**3GPP TSG RAN WG2#109-e R2-200xxxx**

**Electronic meeting, 24th February - 6th March, 2020**

**Title: [Draft]** Guidelines for UE capability definitions

**Response to: -**

**Release:** Rel-16

**Work Item:** -

**Source:** Ericsson, Intel [RAN2]

**To:** RAN1, RAN4

**Cc:** RAN

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**Attachments:** None

**1. Overall Description:**

The discussion on defining UE features parameters for Rel-16 has started. Based on the experience from Rel-15, RAN2 discussed some additional guidelines that should be used in order to have uniquely defined UE capabilities, and would like to share these guidelines with RAN1 and RAN4.

**1 Avoid defining “incapability” bits as they may cause interpretation issues**

The definition of the capability should not say that “a UE setting the bit does not support Rel-16 feature X”. Such statements caused a lot of problems in Rel-15. Additionally, adding such “in-capabilities” In Rel-16 would mean that all Rel-15 UEs, which will of course not report any Rel-16 capabilities, must support the feature. For example, the capability bit *pucch-F0-2WithoutFH* indicates that “the UE does **not** support PUCCH formats 0 and 2 without frequency hopping”.

**2 Absence of a capability bit** shall not imply support for something that is not yet defined

An example could be “absence of *channelBW* means that the UE supports all BWs”. Since new BWs might be added later and maybe in some other specification, “all BWs” can become ambiguous. Any legacy UE would suddenly be expected to support the new bandwidth as well.

Another example is the default capability for UE power class and UL duty cycle. From signalling point of view, reducing the overhead is marginal (unless it is reported per-BandCombination or Per-Band-of-a-BandCombination as discussed in bullet 4 below). Instead, gNB faces difficulty in comprehending the implicit capabilities amongst UEs compliant with different versions of different releases.

**3 Define baseline feature bits that covers the minimum parts of a feature and use additional bits for parts that can be used together with the baseline feature**

If a feature has a baseline feature, the baseline feature must be clearly defined. It is not enough to write that “if the UE does not set the bit it does not support feature group x-y”. If a capability bit for a certain “feature X” has been defined, all UEs that support “feature X” shall set the bit, and additional parts of the feature may not be supported by all UEs.

Capability signalling and rules to determine whether a UE supports a feature should not be mixed. For example, avoid to say

“In TDD band combinations, only UEs that set the featureX capability bit support feature. In FDD-only band combinations all UEs support feature X even if they do not set the bit.”

If later FDD-only band combinations are defined, where UEs are not required to support the feature, band combinations will not be release independent. An example where this caused problem in Rel-15 was the capability *simultaneousRx-Tx* for EN-DC.

**4 Minimize features “per-BandCombination” and “per-Band-of-a-BandCombination”**

The number of features that require capability signaling with “per-BandCombination” and “per-Band-of-a-BandCombination” (FeatureSetPerCC) differentiation should be minimized. Such features cause an explosion in the size of the capability signaling and are even more severe when it comes to the number of possible configurations, making it impossible for the gNB to take all combinations into account. The likely outcome is then that the gNB does not configure such features at all.

It would be of help for RAN2 to be informed of the reasons why “per-BC” or “per-band-of-a-BC” was considered necessary, and whether other alternatives were considered.

**5 Avoid defining functionality that has no RRC configuration but is dependent on capability bits.**

The specification should not be written so that the network determines what configuration it can use for a UE implicitly by the reported UE capabilities. Instead, the gNB should always configure the UE explicitly by DL RRC signalling, respecting the reported capabilities.

A problematic case in Rel-15 was the UL/DL MIMO layers, which resulted in a late-stage introduction of explicit MIMO signalling support by RAN2 (maxLayersMIMO-Indication). In Rel-16, this is basically not feasible since a legacy gNB of course will not behave according to Rel-16 UE capabilities.

**6 Use of “Optional” vs. “Mandatory with capability signaling”**

In both cases, the UE shall set the capability bit if it has successfully performed IODT and a gNB will use the features only if the capability bits are set. Hence, for a gNB these two cases are identical. While being technically equivalent, ‘mandatory with capability signalling’ expresses a higher degree of urgency to implement and test the associated feature than ‘optional’.

**7 Avoid Mandatory (without capability signalling) features in Rel-16**

Any functionality in Rel-16 defined as Mandatory (without capability signalling) basically means that a UE that sets the AccessStratumRelease in the UE capabilities to “Rel-16” must implement all such features. It also means that a UE cannot implement any other Rel-16 feature before having successfully IODTed the mandatory features and may not even be possible to upgrade UEs to Rel-16.

**8 UE capabilities defined in specifications must be self-contained**

All implementation of 3GPP products should be based on specifications and not on TDocs or Technical Reports. Hence, any “features” specified in 3GPP must be fully described in specifications. RAN2 will document the capabilities in TS 3x.306, preferably with references to RAN1/RAN4 specifications and to corresponding RRC configurations (fields and information elements).

RAN2 understands that RAN1 uses the “feature IDs”, since they are useful during the initial stage of discussions. RAN2 would like to request that once the RRC signalling is in place and can be mapped to each “feature ID”, the actual field names used in the signalling are also utilized in the RAN1/RAN4 capability discussions (to avoid inter-WG confusion e.g. in LSs). RAN2 would also like to point out that after the “snapshot” of defined Rel-16 capabilities have been captured in RAN2 TR 38.822, RAN2 does not plan not to update this TR. Discussions (on any WG capabilities) should be based on the actual specification text.

**9 Use per-band capability rather than per-UE capability, if both FDD/TDD and FR1/FR2 differentiations are needed.**

If both FDD/TDD and FR1/FR2 differentiations are required for a per-UE capability, it cannot be supported all of the possible combinations of xDD and FRx, as spotted by the LS from RAN1 in R2-2000013. For such a case, it is simpler and desirable that a UE capability is defined per frequency band (outside the band combination signalling), rather than per UE.

**2. Actions:**

**To RAN1, RAN4:**

**ACTION:** RAN2 would like to respectfully ask RAN1 and RAN4 to use these guidelines in their work on the Rel-16 UE capability definitions.

**3. Date of Next TSG-RAN WG1 Meetings:**

TSG-RAN2 Meeting #109bis 20th – 24th April 2020 Sapporo, Japan.

TSG-RAN2 Meeting #110 25th – 29th May 2020 Athens, Greece (TBC)