3GPP TSG-RAN WG2 Meeting #115 Electronic [R2-210xxxx](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-210xxxx.zip)

Elbonia, 16 – 27 August 2021

**Agenda item: 6.1.4.3**

**Source: Nokia (Rapporteur)**

**Title: Summary of [AT115-e][029][NR16] n77 (Nokia)**

**WID/SID: NR\_RF\_FR1-Core - Release 16**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the report of the following email discussion:

* [AT115-e][029][NR16] n77 (Nokia)

 Scope: Await on-line. Take on-line outcome into account. Determine agreeable parts and agree CRs, Treat [R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip) – 7947, [R2-2108287](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108287.zip), [R2-2108756](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108756.zip), [R2-2108332](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108332.zip)

 Intended outcome: Report, Agreed CRs.

 Deadline: Await on-line, Schedule 1

The "**Schedule 1**" cporresponds to the following;:

* *A* ***first round*** *with* ***Deadline for comments Thursday Aug 19 1200 UTC*** *to settle scope what is agreeable etc*
* *A Final round with* ***Final deadline Thursday Aug 26 1200 UTC.*** *to settle details / agree CRs etc. Additional check points etc if needed are defined by the Rapporteur. In case some parts of an email discussion need more time, doesn’t converge, need on-line treatment etc Rapporteur please contact chair.*

This topic was also noted in the guidance from RAN#92e as follows:

*13) R17 RF requirements enhancement for NR FR1 [RAN4 WI: NR\_RF\_FR1\_enh], on Band n77: (See RP-211587)*

*1. RAN4 focuses on the necessary updates to RAN4 requirements and leave signaling work, if any, to RAN2.*

*2. RAN2 focuses on signaling aspects, with an aim to ensure the network can properly deal with legacy n77 UEs that do not support 3.45-3.55 GHz operation in US*

*3. RAN tasks RAN4/2 to complete the required work in Aug. and report back to RAN#93-e*

*4. RAN4 chair is kindly asked to use an appropriate agenda to facilitate the work in Aug. meeting, i.e., R16 maintenance, R16 TEI, etc.*

This discussion is handled in phases, with phase 1 intended to understand the potential solutions, and phase 2 to understand additional details. After that, rappporteur provides proposal on how to progress with the issue and whether online comeback is needed.

* Phase 1 starts at ***Monday Aug 16 1630 UTC*** and ends by ***Wednesday Aug 18 1000 UTC***
* Phase 2 starts at ***Wednesday Aug 18 1200 UTC*** and ends by ***Thursday Aug 19 1200 UTC***

# 2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
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|  |  |  |

# 3 Discussion

## 3.1 Signalling solutions (phase 1)

As discussed online (as well as in all of [R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip), [R2-2108287](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108287.zip), [R2-2108756](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108756.zip) and [R2-2108332](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108332.zip)), the primary question to decide is how to ensure inter-operability between current UEs (who may not support the new requirements for n77) and new UEs (who will support the new requirements). The view in all of the submitted contributions was that having signalling (in one way or another) is the simplest way to accomplish that, and (as e.g. [R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip) states), the usual way RAN2 deals with such changes to existing features.

To get to the bottom of this, it seems that the starting point would be to list all the possible solution (combinations) that could be considered. The rapporteur notes that the following solutions that utilize signalling have been mentioned:

1. New capability signalling (with e.g. per-UE granularity) (see e.g. [R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip))
2. Reusing existing per-band *modifiedMPR* capability signalling (see e.g. [R2-2108332](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108332.zip))
3. Defining new per-band capability signalling similar to modifiedMPR that allows to modifications to frequency bands (see e.g. [R2-2108332](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108332.zip))
4. Defining a new frequency band (with a new band number) (see e.g. [R2-2108287](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108287.zip))

Some contributions ([R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip), [R2-2108287](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108287.zip)) also note that the signalling would be needed not only for NR CA/DC cases but also for LTE to support EN-DC deployments utilizing n77 in the US. Finally, [R2-2108756](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108756.zip) notes that defining a new NS-value could be used to avoid all UEs (i.e. also roaming UEs) from camping on a cell utilizing the n77 extension in the US.

Naturally, other signalling options may also be possible. In case companies have different proposals that they think would work better, the rapporteur requests companies to add those in the list below:

1. TO BE ADDED BY PROPONENT COMPANY
2. TO BE ADDED BY PROPONENT COMPANY
3. TO BE ADDED BY PROPONENT COMPANY

**Question 1**: Which signalling solution(s) would be acceptable to companies?

|  |
| --- |
| Answers to Question 1 |
| Company | Acceptable solutions (i.e. 1-N)  | Technical arguments |
| DENSO | 1) and 3) | On 2), the existing *modifiedMPR-Behaviour* is defined to enable the UE to indicate support of the modified (A-)MPR as the field name gives. It is not defined to indicate the supported operating band range. The advantage of 2) was thought that the solution does not require ASN.1 update (as well as 36/38.306). However, given that the eNB has to know the modified operating band range, as pointed out by Nokia and Ericsson, ASN.1 update cannot be avoided. In that sense, 2) also requires ASN.1 update anyway, as well as 1) and 3).In addition, necessity of a new NS-value for the n77 extension has to be analysed carefully. The legacy UE capable of accessing 3700 to 3980 MHz in US might search SSBs within 3700 to 3980 MHz by implementation. Such a legacy UE will not acquire SIB1 in the extended range (3450 – 3550 MHz), even though the new NS-value is present in SIB1. This is because the UE will not try to search SSBs within 3450 – 3550 MHz, anyway. Further analysis is deemed as necessary to check how the legacy UE behaves.On 4), if it were the solution, the different frequency band than n77 would have to be defined for 3700 to 3980 from the beginning. There seemed to be some background why n77 was defined with such a region specific restriction.The choice of 1) and 3) depends on whether the similar case will happen to the other band or even in n77 in future. If everyone is firmly confident that it will never happen in future, 1) is sufficient. If not, 3) can be considered for future proofing with the minimum bit length (e.g. 1 or 2 bits). |
| Huawei, HiSilicon | A new band indicator, or new Ns value + new capability indication | We think the key point here is how to deal with idle mode foreign UEs. If the foreign UEs supporting n77 cannot be ensured to also support DoD bands, to ensure the inter-operability we should have some way to bar these UEs when the cell is actually using DoD bands. The clean way is to define a new band, the legacy UEs cannot identify the band number and thus would not camp on these cells. Another alternative is to define a new Ns value, if the legacy UEs cannot understand the new value, it will also bar this cell. For connected mode, the new UE capability can anyway indicate the support of this new band irrespective whether to extend the signalling or to reuse the current signalling, and the inter-operability can be supported easily.  |
| Qualcomm Incorporated | 2) | In general we prefer a solution which does not require ASN.1 change, due to immediate need of supporting the new requirement for n77.4) is another way to do it, but we think it will involve more logistics from the UE implementation perspective, e.g. changing the band combination capabilities, testing UE capability filter logic and so on. |
| Nokia, Nokia Shanghai Bell | Prefer 1), can accept 2) & 3) with LTE signalling as well as 4) if RAN4 agrees | We prefer the option 1) but all of the options are acceptable to us IF the signalling is there for both LTE and NR. * 1) is our preference for much the same reasons as DENSO indicated: Both eNB and gNB need the information, and the CRs we provided shows that the addition is very straightfirward.
* 2) is acceptable for NR but we would like to note that LTE signalling is needed in addition (as LTE only has *modifiedMPR* for LTE bands, not for inter-RAT bands).
* 3) is acceptable but would require similar signalling for both LTE and NR (which may increase signalling size).
* 4) is acceptable as it would work without any changes but carries a RAN4 cost and would require an urgent LS to RAN4 to verify the solution is acceptable to them. If RAN4 says it's not acceptable, then RAN2 should consider another solution.
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| AT&T | 1) | AT&T supports adding a new per-UE capability bit that indicates that UE supports the extended frequency range in the US for band n77 in a release-independent manner.We do not support the introduction of a new frequency band (with a new band number).  |
| Apple | 2 | Adding per-ue capability is similar to adding an interpretation in modifiedMPR, and we can let RAN4 define the exact interpretation of the bit. We think this is simpler approach and also when newer changes are made to n77 in the future. It is also backward compatiable ASN.1 wise and allows for early implementations. |
| Charter Communications | 1 | We prefer solution 1). Other solutions are not desirable because: 2) uses *modifiedMPR-Behaviour* signalling out of its intended context and definition, and 4) sets an undesirable record where RAN defines a new band due to a regional regulatory change and without enough study and.  |
| Intel | 1 | We also prefer a clean and straightforward signaling. In addition to NR capability, this capability should be introduced in LTE for inter-RAT operation. In that sense, given that the purpose of modifiedMPR-Behaviour indication is different from this issue, there is a potential confusion to re-define the value of modifiedMPR-Behaviour. Regarding idle mode issue, we understand that RAN4 is under discussion what the issue is and whether it is critical issue . It would be dependent on how much RF requirement is different from DoD band and global n77 band. RAN2 can wait for further progress in RAN4.  |
| Samsung | 4 or 1 (depending on RAN4 conclusion) | Even though it’s urgent, it is not reasonable to divert any current capability for the different purpose from original intention of the capability.We prefer to have a clean solution. Hence, a new band for extended n77 may accord closely with our preference, if RAN4 concludes in this way. If RAN4 has already discussed new band and kept any concern on it, a per-UE capability bit can be considered for simplicity, because it’s a rare case. |
| MediaTek | 4) if R4 agreed1) and 2) are acceptable | A new band indicator is the cleanest solution which follows legacy convention. It also resolve the IDLE mode camping issue for roaming UEs.For 3), it seems that per band capability is the same as per UE capability if only band n77 could indicate this new capability. Unless other bands also this kind of capability (hope not), we think per-UE capability is enough.If 4) is not agreed, we still need to discuss whether the roaming UE camping issue need to be resolved. |
| OPPO | 4) or 1)(depending on RAN4 conclusion) | We need solution to prevent legacy roaming UE to access DoD band. The solution on the table is either to introduce a new band indicator or a new NS value. But new NS value can only work in IDLE state. When legacy roaming UE access the network via C-band, network may handover the UE to extension range because the UE can’t be identified by new signaling. That’s why NS value doesn’t work unless other capability signaling is introduced or reused. Plus NS value will be mandatory for UE supporting n77 for all UE once it is introduced in RAN4.For UE capability signaling, Option 2 interprets existing UE capability bit in different way. It is not clean way. Option 1 is better than option 3 because it is per UE capability instead of option3 which is per band UE capability i.e. less signaling overhead which is reasonable since such extension occurs occasionally. In case RAN4 decide there is no issue in IDLE state, then 1) is also acceptable for us.Option 4 is solution for both IDLE and CONNECTED without ASN.1 change.  |
| vivo | 4 or 1  | We prefer option 4 because it is clearest method from RAN2 point of view. However if RAN4 has concern about option4 for some reasons from RAN4 Aspect, we can go to option1.  |
| T-Mobile USA | Prefer 4, can accept 1 | 1. Foundation of RAN2 signalling/procedures is built on Band Numbers. T-Mobile USA is concerned about the unforeseen impacts of introducing a brand new method to identify sub bands. Already companies above are discussing how to bar roaming UE’s from part of n77 when this is functionality is currently supported and successfully deployed using band numbers. Another example is the impact on 5G UI capabilities that RAN WG spent considerable time developing.
2. After a band is created Regional Regulatory approval for spectrum or UE operation should remain outside the scope of 3GPP specifications.
	1. RAN4 introduced n77 Note 12 because the FCC hadn’t developed regulatory requirements for the entire 900 MHz range that n77 covers. Enabling a sub band based on regional availability n77 spectrum/ and or UE approval from the local regulatory body negates the benefit of a global band. We are interested to know why other countries can have devices certified to operate in n77 even though there are only regulations for part of the band available in a given country.
3. RAN4 has limited knowledge of RAN2 specifications and didn’t consider the signalling impact of n77 Note 12, especially as additional spectrum is allocated within n77. RAN plenary tasked RAN2 to define the best path forward from a RAN2 perspective.
4. T-Mobile USA agrees with Ericsson in R2-2108287 that creating a n77 shadow band is technically feasible.
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**Summary 1**: TBD.

**Proposal 1**: TBD.

## 3.2 Solution details and LS communication (phase 2)

**TBD - once the candidate signalling solution has been chosen, the more precise details will be discussed in phase 2 (including CRs). In case LS to RAN4 is needed, a draft version may be created during Phase 2.**

# 4 Conclusion

TBD.

# Annex A: RAN2 online notes (including list of documents)

Below shows the result of the initial online discussion on this topic, including the list of documents discussed.

Extended band n77

Treat on-line first

* [AT115-e][029][NR16] n77 (Nokia)

 Scope: Await on-line. Take on-line outcome into account. Determine agreeable parts and agree CRs, Treat [R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip) – 7947, [R2-2108287](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108287.zip), [R2-2108756](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108756.zip), [R2-2108332](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108332.zip)

 Intended outcome: Report, Agreed CRs.

 Deadline: Await on-line, Schedule 1



[R2-2107935](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107935.zip) Inter-operability of band n77 extension in US Nokia, Nokia Shanghai Bell discussion Rel-16 NR\_RF\_FR1-Core

[R2-2107936](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107936.zip) Distinguishing support of extended band n77 for EN-DC, Alt.1 (R16, 36306) Nokia, Nokia Shanghai Bell CR Rel-16 36.306 16.5.0 1820 - C NR\_RF\_FR1-Core

[R2-2107937](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107937.zip) Distinguishing support of extended band n77 for EN-DC, Alt.1 (R16, 36331) Nokia, Nokia Shanghai Bell CR Rel-16 36.331 16.5.0 4702 - C NR\_RF\_FR1-Core

[R2-2107938](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107938.zip) Distinguishing support of extended band n77 for NR, Alt.1 (R16, 38306) Nokia, Nokia Shanghai Bell CR Rel-16 38.306 16.5.0 0615 - C NR\_RF\_FR1-Core

[R2-2107939](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107939.zip) Distinguishing support of extended band n77 for NR, Alt.1 (R16, 38331) Nokia, Nokia Shanghai Bell CR Rel-16 38.331 16.5.0 2747 - C NR\_RF\_FR1-Core

[R2-2107940](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107940.zip) Distinguishing support of extended band n77 for EN-DC, Alt.2 (R15, 36306) Nokia, Nokia Shanghai Bell CR Rel-15 36.306 15.10.0 1821 - C NR\_RF\_FR1-Core

[R2-2107941](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107941.zip) Distinguishing support of extended band n77 for EN-DC, Alt.2 (R16, 36306) Nokia, Nokia Shanghai Bell CR Rel-16 36.306 16.5.0 1822 - A NR\_RF\_FR1-Core

[R2-2107942](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107942.zip) Distinguishing support of extended band n77 for EN-DC, Alt.2 (R15, 36331) Nokia, Nokia Shanghai Bell CR Rel-15 36.331 15.14.0 4703 - C NR\_RF\_FR1-Core

[R2-2107943](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107943.zip) Distinguishing support of extended band n77 for EN-DC, Alt.2 (R16, 36331) Nokia, Nokia Shanghai Bell CR Rel-16 36.331 16.5.0 4704 - A NR\_RF\_FR1-Core

[R2-2107944](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107944.zip) Distinguishing support of extended band n77 for NR, Alt.2 (R15, 38306) Nokia, Nokia Shanghai Bell CR Rel-15 38.306 15.14.0 0616 - C NR\_RF\_FR1-Core

[R2-2107945](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107945.zip) Distinguishing support of extended band n77 for NR, Alt.2 (R16, 38306) Nokia, Nokia Shanghai Bell CR Rel-16 38.306 16.5.0 0617 - A NR\_RF\_FR1-Core

[R2-2107946](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107946.zip) Distinguishing support of extended band n77 for NR, Alt.2 (R15, 38331) Nokia, Nokia Shanghai Bell CR Rel-15 38.331 15.14.0 2748 - C NR\_RF\_FR1-Core

[R2-2107947](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2107947.zip) Distinguishing support of extended band n77 for NR, Alt.2 (R16, 38331) Nokia, Nokia Shanghai Bell CR Rel-16 38.331 16.5.0 2749 - A NR\_RF\_FR1-Core

[R2-2108287](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108287.zip) Band n77 issues in the US Ericsson discussion Rel-17 TEI17

[R2-2108756](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108756.zip) Discussion on n77 issue MediaTek Inc. discussion

[R2-2108332](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_115-e/Docs/R2-2108332.zip) UE capability signalling for Band n77 Ues DENSO CORPORATION discussion Rel-16 NR\_RF\_FR1\_enh