3GPP TSG-RAN WG2 Meeting #110-e R2-2005444

Electronic Meeting, 1 June – 12 June, 2020

**Agenda item: 6.19**

**Source: CMCC**

**Title:** **Discussion on R16 NR HST enhancement**

**Document for: Discussion and Decision**

# Introduction

In last meeting, RAN4 sent LS to RAN2 on the capability and signalling for inter-RAT measurement enhancement for NR high speed train in R16 [1]. RAN4 respectfully asks RAN2 to design the corresponding signalling to support the enhanced inter-RAT measurement requirements for R16 NR HST.

RAN4 also sent LS to RAN2 on supporting Rel-16 NR HST from Rel-15 UEs to check with RAN2 whether the early implementation approach used in LTE is applicable for NR HST features [5].

This contribution provides analysis on above issues and provides our consideration.

# Discussion

2.1 signalling impact

Following is the RAN4 LS on UE capability and network assistance signalling for Rel-16 NR HST RRM [1]:

**1. Overall Description:**

In last November meeting, RAN4 sent LS to RAN2 on the signalling for NR HST (R4-1915855/R2-200040), including a per-UE network assistance signalling and a per-UE capability. The network assistance signalling is used to indicate UEs that the enhanced RRM requirements apply in the cell and is provided to UE in idle mode and connected mode. The UE capability is used to indicate that UE is capable of supporting the enhanced RRM requirements.

In February RAN4 meeting, it was agreed to enhance the inter-RAT measurement requirements for HST, including NR-EUTRA inter-RAT measurement and EUTRA-NR inter-RAT measurement. Additional signalling for inter-RAT measurement enhancement is needed. RAN4 would like to provide further clarification on the related signalling.

For Rel-16 NR HST WI, the target scenarios are NR SA single carrier scenario and EN-DC scenario. In total, the enhanced RRM requirements for NR HST include three parts: the enhancement requirements within NR, the enhanced NR-EUTRA inter-RAT measurement requirements, and the enhanced EUTRA-NR inter-RAT measurement requirements.

The enhancement requirements within NR, and enhanced NR-EUTRA inter-RAT measurement requirements are specified in TS 38.133, and the already agreed network assistance signalling (as stated in the first paragraph) can be used to indicate UEs that the enhanced RRM requirements apply in the cell. And, similarly, the already agreed UE capability (as stated in the first paragraph) can be used to indicate that UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133.

The enhanced EUTRA-NR inter-RAT measurement requirements will be specified in TS36.133. RAN4 agreed to introduce a new per-UE capability to indicate that UE is capable of supporting the enhanced EUTRA-NR inter-RAT measurement requirements as specified in TS 36.133. In addition, RAN4 agreed to introduce a new LTE network assistance signalling to indicate UEs that the enhanced EUTRA-NR inter-RAT measurement requirements apply in the cell. The signalling is a per-cell signalling and is provided to UE in idle mode and connected mode.

RAN4 also had agreed to introduce network flag per inter-RAT carrier to indicate UE whether the enhanced inter-RAT measurement requirements need to be applied to the inter-RAT carrier. The network flag is needed for both NR inter-RAT carrier and LTE inter-RAT carrier. The network flag is a per-cell signalling and is provided to UE in idle mode only.

RAN4 kindly ask RAN2 to design the corresponding network assistance signalling and UE capability to support the enhanced RRM requirements for Rel-16 NR HST.

**2. To RAN WG2 group.**

ACTION: RAN4 kindly ask RAN2 to design the corresponding network assistance signalling and UE capability to support the enhanced RRM requirements for Rel-16 NR HST.

According to RAN4 LS [1], in total, the enhanced RRM requirements for NR HST include three parts: the enhancement requirements within NR, the enhanced NR-EUTRA inter-RAT measurement requirements, and the enhanced EUTRA-NR inter-RAT measurement requirements. The signalling impact can be categorized as two parts: signalling impact on TS38.331, signalling impact on TS36.331. Following sections provide detail discussion.

2.1.1 Signalling impact on TS38.331

2.1.1.1 Network assistant signalling and UE capability on the enhanced requirements within NR and the enhanced NR-EUTRA inter-RAT measurement requirements as specified in TS 38.133

According to RAN4 LS [1], the enhancement RRM requirements within NR, and enhanced NR-EUTRA inter-RAT measurement requirements are specified in TS 38.133, and the already agreed network assistance signalling in previous RAN4 LS [2] can be used to indicate UEs that the enhanced RRM requirements apply in the cell. And, similarly, the already agreed UE capability in previous RAN4 LS [2] can be used to indicate that UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133. In RAN2#109 meeting, there are following agreements on the signalling design for RRM enhancement for NR HST. In last meeting, 38.331 CR on introduction of RRC parameters and UE capabilities for Rel-16 NR HST RRM was agreed in principle [3]. In our view, RAN4 new LS [1] has no impact on this 38.331 CR, and this 38.331 CR can be used to cover the enhanced requirements within NR and enhanced NR-EUTRA inter-RAT measurement requirements as specified in TS 38.133. A CR is provided in the accompanied contribution.

Agreements in RAN2#109e:

* Introduce network assistant signalling in the IE ServingCellConfigCommon and IE ServingCellConfigCommonSIB to enable the enhanced RRM requirements for Rel-16 NR HST.
* Introduce new UE capability for NR HST to indicate whether UE is capable of supporting the enhanced RRM requirements.

***Proposal 1: the network assistant signalling in the IE ServingCellConfigCommon and IE ServingCellConfigCommonSIB is used to enable the enhanced RRM requirements for Rel-16 NR HST as specified in TS 38.133 (including the enhancement RRM requirements within NR and enhanced NR-EUTRA inter-RAT measurement requirements).***

***Q1: Is P1 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** |  |
| ***Qualcomm Incorporated*** | ***Yes*** | The wording used in RAN4 LS is not very clear. We understand:   * “NR-EUTRA inter-RAT measurement” represents inter-RAT EUTRA measurements when the UE is served in NR. * “EUTRA-NR inter-RAT measurement” represents inter-RAT NR measurements when the UE is served in EUTRAN. |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** |  |
| Samsung | Yes | It’s based on RAN2/4 agreements. |

***Proposal 2: the UE capability for NR HST is used to indicate whether UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133 (including the enhancement RRM requirements within NR and enhanced NR-EUTRA inter-RAT measurement requirements).***

***Q2: Is P2 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** |  |
| ***Qualcomm Incorporated*** | ***No*** | The wording used in RAN4 LS is not very clear. We understand:   * “NR-EUTRA inter-RAT measurement” represents inter-RAT EUTRA measurements when the UE is served in NR. * “EUTRA-NR inter-RAT measurement” represents inter-RAT NR measurements when the UE is served in EUTRAN.   With that in mind, it looks strange to have a single UE capability covering NR measurements and EUTRA measurements. |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** | ***For my understanding, it means one UE capability in NR for RRM enhancement due to high speed cover both NR🡪NR and NR🡪LTE cases.*** |
| Samsung | Yes | It’s based on RAN2/4 agreements. |

2.1.1.2 Network flag per inter-RAT carrier

According to the LS [1], RAN4 agreed to introduce network flag per inter-RAT carrier to indicate UE whether the enhanced inter-RAT measurement requirements need to be applied to the inter-RAT carrier. The network flag is needed for both NR inter-RAT carrier and LTE inter-RAT carrier. The network flag is a per-cell signalling and is provided to UE in idle mode only. For NR- EUTRA inter-RAT measurement, it is suggested to introduce a per carrier network flag in SIB5 to indicate UE whether the enhanced NR- EUTRA inter-RAT measurement requirements need to be applied to the E-UTRA inter-RAT carrier. A CR is provided in the accompanied contribution.

***Proposal 3: introduce a per carrier network flag in SIB5 in TS38.331 to indicate UE whether the enhanced NR- EUTRA inter-RAT measurement requirements need to be applied to the E-UTRA inter-RAT carrier.***

***Q3: Is P3 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** |  |
| ***Qualcomm Incorporated*** | ***Yes*** |  |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** |  |
| Samsung | Yes | It’s straight forward with SIB5. |

2.1.2 signalling impact on TS36.331

2.1.2.1 Network assistant signalling and UE capability on the enhanced EUTRA-NR inter-RAT measurement requirements as specified in TS 36.133

As per the RAN4 LS [1], RAN4 agreed to introduce a new per-UE capability to indicate that UE is capable of supporting the enhanced EUTRA-NR inter-RAT measurement requirements as specified in TS 36.133. In addition, RAN4 agreed to introduce a new LTE network assistance signalling to indicate UEs that the enhanced EUTRA-NR inter-RAT measurement requirements apply in the cell. The signalling is a per-cell signalling and is provided to UE in idle mode and connected mode.

In Rel-14 and Rel-16 WI on performance enhancements for high speed scenario in LTE, the related network signallings to enable the enhancement for LTE HST are per-cell configured and are included in the IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon* for common radio resource configurations in the system information and in the mobility control information, respectively. In our view, similar signalling design can be reused to design the new LTE network assistance signalling to indicate UEs that the enhanced EUTRA-NR inter-RAT measurement requirements apply in the cell. The signalling can be included in the IE *RadioResourceConfigCommonSIB* and IE *RadioResourceConfigCommon*. A CR is provided in the accompanied contribution.

***Proposal 4: the new network assistant signalling to indicate UEs that the enhanced EUTRA-NR inter-RAT measurement requirements apply in the cell is suggested to be included in RadioResourceConfigCommonSIB and IE RadioResourceConfigCommon* *in 36.331.***

***Q4: Is P4 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** | ***Is it really so that this high speed measurement requirement is not supported in connected mode?*** |
| ***Qualcomm Incorporated*** | ***Yes*** |  |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** |  |
| Samsung | Yes | It’s straight forward |

Similarly, for UE capability, as per RAN4 LS [1], it is suggested to introduce a new UE capability for NR HST to indicate that UE is capable of supporting the enhanced EUTRA-NR inter-RAT measurement requirements as specified in TS 36.133.

***Proposal 5: introduce a new UE capability for NR HST in 36.331 and 36.306 to indicate that UE is capable of supporting the enhanced EUTRA-NR inter-RAT measurement requirements as specified in TS 36.133.***

***Q5: Is P5 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** |  |
| ***Qualcomm Incorporated*** | ***Yes*** |  |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** |  |
| Samsung | Yes | It’s from RAN4 agreement |

2.1.2.2 Network flag per inter-RAT carrier

According to the LS [1], RAN4 agreed to introduce network flag per inter-RAT carrier to indicate UE whether the enhanced inter-RAT measurement requirements need to be applied to the inter-RAT carrier. The network flag is needed for both NR inter-RAT carrier and LTE inter-RAT carrier. The network flag is a per-cell signalling and is provided to UE in idle mode only. For EUTRA-NR inter-RAT measurement, it is suggested to introduce a per carrier network flag in SIB24 to indicate UE whether the enhanced EUTRA-NR inter-RAT measurement requirements need to be applied to the NR inter-RAT carrier.

***Proposal 6: it is suggested to introduce a per carrier network flag in SIB24 in TS36.331 to indicate UE whether the enhanced EUTRA-NR inter-RAT measurement requirements need to be applied to the NR inter-RAT carrier.***

***Q6: Is P6 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** |  |
| ***Qualcomm Incorporated*** | ***Yes*** |  |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** |  |
| Samsung | Yes | It’s straight forward with SIB24, where NR frequencies can be indicated for inter-RAT cell reselection |

2.1.2.3 for EN-DC, Network assistant signalling and UE capability on the enhanced RRM requirements and enhanced demodulation requirement

According to the WID on NR HST [3] and RAN4 LS [1], the target scenarios includes SA and EN-DC. In RAN2#109 meeting, there are following agreements on the network assistant signalling and UE capability on the enhanced RRM requirements and enhanced demodulation requirement. In last meeting, 38.331 CR on introduction of RRC parameters and UE capabilities for Rel-16 NR HST RRM was agreed in principle [3]. As discussed in section 2.1.1, the network assistance signalling can be used to cover the enhanced requirements within NR and enhanced NR-EUTRA inter-RAT measurement requirements as specified in TS 38.133.

Agreements [AT109e][050][R16 Other WISI]

* Introduce network assistant signalling in the IE ServingCellConfigCommon and IE ServingCellConfigCommonSIB to enable the enhanced RRM requirements for Rel-16 NR HST.
* Introduce network assistant signalling in the IE ServingCellConfigCommon and IE ServingCellConfigCommonSIB to enable the enhanced UE demodulation requirements for HST-SFN deployment with joint transmission scheme for Rel-16
* Introduce new UE capability for NR HST to indicate whether UE is capable of supporting the enhanced RRM requirements.
* Introduce new UE capability for NR HST to indicate whether UE is capable of the enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h.

For the case of EN-DC, considering the network assistance signaling are per-cell signalling and are provided to UE in idle mode and connected mode, it is necessary to introduce the network assistance signalling in TS36.331 to enable the enhanced RRM requirements as specified in TS 38.133 and the enhanced demodulation requirements as specified in TS 38.101-4.

***Proposal 7: for EN-DC, it is suggested to introduce two network assistant signalling in the IE RadioResourceConfigCommonSIB and IE RadioResourceConfigCommon in TS 36.331. One is to enable the enhanced measurement requirements as specified in TS 38.133. The other one is to enable enhanced UE demodulation requirements for HST-SFN deployment with joint transmission scheme as specified in TS 38.101-4.***

***Q7: Is P7 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***No*** | ***Could you clarify why one needs to indicate in LTE UE to utilize highSpeedMeasFlag and highSpeedDemodFlag* for NR frequencies. Wouldn’t just indicating inter-RAT support be sufficient?** |
| ***Qualcomm Incorporated*** | ***Yes*** | ***The proposal is not very clear, but we understand the proposal is to enable / disable NR measurements and NR demodulation separately.*** |
| ***Ericsson*** | ***Not sure*** | ***We support the intention to make this work in EN-DC, but we are not sure about this proposal. Isn't it sufficient if the network assistance signalling related to enhanced measurement requirements in TS 38.133 is sent as part of the NR RRC configuration? If so, then we already agreed to them and we don't have to do anything.*** |
| ***OPPO*** | ***Not sure*** | ***Same concern as Ericsson.*** |
| Samsung | Yes |  |

Similar discussion as above for network assistance signalling, for EN-DC, it is necessary to introduce two new UE capabilities for NR HST in TS36.331, one capability is to indicate whether UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133. The other capability is to indicate whether UE is capable of the enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h as specified in TS 38.101-4.

***Proposal 8: for EN-DC, it is suggested to introduce two new UE capabilities for NR HST in TS36.331, one capability is to indicate whether UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133. The other capability is to indicate whether UE is capable of the enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h as specified in TS 38.101-4.***

***Q8: Is P8 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***No*** | ***Could you clarify why one needs to indicate in LTE UE supporting highSpeedMeasFlag and highSpeedDemodFlag* for NR frequencies. Wouldn’t just indicating inter-RAT support be sufficient?** |
| ***Qualcomm Incorporated*** | ***Yes*** | ***The UE that is capable of the inter-RAT NR measurement enhancement will most likely support the same in EN-DC. But the other way around cannot be established. It is good to introduce a separate capability.***  ***Demodulation enhancement is anyway EN-DC specific.*** |
| ***Ericsson*** | ***Not sure*** | ***We think correct capabilities are needed, but we are not sure about the details and how it all works together. Do you want separate capabilities for the inter RAT EUTRAN-NR measurements and the EN-DC measurements? How does this proposal relate to P5?*** |
| ***OPPO*** | ***Not sure*** |  |
| Samsung | Yes |  |

2.2 early implementation

Following is the RAN4 LS on supporting Rel-16 NR HST from Rel-15 UEs [5]:

|  |
| --- |
| **1. Overall Description:**  Under the release 16 work item on NR support for high speed train scenario (NR\_HST), RAN4 is discussing whether Rel-15 UE supports Rel-16 NR HST Demod Enhancement. Early implementation was already introduced in LTE HST, that is, Rel-14 LTE HST feature can be early implemented by Rel-13 UEs without Rel-13 specification change, according to RAN2 reply LS (R2-1705861).  RAN4 would like to check with RAN2 whether this early implementation approach is applicable for NR, that is, the early implementation Rel-16 NR HST Demod Enhancement is applicable for Rel-15 NR UE without Rel-15 specification changes.  **2. To RAN WG2 group.**  **ACTION:** RAN4 would like to check with RAN2 whether the early implementation approach is applicable for NR HST Demod Enhancement. |

As mentioned in the RAN4 LS, Rel-14 LTE HST feature can be early implemented by Rel-13 UEs without Rel-13 specification change, according to RAN2 reply LS (R2-1705861). From our point of view, the approach of early implementation in LTE can be reused for NR.

High speed scenario is an important deployed scenario. And the improvement of UE experience is necessary. RAN4 does not specify the NR HST requirements in Rel-15 due to the limited timeline. But NR high speed scenario is supported in Rel-15 from RAN1 point of view. Taking above into consideration, it is proposed that Rel.16 NR HST feature can be early implemented by Rel-15 UEs. Early implementation of HST enhancement by Rel-15 UE does not cause any inter-operability issues.

***Proposal 9: Rel.16 NR HST enhancement can be early implemented by Rel-15 UEs. Early implementation of HST enhancement by Rel-15 UE does not cause any inter-operability issues.***

***Q9: Is P9 agreeable?***

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| ***Nokia*** | ***Yes*** |  |
| ***Qualcomm Incorporated*** | ***Yes*** |  |
| ***Ericsson*** | ***Yes*** |  |
| ***OPPO*** | ***Yes*** |  |
| Samsung | Yes |  |

# Conclusions

This contribution analyses the signalling issue on the HST enhancement for Rel-16 NR HST, and the proposals are:

**Signalling impact on TS38.331**

***Proposal 1: the agreed network assistant signalling in the IE ServingCellConfigCommon and IE ServingCellConfigCommonSIB is used to enable the enhanced RRM requirements for Rel-16 NR HST as specified in TS 38.133 (including the enhancement RRM requirements within NR and enhanced NR-EUTRA inter-RAT measurement requirements).***

***Proposal 2: the agreed UE capability for NR HST is used to indicate whether UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133 (including the enhancement RRM requirements within NR and enhanced NR-EUTRA inter-RAT measurement requirements).***

***Proposal 3: it is suggested to introduce a per carrier network flag in SIB5 in TS38.331 to indicate UE whether the enhanced NR- EUTRA inter-RAT measurement requirements need to be applied to the E-UTRA inter-RAT carrier.***

**Signalling impact on TS36.331**

***Proposal 4: the new network assistant signalling to indicate UEs that the enhanced EUTRA-NR inter-RAT measurement requirements apply in the cell is suggested to be included in RadioResourceConfigCommonSIB and IE RadioResourceConfigCommon.***

***Proposal 5: it is suggested to introduce a new UE capability for NR HST to indicate that UE is capable of supporting the enhanced EUTRA-NR inter-RAT measurement requirements as specified in TS 36.133.***

***Proposal 6: it is suggested to introduce a per carrier network flag in SIB24 in TS36.331 to indicate UE whether the enhanced EUTRA-NR inter-RAT measurement requirements need to be applied to the NR inter-RAT carrier.***

***Proposal 7: for EN-DC, it is suggested to introduce two network assistant signalling in the IE RadioResourceConfigCommonSIB and IE RadioResourceConfigCommon in TS 36.331. One is to enable the enhanced measurement requirements as specified in TS 38.133. The other one is to enable enhanced UE demodulation requirements for HST-SFN deployment with joint transmission scheme as specified in TS 38.101-4.***

***Proposal 8: for EN-DC, it is suggested to introduce two new UE capabilities for NR HST in TS36.331, one capability is to indicate whether UE is capable of supporting the enhanced RRM requirements as specified in TS 38.133. The other capability is to indicate whether UE is capable of the enhanced demodulation processing for HST-SFN joint transmission scheme with velocity up to 500km/h as specified in TS 38.101-4.***

**Release independent**

***Proposal 9: it is suggested that Rel.16 NR HST enhancement can be early implemented by Rel-15 UEs. Early implementation of HST enhancement by Rel-15 UE does not cause any inter-operability issues.***

# References

[1]R4-2005359 LS on the UE capability and network assistance signalling on inter-RAT measurement for Rel-16 NR HST RRM

[2] R4-1915855 LS on the UE capability and network assistance signalling for Rel-16 NR HST RRM

[3 ] [R2-2004181](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_109bis-e\Docs\R2-2004181.zip) 38.331 CR on introduction of RRC parameters and UE capabilities for Rel-16 NR HST, CMCC

[4] RP-191512 New WID on NR support for high speed train scenario, CMCC

[5] R4-2005533 LS on supporting Rel-16 NR HST from Rel-15 UEs