3GPP TSG-RAN WG2 #115-e Tdoc R2-21xxxxx

Electronic meeting, November 1th – November 12th 2021

Agenda Item: 8.13.2.1

Source: Ericsson

Title: [Post115-e][899][SON/MDT] Handover related SON aspects (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This document captures the outcome of this email discussion:

* [Post115-e][899][SON/MDT] Handover related SON aspects (Ericsson)

 Scope:

 Technical discussion rather than voting yes/no on FFS issues figured out so far and the timers of CHO context.

 How to capture all the related agreements we got so far.

 Intended outcome: Report

 Deadline: until next meeting

Companies inputs to this email discussion are appreciated by the 18th October 2021 (EOB).

# 2 Discussion

## 2.1 CHO

### 2.1.1 “Time D” definition

RAN2 has agreed to include in the RLF-Report, associated to CHO, the following timer:

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| C | Time elapsed between the first CHO execution and the corresponding latest CHO configuration received for the selected target cell, i.e. timeSinceCHOReconfig. | Time of received CHO configuration | Time of CHO execution | Agreed in RAN2#112 |
| D | Time elapsed between CHO execution until the first HOF/RLF  | Time of executing the first CHO | Time of first HOF/RLF | Agreed in RAN2#113 |

Related to timer D, it was debated in RAN2#115 how to capture it in the specification, and the following FFS was captured:

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| **From RAN2#115-e:**FFS in the next meeting:Proposal 1 RAN2 to select one of the following two options to represent Time D:a. Option 1: The “Time D” is equal to the timeConnFailure, which is supposed to start at CHO execution and stop when the HOF/RLF occurs. b. Option 2: The timeConnFailure is supposed to start at reception of the CHO configuration and stop when the HOF/RLF occurs. The “Time D” is equal to the difference between timeConnFailure and “Time C”  |

Before discussing which option to select, Rapporteur would like to recap the definition of too early/too late HO according to the specification and the usage of timeConnFailure.

According to TS 38.300, the definition of the “too late/too early HO” and the associated detection mechansims are defined as follows:

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| **From TS 38.300:****Too Late/Too Early HO definitions:**- Intra-system Too Late Handover: an RLF occurs after the UE has stayed for a long period of time in the cell; the UE attempts to re-establish the radio link connection in a different cell.- Intra-system Too Early Handover: an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in the source cell.**Too Late/Too Early HO detection mechanism:**- Intra-system Too Late Handover: there is no recent handover for the UE prior to the connection failure e.g. the UE reported timer is absent or larger than the configured threshold (e.g. Tstore\_UE\_cntxt).- Intra-system Too Early Handover: there is a recent handover for the UE prior to the connection failure e.g. the UE reported timer is smaller than the configured threshold (e.g. Tstore\_UE\_cntxt), and the first re-establishment attempt cell/the successful re-connect cell is the cell that served the UE at the last handover initialisation. |

The above detection mechanism described in the stage-2 specification implies that there are two scenarios when the timeConnFailure (included by the UE in the RLF report) is useful in classifying a HO:

1. When there is an RLF in the target cell due to “too late HO” triggered by the target cell
2. When there is an RLF in the target cell due to “too early HO” triggered by the source cell

So far, in case of RLF in the target, RAN2 understanding has been that the timeConnFailure (reported by the UE as part of the RLF-Report) is used by the network to evaluate whether an HO was a too late HO or a too early HO, as described above.

Companies are asked to confirm this assumption:

* **Q1: Given the above specified definitions of “Too Late/Early HO”, in case of RLF in the target do you agree that the timeConnFailure (included in the RLF-Report) is used by the network to evaluate whether an HO was a Too Late HO (triggered by the target cell) or a Too Early HO (triggered by the source cell)?**

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| **Company** | **Yes/No** | **Comments** |
| **Qualcomm** | NO (The current definition of too early or too late handover failure in TS 38.300 is provided in the context of legacy handover) | In CHO, a handover should be considered too late if UE has received the CHO configuration but is unable to execute due to improper configuration. Therefore, the evaluation mechanism for too late and too early needs to be modified considering CHO in TS 38.300. Furthermore, RAN3 has already agreed to extend the definition of early and late handover in R3-213180 as:- Intra-system Too Late Handover: there is no recent handover for the UE prior to the connection failure e.g. the UE reported timer is absent or larger than the configured threshold (e.g. Tstore\_UE\_cntxt), or if CHO is configured but the CHO execution is not initiated for the UE prior to the connection failure, or if DAPS HO is configured but an RLF is detected in the source cell with successful DAPS HO.- Intra-system Too Early Handover: there is a recent handover for the UE prior to the connection failure e.g. the UE reported timer is smaller than the configured threshold (e.g. Tstore\_UE\_cntxt), and the first re-establishment attempt cell/the cell UE attempts to re-connect is the cell that served the UE at the last handover initialisation or fall back to the source cell configuration in case of DAPS HO. |
| **Intel** | Yes or no | Not sure the intend of the question. Since CHO is a little different by nature compare to regular HO when the HO triggering (HO starts). In regular HO, HO starts at HO command sent to the UE by the network. In CHO, HO starts at HO execution when condition met. RLF report should evaluate the condition is execute too early or too late. But on the other hand, network resource is held starting from conditional HO reconfiguration in CHO, this time is also very important for network to evaluate how long the resource is held to particular UE. |
| **OPPO** | Yes | timeConnFailure should be used for evaluating the condition for too early or too late HO, regardless of CHO or legacy HO being applied/ |
| **Samsung** | Yes, but | To be exact, the timeConnFailure for legacy handover is used for the network to decide whether there is recent handover i.e. to differenciate too late from too early/wrong cell handover.On the other hand, we need to clarify what the legacy case “too late HO” is in the CHO scenarios, which differentiates from “too late CHO”. We have assumed that the “too late HO” in CHO scenarios means that RLF occurs, before the reception of CHO configuration. |
| **vivo** | Yes, but only for legacy HO | We checked the RAN3#113-e minutes and found that the following was agreed:

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| [R3-213180](file:///D%3A%5C%E4%BC%9A%E8%AE%AE%E7%A1%AC%E7%9B%98%5CTSGR3_113-e%5CDocs%5CR3-213180.zip) | BLCR to 38.300\_Addition of SON features enhancement (CMCC) | draftCRRev in [R3-214314](file:///C%3A%5CUsers%5Cebeimao%5CDownloads%5CInbox%5CR3-214314.zip)  **Endorsed as BL** |

So we agree with QC that the current text in TS 38.300 is only defined for legacy HO. |
| **Ericsson** | Yes | Note that the question is quite clearly asking about legacy HO, not about CHO. Hence the legacy handling of too early/late HO applies.Note also that in the scenario depicted in Figure 1 there is an ordinary HO (not a CHO) from cell A to cell B, followed by a failure in the cell B. Hence, since in that scenario the last HO is an ordinary HO, the legacy definitions of too early/too late HO should still be valid. |
| **Nokia** | Yes |  |
| **sharp** | Yes  | The definitions in this question applies for legacy handover. |
| **NEC** | Yes | We think the meaning of “too late HO” for CHO is aligned with legacy HO, i.e. RLF occurs before the triggering of CHO/HO, and timeConnFailure should be used for evaluating the condition for too early or too late HO. |
| **CMCC** | Yes |  |
| **Lenovo** | Yes |  |
| **Huawei, HiSilicon** | Yes | We agree that that the definitions in this question are applied for legacy HO (not about CHO). |

Companies are now asked to evaluate the impact on the Option 1 and Option 2 on the current legacy mechanism described above.

In particular, in the email discussion during RAN#115-e [1], it was discussed whether the two proposes options still allows the network to make proper use of the timeConnFailure to classify the RLF as we did in the legacy. The scenario considered was the one in Figure 1 below.



Figure 1: Comparison between Option 1 and Option 2 for the "Time D".

**Description of scenario in Figure 1:** The UE receives and ordinary HO command for HO from cell A to cell B. The UE moves in cell B and it receives a CHO configuration. However, before executing the CHO to cell C, the UE experiences an RLF, and as a consequence it logs the RLF-Report.

* Implications of Option 1 in the scenario in Figure 1: Option 1 assumes that the time D starts at CHO execution. Hence, when the UE experiences an RLF in cell B before the CHO execution, the timeConnFailure associated to the previous HO is still up and running. It will then represent the time elapsed since the HO command execution in cell A until the RLF in cell B. Once the RLF-Report is retrieved, the network can use this timeConnFailure as in legacy operations, i.e. to evaluate whether the HO from cell A to cell B was “too early” or if the cell B was “too late” with the HO.
* Implications of Option 2 in the scenario Figure 1: In Option 2, the timeConnFailure is started at reception of the CHO configuration. This implies that the previous timeConnFailure that was started at HO from cell A to cell B is overwritten. Hence, when the RLF occurs in cell B, the UE only includes the timeConnFailure started at CHO configuration. Once the RLF-Report is retrieved, the network may not know how to interpret the value of timeConnFailure and to properly use it for the “too early/too late” evaluation as it happens in legacy. For example, cell A, i.e. the previous PCell, does not know that the UE was configured with CHO at the time of RLF, hence it will think that the timeConnFailure represents the time since the HO from cell A to cell B, but in fact the UE had restarted the timeConnFailure and hence in reality it would represent the time since the CHO configuration reception.

Taking the above scenario into account and the legacy definitions of too Early/Late HO, as well as the usage of timConnFailure as per Q1, companies are now asked to describe their concerns on the Option 1 and 2.

* **Q2: In case Option 2 is adopted, which concerns do you have?**
	+ **A:** The legacy usage of timeConnFailure as described in Q1 is affected, because the interpretation of timeConnFailure would become ambiguous, and hence erroneous HO failure classifications may occur, i.e. the previousPCell (which could be a legacy PCell) will think that the timeConnFailure represents the time since the HO from cell A to RLF in cell B, but in fact this is wrong because the UE restarted the timeConnFailure at reception of CHO configuration.
	+ **B:** None. Please motivate your reply.
	+ **C:** Other. Please motivate your reply.

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| **Company** | **A/B/C** | **Comments** |
| **Qualcomm**  | B | Consider a scenario in legacy HO:UE has received the configuration in cell A $->$ perform successful HO to cell B $->$ receives a new configuration for performing HO to cell C (just after successful completion of Handover). Once the new configuration is received the reference point is shifted to the time/event of reception of the new RRCReconfig.We should follow the same/similar mechanism. Once the new configuration is received UE is expected to evaluate and perform the handover. If the UE is unable to perform the HO, then that implies the CHO configuration is inappropriate and needs to be optimized. |
| **Intel** | C | Option 2 provides the time when CHO configuration to the UE (similar to HO command in legacy) until RLF. This is the amount of time where the network reserves the resource to the UE. The network may not know when the UE condition met to trigger HO happens. I guess this is what E/// concerns as to compare to too early HO or too late HO configuration. |
| **OPPO** | A | We agree that overwriting the timeConnFailure is a critical problem that should be avoided. Also, the scenario given in the figure is not a corner case, which could happen in e.g., highway mobility sceanario. |
| **Samsung** | B | In legacy, the timer *timeConnFailure* and the field *previousPCell* can be typically used to identify the RLF shortly after successful HO. And, if a new HO is initiated, *timeConnFailure* restarts (see the captured from TS38.331):***timeConnFailure***This field is used to indicate the time elapsed since the last HO initialization until connection failure. Actual value = field value \* 100ms. The maximum value 1023 means 102.3s or longer.The concern A assumes that *timeConnFailure* should keep to run until the CHO execution, i.e. CHO initialization is CHO execution.A question is whether the CHO initialization is the reception of CHO configuration or CHO execution. After receving CHO configuration, we think that UE should consider RLF with ongoing CHO, rather than the previous HO.Since we have assumed that the CHO initialization means the reception of CHO configuration, we see no problem.One more reason to support B is that the scenario above also exist for legacy handover. In legacy two consecutive HOs, timeConnFailure represent the latest one. |
| **vivo** | B | We also think it is reasonable to assume an RLF was associated with the latest RRC reconfiguration. |
| **Ericsson** | A | If Option 2 is adopted, it will not be possible for cell A to properly categorize the RLF in cell B. That is because the cell A will receive the timeConnFailure, but it cannot know whether this timeConnFailure was started at reception of the HO command in cell A or at reception of CHO configuration in cell B. Hence erroneous classification may occur at cell A. So basically with option 2, the network cannot optimize anymore HO parameters of cell A (as it did in legacy), it can only optimize CHO parameters of cell B. That breaks a legacy functionality, and it also leads to some strange consequences, e.g:* if cell B does not configure CHO then the network **can** classify the HO from cell A to cell B as a too early HO, and then it can optimize the cell A ordinary HO parameters accordingly.
* If cell B configures CHO, then the network **cannot** classify the HO from cell A to cell B as a too early HO, and it can only optimize the cell B CHO parameters

The above behavior is not technically justified. The classification of the HO from cell A to cell B should always be the same, irrespective of whether the cell B configures CHO or not, because if the HO parameters of cell A are lousy, they are lousy both when the CHO in cell B is configured and when it is not configured. We also note, as highlighted in our comments above to Samsung and Qualcomm, that it is not possible to compare the scenario in Figure 1 with a legacy scenario. In legacy, it can never happen that after reception of the legacy HO command in one cell, the UE gets an RLF in the same cell. Only HOF can occur in that cell after reception of the HO command or an RLF in the next cell. Whereas in Rel.17, an RLF can occur in cell B after reception of the CHO configuration. This is a new scenario different than legacy. So when this scenario occurs, we want to maintain the possibility for the network to evaluate whether the ordinary HO from cell A to cell B followed by an RLF was a too early HO. If we go for option 2 this possibility considered by Rel.16, will not be possible anymore in Rel.17. That is why we believe that option 2 would break a legacy functionality. |
| **Nokia** | B | If Option 2 is adopted, even if CHO is never triggered, the network will have information on the time between the configuration of CHO and CHO failure |
| **Sharp**  | A | Agree with Ericsson, there may be ambiguous interpretation of timeConnFailure in the listed scenario for option 2. |
| **NEC** | A | We agree that we should avoid the overwriting the timeConnFailure. |
| **CMCC** | A | We also agree that ambiguous interpretation of timeConnFailure in the listed scenario should be avoided. |
| **Lenovo** | A | We agree that if Option 2 is adopted, erroneous HO failure classifications may occur. |
| **Huawei, HiSilicon** | B | For figure 1, option 1 is to identify handover problem related to cell A, and we think it can be already supported by non-CHO Ues, e.g. if we remove CHO config step from option 1, the UE will use the timeConnFailure as legacy and then the network can do optimiation to Cell A based on Ues’ RLF report. For option 2, we think the RLF problem is related to CHO, and there are two reasons:Reason#1: after the UE moves to cell B, for CHO functionality, the network should firstly send measurements to UE to collect CHO candidate cells (i.e. measurement control and measurement report), and then the network will check with candidate cell in order to generate CHO config. In summary, CHO config step needs some time and it is a set of Uu/Xn procedures. We think that after CHO config step (i.e. after receving CHO configuration from Cell B), RLF events should be relevant to ongoing CHO (configured in Cell B), and it seems to be little relations to the handover from cell A to cell B.Reason#2: as mentioned above, if there is no CHO configured in figure 1, the RLF problem is seen to be related to handover from cell A to cell B and it has been covered by Rel-16 MRO.Regarding the concern from Ericsson “option 2 would break a legacy functionality.”, we do not think so. If option 2 is to be selected, timeConnFailure can be defined as below:* Legacy definition (started from reception of legacy HO command) + CHO part (started from reception of CHO HO command)

It will not break the legacy functionality, i.e. if the UE performs legacy HO, legacy definition takes effects; if the UE performs CHO, CHO part takes effects. |

* **Q3: In case Option 1 is adopted, which concerns do you have? Please motivate your reply.**

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| **Company** | **Comments** |
| **Qualcomm** | It breaks the framework and creates more confusion in the process of evaluation. It will make it unclear when the handover process should be considered too late. For example, if UE receives the configuration in cell B but didn’t execute the configuration for a long duration and RLF happens at cell B. Then, we will not optimize CHO configuration considering too early Handover. In my understanding, if a new configuration is received then we should optimize the configuration such that CHO is performed in a timely fashion. |
| **Intel** | Option 1 report the time where the CHO execution to RLF. Network will not have the time CHO is sent to the UE til CHO execution. This time is part of the total time network reserve the resource to the UE. It is as important for network to lean for adjusting measurement event configuration. |
| **OPPO** | Respond to Intel: RAN2 has agreed to include the time CHO is sent to the UE til CHO execution into the spec, as follows:RAN2 #112e agreements:The following time information is as part of the UE RLF report:  Time between the first CHO execution and the corresponding CHO command received at UE at least in the CHO failure case.This might could address Intel’s concern. |
| **Samsung** | If the option 1 is adopted and the *timeConnFailure* restarts at the CHO execution, we cannot see the time elapsed since the last CHO initialization (i.e. the last reception of CHO configuration) until the connection failure happened before CHO execution. The time would be useful to identify “Too late execution”, where is one of key CHO scenarios.Since the timer C is the time elapsed between the first CHO execution and the corresponding latest CHO configuration received for the selected target cell, it’s invalid if the CHO execution doesn’t occur due to RLF. |
| **Ericsson** | We do not foresee really any issue. There will not be any ambiguity on the handling of the timeConnFailure, since the handling will be exactly same as in legacy both from the network point of view and UE point of view.**@Qualcomm:** we do not understand this argument “we will not optimize CHO configuration considering too early Handover”. The too early CHO is actually considered because when the UE executes a CHO from cell B to cell C, the timeConnFailure is started, and the NW can judge whether the CHO from cell B to cell C was a too early CHO, in case an RLF occurs in cell C. Rather, with option 2, it will not be possible anymore to evaluate the too early ordinary HO from cell A to cell B. So that is what creates confusion in the evaluation process.**@Samsung:** Note that the UE will always start the time C when it gets a CHO configuration, because it does not know whether it will really execute this CHO or if an RLF will happen before executing the CHO. Hence, the UE has to always start the Time C at CHO configuration reception. So if an RLF occurs in cell B, it seems very straightforward for the UE to include the Time C (which will be the time between CHO configuration and RLF) in the RLF-Report. |
| **Nokia** | In option 1, if CHO is configured but never triggered, none of the timers (C and D=timeConnFailure) will have a meaningful value so no useful information is offered to the network.   |
| **CMCC** | @Nokia: For the scenario that CHO is configured but never triggered, some special value could be defined or used to indicate the time information. |
| **Huaei, HiSilicon** | As we mentioned above, for figure 1, we think the problem is related to ongoing CHO in Cell B. For option 1, it can be covered by Rel-16 MRO functionality, i.e. for Ues doing handover without CHO, the UE will log RLF report (and set timeConnFailure as legacy way) and then the network will know the problem and optimize the handover parameters in cell A. |
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Companies are now asked to express their preference on Option 1 or 2:

* **Q4: Which option do you prefer to represent the Time D?**
	+ **Option 1:** The “Time D” is represented via the timeConnFailure, which is supposed to start at CHO execution and stop when the HOF/RLF occurs.
	+ **Option 2**: The timeConnFailure is supposed to start at reception of the CHO configuration and stop when the HOF/RLF occurs. The “Time D” amounts to the difference between timeConnFailure and “Time C”.

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| **Company** | **Option 1/2** | **Comments** |
| **Qualcomm** | Option 2 | See above arguments. |
| **Intel** | Option 2 | We think that the resource reservation aspect is important for the network as well as the time from network sending CHO configuration to RLF is more align with legacy handover.  |
| **OPPO** | Option 1 | As addressed in Q2 |
| **Samsung** | Option 2 |  |
| **vivo** | Option 2 |  |
| **Ericsson** | Option 1 | Due to the reasons above |
| **Nokia** | Option 2 |  |
| **Sharp**  | Option 1 |  |
| **NEC** | Option 1 |  |
| **CMCC** | Option 1 |  |
| **Lenovo** | Option 1 |  |
| **Huawei, HiSilicon** | Option 2 | Based on our replies to Q2 and Q3, we think it is possible to consider extending the legacy timeConnFailure to support CHO case, and there is no problem for UE to log RLF reports for both legacy HO and CHO scenarios.For option 2, time D is implicitly indicated and thus it is good for signalling overhead. |

### 2.1.2 CHO indicator in case of RLF in target cell after HO

Some contributions submitted to previous RAN2 meetings highlighted that a HO indicator can be used in case of RLF in a target cell after a CHO. This HO indicator would indicate whether the last HO was a CHO or an ordinary HO.
The reasoning for this proposal would be that the CHO parameters for HO to this target cell might be different than the ordinary HO parameters for the same target cell. Hence the network may use this information to tune the CHO or the HO parameters accordingly, depending on whether the last HO was a CHO or ordinary HO.

Note that the network may not have other ways to retrieve this information implicitly from the RLF-Report, because at the time of RLF in target cell the UE does not have available anymore the CHO configuration previously provided by the source cell, e.g. the UE cannot include in the RLF-Report the information on the candidate cells (as instead it will happen for the HOF case).

* **Q5: Do you believe that it is beneficial to include in the RLF-Report an indicator indicating whether the last executed HO before the RLF in the target cell was a CHO HO?**

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| **Company** | **Yes/No** | **Comments** |
| **Qualcomm** | No | Don’t see a use case. |
| **Intel** | No | We don’t see a strong need for it. |
| **Samsung** | Probably, yes |  |
| **vivo** | No |  |
| **Ericsson** | Yes | The HO parameters used in the CHO configuration may be different than the HO parameters used for an ordinary HO. So it is beneficial to know whether the last HO was CHO or not. |
| **Nokia** | Yes |  |
| **Sharp** | Yes | we understand the intention, and an CHO indicator is needed in this case if there is no other implicit information for CHO. |
| **NEC** | No |  |
| **CMCC** | Yes | The indicator is necessary for the case that network does not have other ways to retrieve this information implicitly from the RLF-Report. |
| **Lenovo** | No | CHO specific information is included in the RLF report, e.g. CHO execution condition(s) or time elapsed between the CHO execution and the corresponding received latest CHO configuration, thus the network can understand it is a RLF in CHO implicitly from the RLF report. |
| **Huawei, HiSilicon** | Yes | We think different handover types are about different parameters setting, and the network may not know the handover type purely based on the RLF report (sent from the UE). We agree with the email rapporteur’s following comments:**Hence the network may use this information to tune the CHO or the HO parameters accordingly, depending on whether the last HO was a CHO or ordinary HO** |

### 2.1.3 Other issues on CHO

* **Q6: Is there any other issue/enhancement related to CHO that you would like to discuss?**

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| **Company** | **Issue** | **Comments** |
| **Qualcomm**  | No |  |
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## 2.2 DAPS

The following agreements about DAPS were reached in the last RAN2#115-e meeting:

**Agreements on DAPS from RAN2#115-e:**

1 In case the RLF occurs in source cell after fallback, the timeConnSourceFailure is used to represent the time elapsed between the DAPS HO execution and the RLF in the source.

2 For the case of HOF while performing DAPS HO followed by a fallback to the source cell, following signalling is applied: The detailed handover failure related information are included in the RLF-Report and this RLF report can be fetched like any other RLF report.

The legacy timeConnFailure can be reused to represent in the RLF report the scenario of DAPS HOF or RLF in target cell (after DAPS HO).

3 For the case of RLF in source cell while performing DAPS HO (i.e. before fallback), the follow time information is included in the RLF-Report:

a. timeConnSourceFailure: The time elapsed since DAPS HO execution until RLF occurs in source cell while performing DAPS HO before the fallback

4 The RLF report is used to log the failure related measurement in these scenarios:

 a. Failure at the source (RLF) while performing access to DAPS target cell and failing to access the target (HOF)

 b. Failure at the target cell (HOF) and failing to perform fallback (RLF at source)

FFS in the next meeting:

Proposal 3 Include a DAPS HO indicator in the RLF-Report, in case the RLF occurs in the target cell after a DAPS HO

### 2.2.1 DAPS HO indicator in case of RLF in target cell after HO

Related to the FFS highlighted above, in the email discussion during RAN2#115-e [1] it was discussed the benefits of including the DAPS HO indicator in the RLF-Report. Supporting companies claimed that the network cannot know that the last performed HO was a DAPS HO or an ordinary HO, hence obtaining this information can be beneficial for the network to optimize HO parameters, especially if the configuration of DAPS HO parameters is different from the configuration of the ordinary HO parameters.

* **Q7:** **Do you believe that it is beneficial to include in the RLF-Report an indicator indicating that the last executed HO before the RLF in the target cell was a DAPS HO?**

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| **Company** | **Yes/No** | **Comments** |
| **Qualcomm** | No | We have introduced the timeConnSourceFailure report time since reception/execution of DAPS HO until RLF at the source. In scenarios, where have RLF happens at the source, this timer can be indicative of DAPS HO.One scenario, I can think where I the network cannot determine the above scenario if the timeConnFailre is set as NULL, i.e. no RLF at the source. However, we can optimize this timeConnSourceFailure and set this timer value as 0 indicative that DAPS HO was configured prior to RLF at target after successful HO. |
| **Intel** | No | We don’t see a strong need for it. |
| **Samsung** | Probably, yes |  |
| **vivo** | No |  |
| **Ericsson** | Yes | Same as for the CHO case, i.e. the DAPS HO parameters may be different than the legacy HO parameters. So by knowing that the last HO was a DAPS HO, the network can optimize the associated DAPS parameters |
| **Nokia** | Yes |  |
| **Sharp**  | Yes  | A DAPS HO indicator is needed in this case if there is no other implicit information for CHO. For timeConnSourceFailure mentioned by Qualcomm, set timeConnSourceFailure to a specific value even if there is no source RLF, we think this is actually another way to implement the “DAPS HO indicator”. However, this is not a preferred way, as timeConnSourceFailure is introduced for source RLF case, but there is no source RLF in this issue, we donot want to mix it up. |
| **NEC** | No |  |
| **CMCC** | Yes | Similar with CHO. |
| **Lenovo** | Yes | Similar as the agreed explicit indicator for HOF during DAPS procedure in RAN2#113bis meeting, an explicit indicator for RLF in target cell shortly after successful DAPS handover is needed. |
| **Huawei, HiSilicon** | Yes | Similar as CHO (Q5). |

### 2.2.2 Other issues on DAPS

* **Q8: Is there any other issue/enhancement related to DAPS that you would like to discuss?**

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| **Company** | **Issue** | **Comments** |
| **Qualcomm** | No |  |
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## 2.3 Successful HO Report (SHR)

The following agreements and FFS were captured in RAN2#115-e about SHR:

**From RAN2#115-e**

Agreements:

1: Define separate thresholds for T310/T312/T304, and the percentage values are 40%, 60%, 80%. The percentage is to indicate the ratio of the threshold value (unit: ms) over the signalled T310/T312/T304 value (unit: ms).

1a: For threshold for T312, the percentage value also includes 20%.

2: For the thresholds of T310/T312 in the source cell, the source cell configures the values. FFS source cell or target cell can configure the threshold for T304.

3: Introduce a UE capability indication for SHR.

4: The UE may discard the SHR, i.e. release the UE variable VarSuccHO-Report, 48 hours after the SHR is stored.

### 2.3.1 T304 configuration

Related to T304 configuration, in the email discussion [3], some companies indicated that T304 pertains to the target cell and it is provided to the UE by the target cell via the HO command. Hence, some companies are proposing that the threshold on T304 for the SHR configuration should be provided by the target cell.

* **Q9: Should the target cell configure the value of the T304 threshold to be provided in the SHR configuration?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| **Qualcomm** | No strong opinion  |  |
| **Intel** | Yes | Seem reasonable. |
| **OPPO** | No | T304 threshold for the SHR configuration is not necessarily related to the T304 absolute value set by the target cell. SHR is for source cell to optimize itself handover performance, so it is better for the source cell to set the T304 threshold. Source cell could choose any value between 0 and T304 value given by the target cell for setting the T304 threshold for triggering SHR. |
| **Samsung** | Yes | Source cell doesn’t know the value of T304. It is arbitrary for the source cell to configure the threshold without knowing the value of T304. |
| **vivo** | No | In our understanding, SHR is used by the source node to optimize the relevant parameters, such as the threshold to trigger HO. Besides, SHR will be finally delivered to source node instead of being used by target node, so we think the SHR configuration should be initiated by source node.As for Samsung’s concern: note that we agreed that percentage values will be used to indicate the SHR triggering conditions, therefore the source source node can still propoerly select one of the percentage (e.g., 60%) from the candidate values even if it does not know the exact value of T304. |
| **Ericsson** | Yes | Agree with Samsung, because T304 is provided by the target via the HO command. So it is more appropriate that the threshold on T304 is configured by it. Also any optimization of T304 upon reception of the SHR should be done at the target not at the source. |
| **Nokia** | No | It makes more sense that the Source also configure T304 threshold.  |
| **Sharp**  | Yes  | T304 is configured by target, so it seems reasonable the target cell configure the T304 threshold. |
| **NEC** | No  | SHR is used by the source node to optimize the timing/triggering conditions of handover procedure. So it is up to the source to configure SHR. |
| **CMCC** | Yes | It makes sense for target node to configure it. |
| **Lenovo** | Yes | Since T304 is configured by the target node in the HO command, it is suitable for the target node to configure the T304 threshold for SHR trigger condition.  |
| **Huawei, HiSilicon** | Yes | T304 is generated by the targete cell, and RAN2 agreed that network signals the percentage values in RRC signalling and then the UE gets the threshold value based on T304 and the percentage value.If the source cell is to decide on the T304 percentage value, it may choose a fixed value because it has no idea about T304 value. In this case, the threshold value (unit: ms) will vary as T304 value varies.For example, if the source cell would like to enable SHR and set 40% for T304 threshold. Since there may be different target cells for different Ues, and T304 may be different (e.g. ms50, ms10, ms500). And then the threshold value for these Ues will be ms20, ms40 and ms200 respectively.In our opinion, it should be possible for the network to be aware of the threshold value, otherwise, diverse threshold values may lead to some problems. So we prefer that the target cell decides on the percentage value for T304 and then send it to the source cell. |

### 2.3.2 RA-InformationCommon in SHR

In the email discussion [3], it was also discussed whether/when to include the RA information in the SHR. Since there was no clear consensus on how to proceed, Rapporteur proposes to further discuss this issue. In particular, some companies believe that the RA-InformationCommon should always be included in the SHR, whereas some others believe that it should be included only if the SHR is triggered due to certain conditions, e.g. T304 above the configured threshold.

* **Q10: Should the RA-InformationCommon be included in the SHR?**
	+ **A:** Yes, always. Irrespective of the fulfilled triggering conditions.
	+ **B:** Yes, but only in case the SHR is generated due to T304 above the threshold
	+ **C:** No, never.
	+ **D:** Others. Please explain the scenario in which RA-InformationCommon should be included

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C/D** | **Comments** |
| **Qualcomm** | C | Already part of RA-report. No need to duplicate it. |
| **Intel** | C | Network should have this information  |
| **OPPO** | B and D | It should be noted that SHR generation does not necessarily imply RACH problems. The SHR generation could be due to other reasons such as T312 exceeding configured value. Hence, we should restrict the cases when including the RACH information into the SHR report, for avoiding unnecessary signalling/storing overheadBesides T304, another condition triggering including the RA-InformationCommon could be pre-configured dedicated RACH resource is not used and the UE is forced to use the CBRA for HO. Source gNB could use such information (e.g., ssb-index-r16) for more proper dedicated RACH resource configuration. |
| **Samsung** | A | RA report already has RA-InformationCommon.However, the RA-InformationCommon corresponding to SHR could be replaced or deleted from RA report (e.g. due to PLMN change). Furthermore, there is currently no way to link it with the SHR. |
| **vivo** | B/D | It is preferred to conditionally include the RA information considering the gigantic size of the IE. |
| **Ericsson** | A, B (if A not agreeable) | It is not possible for the network to associate the SHR content with the RA attempts in the RA-Information because there is no indicator or timestamp to associate the SHR to the RA-Report (which contains the RA information for any HO, not only the HOs included in the SHR).We prefer A because it is always beneficial for the network optimization to know the performances of RA during HO. However, if A is not agreeable, we believe that at least B should be considered, because a high value of T304 clearly points to an RA problem during HO. |
| **Nokia** | C | No need to include RA-InformationCommon in SHR. It is already part of ra-Report.  |
| **Sharp**  | C | If the intention of including RA information is for RA parameter optimization, current RA-report maybe enough. |
| **NEC** | C | Network can obtain this information by RA-report already. Do not see any need to support features with duplicated functions. |
| **CMCC** | B | We agree the intention, but it is better to report only in case the SHR is generated due to T304 above the threshold. |
| **Lenovo** | B, D | D: Besides T304, another condition for including the RA-InformationCommon in the SHR could be the number of preamble attempt in target cell is greater than one threshold. |
| **Huawei, HiSilicon** | C,B (if C is not agreeable) | RA report functionality can be used to send RA-InformationCommon, so we do not see a strong need to include it again in SHR.We are also open for B as it can minimize the overhead impacts. |

### 2.3.3 RLF-Report and SHR after the same HO

According to the Rapporteur, another relevant issue discussed in [3] is how to deal with scenarios in which the UE generates both an RLF report and HO success report associated to the same HO. This can happen for example, in case the UE successfully completes an HO to a target cell (upon which it generates an SHR), and slightly after an early RLF is detected in the target (upon which an RLF Report is generated).

The concern is that the RLF-Report and the SHR for the same target cell may be fetched separately by the network. For example, the RLF-Report may be feched by a Rel.16 gNB, but the SHR can only be fetched by a Rel.17 gNB. Hence the source gNB of this HO may receive the SHR and the RLF-Report separately (at different points in time) and it may not be able to correlate that this SHR and this RLF-Report are in fact associated to the same HO. Hence the source gNB may change the HO parameters twice (once after RLF-Report reception, and once again after SHR reception).

Companies are asked to provide their view on whether the above is an issue or not, and also to provide solutions (if any) to it.

* **Q11: Do you believe that fetching separately (at different points in time) the RLF-Report and the SHR associated to the same HO may cause issues at network side, e.g. the source gNB changing the HO parameters twice? Please motivate your answer and also provide your solution (if any) on how to fix this issue.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| **Qualcomm** | No | I do not see any issue with this. The two reports have different optimization objectives. For example, even if the RLF happens after successful completion of the handover, then the lower layer parameters need to be optimized considering the CHO report. If CHO is extracted by the target cell and reported to the source, then the source can implement optimization of the lower layer. When the RLF report is received by another cell, it will be forwarded to the source to implement optimizations related to the selected target cell and others.As the two reporting has different optimization objective, we don’t see any issue with the reports being fetched separately. If the SHR is not fetched by the target cell and RLF happens at the target then UE should be allowed to throw out the SHR report to avoid wastage of UE memory. |
| **Intel** | No | I think this is related to network implementation issue. Network can resolve this base on the time stamp.  |
| **OPPO** | No | Maybe only a implementation issue. Details could be further discussed in the next meeting.  |
| **Samsung** | No | For RLF and Successful handover, the optimization parameters are different. So there is no problem to handle them separately. |
| **vivo** | Maybe | Since the two reports were caused by a single event, it may be beneficial to correlate them for further parameters analysis. Though this could possibly be resolved by implementation, we note that SHR does not have a timestamp currently and it seems not feasible for the NW to perform the correlation. |
| **Ericsson** | Yes | We believe that something has to be done, because otherwise if an RLF occurs after successful handover, the UE will report to the network both the SHR and the RLF-Report for the same HO event. Since the SHR and RLF-Report may be fetched separately (e.g. a Rel.16 node can fetch only the RLF-Report not the SHR), then the source cell will not know that the SHR and the RLF-Report are associated to the same event. This source cell may think that the received SHR and RLF-Report are associated to two separate HO events, e.g. it may think that the SHR is for an HO that occurred after the RLF-Report. Hence, the source will tune the HO parameters twice, once after the reception of the RLF-Report, and then once again after the reception of the SHR (or viceversa). This double tuning is wrong since the SHR and RLF-Report are in fact for the same HO. It is not clear how the network implementation can fix this issue, given that there will not be any indicator or timestamp linking the RLF-Report to the SHR (and viceversa).As Qualcomm mentioned, one solution is to allow the UE to discard the SHR if the RLF-Report is generated. Another is the timestamp (as Vivo indicated). Other solutions can also be discussed, if RAN2 confirms the issue. |
| **Nokia** | Maybe | First of all, we doubt that the network would change HO parameters based on a single report. Several reports would need to be collected from a multitude of UE over a longer time window in order to have statistically relevant KPIs.  Secondly, in our opinion the scenario described above may not represent a valid scenario for generating and sending SHR. SHR should be only generated if a (near) failure has happened prior to HO being successful and details of such (near)failure should be included in SHR. As such, in the scenario described above, the UE would only generate RLF report as a result of RLF@Target. A scenario that is better suited for SHR discussions would be RLF/HOF/CHO failure + successful CHO recovery. In such a case it can be debated if RLF report or selected parts of it are included in SHR and the RFL report discarded.   |
| **Sharp**  | No | We tend to think this can be handled by the network implementation. Though it is possible that SHR and RLF report may be fetched separately at different time. We think the NW will do the HO parameter adjusting on top of enough samples of SHR and RLF report for many UEs collected in a long time period, instead of one single UE. The NW can consider the collected samples of SHRs and RLF-reports together for SON adjusting. |
| **NEC** | No | We do not see any issue that UE report information of SHR and RLF after the successful handover. Network implementation can decide how to further optimize the configuration based on the SHR and RLF-report. |
| **CMCC** | Maybe | Not sure it is a normal case. |
| **Lenovo** | See comments | Instead of NW handling, we think the issue to be discussed first is how the UE handles the case that the UE successfully completes an HO to a target cell and RLF is detected in the target after a short time. In this case, both SHR and rlf-report are triggered. We need to discuss whether one of them is reported or both are reported. |
| **Huawei, HiSilicon** | No | RLF report and SHR are two separate functionalities, and they were also disucssed separately, e.g. scenario, problem, solutions. We think with these mechanisms (SON features), the network can identify some problems and do optimizations but it is implementation related.As mentioned by the email rapporteur, one scenario is as below:UE successfully completes an HO to a target cell (upon which it generates an SHR), and slightly after an early RLF is detected in the target (upon which an RLF Report is generated).Firstly, we think the network needs to collect enough SON reports and then can do a full anaysis on the issues.Secondly, RLF report and SHR are serateply reported, and then whether and how to handle them together are network implementation. If it is to let UE correlate both mechanisms together, we wonder how complex it will be. |

### 2.3.4 SHR for early HO right after successful HO

Still in the email discussion [3], it was discussed whether to adopt the SHR in other scenarios. In particular, it was discussed the scenario in which a UE performs a successful HO upon which it generates an SHR. However, it can happen that after this successful HO the UE is handed-over to another cell or to the previous cell, e.g. in case of ping-pong between source cell and target cell.

* **Q12: Should the SHR include information on whether the UE is handed-over to another cell early after the successful HO?**
	+ **A:** Yes, but only in case there is an early HO back to the source cell after the successful HO (ping-pong effect)
	+ **B:** Yes, whenever there is an early HO right after the successful HO
	+ **C:** No, never.

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C** | **Comments** |
| **Qualcomm** | C | It comes under the domain of RLF. SHR shouldn’t consider this. IF a handover fails early UE should discard SHR.  |
| **Intel** | C | Agree with QC |
| **OPPO** | C | SHR report should be only generated at one single time moment (complete of the HO). It will bring more complexity to UE if more contents are allowed to be included in the SHR report afterwards. |
| **Samsung** | C |  |
| **vivo** | C |  |
| **Ericsson** | B | Capturing ping-pong effects as part of the SHR is beneficial for network optimization. Even if the HO was successful, ping-pong effects should be avoided to improve UE performances.Also after handover to the target cell, another handover may be triggered very soon, before the target cell manges to configure the SHR. Hence, this early HO may not be captured in any SHR which is not good. |
| **Nokia** | Maybe A | Not sure what the difference between A and B is.  |
| **Sharp**  | C | This may not be needed; the network can know there is ping-pong based on other information, e.g. UE history information. |
| **NEC** | C |  |
| **CMCC** | C |  |
| **Lenovo** | C |  |
| **Huawei, HiSilicon** | C | The use case listed by the email rapporteur is interesting, but we think it may be an optimization. We think Rel-17 SHR can focus on the simple use case, i.e. hanodver from one cell to another cell, and other use cases may be postponed to later release. |

### 2.3.5 UP measurements

Related to UP measurements, the following agreement and FFS was captured in RAN2#115e:

|  |
| --- |
| **From RAN2#115-e:** 1 UP measurements for Successful Handover Report will be introduced as RAN3 required. FFS the details |

Given the above FFS, Rapporteur proposes discussing which UP measurements should be considered relevant during an HO procedure.

In the following, it is a list of possible UP measurements and related definitions. Companies are invited to review the below list and include (if needed) additional UP measurements.

1. **User plane interruption at handover, as evaluated at MAC layer**

Definition: Time between the reception of the first packet from the target cell and the time of reception of last packet from the source cell, measured at the time of reception of the first packet from the target cell.

Usefulness: This measurement indicates the actual performance of the handover in terms of whether the UE experienced any DL UP delay or not as measured at lower layers.

1. **User plane interruption at handover, as evaluated at PDPC layer without considering duplicates**

Definition: Time from the last packet received from the source and the first non-duplicate packet received from the target, measured at the time of reception of the first non-duplicate packet from the target cell.

Usefulness: Unlike A), this measurement represents the time without new packets being forwarded to upper layers. Hence, it indicates the actual interruption perceived by upper layers in the UE.

1. **Number of duplicated packets received from source and the target cell during the DAPS HO**

Definition: The number of packets that were sent both from the source cell and the target cell while performing the handover

Usefulness: The source may not know if the same PDCP PDU has been received successfully by the UE from both source and target. For example, if the amount of successfully received duplicates from source and target is very high, the source may decide to trigger a DAPS HO a bit later or reduce duplicates’ generation, in order to reduce radio resource consumption and UE burden

1. **Others. Please describe possible UP measurements and provide description on the “definition” and “usefulness”.**
* **Q13: Which of the above UP measurements should the UE include in the SHR?**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C/D** | **Comments** |
| **Qualcomm** | **B** | In my understanding, only B matters. The network knows what is the first sequence number it has forwarded to both MN and SN and the last sequence number it has forwarded to both MN and SN. Therefore, to optimize the no of duplicated packets or reduce the user plane interruption (where the definition in B should be followed instead of A).  |
| **Intel** | B | Base on RAN2 agreement: Mobility interruption time means the shortest time duration supported by the system during which a user terminal is not able to exchange user plane packets with any base station during transitions. Therefore, option B seems more suitable.  |
| **OPPO** | A or B | We doubt the usefulness of C. The amount of successfully received duplicated packets is different for different data services being used during handover. Suppose A is doing internet surfing, and B is doing data downloading. In such cases, their amount of successfully received duplicated packets during the DAPS HO is totally different, but they all require demands of no-interruption data transmission service. It is difficult for the network to optimize the DAPS HO triggering with only data packet transmission information.  |
| **Samsung** | N/A, currently | We should start discussing it when RAN3 triggers? |
| **vivo** | B | Share similar view with Qualcomm. |
| **Ericsson** | A,BC (possibly) | A and B serves different purposes, and both are useful.A gives the interruption as seen by lower layers. So it allows the network for example to see the gain from the lower layer interruptions perspective of a DAPS HO compared with an ordinary HO. B instead provides the interruption as seen by the upper layers of the UE, since the duplicates reception is excluded from the interruption time computation.C is also useful to give an information to the source cell on how many duplicates were really received by the UE.  |
| **Nokia**  | B and C |  |
| **NEC** | A | In Rel-16 DAPS discussion, the mobility interruption time means the shortest time duration supported by the system during which a user terminal is not able to exchange user plane packets with any base station during transitions. So even duplicated packets are received from the target, it is still not considered at interruption. So we think we need to follow the same principle. |
| **CMCC** | B | We think B is enough. |
| **Lenovo** | A | Agree with NEC. |
| **Huawei, HiSilicon** | A, B | In Rel-16 DAPS, RAN2 made some agreements regarding the definition of interruption time but not so accurate. For now, it is required to introduce an accurate definition for the measurement.We also think that A and B are useful, and both are for different purposes. Whether to consider duplicated packets for the definition needs more discussions. |

### 2.3.6 Other issues on SHR

* **Q14: Is there any other issue/enhancement related to SHR that you would like to discuss?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Issue** | **Comments** |
| **Qualcomm** | No |  |
| **Samsung** | Support of inter-RAT SHR reporting | How to support inter-RAT SHR reporting? Whether a gNB could pull the SHR report in LTE format or vice versaSHR report should be forwarded to the source cell or the target cell? Optimisation of T310/312 should be down by the source cell, while optimisaiton of T304 should be done by the target cell. |
| **Samsung** | time between the source RLF and DAPS HO completion | We see use case from RAN3 common understanding |
| **NEC** | Discard stored SHR information in case of the HO failure (T304 expiry) | The UE stores and indicates the availiabilty of SHR in RRCReconfigurationComplete message, however the handover procedure could end up in failure (T304 expires finally), there is a need to specify the discard of the stored SHR information in this case. |
| **NEC** | How to indicate SHR availability in case of RRCReconfigurationComplete message has already been generated | For the case that SHR triggering condition is T304 threshold, UE logs SHR when the T304 threshold has been reached, then the question is when and how to indicate SHR availability to the network, because the RRCReconfigurationComplete message without SHR availability indication has already been generated and being transmitting. Also, for The SHR scenario 3b, i.e. “Successful HO completion, but RLF in source during DAPS HO” , the source RLF can happen after the generation of RRCReconfigurationComplete message.If the indication can only be sent when next HO complete or RRC (re)establishment, it may cause information being overwriting or being discarded. |
| **Lenovo** | Trigger condition for SHR | According to the current agreement, the trigger condition for SHR report is ‘exceeding thresholds on T310/T312/T304’which is associated with the source cell. The above conditions for T310 and T312 are used to optimize the mobility from source link point of view. However, we did not optimize the successful HO from target point of view. For example, we need to discuss another successful HO case that T310/T312 in target cell is started after a short time of successful HO, or the number of preamble attempt in target cell is greater than one threshold. |
| **Huawei, HiSilicon** | Threshold for UP interruption time | Like T304/T310/T312, whether to have a threshold for UP interruption time (as a triggering condition for SHR) may need some discussions. |
|  |  |  |

# 3 Conclusion

To be updated later….

# 4 References

1. R2-2108961, [AT115e][851][SON/MDT] CHO and DAPS related RLF reports (Ericsson), Ericsson, RAN2#115-e
2. R2-2109141, Report of [AT115e][852][SONMDT] Procedures and Modeling of successful HO (Huawei), Huawei, RAN2#115-e
3. R2-2108564, Report of [Post114-e][851][SONMDT] Procedures and Modeling of successful HO report (Huawei), Huawei, RAN2#115-e