**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-TEIs-03]

Agenda Item: 7.2.12

**Document for:** **Discussion and Decision**

# **Introduction**

This contribution summarizes the NR Rel-16 TEI related and CLI/RIM related discussions and proposals in AI 7.2.12.

100b-e-NR-TEIs-03]: Email discussion/approval on whether or not (and if yes, how) the text below in UE feature 6-1 needs to be updated:

* *This feature should be mandatory without capability signaling for at least BWPs which is the same as the set of specified channel BW. RAN4 may discuss other BW requirements.*

Note: this is due to the motivation that an operator may need to deploy NR with reduced BW between 5MHz and 10MHz due to necessity to transmit TRS within whole 10MHz BWP, i.e. 52PRBs.

Till 4/24 – Hiroki (DCM)

# **Issue for TRS bandwidth**

In [6], the following issues regarding TRS bandwidth is identified.

* An operator may not deploy R16 NR with reduced BW between 5MHz and 10MHz due to necessesity to transmit TRS within whole 10MHz BWP, i.e. 52PRB.
* If it is agreed to reduce the TRS RB size minimum requirement for 15 kHz carrier smaller or equal to 52 RB, the exact reduced size of TRS should be defined.

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| On a carrier smaller than 52 PRB, TRS need to span across whole BWP. In addition, R15 and also R16 UEs are mandated to support only BWP sizes corresponding to nominal channel BW, e.g. 5MHz or 10MHz. An operator may not deploy R16 NR with reduced BW between 5MHz and 10MHz due to necessesity to transmit TRS within whole 10MHz BWP, i.e. 52PRB. **Figure 1 Illustration of intended operation**To solve this issue, the following options were discussed in RAN1#99 * **Alt1:**  Reduce the TRS RB size minimum requirement for 15kHz carrier smaller or equal to 52 RB
* **Alt1b**: Reduce the TRS RB size minimum requirement for 15kHz carrier smaller or equal to 52 RB and UE is not expected to receive on RBs of a BWP not containing TRS resources
* **Alt2:**  Introduce R16 capability 14-x, which indicates the support of 34 PRB BWP size
* **Alt3:** Send LS to RAN5 and CC RAN4 and ask RAN5 to add a demodulation test case for 34 PRB BWP size at least for Rel-16 UEs.
	+ No further RF requirement is added compared with Rel-15

No discussion was allowed in RAN1#100e to resolve this critical deployment case. Unless BWPs with non-nominal size (i.e. other than nominal channel BW) become mandatory for all R16 UEs, we think that Alt1 is the cleanest and simplest option to solve the above issue with the following TP

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| TP for 38.2145.1.6.1.1 CSI-RS for tracking<unchanged text omitted >Each CSI-RS resource, defined in Subclause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:- the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of- , , or for frequency range 1 and frequency range 2,- , , , , ,  or  for frequency range 2.- a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.* - if carrier $N\_{grid}^{size,μ}\leq 52$ and $μ=0, $the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of [32] and $N\_{BWP,i}^{size}$ resource blocks, or is equal to $N\_{BWP,i}^{size}$ resource blocks, otherwise, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and $N\_{BWP,i}^{size}$ resource blocks, or is equal to $N\_{BWP,i}^{size}$ resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and $N\_{BWP,i}^{size}$ resource blocks, or is equal to $N\_{BWP,i}^{size}$ resource blocks.<unchanged text omitted > |

What remains open is the exact reduced size of TRS. Size of 32 RBs should be able to accommodate the case above, however it would not be sufficient anymore for deployments with available BW smaller than 7MHz. **Proposal 1:***To resolve critical NR deployment issue****,*** *Adopt Alt1 and corresponding enclosed Draft CR1 (including TP) co-sourced by several companies.* |

In [7], same view as in [6] is provided as below.

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| In RAN1#99, the issue of blanking the TRS bandwidth was discussed [1]. On carriers smaller than or equal to 52 resource blocks, the tracking reference signal (TRS) spans across whole bandwidth part bandwidth. With Rel-15 UE supporting only bandwidth part bandwidths equal to the nominal channel bandwidths as defined by RAN4, e.g. 5MHz and 10MHz, the TRS bandwidth is the same as the channel bandwidth. This means that an operator cannot deploy Rel-15 NR with a reduced bandwidth between 5MHz and 10MHz without the TRS interfering with transmissions outside the frequency part allocated to NR.In order to avoid this, it was proposed to allow an additional signaling value of 32 RB as a valid bandwidth for carriers with 52 RBs or less. Additionally, in order to have maximum bandwidth available for scheduling of other channels, Alt1 from [1] should be selected. Since the configuration of TRS is using the generic signaling for CSI-IM, no new signaling needs to be defined in Rel-16. No new signaling, also means that it would be possible for Rel-15 UEs to implement the change early allowing the deployment scenario in question to happen as soon as possible. From this perspective, it is also important that the agreement is made already in the RAN1#100bis-e and is not delayed to a later meeting. A joint company draft CR has been submitted in R1-12002229[2].It is therefore proposed:**Introduce a new allowed TRS bandwidths for carriers with less than or equal to 52 RBs as proposed in draft CR in R1-12002229** |

In [5], different view from [6] and [7] on how to solve the issue is provided as below.

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| As pointed in a RAN1 LS to RAN2/4 (R1-1909900), RAN1 specifications have the flexibility to support any BWP size from 1 PRB to 275 PRBs, although currently Rel-15 does not support BWP sizes smaller than the RBG size or the PRG size. Therefore, we don’t see any problem in RAN1 specifications to support the deployment shown in Figure 1. However, we understand that companies have no consensus on the support of non-nominal BWP sizes in Rel-15 according to the LS (R1-1909900). Therefore, we proposed the following options for companies to discuss to resolve the issues.* Option #1: All Rel-16 UEs are required to support BWP sizes from 2 to 273 PRBs in FR1 and from 2 to 264 PRBs in FR2
	+ No new RF requirements for BWP sizes other than RAN4-defined UE channel bandwidths are needed
* Option #2: For Rel-16, TRS bandwidth is given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping* when a UE is configured with a carrier bandwidth ≤ 10MHz using 15KHz SCS
	+ UE reports via capability signalling whether it supports or not

Our preference is Option #1 because it’s a more clean & natural way to support the deployment in Figure 1. However, Option #2 is acceptable if companies still don’t have consensus on Option #1. In order to avoid potential comebacks for other carrier bandwidth sizes, we slightly modify the proposal in R1-2001121 as Option #2. Note that above options don’t fully resolve the issues for the deployment in Figure 1. Due to the lack of UE RF requirements for 7MHz, network has to guarantee there is no excessive out of band emission between two neighbouring systems; otherwise, it doesn’t work.**Proposal #1: Adopt one of the following options.*** **Option #1: All Rel-16 UEs are required to support BWP sizes from 2 to 273 PRBs in FR1 and from 2 to 264 PRBs in FR2**
	+ **No new RF requirements for BWP sizes other than RAN4-defined UE channel bandwidths are needed**
* **Option #2: For Rel-16, TRS bandwidth is given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping* when a UE is configured with a carrier bandwidth ≤ 10MHz using 15KHz SCS**
	+ **UE reports via capability signalling whether it supports or not**

**Proposal #2: If Option #1 is adopted, adopt one of the following alternatives.*** **Alt. #1: Capture the following conclusion in RAN1 chairman notes**
	+ **All Rel-16 UEs are required to support BWP sizes from 2 to 273 PRBs in FR1 and from 2 to 264 PRBs in FR2**
* **Alt. #2: Adopt the following TP for TS38.213.**

**-----------------Begin of Text Proposal-------------------------------**12 Bandwidth part operation<Omitted>For each DL BWP or UL BWP in a set of DL BWPs or UL BWPs, respectively, the UE is provided the following parameters for the serving cell as defined in [4, TS 38.211] or [6, TS 38.214]:- a SCS by *subcarrierSpacing*- a cyclic prefix by *cyclicPrefix*- a common RB  and a number of contiguous RBs  provided by *locationAndBandwidth* that indicates an offset  and a length  as RIV according to [6, TS 38.214], setting , and a value  provided by *offsetToCarrier* for the *subcarrierSpacing*, where  is any integer value between 1 and 275.- an index in the set of DL BWPs or UL BWPs by respective *BWP-Id*- a set of BWP-common and a set of BWP-dedicated parameters by *BWP-DownlinkCommon* and *BWP-DownlinkDedicated* for the DL BWP, or *BWP-UplinkCommon* and *BWP-UplinkDedicated* for the UL BWP [12, TS 38.331]For unpaired spectrum operation, a DL BWP from the set of configured DL BWPs with index provided by *BWP-Id* is linked with an UL BWP from the set of configured UL BWPs with index provided by *BWP-Id* when the DL BWP index and the UL BWP index are same. For unpaired spectrum operation, a UE does not expect to receive a configuration where the center frequency for a DL BWP is different than the center frequency for an UL BWP when the *BWP-Id* of the DL BWP is same as the *BWP-Id* of the UL BWP.<Omitted>**-----------------End of Text Proposal-------------------------------****Proposal #3: If Option #2 is adopted, adopt the following TP for TS38.214.****-----------------Begin of Text Proposal-------------------------------**5.1.6.1.1 CSI-RS for trackingA UE in RRC connected mode is expected to receive the higher layer UE specific configuration of a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*.For a *NZP-CSI-RS-ResourceSet* configured with the higher layer parameter *trs-Info*, the UE shall assume the antenna port with the same port index of the configured NZP CSI-RS resources in the *NZP-CSI-RS-ResourceSet* is the same. - For frequency range 1, the UE may be configured with one or more NZP CSI-RS set(s), where a *NZP-CSI-RS-ResourceSet* consists of four periodic NZP CSI-RS resources in two consecutive slots with two periodic NZP CSI-RS resources in each slot. If no two consecutive slots are indicated as downlink slots by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated*, then the UE may be configured with one or more NZP CSI-RS set(s), where a *NZP-CSI-RS-ResourceSet* consists of two periodic NZP CSI-RS resources in one slot. - For frequency range 2 the UE may be configured with one or more NZP CSI-RS set(s), where a *NZP-CSI-RS-ResourceSet* consists of two periodic CSI-RS resources in one slot or with a *NZP-CSI-RS-ResourceSet* of four periodic NZP CSI-RS resources in two consecutive slots with two periodic NZP CSI-RS resources in each slot. A UE configured with *NZP-CSI-RS-ResourceSet(s)* configured with higher layer parameter *trs-Info* may have the CSI-RS resources configured as:- Periodic, with the CSI-RS resources in the *NZP-CSI-RS-ResourceSet* configured with same periodicity, bandwidth and subcarrier location- Periodic CSI-RS resource in one set and aperiodic CSI-RS resources in a second set, with the aperiodic CSI-RS and periodic CSI-RS resource having the same bandwidth (with same RB location)and the aperiodic CSI-RS being 'QCL-Type-A' and 'QCL-TypeD', where applicable, with the periodic CSI-RS resources. For frequency range 2, the UE does not expect that the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is smaller than the UE reported *ThresholdSched-Offset*. The UE shall expect that the periodic CSI-RS resource set and aperiodic CSI-RS resource set are configured with the same number of CSI-RS resources and with the same number of CSI-RS resources in a slot. For the aperiodic CSI-RS resource set if triggered, and if the associated periodic CSI-RS resource set is configured with four periodic CSI-RS resources with two consecutive slots with two periodic CSI-RS resources in each slot, the higher layer parameter *aperiodicTriggeringOffset* indicates the triggering offset for the first slot for the first two CSI-RS resources in the set.A UE does not expect to be configured with a *CSI-ReportConfig* that is linked to a *CSI-ResourceConfig* containing an *NZP-CSI-RS-ResourceSet* configured with *trs-Info* and with the *CSI-ReportConfig* configured with the higher layer parameter *timeRestrictionForChannelMeasurements* set to 'configured'.A UE does not expect to be configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to other than 'none' for aperiodic NZP CSI-RS resource set configured with *trs-Info.*A UE does not expect to be configured with a *CSI-ReportConfig* for periodic NZP CSI-RS resource set configured with *trs-Info*.A UE does not expect to be configured with a *NZP-CSI-RS-ResourceSet* configured both with *trs-Info* and *repetition*.Each CSI-RS resource, defined in Subclause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:- the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of- , , or for frequency range 1 and frequency range 2,- , , , , ,  or  for frequency range 2.- a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.* - if carrier $N\_{grid}^{size,μ}\leq 52$ and $μ=0, $the bandwidth of the CSI-RS resource is given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, otherwise, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and $N\_{BWP,i}^{size}$ resource blocks, or is equal to $N\_{BWP,i}^{size}$ resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and $N\_{BWP,i}^{size}$ resource blocks, or is equal to $N\_{BWP,i}^{size}$ resource blocks.- the UE is not expected to be configured with the periodicity of  slots if the bandwidth of CSI-RS resource is larger than 52 resource blocks.- the periodicity and slot offset for periodic NZP CSI-RS resources, as given by the higher layer parameter *periodicityAndOffset* configured b*y NZP-CSI-RS-Resource*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Subclause 4.3 of [4, TS 38.211]. - same *powerControlOffset* and *powerControlOffsetSS* given by*NZP-CSI-RS-Resource* value across all resources.<Omitted>**-----------------End of Text Proposal-------------------------------** |

During the preparation phase discussion, following views were provided.

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| Company | Comment |
| Nokia | Our opinion is that TRS bandwidth issue is of high priority and should have an email thread in RAN1#100be. It is clear that R16 UEs are mandated to support only BWPs corresponding to nominal channel BW. Issue is clear. Moreover, this is critical deployment scenario, therefore, question is not “whether to solve” but “how to solve” and for that technical discussion is needed.  |
| ZTE | We are okay with the priority in general. From our perspective, 2nd priority issues can be discussed in next meeting instead, depending on the overall email thread situation in next meeting. Regarding the 2nd issue of the first priority issues, it is related to UE capability. Hence it is suggested to be treated under UE feature AI to avoid duplicated discussion. |
| Ericsson | Share the same opinion as Nokia on TRS bandwidth. This topic falls under 3GPP obligation and commitment to in Rel-16 address learnings from early deployments and is more important, and should have higher priority, than any of the issues listed above as high priority. |
| Samsung | On the priority of TRS bandwidth, we share the same view with Nokia and Ericsson.  |
| Huawei, HiSilicon | At first, we support Feature lead’s guideline to handle Rel-16 endorsed TEIs first but not to treat or open other TEIs. For the issue of TRS bandwidth, we do not think it need to be discussed. In the current spec, it is clear that the TRS bandwidth (TS38.213) can be min(52, NBWP) or NBWP size. In the case that 7MHz (5MHz~10MHz), the TRS bandwidth can be equal to NBWP size. So, there is no issue at all.Then, for the concern that bandwidth configuration is nominal or non-nominal, I copied the agreement in RAN4 (R4-1910522) as follows:*RAN4 agreed that “UE can access the cell if UE supports a channel bandwidth which is equal to or narrower than the channel bandwidth in SIB1 and is equal to or wider than the initial BWP-bandwidth.”****BWP-bandwidth can be configured with any number of RBs equal to or narrower than RB size of the supported channel bandwidths****.**Although the core requirement is applied to any RB configuration, it is noted that only the set of supported channel bandwidths are included in conformance tests due to the test coverage limitation.*From the agreement, it is clear that NBWP can be any number of RBs, not restricted as nominal cases. So, we do not see any problems on current specs.  |
| CATT | On supported BWP size, RAN1 has reached consensus which is captured in agreed LS to RAN2 (R1-1909900). I copied related part below            RAN1 view: –      As per the RAN1 UE feature 6-1, all UEs are required to support “at least BWPs which is the same as the set of specified channel BW” without any capability indication.–      Specifically, for initial DL BWP, all possible sizes of CORESET 0 (24, 48, 96 PRBs) need to be supported by all UEs.–      RAN1 specifications have the flexibility to support any BWP size from 1 PRB to 275 PRBs, although currently Rel-15 does not support BWP sizes smaller than the RBG size or the PRG size. Our understanding is that RAN1 specs support configuration of BWP of any size. Since there is no capability reporting on supported BWP size, all UEs are mandated to support BWPs with non-nominal size. |
| MediaTek | As Qiubin pointed out below, RAN1 did conclude that RAN1 specifications have the flexibility to support any BWP size from 1 PRB to 275 PRBs in the LS to RAN2 (R1-1909900).But I also agree with Karol that RAN1 didn’t reach consensus on whether all Rel-15 UEs shall support any BWP size other than RAN4-defined channel bandwidths (given a SCS) and CORESET0 size.So the fundamental issue is the UE capability to support non-nominal BWP size, rather than RAN1 spec problem.From our perspective, we support to resolve the issue in TEI this meeting though we don’t think RAN1 spec has any problem to support the scenario mentioned in Nokia’s Tdoc. |
| Verizon | We second Ericsson's opinion that we should try to seek a pragmatic solution during RAN1#100b-e.We have a critical situation where we have to keep some legacy narrowband systems around for a long time, due to our past long-term customer commitment. As of today, it looks like we may have to sacrifice a wide NR band just to do that - which is inconceivable, but unfortunately, the reality of the state of industry.We can argue that RAN1 supports all non-nominal BWPs, and we can just ask RAN4 to specify their requirements accordingly. But RAN4 needs to do the bandwidth one by one, delivering the whole set of the requirements for a proposed BW in the same way as it did for nominal BW. Not only does it take time, but if operators don't have consensus on.one or a few bandwidths, their work is just not going to get started.Ideally it would be very desirable to seek a relatively easier-to-manage RAN1 solution that keeps it in the "signaling/control" domain and does not need RAN4 to go the full length to redefine requirements, e.g., rx performance of a 7MHz control channel, and then the set for maybe 8.5MHz and so on.   So we are looking for a pragmatic approach, not just from RAN1 point of view but from end user point of view. As a user, we are neutral to all technical solutions but we want one of them that we can implement.Another reason why we can't delay it further is that without a solution, there will be more and more NR UEs coming to the market that will become "legacy" when eventually a solution to this is found. And our experience is that such "legacy" UEs are a headache to the operation, as we are bound by our commitment to customers.Thank you all, and please kindly at least allow this topic to be discussed next week - let's give it a try please. This is indeed an urgent need and we appreciate the support from the vendor community.  |

Based on above, whether or not (and if yes, how) the text below in UE feature 6-1 needs to be updated:

* *This feature should be mandatory without capability signaling for at least BWPs which is the same as the set of specified channel BW. RAN4 may discuss other BW requirements.*

## 2.1 Discussion 1

**Companies are encouraged to provide views whether or not the text below in UE feature 6-1 needs to be updated. If a company thinks the text needs to be updated, the company is also encouraged to provide how to update the text.**

* *This feature should be mandatory without capability signaling for at least BWPs which is the same as the set of specified channel BW. RAN4 may discuss other BW requirements.*

**Alt.1: The text is updated to e.g., “***This feature should be mandatory without capability signaling for ~~at least~~all BWPs from 1 to 275 PRBs ~~which is the same as the set of specified channel BW~~. ~~RAN4 may discuss other BW requirements~~***”**

**Alt.2: The text is not updated**

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| Company | Comment |
| Nokia, NSB | While Alt1 would be the best option, we are not sure how we could change R15 capability captured in TR that has been deemed as not to be maintained by RAN2.Therefore, we are left with Alt2, and we see the following options for R16(Opt1): introduce capability for support of BWP sized other than specified channel BW(Opt2): introduce TRS BW relaxation for 10MHz carrier with 15kHz sub-carrier spacing, potential subject to capability. We prefer Opt2, as it allows for simpler implementation at both UE and gNB. |
| MediaTek | We support Alt. 1 with one additional sentence highlighted with blue color as follows to clarify that BWP size is mainly UE baseband capability, not bundled with UE RF capability.**Alt.1: The text is updated to e.g., “***This feature should be mandatory without capability signaling for ~~at least~~all BWPs from 1 to 275 PRBs ~~which is the same as the set of specified channel BW~~. ~~RAN4 may discuss other BW requirements~~.**No**additional new RF requirements are required for the BWP sizes other than the ones corresponding to CORESET 0 sizes and RAN4-specified channel bandwidths for a given band deemed mandatory by RAN4***”** |
| Samsung | We share the similar view with Nokia. Alt 1 would be the best choice but not sure whether it is really feasible solution or not. If Alt 1 is selected, we prefer the modified version suggested by MeidaTek rather than the original version. If Alt 2 is selected, we are okay to either Opt 1 or Opt 2 suggested by Nokia. |
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# **References**

[1] R1-2001589 Discussion on CLI and TBS ambiguity ZTE

[2] R1-2001957 Remaining details of CLI measurement and reporting at a UE LG Electronics

[3] R1-2002027 Maintenance of aperiodic CSI-RS triggering with beam switching timing of 224 and 336 Intel Corporation

[4] R1-2002074 Remaining issues of half-duplex operation in CA CATT

[5] R1-2002170 On TRS muting for NR coexistence with a narrow band system MediaTek Inc.

[6] R1-2002229 On remaining NR TEI issues Nokia, Nokia Shanghai Bell

[7] R1-2002282 Remaining issues for Rel-16 maintenance and TEI Ericsson

[8] R1-2002355 Considerations on HARQ/CSI enhancements Apple

[9] R1-2002679 Discussion on conditions of rate matching pattern overlapping with PDSCH DMRS symbols Huawei, HiSilicon

[10] R1-2001724 Discussion on UE TEI feature 14-7 vivo

[11] R1-2001834 Views on Rel-16 UE features for NR TEIs MediaTek Inc.

[12] R1-2002025 UE features for NR TEI Intel Corporation

[13] R1-2002280 UE features for TEIs Ericsson

[14] R1-2002597 Rel-16 UE features for TEIs Huawei, HiSilicon