3GPP TSG-RAN WG3 #111e R3-21xxxx

Online, 26 Jan- 5 Feb 2021

Agenda Item: 10.2.6

Source: Lenovo, Motorola Mobility (moderator)

Title: Summary of Offline Discussion on Mobility Enhancement Optimization

Document for: Approval

# Introduction

**CB: # 1011\_SONMDT\_MobEnh**

**DAPS**

**- Case 3 and 8? Other scenarios?**

**- Mixed scenario of case 1 and case 6: HOF@Target->report DAPS HO failure@src->RLF@src?**

**- Scenario where a successful HO is followed by a DASP HO?**

**- DAPS specific failure types?**

**- MRO for successful DAPS handover?**

**- Which Xn messages to use?**

**- What information should be included in the RLF report for DAPS HO MRO?**

**CHO**

**- CHO failure types**

**- Candidate cell list?**

**- CHO execution condition(s)?**

**- Time since CHO configuration to immediate HO trigger?**

**- Time UE have stayed in source cell?**

**- Time between the first CHO execution and the latest CHO command received?**

**- Successful CHO recovery related information?**

**- Whether the execution condition associated with CHO recovery cell is met or not?**

**- Two consecutive failures in CHO**

**- Optimization of the number of prepared cells**

**- Which Xn messages to use?**

**LS to RAN2**

**May also discuss other issues based on papers submitted**

**Try to reach high-level agreements in the first phase, proceed to TPs and draft LS in the second phase of the email discussion**

(Lenovo - moderator)

Summary of offline disc [R3-210999](file:///C:\\Users\\daimz4\\AppData\\Local\\Microsoft\\Windows\\INetCache\\Content.Outlook\\4WYYS2HU\\Inbox\\R3-210999.zip)

# For the Chairman’s Notes

The following proposals can be agreed:

Propose the following:

R3-20xxxa, R3-20xxxc merged

R3-20xxxc rev [in xxxg] – agreed

R3-20xxxd rev [in xxxh] – agreed

R3-20xxxe rev [in xxxi] – agreed

R3-20xxxf rev [in xxxj] – endorsed

Propose to capture the following:

**Agreement text…**

**Agreement text…**

**WA: carefully crafted text…**

**Issue 1: no consensus**

**Issue 2: issue is acknowledged; need to further check the impact on xxx. May be possible to address with a pure st2 change. To be continued…**

# Enhancements for CHO

The agreement on MRO for CHO in RAN3#110e:

* Cover CHO failure scenarios; whether to define CHO specific failure types or reuse the existing failure types with some necessary update is FFS.
* CHO recovery procedure is considered in the definition of failure types and/or failure types detection.
* At least the following CHO failure scenarios need to be considered: Too Late CHO Execution, Too early CHO Execution, and CHO to Wrong Cell. FFS on how CHO recovery applies to legacy HOs. FFS on other failure scenarios.
* UE reports the time elapsed since CHO execution until connection failure to network (LS to RAN2).
* the source node needs to know the candidate cell list and CHO execution condition(s). It is FFS on how the source node knows these information
* if UE has experienced failure twice, UE reports information related with the two failures (LS to RAN2 for confirmation)
* Data forwarding enhancements on HO to wrong cell is de-prioritized in this WI
* Resource optimization for Conditional Handover is FFS.

## Failure scenarios and types

In RAN3#110e, it was agreed that:

* *CHO recovery procedure is considered in the definition of failure types and/or failure types detection.*

In RAN2#111e, it was agreed that:

|  |
| --- |
| *=> The following scenarios are considered:*  *1) Successful CHO and HO (i.e. no failure happens). FFS consideration in RAN2/3*  *2) Unsuccessful CHO due to late CHO execution.*  *3)* *Unsuccessful CHO after CHO execution.*  *4) Successful or Unsuccessful CHO after unsuccessful CHO or handover failure.*  *Note: other scenarios are not ruled out…* |

In RAN2#112e, it was further agreed that [3]

|  |
| --- |
| *In case of successive CHO related failures, the UE stores and reports both RLF related information in the RLF report. The successive failure referred above, includes at least the following scenarios.*  *a. A UE that has CHO configuration declares RLF in the source cell. The UE selects for connection re-establishment a configured candidate CHO target cell. The UE fails to re-establish to the selected CHO candidate cell.*  *b. A UE that has CHO configuration executes the CHO towards the target cell upon fulfilling the configured condition and experiences a HO failure. The UE selects for connection re-establishment a configured candidate CHO target cell. The UE fails to re-establish to the selected CHO candidate cell.*  *c. A UE that has CHO configuration executes the normal HO towards the target cell and experiences a HO failure. The UE selects for connection re-establishment a configured candidate CHO target cell. The UE fails to re-establish to the selected CHO candidate cell using CHO procedure.*  *Note: other scenarios still can be discussed.* |

For CHO, [1] and [2] provide the detailed failure scenarios. [2] illustrates the sub-scenarios for too late handover in Figure 1, the too early handover in Figure 2, and handover to wrong cell in Figure 3 and Figure 4.



**Figure 1 too late handover failure type**

In a summary, the scenarios for too late CHO may include the following cases:

Case 1: the UE receives CHO configuration; an RLF occurs in the cell before CHO execution; the UE attempts to re-establish the radio link connection in a cell other than the source cell.

Case 2: the UE receives CHO configuration; an RLF occurs in the cell before CHO execution; the UE attempts to CHO recovery in a CHO candidate cell.

Case 3: the UE receives CHO configuration; an RLF occurs in the cell before CHO execution; the UE attempts to CHO recovery to a CHO candidate cell but fails; the UE attempts to re-establish the radio link connection in a cell other than the source cell.

Case 4: the UE receives CHO configuration; an RLF occurs in the cell before CHO execution; the UE attempts to CHO recovery to a CHO candidate cell but fails; the UE attempts to re-establish the radio link connection in the source cell.

Case 5: the UE receives CHO configuration; an RLF occurs in the cell before CHO execution; the UE attempts to CHO recovery to a CHO candidate cell and successes; the UE occurs an RLF in a short period after CHO recovery; the UE attempts to re-establish the radio link connection in a cell other than the source cell.

Case 6: the UE receives CHO configuration; an RLF occurs in the cell before CHO execution; the UE attempts to CHO recovery to a CHO candidate cell and successes; the UE occurs an RLF in a short period after CHO recovery; the UE attempts to re-establish the radio link connection in the source cell.

**Q1: Companies are invited to provide their view on whether to consider the above scenarios for too late CHO?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | Yes | We shall start from the definition used for classic too late, with the prior CHO config as a criterion for CHO-related failure (like 1 or 2 above). More complicated scenarios should be addressed later. |
| Lenovo and Motorola Mobility | Case1/2/3/5 | In Case 4/6, the UE attempts to re-establish the radio link connection in the source cell after CHO recovery failure or RLF in the CHO recovery cell, these two cases are corner cases, even if these cases occur, it is hard to define they are too late CHO or too early CHO. |
| Samsung | Case1-Case 3  Case 4-Case 6 are not MRO issue |  |
| Qualcomm | Case1/2 for scenario definitions | Agree with Nokia. Case 1 and Case 2 should suffice for defining “Too late CHO Execution”. What happens after CHO recovery is probably not needed in the definitions. |
| CATT | 1，2，3，5 may be considered  4, 6 should not be considered | Cases except for reestablish to source cell may be considered. |
| ZTE | At least Case 1,2,3 | Other scenarios need to be consider late based on input e.g RAN2 ‘s progress. |



**Figure 2 too early handover failure type**

In a summary, the scenarios for too early CHO may include the following cases:

Case 1: the UE receives CHO configuration; the CHO execution fails; the UE attempts to re-establish the radio link connection in the source cell.

Case 2: the UE receives CHO configuration; the CHO execution successes; an RLF occurs shortly after the successful CHO; the UE attempts to re-establish the radio link connection in the source cell.

Case 3: the UE receives CHO configuration; an legacy handover is performed but fails; the UE attempts to re-establish the radio link connection in source cell.

Case 4: the UE receives CHO configuration; a legacy handover is performed and successes; an RLF occurs shortly after the successful legacy handover; the UE attempts to re-establish the radio link connection in the source cell.

**Q2: Companies are invited to provide their view on whether to consider the above scenarios for too early CHO?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | Yes | We shall start from the definition used for classic too early, with the prior CHO config as a criterion for CHO-related failure (like 2 above). More complicated scenarios should be addressed later. |
| Lenovo and Motorola Mobility | Yes for case1/2/3/4 |  |
| Samsung | Yes |  |
| Qualcomm | Yes for case 1/2 | Case 1 and Case 2 can be considered for defining “Too early CHO execution”.  Case 3 and 4 are not CHO specific; it does not matter if UE has received CHO config or not i.e. these are already covered by classic too early HO. |
| CATT | Yes | All cases may be too early CHO failure type. |
| ZTE | At least for case 1/2 | Take into account of case 3/4 based on RAN2’s further progress. |



**Figure 3 CHO to wrong cell failure type**

In a summary, the scenarios for CHO to wrong cell may include the following cases:

Case 1: the UE receives CHO configuration; the CHO execution fails; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells.

Case 2: the UE receives CHO configuration; the CHO execution fails; the UE successfully performs CHO recovery in another CHO candidate cell.

Case 3: the UE receives CHO configuration; the CHO execution fails; the UE attempts to CHO recovery to a CHO candidate cell but fails; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells.

Case 4: the UE receives CHO configuration; the CHO execution fails; the UE attempts to CHO recovery to a CHO candidate cell and successes; a RLF occurs shortly after CHO recovery; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells.

Case 5: the UE receives CHO configuration; the CHO execution successes; a RLF occurs shortly after the successful CHO; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells.

**Q3: Companies are invited to provide their view on whether to consider the above scenarios for CHO to wrong cell?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | Yes | We shall start from the definition used for classic HO to wrong cell, with the prior CHO config as a criterion for CHO-related failure (like 5 above). More complicated scenarios should be addressed later. |
| Lenovo and Motorola Mobility | Yes for case1/2/3/4/5 |  |
| Samsung | Yes |  |
| Qualcomm | Yes | Case 5 should be considered.  Cases 1-4 can be classified into one category i.e CHO failure followed by reestablishing/CHO recovery @ other cell |
| CATT | Yes | All cases may be CHO to wrong cell failure type. |
| ZTE | Yes |  |



**Figure 4** mixed scenarios of legacy HO and CHO

Considering the mixed scenarios of legacy HO and CHO, there are another 5 cases in figure 4, which may also be considered as CHO/HO to wrong cell failure type and included in stage2 definition and detection mechanisms.

Case 6: the UE receives CHO configuration; a legacy handover is performed but fails; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the CHO candidate cells.

Case 7: the UE receives CHO configuration; a legacy handover is performed but fails; the UE successfully performs CHO recovery in a CHO candidate cell.

Case 8: the UE receives CHO configuration; a legacy handover is performed but fails; the UE attempts to CHO recovery to a CHO candidate cell but fails; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells..

Case 9: the UE receives CHO configuration; a legacy handover is performed but fails; the UE attempts to CHO recovery to a CHO candidate cell and successes; a RLF occurs shortly after CHO recovery; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells.

Case 10: the UE receives CHO configuration; a legacy handover is performed and successes;; a RLF occurs shortly after the successful legacy HO; the UE attempts to re-establish the radio link connection in a cell other than the source cell and the previously selected target cells.

**Q4: Companies are invited to provide their view on whether to consider the above scenarios for mixed HO/CHO to wrong cell?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No | Mixed scenarios should be addressed once CHO-only is ready. |
| Lenovo and Motorola Mobility | Yes for case6/7/8/9/10 |  |
| Samsung |  | Fine to consider the mixed scenario.  RAN2 agreed to consider some mixed scenarios. It’s better to keep alignment between RAN2/RAN3. |
| Qualcomm | Yes, but deprioritize | Same view as Nokia. We can keep the definitions simpler and look at the different sub scenarios to see if any handling is missing |
| CATT | Yes | All cases may be CHO to wrong cell failure type. |
| ZTE |  | Share the view as Samsung |

**Q5: Are there any other scenarios need to be considered?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No |  |
|  |  |  |

In RAN3#110e meeting, it has agreed that CHO recovery procedure is considered in the definition of failure types and/or failure types detection, and it is FFS about whether to define CHO specific failure types or not.

* **Option 1: Reuse the existing handover failure types definitions for CHO (too late handover /too early handover/ handover to wrong cell) with necessary updates [1] [3];**
* **Option 2: Define CHO specific failure types: Too Late CHO execution/** **CHO Execution Too Late, Too Early CHO execution/** **CHO Execution Too Early, CHO to Wrong Cell /** **CHO Execution to Wrong Cell [4].**

**Q6: Companies are invited to provide their view on option 1 or option 2?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 or Option 2** | **Comment** |
| Nokia | Neutral | If we agree to address CHO like a classic MRO, but with the CHO config active, existing definitions are fine. But we can also copy them into new definitions to facilitate future enhancements. |
| Lenovo and Motorola Mobility | Option 1 | The failures in CHO, e.g. too late handover /too early handover/ handover to wrong cell can be covered by the existing handover failure types definitions with necessary updates, it is not necessary to define CHO specific failure types. |
| Samsung | Option 1 | One point we want to emphasize is that definition is not scenario description. The definition should be general concept.  For example, for legacy handover, the UE can access to the network via RRC Reestablishment or RRC Setup (re-connect) after the failure. Only RRC Reestablishment is described in the definition.  While in the detection part, all the scenarios are considered and covered.  To have all the scenarios reflected in the definition will also restrict its extension. |
| Qualcomm | Option 2 might be cleaner; | We can define CHO specific failure types separately to not complicate existing definitions and allow flexibility to incorporate mixed scenarios later.  Also we think that including “execution” in the definitions of MRO for CHO (such as Too late/early CHO execution”) gives better understanding. |
| CATT | O1 | For CHO failure type definition, it is proposed to be general and reuse the existing handover failure type. For CHO failure types detection, it is necessary to be detailed to include the cases above. |
| ZTE | Slightly prefer option 2 | Option 2 is more flexible for further scenario to be identified. |

## Timers

In RAN3#110e meeting, it is agreed that UE reports the time elapsed since CHO execution until connection failure to network. And in RAN2#112e, it is agreed that UE reports the time elapsed between the first CHO execution and the corresponding CHO command received at UE at least in the CHO failure case.

Firstly, there are two different understanding on the *timeConnFailure* IE for CHO. We should first clarify how to understand the *timeConnFailure* IE for CHO.

* **Option 1: it represents the time elapsed since the CHO execution until the connection failure;**
* **Option 2: it represents the time elapsed since receiving the CHO configuration at the UE until the connection failure.**

**Q7: Companies are invited to provide their view on how to understand the *timeConnFailure* IE for CHO ?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 or Option 2** | **Comment** |
| Nokia | Sounds like 2… | This shall be resolved in RAN2, if RAN2 added the timer. |
| Lenovo and Motorola Mobility | Option 1 | For legacy handover, the existing *timeConnFailure* IE is used to indicate the time elapsed since the last HO initialization until connection failure. In CHO, handover is triggered/initialized when CHO execution condition is met, so *timeConnFailure* IE can be reused to indicate the time elapsed since the CHO execution until the connection failure. |
| Samsung | Option 2 | Option 2 is RAN2 understanding. |
| Qualcomm | RAN2 to decide | RAN2 need to decide whether they want to reuse existing IE timeConnFailure for CHO as Option 1 or Option 2 |
| CATT | O1 | CHO configuration may be received by UE at early time and CHO **execution may occure after a long time. The time between them should not be included in** *timeConnFailure*. |
| ZTE | Option 2 |  |

It was agreed in RAN2#112e:

* *UE reports the time elapsed between the first CHO execution and the corresponding CHO command received at UE at least in the CHO failure case.*

The CHO configuration contains the configuration of CHO candidate cell(s) generated by the candidate gNB(s) and execution condition(s) generated by the source gNB. However, both configuration of CHO candidate cell(s) and execution condition(s) can be updated or modified for one of candidate cells by the network. It could be better to clarify that the UE reports the time between the first CHO execution and the latest CHO command received for the selected target cell received at UE.

**Q8: Following RAN2 agreement, the UE reports the time between the first CHO execution and the latest CHO command received for the selected target cell received at UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | - | We shall not “agree” interpretation of RAN2’s decisions! RAN2 should simply clarify this. |
| Lenovo and Motorola Mobility | Yes | Since it is the latest CHO execution condition determines the CHO execution, it is reasonable to report the time between the first CHO execution and the corresponding latest CHO configuration received at UE. |
| Samsung |  | Better to clarify this in RAN2. |
| Qualcomm |  | Wait for RAN2 agreements |
| CATT |  | Wait for RAN2 agreements |
| ZTE |  | Wait for RAN 2 |

[1] proposed to define a new time IE, e.g., timeBetwFailures, to indicate the time elapsed since the first connection failure until the second one.

**Q9: Companies are invited to provide their view on whether to report the time elapsed since the first connection failure until the second one?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No | Shouldn’t it be proposed in RAN2? |
| Lenovo and Motorola Mobility | See comments | Wait for the progress on how to signal the two consecutive failures in RAN2. If two entries in one RLF report is agreed, it may be unnecessary to report the time elapsed since the first connection failure until the second one. |
| Samsung | No | This can be get from two *timeConnFailure* IE. |
| Qualcomm | RAN2 decision | Same view as Lenovo |
| CATT |  | Considering the case that RLF occurs shortly after successful recovery, it is necessary to introduce a timer to judge whether UE keep stable after recovery. But timer may be defined from the start of CHO recovery to RLF. |
| ZTE | RAN2 | Share the view as Lenovo |

[2] proposed that to study whether to report the time UE have stayed in source cell for too late CHO.

**Q10: Companies are invited to provide their view on whether to report the time UE have stayed in source cell for too late CHO?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No? | Does it exist in classic MRO? |
| Lenovo and Motorola Mobility | See Comments | It is not clear what is the time UE have stayed in the source cell.  The network can perform mobility optimization based on the time between the UE receiving the CHO command and RLF happed in the source node, e.g. it can transmit a normal handover after CHO command and before source RLF, or relax the execution conditions (e.g. thresholds on CondEvent A3 or CondEvent A5) before source RLF. |
| Samsung | No | This seems doesn’t help MRO detection. The network needs to know whether there is recent HO in order to differentiate too late and too early/wrong cell. *timeConnFailure* and the new time agreed by RAN2 can achieve this. |
| Qualcomm |  | Not clear about the definition of this timer. |
| CATT | Yes | For legacy too late HO, the time UE have stayed in source cell is required to judge whether UE can keep stable in source cell. So, CHO may also follow this rule. |

[5] proposed that for the case of CHO configuration followed by immediate normal handover trigger, it is also beneficial for the source node to know the timer between CHO configuration and handover trigger in order to have proper optimization. The solution in [5] is that the source node sends the time since CHO configuration to immediate HO trigger to the target and the target transmit the info back to the source in Handover Report message.

**Q11: Companies are invited to provide their view on whether the** **source node needs to know the** **timer between CHO configuration and immediate handover trigger, if needed how to know this time information?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No | Mixed scenarios should not be addressed yet. |
| Lenovo and Motorola Mobility | Yes | It is beneficial for the source node to know the timer between CHO configuration and immediate handover trigger. We prefer to include this time information in the UE RLF report. |
| Samsung | Yes | For CHO followed by immediate normal handover especially failure case, it means the CHO configuration and normal handover are not well configured which will reserve a lot of radio resource in the network side and bring complexity to the UE. This situation should be avoided and optimized. For this purpose, the timer is needed.  For those information that the network can get, network based solution should be used. |
| Qualcomm | No | RAN has the knowledge of when it sent the CHO config and whether it sent the legacy HO config before CHO execution and can compute this time if needed. No need for UE to report this. |
| CATT | NO | It is enough for source node to know the event that CHO configuration followed by immediate normal handover trigger. We could not see the benefit of introducing this IE |
| ZTE | Yes | We see the benefit for source gNB identify sub-optimized CHO configuration. |

**Q12: Are there any other timers need to be considered?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Samsung | So far seem no. |  |
|  |  |  |

## Candidate Cell List and CHO execution condition(s)

In RAN3#111e meeting, it agreed that the source node needs to know the candidate cell list and CHO execution condition(s). There potential options for the source node to know the candidate cell list and CHO execution condition(s) are summarized as below:

* **Option 1: UE reports the candidate cell list and CHO execution condition(s) in RLF Report [2] [3] and [6];**
* **Option 2: Source nodes sends candidate cell list and CHO execution condition(s) to the target node in SN status Transfer or a new message, the target transmits the info back to the source in Handover Report message [5];**
* **Option 3: The source node stores the candidate cell list and CHO execution condition(s) [1].**

**Q13: Companies are invited to provide their view on which option is preferred?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 or Option 2 or Option 3** | **Comment** |
| Nokia | None, 1 or 3 | This makes sense only of it is provided once and represents the moment of the failure. So, source should not provide such list to all targets. |
| Lenovo and Motorola Mobility | Option1 | Option 2 would impact Xn interface since the Xn Status Transfer message needs to be extended or a new Xn message needs to be introduced to include candidate Cell List and CHO execution condition(s).  For Option 3, the valid time for the source node storing candidate cell list and CHO execution condition(s) is limited, on the other hand, UE context at the source node may be released for the case that an RLF occurs shortly after the successful handover. |
| Samsung | Option 2 | For HOF, the source cell has such information, no additional mechanism is needed.  For RLF shortly after successful handover, option 2 can be used.  Clarify to Nokia: For option 2, the source sends the information to the target to which the UE success handed over. The information is provided once with the latest configuration. For other candidate cells, the source doesn’t need to provide such information.  Candidate cell list and CHO execution condition(s) are big information which should be avoided to transmit over the air.  More and more information are proposed to be reported from the UE which bring a lot of burden for UE’s logging, saving and reporting over the air. We should have a principle here, for those information which is necessary and cannot be get in the network side e.g. timer of the failure, it should be reported from the UE. Otherwise, network based solution should be used. |
| Qualcomm | Option 3 or Option 2 | Source node already knows the candidate cell list and CHO execution condition and we therefore should avoid UE to report it.  Option 3 might be the simplest if source node can store the info even after UE context release, or option 2 if we can use Xn signaling to retrieve the info back post UE context release |
| CATT | O1 | Network may continue modifying candidate cell list after first CHO configuration. Network is not aware of the CHO execution target cell and accurate time. For O2, it will lead to:   1. Each time when modifying CHO candidate cell list, all the the target node needs to be notified. 2. When CHO executes, network cannot receive notification and maybe still modifies the CHO candidate cell list to each target node. It will lead to wrong CHO candidate cell list kept in network.   So, O1 is prefered. Maybe 1bit in measureResult for each cell is enough to identify it as CHO candidate cell. It is up to RAN2. |
| ZTE | Option 3 or Option 1 | Option 3 is the simplest solution , the valid timer need ffs. |

## Other information

There are many proposals on UE reporting information for SON enhancements for CHO:

1. Use *reestablishmentCellId* to indicate the successful CHO cell; [1]
2. new cell information IE, e.g., *CHOCellId*, to indicate the selected CHO cell after the first connection failure and before the reestablishment; [1]
3. successful CHO recovery related information in case of RLF/HO Failure/CHO Failure with CHO Recovery Success; [3]
4. whether the execution condition associated with CHO recovery cell is met or not in the case that UE successfully performs CHO recovery; [3]
5. the second failure (RLF failure) to the network in case of RLF/HO Failure/CHO Failure with CHO Recovery Success followed by an RLF; [3]
6. an explicit CHO failure indicator; [3]
7. whether the selected cell after the first CHO failure is a configured candidate CHO target cell; [6]
8. the information of CHO events/conditions, e.g. the first satisfied event or condition, the time difference between the triggering of the two events or conditions, the measurements of the second condition when the first condition met, etc. [6]
9. others?

**Q14:** **Companies are invited to provide their view on which information are needed?**

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| --- | --- | --- |
| **Company** | **a, b, …** | **Comment** |
| Nokia | - | This depends on the definitions, which should be agreed first. |
| Lenovo and Motorola Mobility | c,d,e,f | For a and b, we can discuss how to represent the successful CHO recovery cell and the failed CHO recovery cell when how to signal the two consecutive failures is decided.  For g, if candidate cell list is reported, it does not need to report whether the selected cell after the first CHO failure is a candidate cell.  For h, reporting CHO execution condition(s) is enough, h seems unnecessary. |
| Samsung |  | RAN2 is trying to reuse the existing IE. After RAN2 make the existing definition clear, we can check whether new information is needed or not. |
| CATT | b,c,e,g,h | for a, it may be still used for reestablishment case as legacy.  for b/c/e/g, it is useful but how to record it needs discuss.  for d, it can be inferred from measureResult.  for f, it may be implicitly indicated. |

## How to signal two consecutive failures

In RAN3#110e meeting, it agreed that if UE has experienced failure twice, UE reports information related with the two failures. Furthermore, we should study how to signal two consecutive failures. [1] states that the UE reuses the existing contents of the legacy RLF report to record the first failure related information for CHO. RAN2 also has organized an email discussion to consider signaling model for RLF report and the potential options in R2-2101451 are summarized as below, we can notice that most RAN2 companies support Option B, and Option B is proposed to be agreed by RAN2.

Option A: Two separate entries in the RLF report are used, i.e. one entry is used to represent measurements/parameters related to the first HOF, the second one is used to represent measurements/parameters related to the second HOF;

Option B: Separate IEs within the existing RLF-report are used to represent the second HOF. The first HOF can be represented by reusing as much as possible existing IEs;

Option C: Two separate RLF reports are introduced, one containing IEs related to the first HOF, the other one containing IEs related to the second HOF;

Option D: Too early to decide;

**Q15: Companies are invited to provide their view on how the UE reports the two consecutive failures.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Nokia | If RAN2 already discusses it, shouldn’t we wait for the conclusion? |
| Lenovo and Motorola Mobility | Prefer Option B since it has fewer spec impacts. |
| Samsung | Ok to wait for RAN2 conclusion. |
| Qualcomm | Wait for RAN2 conclusion |
| CATT | RAN3 only needs to confirm the failure cases and send it to RAN2. How to record two consecutive failures in these cases is up to RAN2. |
| ZTE | Wait for RAN2 |

## Xn aspects

There are several proposals regarding Xn aspects, including:

* Introduce new initiated reporting methods including CHO Initiated Reporting. [1]
* enhance Failure Indication to include CHO failure related information such as CHO recovery cell ID and RLF Report; [2]
* The XnAP FAILURE INDICATION message needs to be extended to include multiple failures information. [3]
* XnAP HANDOVER REPORT message needs to be extended to include multiple failures information. [3]
* Add Handover Report value Too Early CHO Execution and CHO Execution to Wrong Cell in Handover Report message; [5]

**Q16: Companies are invited to provide their view on Xn aspects?**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Nokia | Since CHO MRO should be based on existing MRO, the existing signalling is just fine. Other details should be decided once we have the definitions. |
| Lenovo and Motorola Mobility | XnAP FAILURE INDICATION message and XnAP HANDOVER REPORT need to be extended to include multiple failures information, e.g. the failed CHO recovery cell.  No need to introduce new HO type in Xn/NG, the existing “Too Early HO” and “HO to Wrong Cell” can be reused. |
| Samsung | XnAP FAILURE INDICATION and XnAP HANDOVER REPORT can be extended e.g. including new Handover Report value, multiple failure information. |
| Qualcomm | Regarding the need to include multiple failures information e.g. the failed CHO recovery cell in Xn, we need to wait for RAN2 conclusions.  If RAN2 chooses to go with single RLF report with just new IEs (Option B in sec 3.5), we might not need to enhance Xn :FAILURE INDICATION as we just use RAN2 RLF report as container in Xn |
| CATT | New scenarios that trigger Failure Indication message needs further discussion, such as CHO handover success and CHO recovery success. |

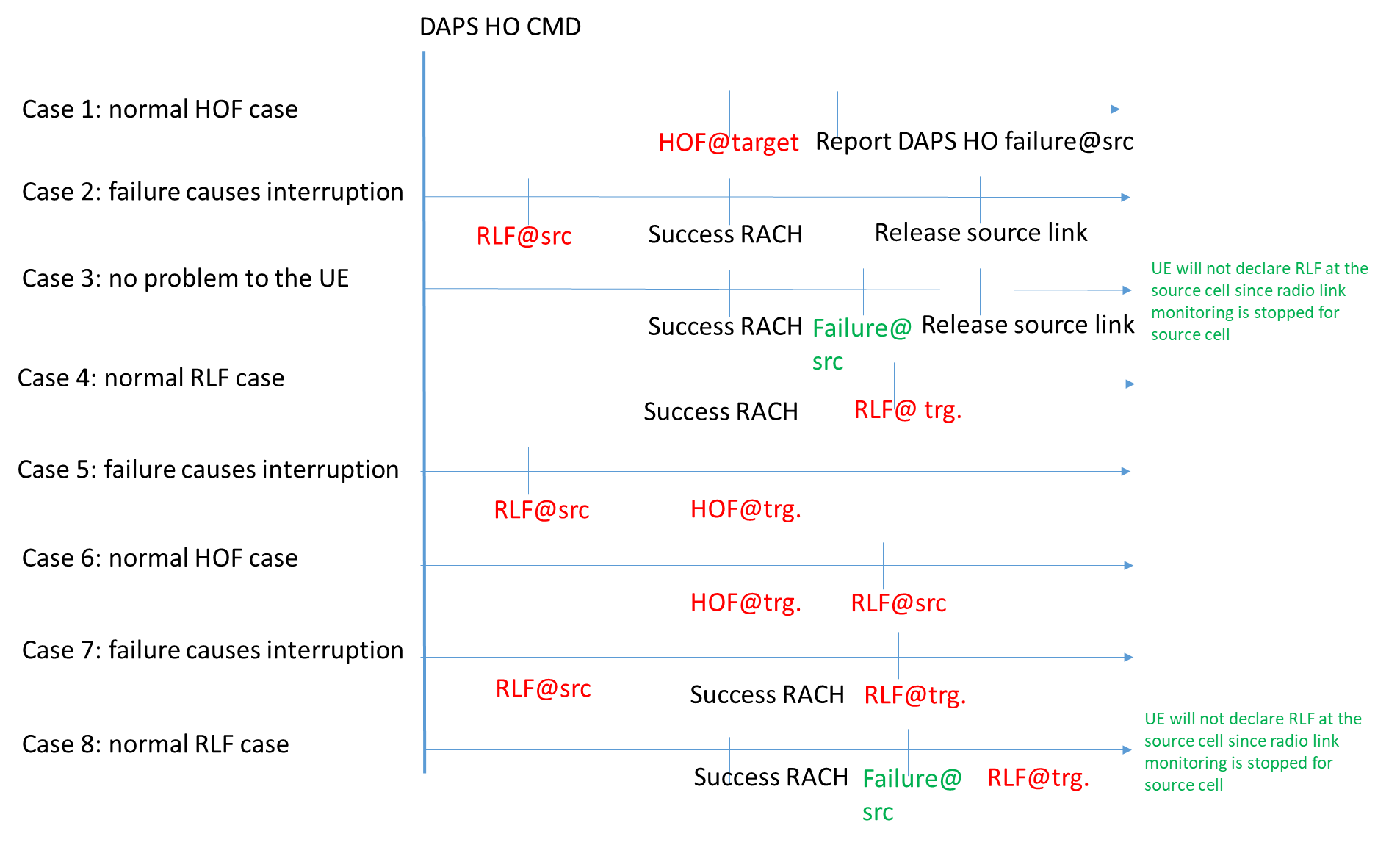
# Enhancements for DAPS HO

In RAN3 #110 online meeting following agreements have been made:

* Consider DAPS handover failure cases 1, 2, 4, 5, 6, and 7 for further study. It is FFS on case 3 and case 8.
* UE reports DAPS HO Failure Indication to Network (LS to RAN2).
* Try to capture DAPS handover failure cases as part of current definitions of handover failure types first. If not feasible, define a set of specific DAPS handover failure types.

## Failure scenarios and types

Fig. 5 gives the possible failure events during the DAPS handover procedure. Cases 1, 2, 4, 5, 6, and 7 are agreed for further study, it is FFS on case 3 and case 8. In [7] and [8], it proposed to study case 3 and case 8 since data transmission in the source cell is kept after successful RACH to the target cell, and RLF in the source cell may occur if maximum number of RLC retransmissions is reached.



**Figure 5 Failure events during the DAPS handover**

**Q17: Companies are invited to provide the view on whether case 3 and/or case 8 should be supported in SON for DAPS handover.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No | Perhaps later, once the solution is ready. |
| Lenovo and Motorola Mobility | Yes | After successful RACH towards the target cell, the UE would not perform RLM for source cell, but it can still perform HARQ/ARQ retransmission and ROHC feedback transmission to the source gNB, the UE may declare RLF at the source gNB due to RLC failure. So, case 3 and case8 can be considered. |
| Samsung | No | Case 3 and 8 will not cause any service interruption. Not typical cases which should be optimised. |
| Qualcomm | Deprioritize | The intention to study case 3 and case 8 looks to be to report the state of source link post successful DAPS HO.  If we know there was a failure@src post successful DAPS HO consistently, is this a gNB optimization to release the source link more quickly?  If that is the objective, we can study this but with a lower priority. |
| CATT | Yes | After successful access to target cell in DAPS handover, there may be data transferred in source cell for DL. For AM DRBs configured, the maximum number of retransmissions for source MCG RLC may be reached and RLF may occur. |
| ZTE | Deprioritize |  |

Besides the above eight cases, two new cases are proposed in [7]:

Case 9: Mixed scenario of case 1 and case 6, i.e. HOF@Target->report DAPS HO failure@src->RLF@src;

Case 10: RLF@src before/after successful RACH in a DASP HO procedure after a successful normal HO.

**Q18: Companies are invited to provide the view on whether case 9 and/or case 10 should be supported in SON for DAPS handover.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No | Mixed scenarios should be discussed once basic DAPS MRO is ready. |
| Lenovo and Motorola Mobility | See comments | For case 9, no strong opinion.  For case 10, isn’t it similar as RLF@src before/after successful RACH in a DASP HO procedure? Not clear why to emphasize “after a successful normal HO”. |
| Samsung | No | We don’t see the motivation to have mixed DAPS HO and normal HO. |
| Qualcomm |  | Same view as Lenovo |
| CATT | Yes | For case 9, RLF@src may occurs shortly after reverting to source cell or a period of time after reverting. The time between HOF@Target and RLF@src may needs discuss to judge whether UE can be kept stable after reverting. If UE is kept stable, there may be another too late handover, or maybe DASP causes.  For case 10, if RLF@src shortly after a previous HO, it is the previous HO not the DAPS which should be optimized |
| ZTE |  | Same view as Lenovo |

**Q19: Are there any other scenarios need to be considered for SON for DAPS handover.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |

To cover failure scenarios in DAPS HO, the open issue is whether DAPS HO specific failure types need to be defined or not. Two main options are proposed:

**Option 1: Reuse the existing handover failure types definitions for DAPS HO with necessary updates [1] [8];**

**Option 2: Define DAPS HO specific failure types, e.g. Too Late DAPS Handover, Too Early DAPS Handover, DAPS Handover to Wrong Cell [7].**

**Q20: Companies are invited to provide their view on whether DAPS HO specific failure types need to be defined or not?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | Neutral | If we agree to address DAPS like a classic MRO, but with the DAPS config, existing definitions are fine. But we can also copy them into new definitions to facilitate future enhancements. |
| Lenovo and Motorola Mobility | No, prefer Option 1 | The failures in DAPS HO, e.g. too late handover /too early handover/ handover to wrong cell can be covered by the existing handover failure types definitions with necessary updates, it is not necessary to define DAPS HO specific failure types. |
| Samsung | Option 1 |  |
| Qualcomm | Option 1 | There are no specific scenarios being defined for DAPS HO (such as too early/late DAPS) and can be covered by existing MRO definitions with necessary updates |
| CATT | No strong opinion on option 1 and option 2 | Both of the option are OK,However,if we reuse the current definition,update is needed to include DAPS specific failure. |
| ZTE | Prefer Option 1 |  |

## Whether to support MRO for successful DAPS HO

[8] proposed to study MRO procedure for successful DAPS handover including the case that source RLF occurs when T304 is running but the UE finally completes DAPS handover successfully, and the case that there is no source RLF and the UE finally completes DAPS handover successfully.

**Q21: Companies are invited to provide their view on whether to support MRO for successful DAPS HO?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | No | Perhaps later. |
| Lenovo and Motorola Mobility | Yes |  |
| Samsung |  | Source RLF occurs when T304 is running but the UE finally completes DAPS handover successfully -> this is case 2, right?  there is no source RLF and the UE finally completes DAPS handover successfully -> this is not needed. No issue in this case. |
| Qualcomm | Maybe | Source RLF and successful DAPS handover is already covered by Case 2  No source RLF and successful DAPS HO => If the intention is to capture RLM related issues in source cell as in the case of successful HO, we are okay. But need to check what is different from a successful legacy HO |
| CATT | Yes | RLF@src during DAPS needs optimization. |
| ZTE |  | Same view as Samsung. |

## Whether to enhance report for Case 1

For case 1, the UE falls back to the source link if the source link is still available when T304 expires. Currently, the UE would report the *FailureInformation* message including the DAPS-failure indication to source gNB. In [1] and [8], it is proposed that no enhancement is introduced for the legacy *FailureInformation* message. In [9], it is proposed that the UE reports the RRM measurement information for rout cause analysis by the source gNB.

**Q22:** **Companies are invited to provide their view on whether to enhance report for Case 1?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | ? | Isn’t it RAN2’s problem? |
| Lenovo and Motorola Mobility | No | Since source link is always maintained in case 1, the source node knows the source cell, target cell, measurement info and etc, it can identify the problem when it receives the *FailureInformation* message. Enhancements for the *FailureInformation* message are not needed. |
| Samsung | No |  |
| Qualcomm |  | RAN2 should discuss this |
| CATT | Yes | RRM measurement information for rout cause analysis is useful. |
| ZTE |  | Depends on RAN2. |

## Timers

[1][7][10] proposed to report some time related information for DAPS HO.

1. the time length between RLF@source and the success access to the target; [1][10]
2. the time elapsed since the first connection failure until the second one; [1]
3. to reuse *timeConnFailure* IE to record the time duration from the last HO initialization to DAPS HO failure or RLF@trg; [7]
4. the time elapsed since the last HO initialization until connection failure occurred in DASP source cell; [7]

**Q23: Companies are invited to provide their view on which time information are needed?**

|  |  |  |
| --- | --- | --- |
| **Company** | **a, b, c, d** | **Comment** |
| Nokia | - | This should be considered once the definitions are formulated. Then, it will be known what is needed. |
| Lenovo and Motorola Mobility |  | For b, we can wait for the progress on how to signal the two consecutive failures. If two entries in one RLF report is agreed, it may be unnecessary to report the time elapsed since the first connection failure until the second one. |
| Samsung | a | b is not needed.  The time length between two successive failures can be deduced based on the two timeConnFailure.  c is the existing timeConnFailure |
| Qualcomm | Probably a | For a, this time gives us the mobility interruption time in a succeesful DAPS HO with src failure scenario  For b, Agree with Lenovo  For c, RAN2 should decide on definition of timeConnFailure for DAPS HO  For d, probably not needed. Instead of the timer, we can indicate the state of source link if needed |
| CATT | c, d | For a, RLF@source may occurs before or after success access to the target. So, it may be unsuitable to define this timer.  For b, the first and second connection failure may be RLF@src or HOF. It is not for sure. It may be better to record the time for RLF@src and HOF separately.  For c, it is proposed to reuse legacy timeConnFailure IE.  For d, it is used to identify case 10 above. |
| ZTE |  | Share the view as Lenovo |

## Other information

There are many proposals on UE reporting information for SON enhancements for DAPS handover:

1. use *reestablishmentCellId* to indicate the successful DAPS HO cell; [1]
2. failure order indicator, e.g., failureoder, to indicate whether the failure between the UE and the source cell occurs before the one between the UE and the target cell; [1]
3. new HO type IE, e.g., DAPS HO; [1]
4. an explicit indication for DAPS handover failure; [8]
5. the state of source link for the case that source RLF occurs after successful DAPS HO and before source link is released; [8]
6. the state of source link for the case that UE successfully completes DAPS handover; [8]
7. the failure cause for the source cell for the case that source link fails but DAPS handover to the target cell is successfully completed; [8]
8. the RLF of the source cell for the scenario that DAPS HO success but RLF in the source cell; [9]
9. the successive failure types as well as related RRM measurements for the scenario that UE experience DAPS HO failure and RLF in the source cell; [9]
10. UP aspects of DAPS handover, e.g. the UL/DL HO interruption time, amount of data correctly send/received on the UL/DL in the source and target cells; [11]
11. others?

**Q24: Companies are invited to provide their view on which information are needed?**

|  |  |  |
| --- | --- | --- |
| **Company** | **i, ii,…** | **Comment** |
| Nokia | - | This should be considered once the definitions are formulated. Then, it will be known what is needed. |
| Lenovo and Motorola Mobility | iv, v, vi, vii, viii, ix | For i, we can discuss how to represent the successful DAPS HO cell when how to signal the two consecutive failures is decided.  For ii, not needed.  For iii, is it similar as iv? |
| Samsung |  | RAN2 is trying to reuse the existing IE. After RAN2 make the existing definition clear, we can check whether new information is needed or not. |
| Qualcomm | v, vi, viii, ix | If state of source link is signaled, this can be an implicit indicator that this is a DAPS HO and might not need explicit indicator (iii or iv) |
| CATT | ⅷ,ⅸ | For i, it may be still used for reestablishment case as legacy.  For ⅱ/ⅴ/ⅵ, it can be indicated by timer for RLF@src and HOF. It is proposed to define time from DAPS configuration to RLF@src or HOF to indicate this.  For ⅲ, it is needed but may be implicitly indicated.  For ⅳ, it may be indicated by timer for HOF and legacy *timeConnFailure* IE may be reused.  For ⅶ/ⅹ, this kind of information may be not included in legacy MRO. |
| ZTE |  | Share the view as Samsung. |

## How to signal two consecutive failures

In case of successive failures associated to DAPS, the UE stores and reports both failure related information. The potential options are summarized as below:

* **Option 1: The UE reuses the existing contents of the legacy RLF report to record the failure in the target cell related information; [1]**
* **Option 2: Re-use the existing rlf-report with updates/extensions to cover all the two successive failures related information; [8]**
* **Option 3: Since the legacy entry rlf-report in the RLF Report can only cover the information for the latest failure, introduce a new entry in the same one RLF Report for the first failure; [8]**
* **Option 4: Use Two separate RLF Reports, one containing IEs related to the first failure, the other one containing IEs related to the second failure. [8]**

**Q25: Companies are invited to provide their view on how to signal two consecutive failures** **for DAPS HO?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option1 or Option2 or** **Option3 or Option4** | **Comment** |
| Nokia | - | RAN2… |
| Lenovo and Motorola Mobility | Option 2 | Option 2 has fewer spec impacts. |
| Samsung |  | Wait for RAN2 conclusion. |
| Qualcomm |  | RAN2 should decide |
| CATT |  | RAN2 decision |
| zte |  | Depends RAN2 ‘s progress. |

## Xn aspects

There are several proposals regarding Xn aspects, including:

* Introduce new initiated reporting methods including DAPS HO Initiated Reporting [1].
* XnAP FAILURE INDICATION or XnAP HANDOVER REPORT message needs to be extended to include DAPS handover, e.g. DAPS handover without RRC Reestablishment [8].

**Q26: Companies are invited to provide their view on Xn aspects?**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Nokia | Since DAPS MRO is supposed to be based on the classic MRO, we should first try to reuse the existing signalling. |
| Lenovo and Motorola Mobility | Too early to decide |
| Samsung | Consider extension based on XnAP FAILURE INDICATION or XnAP HANDOVER REPORT message |
| CATT | New scenarios that trigger Failure Indication message needs to be considered ,such as DAPS handover success. |
|  |  |

# Data forwarding enhancements for CHO

[11] proposed to study how to optimize early data forwarding since early data forwarding will increase overhead on backhaul and memory usage in candidate cells, [11] provided some possible optimizations.

* **Option 1: If several candidate cells are in the same node, then one possible optimization is to bundle traffic for one UE to these cells, namely, to use one data forwarding connection for the whole set of target cells**
* **Option 2: Only forward traffic for critical services like voice**
* **Option 3: Don’t set up forwarding traffic immediately, wait for other triggers, which could be e.g. another measurement report from the UE**

**Q27:** **Companies are invited to provide their view on the data forwarding enhancements for CHO.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Options** | **Comment** |
| Nokia | - | At the #110, it was decided that data forwarding aspects are not part of SON for MobEnh. |
| Lenovo and Motorola Mobility |  | Data forwarding enhancements for CHO seems out of R17 SON scope. |
| Samsung |  | Prioritize MRO related. |
| Qualcomm |  | Out of SON WI scope |
|  |  |  |

# **The number of prepared cells and/or radio resource optimization for CHO**

[11] stated that CHO mechanism leverages significant amount of network resources to provide robust mobility. The reservation of resources in the target would lead to an overload of the network, which is clearly undesirable. Therefore, [11] proposed to investigate methods to optimize the number of prepared cells.

On the other hand, currently there is no time limit for how long a candidate cell will be reserved for CHO. [11] proposed that a time limit is needed to help limit the amount of resources reserved for CHO, which includes:

* RAN3 to study the optimization of the number of prepared cells.
* RAN3 to study a timer deciding time limit for how long the resources in candidate cells should be occupied and how it can be communicated between source and candidate cell.

**Q28: Companies are invited to provide their view on the potential enhancements on resource optimization for CHO?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Nokia | ? | Fine to discuss it once the basics of MRO for MobEnh are settled (definitions, procedures to use). But those would not really be “MRO problems” in the classic sense, rather like new problems. |
| Lenovo and Motorola Mobility |  | Enhancements on resource optimization for CHO should be de-prioritized. RAN3 should focus on MRO for CHO first. |
| Samsung |  | Prioritize MRO related. |
| Qualcomm |  | Deprioritize |
| ZTE |  | De-prioritize |

# References

1. R3-210401 (TP for SON BLCR for 38.300) Mobility Enhancement Optimization (Huawei)
2. R3-210291 Discussion on MRO for CHO mobility enhance (CATT)
3. R3-210552 SON Enhancements for CHO (Lenovo, Motorola Mobility, ZTE)
4. R3-210686 (TP for SON BL CR for TS 38.300): Conditional handover SON aspects (Ericsson)
5. R3-210257 Discussion on SON enhancements for CHO (Samsung)
6. R3-210933 SON Enhancement for CHO (CMCC)
7. R3-210292 Discussion on MRO for DAPS mobility enhance (CATT)
8. R3-210554 SON Enhancements for DAPS Handover (Lenovo, Motorola Mobility, ZTE)
9. R3-210934 SON Enhancement for DAPS (CMCC)
10. R3-210215 Discussion on MRO for DAPS (Samsung)
11. R3-210685 (TP for SON BL CR for TS 38.300): DAPS handover SON aspects (Ericsson)