3GPP TSG-RAN WG2 Meeting #117 Electronic DRAFTR2-2203638

Elbonia, 21st of Feb – 3rd of Mar 2022

**Agenda item: 8.2.3.2**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Report from [AT117-e][224][DCCA] CPAC procedures from UE perspective (Nokia)**

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

**Document for: Discussion and Decision**

# 1 Introduction

The scope of this paper is as follows:

* [AT117-e][224][DCCA] CPAC procedures from UE perspective (Nokia)

Scope: Attempt to resolve critical open issues for CPAC procedures from UE perspective based on contributions to 8.2.3.2

Intended outcome: Discussion report in R2-2203638.

Deadline: Deadline 3

The topics are discussed in detail within the next sections.

# 2 Discussion

This section is divided topic-wise, based on what has been contributed by the companies.

## 2.1 CPC with deactivated SCG

First topic to discuss in this thread concerns the coexistence of two main WI objectives, namely CPC and deactivated SCG. This has been listed within [1] and also addressed in several papers to RAN2#117, e.g. [3][5][7][9][12][13]. Various approaches have been provided:

* SCG activation state is included in conditionalReconfiguration [7]
* T-SN prepares candidate PSCells with suggested SCG state [5]
* No CPC triggering when SCG is deactivated[2][7][10]
* UE always considers SCG as activated when executing CPC [12]
* Do not support/address this coexistence [9][11][3]

The basic question should be whether this topic needs to be addressed in Rel-17 and what are the possible consequences if such coexistence is not resolved via specification.

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| **Question 1: Do you think the coexistence of CPAC and SCG deactivation needs to be addressed via specification? Please clarify in the Comments column what is the expected behavior.** | | |
| **Company** | **Answer** | **Comments** |
| CATT | No | These options seem not orthogonal to each other.  RAN2 agreed that “the work will focus on the single deactivated SCG”, it could be understood that SCG deactivation with CPAC scenario is deprioritized. Thus, we think there is not necessary to mix the discussion of CPAC and deactivated SCG, especially considering of the limited time of R17.  And if needed, we can add some restrictions in the specification as provided in our TP in [9] R2-2203101. |
| Huawei, HiSilicon |  | CPC cannot be configured if the SCG is deactivated, SCG cannot be deactivated if CPC is configured, support the corresponding TP in [9] |
| Intel | No | We can add some restriction in spec to not support this coexistence. |
| LG | Yes | CPC is helpful to keep the connection when radio link has sudden deteriorate. So, there is no significant reason to stop CPC when SCG is deactivated.  We think it is not appropriate for the network to pre-configure the SCG state in CPC configuration because the network does not know when the CPC condition will be met in the UE. However, to prevent unnecessarily SCG activation upon CPC execution in SCG deactivated state, the UE should maintain the SCG state of S-SN, i.e., deactivated state. This is consistent with what previous agreements have attempted to prevent unnecessary SCG (de)activation. (It seems our suggestions from R2-2202767 are missed in this document.) |
| ZTE | No | Considering of the limited time in R17, it’s fine to not support the coexistence of CPAC and SCG deactivation. The TP in [9] seems fine to us. |
| Lenovo, Motorola Mobility | Yes, if spec impact is minimal | In the RAN2 and RAN3 discussion so far, UE can add or switch to a new SCG that is deactivated. So, we feel the same principle can be simply applied in CPAC. The only complexity we foresee is if SN can accept the addition due to CPAC but reject the SCG (de)activation as discussed in RAN3. If we can agree T-SN cannot reject the SCG (de)activation due to CPAC if accept the SN addition, the following steps are straight forward i.e. indicate SCG state in conditional configuration. |
| MediaTek | No | For the sake for progress, we prefer NOT to support the coexistence of CPAC and SCG deactivation in Rel-17. |
| Ericsson | No | We support the coexistence, as we do not need to change the specifications. Why shouldn’t be allowed that CPC is configured if the SCG is deactivated, and SCG is deactivated be deactivated if CPC is configured, if this does not require spec changes? Not sure we follow the reasoning behind this thought. |
| Apple | Prefer No | We prefer not to consider the combination of the two features. |
| NEC | No | CPC is expected to reduce a failure and/or latency (in accessing PSCell) during PSCell change. However, there is almost no gain in this coexistence, because RACH is not performed in target PSCell. So, we prefer not to support this to avoid spending time for further discussions and specification changes. |
| Nokia | No | The inter-working of CPAC and SCG de-activation can be useful but the time might be limited in Rel. 17 to address this topic, especially as we have not discussed this at all so far. We prefer to defer the inter-working of the features to future 3GPP releases. |
| Samsung | Please see the comments. | Regardless of whether this coexistence is supported or not, it needs some level of a specification on that decision. One way could be blocking deactivation on CPC configured UE from network as CATT. And we are also ok to only block CPC execution during deactivation while keeping conditional Reconfiguration, which can reduce the network’s signalling when SCG changes its state. |
| Sharp | Yes | It seems too restricted to not support configuration of both SCG deactivation and CPC for a UE, as the two are for different purposes. And consider the limited time of R17, we think the simple way is no CPC triggering/execution when SCG is deactivated in Rel-17 and the combination should be considered at future release. |
| Qualcomm | Yes | There are two issues to consider:  1. Whether CPC can be triggered if SCG is deactivated:  We think that CPC can be triggered if SCG is deactivated. If CPC gets triggered, it means that UE should perform PSCell change since the source PSCell is not providing good coverage. If CPC is not allowed to be triggered if SCG is deactivated, then UE may lose DC connectivity.  2. Whether SCG state can be set to deactivated in a CPC configuration:  We think that SCG state cannot be set to deactivated in a CPC configuration since the time until when CPC gets triggered is unknown and a target SN cannot determine whether there would be SCG traffic to transmit when CPC gets triggered. Upon completing CPC execution, network may configure the SCG to be deactivated, if needed. |
| ITRI | No | Considering the limited time in Rel. 17, we think it is better to postpone the discussion and decision on the coexistence of CPAC and SCG deactivation to future releases. |
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## 2.2 Unsynchronized update of MCG configuration

Another topic which ultimately deserves to be resolved is how to handle the update of MCG configuration when it is also to be modified when CPC triggers. MN does not know the point in time when new MCG configuration will be applied by the UE, so there might be a configuration mismatch (i.e. MN expects the UE uses “old” configuration while the UE has already applied “new” MCG configuration). This has been addressed at least by the authors of [2][3][6][7][8][9][10][11].

Some companies claim this can be addressed via NW implementation, but that would actually require the MN to somehow wait for UE’s message using any configuration. It has been also proposed that the UE can respond to the MN using the old configuration and then apply the new one and complete CPC (via sending another message to the MN). This is a possible approach, but causing some delay in the overall procedure and in rapporteur’s opinion may lead to another issue when the UE (later) fails to comply with the new configuration, while the UE has already confirmed (earlier) the use of the new configuration.

Companies are asked to provide their views below.

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| **Question 2: How to resolve the “unsynchronized update of MCG configuration” issue? Choose from the list and provide the details:**   1. **UE sends ULInformationTransferMRDC using old config and then subsequently the RRCReconfigurationComplete using new configuration** 2. **UE sends ULInformationTransferMRDC with embedded RRCReconfigurationComplete** 3. **Up to the NW how to handle it** 4. **Other** | | |
| **Company** | **Answer** | **Comments** |
| CATT | c) | The intention of the CPAC is to configure the target PSCell configuration, the MN configuration related to the target PSCell configuration mainly includes the *sk-counter* and provide the *RadiobearerConfig* for the UE, i.e., the contained MCG configuration for each candidate PSCell will not include the SRB configuration to update the SRB or lower layer configuration of the MN, at least network can guarantee that MN can receive the RRC Reconfiguration Complete message upon CPAC execution.  And if needed, we can add some restrictions in the specification as provided in our TP in [9] R2-2203101. |
| Huawei, HiSilicon | c) | We have no time to design a new mechanism.  For c), we don't see the need to capture anything.  In b), what is the use of encapsulating the RRCReconfigurationComplete? |
| Intel | a or c | We are ok to leave it to NW. And if we specify the UE behaviour, we think option b) breaks the current default model that a complete message is generated only after the UE applies the configuration. As the UE is sending the UL message (with the encapsulated complete message) using the old configuration, it will not be possible for UE to apply the new reconfiguration before sending the complete. |
| LG | c | The MN should store both old and new MCG configurations until CPAC execution. How the MN maintains both configurations and how the MN differentiate the configuration of UE RRC message are up to the network implementation. |
| ZTE | c) | We think it can be up to the NW implementation to handle this. And no need to capture anything in the spec. |
| Lenovo, Motorola Mobility | c | We agree NW implementation can handle this. And agree with CATT that SRB configuration is unlikely to be modified during CPAC. |
| MediaTek | c | Same view as CATT. |
| Ericsson | a or b | The following understanding seems inaccurate “the contained MCG configuration for each candidate PSCell will not include the SRB configuration to update the SRB or lower layer configuration of the MN”. Target candidate SN(s) may have different capabilities, which may lead the MN to reconfigure different MCG configuration (including lower layers, measurements, etc.). If we add a restriction to the MN, CPAC would look different and possibly worse than legacy PSCell Addition/ Change from that perspective and further complicate network implementation. |
| Apple | c | CATT has a point. And even though if NW changes the SRB configuration, we would prefer NW to handle it. |
| NEC | a) or c) | Slightly prefer a) but with a condition that the UE shall perform compliance check before sending ULInformationTransferMRDC to avoid the issue pointed out by Rapporteur. Otherwise, c). |
| Nokia | b) | Option b) has the lowest signaling overhead and delay.  It is not clear how this issue can be resolved by the network implementation (can the supporters of c) provide solid details?). It may actually restrict the MCG configurations that can be provided to the UE as part of CPC configuration.  We agree with Ericsson – the MCG config can be different for different CPC candidate PSCells, so how come such a large number of potential configurations is found to be easily handled by the NW? |
| Samsung | c | We are ok to leave it to NW. MN already know the possible mismatch of the configuration upon receiving ULInformationTransferMRDC for CPC completion message. As from CATT’s reasoning , there seems no critical configuration mismatch so that network cannot handle that. |
| Sharp | c) | Since the time between configuring the CPC to UE and CPC execution may not be long, it seems not a hard work for the network to wait for UE’s response using any configuration just within this short time. |
| Qualcomm | Option c) |  |
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## 2.3 Target SN’s full or delta-configuration

For few meetings RAN2 is considering how to efficiently use delta-configuration for T-SN config when CPC is prepared. The topic has been mentioned at least in [2][3][7][9][12]. In rapporteur’s understanding, the acceptance of all suggested PSCells by T-SN is a relatively simple case, as the S-SN will not update its configuration, due to the preparation of the full set of suggested cells. Thus, delta configuration can be rather safely used by the T-SN without major risk of configuration mismatch. However, in a more likely scenario, not all cells will be acknowledged by T-SN and S-SN may still want to pursue reconfigurations after T-SN preparations. According to some papers, using full-config does not seem to be an efficient way and restricts NW’s flexibility too much. Please note that in rapporteur’s understanding, this may also be signalling-heavy, if all candidate cells (e.g. up to 8 CPC candidates) are prepared using full configuration. Thus, companies are asked to share their views on this topic.

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| **Question 3: How to ensure the T-SN can use delta-configuration for preparing PSCells even when not all suggested PSCells are acknowledged and eventually prepared?** | |
| **Company** | **Answer** |
| CATT | In [9] R2-2203101 we discussed on this matter and we have suggested TPs to handle them. In details we think there are two different aspects to discuss.  For measConfig except for measGap, e.g., measIds, measObjects and reportConfig, we think that NW can avoid using delta configuration based on CPC related measIds, measObjects and reportConfig (i.e., but for other non-CPC related parameters, delta configurations are possible), since the NW already knows that these CPC related measIds, measObjects and reportConfig configuration will be deleted by UE automatically upon CPC execution.  While, for measGap, it is common for both CPC related measurements and normal RRM measurements, and the UE will not delete the measurement gap related configuration automatically upon CPAC execution. Therefore, we need to restrict T-SN shall always use full configuration to generate the measurement gap related configurations during CPAC configuration. |
| Huawei, HiSilicon | If the S-SN wants to reconfigure the UE after T-SN preparation, the S-SN can ask the T-SN to update the conditional configurations and include the update of the conditional configurations in the reconfiguration message to the UE.  So we see no problem.  With respect to the note proposed by CATT:  - the parts on measObject/reportConfig is unclear  - gaps are configured by the MN only (not by T-SN) unless for the case of EN-DC with per FR gaps  We are not sure this note is useful. |
| LG | No strong view but if the CPC can be affected by reconfiguration from S-SN after configuring CPC to the UE, T-SN would be better to use full configuration for simple solution. However, since there is a clear gain for both the UE and the network in using the delta configuration, the delta configuration seems necessary if possible. Since, in our view, S-SN should know whether the T-SN will use the delta configuration for this case, additional signaling between the T-SN and the S-SN to inform whether the delta configuration is allowed may be necessary. |
| ZTE | For the measurement configuration of candidate PSCell, we share the same view with CATT that the T-SN should not provide delta configuration based on CPC related meas configuration (which shall be removed upon successful completion of CPC), but allow the delta configuration for non-CPC related part.  For the measGap configuration, a possible solution to also avoid full configuration on this, is that the S-SN provide a CPC specific measGap to the UE after knowing the accepted candidate PSCells by T-SN (i.e. in case of EN-DC with per FR gaps), similar to CPC related measId/reportConfig. The CPC specific measGap is only used during CPC evaluation, and shall be released upon successful completion of one CPC procedure. So the T-SN can still provide the delta configuration of measGap for the candidate PSCell based on the original gap configuration. It may require the UE to store two sets of measGap configuration, so the UE can apply the new candidate PSCell configuration based on the original configuration. But it can save signalling overhead for providing full measGap configuration for all candidate PSCells (at most 8). |
| Lenovo, Motorola Mobility | Delta configuration is possible for non-CPC specific configurations, e.g., source SN can inform target SN about the updated configuration, if any, via MN. For CPC specific measurement configuration, CATT has a point that the CPC related measurement configuration will be released after CPC execution, so a note in the spec as CATT proposed could be helpful. |
| Ericsson | When T-SN generates the RRCReconfiguration, delta is supported. However, if the T-SN wants to configure a measurement gap, it needs to be explicitly included as the T-SN should assume that the UE’s current gap configuration may have been modified by the S-SN. When it comes the SCG MeasConfig for CPC and execution conditions, these are deleted upon successful execution, so they may be modified without the need to update the TC-SN. |
| Apple | If some configurations are updated by S-SN, a new round of exchange can be performed. We also agree with CATT’s analysis on measurement configuration. |
| NEC | We agree with CATT and ZTE on the measurement configuration. For measGap, we assume it would be much simpler to apply the full configuration in CPC, which works with good trade-off between simplicity and signalling overhead.  On the other hand, we have general concern on delta configuration. In any case, we see additional signalling is needed for delta-configuration. For example, during evaluation phase of CPC, if the S-SN modifies the source SCG configuration but such modification is not informed to the candidate T-SN, the delta configuration will not work as expected. To avoid this, the S-SN should inform the modification to the candidate T-SN via MN so that the candidate T-SN can modify the CPC configuration. This already cause additional signalling over X2/Xn and Uu. Thus, it may be simpler to always apply the full configuration for inter-SN CPC. Having said that, if majority considers such case will not happen or signalling reduction by delta configuration is more important, we can also support the delta. |
| Nokia | The solution of providing always full configuration for CPC is very limiting and causes high signalling overhead considering that multiple cells can be prepared.  The source SN knows the best whether there might be a need to update the SN measurement configuration after the target SN provides the CPC configurations. So, we propose that source SN indicates to target SN whether full or delta configuration shall be applied for CPC configurations.  We are against specifying the procedures using a NOTE (supported above by CATT and others). |
| Samsung | We think in principle to use S-SN configuration modification procedure has no problem when the S-SN configuration is updated after the CPC configuration is given to the UE. If companies think this additional signalling is heavy then we think to use the note by CATT. |
| Sharp | Firstly, we share the same view with the rapporteur that delta configuration should be supported to avoid heavy signalling of full configuration. And in order to make this possible, S-SN may inform MN/T-SN whether delta-configuration can be used or not in case that one or more suggested cells(or which cells) are rejected. |
| Qualcomm | One possible approach that may not have significant signalling overhead is that the T-SN always uses full configuration but only for the SCG measurement configuration or the SCG measurement gap configuration. |
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## 2.4 Number of CPC configurations and coordination

RAN2 needs to also decide on the number of CPC configurations that can be supported in Rel-17 and their relationship with other CPC (e.g. intra-SN CPC, as defined in Rel-16) or CHO (if the decision to support CHO/CPC coexistence is taken) features. The topic was addressed at least by the authors of [2][3][9][11][12].

As has been observed in [3], as not all procedures will be initiated by the same node, there may be a need for inter-node coordination, especially if the UE is allowed to be configured with a relatively low total number of conditional configurations in parallel. In the simplest approach, there might be a static split of the number of CPC configurations each node can initiate. This would also have to consider the configuration ID handling. Please share any views you may have on this topic.

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| **Question 4: Considering various types of Conditional Reconfigurations for PSCell (CPA, intra-SN CPC, inter-SN CPC MN- or SN-initiated), what shall be the maximum supported number of CPAC configurations in Rel-17?** | | |
| **Company** | **Answer** | **Comments** |
| CATT | Assuming that no coexistence of any types of CHO, R16 CPC or R17 CPAC is supported, we prefer the following:  8 for MN initiated CPA;  8 for SN initiated CPC;  8 for MN initiated CPC; | In legacy, the maximum number of candidate configurations that the NW can configure for CHO or R16 CPC is 8, which is a trade-off among lots of factors, e.g. signalling overhead, future extension. From our perspective, the same principle should also apply to R17 CPAC. |
| Huawei, HiSilicon | Same view like CATT |  |
| Intel | Same view like CATT |  |
| LG | 8 | See comments in Q5. |
| ZTE | 8 | Can simply reuse the maximum number defined for R16 CHO or R16 CPC. |
| Lenovo, Motorola Mobility | Same view like CATT | We can rediscuss this if RAN2 agree to support some coexistence scenario. |
| Ericsson | 8 | See other email discussion |
| Apple | Same view like CATT |  |
| NEC | 8 | At first, it should be clarified whether intra-SN CPC and inter-SN CPC can coexist? Depending on this, the answer could be different. Here, we assume not to support coexistence of intra-SN CPC and MN-initiated inter-SN CPC for simplicity (e.g. to avoid much signalling due to modifications of MN-initiated CPC configuration after intra-SN CPC execution).  Then, we do not think it would be good to keep so many preparations in parallel. Total 8 will be sufficient. |
| Nokia | 8 | Similar to CHO, we propose to have 8 for CPAC including both Rel. 17 inter-SN CPC and Rel. 16 intra-SN CPC. |
| Samsung | Same view with CATT | In principle, we have the same view on number 8 for each sub-feature. But even for R17 CPAC, there could be three types of subfeatures, and if we don’t allow any combination of coexistence among these sub-features, this feature seems lame. |
| Sharp | 8 |  |
| Qualcomm | 8 | The maximum number of CPAC configurations that can be configured for a UE should be 8, as in CHO. |
| ITRI | Same view with CATT |  |
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Assuming your answer to Q4 is greater than 0, please also share your opinion how to ensure the coordination between the nodes.

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| **Question 5: How the coordination between MN and SN on CPAC configuration handling is done, so that the maximum number of configurations is not exceeded?** | |
| **Company** | **Answer** |
| CATT | As commented in Q4, we prefer no existence between the features. Therefore, we don’t see a strong need to introduce any coordination. We just follow the Rel-16 mechanism that this is based on OAM, i.e., MN/SN is aware whether to configure a feature or not. |
| Huawei, HiSilicon | Same view like CATT. Supposing there is coexistence between SN-initiated Rel-17 CPC and Rel-16 CPC, no coordination is needed. |
| LG | We think RAN2 needs to newly define the maximum number of candidate PSCells for conditional mobility as 8 irrespective of that for PCell conditional mobility. Then, the UE supports up to 16 candidate cells for PCell/PSCell conditional mobility, where 16 candidate cells are distinguished by type of configuration, i.e., there are 8 candidate cells for CHO and 8 candidate cells for CPAC. If the maximum numbers for PCell and PSCell conditional mobility are defined independently each other, there is no need to MN-SN coordination to arbitrate the maximum numbers of candidate PCells and PSCells. |
| ZTE | For simplicity, the MN can directly decide the maximum number of candidate cells to be configured for SN initiated CPC and inform the SN. |
| Ericsson | This is being discussed in the other email discussion, right? This is not about network procedures. |
| Apple | If no coexistence is supported, there would be no need for coordination. |
| NEC | As commented in Q4, we assume there is no coexistence of intra-SN CPC and MN-initiated inter-SN CPC, although how to ensure this still needs to be considered. Also, we do not expect any coexistence of CPA and CPC. So, the coordination should be between MN-initiated inter-SN CPC and SN-initiated inter-SN CPC. Like measurement coordination, the MN can allocate a space/number available for SN-initiated inter-SN CPC. |
| Nokia | Agree, there is certain overlap between [223] and [224]. Our view is as follows (it is not overly complex):  In case intra-SN CPC execution is triggered first, the inter-SN CPC configurations are released by the UE but not in the network side since intra-SN CPC execution is transparent to MN. As a result, MN cannot release the configured MN-initiated inter-SN CPC at the target node or re-initiate the preparation of MN-initiated inter-SN CPC configurations, if needed.  For the coordination between MN and source SN with respect to MN-initiated CPC and intra-SN CPC, the following is proposed:   1. MN informs source SN about MN-initiated CPC even in case early data forwarding is not performed. 2. If informed by MN about MN-initiated CPC, source SN informs MN when an intra-SN CPC is executed and includes the new SCG configuration such that MN can use it for re-triggering the preparation of MN-initiated CPC.   As the proposals require extension of network node interfaces, we propose to send an LS informing RAN3 about the need to specify a coordination mechanism with respect to MN-initiated CPC and intra-SN CPC. |
| Samsung | As Huawei commented, if coexistence between R16 CPC and R17 SN initiated CPC is allowed, then there is no need of coexistence. If coex among CHO, R17 CPA and R17 MN initiated CPC is allowed, also no need of coordination. In the other combinations, there should be a coordination between MN and SN. The easiest way is for MN just to indicated the allowable max number of conditional reconfiguration to SN, and SN can follow. We don’t think this takes lots of time or effort to realize in the spec. |
| Qualcomm | In cases where different nodes initiate CPC procedures at almost the same time, e.g., MN initiated Inter-SN CPC and SN initiated Intra-SN CPC, the simplest approach as proposed by the rapporteur is a static split of the number of CPC configurations each node can initiate.  After CPC preparation initiated by a node is complete, the node may indicate to the other node the number of CPC configurations prepared. The other node may then initiate additional preparations if the total number of CPC configurations is less than 8. |
| ITRI | The MN involves in all types of R17 CPAC procedure and knows the number of already configured candidate cells, so it can decide the maximum number of candidate cells allowed for SN- or MN- initiated procedure and inform S-SN if needed. |
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# 3 Conclusion

The following proposals have been made in this document:

**Proposals for agreement:**

**Proposal y:**

**Proposals for discussion:**

**Proposal x**

# References

1. R2-2202029 Open issues for MR DC/CA further enhancements 3GPP TSG-RAN WG2#116bis-e Online, 17 - 25 January 2022
2. R2-2202305 Discussion on CPAC procedures from UE perspective vivo
3. R2-2202469 Open issues on Rel-17 CPAC procedures from UE perspective Nokia
4. R2-2202516 Text proposal to Uu siganling in CPAC Apple
5. R2-2202578 Discussion on CPAC with deactivated SCG Lenovo, Motorola Mobility
6. R2-2202777 Discussion on CPAC related open issues LG Electronics
7. R2-2202825 Remaining issues on CPAC from UE perspective ZTE Corporation, Sanechips
8. R2-2202924 Discussion on UE behaviour upon CPC execution MediaTek Inc
9. R2-2203101 Remaining issues on CPAC from UE perspective CATT
10. R2-2203171 Remaining issues for CPAC in UE perspective Samsung
11. R2-2203379 Remaining issues for CPAC Huawei, HiSilicon
12. R2-2203433 UE procedures and signalling for CPAC Ericsson
13. R2-2203476 CPC and SCG deactivation Sharp