3GPP RAN TSG Meeting #98 RP-223547

Electronic meeting, December 12 – 16, 2022

Agenda item: 9.2.2

Source: Apple Inc, AT&T, Ericsson, T-Mobile USA, Qualcomm, Nokia, Huawei

Title: Text proposal for Study on UE support of regionally-defined subsets of an NR band

WI/SI: FS\_NR\_subset\_band\_support

Release: Rel-18

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# 1 Introduction

During the RAN#95 meeting an issue of so-called phased introduction of frequency ranges was raised and discussed. And as further discussed in [1-3], this issue comes from the fact that while 3GPP tends to define, when possible, large bands covering large contiguous chunk of spectrum, it is not necessarily the case that all countries or geographical areas will have the same allocation. Some countries or regions might have only a sub-range within an NR band, and the UEs will support this sub-range and will be tested for it. However, if a particular country/region extends further available frequencies within the same band – effectively resulting in phased introduction of frequency (sub-)ranges within the same NR band – there will be two types of UEs supporting only the initial set of frequency sub-ranges and supporting an extended set of frequencies.

While 3GPP resolved this issue for US and Canada, several companies expressed the preference to have a common solution or framework for similar cases. As a result, RAN#96 agreed a new RAN SI [5], which aims at studying further general solutions for this problem.

This paper presents a summary of discussions for potential solutions that both involve a new band number as well as solutions that do not require a new band number.

The content relating to potential solutions involving a new band or band number is a summary of inputs and comments from Ericsson, T-Mobile USA, AT&T, Qualcomm, Nokia, and Huawei

The content relating to potention solutions not involving a new band or band number is a summary of inputs and comments related to the following documents:

- RP-223196 (Apple Inc.)

- RP-223339 (AT&T)

- RP-223357 (Huawei, HiSilicon)

# 2 Text proposal for TR 38.893

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# 6 Possible solutions

## 6.x Solution x: New Band

Introducing a new band is a well-known technique for RAN4, which has been used to differentiate between different (sub-)bands or portions thereof in 3GPP specifications. For instance, B26/n26 are supersets of Band 5/n5, and Band 25/n25 are supersets of Band 2/n2. Also, Band 19/n19 are regional subsets of band 5/n5. These new bands have separate band combinations and separate RF requirments, including different refsens and MSD. However, in the case of B26 B25, the superset bands were introduced in 3GPP after the smaller B5 and B2 were in the specs, so it is not quite the same situation as with n77, where there is an existing wider band, but a need for a regional sub-band.

One downside of introducing a new band for a regional sub-band is that new band combinations are required for the new bands. This can create significant workload for RAN4 because of the redundant effort. Also, RAN4 would need to specify all of the requirements for the sub-band including rf and performance requirments.

The use of new bands for regional sub-bands would provide a means to limit access to spectrum in a region that only has regulations for the sub-band, but it could lead market fragmentation if vendors introduce UEs that only support the new regional band, and not the wider full band.

6.y Solution y: New Band Number

Another potential solution is to introduce a new band number, which is not really a new band. The difference between a new band and a new band number is that all the requirements of the original band would apply to the new band-number, but the new band number would allow for differentiation of which part of the spectrum a UE is certified to operate in in the region. All the band combinations that applied to the parent band would also apply to the new band number.

One example of a new band number is n90, which is identical to n41 except that n90 also supports the 100 kHz raster and the 7.5 kHz uplink shift. There are no band combinations defined for n90 because all the n41 combinations apply to n90 also. In the case of n90, the new band number was more of a capability signalling mechanism to allow the network to identify UEs that support the 100 kHz raster and 7.5 kHz shift, and bar n41 only UEs that don’t support those features.

For regional sub-bands, the new band number can be thought of more as a signalling mechanism used to allow or bar devices based on support for a particular part of the band. It is similar to the extendedBand-n77-r16 / NS\_55 solution, except that it uses existing UE capability signalling and barring and does not require any new network signalling.

An example of how this would work is that at some point in time 3300-3450 MHz might become available in the USA for Mobile use. If this spectrum does become available, then a new band number could be allocated to indicate that a UE supports 3300-3450 MHz, as well as 3450-3550 and 3700-3980 MHz, in the US. Only the new band number would be reported in the new frequency range in the US so that only UEs that support the new band number would attempt to access 3300-3450 MHz in the US. Also, when the gNB examines the UE capabilities, it would know if the UE supports 3300-3450 MHz in the US based on if it reports support for the new band number or not in its UE capabilities.

The benefits of the new band number approach are:

* No new RAN2 signalling needed as new parts of the band become available.
* No new NS values required for barring UEs
* There are many available band numbers (107 of 1024 have been used so far for NR)

3GPP would pro-forma select a new band number based on regional frequency allocations within an existing 3GPP band, the existing band being referred to as the parent band.

If the network wants to avoid that a legacy device supporting only the parent band (but not indicating support for the new band number) will camp on a cell in the new sub-band, the network can indicate only the new band number on cells in the new sub-band. In this manner the technique of a new band number should prevent UEs which are not compliant to the requirements of the new sub-band from camping on or accessing the cell in such a sub-band. And the gNB sees from UE capabilities the bands and band numbers that the UE supports and hence the gNB knows if the UE can be handed over to a cell in the new sub-band.

For this technique, the new band number would reference the parent band for RF requirements. Dedicated sub-band hardware for the UE such as RF filters is not assumed to be utilized for the new band number. In addition, the new band number should be a collection of a new sub-band and previously introduced sub-band(s) (chronologically) to avoid having inter-band CA within the parent band. To avoid market fragmentation and to support roaming, it should be mandated that the new band number can only be supported by a UE which also supports the associated parent band. If a UE including roaming UE is not certified to operate in new band number based on regional regulatory certification, the UE shall not advertise the new band number in its capabilities nor shall it attempt to connect to a cell broadcasting this new band number.

In current practice, adding a new band triggers introduction of new band combinations, which would add many new band combinations to the specification and UE capability signalling. By contrast, adding a new band number, such as when n90 was added, does not require new band combinations, but rather text stating that combinations for the parent band apply to the new band number. To ensure that UE capability signalling is not adversely impacted by the number of supported band combinations, this technique requires that the new band number corresponding to the new sub-band has a reference to the parent band for signalling carrier aggregation (CA) and dual-connectivity (DC) band combinations.

NOTE: It should be studied further whether a UE shall report band combinations for the parent and sub-bands, and if not, which specification impact it will have.

This technique requires no new signalling and can work for any release UEs, but it does change the semantics of 3GPP frequency bands and 3GPP should clarify the association between a new band number and their parent band in signalling requirements. If the new band number approach is applied, 3GPP RAN4 should:

• Consider accommodations for cases where the UE subset support precludes the possibility to test some MSD exceptions: If the UE supported subset precludes the possibility to test some MSD exceptions, just like with Note 12 for n77 either the MSD configuration can be changed so the MSD is testable in the country that uses the sub-band or a note can be added to waive the MSD.

• Ensure that the number of new band number definitions does not exhaust the range of possible band numbers: Rel-17 signaling supports 1024 NR band numbers, or which 104 are assigned in Rel-17. Exhaustion of the range of band numbers is not anticipated to be an issue.

### 6.z Solution Z (reuse NR band number, new signalling)

With this solution, the existing NR band is re-used, but there is also explicit signalling – either from the UE to the network, from the network to the UE, or both – providing further information to the communicating entities regarding which sub-bands are supported. Hence for the sake of clarity we will focus separately on potential options for signalling for both communication sides.

The premise for introduction of signalling from the network to the UE is to prevent legacy UEs from camping on particular sub-bands for which they do not indicate the UE capability signalling, i.e., sub-bands added in later releases. The easiest way to accomplish this is to define new NS value associated with the corresponding band. With this approach the network broadcasting new NS value can be always sure that a legacy UE will not camp on a particular sub-band. It does not matter how many sub-bands are added and in which release – as long as every sub-band is associated with a particular NS value, the network remains in controls of permissible cells for camping destinations.

As for the UE to the network signalling, one of the main reasons to have it is to provide the network with additional information regarding which sub-bands a UE supports to facilitate network sub-band selection for re-direction and handover procedures. This information on supported sub-bands can be implemented in at least the following ways (not precluding other options):

- **Explicit UE capability**. As follows from its name, the UE capability is implemented as an explicit capability in the UE capability container, whereupon it can be as simple as one bit or something more versatile as a bitmap container. Since such a generic UE capability does not exist, RAN WG4 will need to contact RAN WG2 every time such a capability is needed (as it already happened with the DOD-band). To reduce such issues, a generic approach (as illustrated by the next alternative) could be preferable

- **Implicit UE capability (via e.g., *modifiedMPR-Behaviour* field bitmap or a new bitmap)**. This approach is logically identical to the previous alternative, with the difference being that instead of the asking RAN WG2 to define a new capability for each new sub-band, a more generic signalling is used, which can be defined as per-band signalling and whose content can be defined by RAN WG4. Two options below are examples of how it can be accomplished.

1. One option is that the existing capability *modifiedMPR-Behaviour* can be leveraged for this purpose. The *modifiedMPR-Behaviour* can already be signalled for every band not requiring any RAN WG2 changes. Since it is up to RAN WG4 to define the purpose and meaning of every value of that field, UE can use this capability to indicate supported sub-bands based on meaning defined in RAN4. However, this would be changing the original intent of this capability since it relates to MPR, not to sub-bands, and Repurposing the existing capability may create unforeseen issues.
2. Another option is to include a new band subset indication to UE capabilities. In this proposal, the parent 3GPP band designation may be followed by an indicator which identifies which sub-allocation of the band applies to the region in question. From the signalling perspective this approach is similar to *modifiedMPR-Behaviour* described above, but a new dedicated capability would be defined by RAN2 WG2, content of which will be further specified by RAN WG4. This proposal avoids the issue of parent-band association, but at the cost of defining new signalling and requiring constant overhead whenever present (since a bitmap typically needs to be of fixed size).

As an example, the solution adopted for band n77 was a combination of the following elements:

- UE-to-NW signalling: defining the explicit UE capability indications (extendedBand-n77-r16 and extendedBand-n77-2-r17); and

- NW-to-UE signalling: defining new value NS\_55 and NS\_57 for barring UE access to the sub-bands.

-------------------- TEXT PROPOSAL (END) --------------------

# 3 Conclusions

# 4 References

1. RP-220457, "Views on phased introduction of operation frequency ranges in an NR Band", Apple
2. RP-220545, "Regulatory Issues with wide global bands", T-Mobile USA
3. RP-220762, "Handling of Canada n77 band", MediaTek Inc.
4. RP-220899, "Moderator’s summary of discussion [95e-39-R17-TEIs]", Moderator (RAN4 Chair)
5. RP-221872, "New SI on generalizing the specification for subsets of NR band support", Qualcomm Inc.
6. RP-222210, "TP for TR38.xxx Band Subsets; Root cause and New band number", T-Mobile USA Inc.
7. RP-222223, "TP for TR 38.893: Views on UE support of regionally-defined subsets of an NR band", Qualcomm Inc.
8. RP-222365, "On UE support of regionally-defined bands", Nokia, Nokia Shanghai Bell
9. RP-222368, "Generic solution for n77-like issues", Ericsson
10. RP-222510, "Discussion on UE support of regionally-defined subsets of an NR band", Huawei, HiSilicon