

**[101-bis-e][229] NB\_IOTenh4\_LTE\_eMTC6\_RRM - Version 0.0.12**  
**RAN4**

3GPP TSG-RAN WG4 Meeting #101-bis-e

Online Meeting, Jan 17 – 25, 2022

R4-2202746

**Agenda item:** 8.9.4, 8.9.5

**Source:** Moderator (Huawei)

**Title:** Email discussion summary for [101bis-e][229] NB\_IOTenh4\_LTE\_eMTC6\_RRM

**Document for:** Information

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## 1 Introduction

*List of candidate target of email discussion for 1<sup>st</sup> round and 2<sup>nd</sup> round*

- 1<sup>st</sup> round:
  - Discuss the issues on neighbour cell measurements in connected mode before RLF for Rel-17 NB-IoT.
  - Discuss the issue on capturing channel quality reporting table in TS 36.133
- 2<sup>nd</sup> round: Keep discussion on remaining issues.

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## 2 Topic #1: Neighbour cell measurements in connected mode before RLF or NB-IoT

### 2.1 Companies' contributions summary

**Table 1:**

R4-2200764	Qualcomm Incorporated
R4-2201208	Huawei, Hisilicon
R4-2201866	Ericsson

## 2.2 Open issues summary

### 2.2.1 intra-frequency measurement requirement

#### Issue 1-1-1: Intra-frequency requirement when DRX is not configured

- Proposals

Option 1: (Qualcomm P11, Huawei P1, Ericsson P5)

$T_{\text{detect\_intra}} = 1400$  ms

$T_{\text{measure\_intra}} = 800$  ms for NRS-based measurement

$T_{\text{measure\_intra}} = 1600$  ms for NSSS-based measurement

- Recommended WF
  - Agree on Option 1

#### **Feedback Form 1: Issue 1-1-1: Intra-frequency requirement when DRX is not configure**

<b>1 – HUAWEI TECHNOLOGIES Co. Ltd.</b> We support option 1.
<b>2 – Qualcomm Incorporated</b> We support option 1.
<b>3 – Ericsson Hungary Ltd</b> <b>Option 1 is agreeable.</b>
<b>4 – Nokia Germany</b> We support recommended WF.

#### Issue 1-1-2: Intra-frequency requirement when DRX is configured

- Proposals

Option 1: (Huawei P1)

$T_{\text{detect\_intra}} = 6$  DRX cycles

$T_{\text{measure\_intra}} = 5 \text{ DRX cycles}$

Option 2: (Qualcomm P11)

$T_{\text{detect\_intra}} = \text{FFS}$

$T_{\text{measure\_intra}} = 5 \text{ DRX cycles}$

– Recommended WF

Agree on  $T_{\text{measure\_intra}} = 5 \text{ DRX cycles}$ , and discuss detection requirements

**Feedback Form 2: Issue 1-1-2: Intra-frequency requirement when DRX is configured**

<p><b>1 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>We think the only difference is about <math>T_{\text{detect\_intra}}</math>. We would like to further clarify how 6 is derived. It is derived based on the agreed detection time 1400 ms and minimum CDRX cycle 256 ms, and then <math>\text{Ceil}(1400/256) = 6</math>.</p>
<p><b>2 – Ericsson Hungary Ltd</b></p> <p>Recommended WF is agreeable.</p>
<p><b>3 – Nokia Germany</b></p> <p>We support recommended WF with the addition "... for configured DRX".</p>
<p><b>4 – Qualcomm Incorporated</b></p> <p>Agree with the recommended WF.</p>

2.2.2 inter-frequency measurement requirement

**Issue 1-2-1: General How to formulate inter-frequency measurement**

– Proposals

Option 1: Based on length of available measurement occasions and number of measurement occasions to satisfy needed measurement time (800/1600 for measurement) (Qualcomm)

Option 2: Based on number of available measurement samples to satisfy needed measurement samples (Ericsson, Huawei)

– Recommended WF

- Discuss above options. Companies supporting option 2 please also comment on number of samples needed

**Feedback Form 3: Issue 1-2-1: General – How to formulate inter-frequency measurement**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We believe option 1 and option 2 are basically the same, just different approaches to formulate the requirements. Option 1 is to guarantee UE have enough time according to the agreed value (e.g. 1400ms), and option 2 is to guarantee that UE have enough number of available samples. We slightly prefer option 2 to formulate the requirements. Considering both option 1 and option 2. Companies please check whether following option 3 is acceptable:

**Option 3:**

**Define inter-frequency measurement requirements based on number of available samples in available measurement occasions.**

**Number of samples are determined based on agreed time in LS reply and sampling rate.**

Thus, for measurement number of samples are:

60 for NRS-based measurement

40 for NSSS-based measurement

**2 – Ericsson Hungary Ltd**

We support option 2, and the number of samples are:

60 for NRS-based measurement

40 for NSSS-based measurement

**3 – Nokia Germany**

We agree that options 1 and 2 are very similar. We propose to agree on proposal 3 as a baseline. This is for a target cell in normal coverage.

**4 – Qualcomm Incorporated**

We believe both approaches can be similar but we have some concerns specifying requirements that assume the UE will measure one sample at a time during each inter-frequency measurement opportunity. e.g. we have not accounted for any samples for AGC in an inter-frequency carrier. With a measurement occasion approach, unless each occasion is very short, it is reasonable to assume that some RS samples within each occasion could be used for updating AGC. With a one-sample-at-a-time approach we may have to account for the extra samples explicitly, since the time between adjacent samples could be long.

In short, the concern with the one-sample-at-a time approach is that it could incur higher overhead. e.g. from retuning and Rx AGC. Of course, if we account for the higher overhead correctly, it could work.

**Issue 1-2-2: General How to formulate inter-frequency detection**

- Proposals

Option 1: Based on length of available measurement occasions and number of measurement occasions to satisfy needed detection time (1400 ms) (Qualcomm, Huawei)

Option 2: Based number available of measurement samples to satisfy needed measurement samples (Ericsson)

– Recommended WF

- Discuss above options. Companies supporting option 2 please also comment on number of samples needed

**Feedback Form 4: Issue 1-2-2: General – How to formulate inter-frequency detection**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

Based on simialr consideration in issue 1-2-1. We propose following option.

**Option 3:**

**Define inter-frequency detection requirements based on number of available samples in available measurement occasions.**

**Number of samples are determined based on agreed time in LS reply and NPSS/NSSS interval.**

Then number of samples is derived as  $1400/20 = 70$

**2 – Ericsson Hungary Ltd**

Agree, we should follow the same approach used for cell measurement. Option 3 is agreeable.

**3 – Nokia Germany**

We propose to agree on option 3 as baseline. This is for a target cell in normal coverage.

**4 – Qualcomm Incorporated**

For cell detection we also have concerns about using a one-sample-at-a-time approach. The UE may benefit from processing multiple samples at a time. We think that a reasonable minimum measurement occasion should be assumed.

**Issue 1-2-3: Condition on inter-frequency measurement**

– Proposals

**Sub-1:**

Option 1: The measurement period requirements for inter-frequency cell detection and measurements in connected mode shall apply assuming no UL/DL scheduling for the UE during the measurement period. (Qualcomm P1)

**Feedback Form 5: Issue 1-2-3: Condition on inter-frequency measurement - Sub 1**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We can understand the consideration of option 1, which is to make sure that the available measurement occasion in each NPDCCH period are same, then the requirements can be derived accordingly. However, we think in real scenario, we can not assume there is no data in measurement period in CONNECTED mode. If there is no data for long time, UE will probably go to IDLE mode and this feature is not that useful. So we suggest to follow previous agreement that UE use vacant slot without data to do measurement.

**2 – Ericsson Hungary Ltd**

RAN4 already discussed and identified the conditions for inter-frequency measurements, which were summarized. We think those agreements are sufficient.

**3 – Nokia Germany**

We agree that interruptions due to data traffic should be taken into account.

**4 – Ericsson Hungary Ltd**

This issue should be already covered by following previous agreement [R4-2105800]:

- When the carrier frequencies of serving cell and of measurement neighbour cell are different (scenarios B/D/E), UE can perform neighbour cell measurement without gaps without causing interruptions to serving cell using any occasion where the UE is not scheduled which includes any of the following:
- Vacant slots not scheduled for data transmission, i.e. when not required to do data transmission/reception
- When not required to do NPDCCH monitoring
- during the DRX inactive period i.e. when the UE is configured with DRX.

**5 – Qualcomm Incorporated**

What we mean here is that the proposed measurement period requirement would apply when there is no UL/DL scheduling. If there is UL/DL data scheduled the measurement period can be extended. Note that depending on the NPDCCH period configuration, only a few periods (sometimes less than one) may be needed to perform the measurements for one inter-freq carrier.

**Sub-2: Minimum length per occasion**

Option 1: (Qualcomm P2)

Minimum length of occasion for measurements: 50 ms

Minimum length of occasion for cell detection: 200 ms

Option 2: (Huawei P2)

Minimum length of occasion for cell detection is 21 ms.

Minimum length of occasion for NRS based measurement is 11 ms, and 21ms for NSSS based measurement.

Option 3: (Ericsson P2)

No need to introduce condition on minimum occasion between two measurements.

**Feedback Form 6: Issue 1-2-3: Condition on inter-frequency measurement - sub2 : Minimum length per occasion**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We support option 2. The reason is to make sure that there is at least one sample available in ONE measurement occasion. If the length is too short, then it should not be counted as available measurement occasion when defining the requirements.

**2 – Nokia Germany**

We support option 2.

**3 – Qualcomm Incorporated**

We support option 1. If we shrink the measurement occasion we have to be more careful to account for overhead. e.g. account for samples for Rx AGC.

**Sub-3: Assumed sampling rate for measurement**

Option 2: (Huawei, Ericsson)

20 ms for NRS and 40 ms for NSSS

Option 3: (Qualcomm)

The minimum time interval between adjacent occasions in the same NPDCCH monitoring period is 50 ms

- Recommended WF
- Discuss above options.

**Feedback Form 7: Issue 1-2-3: Condition on inter-frequency measurement Sub 3: Assumed sampling rate for measurement**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We support option 2 which is the agreed sampling rate to derive the requirements (800 for NRS and 1600 for NSSS).

**2 – Ericsson Hungary Ltd**

Support option 2.

### 3 – Nokia Germany

We support option 2,

### 4 – Qualcomm Incorporated

Option 3 was not intended to be used as a proxy for sampling rate. A guard period between occasions may not be needed in the end. It was proposed as a parameter in the measurement period formulation, in case other companies had a strong reason for requiring a minimum spacing between occasions. We don't see a strong need for it.

## Issue 1-2-4: Detailed requirements for inter-frequency measurement

– Proposals

Option 1: (Qualcomm)

Without DRX and assuming no UL/DL scheduling, the available time for measurements during one NPDCCH monitoring period would be  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot T_{RT}$ , where

$T_{NPDCCH}$  is the NPDCCH monitoring period length,

$L_{NPDCCH}$  is the duration of a NPDCCH candidate with  $R_{max}$  repetitions,

$T_{proc} = 4$  ms is the NPDCCH processing time,

$T_{RT} = 1$  ms is the receiver retuning time.

Choose the duplexing mode (FDD/TDD) and carrier type (anchor, non-anchor).

For TDD, choose the UL/DL configuration.

Calculate  $T_{NPDCCH}$  and  $L_{NPDCCH}$  for all applicable values of  $(G, R_{max})$ .

Calculate  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot T_{RT}$ .

Given  $T_{(meas, basic)} = 800$  ms for NRS-based measurements in normal coverage, calculate the required number of measurement occasions:  $N_{occ} = \lceil T_{(meas, basic)} / T_{(meas, occ)} \rceil$ .

Calculate the number of available measurement occasions per NPDDCH period:

$$N_{avail} = \lceil (T_{avail} - T_{(meas, occ)}) / (T_{(meas, occ)} + T_g) \rceil + 1$$

$$\text{Set } D = N_{occ} - \lceil N_{occ} / N_{avail} \rceil \cdot N_{avail}$$

For  $D > 0$ , the measurement period is given by

$$T_{meas} = \lceil N_{occ} / N_{avail} \rceil \cdot T_{NPDCCH} + D \cdot (T_{occ} + T_g) - T_g + L_{NPDCCH} + T_{proc} + 2 \cdot T_{RT}$$

For  $D = 0$ , the measurement period is given by

$$T_{\text{meas}} = (\lceil N_{\text{occ}} / N_{\text{avail}} \rceil - 1) \cdot T_{\text{NPDCCH}} + N_{\text{avail}} \cdot (T_{\text{occ}} + T_g) - T_g + L_{\text{NPDCCH}} + T_{\text{proc}} + 2 \cdot T_{\text{RT}}$$

Option 2: (Ericsson)

- RRM measurement requirements on a target carrier different from the serving carrier is defined as:

$$T_{\text{measure\_inter}} = 5 \cdot \min(5000, T_a) \text{ ms}$$

- o Where  $T_{\text{min}} \leq T_a \leq 5000 \text{ ms}$ 
  - $T_{\text{min}}$  = time interval length between two successive measurement occasions.
- o Assuming DL subframes containing NRS signals of the measured cell is available within  $(5, T_a)$  at the UE assuming the measured cell is an identified cell.

Option 3 (Huawei):

Requirements for inter-frequency measurement on a carrier different from serving carrier requirements is defined as:

$$T_{\text{measure\_inter}} = \sum_{(i=1)}^N \text{Min}(5000, T_{a,i}) \text{ ms},$$

where  $T_{a,i}$  is the interval between available measurement samples, where  $T_{a,i} \geq 20 \text{ ms}$  for NRS and  $T_{a,i} \geq 40 \text{ ms}$  for NSSS.  $N = 60$  for NRS-based measurement and  $40$  for NSSS based measurement.

- Recommended WF

Discuss above options.

### **Feedback Form 8: Issue 1-2-4: Detailed requirements for inter-frequency measurement**

#### **1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We think option 1 give an precise formulation based on measurement occasion. But as commented in issue 1-2-3, it is based on the assumption that no data scheduled during measurement period. So we prefer to derive the requirement based on number of available samples.

For Option 2, we think 5 is derived based on intra-f DRX case, which seems not feasible for non-DRX according to previous agreement. And we think Summation should be used in the formular.

Based on above analysis, we suggest to use option 3.

#### **2 – Ericsson Hungary Ltd**

We support option 3.

### 3 – Nokia Germany

We support option 3 as baseline.

### 4 – Qualcomm Incorporated

On option 2, the proposal assumes 5 samples per measurement? What is the justification for 5 samples? Also, it does not seem to account for the duration of each sample and it seems to assume that  $T_a$  is the same between all adjacent samples.

On option 3, our understanding is that  $T_{a,i}$  is not known precisely unless some assumptions are made. Without any further assumptions, the measurement period could last up to  $60 \cdot 5000 \text{ ms} = 5 \text{ minutes}$  for NRS based measurements on one carrier. Please confirm if this is the correct interpretation.

### 5 – Qualcomm Incorporated

We support option 1 and we're open to discuss modifications or compromise.

## Issue 1-2-5: Detailed requirements for inter-frequency detection

Option 1: (Qualcomm)

Without DRX and assuming no UL/DL scheduling, the available time for measurements during one NPDCCH monitoring period would be  $T_{\text{avail}} = T_{\text{NPDCCH}} - L_{\text{NPDCCH}} - T_{\text{proc}} - 2 \cdot T_{\text{RT}}$ , where

$T_{\text{NPDCCH}}$  is the NPDCCH monitoring period length,

$L_{\text{NPDCCH}}$  is the duration of a NPDCCH candidate with  $R_{\text{max}}$  repetitions,

$T_{\text{proc}} = 4 \text{ ms}$  is the NPDCCH processing time,

$T_{\text{RT}} = 1 \text{ ms}$  is the receiver retuning time.

Choose the duplexing mode (FDD/TDD) and carrier type (anchor, non-anchor).

For TDD, choose the UL/DL configuration

Calculate  $T_{\text{NPDCCH}}$  and  $L_{\text{NPDCCH}}$  for all applicable values of  $(G, R_{\text{max}})$

Calculate  $T_{\text{avail}} = T_{\text{NPDCCH}} - L_{\text{NPDCCH}} - T_{\text{proc}} - 2 \cdot T_{\text{RT}}$

Given  $T_{(\text{detect, basic})} = 1400 \text{ ms}$  in normal coverage, calculate the required number of measurement occasions:

$$N_{\text{occ}} = \lceil T_{(\text{detect, basic})} / T_{(\text{detect, occ})} \rceil$$

Calculate the number of available measurement occasions per NPDDCH period:

$$N_{\text{avail}} = \lfloor (T_{\text{avail}} - T_{(\text{detect, occ})}) / T_{(\text{detect, occ})} \rfloor$$

$$\text{Set } D = N_{\text{occ}} - \lceil N_{\text{occ}} / N_{\text{avail}} \rceil \cdot N_a$$

For  $D > 0$ , the measurement period is given by

$$T_{\text{detect}} = \lceil N_{\text{occ}} / N_{\text{avail}} \rceil \cdot T_{\text{NPDCCH}} + D \cdot (T_{\text{occ}} + T_g) - T_g + L_{\text{NPDCCH}} + T_{\text{proc}} + 2 \cdot T_{\text{RT}}$$

For  $D=0$ , the measurement period is given by

$$T_{\text{detect}} = (\lceil N_{\text{occ}} / N_{\text{avail}} \rceil - 1) \cdot T_{\text{NPDCCH}} + N_{\text{avail}} \cdot (T_{\text{occ}} + T_g) - T_g + L_{\text{NPDCCH}} + T_{\text{proc}} + 2 \cdot T_{\text{RT}}$$

Option 2: (Ericsson)

- Cell detection requirements on a target carrier different from the serving carrier is defined as:

$$T_{\text{detect}} = N_d \cdot \min(5000, T_a) \text{ ms}$$

- o Where  $T_{\text{min}} \leq T_a \leq 5000 \text{ ms}$
- o  $M_s$  = number of detection attempts needed for successful cell detection
  - $T_{\text{min}}$  = minimum time interval between two successive measurement occasions.
- o Assuming that at least subframes # 0, #4, #5 or #9 containing NPSS/NSSS of the measured cell is available within  $\min(5, T_a)$

Option 3 (Huawei):

$T_{\text{detect\_inter}} = \sum_{(i=1)}^N T_{a,i}$ , where  $T_{a,i}$  is the interval between available measurement occasions. And  $N$  is the number of occasions when  $\sum_{(i=1)}^N L_{a,i} \geq 1400 \text{ms}$  and  $\sum_{(i=1)}^N L_{a,i} < 1400 \text{ms}$ , and  $L_{a,i}$  is the length of each available measurement occasions.

- Recommended WF
  - o Discuss above options.

### **Feedback Form 9: Issue 1-2-5: Detailed requirements for inter-frequency detection**

#### **1 – HUAWEI TECHNOLOGIES Co. Ltd.**

Based on the consideration on how to formulate the requirements. We support option 3 or following option 4. Companies please check whether it is agreeable:

#### **Option 4:**

**Requirements for inter-frequency detection on a carrier different from serving carrier requirements is defined as:**

$$T_{\text{detectinter}} = \sum_{(i=1)}^N \text{Min}(5000, T_{a,i}) \text{ms},$$

**where  $T_{a,i}$  is the interval between available measurement samples,  $T_{a,i} \geq 40 \text{ ms}$  and  $N = 70$**

## 2 – Ericsson Hungary Ltd

Option 4 is agreeable.

## 3 – Nokia Germany

We support option 4 as baseline. It is noted for option 3 above, for term < 1400 ms, the sum goes only up to N-1.

## 4 – Qualcomm Incorporated

We support option 1.

On option 2, it does not seem to account for the duration of each sample and it seems to assume that  $T_a$  is the same between all adjacent samples.

On option 3, similar comments as for issue 1-2-4 but additionally it seems harder to understand what the required measurement period is since  $L_{a,i}$  are not known a priori without additional assumptions. The requirement says the measurement period will last as long as necessary to accumulate a sufficient number of occasions that add up to 1400 ms.

On option 4, similar comments as for option 3.

In addition, we have the concern mentioned earlier that options 2-4 may not account correctly of inter-frequency measurement overhead.

### 2.2.3 Multi carrier operation

#### Issue 1-3-1: Requirements when UE is required to monitor multiple carriers

##### – Option 1 (Huawei)

- Requirements for cell detection and measurement when UE is required to monitor multiple carriers are defined as:
- $T_{\text{detect}} = T_{\text{detect\_intra}} + N_{\text{freq}} * T_{\text{detect\_inter}}$
- $T_{\text{measure}} = T_{\text{measure\_intra}} + N_{\text{freq}} * T_{\text{measure\_inter}}$
- Where  $N_{\text{freq}}$  is number of inter-frequency layers to be measured according to the measurement capability.

##### – Recommended WF

- Agree on option 1.

**Feedback Form 10: Issue 1-3-1: Requirements when UE is required to monitor multiple carrier**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We support option 1.

It is straightforward that the overall time is scaled by number of carriers. The requirements for single carrier can be discussed in other issues, and there is no need to couple them.

**2 – Qualcomm Incorporated**

Option 1 is agreeable.

**3 – Nokia Germany**

We support option 1.

**4 – Ericsson Hungary Ltd**

Option 1 is agreeable.

**Issue 1-3-2: Carriers to be measured in connected mode**

Option 1 (Ericsson)

- The UE may continue measuring on neighbour cells detected in RRC\_IDLE/INACTIVE modes continuously (e.g. every 5 seconds) after transition to RRC\_CONNECTED state provided the carrier of the detected cell is one of the configured carriers for RRC connection reestablishment.

Recommended WF:

Discuss above proposal and discuss what the impact of spec is of option 1.

**Feedback Form 11: Issue 1-3-2: Carriers to be measured in connected mode**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We think companies have comments on "configured carriers for RRC connection Reestablishment" in last meeting. From our understanding, there is no NW configurations on carriers for Reestablishment. And can proponent company clarify what is the impact of option 1 as it says UE *may* continue.

**2 – Qualcomm Incorporated**

Agree with the above comment from Huawei. We provided comments in the previous meeting asking for clarification but no response was given.

**3 – Ericsson Hungary Ltd**

Thanks for checking and providing comments. Based on company's view, we have further revised our proposal. Typically and most likely, the UE measures on the intra-frequency carriers before inter-frequency

carriers. Therefore that is also expected to be potential target carrier for reestablishment. Since intra-frequency (serving carrier) is known to the UE, UE measures on that serving carrier. We have revised our original proposal as follows:

**Revised proposal:**

The UE continues measuring on at least one neighbour cell detected in RRC\_IDLE/INACTIVE modes at least once every 5 seconds after transition to RRC\_CONNECTED state provided that it belongs to the serving carrier frequency and meets the side condition ( $E_s/I_{ot} \geq -6$  dB).

**4 – Nokia Germany**

In our view further justification should be given for option 1 or the revised proposal in terms of benefit over current measurements.

**5 – Ericsson Hungary Ltd**

Further justification:

Intra-frequency carriers are typically more often for mobility than inter-frequency carriers. As an example (side note), it is for this reason large part of the measurement gap sharing values in measurement gaps sharing tables in CONNECTED are considered for intra-frequency carriers compared to inter-frequency carriers. Similarly, it is what is expected that the UE may try to perform the reestablishment on one of the neighbour cell of the serving carrier on which it has measurement in IDLE Mode rather than trying any other random carrier. Therefore we think there should be significant advantage (i.e. much shorter delay since the cell is already known which means only 80 ms for Tsearch) for the UE to continue measure at least once every 5 seconds (i.e. as long when the cell is known) on one neighbour cell of the serving carrier. Please note that measuring once every 5 seconds may not significantly lead to increased power, but it will make sure that the target cell for re-establishment is already measured and ready when it is time to perform the re-establishment. In fact, we believe this will be much faster approach than the other approach as being discussed which rely on vacant slots, no scheduling etc.

2.2.4 Scenarios

**Issue 1-4-1: Whether to deprioritize defining requirements when serving cell in enhanced coverage.**

- Proposals

Option 1: Deprioritize defining CONNECTED mode neighbour cell measurement requirements when the serving cell is in enhanced coverage (Ericsson, Huawei)

- Recommended WF
  - Discuss above options.

**Feedback Form 12: Whether to deprioritize defining requirements when serving cell in enhanced coverage**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

From requirements perspective, the requirements are same when serving cell is in NC or EC. Considering the real scenarios, it maybe not the targeting scenario that UE in EC to perform neighbour cell measurement where the triggering condition could be very low. Based on above, we have no strong veiws. From perspective of real scenarios, we support option 1.

**2 – Qualcomm Incorporated**

If this issue does not have any material impact on requirements we prefer not to discuss it.

**3 – Ericsson Hungary Ltd**

We don't have strong view.

**4 – Nokia Germany**

In our view, as commented in previous meetings, this is a valid use case to be considered, as the UE could move to an area where it is in enhanced coverage of serving cell, but at some point in time (e.g. prior to RLF declaration) detects a good target cell in normal coverage. Thus, the scenario should not be de-prioritized.

**5 – Ericsson Hungary Ltd**

We can compromise and keep the scenario where serving cell is in EC.

2.2.5 Additional triggering conditions

**Issue 1-5-1: Whether to have additional triggering conditions**

– Proposals

- Option 1: In addition to the already agreed triggering conditions, the UE shall initiate the neighbour cell measurements if K number of out-of-sync indications are detected in the cell. (Ericsson)

– Recommended WF

- Discuss above options.

**Feedback Form 13: Whether to have additional triggering conditions**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

From our understanding, RAN2 has already conluded on triggering mechanism, and OOS was considered also but not defined finally. So we prefer not to revisit RAN2's agreement at this late stage.

## 2 – Qualcomm Incorporated

The definition of triggering conditions is within RAN2 scope.

## 3 – Ericsson Hungary Ltd

We support option 1. This issue is related to the RAN2 agreement from previous meeting. At previous RAN2 meeting, RAN2 has agreed to introduce two thresholds for triggering intra-frequency and inter-frequency measurements, i.e. the NRSRP measurements are compared to those threshold for determining whether to initiate the neighbor cell measurements. The agreements are shown below:

“RAN2#116-e agreements:

¶ NW signals two separate thresholds for intra- and inter-frequency measurements.

¶ The values of s-SearchDeltaP and TSearchDeltaP may be different in *RRCCONNECTED* and *RRCIDLE*, they are signalled in a separate set of parameters.

§ s-SearchDeltaP has the same value range as the existing *RRC\_IDLE* parameter

FFS how to specify the state change”

It is important to note that the measurements used in the above agreements are based on several samples that are averaged over time. However, the radio conditions of the UE can change much faster (e.g. in slot-level). For instance, the RLM out-of-sync evaluation is 400 ms for  $R_{max} \leq 64$ , however, the NRS based measurement period is 800 ms or NSS-based measurement period is 1600 ms. This means the radio link problems can be detected much faster compared to the conditions based on configured threshold or mobility state. Therefore we see benefits in UE initiating neighbour cell measurements if UE has detected K number of out-of-sync indications regardless of the other already agreed conditions. Therefore we support option 1.

## 4 – Nokia Germany

We agree, this is within RAN2 scope.

### 2.2.6 Indication when UE needs to start inter-f measurements

#### Issue 1-6-1: Whether to indicate when UE needs to start inter-f measurements

##### – Proposals

- Option 1: RAN4 should send an LS to RAN2 informing RAN2 that our analysis shows that, in many scenarios, it would be beneficial for the UE to indicate when it needs to start performing inter-frequency measurements so that the serving cell may create measurement opportunities for the UE. (Qualcomm)

##### – Recommended WF

- Discuss above options.

**Feedback Form 14: Whether to indicate when UE needs to start inter-f measurements**

<p><b>1 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>We think RAN2 has discussed the issue for meetings. So we suggest to wait for RAN2 conclusion on this issue and let RAN2 to decide it.</p>
<p><b>2 – Qualcomm Incorporated</b></p> <p>In the previous meeting, it was suggested (mentioned by the session chair, at least) that RAN2 may not make a decision on this matter unless RAN4 can show that there would be benefit. Based on the analysis presented in our paper we think there would be benefit.</p>
<p><b>3 – Ericsson Hungary Ltd</b></p> <p>We have similar view as Huawei that there is no need to send LS at this point.</p>
<p><b>4 – Nokia Germany</b></p> <p>This should be further addressed by RAN2. In the analysis, we see the assumption that all subframes are valid subframes where NPDCCH can be transmitted. Hence concurrent DL data transfer seems not to be accounted for. Maybe the proponent can clarify.</p>

2.3 Summary for 1st round

**Table 2: Summary for 1st round**

	<b>Status summary</b>
<b>Sub-topic #1-1</b>	<p><b><u>Issue 1-1-1: Intra-frequency requirement when DRX is not configure</u></b></p> <p>Four companies commented in 1<sup>st</sup> round, and all agree with option 1.</p> <p><b><i>Tentative agreements:</i></b></p> <p><math>T_{\text{detect\_intra}} = 1400</math> ms</p> <p><math>T_{\text{measure\_intra}} = 800</math> ms for NRS-based measurement</p> <p><math>T_{\text{measure\_intra}} = 1600</math> ms for NSSS-based measurement</p> <p><b><i>Candidate options: NA</i></b></p> <p><b><i>Recommendations for 2<sup>nd</sup> round: NA</i></b></p>

	<p><b><u>Issue 1-1-2: Intra-frequency requirement when DRX is configured</u></b></p> <p>Four companies commented in 1<sup>st</sup> round, and all agree with WF.</p> <p><b><i>Tentative agreements:</i></b>  <math>T_{\text{detect\_intra}} = [6]</math> DRX cycles  <math>T_{\text{measure\_intra}} = 5</math> DRX cycle</p> <p><b><i>Candidate options: NA</i></b></p> <p><b><i>Recommendations for 2<sup>nd</sup> round:</i></b>  Companies please check <math>T_{\text{detect\_intra}} = [6]</math> DRX cycles</p>
<p><b>Sub-topic #1-2</b></p>	<p><b><u>Issue 1-2-1: General How to formulate inter-frequency measurement</u></b></p> <p>Four companies commented in 1<sup>st</sup> round, and three companies support option 3. One companies had concerns on the overhead of retuning and RX AGC if it is one-sample-at-a time approach.</p> <p><b><i>Tentative agreements:</i></b>  Take option 3 as baseline and discuss the FFS points in 2<sup>nd</sup> round.  Option 3:  Define inter-frequency measurement requirements based on number of available samples in available measurement occasions.  Number of samples are determined based on agreed time in LS reply and sampling rate.  FFS: Whether UE can process multiple samples within in one measurement occasions at a time?  FFS: Whether to add additional assumptions on minimum measurement occasions?</p> <p><b><i>Candidate options: NA</i></b></p> <p><b><i>Recommendations for 2<sup>nd</sup> round:</i></b>  Discuss the FFS point.</p>

**Issue 1-2-2: General – How to formulate inter-frequency detection**

Four companies commented in 1<sup>st</sup> round, and three companies support option 3. One company had concerns on whether UE can process multiple samples at a time.

***Tentative agreements:***

Take option 3 as baseline and discuss the FFS points in 2<sup>nd</sup> round.

Option 3:

Define inter-frequency detection requirements based on number of available samples in available measurement occasions.

Number of samples are determined based on agreed time in LS reply and NPSS/NSSS interval.

FFS: Whether UE can process multiple samples within in one measurement occasions at a time?

FFS: Whether to add additional assumptions on minimum measurement occasions

***Candidate options: NA***

***Recommendations for 2<sup>nd</sup> round:***

Discuss the FFS point.

**Issue 1-2-3: Condition on inter-frequency measurement**

**Sub-1: Interruption due to data traffic**

Four companies commented in 1st round, and three companies agreed that the interruptions due to data traffic should be considered. One company clarify that if there is data scheduled the measurement period can be extended.

***Tentative agreements: NA***

***Candidate options:***

Option 1: The measurement period requirements for inter-frequency cell detection and measurements in connected mode shall apply assuming no UL/DL scheduling for the UE during the measurement period.

***Recommendations for 2nd round:***

Discuss in 2nd round whether previous agreements are sufficient.

**Sub-2: Minimum length per occasion**

Three companies commented in 1st round, and two companies support option 2 and one company support option 1.

***Tentative agreements: NA***

***Candidate options:***

Option 1

Minimum length of occasion for measurements: 50 ms

Minimum length of occasion for cell detection: 200 ms

Option 2

Minimum length of occasion for cell detection is 21 ms.

Minimum length of occasion for NRS based measurement is 11 ms, and 21ms for NSSS based measurement.

***Recommendations for 2nd round:***

Continue discussion in 2nd round and try to find whether there is compromised solution considering the overhead of UE implementation.

**Sub-3: Assumed sampling rate for measurement**

Four companies commented in 1<sup>st</sup> round. Three companies support option 2. One company explains Option 3 is not for sampling rate but for whether there should be minimum spacing between occasions. Thus, a new sub issue is added.

***Tentative agreements:***

Assumed sampling rate for measurement is 20 ms for NRS and 40 ms for NSS

***Candidate options:***

***Recommendations for 2nd round:***

20 Discussion following question:

**Sub-4: Whether to have minimum spacing between occasions.**

**Issue 1-2-4: Detailed requirements for inter-frequency measurement**

Four companies commented in 1<sup>st</sup> round. Three companies support option 2. One company support 1.

**Tentative agreements: NA**

**Candidate options:**

Option 1:

Without DRX and assuming no UL/DL scheduling, the available time for measurements during one NPDCCH

monitoring period would be  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot TRT$ , where

$T_{NPDCCH}$  is the NPDCCH monitoring period length,

$L_{NPDCCH}$  is the duration of a NPDCCH candidate with  $R_{max}$  repetitions,

$T_{proc} = 4$  ms is the NPDCCH processing time,

$TRT = 1$  ms is the receiver retuning time.

Choose the duplexing mode (FDD/TDD) and carrier type (anchor, non-anchor).

For TDD, choose the UL/DL configuration.

Calculate  $T_{NPDCCH}$  and  $L_{NPDCCH}$  for all applicable values of (G,  $R_{max}$ ).

Calculate  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot TRT$ .

Given  $T_{(meas, basic)} = 800$  ms for NRS-based measurements in normal coverage, calculate the required number

of measurement occasions:  $N_{occ} = \lceil T_{(meas, basic)} / T_{(meas, occ)} \rceil$ .

Calculate the number of available measurement occasions per NPDCCH period:

$N_{avail} = \lceil (T_{avail} - T_{(meas, occ)}) / (T_{(meas, occ)} + T_g) \rceil + 1$

Set  $D = N_{occ} - \lceil N_{occ} / N_{avail} \rceil \cdot N_{avail}$ .

For  $D > 0$ , the measurement period is given by

$T_{meas} = \lceil N_{occ} / N_{avail} \rceil \cdot T_{NPDCCH} + D \cdot (T_{occ} + T_g) - T_g - L_{NPDCCH} - T_{proc} - 2 \cdot TRT$

For  $D = 0$ , the measurement period is given by

$T_{detect} = (\lceil N_{occ} / N_{avail} \rceil - 1) \cdot T_{NPDCCH} + N_{avail} \cdot (T_{occ} + T_g) - T_g - L_{NPDCCH} - T_{proc} - 2 \cdot TRT$

Option 3:

Requirements for inter-frequency measurement on a carrier different from serving carrier requirements is defined as:

$T_{measure\_inter} = \sum_{(i=1)}^N \text{Min}(5000, T_{a,i})$  ms,

where  $T_{a,i}$  is the interval between available measurement samples, where  $T_{a,i} \geq 20$  ms for NRS and  $T_{a,i} \geq 40$ ms for NSSS.  $N = 60$  for NRS-based measurement and 40 for NSSS based measurement.

21 **Recommendations for 2nd round:**

Keep discussion in 2<sup>nd</sup> round and identify whether additional assumptions are needed.

**Issue 1-2-5: Detailed requirements for inter-frequency detection:**

Four companies commented in 1<sup>st</sup> round. Three companies support option 4. One company supports option 1.

**Tentative agreements: NA**

**Candidate options:**

Option 1:

Without DRX and assuming no UL/DL scheduling, the available time for measurements during one NPDCCH

monitoring period would be  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot TRT$ , where

$T_{NPDCCH}$  is the NPDCCH monitoring period length,

$L_{NPDCCH}$  is the duration of a NPDCCH candidate with  $R_{max}$  repetitions,

$T_{proc} = 4$  ms is the NPDCCH processing time,

$TRT = 1$  ms is the receiver retuning time.

Choose the duplexing mode (FDD/TDD) and carrier type (anchor, non-anchor).

For TDD, choose the UL/DL configuration.

Calculate  $T_{NPDCCH}$  and  $L_{NPDCCH}$  for all applicable values of (G,  $R_{max}$ ).

Calculate  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot TRT$ .

Given  $T(\text{detect, basic}) = 1400$  ms, calculate the required number

of measurement occasions:  $N_{occ} = \lceil T(\text{detect, basic}) / T(\text{detect, occ}) \rceil$ .

Calculate the number of available measurement occasions per NPDDCH period:

$N_{avail} = \lceil (T_{avail} - T(\text{detect, occ})) / (T(\text{detect, occ}) + T_g) \rceil + 1$

Set  $D = N_{occ} - \lceil N_{occ} / N_{avail} \rceil \cdot N_{avail}$ .

For  $D > 0$ , the measurement period is given by

$T_{detect} = \lceil N_{occ} / N_{avail} \rceil \cdot T_{NPDCCH} + D \cdot (T_{occ} + T_g) - T_g + L_{NPDCCH} + T_{proc} + 2 \cdot TRT$

For  $D = 0$ , the measurement period is given by

$T_{detect} = (\lceil N_{occ} / N_{avail} \rceil - 1) \cdot T_{NPDCCH} + N_{avail} \cdot (T_{occ} + T_g) - T_g + L_{NPDCCH} + T_{proc} + 2 \cdot TRT$

Option 4:

Requirements for inter-frequency detection on a carrier different from serving carrier requirements is defined as:

$T_{detectinter} = \sum_{(i=1)}^N \text{Min}(5000, T_{a,i})$  ms,

where  $T_{a,i}$  is the interval between available measurement samples,  $T_{a,i} \geq 40$  ms and  $N = 70$

**Recommendations for 2nd round:**

22 Keep discussion in 2<sup>nd</sup> round and identify whether additional assumptions are needed.

<p><b>Sub-topic #1-3</b></p>	<p><b>Issue 1-3-1: Requirements when UE is required to monitor multiple carriers</b></p> <p>Four companies commented in 1<sup>st</sup> round and all agreed option1.</p> <p><b>Tentative agreements:</b> Requirements for cell detection and measurement when UE is required to monitor multiple carriers are defined as:  <math>T_{\text{detect}} = T_{\text{detect\_intra}} + N_{\text{freq}} * T_{\text{detect\_inter}}</math>  <math>T_{\text{measure}} = T_{\text{measure\_intra}} + N_{\text{freq}} * T_{\text{measure\_inter}}</math></p> <p>Where Nfreq is number of inter-frequency layers to be measured according to the measurement capability.</p> <p><b>Candidate options: NA</b> <b>Recommendations for 2nd round: NA</b></p> <p><b>Issue 1-3-2: Carriers to be measured in connected mode</b></p> <p>Four companies commented in 1<sup>st</sup> round. Three companies commented further justifications are needed. Proponent company revised the proposal in 1<sup>st</sup> round.</p> <p><b>Tentative agreements: NA</b> <b>Candidate options:</b> Option 1(revised in 1<sup>st</sup> round.) The UE continues measuring on at least one neighbour cell detected in RRC_IDLE/INACTIVE modes at least once every 5 seconds after transition to RRC_CONNECTED state provided that it belongs to the serving carrier frequency and meets the side condition (<math>E_s/I_{ot} \geq -6</math> dB).</p> <p><b>Recommendations for 2nd round:</b> Discuss above option in 2<sup>nd</sup> round</p>
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<p><b>Sub-topic #1-4</b></p>	<p><b><u>Issue 1-4-1: Whether to deprioritize defining requirements when serving cell in enhanced coverage.</u></b></p> <p>Four companies commented in 1<sup>st</sup> round, and all companies are fine to keep the case when serving cell in EC.</p> <p><b>Tentative agreements:</b> Defining CONNECTED mode neighbour cell measurement requirements when the serving cell is in enhanced coverage</p> <p><b>Candidate options: NA</b></p> <p><b>Recommendations for 2nd round: NA</b></p>
<p><b>Sub-topic #1-5</b></p>	<p><b>Issue 1-5-1: Whether to have additional triggering conditions</b></p> <p>Four companies commented in 1<sup>st</sup> round and 3 companies commented that it is within RAN2 scope.</p> <p><b>Tentative agreements: NA</b></p> <p><b>Candidate options:</b></p> <p>Option 1: In addition to the already agreed triggering conditions, the UE shall initiate the neighbour cell measurements if K number of out-of-sync indications are detected in the cell.</p> <p><b>Recommendations for 2nd round:</b> Discuss in 2<sup>nd</sup> round.</p>
<p><b>Sub-topic #1-6</b></p>	<p><b>Issue 1-6-1: Whether to indicate when UE needs to start inter-f measurements</b></p> <p>Four companies commented in 1<sup>st</sup> round and 3 companies commented that it within RAN2 scope.</p> <p><b>Tentative agreements: NA</b></p> <p><b>Candidate options:</b></p> <p>Option 1: RAN4 should send an LS to RAN2 informing RAN2 that our analysis shows that, in many scenarios, it would be beneficial for the UE to indicate when it needs to start performing inter-frequency measurements so that the serving cell may create measurement opportunities for the UE.</p> <p><b>Recommendations for 2nd round:</b> Discuss in 2<sup>nd</sup> round.</p>

## 2.4 Discussion on 2nd round (if applicable)

Companies commented on WF directly in 2nd round. The comments are captured in this summary for information.

### 2.4.1 Issue 1-1-1: Intra-frequency requirement when DRX is not configure

Agreement:

$$T_{\text{detect\_intra}} = 1400 \text{ ms}$$

$$T_{\text{measure\_intra}} = 800 \text{ ms for NRS-based measurement}$$

$$T_{\text{measure\_intra}} = 1600 \text{ ms for NSSS-based measurement}$$

### 2.4.2 Issue 1-1-2: Intra-frequency requirement when DRX is configured

Agreement:

$$T_{\text{detect\_intra}} = [6] \text{ DRX cycles}$$

$$T_{\text{measure\_intra}} = 5 \text{ DRX cycle}$$

**Recommended WF**

Agree on  $T_{\text{detect\_intra}} = [6] \text{ DRX cycles}$

**Table 3:**

Company	Comments
Huawei	<b>Issue 1-1-2</b> We support the recommended WF.
Ericsson	<u>Recommended WF is agreeable.</u>
Qualcomm	<u>We support the recommended WF.</u>

### 2.4.3 Issue 1-2-1: General – How to formulate inter-frequency measurement

Agreement:

Define inter-frequency measurement requirements based on number of available samples in available measurement occasions.

Number of samples are determined based on agreed time in LS reply and sampling rate.

FFS: Whether UE can use multiple samples within in one measurement occasions at a time?

FFS: Whether to add additional assumptions on minimum measurement occasions

**Recommended WF** □

Agree on following assumptions:

UE can process multiple samples within in one measurement occasion at a time

Add addition assumption on minimum length of measurement occasions to avoid high overhead which will be discussed in issue 1-2-3

**Table 4:**

Company	Comments
Huawei	<p><b>Issue 1-2-1</b>            We support the addition clarifications.            One of the concerns received from 1<sup>st</sup> round discussion is that whether sample-based approach means UE can only process one sample at a time. We believe the answer is no. How requirements are defined will not focus UE to do such strange implementation. For instance, if there is an available measurement occasion of 100 ms. There could be multiple NPSS/NSSS, in this occasion. The intention is not to required UE to switch to the target cell and get one sample and switch back and repeat it for several times in 100 ms. As an available measurement occasion is the time period without data and NPDCCH, we don't say the reason for doing this which leads to a lot unnecessary RF tuning.            For minimum length of measurement occasion, we think the comments are valid about overhead. For example, if one available measurement occasion is very short, there will be overhead issue with a lot RF tuning. We agree to consider a longer minimum length of measurement occasion as this is a kind of best efforts measurement. Then minimum length will be discussed in 1-2-3.</p>

Ericsson	<u>We would like to understand the recommend WF better. How is this assumption supposed to be captured if agreed. Is the recommend WF to agree on the option 3 for issue 1-2-4 and option 4 for issue 1-2-5 under assumption that the minimum length of measurement occasion shall not be below certain value? If that is the correct understanding, then we are fine with the recommend WF.</u>
Huawei2	<u>To Ericsson: To address the concerns from companies in first around about overhead of “one-sample a time”. It is suggested to add following two clarification: UE can process multiple samples within in one measurement occasion at a time Minimum length of occasion for measurements and detection are X and Y, which are discussed in issue 1-2-3.</u>
Ericsson2	<u>We are fine with the recommended WF.</u>
Qualcomm	<u>We agree with the first statement in the recommended WF: UE can process multiple samples within in one measurement occasion at a time. It’s not clear to us how a minimum duration per occasion would be incorporated into the proposals for inter-frequency measurement/detection period based on number of samples.</u>

#### 2.4.4 Issue 1-2-2: General – How to formulate inter-frequency detection

Agreement:

Define inter-frequency detection requirements based on number of available samples in available measurement occasions.

Number of samples are determined based on agreed time in LS reply and NPSS/NSSS interval.

FFS: Whether UE can use multiple samples within in one measurement occasions at a time?

FFS: Whether to add additional assumptions on minimum measurement occasions

#### **Recommended WF** □

Agree on following assumptions:

UE can process multiple samples within in one measurement occasion at a time

Add addition assumption on minimum length of measurement occasions to avoid high overhead which will be

discussed in issue 1-2-3

**Table 5:**

Company	Comments
Huawei	<p><b>Issue 1-2-1</b> Based on the similar consideration in issue 1-1-1. We agreed to add the assumptions and consider a longer minimum length of measurement occasions in issue 1-2-3.</p>
Ericsson	<p><u>We would like to understand the recommend WF better. How is this assumption supposed to be captured if agreed. Is the recommend WF to agree on the option 3 for issue 1-2-4 and option 4 for issue 1-2-5 under assumption that the minimum length of measurement occasion shall not be below certain value? If that is the correct understanding, then we are fine with the recommend WF.</u></p>
Huawei2	<p><u>To Ericsson:</u> <u>To address the concerns from companies in first around about overhead of “one-sample a time”. It is suggested to add following two clarification:</u> UE can process multiple samples within in one measurement occasion at a time Minimum length of occasion for measurements and detection are X and Y, which are discussed in issue 1-2-3.</p>
Ericsson	<p><u>We are fine with the recommend WF.</u></p>
Qualcomm	<p><u>Same comment as for issue 1-2-1.</u></p>

2.4.5 Issue 1-2-3: Condition on inter-frequency measurement

**Sub-1: Interruption due to data traffic**

FFS:

Option 1: The measurement period requirements for inter-frequency cell detection and measurements in connected mode shall apply assuming no UL/DL scheduling for the UE during the measurement period.

**Recommended WF**

Previous agreements on conditions for inter-frequency measurement are sufficient

**Table 6:**

<b>Company</b>	<b>Comments</b>
Huawei	<b><u>Issue 1-2-3 sub-1</u></b> We support Recommended WF that previous agreements are sufficient
Ericsson	<u>We have similar view as HW that previous RAN4 agreements are sufficient.</u>
Qualcomm	<u>The previous agreement mentioned the conditions in which the UE would be able to perform inter-frequency measurements without causing interruptions in communication with the serving cell. There was nothing specific about measurement period in the previous agreement.</u> <u>Option 1 is not meant to be taken in isolation. It complements our proposal for inter-frequency measurement period duration and it means to say that the proposed requirement is expected to be met under certain conditions, specified in option 1. If those conditions are not met, the measurement period can be extended.</u> <u>We understand that Huawei and Ericsson do not support a requirement for measurement period duration, other than an upper bound based on a maximum time separation of 5 sec between measurement samples.</u>

**Sub-2: Minimum length per occasion**

FFS:

Option 1

Minimum length of occasion for measurements: 50 ms

Minimum length of occasion for cell detection: 200 ms

Option 2

Minimum length of occasion for cell detection is 21 ms.

Minimum length of occasion for NRS based measurement is 11 ms, and 21ms for NSSS based measurement.

**Recommended WF**

Company are encouraged to comment in 2<sup>nd</sup> round whether option 1 is agreeable or other compromised value considering the overhead of inter-frequency measurement.

**Table 7:**

<b>Company</b>	<b>Comments</b>
Huawei	<b>Issue 1-2-1 sub-2</b> We think the concerns of overhead caused by two short measurement occasions is valid. So we can agree on option 1 or some compromised value between option 1 and option 2.
Ericsson	We also prefer option 2, but open to consider other values as compromise.
Qualcomm	If we agree on a minimum length per occasion, it's not clear to us how that would be incorporated in Huawei's proposals for inter-frequency measurement/detection period.

**Sub-3: Assumed sampling rate for measurement**

Agreement:

Assumed sampling rate for measurement is 20 ms for NRS and 40 ms for NSS

**Sub-4: Whether to have minimum spacing between occasions.**

FFS:

Option 1:

No need to define minimum spacing between occasions

Recommended WF

Agree on option 1

**Table 8:**

<b>Company</b>	<b>Comments</b>

Huawei	<b>Issue 1-2-1 sub-4</b> We support recommended WF. The intention of formulating the requirements by number of samples is not to restrict UE to only have one sample at one time with unnecessary RF tuning.
Ericsson	<u>We support the WF, i.e. to formulate the requirements based on a number of samples and no need to further define minimum spacing between occasions.</u>
Qualcomm	<u>Support the recommended WF but suggest alternate wording: No need to require a minimum spacing between measurement occasions.</u>

#### 2.4.6 Issue 1-2-4: Detailed requirements for inter-frequency measurement

FFS:

Option 1:

Without DRX and assuming no UL/DL scheduling, the available time for measurements during one NPDCCH monitoring period would be  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot T_{RT}$ , where

$T_{NPDCCH}$  is the  $N_{PDCCH}$  monitoring period length,

$L_{NPDCCH}$  is the duration of a  $N_{PDCCH}$  candidate with  $R_{max}$  repetitions,

$T_{proc} = 4$  ms is the NPDCCH processing time,

$T_{RT} = 1$  ms is the receiver retuning time.

Choose the duplexing mode (FDD/TDD) and carrier type (anchor, non-anchor).

For TDD, choose the UL/DL configuration.

Calculate  $T_{NPDCCH}$  and  $L_{NPDCCH}$  for all applicable values of  $(G, R_{max})$ .

Calculate  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot T_{RT}$ .

Given  $T(\text{meas, basic}) = 800$  ms for NRS-based measurements in normal coverage, calculate the required number

of measurement occasions:  $N_{occ} = \lceil T(\text{meas, basic}) / T(\text{meas, occ}) \rceil$ .

Calculate the number of available measurement occasions per NPDDCH period:

$$N_{avail} = \lfloor (T_{avail} - T(\text{meas, occ})) / (T(\text{meas, occ}) + T_g) \rfloor + 1$$

$$\text{Set } D = N_{occ} - \lfloor N_{occ} / N_{avail} \rfloor \cdot N_{avail}$$

For  $D > 0$ , the measurement period is given by

$$T_{\text{meas}} = \left( \frac{N_{\text{occ}}}{N_{\text{avail}}} - 1 \right) \cdot T_{\text{NPDCCH}} + D \cdot (T_{\text{occ}} + T_{\text{g}}) - T_{\text{g}} + L_{\text{NPDCCH}} + T_{\text{proc}} + 2 \cdot T_{\text{RT}}$$

For  $D = 0$ , the measurement period is given by

$$T_{\text{detect}} = \left( \frac{N_{\text{occ}}}{N_{\text{avail}}} - 1 \right) \cdot T_{\text{NPDCCH}} + N_{\text{avail}} \cdot (T_{\text{occ}} + T_{\text{g}}) - T_{\text{g}} + L_{\text{NPDCCH}} + T_{\text{proc}} + 2 \cdot T_{\text{RT}}$$

Option 3:

Requirements for inter-frequency measurement on a carrier different from serving carrier requirements is defined as:

$$T_{\text{measure\_inter}} = \sum_{i=1}^N \text{Min}(5000, T_{a,i}) \text{ms},$$

where  $T_{a,i}$  is the interval between **available** measurement samples, where  $T_{a,i} \geq 20$  ms for NRS and  $T_{a,i} \geq 40$  ms for NSSS.  $N = 60$  for NRS-based measurement and 40 for NSSS based measurement.

### Recommended WF

Agree on Option 3 with additional conditions in issue 1-2-1

In one measurement occasions, there could be multiple samples. The number of samples is counted by length of occasions and assumed sampling rate. For instance, the length is 120 ms, we assume UE can use 3 samples in this occasions. If  $T_{a,i+2}$  in the fig is longer than min 40ms, it is calculated by actually value e.g. 60 ms.

And if it is too long, for instance longer than 5000ms.

Ericsson

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We support the recommended WF from the moderator.

Huawei2

To address the concerns of companies in 1<sup>st</sup> round.  $T_{a,i}$  is the actual interval between **available/usable samples** in **available/usable measurement occasion** according to the inter-f condition.

$T_{a,i} \geq 40$  is the assumption that UE is no need to measure by every RS.

And  $\text{Min}(5000, T_{a,i})$  is to add the samples that the interval between two samples/usable samples can not be too long. It doesn't the delay is  $60 \cdot 5000$  ms, as  $T_{a,i}$  is the samples interval.

To address the concern, companies please check whether it is fine to add following clarification:

**UE will restart the measurement when the samples between two samples are larger than 5000, and the delay requirements are extended accordingly.**

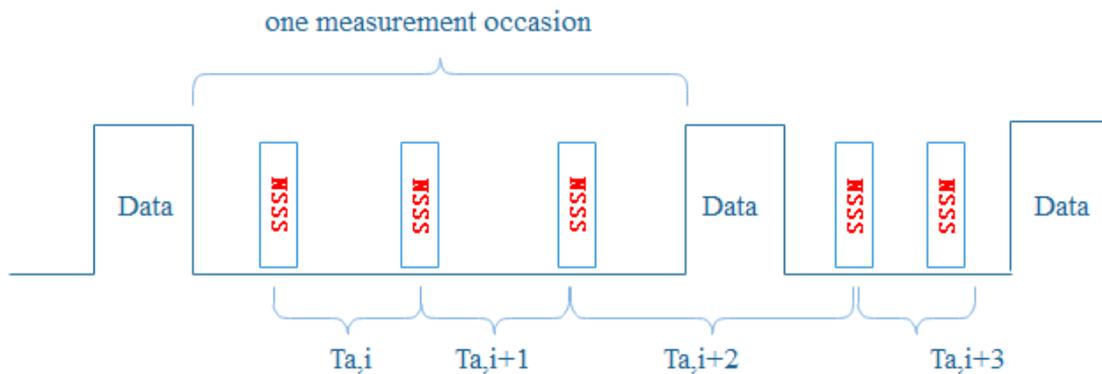
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Qualcomm

Thanks to Huawei for the efforts to converge to an agreement.

Regarding option 3, it basically says that for an inter-frequency measurement the UE needs to measure 60(40) samples of NRS(NSSS), where the time interval between adjacent samples may be between 20 ms(40 ms) and 5 sec. So the measurement period (per carrier) could last between 1.2 (1.6) sec and 5 (3.3) minutes. It's a very wide range and the upper bound is much longer that it would take the UE to declare RLF. In our view, with this requirement it means that the measurements are best effort. The key elements of the proposal are: a) min. number of samples used for the measurements, b) minimum spacing between samples.

As we commented in issue 1-2-1, it's not clear how to incorporate a minimum duration per occasion into option 3.



#### 2.4.7 Issue 1-2-5: Detailed requirements for inter-frequency detection:

FFS:

Option 1:

Without DRX and assuming no UL/DL scheduling, the available time for measurements during one NPDCCH monitoring period would be  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot T_{RT}$ , where

$T_{NPDCCH}$  is the  $N_{PDCCH}$  monitoring period length,

$L_{NPDCCH}$  is the duration of a  $N_{PDCCH}$  candidate with  $R_{max}$  repetitions,

$T_{proc} = 4$  ms is the NPDCCH processing time,

$T_{RT} = 1$  ms is the receiver retuning time.

Choose the duplexing mode (FDD/TDD) and carrier type (anchor, non-anchor).

For TDD, choose the UL/DL configuration.

Calculate  $T_{NPDCCH}$  and  $L_{NPDCCH}$  for all applicable values of  $(G, R_{max})$ .

Calculate  $T_{avail} = T_{NPDCCH} - L_{NPDCCH} - T_{proc} - 2 \cdot T_{RT}$ .

Given  $T(\text{detect, basic}) = 1400$  ms, calculate the required number of measurement occasions:  $N_{occ} = \lceil T(\text{detect, basic}) / T_{avail} \rceil$

basic)/T(detect,occ) □ .

Calculate the number of available measurement occasions per NPDDCH period:

$$N_{avail} = \lfloor (T_{avail} - T(\text{detect,occ})) / (T(\text{detect,occ}) + T_g) \rfloor + 1$$

$$\text{Set } D = N_{occ} - \lfloor N_{occ} / N_{avail} \rfloor \cdot N_{avail}.$$

For  $D > 0$ , the detection period is given by

$$T_{detect} = \lfloor N_{occ} / N_{avail} \rfloor \cdot T_{NPDCCH} + D \cdot (T_{occ} + T_g) - T_g + L_{NPDCCH} + T_{proc} + 2 \cdot T_{RT}$$

For  $D = 0$ , the detection period is given by

$$T_{detect} = (\lfloor N_{occ} / N_{avail} \rfloor - 1) \cdot T_{NPDCCH} + N_{avail} \cdot (T_{occ} + T_g) - T_g + L_{NPDCCH} + T_{proc} + 2 \cdot T_{RT}$$

Option 4:

Requirements for inter-frequency detection on a carrier different from serving carrier requirements is defined as:

$$T_{detectinter} = \sum_{(i=1)}^N \text{Min}(5000, T_{a,i}) \text{ ms},$$

where  $T_{a,i}$  is the interval between **available** measurement samples,  $T_{a,i} \geq 40$  ms and  $N = 70$

### Recommended WF □

Agree on Option 3 with additional conditions in issue 1-2-1

**Table 10:**

Company	Comments
Huawei	<b>Issue 1-2-5</b> With addition assumptions and clarifications, we support option 3.
Ericsson	<u>Does recommend WF refer to option 4? Option 4 is agreeable.</u>
Huawei	<u>To Ericsson: yes thanks for spotting the typo.</u>
Qualcomm	<u>Similar comment as in issue 1-2-4.</u>

### 2.4.8 Issue 1-3-1: Requirements when UE is required to monitor multiple carriers

Agreement:

Requirements for cell detection and measurement when UE is required to monitor multiple carriers are defined as:

$$T_{\text{detect}} = T_{\text{detect\_intra}} + N_{\text{freq}} * T_{\text{detect\_inter}}$$

$$T_{\text{measure}} = T_{\text{measure\_intra}} + N_{\text{freq}} * T_{\text{measure\_inter}}$$

Where  $N_{\text{freq}}$  is number of inter-frequency layers to be measured according to the measurement capability.

#### 2.4.9 Issue 1-3-2: Carriers for neighbour cell measurement

FFS:

Option 1:

The UE continues measuring on at least one neighbour cell detected in RRC\_IDLE/INACTIVE modes at least once every 5 seconds after transition to RRC\_CONNECTED state provided that it belongs to the serving carrier frequency and meets the side condition ( $E_s/I_{\text{ot}} \geq -6$  dB).

#### Recommended WF

Discuss in 2<sup>nd</sup> round and please proponent company clarify whether it required UE to start intra-frequency measurement immediately after entering CONNECTED before the triggering conditions are meet.

**Table 11:**

Company	Comments
Huawei	<p><b>Issue 1-3-2</b>                      We would like to if it means UE has to measure neighbor cell when UE enters RRC CONNECTED mode immediately even before the conditions are met. If so, we think it is kind of new procedures apart from the CONNECTED mode neighbor cell measurement before RLF.</p>

Ericsson	We support option 1. To clarify option 1, the UE after switching to CONNECTED continues to measure on one of the cells of the serving carrier it has been measuring on in IDLE mode provided that the side condition is met (e.g. $E_s/I_{ot} \geq -6$ dB), but such measurement can be done infrequently (e.g. every 5 ms which is the known cell condition). Since the measurement of serving carriers are typically more often used for mobility, we think it is very likely that that cell of the serving carrier might be used for the reestablishment when it is time. In fact, this option is inspired by the original proposal presented in Qualcomm's [R4-2114201] presented at RAN4#100-e meeting.
Qualcomm	In previous meetings we proposed that it would be useful to continue measuring neighbor cells that were previously measured in IDLE mode. Now, we understand that RAN2 should be involved in the decision and at this point RAN2 has already specified the triggering mechanism for the measurements in connected mode. Does Ericsson suggest sending an LS to RAN2?

2.4.10 Issue 1-4-1: Whether to deprioritize defining requirements when serving cell in enhanced coverage.

**Agreement:**

Define CONNECTED mode neighbour cell measurement requirements when the serving cell is in enhanced coverage

2.4.11 Issue 1-5-1: Whether to have additional triggering conditions

**FFS:**

Option 1: In addition to the already agreed triggering conditions, the UE shall initiate the neighbour cell measurements if K number of out-of-sync indications are detected in the cell.

Recommended WF:

According to comments received in 1<sup>st</sup> round, it is within in RAN2 scope and no need to further discuss in RAN4

**Table 12:**

Company	Comments
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Huawei	<b><u>Issue 1-5-1</u></b> We agree with companies comments in 1 <sup>st</sup> round that it is RAN2 to discuss it.
Ericsson	<u>We suggest to keep option 1 as FFS in the WF, since it is the first time it is being brought up and to give some time for companies.</u>
Qualcomm	<u>We can support the recommended WF.</u>

2.4.12 Issue 1-6-1: Whether to indicate when UE needs to start inter-f measurements

**FFS:**

Option 1: RAN4 should send an LS to RAN2 informing RAN2 that our analysis shows that, in many scenarios, it would be beneficial for the UE to indicate when it needs to start performing inter-frequency measurements so that the serving cell may create measurement opportunities for the UE.

Recommended WF:

According to comments received in 1<sup>st</sup> round, it is within in RAN2 scope and no need to further discuss in RAN4

**Table 13:**

<b>Company</b>	<b>Comments</b>
Huawei	<b><u>Issue 1-6-1</u></b> We agree with companies comments that it is within in RAN2 scope.
Ericsson	<u>Agree to the recommended WF.</u>

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### 3 Topic #2: Capture channel quality reporting table for 16-QAM in TS 36.133

#### 3.1 Companies' contributions summary

**Table 14:**

Huawei, Hisilicon	R4-2201208
Huawei, Hisilicon	R4-2201437
Ericsson	R4-2201431

#### 3.2 Open issues summary

##### Issue 2-1-1: Capture channel quality reporting table for 16-QAM in TS 36.133

– Proposals

- Option 1: Capture the mapping table for channel quality reporting of 16-QAM in 36.133, and the corresponding performance requirements will be discussed in Demod session. (Huawei, Ericsson)

– Recommended WF

- Discuss above options, and companies please also involve Demod experts as it is related to Demod work.

**Feedback Form 15: Capture channel quality reporting table for 16-QAM in TS 36.133**

**1 – HUAWEI TECHNOLOGIES Co. Ltd.**

We support option 1.

**2 – Qualcomm Incorporated**

Option 1 is agreeable.

### **3 – Ericsson Hungary Ltd**

WE support option 1.

On top of that, RAN4 need to decide which spec (TS36.101 or TS36.133) should specify the following issues:

1. How UE determine the reported CQI index.

\* Example (R4-2201866)

NPDCCH repetition level satisfying the hypothetical NPDCCH block error rate of 1%, if UE determines the required NPDCCH repetition level  $> 1$ ,

NPDSCH MCS and repetition level satisfying the hypothetical PDSCH block error not exceeding 10%, if UE determines the required NPDCCH repetition level is 1

2. CQI measurement resources

\* Example (R4-2201866)

reported NPDSCH MCS and repetition shall be derived from the channel quality measured from the time UE finish the decode of Downlink Channel Quality report MAC CE to the end of NPDCCH carrying the uplink grant of channel quality report. Note UL transmission period and RF switching period is excluded from the measurement period.

Such requirements should be usually specified in RAN1 spec such as TS36.213, however RAN1 agreed not to specify it in RAN1 spec. So we think RAN4 need to capture them in TS36.133 or TS36.133. We slight prefer to specify it in TS36.133 because it can specify the core requirements.

### **4 – Nokia Germany**

We support option 1.

#### 3.2.1 CRs/TPs comments collection

**Feedback Form 16: R4-2201437 Draft CR on including channel quality table for 16 QAM for Rel-17 NB-IoT**

**1 – Ericsson Hungary Ltd**

Support this draft CR although the table name needs improvement as proposed in our paper R4-2201431

### 3.3 Summary for 1st round

**Table 15: Summary for 1st round**

<p><b>Sub-topic #2-1</b></p>	<p><b><u>Issue 2-1-1: Capture channel quality reporting table for 16-QAM in TS 36.133</u></b></p> <p>Four companies commented in 1<sup>st</sup> and all agreed with option 1. One company commented about where to capture the core requirements. Thus, a new issue is added on whether the capture the core requirements in TS 36.133.</p> <p><b><i>Tentative agreements:</i></b> Capture the mapping table for channel quality reporting of 16-QAM in 36.133, and the corresponding performance requirements will be discussed in Demod session.</p> <p><b><i>Candidate options: NA</i></b></p> <p><b><i>Recommendations for 2nd round:</i></b> Discuss the following issue.</p> <p><b><u>Issue 2-1-2: Capture core requirements of channel quality reporting for 16-QAM in TS 36.133 if any</u></b></p> <p>Option 1: The issues related to core requirements for channel quality reporting for 16-QAM will be discussed in Demod session, and the corresponding core requirements will be captured in TS 36.133 if any.</p>
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### 3.4 Discussion on 2nd round (if applicable)

Companies commented on WF directly in 2nd round. The comments are captured in this summary for information.

3.4.1 Issue 2-1-1: Capture channel quality reporting table for 16-QAM in TS 36.133

Agreement:

Capture the mapping table for channel quality reporting of 16-QAM in TS 36.133, and the corresponding performance requirements will be discussed in Demod session.

3.4.2 Issue 2-1-2: Capture core requirements of channel quality reporting for 16-QAM in TS 36.133

FFS:

Option 1: The core requirements related to channel quality reporting for 16-QAM (e.g. measurement resource and/or period) will be discussed in Demod session, and the corresponding requirements can be captured in TS 36.133

Recommended WF:

Agree on option 1 and companies please also involve Demod experts to the discussion.

**Table 16:**

Company	Comments
Huawei	<b>Issue 2-1-2</b> We support option 1 according to the agreed work plan R4-2107255 and work scope R4-2108369
Ericsson	<b>Issue 2-1-2</b> We support option 1. Demod session will discuss, for example, assumption of CQI measurement resource and how to determine the reported CQI index. The agreements are captured in e.g. TS36.133 9.1.22.17 and 8.14.x. Since this is related to the core part, we need draft CR is filed in Feb meeting. We propose the CR list below includes the channel quality report for NB-IoT UE supporting 16QAM. Demod session will also discuss the CQI test cases, but test cases should be captured in TS36.101.
Qualcomm	Option 1.

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4 Draft CR Work split

**Table 17:**

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Requirements	Section	Spec	Company
Connected mode intra-frequency neighbour cell measurement before RLF	8.14.5 (new) 8.14.5.1 (new)	TS 36.133	Huawei
Connected mode inter-frequency neighbour cell measurement before RLF	8.14.5 (new) 8.14.5.2 (new)	TS 36.133	Ericsson
Channel quality report	8.14.6 (new)	TS 36.133	

## 5 Recommendations for Tdocs

### 5.1 1st round

#### New tdocs

**Table 18:**

Title	Source	Comments
WF on RRM requirements for Rel-17 NB-IoT and LTE-MTC	Huawei, HiSilicon	To capture the agreements in this meeting
Big CR on RRM requirements for Rel-17 NB-IoT and LTE-MTC	Huawei, HiSilicon	Big CR to capture draft CRs

#### Existing tdocs

**Table 19:**

Tdoc number	Title	Source	Recommendation	Comments
R4-2201437	Draft CR on including channel quality table for 16 QAM for Rel-17 NB-IoT	Huawei, HiSilicon	Revised	


5.2 2nd round

**Table 20:**

<b>Tdoc number</b>	<b>Title</b>	<b>Source</b>	<b>Recommendation</b>	<b>Comments</b>
R4-2202715	WF on RRM requirements for Rel-17 NB-IoT and LTE-MTC	Huawei, HiSilicon	Agreeable	Formal version uploaded. Can be revised if new agreements are reached in extended discussion or Tue GTW
R4-2202717	Draft CR on including channel quality table for 16 QAM for Rel-17 NB-IoT	Huawei, HiSilicon	Agreeable	
R4-2202716	Draft Big CR on RRM requirements for Rel-17 NB-IoT and LTE-MTC	Huawei, HiSilicon	Not needed	Only single Draft CR to be endorsed this meeting

