | High | Apparently, option 3 requires quite some modification to X2/Xn messages as pointed out by rapporteur. |
| Sharp | Low | High | We expect more spec impact based on the observation in the previous questions 3~5. |
| Sharp | Low | High | We expect more spec impact based on the observation in the previous questions 3~5. |
| CATT | Low | High | -option 1 does not require introducing new inter-node messages  - for Option 3, the message involved in step 4 in Figure 2 adds spec impacts.  - for option 3, how to enable the MN involvement for Inter-SN CPC in order to provide sk-Counter, affected MN radio bearer configuration, etc. would require additional modification to the Rel-16 CPC procedure in RAN2. |
| China Telecom | Low | High | The specification impact of **Option 1** is as follows:  Step 1(RAN2 impact): it needs to introduce additional message content in the SN Change Required message, that is, the CPC execution condition for each candidate.  Step 3(RAN2 impact): the existing container in SN addition request acknowledgement message should be extended to support multiple candidate PSCell configuration.  The specification impact of **Option 3** is as follows:  Step 3(RAN2 impact) : similar to Option 1  Step 4(both RAN2 and RAN3 impact): it needs to introduce additional S-Node Change Confirm message for MN to provide the CG-Config received from the target SN to the source SN. In addition, it may contain the sk-Counter and the MN configuration (affecting capability coordination which could be applied at the CPC execution).. |
| KDDI | Low | High | Share the comments with Lenovo |
| ITRI | Low | High | Based on the discussion points in previous questions, we consider that option 3 will introduce more spec impact than option 1. |
| Samsung | Low | High |  |
| Huawei |  |  | We feel it is hard to compare for now, but at least the specification impact of option1 is clear and acceptable to us. |
| Apple | Low | High |  |
| Nokia | Moderate to low | Higher than Option 1 | In Option 1 legacy INM are used. In Option 3, new messages could be needed (either for direct SN-SN communication or for providing the T-SN’s configs from the MN to the S-SN). |
| ZTE | Low | High | For option 3, the message involved in step 4 and how to provide and encapsulate MN involved configuration (e.g. sk-Counter, MN radio bearer configuration) shall cause more spec impact than option 1. |
| Futurewei | Low | High | Option 1 can largely reuse the legacy spec. while option 3 need to develop new mechanism. |

**Summary of Q8:** all companies agreed that Option 1 would potentially result in lower specification impacts than that of Option 3.

**Observation 8: Considering inter-node message content, enabling MN involvement in CPC configuration, etc., Option 1 would potentially result in lower specification impact (in RAN2 and RAN3) than that of Option 3 for introduction of SN initiated Inter-SN CPC.**

**Any other point to be considered for comparison of Option 1 and Option 3**

**Samsung: Propose to confirm whether from RAN2 perspective it is acceptable to** **support single CPAC candidate per RAN3 message**

We think it would be good for RAN2 to discuss/ conclude whether from RAN2 perspective it is fine to support addition/ modification of a single CPC candidate per RAN3 message. Some remarks regarding this (as mentioned in [2]):

* Single candidate per RAN3 message/ procedure facilitates option 1 (as there is no need for MN to determine which of the multiple candidates were accepted or rejected, e.g. by peeking into an inter-node message)
* Single candidate per RAN3 message/ procedure affects to what extend SN can have a say in selecting/ deciding the PSCell. I.e. in the non-conditional case, it is the SN that decides PSCell based on measurements of multiple candidate PSCells as provided by the node initiating PSCell addition/ change. When there is a single candidate per RAN3 message/ procedure, SN can only have a say in selecting/ deciding the PSCell if:

1. SN delays responding to the RAN3 CPAC requests message so it may collect multiple requests and based on this decide which candidate to actually select
2. The execution condition somehow reflects SN say in PSCell selection, at least regarding RRM measurement related conditions (could be by OAM coordination)

**2.4 Decision on option 1 or option 3 [Phase 2]**

The following observation can be made from the phase 1 discussion.

Observation 1: For the purpose of comparing option 1and option 3, Figure 1 could be considered to illustrate Option 1.

Observation 2: For this discussion on comparing option 1and option 3, it could be assumed that direct communication between the source SN and the target SN should be avoided.

Observation 3: For the purpose of comparing option 1and option 3, Figure 2 could be considered to illustrate Option 3.

Observation 4: It is clear how option 1 allows a key refresh upon an SN change triggered by CPC, as sk-Counter is an MN/MCG configuration (i.e sk-counter is provided as a part of MCG configuration included in the final conditional configuration message). However it is not clear how to provide sk-Counter for key refresh in Option 3.

Observation 5: Considering final conditional configuration is performed by the MN, it is clear how the bearer configuration (reflecting the change of SN terminated bearer to MN terminated bearer) be signalled in Option 1. However it is not clear how the CPC configuration affecting MN bearer configuration can be signalled in Option 3.

Observation 6: With Option 1, it is clear how to provide MN configuration, affecting capability coordination which could be applied at the CPC execution, to the UE. However it is not clear how this can be enable in Option 3.

Observation 7: Considering the number of inter-node messages and signalling content in each message, Option 1 may result in low signalling overhead than that of Option 3.

Observation 8: Considering inter-node message content, enabling MN involvement in CPC configuration, etc., Option 1 would potentially result in lower specification impact (in RAN2 and RAN3) than that of Option 3 for introduction of SN initiated Inter-SN CPC.

Based on observation 1 to 8, we could conclude that Option 1 is more suitable approach than Option 3 for introducing SN-initiated Inter-SN CPC when considering message flow, MN involvement, signalling overhead and specification impacts.

**Question 9: Companies are requested to comment on which option should be used for the generation of conditional reconfiguration for SN initiated inter-SN conditional PSCell change.**

**Option 1: The MN generates CPC. The source SN sets the execution condition and communicates it to the MN. The MN generates the conditional reconfiguration message including the execution condition(s) provided by the source SN and RRCReconfiguration provided by the candidate PSCell(s).**

**Option 3: The source SN generates CPC. The source SN sets the execution condition. The source SN communicates with target SN and receives RRCReconfiguration provided by the candidate PSCell(s). The source SN generates the conditional reconfiguration message and provide it to the MN (possibly in a transparent container) for transmission to the UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| CATT | Option 1 | Option 1 is better than Option 3 when considering how to enable MN involvement, signaling overhead and specification impacts. Also Option 1 follows legacy SN initiated SN change procedure. |
| Samsung | Option 1, but | We think option 1 is better in providing the MN configuration that may need to be set at SN initiated SN change  We furthermore think option 1 is feasible in case we need not support addition/ modification of multiple CPC candidate per inter-node RAN3 message. As this affect the SN say in deciding PSCell, we think it would be good to confirm that from RAN2 perspective the limitation is fine (at least for R17) |
| KDDI | Option1, but | Based on the above discussion, option1 seems to be better than option3. But considering the scope of this discussion is to have better understanding of the technical details so we are also fine to postpone the decision to the next meeting. |
| China Telecom | Option 1 | Option 1 is a simple and straightforward solution.  Option 3 has too much impact on current network architecture. And its performance gain needs further study. |
| Qualcomm | Option 1 | A primary concern with Option 3 is not to be able to include MN configuration changes in the CPC configuration. Trying to do that by allowing MN involvement seems to result in higher signaling overhead, specification impact, and latency even if direct communication between source and target SNs is allowed and SRB3 is enabled. |
| DOCOMO | Option 1, but | Regarding Samsung’ comment above, we think RAN2 should send LS to RAN3 before final decision.  In my understanding, only one P(S)Cell configuration can be provided in a single inter-Node message in CHO and intra SN CPC (RAN3 scope) cases. However, unlike them, in case of legacy inter SN change procedure (as well as legacy SN addition procedure), MN or S-SN makes *candidateCellInfoListMN (or SN)* and sends it to T-SN, and T-SN chooses one of them. It is different from current CHO and intra SN CPC mechanism. If S-SN performs measurement in order to decide candidate PSCell(s) before S-SN decides to request CPC, *candidateCellInfoListMN (or SN)* may be useful to inform T-SN of candidates, and then T-SN may send target PSCell configurations back in a message. Although we think it is straightforward that limitation in support of multiple candidate cell configurations in single inter-Node message, it should be discussed by RAN3 once.  We think that one of advantage of this limitation is that it is easy to map of execution condition and target PSCell configuration. As Samsung pointed out, MN need not to comprehend the content of execution condition and target PSCell configuration, especially in inter RAT scenario. If the MN receives multiple execution conditions with the same message from S-SN and multiple target PSCell configurations the same message from T-SN, the MN need to associate with (i.e., map) them without comprehending them. On the other hand, one of advantage of support of multiple candidate cell configurations in single inter-Node message is that it may reduce internode signaling itself. Therefore, RAN2 should inform RAN3 of current RAN2 perspective and should ask RAN3 to take it into account. |
| Nokia | Option 1, but Option 3 also may work well if SRB3 is used | Option 1 likely has a lower number of issues to address. However, Option 3 seems viable, especially if used together with SRB3. |
| Lenovo and Motorola Mobility | Option 1 | Option 1 is simpler, less spec impact. We have difficulty to see the advantage of Option 3. |
| Huawei | Option 1 | We prefer to keep the solution simple, and generally fine with the description of the option 1. But as commented in phase 1 discussion, we have much more details to figure out. |

# 5 Conclusion

[TBC]

# 6 Reference

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[2] R2-2010088 Progressing conditional configuration for R17 Samsung Telecommunications discussion Rel-17 LTE\_NR\_DC\_enh2-Core

[3] R2-2010626 Further consideration for Conditional PSCell addition and change NTT DOCOMO INC. discussion Rel-17 LTE\_NR\_DC\_enh2-Core Late

[4] R2-2010130 Configuration of Conditional PSCell addition/change Qualcomm Incorporated discussion Rel-17

[5] R2-2010529 Regarding inter MN-SN signaling design for Conditional PSCell Addition Intel Corporation discussion Rel-17 LTE\_NR\_DC\_enh2-Core

[6] R2-2010003 Conditional PSCell Change / Addition Ericsson discussion LTE\_NR\_DC\_enh2-Core

[7] R2-2009771 On Rel-17 Conditional PSCell Addition and Change (CPAC) Nokia, Nokia Shanghai Bell discussion Rel-17 LTE\_NR\_DC\_enh2-Core

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[10]R2-2009379 Discussion on conditional PSCell addition/change ZTE Corporation, Sanechips discussion Rel-17 LTE\_NR\_DC\_enh2-Core

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[14] R2-2009358 Discussion on Further CPAC Enhancements CATT discussion Rel-17 LTE\_NR\_DC\_enh2-Core

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[19] R2-2009260 Coexistence of CHO and CPC InterDigital discussion Rel-17 LTE\_NR\_DC\_enh2-Core

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[22] R2-2010248 Discussion on SN initiated CPC and CPAC Execution ETRI discussion Rel-17 LTE\_NR\_DC\_enh2-Core

[23] R2-2010282 Considerations of CPAC in Rel-17 LG Electronics discussion Rel-17 R2-2007985