3GPP TSG-RAN WG2 #119-bis-e R2-22xxxxx

Electronic meeting, 10th – 19th October 2022

Agenda Item: x.x.x

Source: Ericsson

Title: [Post119-e][048][feMob] Candidate target configurations for L1/L2 mobility

Document for: Discussion, Decision

# 1 Introduction

This paper addresses the following email discussion:

* [Post119-e][048][feMob] Candidate target configurations for L1/L2 mobility (Ericsson)

Scope: Explore/Identify the pros/cons of options on the table in the support of the different target scenarios, supporting with high performance cell changes without reconfiguration. Can identify specific aspects of the configurations, that are potentially necessary.

Intended outcome: Report, with proposals to be addressed at next meeting.

Deadline: long (to next meeting)

According to the chair instruction, the outcome of this email discussion is for the next RAN2 meeting in October. Because of this, the rapporteur would like to set the following deadlines:

A first round with Deadline on Friday September 24th 10:00 UTC to provide comments an input.

A final round with Final Deadline on Thursday September 29th 12:00 UTC to check the report and the proposals.

# 2 Contact information

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| --- | --- | --- |
| Company | Name | Email address |
| MediaTek | Li-Chuan TSENG | li-chuan.tseng@mediatek.com |
| InterDigital | Brian Martin | Brian.martin@interdigital.com |
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# 3 Discussion

## 3.1 Aspects to be considered when modelling a candidate target configuration for L1/L2 inter-cell mobility

Before going deep into the possible RRC models for configure a L1/L2 inter-cell mobility candidate target cell, it would be good to set what aspects one should keep in mind when analysing the pros and cons of a certain model. This is because how to configure a L1/L2 inter-cell mobility candidate target cell may have an impact on the latency (of course) but also on the configuration and execution parts of the overall L1/L2 inter-cell mobility procedure.

According to this, in addition to the latency caused by a certain model (that seems quite a straightforward aspect), one should also at least consider how the model is scalable when considering the scenarios that needs to be addressed in the WID, but also how complex is a certain model. Further, also the degree of configuration flexibility in relation to the signalling overhead required should also be kept in mind when analysing the different RRC models.

**Question 1**: Do companies agree that the following aspects should be kept in mind when considering a certain RRC model for modelling a candidate target configuration for L1/L2 inter-cell mobility?

* Impact on latency
* Support of the scenarios mentioned in the WID (i.e., non-CA, CA, NR-DC, inter-DU, intra-DU, inter-frequency, intra-frequency)
* Complexity
* Degree of configuration flexibility versus signalling overhead.

*Please provide in the “Detailed comments” column if there is some other aspect that you think should be considered.*

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| Company | Yes/No | Detailed comments |
| MediaTek | Yes | The abovementioned aspects are important. Regarding configuration flexibility, we think it should consider not only the flexibility of candidate configurations, but also the flexibility or configuration complexity for UE to switch between candidates (e.g., UE switching back-and-forth between two nearby cells)  Moreover, we’d like to point out that only one solution should be selected from the three for candidate configuration in L1/L2-based inter-cell mobility. |
| InterDigital | Yes |  |
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## 3.2 RRC models for a candidate target configuration for L1/L2 inter-cell mobility

The first aspect to be clarified is what is meant with a L1/L2 inter-cell mobility candidate target configuration. Regarding this, one interpretation is that, in L1/L2 inter-cell mobility, a candidate target configuration is an RRC configuration used by the UE to operate in a candidate (target) cell and that is received and stored by the UE during preparation (e.g., in an *RRCReconfiguration* message) before the network sends the lower layer switching command for L1/L2 inter-cell mobility execution. Therefore, the following question is asked:

**Question 2**: Do companies agree that a L1/L2 inter-cell mobility candidate target configuration is a configuration for L1/L2 inter-cell mobility received in an RRC message (e.g., *RRCReconfiguration* message) and that is used to operate in a L1/L2 inter-cell mobility candidate target cell upon later reception of a lower layer switching command from the network?

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| Company | Yes/No | Detailed comments |
| MediaTek | Yes |  |
| InterDigital | Yes | We assume the UE will receive multiple candidate configurations, and L1/2 signalling is used to trigger the reconfiguration to one (or potentially more, in case of SpCell + SCell changes and depending on model) of those |
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To model a L1/L2 inter-cell mobility candidate target configuration, different RRC models can be considered. Hereafter we are going to analyse pros and cons of the main three RRC models that has been decided in the last RAN2 meeting to be considered in this email discussion.

### 3.2.1 Model 1: one *RRCReconfiguration* message for each candidate target configuration

This is the solution that provides the full flexibility in the modelling of a L1/L2 inter-cell mobility candidate target configuration (similar to a L3 handover). In this case the UE receives one *RRCReconfiguration* message for each L1/L2 inter-cell mobility candidate target cell. Each *RRCReconfiguration* message containing the configuration of a L1/L2 inter-cell mobility candidate target SpCell and SCell(s) needs to be stored by the UE upon reception and applied/used/activated when receiving the lower layer signaling for L1/L2 inter-cell mobility serving cell change by the network.

To address CA, each *RRCReconfiguration* has a *CellGroupConfig* IE, with an SpCell configuration and the configuration of one or more SCell(s). In inter-DU, a target candidate DU (which may be the same as the Serving DU) generates the *CellGroupConfig* IE for the target candidate and provides to the CU, which generates the *RRCReconfiguration* per target candidate cell to be included in the L1/L2 inter-cell mobility configuration. In such a model, upon L1/L2 inter-cell mobility execution (reception of the lower layer signaling) the UE changes its SpCell and the set of SCells for the MCG (or SCG).

RRCReconfiguration-IEs ::= SEQUENCE {

radioBearerConfig RadioBearerConfig OPTIONAL, -- Need M

masterCellGroup OCTET STRING (CONTAINING CellGroupConfig) OPTIONAL, -- Cond SCG

measConfig MeasConfig OPTIONAL, -- Need M

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension RRCReconfiguration-v1530-Ies OPTIONAL

}

RRCReconfiguration-vXXXX-Ies ::= SEQUENCE {

candidates-L1L2-Config-r18 Candidates-L1L2-Config OPTIONAL,

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension RRCReconfiguration-v1530-Ies OPTIONAL

}

Candidates-L1L2-Config-r18 ::= SEQUENCE {

candidates-L1L2-ToRemoveList-r16 Candidates-L1L2-ToRemoveList-r18 OPTIONAL, -- Need N

candidates-L1L2-ToAddModList-r16 Candidates-L1L2-ToAddModList-r18 OPTIONAL, -- Need N

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}

Candidates-L1L2-ToAddModList-r18 ::= SEQUENCE (SIZE (1.. maxNrofL1L2Candidates-r18)) OF Candidates-L1L2-ToAddMod-r18

candidates-L1L2-ToAddMod-r18 ::= SEQUENCE {

candidates-L1L2-Id-r18 Candidates-L1L2Id-r18,

candidates-L1L2-CellsConfig-r18 OCTET STRING (CONTAINING RRCReconfiguration) OPTIONAL,

}

**Figure 1. Example of configuring a L1/L2 inter-cell mobility candidate target configuration with an RRCReconfiguration message (*Note that this ASN.1 implementation is just an example, and the final implementation of this model may look different*).**

Even if this solution allows for full flexibility, one may question whether this full flexibility is needed as only few configurations and/or parameter (e.g., as generated by a target candidate DU) may change when performing the execution of L1/L2 inter-cell mobility serving cell change. Further, the fact that the UE needs to process and store multiple *RRCReconfiguration* messages may result in long latency unless restrictions on what can be reconfigured and stricter latency requirements in the RRC processing of the message(s) are applied.

**Question 3**: Companies are invited to provide pros and cons of this solution and whether or not they see it feasible to be used as RRC model for a L1/L2 inter-cell mobility candidate target cell.

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| Company | Pros | Cons |
| MediaTek | Such ‘CHO-like’ method may be straightforward as it allows us to ‘reuse’ the CHO works. | This method may not be a good choice for L1/L2 mobility. The reasons are two-fold: First, modelling candidates using *RRCReconfiguration* container provided best configuration flexibility (everything can be reconfigured), but since the scenario is limited to intra-CU, layers above RLC should not be reconfigured (e.g., *RadioBearerConfig* should be the same) upon cell switch. If we adopt this method, we may need to clarify in the spec which part should not change. Second, unlike CHO where other candidates are released upon HO/CHO execution, in L1/L2-mobility we expect that UE switches between 2 or 3 nearby cells. This is not possible if the candidates are modelled as *RRCReconfiguration* unless every *RRCReconfiguration* is a full config. Signalling optimization is possible, but then we cannot reuse CHO designs. |
| InterDigital | This could allow the same framework to be used for both CHO and L1/2 cell change. With correct design of “delta” configuration the overhead may not be significantly worse than any other option. It would also be more future proof in case e.g. inter-CU is supported in the future. | It can work but in most cases only cell switch is needed, and inter-CU is not needed for L1/2 mobility in R18 so this degree of flexibility may be overkill. |
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### 3.2.2 Model 2: one CellGroupConfig IE for each candidate target configuration

In this model the UE receives within an *RRCReconfiguration* message a list of *CellGroupConfig* IEs and each one of them associated to a configuration of a L1/L2 inter-cell mobility candidate target cell. In this case, each *CellGroupConfig* IE is stored at the UE upon reception, during preparation. The configuration may be applied/used/activated when receiving the lower layer signaling for L1/L2 inter-cell mobility serving cell change by the network.

RRCReconfiguration-Ies ::= SEQUENCE {

radioBearerConfig RadioBearerConfig OPTIONAL, -- Need M

masterCellGroup OCTET STRING (CONTAINING CellGroupConfig) OPTIONAL, -- Cond SCG

measConfig MeasConfig OPTIONAL, -- Need M

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension RRCReconfiguration-v1530-Ies OPTIONAL

}

RRCReconfiguration-vXXXX-Ies ::= SEQUENCE {

candidates-L1L2-Config-r18 Candidates-L1L2-Config OPTIONAL,

lateNonCriticalExtension OCTET STRING OPTIONAL,

nonCriticalExtension RRCReconfiguration-v1530-Ies OPTIONAL

}

Candidates-L1L2-Config-r18 ::= SEQUENCE {

candidates-L1L2-ToRemoveList-r16 Candidates-L1L2-ToRemoveList-r16 OPTIONAL, -- Need N

candidates-L1L2-ToAddModList-r16 Candidates-L1L2-ToAddModList-r16 OPTIONAL, -- Need N

…

}

Candidates-L1L2-ToAddModList-r18 ::= SEQUENCE (SIZE (1.. maxNrofL1L2Candidates-r18)) OF Candidates-L1L2-ToAddMod-r18

candidates-L1L2-ToAddMod-r18 ::= SEQUENCE {

candidates-L1L2-Id-r18 Candidates-L1L2Id-r18,

candidates-L1L2-CellsConfig-r18 OCTET STRING (CONTAINING CellGroupConfig) OPTIONAL,

}

**Figure 2. Example of configuring a L1/L2 inter-cell mobility candidate target configuration with a list of CellGroupConfig IEs (*Note that this ASN.1 implementation is just an example, and the final implementation of this model may look different*).**

This model allows the target node to modify/release/keep any parameter/field that is part of a *CellGroupConfig* IE while the rest of the *RRCReconfiguration* message (that is where the *CellGroupConfig* IE is received by the UE) remain unchanged. This means that some higher layer configurations e.g., bearers, and security are not changed when performing the switch from a L1/L2 inter-cell mobility serving cell to a target cell, which makes sense as the UE is in the same CU.

As in the previous case, CA is easily addressed as each *CellGroupConfig* IE has an SpCell configuration and the configuration of one or more SCell(s). In inter-DU, a target candidate DU (which may be the same as the Serving DU) generates the CellGroupConfig for the target candidate and provides to the CU, which includes it in the L1/L2 inter-cell mobility configuration (easier for CU compared to previous case). In such a model, as in the previous one, upon L1/L2 inter-cell mobility execution (reception of the lower layer signaling) the UE changes its SpCell and the set of SCells for the MCG (or SCG) by changing the CellGroupConfig configuration.

Further, among the benefits that this model brings, the configuration received by the UE works both in case of DC and CA and can be equally used in case of intra-DU and inter-DU scenarios. Most importantly, the configuration received by the UE is quite lean and thus its processing and application should be faster than in case of receiving the whole *RRCReconfiguration* message.

**Question 4**: Companies are invited to provide pros and cons of this solution and whether or not they see it feasible to be used as RRC model for a L1/L2 inter-cell mobility candidate target cell.

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| Company | Pros | Cons |
| MediaTek | This method supports all scenarios (CA/non-CA, NR-DC, intra/inter-DU, intra-/inter-frequency), with reasonable signalling overhead. It also allows UE to switch back-and-forth between two candidate CGs, by e.g., keep two MCG configurations and applying the one for selected CG. Note that the cellGropuConfig needs not to be “full config”, signalling optimization is possible (e.g., keep some “reference cellGroupConfig” and model candidates as delta config) | No (This is our preference) |
| InterDigital | In case of inter-DU it is likely that cell group reconfiguration is needed. | For intra-DU where only the SpCell and/or SCell config changes this option could result in too much configuration overhead. Configuring one CellGroupConfig for each and every candidate cell is not necessary. Configuring one CellGroupConfig for multiple candidate cells seems more intuitive (this could also be supported using correct delta signalling design, there is not much difference) |
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### 3.2.3 Model 3: one SpCellConfig IE (and eventually SCellConfig IE) for each candidate target configuration

With this model, the UE receives a list of *SpCellConfig* IEs (and eventually a list of *SCellConfig* IEs) one for each L1/L2 inter-cell mobility candidate cell. In this case, each *SpCellConfig* IE (and *SCellConfig* IE) is stored at the UE in the moment is received and is applied/used/activated when receiving the lower layer signaling for L1/L2 inter-cell mobility serving cell change by the network.

CellGroupConfig ::= SEQUENCE {

cellGroupId CellGroupId,

rlc-BearerToAddModList SEQUENCE (SIZE(1..maxLC-ID)) OF RLC-BearerConfig OPTIONAL, -- Need N

rlc-BearerToReleaseList SEQUENCE (SIZE(1..maxLC-ID)) OF LogicalChannelIdentity OPTIONAL, -- Need N

mac-CellGroupConfig MAC-CellGroupConfig OPTIONAL, -- Need M

physicalCellGroupConfig PhysicalCellGroupConfig OPTIONAL, -- Need M

spCellConfig SpCellConfig OPTIONAL, -- Need M

sCellToAddModList SEQUENCE (SIZE (1..maxNrofSCells)) OF SCellConfig OPTIONAL, -- Need N

sCellToReleaseList SEQUENCE (SIZE (1..maxNrofSCells)) OF SCellIndex OPTIONAL, -- Need N

...,

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candidate-L1L2-Config Candidates-L1L2-Config OPTIONAL,

}

Candidates-L1L2-Config-r18 ::= SEQUENCE {

sCell-L1L2-ToRemoveList-r18 Candidates-L1L2-ToRemoveList-r18 OPTIONAL, -- Need N

sCell-L1L2-ToAddModList-r18 SEQUENCE (SIZE (1..maxNrof-L1L2-Cells)) OF SCellConfig OPTIONAL, -- Need N

spCell-L1L2-ToRemoveList-r18 Candidates-L1L2-ToRemoveList-r18 OPTIONAL, -- Need N

spCell-L1L2-ToAddModList-r18 SEQUENCE (SIZE (1..maxNrof-L1L2-Cells)) OF SpCellConfig OPTIONAL, -- Need N

}

**Figure 3. Example of configuring a L1/L2 inter-cell mobility candidate target configuration with a list of SpCellConfig IEs (*Note that this ASN.1 implementation is just an example, and the final implementation of this model may look different*).**

This model allows for less flexibility compared to the models based on the *RRCReconfiguration* message and the *CellGroupConfig* IEs in terms of what may be modified during L1/L2 inter-cell mobility execution, but the configuration received by the UE to be applied/ switched to is even more lean, which speeds up the processing during L1/L2 inter-cell mobility execution. Nevertheless, while this model works fine for configuring the P(S)Cell, the UE also needs a list of *SCellConfig* IEs to support CA. Here the tricky part is that one *SpCellConfig* may be associated with one or multiple *SCellConfig* IEs and thus also a mapping between candidate P(S)Cell and SCell(s) needs to be provided, either during preparation and/or execution. One advantage of this model is that it enables the possibility to have L1/L2 inter-cell mobility execution per serving cell (e.g., SCell(s)), not for the whole cell group.

**Question 5**: Companies are invited to provide pros and cons of this solution and whether or not they see it feasible to be used as RRC model for a L1/L2 inter-cell mobility candidate target cell.

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| Company | Pros | Cons |
| MediaTek | Signalling overhead may be low | This method may not support inter-DU scenario, where RLC/MAC configurations are needed |
| InterDigital | Suitable for most cases of cell change (SpCell and/or SCell). | We don’t really agree with the rapporteur’s suggestion that one SpCellConfig needs to be associated with one or more SCellConfig, a more intuitive approach would be to have a list of multiple candidate cells, each having an SpCellConfig and an SCellConfig (i.e. the candidate cell can be configured as either a SpCell or an SCell).  Cell group reconfiguration, however, needs to be supported for inter-DU, this may require a different ASN.1 structure, although this isn’t a significant drawback. Each candidate cell can be linked with a CellGroupConfig, it’s not complicated. |
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## 3.3 Final remarks and additional aspects

According to the inputs provided in section 3.2, the final aspect is which RRC model is the preferred one to be used for modelling a L1/L2 inter-cell candidate target configuration. In doing this, please keep in mind that during the last RAN2#119-e meeting the following agreement was made:

* The design for intra-DU and inter-DU L1/L2-based mobility should share as much commonality as reasonable. FFS which aspects need to be different.

**Question 6**: Which RRC model do companies believe that is the most appropriate for modelling a L1/L2 inter-cell mobility candidate target configuration?

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| Company | Model (1/2/3) | Detailed comments |
| MediaTek | Model 2 |  |
| InterDigital | Model 2/3 | A hybrid approach could also be considered. It’s not necessary to provide a cell group configuration for every possible cell change (e.g. intra-DU) when the ServingCellConfig would suffice. On the other hand, there are some cases (at least inter-DU) which require cell group reconfiguration. We could consider multiple cell group configurations (e.g. 1 per DU), each having multiple candidate cell (SpCell and SCell) configurations, rather than having a cell group configuration for every single possible cell change. While this would need more of an ASN.1 structure re-design, it isn’t particularly complicated e.g. we just need to associate a list of candidate cell configs with each CellGroupConfig (e.g. SpCell + SCell config for each candidate cell associated with the cell group) and provides a reasonable trade-off between overhead and flexibility.  As long as the L1/2 signalling can uniquely identify the candidate cell configuration, and we consider how to do the delta signalling in a good way, then actually any of the 3 models can work and they are not that different – it’s not completely clear at this stage which one would be best because we have not agreed the overall procedure.  Perhaps we should look more at the stage 2 details before agreeing the ASN.1 signalling structure. |
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Finally, companies are invited to provide additional inputs on aspects that should be considered in the email discussion and that have not been included so far.

**Question 7**: Companies are invited to point out additional aspects that should be addressed in this email discussion and that not included so far.

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| Company | Detailed comments |
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# 5 Conclusion

Based on the discussion in the previous sections we propose the following:

[Proposal 1 To be updated.](#_Toc509923397)