[RAN93e-R18Prep-14] Additional RAN1/2/3 candidate topics, Set 1 - Version 0.0.9
RAN

3GPP TSG RAN Meeting #93-e **RP-211664**

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Source: RAN1 Chair (Samsung)

Title: Moderator's summary for discussion [RAN93e-R18Prep-14] Additional RAN1/2/3 candidate topics, Set 1

Document for: Discussion and Decision

The discussion in this email thread covers topic #14 (Additional RAN1/2/3 candidate topics, Set 1) from RAN Rel-18 Workshop in RWS-210659:

- UE power savings
- Enhancing and extending the support beyond 52.6GHz
- CA (Carrier Aggregation)/DC (Dual-Connectivity) enhancements (e.g., MR-MC (Multi-Radio/Multi-Connectivity), etc.)
- Flexible spectrum integration
- RIS (Reconfigurable Intelligent Surfaces)
- Others (RAN1-led)

Guidance from RAN chair is to aim for converged high-level description of the topics with a reasonable scope

- "high-level description" herein is not a "draft SID/WID" but is something like a single slide with a set of bullets. In other words, it can be viewed as a skeleton of the possible objectives with some high-level notes

1 Initial Round

1.1 Collection of company views

1.1.1 General high-level views

Companies are invited to provide general high-level views on 'Additional RAN1/2/3 candidate topics, Set 1' (if any).

Feedback Form 1:

1 – VODAFONE Group Plc

The lifespan of GSM IoT devices shows us that LTE IoT devices will probably be around for decades! This will make it difficult to turn off LTE transmissions and hence DSS sites may be needed (on e.g. sub 1 GHz bands) for a very long time. This need to maintain DSS operation (in some low band(s)) should be kept in mind as NR is evolved.

2 – Telia Company AB

Telia Company has similar view as Vodafone regarding DSS enhancements for Release 18 work.

Telia Company believes that DSS enhancements should be important part of Release 18 and should be included as integral part of NR&LTE development path in 3GPP RAN. Telia Company is now actively implementing DSS in commercial networks, so we see that DSS development should not stop to Release 17. Telia Company supports DSS enhancement proposals described in document RWS-210308.

Telia Company would like 3GPP RAN to prioritize DSS enhancements in Release 18 discussions and work plan.

3 – KT Corp.

KT would also like to see DSS enhancement considered for Rel-18. Some part of LTE spectrum needs to be utilized for NR usage however we also needs to consider LTE subscribers will still remain for quite a while. If DSS overheads can be reduced this should be very useful technology to support both LTE and NR in such a limited spectrum operators have.

4 – TELENOR ASA

Telenor Group has similar view as expressed by Vodafone and Telia Company. DSS enhancements is important and should be a part of R18. DSS enhancements should be an integrated part of the NR and LTE development in 3GPP RAN.

5 – FirstNet

One of the important features of a UE to a first responder is to provide reliable communications over a long period without a recharge. It is common for a first responder to run multiple Apps simultaneously on their mobiles thus making a UE power savings feature a must. Hence, Rel18 should consider further enhancements to improve UE battery consumption.

6 – TELECOM ITALIA S.p.A.

We think that DSS enhancements are important and solutions to ensure capacity enhancements are required

7 – Sony Group Corporation

In our opinion, it makes more sense to discuss RIS and smart repeaters in the same topic/thread. This is because, as pointed by several companies during the pre-Rel18 workshop discussions, commonalities (and key differences) between RIS and smart repeaters need to be understood (see our comment to Sec. 1.6 below for details.) Because of this, we propose that the discussions on reconfigurable intelligent surfaces is moved from topic 14 ”Additional RAN1/2/3 candidate topics” into topic 4 ”Additional topological improvements.

1.1.2 UE power savings

Companies are invited to make proposals or provide their views on potential enhancements for UE power savings.

Feedback Form 2:

1 – vivo Communication Technology

Introduction of Rel-18 ultra-low wake-up receiver

In Rel-16 and Rel-17, there were UE power saving features developed by wake-up signals, which can save fraction of the total power consumption by receiving a signal/channel before DRX on for connected and idle/inactive state respectively. However (1) industrial wireless sensors: the battery should last at least few years. (2) Wearables: Battery of the device should last 1 -2 weeks. These requirements cannot be satisfied by the current wake-up mechanisms.

eDRX can reduce the power consumption a lot by extending the UE wake-up period a lot, e.g., in minutes / hours. However it will increase the latency a lot and lead the wake-up to a 'non-real time' way.

In Rel-18, it is proposed to introduce an ultra-low power wake-up receiver, it is a separate wake-up receiver which is used only for wake-up only. The main radio can be switched off or in deep sleep when no data to transmit or receiver. The main radio only wakes up when there is an on-demand wake-up from gNB.

By doing this, the followings can be achieved,

- Low power consumption: The claimed almost-zero power (AZP) wake-up receiver consumes tens/hundreds of uW for standby. It reduces 100-1000x power compared to the current IDLE state UE power consumption [RWS-210168].
- Low latency: a separate wake-up receiver can wake up devices at any time without long waiting time and still low power consumption

In practical, the above benefits are useful for wearable, e-Health, glass, which are with limited battery capacity and tolerate latency in the level of seconds. Also, in industrial environment, sensors / trackers / actuators which has similar requirements as the aforementioned devices can also benefits from an ultra-low power wake-up receiver.

Technical feasibility

The key factors to achieve low power consumptions, e.g., relies on simple receiver architecture.

For UE side, for example, a simple envelope detector which does not relies on local oscillator, mixer, and simple comparator can largely reduce the power consumptions.

For gNB side, OOK waveform is transmitted for UE envelope detector. Considering current gNB implementation, e.g., OFDM based transmitter, reusing current Tx side signal processing as much as possible should be considered. For example, OOK symbol is constructed by frequency domain subcarrier-level mapping of a sequence, which has been used by IEEE 802.11ba.

From academic and industrial community there were a lot of experience / works / standardizations has been accomplished.

It is mature enough for a study of Almost zero power (AZP) receiver in 3GPP Rel-18.

Potential impacts

The AZP receiver can be applicable for all types of UEs. During the NWM discussion in Rel-18 WS, there were several questions being addressed as follows,

- Measurement, mobility, RRM

  Companies are very much interested in how to solve the mobility issues for such low power UE with wake-up receiver. Our view is that the ultra-low power wake-up is not limited to stationary scenario, others like, nomadic, low-mobility scenario is also considered. And solutions to mobility scenario can be studied in SID work.

  Currently, three options can be considered to address the mobility issue when UE is monitoring AZP WUS,

  - Option 1: no measurement, applicable for certain scenarios for example based on BS type

  - Option 2: relaxed measurement, applicable for certain scenarios based on low mobility and so on.

  - Option 3: design new low power RS for such measurement for RRM, the measurement can be operated by this separate WUS receiver.

- RRC state support

  The ultra-low power wake-up signal/receiver is mainly proposed for reducing power consumption in idle/inactive state.

- "warm-up time" for main radio by wake-up indication

  There is warm-up time, and about 1-2s is expected, including hardware turning on, synchronization, paging reception and etc.

- coverage

  There is a trade-off between power consumption and receiver sensitivity (i.e., coverage). There would be sensitivity degradation if an extremely low power consumption is targeted. We have investigation by system level simulation for at least InH and Dense Urban in [RWS-210168] most UEs can benefits from such deployment.

- cost

  Additional hardware cost is also very important to take into consideration. A simple envelop detector receiver, can be used. From literature, the size of such receiver based on 65nm CMOS can be designed as small as 1mm * 1mm. The chipset cost can be estimated based on the die size. And it is expected that the cost increase is marginal for such a small die size. We can further discuss the cost in the study item.

In view of these, currently we think it is valuable to study the followings for AZP in Rel-18,

- Study and evaluate the receiver sensitivities and possible coverage by considering feasible receiver architecture, e.g., RF/Analog Front-end, with ultra-low power consumptions [RAN1, RAN4]

- Study the wake-up signal design enabling the UE wake-up with ultra-low power consumption and efficient system operation. [RAN1, RAN4]

  - Basic structure of wake-up signal, e.g., On-Off-keying
  - Narrow bandwidth
  - Multiplexing of wake-up signals
  - In-band and/or out-band operation by considering the following
  - coexistence with the legacy signal/channels for in-band operation
  - inter-cell interference

- operation on licensed/unlicensed band
- method to ensure network reachability

- Study the possible procedures to support the ultra-low power UE wake up [RAN2, RAN1]
  - The ultra-low UE wake up feature is configured by the network
  - UE procedure for ultra-low power wake up signal monitoring
  - UE procedure for main radio activity triggered by ultra-low power wake up signal
  - Potential UE state transition

2 – VODAFONE Group Plc

Given the huge difference in the 'normal battery life' (e.g. 16 hours) of an "in-use" eMBB device and its very long 'standby battery life' (probably many weeks), and, the more detailed information in e.g. RWS-210312, it seems better to focus any Rel 18 UE power saving work on RedCap devices.

3 – CATT

UE power saving is one of the most important aspects in the wireless technologies development. The UE battery life will reflect on the user experience in the technologies. The UE power consumption of 5G NR is well higher than that of LTE. The traditional power saving technique specified in Rel-16 and Rel-17 might have very limited space for further UE power saving. If the UE power consumption and battery life for operation in 5G NR is worse that in LTE, mobile phone users would be less interested in using 5G NR technologies. The proposed ultra-low power active device or no power passive device as the wakeup receiver will be the trend of the network operation with extended UE battery life for maintaining the UE access to the NR network . Since UE will not have any activity more than 90% of time during network access, the proposed study of low-power or no-power wakeup receiver had shown tremendous reduction in power consumption during inactivity period of network access. We strongly support the proposed study of ultra-low power active device or no power passive device as the wakeup receiver for extending the UE battery and maintaining the UE network access in NR.

4 – MediaTek Inc.

R16 and R17 has developed UE power saving techniques for connected-mode and idle-mode operations, minimizing the power consumption gap with LTE. While the typical standby/sleep power consumption of NR/LTE is still several mW, **WIFI already evolves to realize standby power consumption of 10 – 100 uW** via a very simple receiver based on on-off keying. In the **emerging (semi-)passive IOT use case, there also requires similar standby power consumption target of 10 – 100 uW**. Considering the above, it is clear **NR is not yet competitive enough to provide "uW" level or lower standby power consumption. To achieve a fundamental leap for NR, R18 can be the release for 3GPP to investigate the possibility of providing "*net-zero power consumption communications*"**.

The possibility can be based on studies over the following two technical components:

- **Ultra-low-power interface and link maintenance**
  - The operational power consumption for DL targets 100 uW (w/o duty cycle), where demodulation **based on on-off keying or envelop detection** would be necessary
  - The interface also include ultra-low power UL. One example is **based on backscatter architecture without the need of local oscillator** and power consuming clock generation
  - **Link maintenance based on the ultra-power power interface will be the key differentiation from WIFI** and allows UE to keep connection with NR network. Efficiency and effective will be the major challenges to investigate.

- **Energy harvesting based on network transmitted signal(s)**
  - State of art energy harvesting is difficult to supply mW operations while feasible to supply uW operations.
  - **Compared with harvesting arbitrary RF signals, direction transmission of designed waveform from gNB can maximize the efficiency of energy harvesting** and enable NR to realize "net-zero" standby power consumption

By integrating the ultra-low-power link design and the designated provision of energy harvesting, it is possible for NR to provide net-zero power consumption for standby and small data operations. If the interface is simply enough, **all NR devices can benefit from such design**. **To investigate this fundamental break-through for NR, a "*R18 UE power saving SI for net-zero power consumption communications*" is therefore recommended.**

5 – Ericsson LM

UE power saving has very much been in focus in Rel-16 and Rel-17. In Rel-18, UE power savings are key focus areas of XR and RedCap. Hence, we see no need for a separate work item for UE power savings in Rel-18.

6 – InterDigital Communications

UE power saving is one of the most important features. We agree that to make NR competitive, very low power radio that can provide extremely long battery life should be studied. A low power wake-up radio similar to the one specified in 802.11ba and energy harvesting are two promising techniques that can be considered.

7 – Futurewei Technologies

We are generally supportive of this direction (e.g., WUR). Clarification of the use cases (UE connective modes, UE types, applications, etc.) and power saving requirements may be needed to focus the study and work.

8 – Motorola Mobility UK Ltd.

In our view, ultra-low-power wake-up receiver based UE power saving can be considered under RedCap WI, if RAN agrees to specify further reduced capability UEs in Rel-18.

In XR, carrier aggregation and dual-connectivity may be used to accommodate high user throughput and reliability. And yet, reduced power consumption by an XR device is desired, which may require further enhancements to existing power saving adaptation mechanism.

In summary, we think different power saving aspects can be discussed in respective RedCap and XR SI/WI.

9 – Qualcomm Incorporated

UE power saving is always an interesting and important topic. However, consider bot idle mode and connected mode power saving have been considered in Rel.16 and Rel.17, we do not yet see a need to work on further enhancements.

Low-power wakeup receiver is certainly interesting, but we don't see the urgency to work on it in Rel.18.

10 – Apple Benelux B.V.

Even though we have UE power saving features in both R16 and R17, it is well known that NR UE consumes much more power compared to LTE UE (not to mention Wi-Fi). It is critical for the end-user experience that we continue improving the UE power consumption, including longer stand-by time.

Low power wake-up signal/receiver has been proposed by some companies as part of RedCap. However, it is a generic UE power saving feature that can be potentially applicable to non-RedCap devices. Moreover, there are many open issues that need to be studied first before specification work starts. The issues to be studied include (but not limited to) wake-up signal design that enables low complexity low power receiver design, considerations on RRM measurements, receiver sensitivity, UE procedures, etc. Therefore, we prefer it to be considered in a separate study item.

There are also other UE power saving enhancements that are being discussed as part of other WIs such as XR/Sidelink. We assume that the baseline UE power Saving optimization discussed as part of the proposed generic UE power save SI/WI would be inherited by XR/RedCap/SL devices. Additionally we think that specific (XR/ SL) power save optimizations would be handled in the corresponding WIs because they are targeting particular use cases.

11 – Guangdong OPPO Mobile Telecom.

OPPO

The power saving of UE can be enhanced in Rel-18. More use case and scenarios can be identified. In lower power consumption case, further lower power wake-up scheme can be considered.

12 – China Mobile Com. Corporation

Ultra zero power WUS is an interesting field to be studied in Rel-18, but one thing we want to emphasize is the introduction of ultra zero power WUS should not impact or has limit impact on the system capacity and legacy UE, since the new OOK-based ultra zero power WUS may occupy much resource to guarantee its detection performance, especially the ultra zero power WUS is mainly used in RRC_IDLE/INACTIVE states. Therefore, the coexistence with legacy UE is an important issue to be studied.

As the relationship with Rel-18 RedCap/XR/SL WI, we think some RedCap/XR/SL specific power saving techniques can be specified in these two WIs separately and the ultra zero WUS can be an independent Rel-18 SI.

13 – China Telecom Corporation Ltd.

UE power saving is an important topic for NR, even thought it has already been focused in Rel-16 and Rel-17, there is still potential work for further enhancement. Ultra-low wake-up receiver has a broad prospect for UE power saving, and can be further focused and studied in Rel-18.

14 – Intel Corporation (UK) Ltd

There might be some more areas for UE power saving enhancements, such as for RedCap. Given the scope is not expected to be large, we do not see the need of a separate SI/WI and do think it can be handled under RedCap directly, if needed.

15 – RadiSys

We think UE Power Saving has scope for further enhancement in Rel 18 for wearables and IoT devices. It is a generic topic and not specific to Redcap or XR. Hence we agree for a seperate SI.

16 – SHARP Corporation

eDRX was introduced in Rel-17 RedCap and it is helpful for power saving. The potential combination of eDRX and other features in Rel-17 and previous releases (e.g. Rel-17 ePowSav, Rel17 SDT) can be studied to save UE's power consumption.

17 – Nokia Corporation

Lots of general UE power saving features and enhancements have been specified in Rel-15, Rel-16 and Rel-17. Therefore, we do not see need for any generic UE power saving enhancements in Rel-18. Instead we see that potential additional UE power saving work should focus on specific use cases/applications and their needs like RedCap and XR related UE power savings. Additionally, we see that it is important to utilize the existing specifications and solutions when studying new UE power savings also all the gains should be shown on top of the existing solutions and avoid unnecessary fragmentation on the market.

18 – NTT DOCOMO INC.

The general issues on UE power consumption has been discussed in Rel-16/Rel-17, and most of them has been addressed. UE power saving for RedCap and XR should be discussed in the respective WI.

On the other hand, the long-term study on new area for further power saving can be considered. The ultra-low wake-up receiver is interesting in order to realize low power consumption with reasonable performance.

19 – CAICT

The ultra-low wake-up receiver is a good direction for further UE power saving. In R18, some study should be considered.

20 – Spreadtrum Communications

For low power WUR, we support have an SI for low power WUR (including almost-zero-power and very-low-power WUR). The separate receiver for low power WUS can relax pressure of UE implementation. We should study signal design of the low power WUS, e.g. OOK, and procedure design of the low power WUS, e.g. serving cell relaxation. Therefore, a separate study item is preferred from our view.

For leftovers of R17, we think we can address the power saving for UL-dominant and/or intensive traffics. The enhancement could be DRX and PDCCH monitoring adaptations in our previous contribution [RWS-210064]. Some companies think it could be discussed in XR topic. We are wondering whether some patterns of the UL-dominant/intensive traffic, e.g. live video, is the same as pattern of XR.

21 – Asia Pacific Telecom co. Ltd

UE power saving is always the import topic for wireless communication device. In previous releases, we have identified several features for enhancing the UE power saving considering different traffic patterns and different scenarios (such as RRC_CONNECTED/RRC_IDLE/RRC_INACTIVE, PCell/SCell, FR1/FR2, etc.). It is worth to further discuss the potential power saving mechanism if there is use case needed. Some power saving issues may be discussed in other WIs to fit their requirements/KPI/QoS, such as XR, SL, RedCap. If there is an individual WI for UE power saving, it is suggested to focus on ultra-low power saving signal/receiver and the corresponding procedure.

22 – ZTE Corporation

We think the wake-up radio (WUR) is an interesting area to be considered in Rel-18 to further reduce UE power consumption on the top of the power saving schemes in Rel-16/17. For the study of wake-up radio, the following aspects need to be considered:

(1)Design of WUR that enables the ultra-low power consumption state including waveform, etc

(2)Impact on mobility management and resource overhead

23 – Philips International B.V.

We think it is crucial to pave the way for **ultra low power devices** (lower energy than NB-IoT). In that sense we would like RAN to:

- Study the RAN impact of supporting **energy harvesting / Passive** IoT devices
- Study the use of **backscattering** techniques to send data
- Study the adoption of **LP-WUS** (Low Power Wake Up Signals) that can be detected by low-power receivers.

This work can be carried out in a SI that would be applicable to RedCap, NB-IoT and eMTC

24 – Sony Europe B.V.

Low power wake up radio

We are supportive of studying low-power wake-up radios/receivers to further reduce UE's power consumption. We also think Mobility and RRM measurement is an important aspect that needs to be considered when designing low-power wake-up signalling. Wake-up radio is beneficial for use-cases where the traffic is relatively low, but the device needs to be reachable by the network quite often. Whether low-power wake-up radio is only to be studied for RedCap or as generic UE features depends on the use-case and FFS.

Objectives

Objective I:

- Study and evaluate low-power wake-up receiver architecture and design trade-offs such as sensitivity, data-rate, bandwidth vs. power consumption
- how to compensate for performance/sensitivity loss, if any

Objective II:

- Study and evaluate wake-up signal designs to enable ultra-low power reception
- How to do the multiplexing of wake-up signal and other transmission types signaling, if in-band transmission is selected

Objective III: Study and evaluate mobility aspects, whether to support only stationary devices or adapt the protocol to also support measurement for ultra-low power wake-up receivers

Objective IV: Procedures to adjust/adapt/extend the current protocol to support ultra-low power wake-up receivers

Support for devices operating on harvested energy

Devices can operate with small batteries or capacitors if they operate on harvested energy. Use of ambient harvested energy is more realistic than operating on energy harvested from the incident RF energy. The issue with operating on ambient harvested energy is that signalling exchanges may be interrupted when the UE runs out of harvested energy and can only restart when the UE has harvested sufficient energy. Hence there need to be protocol enhancements to support operation on intermittently available harvested energy.

Objective

- Protocol enhancements for the support of operation on intermittently available ambient harvested energy.

25 – HUAWEI TECHNOLOGIES Co. Ltd.

1) We share similar view as RWS-210168 that low power wake-up radio is one important aspect that needs to be studied in Rel-18 for further power saving, for e.g. sensors, wearables devices and smartphones. The low power wake-up radio can potentially further reduce the power consumption on these UEs. The study could focus on potential use cases/device types, coverage, potential functionalities carried by low power wake-up radio and the power saving gain compared with Rel-17.

2) Rel-16/Rel-17 UE power saving work items addressed mainly downlink UE power saving. There was some discussion/contributions for uplink power saving by companies in the initial phase of Rel-16, however uplink power saving has not been well addressed in Rel-16/Rel-17. As leftover works of Rel-16/17, some companies proposed power saving for uplink in Rel-18 workshop. We share similar view that power saving for uplink should be addressed in Rel-18.

26 – Panasonic Corporation

We think to study of Almost zero power (AZP) receiver is useful to have the competitiveness of cellular technology. On the other hand, ”measurement, mobility, RRM” related aspects are surely different from WiFi. Therefore, holistic approach would be necessary. The power consumption model is also important as this was one of the reason of difficult discussion in Rel.17 power saving.

27 – China Unicom

We share the same view with many companies that Rel-18 UE power saving is an important feature for all types UE, and AZP is an interesting field to be studied in Rel-18.

1.1.3 Enhancing and extending the support beyond 52.6 GHz

Companies are invited to make proposals or provide their views on potential enhancements for the support of NR beyond 52.6 GHz.

Feedback Form 3:

1 – Futurewei Technologies

We do not see the need to go above 71 GHz in Release 18. About enhancing beyond 52.6 GHz (up to 71 GHz), we also do not see the need as long as the Rel-17 WI finishes.

2 – Guangdong OPPO Mobile Telecom.

In our view, the potential Rel-17 leftovers which may provide extra efficiency on the spectrum usage, should have a high priority, e.g.,

1) enhanced LBT mechanisms, e.g. Rx-assisted LBT if not specified in Rel-17;

2) beam management enhancements;

3) lower processing latency with advanced UE capability;

4) power saving and coverage enhancement mechanisms.

On extending the spectrum beyond 71GHz, we understand the motivation but feel it is a little earlier to start the study in Rel-18. Maybe it can be introduced in a later release.

3 – Huawei Tech.(UK) Co.. Ltd

FR2.2 (52.6-71 GHz)

The scope of potential additional work on NR in 52.6-71 GHz would depend on the progress of Rel-17, for example if time doesn't allow completing support for receiver assisted LBT. In addition, optimizations for coverage were excluded from the Rel-17 WI, so this could be considered in Rel-18 if time allows. In general, we consider that DL and UL enhancements for FR2 in Rel-18 would also be useful in this range and may directly be applicable (or at least could be checked for applicability during the Rel-18 work).

Above 71 GHz

We are interested in extending the supported frequency ranges by 3GPP technologies. A study on frequencies above 71 GHz would need to focus on waveform and numerology, considering both fixed licensed and mobile licensed operation. This would require discussing an extension of 3GPP channel model from 100 GHz to 114 GHz.

4 – Samsung Electronics Benelux BV

In our understanding, "enhancing and extending the support beyond 52.6 GHz" has two sub-topics: 1) Enhancement to extending NR to 71 GHz; 2) New study on waveform for up to 114 GHz.

For the first sub-topic, at this moment, it seems hard to make a judgement on the necessity of enhancement to Rel-17 work on extending NR to 71 GHz, since the WI is still on-going. If the leftover from Rel-17 work on extending NR to 71 GHz is marginal, we didn't see a strong need to develop enhancement in Rel-18, and this sub-topic can be deprioritized.

For the second sub-topic, the motivation of extending NR to 114 GHz, with a potential new waveform study, is still not clear. At least within the timeline of Rel-18, the urgency of such study is not driven by the market. Hence, we prefer to deprioritize this sub-topic in Rel-18.

5 – NTT DOCOMO INC.

FR2.2 (52.6-71 GHz)

It is not very clear to us whether the essential discussion for FR2-2 can be leftovers of Rel-17. Further checking of Rel-17 might help us to assess the necessity of Rel-18 work. Our expectation is that there may be few things which could be leftovers since the recent RAN1 shows a considerable progress. On the other hand, as Huawei pointed out, CovEnh for FR2-2 could be considered in Rel-18 since it is clarified as out-of-scope in Rel-17. If time budget allows, we are open to discuss such leftover issues in Rel-18.

Above 71 GHz

It seems commonly understood that the use of beyond 71 GHz has a good potential to further boost NW performance toward 5G advanced and/or 6G, while it needs some fundamental studies e.g. waveform, channel model, RF transmitter/receiver model. We think the main issue is when to trigger such studies, which could be long-term one. Our view is that it would be surely good to initiate this earlier to have deepen observations. At the same time, whether Rel-18 is really appropriate to trigger this is a little bit unclear. We are open to discuss this aspect.

6 – Qualcomm Incorporated

There are two separate tracks for this proposed work

- FR2-2: 52.6-71GHz enhancement on top of Rel.17 WI
- FRx: 71-114.25GHz introduction.

For FR2-2 work, it might be good to wait for the market to respond to the Rel.17 work to identify the exact areas to further enhance.

For FRx, the regulation and market seems to be not ready yet. Even though we believe 3GPP should eventually move on to extend NR to this new FR, there is no urgency. We should at most start a waveform only study item with relatively low TU to scope out the impact.

7 – Apple Benelux B.V.

- We are supportive of the discussion being split in two (a) a WI for NR between 52.6 GHz and 71 GHz and (b) a SI for NR between 71 GHz and 114 GHz

- For WI on NR between 52.6 GHz and 71 GHz

–We should focus on issues not addressed in current WI. The full scope of the new WI will become apparent by the end of the current WI but a few of the topics that can be considered include (a) coverage enhancements (b) improved channel access and (c) Beam Management enhancements for unlicensed access. RAN4 impact, especially on the UE RF implementation, needs to be carefully assessed and limited.

–With higher SCS that is possible with these frequency ranges, we would like to point out that there are possible data-plane protocol changes needed to adapt to the shorter HARQ RTT times. Some RAN2 specific impact needs to be factored in as well.

- For the SI on NR between 71GHz and 114 GHz

–The first and necessary step is to check global regulatory landscape and to determine whether any region has adopted the related regulatory requirements before proceeding with a study of associated physical layer design, etc.

–There will be a need for a discussion of the specific use cases given the current and future spectrum availability and regulations.

–We do agree that similar to AI/ML and Duplexing, it may be good to start studying new waveforms for this spectrum and how understand how they will interact with the existing NR design.

–The study item should continue for all of Rel-18 and any normative work addressed in later releases.

8 – Intel

<u>Enhancement of NR up to 71 GHz</u>

Motivation/Background:

Release 17 NR extension up to 71 GHz provides baseline feature enablement for 60GHz (unlicensed and licensed) bands. The Release 17 WI targets specification development for general eMBB enhancements but is not optimize various verticals. While Release 17 is not complete (as of this writing) and therefore difficult to all the baseline feature that will be available at end of Release 17. It is likely the following improvements will not be considered (or at the vert least not optimized for) in Release 17.

- lower process latency further (compared to FR2),
- lower power consumption and improve energy efficiency,
- Enhancement to peak data throughput (such as 256QAM, etc)
- Improved coverage

Targets and Objectives:

The following are some suggested potential areas for enhancements for Release 18.

- Lower Processing Latency & Higher Peak Data Throughput: Optimized support for UEs not limited to handheld form factors and handheld device power constraints, with the possibility of introducing more advanced UE capability (compared to what is available in Release 17). Increasing peak throughput by supporting 256 QAM or 1K QAM. Investigation on techniques that could lower implementation challenge barrier for even higher order modulation. e.g. non-uniform constellation, etc.
- Improved Energy Efficiency & Lower Power Consumption: Power efficiency in FR2-2 is expected to be lower than of FR2-1 or FR1. Power saving techniques to further improve power consumption and/or power efficiency could be an interesting area to pursue. Some examples of improving power efficiency is supporting multi-rank DFT-s-OFDM transmission.
- Improved Coverage: Coverage enhancement explicitly left out from Rel-17 WID. Potentially supporting transmissio techniques to combat limited EIRP and PSD enforced by regulatory domains. For example, supporting coverage enhancements based on multi-slot PDSCH/PUSCH scheduling developed for Release 17.

Of course, there could be leftovers from Release 17 work, that had interest from companies but did not get adopted due to lack of time. Some of these could be enhancements to improve robustness to phase noise error, enhancements to DMRS and PTRS to optimize support for multi-slot transmissions and improve performance for high rank and MCS cases, channel access improvements based on receiver assisted LBT, enhancements for beam management targeting use cases with LBT and/or fixed wireless access scenarios, etc.

Lastly, there are areas for expansion and optimized support for the following:

- Positioning: Leveraging extremely wide BW for improved precision and accuracy. A key feature in supporting various verticals.
- Fixed wireless & IAB: Optimizations to better support fixed wireless communication, and IAB. Leveraging much higher EIRP regulatory limits (e.g. in UE mobile links are limited to 40dBm EIRP, while fixed wireless has 85dBm EIRP).
- V2X & ITS: Global harmonized ITS band located at 64 66 GHz. Enablement of V2X/ITS operation in 60GHz band.

However, whether positioning, IAB, and V2X enablement for 60GHz band should be done in the NR up to 71GHz extension or in each respective WI should be further discussed.

Waveform study of from 52.6 GHz to 100 (or 114.25) GHz

Motivation/Background:

E-Band & W-Band are enablers for ultra-wide band spectrum usages for both licensed & unlicensed. While 52.6 GHz 71 GHz has been identified as candidates for future licensed operation deployments in Release 17, it currently lacks actual bands that are approved licensing. Therefore, the primary use case for 52.6 to 71 GHz is to support unlicensed operation (in practice).

Based on this, it is a natural extension to investigate licensed bands that are already available in E or W-bands. The focus should be on enablement of ultra-wideband spectrum for licensed operation.

Additionally, E/W-band and spectrum beyond 90 GHz have been identified as candidates for 6G as they have the potential to provide extreme widebands in the order of 10 GHz or more. Therefore, the study of waveform targeted for E/W-bands can also be leveraged for study of 6G.

Targets and Objectives:

Due to increasing implementation challenge to build power efficient RF components that can support E/W-band, 3GPP should start with a study of appropriate waveform. The target study should be to have NR support up to 100GHz (or even up to 114.25 GHz) with the following objectives:

- A general waveform study for 52.6 71 GHz, including whether existing NR waveforms is appropriate above 71 GHz.
- Investigation into whether existing channel model (TR38.901) that supports up to 100GHz need updates/tweaks.

9 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility:

In our view, enhancing and extending support beyond 52.6GHz should be categorized into two separate topics:

Topic 1: Further enhancements to support NR operation from 52.6 to 71 GHz

Topic 2: Extension of NR operation beyond 71GHz up to 114.25GHz

Following potential enhancements should be considered for Topic1: Further enhancements to support NR operation from 52.6 to 71 GHz:

- Potential Objectives:
  - Coverage enhancements for initial access and UL channels
    - *Note: In the on-going WI in Rel-17, coverage enhancement for NR operation beyond 52.6GHz is not within the scope. In our view, coverage (specially for initial access) could be a bottleneck for operating in this FR and therefore in Rel-18 coverage enhancements should be considered for initial access. Furthermore, existing coverage enhancements for UL should be considered as a baseline and it should be used to determine if any further enhancements to operate NR beyond 52.6GHz are needed or not*
  - Enhanced beam-management with narrower and larger number of beams
    - *Note: In the on-going WI in Rel-17, increasing the number of SSB beams beyond 64 was out-scoped, however, for operating within this FR, it is critical to consider further narrower beams and consequently higher number of beams to fully exploit the beamforming gain. Therefore, increasing the beams and the potential impacts on beam-management procedures should be considered in Rel-18*
  - URLLC in 60GHz unlicensed bands
    - *Note: Currently URLLC WI is specifying enhancements for unlicensed access in a controlled environment. However, the scope is mainly limited to FR1. In our view, as we have agreed to specify directional LBT and no LBT in 60GHz bands, so we expect that for supporting URLLC operations in these bands, further enhancements are needed and should be considered within the scope of Rel-18 WI*
  - Potential leftovers
    - *Note: In our view, considering only two meetings remaining to finish the on-going WI, we expect that some features may not be fully specified. Such features include directional LBT, receiver assistance and long-term sensing for channel access mechanisms for unlicensed spectrum. However, we can further determine the exact scope of the potential leftovers in the next plenary in December.*
- *Note: In our view, the WI for this topic 1 should be considered in Rel-18 regardless of potential SI for topic 2: Extension of NR operation beyond 71GHz up to 114.25GHz*

Following potential enhancements should be considered for Topic2: Extension of NR operation beyond 71GHz up to 114.25GHz:

- Potential Objectives:
  - First and foremost enhancement that should be considered is to study the feasibility of CP-OFDM and DFT-s-OFDM for both DL and UL in this FR beyond 71GHz
    - *Note: In order to perform the feasibility study, identifying the right set of simulation assumption is also important, especially the PN models, PA models, new channel models/parameterization (if needed for FR beyond 100GHz).*
  - New candidate waveforms should also be identified
    - *Note: Applicability of DFT-s-OFDM for DL should also be considered as a starting point*
  - If the need to specify new waveform(s) for either of DL or UL is determined, then we should also identify the necessary impacts on the existing frame structure, DL/UL channels/signals and procedures.
    - *Note: The outcome of this objective can help to identify the objectives for follow-up work (if any) for WI*
- *Note: In our view, only SI for this topic 2 should be considered in Rel-18 and normative could be considered for later releases depending up on the outcome of the potential SI*

10 – SHARP Corporation

Our view is that the work should focus on the following two aspects in Rel.18:
- Further enhancement of FR2-2 functions specified in Rel.17 and left-overs of Rel.17.
- Understanding the required functions and regulations in the frequency band above 71 GHz.

The enhancements should be updated according to the progress of Rel.17 and as needed. Study on frequencies up to 114 GHz is necessary, but considering the time required by standardization work, its priority in Rel.18 is unclear.

11 – Deutsche Telekom AG

We do not see a need to enhance 52.6 to 71 GHz nor to extend NR operation in Rel-18 to beyond 71 GHz.

12 – Nokia Corporation

Similar to other companies above, we see two different aspects to be considered here:

Enhancements for 52.6 – 71 GHz:

- We do not see any important aspects being missing from the ongoing Rel-17 WID that would be worth prioritising in Rel-18
- Commercial interest for further developments in this band also needs to be assessed as part of overall prioritization of Release 18 topics.

Extension beyond 71 GHz:

- While there have been proposals for studies on waveform beyond 71 GHz, several companies have raised the issue that spectrum availability for this frequency range is currently unclear.
- In our view, Release 18 is too early for studies beyond 71 GHz
  - Such frequencies have potential for massive additional capacity in a later release or for 6G

13 – TELECOM ITALIA S.p.A.

We share the view that there is no interest in further pursuing these topics. Maybe we can reconsider them for 7G (yes its a seven :-))

14 – ZTE Corporation

Regarding FR2.2, i.e. 52.6 71GHz, some left-over issues may be considered if there is no time to treat them in the Rel-17 timeframe, such as beam management for multi-TRP, enhancements on BFR and a-CSI-RS, HARQ-ACK for multi-PDSCH scheduled by single DCI, and optimization of channel access aspects on beam-based and receiver-assistant LBT. But we think it is hard to predict at this stage since the WI is still ongoing, maybe it can be revisited after RAN#93-e meeting, in which the progress and scope of Rel-17 is expected to be discussed.

Regarding the further extension of NR beyond 71GHz, we are open to study the waveform, as well as the numerology to be supported for both initial and non-initial access. But the frequency range should be limited to below 100GHz, which can be covered by the existing channel model without extra effort.

15 – Ericsson LM

We have a similar view as Futurewei and Samsung in that we don't see the need for either enhancing FR2-2 or studying frequencies above 71 GHz in Rel-18. Thus, both sub-topics can be deprioritized. A better timeframe for studing the frequiencies above 71 GHz would be 6G when the 3GPP technology has become more mature. In addition, as Qualcomm points out, any enhancements for the FR2-2 range should be done once there is a market demand.

16 – Sony Group Corporation

We think the discussion may be categorized into two parts, which includes the enhancement for frequency range from 52 to 71 GHz and the study of spectrum above 71 GHz. Therefore, the scope of the Rel-18 discussion needs to be determined first. The work on spectrum above 71 GHz may not be urgent but we are open for further discussion.

In general, technics to improve the uplink coverage and data throughput in higher frequencies need to be further investigated. For example, advanced modulation and CSI measurement schemes which can improve the throughput and SNR gain can be studied in Rel-18. Moreover, the leftover issues from Rel-17 can also be considered for Rel-18 works, but the detail scope is pending on the Rel-17 discussion.

17 – Beijing OPPO Com. corp.

We are open to discuss the following enhancements for DCCA in R18.

- Multiple connectivity. We think it make sense to support MR-MC in order to achieve fast SCG change in mobility scenario, which is beneficial to improve the service continuity. While for multiple-layer deployment, we have big concern on UE complexity which needs to be evaluated carefully.
- Fast SCell activation
  - Support SRS in dormant state
  - Support fast addition of SCell to STAG
- In addition, we are also fine to discuss other R16/R17 leftovers in R18.

18 – CEWiT

CEWiT

We Support the study of NR above 71 GHz for lower latency and high data rate applications. Channel models and PN models at the frequencies above 71 GHz to be studied. Study on potential waveforms and numerologies for high frequencies should be performed.

1.1.4 CA/DC enhancements

Companies are invited to make proposals or provide their views on potential enhancements for Carrier Aggregation, Dual-Connectivity enhancements (e.g., MR-MC (Multi-Radio/Multi-Connectivity), etc.).

Feedback Form 4:

1 – Ericsson LM

One objective which relate to CA is the following:

- FR2 Scell scheduling for PUSCH on FR1 Pcell

In the Rel-17 DSS WI it is specified that SCells can schedule the PCell. However, due to a limitation it only works within FR1 (SCell and PCell are both in FR1). However, for improved capacity it would be beneficial to allow FR2 SCells to schedule the PCell in FR1.

Based on this, we are supportive of this objective. However, a potential alternative place to address this is within the Rel-18 DSS work item. We can at a later stage decide if this objective fits in a CA enhancments WI or in the DSS work item, or some other place.

Further, something which was discussed during Rel-16 and is something small which we believe would be beneficial without taking up much of the WG's time is the following. Note that MCG recovery via the SCG is already specified:

- Fast PCell failure recovery via SCell in carrier aggregation.

2 – InterDigital

Though normal assumption is that the CHO is configured based on earlier measurement configurations, with the current CHO, it is not possible to guarantee that the chosen CHO candidate cell is the best cell for the UE at that time. The more candidate cells that are prepared, the less likely we are to experience this problem. However, preparing many cells is very resource intensive. **Thus, it will be beneficial to prevent such scenarios or recover from them as soon as possible (e.g. considering the quality of non candidate cells when checking the CHO triggering conditions, including measurement reports in CHO complete messages, etc.)**

Another issue is related to RLF while monitoring CHO triggering conditions. In rel-16/17, if the UE re-selects to a cell that belongs to one of the CHO targets, it will execute the CHO towards that target. However, if the UE performs a re-selection to a cell different from the CHO target, normal re-establishment will be performed. However, in that case, it is possible that the radio conditions towards one or more of the CHO target cells may have been good enough at that time to serve the UE (at least temporarily) , even though they

are not the best cells for cell reselection. This could specially be detrimental in scenarios like the concerned entity is an IAB node that is serving a multitude of UEs (or even other IAB nodes in a multi-hop scenario). In these cases, there is a strong incentive to prevent the IAB node from performing re-establishments, as that may trigger a cascade of re-establishments of the UEs that are directly connected to the IAB node or even other nodes/UEs further down the path in the case of multi-hop. **Thus, it will be beneficial to consider the prioritization of CHO candidate cells for cell re-selection in case of RLF.**

3 – Futurewei Technologies

We suggest to have a joint discussion on CA/DC enhancements and mobility enhancements and this can happen under the email thread of mobility enhancements.

4 – QUALCOMM JAPAN LLC.

We propose the following item as an enhancement for throughput gain.

- PDCCH enhancements for multi-cell PDSCH/PUSCH scheduling

5 – China Telecomunication Corp.

With the increase of the available carriers, we think CA/DC enhancement is in line with the technical trend and could be one of the essential topics for Rel-18, which can provide operators with more effective network control.

In the RAN Rel-18 workshop, many companies showed great interests in this topic including operators, network vendors, UE vendors, etc.. Potential scopes for CA/DC enhancements proposed in company contributions, including extending MR-DC to MR-MC and some further enhancements on CA/DC.

As network operator, we notice that more 5G frequency bands will be unlocked and 4G frequency bands is gradually refarmed, which bring wider bandwidth, higher throughput and larger capacity for the users. Considering the future network deployment, we think multi-layer overlapping deployment will be a normal behavior. Meanwhile, new applications and services require higher bandwidth and capacity together with higher quality of service and user experience assurance. Therefore, we think it is very important to figure out solutions to provide higher bandwidth and capacity and also guarantee user experience. **Extending MR-DC to MR-MC could be a straightforward and beneficial way.**

Regarding MR-MC, we suggest first discuss the number of simultaneous UL transmissions and DL receptions to balance the UE implementation complexity/ RF capability limitation and network performance. Potential solutions are worth to be discussed including fast SCG activation and UL selective activation raised in several company contributions and also in the previous email discussion of RAN Rel-18 workshop. Besides, from our point of view, other objectives including bearer management, UE capability management, measurement aspects can also be further discussed.

Regarding other further CA/DC enhancements to improve network performance especially for FR2, such as EMR enhancements, Fast SCell activation enhancement and so on, we also think they are worth to be further studied or discussed in Rel-18.

6 – Apple Benelux B.V.

We are okay with Rel-18 addressing the left-over items from the R-17 DCCA WI. However, looking at what is left over in R-17 DCCA, we see that most of it has to do with improving SCG aspects like multiple SCGs with two active cells, other combinations where RAN3 involvement is needed etc. To us, these SN configurations etc can also be viewed from a mobility angle (generally a change is needed due to UE mobility) and so view that these enhancements can be included in the mobility WI. This would help with progress of these topics in an efficient manner.

7 – LG Uplus

Here also we want to see the MR-MC to utilize our spectrum efficiently for now and future where most operators have FR1(low band)+FR1(mid band)+(FR1(high band) or FR2(mmWave)) and EN-DC seems unable to cover all flexibility. Like CMCC said, firstly we can discuss the number of simultaneous UL and DL considering UE complexity.

8 – vivo Communication Technology

We are interested in DC enahncement for fast SN switching/activation when multiple-SN can be configured for the UE, and it is important to keep the currrent assumption that at most 2Tx chain is transmitting at the same time from UE perspective.

9 – ZTE Corporation

CADC enhancements are key to unlocking the opportunities for the operators to exploit a wider range of spectrum. Based on the company inputs in the previous email discussion, we have noted that FR2 is a key target area for CADC enhancements and the following broad objectives can be considered for Rel-18

Multiple connectivity with selective activation

To improve the robustness and interruption time, multi-connectivity with selective activation (e.g. by limiting the number of active CGs to two) seems to be a promised solution, which brings a good balance between the performance and complexity.

- Only two cell groups can be activated simultaneously.
- Only the active cell groups will consume UE capability.
- Prioritize the case where the candidate cell groups share the same security key (e.g. within the same CU/gNB) and the same radio bearer level configuration.

With the similar methodology, the multi-connectivity with selective activation can be extended to CA as well, where multiple SCell can be configured but only few of them can be activated simultaneously, which subject to the UE capability (only the active serving cell will consume UE capability).

Fast role change in CA/DC

To improve the interruption time, fast role change can be considered as well. In case PCell/MCG failure is detected, the SCell/SCG can be change to PCell/MCG accordingly in a more efficient way. With the fast role change in CA/DC, the multiple connectivity with selective activation can be used to improve the mobility performance where multiple PCell/MCG can be configured and only one of them will be activated at a certain time.

Fast failure recovery through SCell

FR2 is expected to be used widely in indoor scenarios. In case CA with multiple FR2 carriers are configured, fast failure recovery through SCell will be helpful to improve robustness of the whole system. With the fast failure recovery through SCell, in case PCell failure is detected, the SCell can be used to recovery

the connection and the RRC reestablishment procedure can be avoided. The Fast failure recovery through SCell can be used together with the fast role change to further reduce the interruption time.

Signaling overhead optimization in CA/DC

With the increasing number of serving cells, the signaling overhead will become larger and larger, and clear requirement on RRC signaling overhead reduction can be observed from the market. The enhancement on this aspect has been discussed as part of CA/DC enhancement in Rel-16. However, due to the lack of time, such feature has been excluded from Rel-16. Considering the use of FR2 in Rel-18, the issue will become worse. Therefore, we think some enhancement on this aspect will be needed. If corresponding enhancement cannot be adopted in TEI17, then we propose to include it as part of Rel-18.

Fast SCell/SCG setup/activation

Fast SCell/SCG setup/activation is another hot topic in the previous email discussion. We think a study phase will be helpful to identify the potential enhancement and corresponding solution. The following aspects can be considered as start point:

- enhancement to EMR (early measurement reporting)
- Support SRS in dormant state

10 – HuaWei Technologies Co.

In our understanding, the CA/DC enhancements are mainly to address RAN1-led enhancements. The useful enhancement we see is the cross-carrier HARQ. This can be helpful to further reduce the latency in URLLC scenarios (we have raised similar comments in URLLC).

We did not see other enhancements which have sufficient gains to pursue. One particular aspect may be the FR2 performance enhancements which is RAN4 specific, and we think this part can be discussed in mobility.

We did not see urgent commercial needs for supporting MR-MC. We have specified various MR-DC options, not mentioning how complicated design and how much time spent on the discussion, the majority of these options is not yet deployed. Thus to further extend this to multiple SCGs seems not urgent. Technically speaking, In R17 RAN has already supported inter-SN CPC in MR-DC case, which can configure multi candidate SNs and let the UE directly access one suitable SN. Alternatively DAPS with DC can also solve the requirement to have fast change between SNs as we also explained in the mobility topic. To support MR-MC, how to handle the TA, security etc. needs significant discussion; and if different DL CG and UL CG are configured as proposed by some companies in the workshop, this even requires forwarding of HARQ or RLC feedback via Xn. The Xn delay will impact the timing and effectiveness of these UL control information.

In summary we support cross-carrier HARQ and prefer to discuss it in URLLC, and we are not convinced yet to support MR-MC within Rel-18 timeline.

11 – RadiSys

We are interested in considering the left over topics of CA/DC enhancement from Release 17 in Release 18.

12 – SHARP Corporation

We think some CA/DC enhancements, for example, DAPS with CA/DC can be discussed on the email thread of mobility enhancements.

13 – Spreadtrum Communications

For CA/DC enhancements, from our perspective, the following aspects can be considered in R18:

□1□RLF enhancement, such as MN/SN role switching

We are fine to support MN/SN role switching. It is beneficial to improve robustness through minimizing RRC reestablishment caused by RLF. In order to achieve this objective, the fast/dynamic switching mechanism can be further studied in the procedure of handover or PScell changing.

□2□Early measurement enhancement for SCell setup

For FR2 deployment, frequent CA/DC cell selection and SCell setup would cause great user throughputs degradations. We think it is necessary to do further study on reducing SCell setup delay. The direct way to do this would be enhancement on early measurement. We may need to do research on the trigger condition for early measurement, which is significant and beneficial to balance UE power consumption and SCell setup delay.

14 – Nokia Corporation

Optimizing CA/DC is important in practical deployments, especially for FR2. A number of companies have expressed positive views for CA/DC related enhancements especially (but not limited) to FR2.

The current CA/DC features have been mostly developed from FR1 perspective. Radio conditions may change more rapidly in FR2 beam based deployments even with low and moderate UE mobility . Thus, measurements performed in idle mode and reported in connected mode may not reflect current environment in FR2 deployments which they do in FR1 deployments due to e.g. longer measurement delays. Hence, further work to improve procedures balancing both UE power consumption, network complexity and reduce setup time of CA/DC is needed.

Additional RAN1-led topics (especially those with limited RAN2/RAN4 impact) can also be considered as part of this WI.

15 – CATT

According to the previous email discussion of RAN Rel-18 workshop, we think the following objectives should be taken into consideration for R18:

- MR-MC: for this objective, considering the UE complexity, more than 2 SCG with at most 1 active SCG can be considered in R18 to achieve fast SCG switch
- T-RS for PSCell: temporary RS for SCell activation has been studied in R17 to fast active SCell, similar mechanism can be considered for SpCell for fast scheduling, e.g. applied for PSCell upon PSCell change, or for PCell upon RRC reestablishment.

16 – NTT DOCOMO INC.

Idle/inactive measurement

- Idle/inactive measurement enhancement for FR2: We are interested in further delay reduction.

- Idle/inactive measurement for non-CA/DC case: This feature would be beneficial in non-CA/DC case for delay reduction. Use cases include distributing each UE to the optimal frequency bands taking into account the measured radio quality etc.

[SCG deactivation]

We should discuss Rel-17 leftovers if any, e.g., further enhancement of SCG deactivation including UE autonomous SCG deactivation to reduce signaling in case of frequent activations/deactivations.

17 – China Mobile Com. Corporation

We also suggest to have a joint discussion on CA/DC enhancements and mobility enhancements.

During the RAN R18 workshop, some companies suggested to support the DAPS operating in the CA/DC scenario, but we think this will introduce significant complexity and require high UE capability, which should be deprioritized considering the potential commercial deployment. Also, we don't have urgent commercial needs for MR-DC, maybe we can study it in R19.

In addition, we have similar feeling with Huawei that the CA/DC enhancements are mainly RAN1-led enhancements.

18 – Lenovo (Beijing) Ltd

1. CA enhancement: Due to Rel-17 WID scope only focusing on two DL carriers within FR1, RAN1 did not study the potential benefits for more than 2 carriers for both UL and DL within FR1 and FR2. According to Rel-17 SI, using a single DCI to schedule 2 carriers can save control resource and reduce PDCCH blocking probability. It is worth studying in Rel-18 scheduling more than 2 carriers for both UL and DL within FR1 and FR2.

Furthermore, due to multiple carriers scheduled by a single DCI, the DCI payload size may be quite large if TDRA/FDRA are independent for each scheduled carrier. To guarantee a reasonable DCI payload size and keep "3+1" DCI size budget, two-stage DCI for CA enhancement is supported as two-stage SCI in Rel-16 V2X.

2. MR-MC enhancement: In real implementation, SN often uses FR2 to provide high data rate with the cost of less coverage. It's likely that the UE is under the coverage of the same MN while might change PSCells (intra or inter SN) frequently due to mobility. To reduce the interruption and improve the service continuity, it's considered beneficial to provide UE with multiple PSCell/SCG configurations in advance, and the switch between those candidate PSCells/SCGs can be more dynamic with less interruption compared to legacy PSCell change. As start point, it's suggested to assume the legacy UE capability (e.g. 2 tx chain, 2 rx chain), intra-SN scenario, and take into account the outcome of feMIMO L1/L2 centric mobility.

19 – Samsung R&D Institute UK

We believe that MR-MC with more than two cell groups is essential for Rel-18. We see MR-MC will bring two major benefits to operators:

(1) peak throughput enhancement by aggregation of multiple gNBs/DUs/FRs/RATs

(2) mobility enhancement by fast switching of nodes.

Dual Connectivity (DC) allows only one non-ideal inter-node interface between non-co-located nodes. Considering operators have multiple frequency bands (800 MHz, 3.5 GHz, 28 GHz, >52 GHz, etc), multiple DUs and multi-RAT (LTE and NR), aggregation with 2+ non-ideal interface are inevitable. Aggregation by CA always requires ideal interface which is cost-inefficient and is not always feasible. Thus, we believe MR-MC is an easier extension.

Since more than two uplink transmissions may have uplink power shortage, the enhancements needs to take the current assumption of at most two uplinks at the same time as the starting point. On the contrary, downlink does not have any UE power problem, so more than two active cell groups can be fine to increase the throughput. The number of active cell groups can be dynamically changed depending on the required downlink throughput for a UE. Such dynamic change can be also used for user mobility.

In our view, we see the following features are necessary for Rel-18 MR-MC:

- Supporting more than two cell groups (more than two nodes)
- Defining switching mechanism of active DL/UL cell group
- Enhancement on RAN interface design for inter-node coordination

20 – KDDI Corporation

1. We also think that MR-MC with more than two cell groups would be beneficial, since the solution is applicable to the scenarios where operators cannot use Carrier Aggregation due to network deployment constrains.

2. We also see benefits on improving SCG aspects like multiple SCGs with two active cells, especially beneficial to FR2 secondary cells. We also share the view with other companies that those improving SCG aspects can be considered as a mobility enhancement and we should have a joint discussion with mobility enhancements.

21 – MediaTek Inc.

Regarding multi-connectivity

We believe that capacity improvement target can be achieved by 2 legs/CGs with CA. Supporting simultaneous 3 or more legs/CGs seems not necessary, and we have strong concern on the significant UE complexity (also standardization complexity) increment for 3 or more active legs/CGs.

Regarding fast SN switching with single active SCG

There seems good support on this direction from last RWS. We are supportive to reduce the interruption of SCG change. There is some overlapping with handover improvement. We suggest to develop fast SN switching as part of R18 generic mobility enhancement that can cover both MN and SN and combine the design of fast inter-cell beam switching.

Others

We believe that latency improvements could be done by following small enhancements

- Multi-carrier scheduling (single DCI to schedule multiple cell)
- Fast retransmission via another leg using spilt bearer
- Cross-carrier HARQ

22 – TELECOM ITALIA S.p.A.

The topic is important for the reasons provided by other operators. We think that UL optimizations are also required

23 – Intel Corporation (UK) Ltd

To reduce the switching interruption, and also improve the reliability, it would be good to use fast cell group switching to support following scenarios:

- Switching of PCell;
- Switching of PSCell;
- Switching between sPCell and SCell;
- Switching between PCell and PSCell;

- Intra/inter-DU;
- More than two cell groups, e.g. three

A basic framework for L1/2 triggered CHO/cell switching and RRC involved HO procedure should be used, e.g. to have preconfigured target/candidate cell (group) configuration, and then the UE will do the switching (e.g. bi-direction) based on network request(e.g. L1, L2 or RRC signalling) or preconfigured condition. It can reduce the latency, and also improve the reliability.

To support the preconfigured Cell groups for MR-DU case, more than 2 legs should be supported. To reduce the UE complexity, we considered fast cell group switching with only one activated cell group at a time, i.e. although multiple legs have been configured for the UE, but only MCG and activated SCG are used. Rest Nodes are not activated although have been configured.

Our preference is that this should be discussed under Rel-18 mobility WI, i.e. under [RAN93e-R18Prep-03] Mobility Enhancements.

1.1.5 Flexible spectrum integration

Companies are invited to make proposals or provide their views on potential enhancements for flexible spectrum integration.

Feedback Form 5:

1 – VODAFONE Group Plc

1) Efficiency improvements for bands below 2 GHz would be commercially valuable.

2) The ability to reconfigure some bands to be uplink-only might provide uplink enhancements that are more economic than the new duplex modes discussed in email thread 11.

Specific areas for study include:

a) 'flexible spectrum access' described in slide 6 of RWS-210436;

b) control channel overhead reduction concepts in RWS-210147

2 – Futurewei Technologies

We are supportive of the work for flexible spectrum integration. Potential benefits include downlink control/signaling overhead, accelerating carrier/spectrum access/utilization, UE power saving, etc.

3 – NTT DOCOMO INC.

This looks beneficial to us, while it is not very clear what kind of solution(s) we will focus on to work on this. It may be necessary at first to have common understanding of how to realize the spectrum integration, e.g. extending CA framework, or introducing new design.

4 – QUALCOMM JAPAN LLC.

In this item the following proposal can be relevant. But we put the same proposal in 1.4 "CA/DC enhancements" as we think the proposal better fits in there.

- PDCCH enhancements for multi-cell PDSCH/PUSCH scheduling

For other proposals related to efficient utilization of spectrum, we are hoping RAN email discussion will looking into them from the view point of practical specrum situations/issues rather than directly discussing the proposed solutions. There can be other simpler ways to resovlve the identified problems.

5 – Apple Benelux B.V.

We would like to clarify the following aspects:

1) with flexible spectrum access, is there any impact on UE implementation? Will the UE be required to support more active RF chains simultaneously, especially for the transmitter? As UEs need to support so many bands, CA/DC band combinations, our preference is to limit any additional RF complexity.

2) The key difference/benefits as compared to the current CA/DC scheme. In other words, is it possible to enhance the CA/DC design to achieve such benefits?

6 – LG Uplus

Interesting area while also like Docomo, still unclear about the solution itself and impact to existing working process and band system. (Also discussing technical solution is not the main focus of this week's discussion from the guidance of Chairman.) This area seems more general way of SDL or SUL.

7 – vivo Communication Technology

For flexible spetrum access, we would be interested to consider anchor carrier concept in NR IDLE UE (common control channel transmitted in anchor carrier), for the scenario with scattered carrier with narrow bandwith in low bands.

8 – China Mobile Com. Corporation

We are supportive for Flexible Spectrum Integration for all RRC states.

For Idle and Inactive mode UEs, different duplex types of carriers or multiple carriers can be combinate into one single cell. System information of the cell, as well as paging message, can be broadcast only in one of the multiple frequencies, i.e., so called anchor frequency. And all the frequencies can be chosen by UE for initial access. For instance, after UE receives paging message from the anchor frequency for a MT service, UE can initiate RACH procedure on any of the UL frequencies. The benefits are coverage improvement, flexible usage of spectrum and to allow flexible paring of DL and UL frequencies.

For Connected mode UEs, BWP like behaviour can be used for flexible scheduling between multiple frequencies. The legacy L3 handover is replaced by BWP switching. The benefits are simplicity of cell management and fast switching between frequencies.

Flexible spectrum integration can achieve flexible UL/DL decoupling for idle/inactive/connected state, which can improve UL coverage, allow better and more flexible usage of spectrum and allow flexible paring of one DL and one UL carrier.

9 – CAICT

we support this works in R18 for improving the access performance over several seperated spectrum. The solution could be clarified further.

10 – Spreadtrum Communications

Generally we are fine to have some research on flexible spectrum utilization or integration, to achieve overhead reduction and efficiency improvement. We shared the same view with some proponent companies that the continuous inter-band from refarming 2G/3G band shall be the main use case, to avoid to cause impact on legacy UEs. Regarding how to integrate multiple frequency spectrum: single cell, and/or multiple cell,

in our understanding, both them could achieve the same functionality. Either one is enough. With what we have said, at current stage, we are open, and more study and evaluation are needed.

11 – CATT

We support flexible spectrum integration for more efficient utilization of scattered spectrum. Serving Cell over Multi-Band (SCoMB) as discussed in RWS-210402 could be a potential solution by integrating multiple carriers or BWPs within a frequency band or across multiple frequency bands as one serving cell. It can potentially bring the following benefits:

- less overhead of common signals/messages
- less DCI overhead
- fast carrier switching
- simplified/better mobility management
- flexible utilization of spectrum
- flexible carrier selection for random access procedure

12 – China Telecommunications

We see the importance of accommodating flexible spectrum integration in Rel-18 from operator perspective.

The main purpose of flexible spectrum integration is better and more flexible usage of spectrum, especially for the discrete spectrum re-farmed from legacy RATs. Two key characteristics of these spectrum to be considered:

1) Usually these spectrum are rather scarce and with narrow channel bandwidth.

2) The total number of bands/carriers is large when adding the new NR carriers and re-farming carriers together.

For the scope of this topic, we think at least the cell management and overhead reduction are worth to be highlighted according to majority companies' proposals in the workshop.

1) Cell management:

For multiple cells of CA, enable flexible configuration of downlink and uplink physical carrier for one cell in one or multiple frequency bands.

For single cell, specify single cell mapped into non-contiguous bandwidth of one or multiple frequency bands, subject to aggregated cell bandwidth no more than Rel-17 maximum carrier bandwidth per cell.

2) Overhead reduction:

Combine PDCCHs from multi-carriers and allocate in one of carriers

Simplify SSB designation to allocate in one of carriers

For the UE implementation aspect as asked by Apple, we can limit the number of concurrent/active transmitters based on practical UE implementation.

13 – Lenovo (Beijing) Ltd

We are supportive of this feature due to the overhead reduction gain from using one of the integrated carriers for transmitting common control signaling and scheduling the integrated multiple narrow carriers via a single DCI.

14 – Deutsche Telekom AG

We support flexible spectrum integration as part of Rel-18 work in order to allow operators full flexibility with their spectrum holdings and flexible deployments. Especially we suport a full decoupling of UL/DL bands as illustrated in slide 11 of our contribution RWS-210032. We see especially benefits in UL improvements and ressource optimisation if this flexibility can be applied without any CA. Also for low cost reduced capability devices (REDCAP) this can significantly improve the (UL) coverage and thus user experience (e.g. trackers, smart watches etc) in rural areas.

15 – MediaTek Inc.

We believe one of the motivation here is to have efficient spectrum utilization. So, based on current CA architecture, we could have enhancement on multi-carrier scheduling. The scalable cross-carrier scheduling could be discussed in DCCA enhancement. For flexible spectrum integration, it is indeed an interested idea. However, it is still unclear why re-modeling could improve the efficiency. We suggest to discussion the specific enhancement together with other DCCA proposals.

16 – Ericsson LM

We agree with DoCoMo that the solutions are not very clear. We also believe that it is necessary to reach a common understanding on how to realize spectrum integration, e.g. investigating improvements in extending CA framework, or introducing a new design where key differences and benefits are studied and compared. It is also important to investigate whether the solution is non-backward compatible, which should be avoided.

As also pointed out by Qualcomm and Apple, it is important to understand what enhancements to CA can achieve.

17 – Huawei Tech.(UK) Co.. Ltd

We have seen commonalities in various companies' proposals (e.g. RWS-210441) to the Rel-18 workshop for improving the efficiency of operation with multiple bands, both for initial access and for connected mode. The starting observation is that so far, overhead increases with each new carrier since most of the control and signaling needs to be provided for each carrier independently.

For connected mode, control and signaling overhead could be reduced significantly and user perceived throughput increased by:

- common control signaling (one PDCCH scheduling multiple cells)
- common synchronization signals in one band applicable in neighbor bands (such assumption to be ensured/signaled by the network transmission)
- common SSB/SIB provided in one band instead of being broadcasted in every band (this is at least beneficial in greenfield deployments for NR)

In addition to the above benefits of overhead reduction and user perceived throughput, the improved multi-carrier/band operation can also reduce the UE PDCCH monitoring complexity and achieve the benefit of UE power savings.

For initial access, benefits were identified in proposals for flexible UL/DL bands decoupling (e.g. RWS-210032, RWS-210334), where DL and UL used for initial access by a UE could be in different bands for improving uplink coverage and load balancing, with sufficient network control over which UL bands are available for initial access linked to a DL band.

Note that for both initial access and connected mode, it is more efficient to model the multiple carriers/bands as a single serving cell, rather than multiple serving cells using the existing CA framework. The spectrum resources on the multiple bands can be viewed as different BWPs within a serving cell, instead of different serving cells in the CA framework.

The high level objectives may include the following:

Specify mechanisms for configuring one cell over multiple carriers from one or multiple bands [RAN1/2/4]

- **For operation of initial access, support flexible indication of associated UL carrier(s) to perform initial access**
- **Support multiple active DL&UL BWPs in the serving cell for a RRC_CONNETED UE where each BWP is mapped within a carrier of contiguous bandwidth**
- **Support single PDCCH scheduling PDSCH/PUSCH over multiple BWPs within the serving cell**

18 – Samsung Electronics Co.

Further clarification would be helpful such as:

1) It could be categorized under CA/DC enhancements.

2) The target scenario also needs to be clarified, e.g., whether it is only for FR1 low band operation.

3) We wonder the implication on both UE and BS implementation.

4) Is there any regulation issue?

5) RAN4 impact?

19 – ZTE Corporation

First of all, it would be good if companies can align the understanding on the motivation to have spectrum integration. Based on that, companies can then further discuss potential solutions for it.

From our perspective, some of the main motivations to have flexible spectrum integration are the following.

- 1) Support UL heavy traffic, especially for asymmetrical traffic (light DL traffic with heavy UL traffic). Currently, the existing CA framework can already support high DL traffic load scenario and high DL&UL traffic load scenario, however it cannot support high UL traffic load scenario well.
- 2) On-demand fast UL carrier & DL carrier activation/deactivation to adapt to traffic with different requirements. To support this, UL carrier and DL carrier decoupling is needed.
- 3) Overhead reduction for multiple fragmented spectrum with small bandwidth
- 4) Configuring more candidate DL/UL carriers than its UE capability, i.e., faster/flexible spectrum access to improve UL data rate and load balance, low latency in complementary TDD

- 5) Multicarrier load distribution for IDLE/INACTIVE UE (e.g. avoid the PRACH/Msg3 collision)
- 6) gNB/UE power saving for network/UE configured with multiple carriers
- 7) Efficient switching of the carrier for SSB/SIB/Paging for load balance

Some companies also mentioned about motivation of mobility enhancement in this topic, but we suggest to put all the mobility related discussion under mobility enhancement WI to avoid confliction.

Companies need to first evaluate and justify the motivations above. Once companies have the same understanding on the motivations, then RAN can discuss the potential solutions to satisfy the selected motivations.

Based on our understanding, most of the motivations can be satisfied by enhancement on top of the **existing CA framework**, which can reduce the specification impact and implementation impact. For example, as discussed in our Rel-18 workshop contribution (RWS-210479), flexible association of DL and UL physical carrier based on CA framework can satisfy at least the first two motivations above.

20 – China Unicom

We share common views with several operators, e.g. Vodafone, CMCC, DT, CT.

We support to have an individual Work Item on this topic to fulfill operator commercial deployment demands, to improve spectrum utilization efficiency across multi-bands ranging from low-frequency band, mid-frequency band, and high-frequency band. We are also supportive for Flexible Spectrum Integration for RRC_*IDLE, RRC*_INACTIVE and RRC_CONNECTED states.

It is proposed that the potential solutions should focus on control channel overhead reduction, flexible spectrum access, supporting multiple bandwidth as a single carrier, UE power saving, etc.

21 – Guangdong OPPO Mobile Telecom.

We'd like to understand flexible spectrum integration more. The difference and benefit from CA/DC based enhancement is not clear for us. In addition, whether there is new requirement in UE RF design, in other words, whether current UE RF design can be reused directly. From perspective of UE vendor, we do not expect any impact on hardware, especially for RF design.

22 – Nokia Corporation

As commented by several companies, we see the key aspects being proposed as something that should be achievable in the CA framework and **should be considered under CA/DC enhancements**, where the targeted use cases currently not possible should be identified with the expected benefits those use cases are potentially bringing. After this is should be possible to either integrate the solutions addressing the beneficial use cases either to CA/DC framework or to a separate SI/WI.

It is also important to separate

- enhancements that are related to HW implementation related aspects (need for SSB or other sync signal in every DL band/carrier, need for a DL sync signal on a band/carrier where UL is transmitted, latency and need for sync signal for activating a cell/carrier, etc), where 3GPP can define requirements and eliminate unnecessary signals if the UE support can be anticipated. Also, as noted in R18 WS, things such as SSB-less cell and SSB-less BWP exist in Rel-15, and could be leveraged further in CA enhancements.
- enhancements related to management of multiple cells/carriers, such as flexible selection of the initial access carrier or mapping DL and UL carriers from different bands together (both having some potential implementation implications as well)

There were a lot of potential usages and benefits listed in the different proposals seen in the R18 WS as well as in the comments posted to this NWM document. Many of the uses were somewhat unclear on why a major overhaul on the CA framework would be necessary. Many of those potential benefits would need to be investigated, substantiated and further categorized on what the foreseen specification implementation implication is rather than taking the complete overhaul of the CA framework as a starting point that justifies itself.

1.1.6 RIS (Reconfigurable Intelligent Surfaces)

Companies are invited to make proposals or provide their views on potential enhancements for RIS (Reconfigurable Intelligent Surfaces).

Feedback Form 6:

1 – Xiaomi Communications

First, the application scenarios should be clarified and the gain from RIS should be evaluated in above scenarios. Considering compatibility to legacy UEs, RIS is expected to be transparent to UE in Rel-18.

2 – KT Corp.

KT would prefer to have RIS included in the scope of Rel-18 Smart Repeater SI/WI which is currently categorized as Topological improvement. IAB should be separately treated with repeater and RIS should be included in the repeater discussion.

3 – Futurewei Technologies

We think RIS is premature as a commercially viable solution. At least, extensive study (on modeling, feasibility, etc.) needs to be conducted before specific standards work.

4 – China Telecommunications

We think RIS is a promising technique which may be beneficial for coverage, EE etc. We think at least the following issues can be studied: RIS modeling, channel modeling and control mechanism.

5 – Qualcomm Incorporated

Even though RIS is an interesting topic, we don't believe it is mature enough for immediate consideration.

6 – NTT DOCOMO INC.

We are open for RIS. While we agree it could be promising, we are not pretty much sure if it is mature already. It is not very clear either what is the difference from smart repeater included in topological improvement. If we start working on RIS, the following should be studied, e.g. Definition/classification of RIS, study on use case(s), expected gain, required functionality(es), spec. impact.

7 – Apple Benelux B.V.

We are open to a RIS SI. Potential scope can include: (1) identifying the interesting use cases and application scenarios, for example, coverage extension, throughput improvement etc. (2) channel model study (3) signaling enhancement to support RIS

8 – Samsung Electronics Benelux BV

Reconfigurable intelligent surfaces (RIS) is a new technique to improve coverage and capacity for FR2. In our view, RIS is premature technique and it requires more studies. RIS can be standardized in the later release or 6G.

9 – vivo Communication Technology

We are interested to consider RIS study, the potential study scope may include the use cases, and channel modeling. We believe there are common aspects between RIS and smart repeaters, therefore how to manage the study of these two techniques should be further considered.

10 – Ericsson LM

Ericsson also believes that RIS is an interesting area to look into. However, there are good reasons not to start the standardization work already in the Rel-18 timeframe. The area of RIS is currently in an intensive research phase and standardization may end up obsolete before or shortly after being finished. For that reason, we think that RIS should instead target the 6G timeframe and until then already specified solutions such as IAB can be used.

11 – Huawei Technologies France

We think RIS is a promising technique to improve coverage and enhance performance, but the maturity of this technology is not there yet to start a Rel-18 project on it.

12 – Telia Company AB

We see that RIS could be interesting topic for later releases after Rel-18 work and could be aligned with 6G studies and research activities and if there are potential market requirements that support standardization work in later releases.

13 – MediaTek Inc.

RIS is an interesting technology to enhance coverage for FR2 and higher frequency bands. However, this technology remains on research and feasibility study phase so, from our views, it is pre-mature to go for standardization works in Rel-18. Consequently, we prefer to postpone the related 3GPP works to later releases or 6G.

14 – ZTE Corporation

We are supportive to initialize the RIS related study in Rel-18 since strong interests as shown by multiple companies including operators in last WS (e.g., ZTE: RWS-210465, CU: RWS-210390, KT: RWS-21O361). In our views, the maturity and benefits of this technique is justified by both simulation and field measurement (e.g., from both industrial and academic). For example, the impacts on the adjacent channel can be alleviated by the joint optimization via frequency selective materials and beam design.

In addition, we also share the views as other proponents that a short study phase is needed to conclude the evaluation methodology including channel model, scenarios. And wr.t the technical enhancement part, due to the certain similarity between RIS and smart repeater, joint design on the side control can be considered.

15 – CATT

In recent years, RIS has been widely analyzed and there are many platforms to verify the performance of RIS. It is an attractive technology. In order to apply RIS in NR systems, many issues are to be investigated.

For example, the maturity of the manufacturing and industry of RIS devices, the deployment scenarios, the channel model, the control of reflection elements, the advantages and disadvantages of RIS compared to relay and repeater, the functionality of the passive RIS/active RIS, the interference raised by RIS, etc.

16 – Deutsche Telekom AG

We think RIS are still far way from commercial applicability.

Hence we do not support a RIS SI or integration of RIS in any other Rel-18 work.

17 – China Unicom

We think RIS is a promising technology to improve network performance, especially for 5G network coverage enhancement, capacity boosting, etc. The significant performance gain has been verified from 5G RIS field tests in C-band and mmWave. So we supprt to start a R18 RIS SI. The potential scope of this study item shall include identification of typical scenarios, channel modeling, system performance gain evaluation, co-channel interference avoidance/mitigation, mobility issues, etc.

18 – Sony Group Corporation

During the pre-Rel18 workshop discussions, companies discussed the suitability of deploying RIS for correcting coverage blind spots, expanding cell coverage, enhancing throughput and MIMO rank, improving edge user experience, and using transmissive RIS for improving O2I links. Some companies provided simulation results and shared highlights from initial measurement campaigns with RIS. Meanwhile, ETSI has kicked-off a new ISG on RIS. Because of all of this, we believe the Rel18 time-frame is adequate to start an SI on reconfigurable intelligent surfaces. Such an SI may include the following items:

- Determine deployment scenarios and use cases relevant to RIS. In our view, at least one indoor and one outdoor deployment scenarios should be included in the SI, for both FR1 and FR2 frequency ranges.
- According to feedback from several companies during the pre-Rel18 workshop discussions (RWS-210654), enhancements to the 3GPP channel model might be required for proper evaluation of RIS. The following list of items can be used as a starting point:
  - Simulation scenarios and network layout
    - Indoor and outdoor scenarios for frequency ranges FR1 and FR2, according to bullet 1 above.
  - RIS device modeling
    - Sizes and topologies under consideration.
    - Radiation pattern of unit cells, codebook design, polarization properties, amplitude/phase shift quantization, state-dependent radiation efficiency.
  - Propagation aspects
    - Whether near-field and spherical-wave propagation effects need to be modeled.
    - Modeling of gNB-RIS and RIS-UE links, including association of paths in delay-angle, pathloss, NLOS/LOS, large-scale parameters (DS, AS, SF, K).
    - Modifications to statistical channel models, e.g., CDL models, to account for RISs deployment density.

Many companies have commented (RWS-210654) that the following aspects show quite some overlap between RIS and smart repeaters. In our view, and in the view of several other companies, they should be studied jointly for RIS and smart repeaters in the same SI:

- gNB-smart repeater interface. Although, broadly speaking, the concepts of RIS (controllable reflections) and smart repeater (amplify-and-forward) are different, many companies have pointed out commonalities when it comes to the design of the interface between the gNB and the RIS/smart repeater (RWS-210654). Functions typically associated with this interface are time synchronization, UL/DL split information, spatial information for beamforming, bandwidth and frequency response configuration, and power control. Which functions are common to RIS and smart repeaters, and which ones are specific to either of them? How to design as common as possible an interface?
- Beam management. At least the mechanism enabling beam acquisition and refinement of gNB-RIS/smart repeater and, specially, RIS/smart repeater-UE beams should be considered. The legacy mechanism can be used as a starting point. Due to the potentially large number of beam combinations, enhancements of the RS measurement and CSI reporting mechanisms to improve network efficiency and reduce feedback overhead can be considered. Similar enhancements to beam management may also be needed for the RACH procedure.
- Interference management. Some companies have expressed concerns that the deployment of RIS and/or smart repeaters by one operator may deteriorate the performance of nearby networks deployed by another operator. More specifically, some companies worry about unwanted reflections by RIS of signals outside the intended band of operation, i.e., in neighbouring bands allocated to other operators. The interference issue may be even worse for smart repeaters as these devices make use of active amplification. Interference-related issues from RIS/smart repeaters should certainly be discussed.

19 – Philips International B.V.

Given the huge potential of RIS, Philips considers it important to start studying RIS usage in NG-RAN already during release 18. As a first step, several application scenarios of RIS for Rel-18 and beyond can be defined, from which a sub-selection can be made that is feasible to study in more detail in the Rel-18 scope.

20 – Motorola Mobility UK Ltd.

Lenovo/Motorola Mobility :

In our view, significant study is needed to better understand and characterize the modeling of RIS including channel model impacts and practical RIS hardware constraints. Use cases and deployment scenarios need to be identified and gain/merits of different RIS architectures including passive and active surfaces relative to other techniques (e.g., smart repeater) need to be assessed. RIS is a promising technology but with many open questions, and a topic that would require much input from RAN4, so we think it should have lower priority compared to other SI proposals in Rel-18.

21 – Intel Corporation (UK) Ltd

In our view RIS is an interesting topic to look at. However, from our point of view support of RIS will require extensive cross-WG studies in terms of performance analysis to assess the performance and cost benefits of RIS as well as implementation feasibility and target characteristics. The following aspects shall be studied to assess the benefits of RIS:

- Identify candidate RIS deployment scenarios (e.g., operator or user deployed; FR1/FR2)?
- Identify feasible RIS design and parameters (e.g., RF characteristics, beamforming characteristics, etc)
- Identify RIS specific channel modeling methodology based on measurement data
- Study RIS performance comparing to conventional RRH, IAB and (smart) RF repeater deployments

- Study RIS impacts on other operators deployments (adjacent channel)

The expected scope is quite large for Rel-18 and will affect multiple WGs. We share views from the companies that it can be premature to consider RIS in Rel-18.

22 – CEWiT

In our view, RIS is an interesting topic and can be used to increase coverage. We feel that it is similar to smart repeater with far lesser capabilities. Thus, it can be studied along with smart repeater. The study can be focused on

- Deployment scenario
- Channel Modelling
- Evaluation to find out advantages

23 – KDDI Corporation

We expect RIS to be effective in FR2 in eliminating propagation loss due to blockages and expanding the number of MIMO layers. The potential study can be started with a discussion of use cases and channel models. We also believe that RIS has some aspects in common with smart repeater, and it should be considered how to study and specify these two technologies.

24 – Rakuten Mobile

We believe that commonality between RIS and Smart Repeater's end at scheduling/Beam co-ordination.

Important area of interest for RIS are Propagation Models, Material Types, Beamforming control and beam-forming techniques, Usage scenarios , Interference control.

1.1.7 Others (RAN1-led)

This subsection is to be used for companies to make proposals or provide their views on other RAN1-led enhancements that cannot be categorized into one of the above topics.

Feedback Form 7:

1 – BOUYGUES Telecom

Proposal: DSS Enhancements

DSS is one key feature for the operators in order to ease the swap of LTE to NR and will continue to remain so for the next years.

Bouygues Telecom believes that the kind of enhancements as proposed in RWS-210308 should be part of release 18. In particular, NR PDCCH capacity improvement and LTE-CRS interference cancellation are needed Thus, for the later we can already observe its negative effect on commercial implementation, while the NR PDCCH capacity shortage is expected to occur with the gradual load increase of NR.

We strongly believe that among the overall topics that are mentioned for release 18, DSS is likely to be one of the most deployed feature and it would be not a happy choice to stop any improvement at this point in time.

2 – Beijing Xiaomi Mobile Software

The Radio recognition technique (which is currently also discussed in SA (called as (wireless sensing))) mentioned in RWS-210086 and RWS-210087 is to allow either the gNB or the UE to obtain the coordinates/speed/movement etc. of the reflective objects, by measuring the echo signals reflected by an object which does not transmit the radio signal. From our understanding, a study phase is probably required to select a proper sensing technique or sensing entity in Rel-18, before specifying the details of sensing technique in RAN. The study phase can be done at RAN1 or RAN.

In Rel-18, the sensing work in RAN could include the followings:

1) Study phase: (RAN or RAN1)

a. Determine the scenarios/use cases for sensing.

b. Select the sensing technique which is to be specified from a list of candidates.

c. Determine whether the measurement of echo signal is performed by gNB and/or UE.

2) Specify the selected sensing technique in RAN. (depending on the outcomes of the study phase)

3 – VODAFONE Group Plc

Proposal: DSS enhancements

The lifespan of GSM IoT devices shows us that LTE IoT devices will probably be around for decades! This will make it difficult to turn off LTE transmissions and hence DSS sites may be needed (on e.g. sub 1 GHz bands) for a very long time. Hence techniques to maximise NR/LTE "cell" sharing efficiency are important! RWS-210308 described some potential enhancements, and we believe that the following would be useful:

- enabling DCI based dynamic adaptation between different CRS rate matching patterns to improve NR PDSCH reception (when LTE-CRS is a dominant source of interference)
- allowing NR PDCCH in symbols with LTE-CRS to improve NR PDCCH capacity (when LTE-PDCCH is lowly loaded).

4 – Telia Company AB

Telia Company has similar view as Vodafone regarding DSS enhancements for Release 18 work.

Telia Company believes that DSS enhancements should be important part of Release 18 and should be included as integral part of NR&LTE development path in 3GPP RAN. Telia Company is now actively implementing DSS in commercial networks, so we see that DSS development should not stop to Release 17. Telia Company supports DSS enhancement proposals described in document RWS-210308.

Telia Company would like 3GPP RAN to prioritize DSS enhancements in Release 18 discussions and work plan.

5 – Ericsson LM

As mentioned by several operators, DSS will continue to exists in networks for years to come. In order to further improve DSS operation as the traffic load shifts more and more to NR, we see the following enhancements as needed:

- Support DCI based dynamic adaptation of rate-matching around LTE CRS pattern(s)
- Support NR PDCCH reception in symbols overlapping with LTE CRS

- Support FR2 SCell scheduling PDSCH/PUSCH on FR1 P(S)Cell

6 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility:

Sensing

Considering the ongoing discussion related to wireless sensing in SA WG and the wide range of applications that can benefit from sensing, we share similar view as Xiaomi to consider a potential RAN level study in NR Re-18. In our view, radio sensing, as a first step, can focus on the aspects of sensing-aided communication enhancements to enhance system performance.

A potential promising radio sensing use-case could include blockage detection/tracking to avoid/minimize beam failure events. Especially, with URLLC applications, the proactive/preventive measures for beam failure avoidance that sensing can provide could be quite beneficial.

A Rel-18 RAN-level radio sensing SI can be considered to further identify potential use-cases for sensing-aided communication enhancements and followed by a RAN1-lead SI to further study at least the following:

- Evaluation methodology to investigate potential gains for sensing-aided communication for the identified use cases,
- Necessary enhancements needed to support the identified sensing-aided communication use-cases.

7 – TELENOR ASA

Telenor Group has similar view as expressed by Bouygues, Vodafone, Telia Company and Ericsson. DSS enhancements is important and should be a part of R18. DSS enhancements should be an integrated part of the NR and LTE development in 3GPP RAN.

8 – TELECOM ITALIA S.p.A.

We think that DSS enhancements are important and solutions to ensure capacity enhancements are required

9 – Nokia Corporation

On DSS enhancements, Nokia and Nokia Shanghai Bell submitted RP-201761 to RAN#89 for PDCCH capacity enhancement for DSS, proposing to allow for PDCCH and PDCCH DM-RS puncturing around LTE CRS. Puncturing instead of RM was proposed for implementation simplicity and the loss of link budget was to be recovered by using a higher PDCCH aggregation level if necessary. The proposal was not agreeable at the time due to Rel-17 workload and PDCCH demodulation complexity concerns. We would still see this as a useful improvement helping the NR PDCCH multiplexing problem.

10 – Telstra Corporation Limited

We strongly agree that DSS enhancements are necessary in Rel-18, in particular those highlighted by Ericsson to address current shortcomings of real deployment scenarios where LTE-CRS is a major cause of NR performance degradation.

11 – Intel Corporation (UK) Ltd

Intel supports further DSS enhancements in Rel-18 focusing on scenario with smaller number of LTE users. Regarding detailed objectives we have the following comments.

1. As the fraction of LTE users decreases comparing to NR users in the target scenario, the problem of MU-MIMO pairing of LTE with NR user becomes very important. If the pairing is not allowed, the LTE scheduling is likely to be performed in SU-MIMO consuming uplink resources and degrading spectral efficiency of the system.

To understand performance of DSS, we performed SLS evaluations assuming low number of LTE users (20% of LTE vs 80% of NR users). We used FTP1 traffic, 8 Rx antennas at the gNB, IMT-UMa scenarios and check performance of the following NW configuration:

Joint NR+LTE – LTE and NR UEs can be co-scheduled in MU-MIMO (proposed DSS enhancement)

Separate NR, LTE – LTE and NR UEs can't be co-scheduled in MU-MIMO (current NR system)

SU – SU-MIMO only (reference)

Cell-edge SE results in UL for the above scenarios:

Joint NR+LTE	Separate NR, LTE	SU
21.3 (0%)	15.6 (-27%)	6.5 (-69%)

Based on the results above we propose the following objective for DSS enhancement in Rel-18:

Objective#1 (DSS):

- Specify enhancements to enable orthogonal multiplexing between LTE and NR users to support uplink MU-MIMO operation.

2. Interference handling from CRS, e.g., using dynamic on/off indication of CRS rate matching pattern. Although we acknowledge the problem of CRS interference, the discussion on corresponding enhancements should start later due to ongoing study in RAN4 about interference mitigation using CRS-IC/IM UE receivers and/or rate matching at NW. Once the outcome / results become available the corresponding enhancements can be discussed.

12 – Bharti Airtel Limited

DSS is a long-term solution and we need to enhance its efficiency also within Rel-18. Hence, we agree with Vodafone, Telia and others that a Rel-18 DSS WI should be prioritized. We support the WI objectives as proposed by Ericsson in RWS-210308."

1.2 Moderator summary & recommendation for further discussions

UE power savings

The following observations can be made on UE power savings based on feedback from 27 companies:

- In general, companies were positive towards having some form of UE power savings enhancement in Rel-18
- However, the views were divided on which aspect to focus on and how it should be done
    - Separate SI/WI targeting general purpose use cases (majority view)

    - As part of another SI/WI such as REDCAP or XR targeting specific use cases

- For those companies who supported having a separate SI/WI targeting general purpose use cases, many companies either proposed or were supportive of a new UE power savings enhancement based around an ultra-low power UE receiver and wake up signal

Moderator recommendation for intermediate round on UE power savings: Based on the comments received in the initial round, UE power saving based on an ultra-low power UE receiver and wake up signal seems the proposal that is receiving strong level of support from a number of companies. As the moderator, I would like to check the views of the companies on taking UE power savings based on ultra-low power UE receiver and wake up signal as a potential enhancement for Rel-18.

Enhancing and extending the support beyond 52.6 GHz

The following observations can be made on enhancing and extending the support beyond 52.6 GHz based on feedback from 18 companies:

- Of the 18 companies, significant portion of the companies did not see a strong need for enhancement for the support of spectrum beyond 52.6 GHz. Key reason for these companies taking such position was that they were not convinced of sufficient market demand. Even for those companies who are supportive of having
- Potential areas for enhancement
    - Enhancements for 52.6GHz 71GHz: Such as coverage enhancement, multi-beam enhancement, improved channel access and leftover issues from Rel-17
    - Extension beyond 71GHz: New waveform study

Moderator recommendation for intermediate round on enhancing and extending the support beyond 52.6 GHz: Based on the comments received, the companies' views on the need for further enhancements in Rel-18 is divided. Given the situation, RAN should first establish the need for having enhancements in this area. Also, if there is work to be done, the scope would have to be compact. Supportive companies are recommended to provide the following:

- Any information/argument on why the market currently needs enhancements in this area
- Prioritization of enhancement areas

CA/DC enhancements

The following observations can be made on CA/DC enhancements based on feedback from 23 companies:

- In general, most companies were positive of having some form of CA/DC enhancement in Rel-18
- Potential areas for enhancement
    - Cross carrier scheduling enhancement for better flexibility and efficiency
    - MR-MC (Multi-Radio Multi-Connectivity)

- Mobility enhancement for CA / DC

A number of companies have indicated preference to discuss the third topic under [RAN93e-R18Prep-03]. Given this situation, moderator view is to focus on the first two topics. Moderator recommendation for intermediate round: Companies are invited to provide their views on taking these two topics (Cross carrier scheduling enhancement for better flexibility and efficiency and MR-MC) for Rel-18 enhancement. Also, additional information on necessary specification support would be beneficial to better understand what needs to be done.

Flexible spectrum integration

The following observations can be made on flexible spectrum access based on feedback from 22 companies:

- In general, companies were positive of having some form of enhancement on flexible spectrum access to improve segmented frequency resources (e.g. under 2GHz)
- However, a number of companies have commented that there is overlap with enhancements for CA (i.e. similar benefit could be achieved by enhancing CA rather than introducing a whole new set of framework)

Moderator recommendation for intermediate round on flexible spectrum integration: Based on the comments received, RAN should first identify what can be achieved with flexible spectrum access that cannot be achieved with CA enhancements. Companies are invited to provide their views on the key differences and similarities of flexible spectrum access and CA enhancements (e.g. pros and cons).

RIS (Reconfigurable Intelligent Surfaces)

The following observations can be made on RIS (Reconfigurable Intelligent Surfaces) based on feedback from 23 companies:

- Of the 23 companies, at least 10 companies think that maturity of RIS technology is not sufficient to start work in Rel-18.
- Furthermore, a number of companies think that RIS could be discussed to together with smart repeaters
- While there are quite a few companies who are supportive to RIS, there is not much input on what kind of features need to be studied or supported from 3GPP specification point of view.

From moderator point of view, the level of support on RIS does not seem strong compared to other areas.

Moderator recommendation for intermediate round on RIS: Companies supportive of RIS to provide details on what kind of study or specification support is needed for RIS so that other companies can better assess the situation and reconsider their positions.

Others (RAN1-led)

The following observations can be made on ”Others (RAN1-led)” based on feedback from 12 companies:

- Of the 12 companies, 10 companies proposed enhancements for DSS

– Other than DSS, wireless/radio sensing was proposed by 2 companies

Moderator recommendation for ”Others (RAN1-led)”: Given the very strong support for DSS, focus intermediate phase discussions on DSS. Companies to provide additional details on what features should be enhanced for DSS in Rel-18.

2 Intermediate Round

2.1 Collection of company views

2.1.1 UE power savings

Moderator recommendation for intermediate round: UE power saving based on an ultra-low power UE receiver and wake up signal seems the proposal that is receiving strong level of support from a number of companies. As the moderator, I would like to check the views of the companies on taking UE power savings based on ultra-low power UE receiver and wake up signal as a potential enhancement for Rel-18.

Feedback Form 8:

1 – vivo Communication Technology

Thanks for the good discussion.

First of all, we support the moderator’s observation and recommendation as it reflects the discussion status very well

As the proponent of ultra-low power wake up receiver, we would like to propose the following key aspects as potential study item scope in Rel-18. Comments and suggestions to this study scope are highly welcomed.

- Establish the evaluation methodologies for the study of ultra-low power wake up receiver, and power models [RAN1]
- Study the tradeoff among receiver sensitivity, data rate and power consumption considering the feasible receiver architecture, e.g. envelop detector [RAN1, RAN4]
- Study the basic structure of wake-up signal, e.g. OOK based, which can be detected with simple receiver architecture, considering the following design aspects [RAN1]
  - Narrow bandwidth transmission and multiplexing scheme of wake-up signal
  - Robustness to combat inter-cell interference
  - Co-existence with legacy signal/channels for in-band operation
- Possible procedures to support ultra-low power UE wake-up, e.g. the link maintenance procedure to ensure the network reachability to UE[RAN1, RAN2]
- Note that IDLE/INACTIVE state is to be prioritized for the study

2 – Verizon UK Ltd

We were unable to submit our comment in the first round due to nwm and our time zone. We are interested in low power wake up as vivo mentioned about and we think if good power saving features can be identified, we prefer to have them for all UEs, not just RedCap. Thanks.

3 – Futurewei Technologies

We are generally supportive of low power WUR. Study will be needed first. And clarification of the use cases (UE connective modes, UE types, applications, etc.) and power saving requirements may be needed to focus the study and work.

4 – Intel Corporation (UK) Ltd

While our original preference was to limit studies on low-power WUR to no/low mobility use-cases under RedCap, considering the significant interest to study in context of all UE types, we would be open to such a study.

However, a point to emphasize is that a proper study on identifying performance targets, and the feasibility and applicability of supporting low-power WUR in various scenarios and UE characteristics, e.g., mobility, multi-cellular scenarios, etc., before any normative work is considered.

5 – Qualcomm Incorporated

On top of Rel.15-Rel.17 power saving features, wake-up radio (such as in IEEE 802.11ba) may help UE to save extra power by introducing a new receiver at UE to detect a new waveform that is substantially easier to detect than a normal NR waveform. However, we are not convinced that such waveform detection can achieve the reliability and coverage required by NR. It may be hard to justify an extra radio and additional standardization effort if a technology only helps cell center UEs without a strong enough use case.

6 – CATT

The low-power active or no-power passive wakeup receiver would be the revolution of NR system to further improve the UE power saving. The additional component of front-end low-power or no power receiver could not only benefit the NR in reducing power saving but also LTE and other technologies in multi-mode modem to reduce the UE power consumption as a whole.

7 – Apple Benelux B.V.

We support the moderator's recommendation and we prefer it to be considered in a separate study item.

8 – Samsung Research America

Samsung

We are generally OK to study ultra-low power WUR in Rel-18. We are interested in PS benefit from such ultra-low power WUR, which hopefully can be generic to all type UEs. But we concern about the tradeoff between power saving gain and coverage loss. In order to achieve such low power consumption, some of component such as PA needs to be removed and it will result in coverage loss. Also, we expect a large scope to support this feature. So, we prefer a separate SI with potential scope as follows:

- Evaluation methodology, including new power models, for evaluating power saving gain evaluation and coverage loss
- Feasible receiver architectures,
- VLP/AZP WUS design,
- UE procedures for state transitions before/after detection of VLP/AZP-WUS, and
- Mobility management during VLP/AZP WUS monitoring

9 – Motorola Mobility UK Ltd.

We are open to study an ultra-low-power wake-up receiver and corresponding WUS. RAN should further discuss target use cases and UE types to determine whether a separate SI/WI is needed or they can be considered together with RedCap evolution.

Also, we would like RAN to confirm that Rel-17 paging early indication (PEI) design proposals (e.g. sequence based) are not relevant to the ultra-low power wake-up receiver and will not be re-discussed during Rel-18, if the proposals are not adopted in Rel-17 due to very little support from companies.

10 – China Mobile Com. Corporation

We are generally ok with a seperate SI about low power WUR in R18, but the impact on network should be considered carefully, e.g., resouce overhead, coverage, coexistence with legacy UE, etc.

11 – DOCOMO Communications Lab.

We are generally ok to study ultra-low power WUR in Rel-18. First, we
need to study the use cases, target performance and feasibility of ultra-low power WUR.

12 – HUAWEI TECHNOLOGIES Co. Ltd.

We support moderator recommendation of taking UE power savings based on ultra-low-power wake-up radio as a potential enhancement for Rel-18. It can start with a study and the study could focus on potential use cases/device types, coverage, potential functionalities carried by low power wake-up radio and the power saving gain compared with Rel-17.

13 – CAICT

We support moderator recommendation and having a study on ultra-low power wake-up radio in Rel-18.

14 – LG Electronics Inc.

We care the UE power saving but DRX and WUS already provide sufficient mechanism for power saving. In addition, now we have SDT, where the UE can transmit data with very reduced power. Thus, we need strong justification/motivation to introduce another power saving mechanism in addition to the already complex but nice power saving mechanisms. On the other hand, it may be still considered to take care of the leftovers from Rel-17 WI depending on the result of the Rel-17 WI completion.

15 – Asia Pacific Telecom co. Ltd

In general, we are fine with the moderator's recommendation. However, what kind of UE devices or UE types could/need support the ultra-lower power UE receiver should be clarified at first. In addition, whether the legacy RRC_IDLE/INACTIVE power saving scheme, such as PEI, can co-exist with ultra-low power WUS and the gains of power saving should be studied as well.

16 – ZTE Corporation

We agree with moderator's recommendation that ultra-low power wake up radio can be considered as an enhancement for Rel-18. Further reduction in UE power consumption is needed in Rel-18. For the study of wake up radio, in addition to the design and structure of WUR, other issues, such as, the detection sensitivity, coverage, mobility management, resource overhead and co-existence with other legacy channel/signal, etc, also need to be considered.

17 – Guangdong OPPO Mobile Telecom.

As the device power saving is important issue to us. We looking forward the further enhancement. We are also fine for the moderator's propoals on considering the UZP/AZP WUS in the Rel-18 enhancement.

18 – Spreadtrum Communications

We support to study and/or specify the ultra-low-power WUR and corresponding WUS in R18. It can be a separate SI in R18 at first.

19 – Nokia Corporation

We share the view of Qualcomm.

20 – Ericsson LM

In general, we are supportive of studying ultra low power WUR. Nevertheless, it is not clear to us how such a mechanism can be useful for all types of UEs considering the impact on throughput, coverage and latency. Therefore, we think it should be studied under the relevant UE type which is RedCap in this case.

21 – Philips International B.V.

We support UE power saving based on an ultra-low power UE receiver and wake up signal. We think that the SI can be applicable to all devices

22 – Sony Europe B.V.

We support the moderator's conclusion on taking UE power savings based on ultra-low power UE receiver and wake up signal as a potential enhancement for Rel-18.

The objectives proposed by vivo are a good starting point for scoping the study item. We think that mobility issues, multiplexing with legacy signals and compensation for potential sensitivity loss should also be included in the study. Our updates to the vivo objectives are shown below.

- Establish the evaluation methodologies for the study of ultra-low power wake up receiver, and power models [RAN1]
- Study the tradeoff among receiver sensitivity, data rate and power consumption considering the feasible receiver architecture, e.g. envelop**e** detector [RAN1, RAN4]
- Study the basic structure of wake-up signal, e.g. OOK based, which can be detected with simple receiver architecture, considering the following design aspects [RAN1]
  - Narrow bandwidth transmission and multiplexing scheme of wake-up signal
  - Robustness to combat inter-cell interference
  - Co-existence / **multiplexing** with legacy signal/channels for in-band operation
  - **Coverage / compensation for potential sensitivity loss**
- Possible procedures to support ultra-low power UE wake-up, e.g. **mobility procedures and** the link maintenance procedure to ensure the network reachability to UE **for stationary and mobile UEs** [RAN1, RAN2]

Note that IDLE/INACTIVE state is to be prioritized for the study

23 – vivo Communication Technology

To address some of the questions/comments in the above ,

(1) For ultra-low power wake-up receiver, the sensitivity is a tradeoff between the power consumption and data rate. Literature has some investigation from various receiver sensitivities from -50 -100 dBm and even more. From our investigation in [RWS-200168], such as InH, dense urban we found 80% UEs are in coverage of ULP WUR assuming -70dBm sensitivity, and 100% UEs are in coverage assuming -90dBm sensitivity.

(2) eDRX as an alternative solution for almost zero power standby is specified in both LTE and NR and applicable for all types of UE. We think ULP-WUR can provide better latency performance and enable almost 'real-time' wake-up compared to eDRX 'non-real-time' wake-up.

(3) We focused on IDLE/INACTIVE state UE, the throughput issues is irrelevant.

In view of these, we see potential the ULP-WUR is applicable to all types of UE.

24 – MediaTek Inc.

Moderator suggestion is a good starting point for the evolution of NR power saving techniques in Rel-18. In addition to application to all UE types, **we see this ultra-low-power technique can be applied to gNodeB power saving as well**. **Given the power consumption is so low such that timely monitoring is allowed, WUR at gNodeB side can timely monitor and response to UE WUS and resolve the issue of UE impact due to gNodeB power saving**. In this regard, we suggest the scope of this ultra-low-power technique can include both UE and network nodes, and potential merge of network energy saving and ultra-low-power WUR/WUS in a common Rel-18 SI on system energy efficiency could be one way forward to consider.

25 – VODAFONE Group Plc

We still see that this is better focussed on RedCap devices

26 – China Unicom

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We generally support moderator's proposal of considering UE power
   savings based on ultra-low-power wake-up radio as a potential
   enhancement for Rel-18. We should have a SI phase first.
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27 – InterDigital Communications

We support the moderator's recommendation.

2.1.2 Enhancing and extending the support beyond 52.6 GHz

Moderator recommendation for intermediate round: Companies' views on the need for further enhancements in Rel-18 is divided. Given the situation, RAN should first establish the need for having enhancements in this area. Also, if there is work to be done, the scope would have to be compact. Supportive companies are recommended to provide the following:

- Any information/argument on why the market currently needs enhancements in this area
- Prioritization of enhancement areas

Feedback Form 9:

1 – Futurewei Technologies

Agree with the assessment. As in our inputs for initial round, we do not see the need of the work at this point of time. If there is major leftover feature from R17 WI, it can then be considered separately.

2 – Samsung Electronics Co.

We agree with moderator's assessment on the situation of this topic and guidance on the next step discussion. We also want to clarify the scope of the potential areas regarding the enhancements for FR2-2:

- Coverage enhancement: Rel-17 already has a dedicated WI on coverage enhancement, and a potential Rel-18 WI on further coverage enhancement is also under discussion. We would like to clarify what exact coverage enhancement technologies are within the scope in particular for FR2-2.
- Multi-beam enhancement: Rel-17 WI already discussed multi-beam aspects, and the topic of beam management due to LBT is deprioritized, due to not sufficient support of investigating this issue. Is it considered within the scope of Rel-18 for enhancement?
- Improved channel access: Directional LBT and RX assistant LBT are still under discussion in Rel-17 WI. Is there other aspect regarding the improved channel access considered for Rel-18?
- Rel-17 leftover: The current progress for Rel-17 WI is adequate in our understanding, and if there is leftover from Rel-17, it's more likely due to no consensus on the importance to support such feature, instead of due to lack of time for discussion. Then how could we expect such leftover items can be agreed to support in Rel-18?

3 – Intel

Enhancement of NR up to 71 GHz

Need for enhancement:

Rel-17 FR2-2 design and scope was very limiting from the start with the goal of quickly getting minimal system aspects completed in Rel-17 timeframe (e.g. only 6-month SI instead of entire release), so that there is something available for 60 GHz band soon.

However, in order to grow the eco-system and promote usage of a specification sometimes it isn't enough to have minimally functioning standard but requires competitive technologies with rich features that may not be available by a competing system. For scenarios where there are no competing technologies, it might be sufficient to wait for eco-system to naturally increase and based on commercial needs develop enhancements for the system. However, **60 GHz unlicensed operation is different in that there is already a competing technology, and in order to actually develop any eco-system, the specification needs to be competitive and provide interesting and useful features and functionalities.**

At the time of Rel-17 approval (Dec 2019), 802.11ad was already commercially available and 802.11ay was in progress of standardization. As of today (Aug 2021), 802.11ay specification is complete (published in July 2021) and contain numerous improvements on top of 802.11ad including (but not limited to) the following:

- more efficient power management (power saving) compared to 802.11ad,
- optimized support for fixed wireless systems,
- spatial sharing and interference mitigation using feedback and measurements to allow multiple transmissions that do not interfere with each other significantly to occur simultaneously,
- new channel access for multi-steam transmissions using new MIMO backoff techniques,

- improved beam management features compared to 802.11ad.

In addition, 802.11ad/ay supports as small as 3usec physical layer ACK turn around time, and supports 8 layers with channel bonding up to 10+ GHz of bandwidth. For NR to stay competitive, it will require further efforts in 3GPP.

In summary, waiting for eco-system to pick up with minimal working standards might result in systems never being widely adopted and used as there are better competing technologies. We strongly believe **3GPP should invest to create enhancements for NR extension up to 71 GHz in order to create competitive technology for 60 GHz bands.**

Prioritization of work:

Among the list of objectives that we have provided in the 1st round discussions, if further prioritization-is needed, we can focus on enhancements for unlicensed operations for Rel-18. Among the potential objectives features related to improving performance and robustness can be prioritized, e.g. increased peak throughput, supporting lower latency, and improved power efficiency. With that said, we are open for further discussion on the scoping.

Waveform study of from 52.6 GHz to 100 (or 114.25) GHz

For the waveform study for 52.6 GHz to 100 GHz, this study is essential to enable support for NR all the way up to 100 GHz. This topic was de-prioritized during release 17 due to specification progress for NR extensions up to 71 GHz. We think the timing is appropriate to initial the waveform study at release 18.

I would like to remind companies that when Rel-16 NR started NR had to goal to standardize systems up to 100 GHz, and specification for above 52.6 GHz was not considered in Rel-15 due to lack of waveform study. For Rel-17, the waveform study was not conducted and existing waveform was simply adopted simple due to urgency to standardize minimal working system by end of Rel-17.

The SI should target for future specification development in Rel-19+ timeframe, and also an investment towards 6G standards development as the outcome of the study can be leveraged for Rel-20 Rel-21 work. The **waveform SI being an investment towards future specification is no different from** SI for AI/machine learning, or full duplex operation, or **any other SIs targeted for release 18** in that all of the **study efforts take place so that future releases can take benefit and 3GPP is able to work towards** approving an corresponding WI in Rel-19+ timeframe.

4 – AT&T

We see the situation similar to NR-U after Rel. 16. Many items in B52, that were in the work item, have not been completed and are in danger of never being completed in Rel. 17. Then it needs to be discussed whether the root cause is lack of consensus or lack of TUs. If lack of consensus, was it on a specific solution or on the merit of the proposal? If lack of TUs, was it because the topic was a secondary priority/optimization and not an essential feature or because there was too much discussion because of lack of consensus. Similar to NR-U in Rel. 16, where RAN went through a down scoping exercise, we believe many items were left out of Rel. 17–or are in danger of being left out–because they are secondary priority/optimization items. This is especially true for multi-beam and channel access enhancements. AT&T would like to see these discussed, ideally also for FR1 and NR-U. As said previously, we see the situation very similar at the end of Rel. 16 and 17 for NR-U and B52, respectively. There were many features that had significant interest that were simply dropped because of lack of time. If Rel. 18 can afford to spend time on these, we are supportive of doing so.

5 – Qualcomm Incorporated

We share the same view as moderator.

6 – InterDigital Communications

FR2-2 enhancement

We support the enhancement of FR2-2 in Rel-18 and share a similar view with Intel that supporting minimal functionalities is not enough to compete with other technologies in unlicensed spectrum. In terms of the scope, power saving and beam management enhancement could be prioritized but we are open to discuss other topics as well.

Above 71GHz

We are supportive for the new waveform study for above 71GHz if we have enough TU for this topic in Rel-18.

7 – Apple Benelux B.V.

For FR2-2, the scope suggested by the moderator i.e. coverage enhancement, multi-beam enhancement, improved channel access and leftover issues from Rel-17, is fine with us.

For > 71 GHz, the analysis of the market should include a study/explanation of the regulatory landscape and use cases for this spectrum band. If the SI is approved, the scope should include an update of the methodology including channel models, impairment models etc and then a study on the possible waveforms to be used. This can be done with a small number of TUs and last the entire Rel-18 duration.

8 – NTT DOCOMO INC.

Given the situation, we do not think it is very reasonable to spend many TUs for this topic. On the other hand, higher frequency (e.g. beyond 71 GHz) has potential gain toward 6G clearly. It is also clear that a study of fundamental aspects, e.g., waveform, would be required to support such higher frequency range. This situation seems quite similar to AI or XDD in our understanding. In this sense, with the limited number of TUs (e.g. up to 1 TU), we think study on fundamental aspects (e.g. waveform) for higher frequency range (e.g. beyond 71 GHz) would be certainly worthwhile as a Rel-18 item.
For 52.6 - 71 GHz enhancement it needs further assessment on the progress of Rel-17. Due to its unclearness, we think it could be deprioritized at this moment in this discussion. The aspects not discussed in Rel-17 but supported in 11ad/ay can be considered, while minimized #TUs would be preferred even for such topics.

9 – vivo Communication Technology

FR2-2 enhancement

Rel-17 only provides basic suppoort for NR between 52.6GHz and 71GHz, the actual performance may not be opitmal. We see the value to further performance improvement, for example PDCCH coverage enahncements.

Above 71GHz

We are open to consider the study of >71GHz waveform as a long term technology investment.

10 – Deutsche Telekom AG

-> postpone topic to Rel-19

11 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility

Topic Area 1: Further enhancements for NR operation between 52.6 – 71GHz

As mentioned by several companies that it is not yet clear if and what leftovers from Rel-17 WI will need to be carried over in Rel-18, so any Rel-17 leftovers can be assessed and discussed separately after the November RAN WG meetings and in RAN#94e. Therefore, during this email discussion and RAN#93e, we suggest only discussing and identifying key areas that were left out or not considered in Rel-17and should aim to converge on those aspects.

- Prioritize discussion for topic 1 on new areas that were out-scoped or not considered in Rel-17

In our view, following two aspects with relatively compact scope (as recommended by moderator) should be prioritized for a potential WI on topic 1

- Coverage enhancements for FR2-2
  - Motivation
    - In Rel-17, coverage enhancements have been deliberately left out of scope for NR operation between 52.6-71GHz. Considering that unlicensed access as one of the key areas in this FR2-2, there are strict regulatory requirements in terms of EIRP and PSD. Therefore, we foresee limited coverage as a key issue and coverage enhancement for FR2-2 should be prioritized
  - Objective:
    - Identify the bottleneck channels in terms of coverage for FR2-2 and specify the required enhancements, if needed [RAN1/RAN2/RAN4]
    - Consider the UL coverage enhancements being specified in Rel-17 as baseline for at least multi-PUSCH scheduling [RAN1/RAN2/RAN4]
- Beam enhancements for FR2-2
  - Motivation
    - In Rel-17, extending SSB beams to more than 64 was left out of scope for NR operation between 52.6-71GHz. Considering that more narrower beams are beneficial to further exploit beamforming gain and increase coverage, we believe there is the need to prioritize improved beam-management with potentially narrower and larger number of beams for FR2-2 operation. Moreover, we should emphasize that no-LBT has been agreed to be specified in Rel-17 for regions where LBT is not mandated and the no-LBT based mechanism is reliant on highly directional beams with high beamforming gains. In addition, Rel-17 unified TCI framework for multi-beam should also be considered for FR2-2 enhancements.
  - Objective:
    - Evaluate and extend the currently supported number of beams for FR2-2 and specify the required enhancements [RAN1/RAN2/RAN4]
    - Identify the necessary enhancements to support unified TCI framework with FR2-2 enhancements such as multi-slot PDSCH/PUSCH scheduling [RAN1/RAN2]

Topic Area 2: Extension of NR operation between 71 – 114.25GHz

For topic 2, the main contention point is if there is an immediate market need or motivation to consider a new SI in Rel-18. In terms of areas to be studied, there seems to be a common understanding among companies that a SI focusing on waveform evaluation is the preferred direction.

Motivation:

In our view, the motivation is two-fold for extending the NR operation beyond 71GHz.

First is availability of ultrawide licensed bands in 71-76GHz and 81-86GHz in ITU regions 1, 2 and 3. This would allow to meet the requirements being set out/considered for extreme precision positioning that rely on large contiguous bands. Moreover, low power positioning techniques (currently considered under positioning topic) also need ultrawide bandwidth. Furthermore, we see availability of large bands as a requirement to better facilitate techniques such as cross-duplexing (currently considered under duplexing topic) with non-overlapping sub-bands for DL and UL. With ultrawide bandwidth, the cross-duplexing can still accommodate large UL and DL bandwidths. In addition, high capacity FWA can highly benefit from this.

Second is the impact we foresee of starting this SI in Rel-18 to pave the path for future extensions towards 6G. We expect that waveforms that will be studied under this SI and also evaluation methodologies including PN models, PA models, antenna models, channel models would be applicable to sub-THz bands as well in the future.

Considering above motivations, but also keeping in mind the recommendation from moderator, we propose to consider only SI phase in Rel-18 for extension of NR operation between 71-114.25GHz with following objectives and with relatively compact scope:

Objectives:

- Identify the evaluation methodology including channel models for above 100GHz, antenna models, PN models, reference PA models for waveform analysis [RAN1/RAN4]
- Identify and evaluate a limited set of candidate waveforms for both DL and UL [RAN1]
- Identify and evaluate a limited set of candidate modulation/constellation for DL and UL[RAN1]

12 – WILUS Inc.

For the enhancement of NR upto 71GHz, we are also supportive to further enhance FR2-2 design by sharing a similar view as Intel considering aspects that Rel-17 FR2-2 design and scope were very limited to support full functionality as compared with other RAT which was already commerciaized. And at this stage, it seems difficult to confirm that there will be no remaining issues for current FR2-2 WI within Rel-17 timeframe considering current progress of Rel-17 WI. For the scope of this enhancement, we think that we should focus on supporting potential features such as enhanced channel access, i.e. directional LBT, Rx-assisted LBT on unlicensed aspects, coverage enhancement which was excluded as out of scope in Rel-17 WI, improved power saving and enhanced beam-management. However, for the detailed scope of this enhanement, we are open to discuss.

For study above 71GHz item, we are supportive to study on the new waveform with the limited number of TU for this area in Rel-18.

13 – TELECOM ITALIA S.p.A.

It looks that supporting companies are proposing a quite extensive scope for an activity that received a large number of ”no interest” comments.

We do not see the need to have an activity in Rel 18. In case a very limited scope to manage critical left overs from Rel 17.

14 – CATT

FR2-2 enhancements:

We think due to limited time frame Rel-17 WI still lacks some important feature for deployment, such as improved coverage, peak data rate &latency enhancement, energy efficiency support etc. It would be desirable to provide these features as early as possible to facilitate deployment and adoption.

Above 71GHz:

The study of waveform for beyond 71GHz is also desirable considering the implementation challenges and time it will take. Therefore, we support to study above 71GHz in Rel-18.

15 – ZTE Corporation

Agree with moderator's assessment on the two potential areas for enhancement. We are open for further discussion along with the overall prioritization among Rel-18 topics.

16 – Huawei Tech.(UK) Co.. Ltd

There is merit for 3GPP to proactively tackle longer term studies, as we can see with some other topics like AI/ML. Extending supported frequency range for IMT is of interest to us. For above 71 GHz we might just repeat the same discussion when scoping later releases, so at some point in time 3GPP will have to decide to start this study. We do see some merit to start the study in Rel-18 with a clear focus.

17 – Sony Corporation

We think the work to extend to spectrum above 71 GHz may not be urgent due to the unclear spectrum allocation. For the enhancement of 52 to 71 GHz, we think work with a compact scope as the moderator commented could be considered for Rel-18. Though the detailed scope is pending on the ongoing Rel-17 discussion, but in general, major leftover issues (if any) from Rel-17 can be treated in Rel-18 and coverage/throughput enhancement techniques (e.g., advanced modulations and CSI measurement schemes), can also possibly be studied.

18 – Nokia Corporation

We support the moderator's conclusions in general, and also with Futurewei's comment that in case there is any major leftover from Rel-17 WID that can be considered separately. Regarding >71GHz, some companies have argued that this topic is an investment into the future, like other topics under discussion currently. However, here there is a clear dependency on spectrum allocation before any technology we develop for this range of frequencies can be deployed, which adds a large amount of uncertainty to the work. Moreover, we believe 3GPP needs to balance between short and long term investments, and we should not have too many long-term projects running in parallel.

19 – CEWiT

We support the study of NR beyond 71 GHz as it would pave the path towards 6G evolution. In this regard, we support the prioritizing study on waveforms for NR beyond 71 GHz

20 – Ericsson LM

We agree with moderator assessment.

2.1.3 CA/DC enhancements

Moderator recommendation for intermediate round: Companies are invited to provide their views on the following potential enhancements for Rel-18

- Cross carrier scheduling enhancement for better flexibility and efficiency
- MR-MC for Rel-18 enhancement. Also, additional information on necessary specification support would be beneficial to better understand what needs to be done.

Also, additional information on necessary specification support would be beneficial to better understand what needs to be done.

Feedback Form 10:

1 – Verizon UK Ltd

We were unable to submit our round 1 comment due to NWM and our time zone - so this is our round 1 comment. We think DC/CA operation is a very fundamental network performance issue that should be adequately addressed by 3gpp. We strongly support continued enhancement of DC-CA. We like the enhancements proposed by e.g., ZTE and Samsung. Especially the ZTE proposal - *"Fast role change in CA/DC*

To improve the interruption time, fast role change can be considered as well. In case PCell/MCG failure is detected, the SCell/SCG can be change to PCell/MCG accordingly in a more efficient way. With the fast role change in CA/DC, the multiple connectivity with selective activation can be used to improve the mobility performance where multiple PCell/MCG can be configured and only one of them will be activated at a certain time." This is a solution we needed to solve a very real network problem. We strongly support to include it in R18. I think we should not cut down too much too fast. We support DCCA to be a stand-alone WI in R18.

2 – Apple Benelux B.V.

Regarding the issue of cross-carrier HARQ, any proposals would need to show a significant performance benefit and consider the impact on UE complexity.

Regarding the MR-MC, it is our understanding that the UE would be expected to have only one SCG active at one time, even when MR-MC entails configuration of more than 1 SCG. In such a case, we think it's better to discuss this topic in the mobility topic as well, as configuration, switching among the CGs etc., is better handled as part of mobility, and companies have expressed that UE switching between CGs is a potential way to go in mobility.

3 – QUALCOMM JAPAN LLC.

For Cross carrier scheduling enhancements, we would like to keep the impact within PHY layer / RAN1, and would like to avoid impact to MAC.

For MR-MC, We think it depends on the solution detail whether it falls into the Mobility enhancement. We figured that some companies are considering that MR-MC can be realized by CHO type procedure where the UE is pre-configured for multiple SCGs and the UE selects one of preconfigured SCGs at a given time. That way, it can be faster than the existing SCG change procedure where Measurement Report and RRC Reconfiguration have to take place upon every SCG change.

4 – Beijing OPPO Com. corp.

For the discussion at this intermediate phase, our views are as follows:

Cross carrier scheduling

In our understanding, RAN1 would be mainly involved to support this feature, e.g., FR2 SCell scheduling for PUSCH on FR1 PCell, scheduling two carriers by a single DCI as well as cross-carrier HARQ. For cross-carrier HARQ, the impacts on RAN2 are also significant.

We agree with Apple that it is better to make a tradeoff betwen potential gains and UE complexity.

MR-MC

We think it make sense to support MR-MC in order to achieve fast SCG change in mobility scenario, which is beneficial to improve the service continuity. While for multiple-layer deployment, we do not see much benifits to support this and again we have concern on UE complexity which needs to be evaluated carefully.

5 – HuaWei Technologies Co.

Regarding cross-carrier enhancements, we think cross-carrier HARQ is also useful and some companies also proposed similar things in URLLC area. We'd like to keep it open for the time being, and decide later whether to include it in URLLC or CA/DC enhancements.

For MR-MC, as explained in the 1st round, we are not convinced on the motivation and solution principle. We understand several other companies also expressed similar views and our technical questions on feasibility were not yet responded by the proponents. We still have strong concern to have this without sufficient justification on the urgency of commercial needs and technical concerns. We also share the similar views mentioned by QC. Some companies want to discuss fast role switch of cells and we think this is not the same thing as supporting MR-MC, which should be discussed in mobility and we should not fragment the solution further by discussing this under another topic.

6 – Samsung R&D Institute UK

1) Cross-carrier scheduling

As for cross-carrier scheduling enhancement, we are OK as a potential Rel-18 enhancement. Specifically, it is the single DCI scheduling multi-cell PDSCH/PUSCH where the number of scheduled cell is large enough (> 2).

2) MR-MC

We see MR-MC with more than two cell groups is essential for Rel-18 considering that operators have multiple 5G frequency bands and aggregation of those bands is desirable. However, CA has a limitation of network deployment requiring co-located DUs or ideal backhaul. For instance, aggregation of FR1 (low band) + FR1 (high band) + FR2 (mmWave) or LTE + FR1 + FR2 is not easily supported by the existing DC. Thus, the extension to MR-MC is beneficial to operators for better spectrum efficiency.

In our view, the potential scope of MR-MC includes:

- Support more than two cell groups (more than two nodes) (RAN2, RAN3, RAN1)

+ Procedures for configuring more than two cell groups, e.g., addition, modification, release

+ Active cell group switching e.g. UL cell group switching with at most two active UL, DL cell group switching

+ User plane enhancement, e.g., data forwarding

+ UE capability management

- Support of new bearer types (RAN2, RAN3)

+ Enhancement of bearer types, e.g., split bearer operation with three RLC entities

+ New SRB type

Regarding the UE complexity, we think the restriction of at most two active uplink does not increase UE-side complexity. For downlink, there is no actual difference between CA with multiple DL cells and MR-MC, since UE should be able to receive data from multiple cell.

7 – SK Telecom

As the evolution of the NR network, MR-MC is one of the key features in Rel.18. From the implementation perspective, 3 DL and 2 UL could be the good start point of the discussion, however it does not need to limit the UL capacity.

8 – China Telecomunication Corp.

Regarding **the motivation of MR-MC**, we share similar views to other companies that MR-MC can bring benefits to operators with higher peak throughput/bandwidth and better utilizing the spectrum resource. We also agree with Samsung that CA requires co-located and overlaid or higher backhaul quality, which maybe not always feasible in the actual network deployment. In this sense, MR-MC can be considered as an approach to provide operators with more flexible, effective and uniform network control and radio resource management. We think MR-MC is a useful and meaningful enhancement in Rel-18.

Regarding **the details of MR-MC**, we think the following potential objectives or issues are worth discussing in Rel-18.

(1) **The number of simultaneous UL transmissions and DL receptions in Rel-18**:

In order to balance the UE implementation complexity/RF capability limitation and network performance, we suggest support at most 2 simultaneous UL transmissions and potential extension to 3 DL receptions in Rel-18.

(2) Mechanisms and signalling for multi cell groups management, including

- Fast and dynamic SCG activation and deactivation, such as extending Rel-17 efficient SCG activation / deactivation mechanism to multi SCGs, further discussion on Rel-17 leftovers including UE autonomous SCG deactivation, etc..

- Fast cell group switching, such as preconfiguring multi SCGs and activating SCG dynamically based on network indication / preconfigured events, supporting MN/ SN role switching, etc..

- UL selective activation mechanism, such as dynamic UL switching or forwarding.

(3) Other objectives can be further discussed including bearer management, UE capability management, measurement aspects and so on.

Regarding **the organization of CA/DC enhancements topics**, we prefer to have **a dedicated WI** on CA/DC enhancements to include MR-MC related issues. In our opinion, considering the work load to have a huge scope including many topics, it is better to have dedicated WI instead of putting MR-MC in Mobility topics, since the motivation and scenarios of MR-MC are not only related to mobility issues but also capacity issues.

9 – vivo Communication Technology

We are interested in MRDC enhancement in Rel-18, in particular following potential objectives

- CP and UP architecture enhancement for MR-MC, e.g. new SRB and DRB
- MN and SN initialize secondary SN addition/change/release.
- Lower layer signaling to activate and deactivate SNs.

10 – NTT DOCOMO INC.

Cross carrier scheduling enhancement

For cross carrier scheduling enhancement, we support PDCCH scheduling multi-cell PDSCH/PUSCH. From our perspective, its use case is not limited for DSS only. We prefer to discuss it with wider scopes.

MR-MC

We think the MR-MC achieves flexibility for the design of accommodating cells in gNBs. On the other hand, it should be noted that more inter-gNB coordination may be needed. We should carefully evaluate both benefits and spec impacts.

Idle/inactive measurement

Idle/inactive measurement is a good topic to discuss in terms of FR2 CA/DC enhancements, because SCell setups occur more frequently than FR1.

(Four companies including DOCOMO looked to prefer enhancement of the idle measurement (or early measurement) in the initial round discussion. We think this is as many as companies referring to the cross carrier scheduling, am I misunderstanding?)

11 – MediaTek Inc.

For MR-MC, we think it more practical to consider only fast SN switching in this release (i.e. multiple SCG configuration with only one activated). In addition, it make sense to reuse the enhancement on MN (handover) as much as possible. So we suggest to discuss this in mobility WI.

12 – LG Electronics Inc.

We are fine with the potential enhancement summarized by the moderator. Thank you. Given that the link reliability/stability would not be guaranteed especially on high frequency including FR2, it would be a good to extend MR-DC to MR-MC. Selective use of cell groups and corresponding scheduling enhancement, e.g., BSR, could be included in the scope. Considering the scope and the volume, we think this item should be considered as a separate Rel-18 WI.

13 – CATT

MRMC

RRC configuration needs to be introduced to configure more than one SCG for the UE. Considering the complexity from UE side, it seems a practical way is to support at most one active SCG at a time. Then some RRC/MAC/PHY procedure or signaling might be needed to support such activation and deactivation.

Furthermore, we may also need some changes to the stage 2 specification such as 37.340 on this multi-SCG framework. UE capability signaling is also anticipated but it should be trivial. Overall we believe the specification impact could be kept on a reasonable level if we properly design the mechanism considering both flexibility and complexity.

14 – China Mobile Com. Corporation

For the cross-carrier scheduling enhancements, we share similar view with OPPO that RAN1 would be mainly involved to support this feature, and cross-carrier HARQ would have RAN2 impacts.

For the MR-MC, as mentioned in initial round comment, we don't have urgent commercial needs for MR-MC, maybe we can study it in Rel-19. And we have similar feeling with QC that MR-MC can be realized by CHO type procedure.

In addition, we also suggest that any necessary enhancements for CA/DC need to consider the impacts on the UE complexity because high UE complexity is not beneficial for the future commercial deployment.

15 – Nokia Corporation

We would note that more than "mobility enhancements for CA/DC" were proposed and supported by several companies. Enhancing CA/DC operation for FR2 is not only about mobility so we think **CA/DC enhancements focused on FR2-specific aspects (which also includes RAN4 aspects)** should be considered as first priority in Rel-18 WI. Cross-carrier scheduling aspects could be considered together under CA/DC enhancements since they have relevance to FR2 and reduce PDCCH overhead.

As a separate topic, we think **MR-MC should start with a study item** as the topic can have impacts across all WGs. A study would allow 3GPP to focus on the cases that are most important , and identify the minimum requirements to starting the work item.

Finally, how these topics are exactly allocated to WIs can be considered in a holistic manner once we converge on the topics to include in Rel-18.

16 – Lenovo (Beijing) Ltd

For CA enhancement, regarding cross-carrier scheduling, we propose in Rel-18 to specify multi-carrier scheduling via a single DCI, i.e., a single DCI on one carrier can schedule multiple PDSCHs on multiple carriers where each PDSCH is scheduled on one carrier, or schedule multiple PUSCHs on multiple carriers where each PUSCH is scheduled on one carrier. The multiple carriers can be located within FR1 and FR2 including licensed and unlicensed carriers. Furthermore, to guarantee a reasonable DCI payload size and keep "3+1" DCI size budget, two-stage DCI for CA enhancement is proposed as two-stage SCI in Rel-16 V2X.

We however do not see the necessity for supporting HARQ across carriers as the associated complexity from actual implementation perspective could be too high.

For MR-MC, companies views seem diverging from optimization for normal MRDC scenario (e.g. fast PSCell and SCell role change), and real MRMC scenario (e.g. UE can be configured with multiple SCGs). It would be good to clarify if proposals not for "multi connection" are in the scope. We are open though.

Considering the scenario that SN is using FR2, and due to the dynamic channel condition change of FR2, it seems beneficial to support L1/L2 centric PSCell change. For example, multiple SCG configurations can be provided to the UE in advance, and the PSCell change (i.e. SCG change) can be triggered dynamically by NW based on L1 measurement using L1/L2 signaling. Coordination between MN and SN is needed for MN to understand which is the current "serving/activated" PSCell/SCG. We are open to discuss inter-SN (i.e. inter CU) PSCell change, but believe intra-SN (i.e. intra CU) PSCell change can be a good start point. To avoid overlapping with mobility discussion, e.g. feMIMO, fast/dynamic PSCell change could focus on the signaling design and coordination between MN and SN taking into account the outcome of mobility enhancement.

17 – Spreadtrum Communications

We support the MR-MC enhancements. From our perspective, RLF enhancement, such as MN/SN role switching can be studied in Rel-18. It is beneficial to improve robustness through minimizing RRC reestablishment caused by RLF. In order to achieve this objective, the fast/dynamic switching mechanism can be further studied in the procedure of handover or PScell changing.

18 – Ericsson LM

For the first bullet, we want to make it more explicit what the objective is. In our view we think it is important to support FR2 Scell scheduling for PUSCH on FR1 Pcell.

As indicated by others, switching between SNs using CPC is sufficient from our point of view.

19 – Intel Corporation (UK) Ltd

Regarding Cross carrier scheduling enhancement, it is unclear to us what enhancements should be. We may consider some enhancements based on R17 DSS, e.g.:

- FR2 Scell scheduling for PUSCH on FR1 Pcell (extension of R17 DSS)
- Multi-cell scheduling by single DCI (was discussed in R17 DSS)

For MR-MC enhancements, the question is whether we want to activate multiple SCG simultaneously? Or only activate one of them (selective activation as mentioned by ZTE), and do fast switching based on radio condition/load condition. If it is the latter, then it should be discussed under mobility enhancements.

20 – KDDI Corporation

1. We are supportive to MR-MC, but maybe we mix up the following two different objectives in the initial discussion as Qualcomm and Huawei commented above.

a. Multi cell groups management(fast role switch of cells/fast SN switching/pre-configured more than the number of cells can be used at once)

b. Triple connectivity (Dual connectivity + additional one downlink)

2. With regard to a) Multi cell groups management, some people argue that the same thing can be done by CHO, but we think Multi cell groups management can do more that CHO. CHO is required frequent RRC reconfigurations, and Multi cell groups management tries to address this issue.

3. With regard to b) Triple connectivity, as docomo commented above, it is very attractive to operators, sine achieves flexibility for the design of accommodating cells in gNBs.

21 – ZTE Corporation

<u>Cross carrier scheduling enhancement</u>

We also think cross carrier scheduling can bring more flexibility and efficiency, thus we support it in Rel-18.

<u>MR-MC</u>

FR2 is one of the key enabler for 5G advanced to unlock wider bandwidth, higher throughput, lower latency and larger capacity, and MR-MC is one of the essential enhancements for FR2 to improve the robustness and reduce the interruption time. Therefore, we think MR-MC should be included in Rel-18.

For MR-MC, to balance the performance and complexity and make the feature more promising to the market, we think MR-MC with selective activation (i.e. up to two legs can be activated simultaneously) should be considered as baseline, and the following scopes can be considered:

- Support the configuration of more than two cell groups.
- Dynamic cell group activation/deactivation/switching mechanism
  - The mechanism can be applied to both MCG and SCG, including the role change between MCG and SCG.
  - Both NW triggered and UE triggered mechanism can be considered

- Prioritize the fast activation/deactivation/switching among cell groups within one CU (i.e. without security key change, path switch). Other case can also be considered if time permit.

- UE capability management/coordination enhancement (e.g. only the activated cell group will consume UE capability)

Considering the impact to specs, we also think a separate WI with study phase is preferred. However, we understand the main intention of the email discussion is to identify the potential technical enhancement for Rel-18, how to group the feature for each WI can be discussed in the next phase.

22 – LG Uplus

We have similar view like KDDI with regard to MR-MC where it can be considered into two areas.

2.1.4 Flexible spectrum integration

Moderator recommendation for intermediate round: RAN should first identify what can be achieved with flexible spectrum access that cannot be achieved with CA enhancements. Companies are invited to provide their views on the key differences and similarities of flexible spectrum access and CA enhancements (e.g. pros and cons).

Feedback Form 11:

1 – Charter Communications

Flexible and efficient usage of non-contiguous spectrum holdings is of high priority for us. We have previously proposed the following:

•Study methods of efficient scheduling, data channel transmission, and overhead reduction for a single cell with non-contiguous frequency resources. [RAN1]

–Baseline for enhancements is CA of the non-contiguous resources.

–Leverage as much as possible non-contiguous transmission mode with intra-carrier guardbands introduced in Rel-16 NR-U for channels wider than 20 MHz.

Efficiencies compared to CA operation should be clear, for e.g., reduced L2 overhead, more efficient scheduling via a single DCI, etc.

2 – Futurewei Technologies

The usefulness of the work seems to be clear amongst the group. The exact solution can be study first. Whether it is based on CA framework and otherwise can be the outcome of the study.

3 – NTT DOCOMO INC.

While sympathizing with the views that the benefit seems to be clear, we think the existing CA/DC framework may be able to cover almost all of the targets. In this sense, we think it would be good to clarify the approaches a bit more at first, as suggested by Moderator.

4 – QUALCOMM JAPAN LLC.

It looks to us that many of the issues raised so far can be addressed by utilizing the existing CA framework.

- System information and paging overhead > Non-CD-SSB (SCell only cell)

- Defining narrower carrier bandwidths.
- SCell activation/deactivation.

1. System information and paging on anchor carrier & initial access on non-anchor carrier.

We think the overhead reduction can only be justified if such anchor and non-anchor carriers are very narrowband. But it is not clear from this discussion and even from the discussion in the previous workshop, how narrow such carriers can be. From the information available so far, we do not think additional complexity is justified and do not see the need of enhancements.

2. Multiple active DL&UL BWPs in the serving cell where each BWP is mapped within a carrier of contiguous bandwidth

This seems to be motivated by the non-anchor carrier which cannot be an SCell on its own. So the question above applies here as well. This can be done with SCell activation/deactivation with SCells of narrower bandwidth, for instance.

5 – Deutsche Telekom AG

We are interested in more flexibility for the CA scenarios, but in particular flexibility like proposed by us in RWS-210032 allowing a full decoupling of the the UL/DL frequenvy in a flexible manner, does not required the CA framework and shall be applicable in IDLE mode as well. There are clear benfits in terms of UL coverage enhancement, power consumption reducutions (both UE and network side) as well as spectrum ressource usage (i.e. no signalling on the DL cell which shall not be used (i.e. the one paired to the UL for a given FDD band), less reconfiguration overhead compared to CA etc.

So we see this topic should be treated independent of the CA framework.

6 – Samsung Electronics Co.

We share QC's point above. More importantly, the key question would be what is NOT possible with current CA/DC framework.

SSB-less SCell (by removing the restriction of intra-band CA) can achieve the reduction of common control overhead which is targeted here.

SCell activation/deactivation procedure has been enhanced for Rel-16 & 17 which enables UE power saving and fast cell switching (activation).

Beyond current CA/DC framework, we are lacking of the understanding of implementation impact (UE/BS) from the proposal.

7 – vivo Communication Technology

We are intrerested in the "anchor carrier" concept for IDLE/INACTIVE UEs for the scenario with scattered carrier with narrow bandwith in low bands. In this case the DL common channels e.g. SSB/Paing/SIB is only transmitted on the anchor carrier but not the non-anchor carriers. However, we think allowing random access on the non-anchor carrier is beneficial to avoid the congestion issue on the anchor carrier.

The SSB-less Scell as commented by QC and Samsung can be reused here to reduce the SSB/Paging/SIB transmisison on the non-anchor carrier but it also prevents the UE random access on these carriers, therefore some enhancements would be needed.

8 – China Telecom Corporation Ltd.

We think the motivation for flexible spectrum integration includes two aspects:

1. coverage: the flexible linkage between high frequency and low frequency

2. throughput: reduce the overhead and single DCI schedule multi carriers

For 1, for example, one downlink carrier (high band) may be linked with two uplink carriers(high band + low band), which means one downlink carrier will be shared by two cells. We think this is different from existing CA/DC enhancement scope and will be targeted here.

For 2, we agree with Samsung's suggestion that the SSB-less SCell will be targeted here.

Regarding the Scell activation/deactivation procedure, we think the idle mode shall be considered here.

Regarding the implementation impact, we think at least the concurrent transmission for neighboring bands will have impact to UE, which also could be targeted here.

9 – TELECOM ITALIA S.p.A.

Support DT view

10 – China Mobile Com. Corporation

We are supportive for Flexible Spectrum Integration. The different between Flexible Spectrum Integration and CA is quite clear:

(1) Flexible Spectrum Integration aim to improve for all RRC mode, includes CONNECTED, INACTIVE, IDLE mode, while CA is only for CONNECTED mode UEs.

(2) For IDLE and INACTIVE mode, SI and paging are broadcast on the anchor frequency, and UE can initiate RACH procedure on either anchor frequency or non-anchor frequency. The benefits are coverage improvement, flexible usage of spectrum and to allow flexible paring of DL and UL frequencies.

(3) For CONNECTED mode, BWP switching and activation like procedure is utilized to add frequencies as serving cell, instead of Scell addition/modification/release procedure. The benefit is simplicity of cell management and fast activation/switching of frequencies.

11 – Lenovo (Beijing) Ltd

Compared with CA enhancement, we think the main benefit of flexible spectrum integration is the overhead reduction gain from using one of the integrated carriers for transmitting common control signaling.

12 – China Unicom

We are interested in flexible utilization of non-contiguous/contiguous spectrum treated as one serving cell, as well as allowing decoupling of the UL/DL frequency. There are clear benefits of higher spectrum efficiency and lower cost on control channel overhead. We are interested and supportive to apply for IDLE/INACTIVE UEs.

Therefore, from our view, an individual topic independent from the CA framework is preferred.

13 – Ericsson LM

We agree with some of the prior comments that the benefits of not working within the CA framework are not very clear. Also, it is not clear if the solutions proposed outside of the CA framework are backward compatible. It may therefore be better to first understand what enhancements CA can achieve. We also agree with Qualcomm that many of the existing CA features (e.g. SCell activation/deactivation, BWP switching etc) can address the issues. The feature should therefore be based on existing CA framework.

14 – Spreadtrum Communications

As we commented in initial round, in our understanding both single cell with non-continuous spectrum and multiple cell could achieve the same functionality. Agree with moderator, the additional benefit for single cell with non-continuous spectrum needs to be identified on top of CA framework.

15 – Nokia Corporation

As commented by many, the desired end result of many of the proposals seem achievable within the existing CA framework. The single DCI for multiple carriers having been on the table at least for two releases as a PDCCH overhead reduction candidate, and could be considered in the CA/DC enhancements as a potential enhancement. The ability for more flexibly couple one band's DL to another band's UL should not be foreign to CA framework either, even if some additional enhancements enabling the operation maybe useful.

16 – ZTE Corporation

We agree with moderator that we should first identify what can be achieved with flexible spectrum access that cannot be achieved with CA enhancements.

Based on our analysis, the following claimed potential benefits for flexible spectrum integration can be achieved by enhancements on the existing CA framework.

- 1. SSB/Paging/SIB overhead reduction. Currently, SSB is optional for SCell in intra-band CA. If we extend this to inter-band CA, then the overhead of common signaling can also be reduced. SSB-less SCell has smaller spec impact.
- 2. Overhead reduction. For L1 overhead reduction, One DCI scheduling multiple PDSCH/PUSCHs on multiple carriers can be applied to the existing CA framework if agreed in Rel-18. Also, the multi-slot PDSCH/PUSCH is also possible to reduce the scheduling overhead. For L2/L3 overhead reduction, there is a similar topic of "signaling overhead optimization in CA/DC" in CA/DC item.
- 3. Fast Carrier switching. The existing SCell dormancy and Rel-17 fast SCell activation/deactivation can support fast Carrier switching already. And there is a similar topic of "fast SCell/SCG setup/activation" in CA/DC item.
- 4. Simplified/better mobility management. The Rel-18 mobility enhancement is discussing some enhancements for this aspect. For faster switching the carrier for SSB/SIB/Paging, there is also a similar topic of "fast role change in CA/DC" in CA/DC item.
- 5. Carrier selection during RACH for load balance to reduce PRACH/msg3 collisions. This can also be realized based on the existing CA framework if necessary.
- 6. Flexible association of DL carrier and UL carrier. It can be realized by the existing CA framework as discussed in our previous contribution (RWS-210479).

Overall, we suggest to first identify and align with other companies what needs to be enhanced. Enhancements on top of the existing CA framework is preferred from our perspective.

17 – Huawei Tech.(UK) Co.. Ltd

For initial access where one SSB/SIB in one band carries information for the uplink of initial access in another band, and UE performs a selection of different bands for DL and UL in initial access, it should be clear that this does not exist under the CA framework (by the way CA is only defined once UE is in connected mode). We support the view from DT on this point.

Once a UE has accessed the network in that way, it should not be a requirement that additional DL or UL must be added for the UE to start operating under connected mode. Therefore, the UE should be able to continue operating where the PCell has DL and UL from different bands (currently not allowed by the definition of PCell under CA framework).

Adding more bands with DL and/or UL in that serving cell should then be a straightforward extension. Even if the overhead reduction gains (PDCCH overhead reduction, SSB overhead reduction) could be pursued under the CA framework, there are still differences:

▪ One serving cell solution can support flexible UL/DL band decoupling naturally, including flexible 1 UL + 1 DL decoupling and 1 DL + multiple UL/SUL decoupling, while CA framework does not support a cell without DL.

▪ One PCI is needed and no neighbor relation is needed to be configured for multi-bands of one serving cell, while neighbor relations are needed for CA framework. Therefore, one serving cell solution can simplify O&M.

18 – MediaTek Inc.

CA framework is already in 5G NR since Rel-15. We prefer to further enhance its efficiency to solve the problems, instead of creating a new one. New framework will introduce large impacts on UE implementation. Unless there is problem which can't be solved by CA framework, we don't see strong needs to create a new one. Maybe it's more suitable to consider this in next generation of wireless mobile communication system.

19 – CATT

Compared with CA enhancements, flexible spectrum integration (FSI) can be applied to RRC idle and RRC inactive in addition to RRC connected. UE can select one carrier from multiple carriers for RACH procedure which cannot be supported by CA framework. This can be used to improve coverage, and for flexible spectrum utilization.

BWP framework can be reused for FSI to achieve faster carrier switching compared with SCell activation/deactivation.

In addition, FSI can achieve flexible association of DL carrier and UL carrier.

20 – Intel Corporation (UK) Ltd

We agree with moderator's suggestion that RAN should first identify the different from CA framework and potential enhancements in CA framework.

The following is our view on how flexible spectrum would be related to the existing CA framework.

Regarding single PDCCH scheduling PDSCH/PUSCH over multiple CCs, in RAN1, there was proposals to schedule PDSCH/PUSCH on multiple cells by single DCI in multiple releases. The recent discussion on this feature is in Rel-17 DSS. Reduced PDCCH blocking ration, CCE overhead saving were discussed but it was not concluded due to diverged view on evaluation. This could be discussed in CA framework.

Regarding extending BWP, we don't see any showstopper using BWP to configure different carriers. But the current NR doesn't support simultaneous BWP operation. If the simultaneous BWP operation is supported, it would achieve the same operation as the proposed flexible spectrum operation.

Regarding DL-UL decoupling, RAN2 design supports to indicate different frequency information(ARFCN) for FDD and SUL. So from RAN2 point of view, there is no showstopper to support it. However, RAN4 need to study the feasibility.

Overall, we don't think a new framework is needed to support the flexible spectrum sharing.

21 – Guangdong OPPO Mobile Telecom.

CA framework is already in 5G NR, so we firstly prefer to further enhancement based on CA framework. If there is an insolvable problem by CA framework, we may consider this new concept.

As a UE vendor, we are looking forward response on the impact on UE implementation.

22 – VODAFONE Group Plc

We support DT and Telecom Italia.

2.1.5 RIS (Reconfigurable Intelligent Surfaces)

Moderator recommendation for intermediate round on RIS: Companies supportive of RIS to provide details on what kind of study or specification support is needed for RIS so that other companies can better assess the situation and reconsider their positions.

Feedback Form 12:

1 – Verizon UK Ltd

We were unable to provide input to the first round due to nwm and our time zone. We are interested in RIS as a technology to extend e.g., mmW coverage. We are interested in limited studies in e.g., modeling and control as some companies suggested to pave way for early standardization in the future.

2 – InterDigital France R&D

We had a similar issue as Verizon. We believe that it is an interesting technology with promising use cases. However, it can be down prioritized for now.

3 – Convida Wireless

We think that RIS is an interesting topic to explore and study although it may not be the highest priority for Rel-18 SI/WI.

4 – China Telecommunications

We think at least: use cases for RIS, RIS modeling, channel modeling and control mechanism can be studied in Rel-18. Thus, we supprt a SI for RIS.

5 – Rakuten Mobile

We think there is strong support among both equipment suppliers and operators to include RIS Study Item within Rel-18.

6 – Deutsche Telekom AG

-> postpone topic to Rel-19

7 – Samsung Electronics Benelux BV

We also see some interests on RIS, but we do not see any clear use cases and spec impacts over other entities such as smart repeater or IAB. So, we are not sure that RIS is necessary to be standardized.

8 – vivo Communication Technology

We think a slow-start could be considerd for RIS study in Rel-18, i.e. to start with use cases and channel modeling, etc.

9 – Huawei Technologies France

We think it is premature to have RIS study in Rel-18, but as a promising technology it can be further studied in future releases.

10 – China Unicom

The potential scope of this study item shall include

- scenarios,
- channel modeling,
- study and design side control information (beam related) over the interface between gNB and RIS
- system performance evaluation,
- mobility issues.

11 – TELECOM ITALIA S.p.A.

The topic is of interest, but still a lot of academic research is ongoing. Postpone to further Releases

12 – CATT

We think RIS is an interesting technology. Before we have a conclusion on whether it is studied in Rel-18, the functionality of RIS devices, the benefits of RIS compared to relay and repeater/smart repeater and scenarios of RIS shall be clarified first.

13 – MediaTek Inc.

We understand companies' interests on RIS and potential benefits brought from this technology for high-frequency bands. However, there are already three relay-like solutions (i.e. IAB, smart repeater & SL UE relay) specified in 3GPP. It would be better to observe what's the problem these solutions can't solve in real network first and then consider other solutions. Suggest to postpone the work to later releases.

14 – Sony Group Corporation

We think that the following items can be studied in a Rel18 SI: scenarios/use cases, channel modeling enhancements and side control information, including at least beamforming information configuration. Interference management and the design of the gNB to RIS interface can also be considered. Please, see our comments to the initial round for further details.

We therefore we would like to see a RIS SI in Rel18. In our view, RIS and smart repeaters (currently being discussed in thread#4) should be studied in the same SI.

15 – ZTE Corporation

We are supportive to initialize the RIS related to work in Rel-18 as commented before. Comparing to the others solutions including relay and repeater, the RIS is nearly passive with lower power consumption and can be used to improve the signal quality (SINR) without D-A/A-D. Regarding the scope, in our view, at least the following should be considered:

- Methodology for evaluation including use case identification, channel model, and potential modeling on RIS self.
- The side control-related discussion to enable the adaptive behavior of RIS.

For the 2nd point, there is potential overlapping with discussion for other technique, e.g., smart repeater. And it will be preferred to have a joint discussion on this aspect for these two techniques.

Moreover, investigation on other aspects, e.g., interference management, can also be considered during the study.

16 – Philips International B.V.

We propose to start with a small list of initial study aspects for release 18, for example beam management/beam sweeping, interference management, and side control over the gNB-RIS interface (e.g. beam related), including thinking about control over the state of the RIS and scheduling.

17 – CEWiT

We are open to study RIS in Rel. 18 on following aspects

1. Channel Modeling for RIS
2. Evaluation methodology

18 – KDDI Corporation

As potential study areas, in addition to the channel model, it is important to study how much effect can be obtained in what kind of use case. As necessary specification supports, it is necessary to specify an interface to dynamically control the reflection direction of the RIS. It would be more efficient to discuss this control information together with the discussion on the side information of smart repeater.

2.1.6 Others (RAN1-led)

Moderator recommendation for ”Others (RAN1-led)”: Given the very strong support for DSS, focus intermediate phase discussions on DSS. Companies to provide additional details on what features should be enhanced for DSS in Rel-18.

Feedback Form 13:

1 – Verizon UK Ltd

This is our initial round comment - delayed due to nwm and our time zone. Count us as a firm supporter of futher DSS enhancement in Rel-18. More will be provided in the 2nd round later.

2 – Charter Communications

We suggest DSS be handled separately as a generalization of CA/DC enhancements. A more forward-looking feature is enhancements for coexistence between NR and non-3GPP incumbent systems such as radar. SA1 has proposed a corresponding study in **S1-213015.** We believe RAN1 should have its own study for NR-radar coexistence due to major implications for the PHY.

3 – AT&T

AT&T strongly supports DSS enhancements in Rel. 18. Two areas we see that need improvement are NB-IoT and eMTC coexistence with NR absent LTE eMBB and NR PDCCH enhancements to allow transmission on symbols with LTE CRS.

4 – Qualcomm Incorporated

With the basic/enhanced DSS features supported in Releases 15 – 17, we think many of the issues can be resolved already. Considering that PDSCH rate-matching around LTE CRS RE(s) is only based on semi-static configuration today, DCI based dynamic rate-match pattern indication for LTE CRS RE(s) could be a topic that we can consider in Rel-18.

5 – Apple Benelux B.V.

On the issue of DSS enhancements, the specific proposals need to be carefully selected and discussed. Overall, we have a concern on PDCCH RE level rate matching LTE CRS, from both the implementation perspective and performance perspective.

As an example, for PDCCH and PDCCH DM-RS puncturing around LTE CRS, as Nokia has pointed out, one of the issues raised was the PDCCH demodulation complexity increase. This has not changed. Highlighting one problem with this proposal, not all NR PDCCH is configured after the RRC connection setup. LTE CRS rating matching design principle for DSS does not require the UE to detect the LTE CRS, instead, the UE is explicitly configured with the LTE CRS time domain and frequency domain pattern by RRC. Certain PDCCH, for example controlResourceSetZero, searchSpaceZero which is used for initial acquisition are configured before the RRC connection. Therefore, even if we consider NR PDCCH rate match LTE CRS, we need to consider only specific NR PDCCHs after UE RRC connection setup. Furthermore, as we explained in the RAN plenary meeting last September 2020, RE level rate matching of PDCCH around CRS will inevitably puncture the PDCCH DMRS, since PDCCH DMRS and CRS have different densities, which causes the resulting PDCCH DMRS to be non-uniformly distributed. This will not only increase the UE implementation complexity, but also negatively impact the PDCCH performance. It is important to note that, even for PDSCH, when we support RE level rate matching to CRS, we do not support RE level rate matching of CRS for PDSCH DMRS.

6 – Verizon UK Ltd

We support continued optimization of DSS in Rel-18 (don't care in which WI). DCI based dynamic rate-match pattern indication for LTE CRS RE(s) is the top priority for us. PDCCH enhancements to allow transmission on symbols with LTE CRS and NB-IoT and eMTC coexistence with NR absent LTE eMBB secondary.

7 – Telia Company AB

Telia Company supports DSS enhancement proposals described in document RWS-210308.

8 – Intel Corporation (UK) Ltd

We support DSS enhancements in Rel-18 focusing on scenarios with small fraction of LTE users. Reagrding detailed objectives, we prefer more discussion on this issue:

1. For dynamic indication of CRS rate matching pattern.

   - We are wondering what is scenario that justifies dynamic indication of CRS rate matching including DCI-based CRS on/off? Is there assumption that LTE cells could be dynamically switched on and off? In typical deployment CRS should be always on (e.g. for RRM measurements) and we should expect that CRS interference is relatively static.
   - As far as we understand proposal in RWS-210308, DCI based CRS pattern indication is used to address interference problem from other LTE cells. We are wondering what kind of measurements of NR UE should be used to indicate LTE interfering cells to assist dynamic CRS rate matching pattern indication? Is it L3 inter-RAT CRS based RSRP or something else?
   - From planning perspective we have concern to start this work in parallel to already ongoing Rel-17 study on CRS interference avoidance in RAN4. It would be better to wait outcome so that RAN1 has better baseline to compare with.

2. We support DSS enhancement to enable uplink MU-MIMO pairing of LTE and NR users. Our SLS simulation results shows noticeable cell-edge SE gains when fraction of LTE users is small.

9 – Samsung Electronics Co.

We would like to understand which specific DSS enhancement feature is targeting here.

Regarding dynamic PDSCH rate-matching around CRS, it would be good to know the motivation – We are not aware of LTE networks dynamically changing CRS configurations.

As for FR2 Scell scheduling for PUSCH on FR1 Pcell, it is understood as a generalization of on-going Rel-17 DSS. However, due to the coverage gap between FR1 and FR2, we do not see the motivation.

10 – BOUYGUES Telecom

In addition to our initial round post, we see as critical point to enhance DSS support in a coexistence scenario with eMTC (and NB-IoT?), having in mind decreasing or zero LTE eMBB traffic in the future.

A comment on Intel's proposals: while the idea of pairing UL LTE and NR users in MU-MIMO is technically interesting, we wander about its usefulness in a real deployment scenario, where:

(1) in the DSS bands the operators mostly use passive antennas, without MU-MIMO capability

(2) the capacity challange is DL, so UL MU-MIMO is likely to be an exception rather than a rule.

11 – vivo Communication Technology

1. For NR PDCCH colliding with LTE CRS, we know that REL-15 UE FG3-2 "PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot" was introduced to address this problem in DSS. Wondering if there is strong motivation to not use the existing solution but introduce another solution for it.

2. For dynamic indication of of CRS rate-matching, we have the same question as Intel and Samsung about its use cases.

12 – Beijing Xiaomi Mobile Software

We would like to have a RAN-level study on the wireless sensing, so as to allow more companies to provide their views and uses cases on the sensing technique. The wireless sensing is a promising technique which can be used for auto-driving, smart phone, AR, robots, traffic monitoring and many public safety area. 3GPP with lots of licensed frequencies is able to provide more accurate and reliable sensing service than other techniques (e.g. wifi sensing).

13 – TELENOR ASA

Telenor Group shares Telia Company view. Telenor supports DSS enhancement proposals as described in document RWS-210308.

14 – Nokia Corporation

The PDCCH and LTE CRS in the same symbol is understood to have implications on the PDCCH demodulator in the UE and we acknowledge that the Nokia RP-201761 to RAN#89 did not address such aspects. Nevertheless we have seen this as a more interesting direction than the dynamic LTE CRS RM adaptation to dominant neighbour. The reason being that we don't immediately see the CRS rate matching adaptation requiring for such dynamics. In this context is also good to look at the ongoing RAN4 REl-17 work on CRS-IM and CRS-RM solutions over the interfering cell's LTE CRS (see LS to RAN in R4-2115741),.

15 – ZTE Corporation

Overall, we are open to consider DSS enhancements.

Based on the Rel-17 DSS discussion, some of the enhancements for DSS can be generalized to CA or EN-DC. For example, the SCell scheduling PCell in Rel-17 should also be applicable to CA case. From this perspective, to avoid any confusion and to make the potential enhancemtns for Rel-18 DSS more general, it is proposed to include the potential enhancements in "CA/DC enhancements" topic.

16 – Ericsson LM

We are of course happy to see a DSS being added to the list of Rel-18 topics.

Repeating the proposed objectives:

- Support DCI based dynamic adaptation of rate-matching around LTE CRS pattern(s)
- Support NR PDCCH reception in symbols overlapping with LTE CRS
- Support FR2 SCell scheduling PDSCH/PUSCH on FR1 P(S)Cell

Below we address some of the comments received.

Rate matching PDCCH:

Our proposal is not to ratematch NR PDCCH around CRS, but to allow LTE CRS to puncture NR PDCCH and DMRS in the relevant resource elements. Our evaluations indicate that though there is a loss in PDCCH decoding performance from this, the gain from the additional resources is larger.

Dynamic CRS ratematching pattern:

It is correct that LTE networks does not dynamically change the CRS configurations. However, the CRS interference situation for a mobile UE can change quickly, and hence we believe it is beneficial to allow fast

CRS ratematch pattern switching when CRS ratematching around strong CRS interference is used. Having this in DCI will then avoid excessive RRC reconfigurations. We believe that the current measurements are sufficient to enable identifying the CRS interference. On the relation to the ongoing RAN4 work, we consider this enhancement useful regardless of that work.

Extending SCell scheduling PCell to FR2:

For UEs in DL FR2 coverage but not UL FR2 coverage, it would be beneficial to allow scheduling of UL transmissions on a FR1 PCell from an FR2 SCell

17 – Bharti Airtel Limited

We agree with the moderator's summary that a Rel-18 DSS WI should be prioritized. As said in the Initial Round, we support the 3 WI objectives as proposed in RWS-210308.

18 – HUAWEI TECHNOLOGIES Co. Ltd.

In general, we think DSS enhancement is interesting. However, current solutions mentioned by companies need more clarification, especially on the motivation and the benefits. For example,

- Regarding dynamic adaptation of rate-matching around LTE CRS pattern(s): Not sure why RRC-based configuration is not enough. It is not clear how much more gain can be achieved on top of Rel-17 CRS-IC, which is being specified especially for this scenario. We should avoid specifying multiple options for the same target.
- Regarding NR PDCCH reception in symbols overlapping with LTE CRS: Our understanding is that the minimum necessary standard work would be to remove the constraint that a UE cannot receive PDCCH in a symbol where some REs belong to a CRS rate-matching pattern configured for the UE. Then, scheduling the UE with a sufficiently large aggregation level would help the UE decode the PDCCH in spite of the punctured PDCCH symbols. We should also note that Rel-17 already specifies a method to increase the capacity for scheduling a NR UE on a DSS carrier, with SCell scheduling PCell. In our view this might already be sufficient and it is not clear why Rel-18 UEs could not simply implement the Rel-17 technique instead of specifying yet another technique for sending PDCCH in symbols with LTE CRS. This way the capacity in DSS carrier can still be used for NR PDSCH, where the NR PDSCH can be mapped to the first symbol after the LTE control region (instead of the proposal to use that symbol for PDSCH) by shifting the PDSCH DMRS to a later symbol (as already supported by the NR specs).
- Regarding FR2 SCell scheduling PDSCH/PUSCH on FR1 P(S)Cell: It might be a corner case in practice since PDCCH resource in FR1 is enough. Typical operators have another non-DSS FR1 carrier, e.g., C-band with 100MHz bandwidth, there is no strong motivation to put PDCCH on FR2, especially since the coverage of the scheduling carrier will be much smaller than the scheduled carrier.

19 – MediaTek Inc.

We think most of performance gain for DSS are already exploited in Rel-15 17. We don't see much additional performance gain can obtained from the remaining enhancements. If necessary, we see some benefits to have "DCI based dynamic adaptation of rate-matching around LTE CRS pattern(s)" in Rel-18. For others, we don't see the necessity.

20 – VODAFONE Group Plc

Specific aspects to study are:

- enabling DCI based dynamic adaptation between different CRS rate matching patterns to improve NR PDSCH reception (when LTE-CRS is a dominant source of interference)
- allowing NR PDCCH in symbols with LTE-CRS to improve NR PDCCH capacity (when LTE-PDCCH is lowly loaded).

2.2 Moderator summary & recommendation for further discussions

UE power savings

While there a number companies who do not see necessity of a standalone study/work item on UE power savings, majority of companies have indicated support for a standalone study/work item focusing on ultra-low power UE receiver and wake up signal. The relevant work identified from companies' feedback in the intermediate round can be summarized as

- Performance evaluation UE power savings based on ultra-low power UE receiver and wake up signal (RAN1)
- Hardware feasibility evaluation (RAN4)
- Design of wake up signal for ultra-low power UE receiver (RAN1)
- Relevant procedures (RAN1, RAN2)

While there is good level of support on UE power savings based on ultra-low power UE receiver and wake up signal, a number of companies question the feasibility and benefit of this approach. Moderator tends to agree that the proposed approach has never been evaluated in 3GPP. If RAN does decide to include this item as part of Rel-18, it should start with a study phase (standalone SI or as part of REDCAP).

Companies are invited to refine the relevant work necessary for UE power savings based on ultra-low power UE receiver and wake up signal. In addition, all companies are invited to provide any other comments (if any) for the final round.

Enhancing and extending the support beyond 52.6 GHz

As noted in the initial round summary, companies' views on the need for further enhancements in Rel-18 are divided. Most importantly, multiple companies question whether the need for any enhancements is supported by market demand. If there is any relevant enhancement in Rel-18, the work scope would have to be compact as mentioned in the initial round. From moderator view, following are two possible alternatives:

- Focus only on 52.6GHz 71GHz and target critical areas to make existing specification support for 52.6GHz 71GHz more competitive in the market
    - For example, enhancements on channel access, multi-beam operation, coverage (RAN1)
- Focus only on beyond 71GHz and study new waveforms and relevant regulatory landscape but without any normative work in Rel-18 (RAN1)

Companies are invited to provide their views on which of the above alternatives is preferable. Furthermore, companies are invited to provide further feedback on what they consider to be important areas of

enhancements for 52.6GHz 71GHz (if not already included above). Any other comments are welcome for the final round.

CA/DC enhancements

As noted in the initial round summary, companies' views on further enhancements for CA/DC were generally supportive. Of the two potential areas for enhancement in Rel-18, the following relevant work were identified:

- Cross carrier enhancement: Multi-cell scheduling with single DCI, FR2 Scell scheduling for PUSCH on FR1 Pcell, cross carrier HARQ (RAN1)
- MR-MC: Enhanced simultaneous UL transmissions and DL receptions with multiple cell group management (e.g. fast cell group switching, UL selective activation) (RAN2, RAN3, RAN1)

Compared to MR-MC, cross carrier enhancement has relative higher level of support. For MR-MC, while it had majority support, there were a number of companies who didn't see the need. Companies are invited to refine the relevant work necessary for both cross carrier enhancement and MR-MC.

In addition, it seems that I have missed the proposal on enhancements focused on FR2-specific aspects. For FR2-specific aspects, I would like to have the proponents provide some inputs on what needs to be done and which WG should be handling it.

All companies are invited to provide any other comments (if any) for the final round.

Flexible spectrum integration

Similar to the initial round, company views are divided on whether a new framework needs to be introduced to efficiently handle segmented frequency resources. One group of companies are claiming "obvious benefits" while another group of companies are saying that the benefits over the existing CA framework are not clear.

Although the views are divided, moderator's suggestion is to first identify what needs to be done under flexible spectrum integration. Based on this, RAN could continue discussions to better understand the proposal and what the potential benefits are.

Based on the companies' feedback, following relevant work were identified:

- Decoupling of uplink and downlink bands for UEs in CONNECTED, INACTIVE, IDLE mode for various cellular operations (initial/random access, paging, PDSCH/PUSCH transmission, etc) (RAN1, RAN2)
- Improved BWP switching and activation/deactivation procedure for non-contiguous frequency resources (RAN1, RAN2)

Proponent companies are invited to refine the above relevant work so that other companies can better understand the proposal and potential benefits. In addition, all companies are invited to provide any other comments (if any) for the final round.

RIS (Reconfigurable Intelligent Surfaces)

As noted in the summary of initial round, there are quite a number of companies who do not think RIS is mature enough for Rel-18. And compared to the other candidate topics, the level of support does not seem strong. Given the situation, moderator view is that RIS be considered as a low priority item. If 3GPP does decide to work on RIS in Rel-18, it should be with a very limited work scope without normative work. For example,

- Study potential use cases, evaluation methodology including channel/device modeling, etc (RAN1, RAN4)

Proponent companies are invited to refine the above work scope. In addition, all companies are invited to provide any other comments (if any) for the final round.

Others (RAN1-led)

As noted in the summary of initial round, DSS received strong level of support from operators and vendors alike. Some candidate areas identified on DSS from the intermediate round are

- Improved NR spectral efficiency for LTE-NR coexistence (RAN1)
- More efficient NB-IoT and eMTC coexistence on NR carriers (RAN1)
- Coexistence with non-3GPP radio technology (RAN1)

Of the three candidate areas, enhancements for improved NR spectral efficiency for LTE-NR coexistence received the largest support. On the other hand, some companies questioned the necessity of additional specification support. For example, why dynamic rate matching around CRS when CRS is not a dynamically varying signal.

However, given the positive feedback from companies, moderator recommendation is to take DSS as one of the higher priority items in Rel-18 targeting at least improved NR spectral efficiency for LTE-NR coexistence.

All companies are invited to provide any other comments (if any) for the final round.

3 Final Round

3.1 Collection of company views

For the convenience of the interested companies, the moderator summary & recommendation from Section 2.2 are copied below under the relevant subsections.

3.1.1 General high-level views

Feedback Form 14:

1 – TELECOM ITALIA S.p.A.

Many of the proposed activities have a strong impact in RAN4. RAN4 objectives should be clearly identified to assess the overall workload in 3GPP and ensure that features are not only available on the paper, but can became real products

3.1.2 UE power savings

While there a number companies who do not see necessity of a standalone study/work item on UE power savings, majority of companies have indicated support for a standalone study/work item focusing on ultra-low power UE receiver and wake up signal. The relevant work identified from companies' feedback in the intermediate round can be summarized as

- Performance evaluation UE power savings based on ultra-low power UE receiver and wake up signal (RAN1)
- Hardware feasibility evaluation (RAN4)
- Design of wake up signal for ultra-low power UE receiver (RAN1)
- Relevant procedures (RAN1, RAN2)

While there is good level of support on UE power savings based on ultra-low power UE receiver and wake up signal, a number of companies question the feasibility and benefit of this approach. Moderator tends to agree that the proposed approach has never been evaluated in 3GPP. If RAN does decide to include this item as part of Rel-18, it should start with a study item.

Companies are invited to refine the relevant work necessary for UE power savings based on ultra-low power UE receiver and wake up signal. In addition, all companies are invited to provide any other comments (if any) for the final round.

Feedback Form 15:

1 – CATT

We are supportive of moderator's proposal to have a standalone study item on the ultra-low power WUS front-end device. We can incorporate the requirements of network coverage and impact to the NR network in the scope of study if companies had concerns on the network impact and coverage.

2 – Futurewei Technologies

We are generally support a standalone item focusing on ultra-low power UE receiver and wake up signal starting with a study. On the detailed proposal, as we stated in the previous rounds, a clear understanding of the use cases (UE connective modes, UE types, applications, etc.) and power saving requirements is critical for a focus study and useful design. If this is not yet clear to the group, we suggest that this is also part of the study.

3 – Motorola Mobility UK Ltd.

As pointed by many companies during the intermediate round of discussions, the study should focus on feasibility, applicable UE types, use cases, impact on coverage and latency, and an additional hardware

cost. For performance comparison, Rel-17 UE power saving features for idle/inactive UEs should be used as a baseline scheme.

4 – Qualcomm Incorporated

We agree with Moderator's evaluation of the situation. Some proper study and evaluation may be needed to have better understanding.

5 – Asia Pacific Telecom co. Ltd

For ultra-low power UE receiver and wake up signal, the listed objectives of UE power savings looks a good wayforward. We share the same view that the evaluations on feasibility, UE types, RRC states, use cases, gains (especially comparing to the legacy power saving schemes) should be studied and identified first.

6 – Apple Benelux B.V.

We are supportive of the moderator's recommendation to start with an independent study item. As has been mentioned earlier, the proposed approach has never been evaluated in 3GPP so it would be beneficial if a study item is considered prior to moving to the next phase. The relevant work identified in the proposal is fine.

7 – Samsung Research America

We are supportive to have a standalone SI. For the study scope, the relevant work in moderator's summary is a good starting point. For performance evaluation, we think coverage and system impact should be considered in addition to power savings. The relevant procedures can include UE operation before/after detection of WUS, and mobility management during low power WUS monitoring.

8 – LG Electronics France

While we are not convinced on the strong necessity of introducing ultra-low power UE receiver and wake up signal in Rel-18, we think the study (if introduced) should be clear on its use case (including type of UE) and benefits over Rel-17 power saving schemes in accordance.

9 – Intel Corporation (UK) Ltd

We agree with the moderator proposal that a proper study is necessary on this, and are open to a SI.

Also, it would be necessary to resolve/consolidate the decisions/conclusions on similar objectives discussed for "eRedCap" *[RAN93e-R18Prep-07]*.

10 – NTT DOCOMO INC.

We are supportive of moderator's proposal to study including the use cases, impact and feasibility of ultra-low power WUR.

11 – TELECOM ITALIA S.p.A.

It looks to me that the same proposal is under discussion under RedCap enhancements. The two threads should be merged and we support the moderator's proposal to have a study

12 – China Mobile Com. Corporation

We are generally fine with moderator's proposal. But we think the network impact, e.g., resource overhead, coverage, coexistence with leagacy UE should also be included in the objective of this SI.

13 – Beijing Xiaomi Mobile Software

We agree with the moderator and support a standalone study item on ultra-low power UE receiver and wake up signal.

14 – vivo Communication Technology

We agree with moderator observation and proposal. The proposed objectives can be the good starting point for further consolidation.

To address some of the comments from companies

1. For use cases and device types: We think the SI should target general NR use cases, and we can evaluate the power saving gain for differnt use cases (different use case may imply different device types, traffic models, power models)

2. For the Connection state, our main focus is IDLE/INACTIVE state. We could make it clear in the future discusison when drafting the SI objectives.

3. For system impact, coverage, overhead, co-existence with legacy signal/channels, we agree these are important aspects to be considered. We can discuss further how to incoperate them in the SID.

15 – China Unicom

We are supportive to have a SI phase on the ultra-low power WUS front-end device. And we agree with the scope that moderator proposed.

16 – Nokia Corporation

We agree with the moderator's assessment that the proposed approach has never been evaluated in 3GPP and that if RAN does decide to include this item as part of Rel-18, it should start with a study item. Considering that the benefits and suitable general use cases for wake up signal for ultra-low power UE receiver are not clear as proposed solutions are only available is small part of the cell area (cell centre), we don't see this as priority item especially before more analyses are provided to RAN discussion. Furthermore, It is important that every work and study item that adopts solutions that might impact network power consumption should consider those impacts as part of the assessment of different solutions. For example, UE power consumption should not be considered in isolation without considering the impact on network power consumption. If a dedicated study is adopted, it should be additional to suitable evaluations in other WIs, and it should also provide a suitable model for those other WIs to use.

17 – Spreadtrum Communications

We support moderator's proposal, additionally, we share with Motorola that additional hardware cost should be included into study as well.

18 – HUAWEI TECHNOLOGIES Co. Ltd.

We are generally supportive on the moderator's suggestion. We have one detailed comment as below: Wake-up signal was discussed in Rel-16 power saving study item and PDCCH-based WUS was specified in Rel-16. To avoid any confusion with legacy WUS, we suggest not to use "wake up signal" here. Instead,

we recommend the term of "signal design enabling the ultra-low power UE receiver". So we suggest to have the following revision:

− Performance evaluation of UE power savings based on ultra-low power UE receiver and signal design enabling the ultra-low power UE receiver ~~wake up signal~~ (RAN1)

- Design of ~~wake up~~ signal enabling ~~for~~ ultra-low power UE receiver (RAN1)

19 – TELENOR ASA

Telenor agree with Telecom Italy's comment.

20 – Panasonic Corporation

We support the standalone study item. Our view is performance evaluation UE power savings based on ultra-low power UE receiver should include the feasibility study and the power consumption model of ultra-low power UE receiver. Wake up signal would be one of the possibilities but the power consumption in poor SINR is more dominant by the measurements/mobility. Therefore, we don't want to limit wake up signal before the study conclusion of ultra-low power UE receiver.

21 – CAICT

We support moderator's proposal and the scope proposed by moderator should be the starting point.

22 – Ericsson LM

We are in general fine with the moderator's proposal, but even if a separate study item is agreed we would still like to see a strong emphasis on the RedCap use case and would like that explicitly mentioned.

23 – Philips International B.V.

We agree with moderator's proposals that a SI is needed on this. As pointed out by Intel, some consolidation with eRedCap (RAN93e-R18Prep-07) is needed.

24 – RadiSys

We agree with moderator's proposal that proper study and evaluation is needed on WUS and WUR.

25 – VODAFONE Group Plc

If any RAN study is viewed as successful, the system aspects will then need to be studied.

26 – VODAFONE Group Plc

The impact on the design of WUS/WUR should be evaluated for all UEs as it may impact the battery lifetime of other devices. Some clarification on the difference between the Rel-17 PEI and its overlapping functionalities need to be considered

27 – ROBERT BOSCH GmbH

We support the moderator view and summary. We also want to add our support for a standalone SI/WI focusing on ultra-low power UE receiver and wake up signal

28 – Sony Europe B.V.

There are two on-going threads of discussion, here and in Prep07/RedCap, on supporting low-power wake-up receivers/radios in Rel 18. These two threads should be merged.

We are supportive of moderator's proposal on starting with study phase. Details on related work can be discussed more after/during the study phase.

On the issue of performance evaluation in the list of identified work, the performance evaluation presumably is not just about the UE power savings (although this is of primary importance). Shouldn't the performance evaluation also include issues of coverage and potentially capacity? The first bullet could be re-phrased as:

Performance evaluation, **including** UE power savings, **of UE operation** based on ultra-low power UE receiver and wake up signal (RAN1)

29 – MediaTek Inc.

Thanks for moderator summary, and starting with a SI looks reasonable.

Since there is parallel network energy saving discussion and the targeted evaluation methodology will take into account UE power consumption, it is curious to know whether the network energy consumption impact should be investigated for the ultra-low-power UE receiver and wake-up mechanism. **Thinking one step further, can the technology leverage the unified evaluation method (including network nodes and UEs) and also be developed to benefit both network nodes and UEs? If we would like to extend UE power saving evaluation methodology, we suggest to discuss the synergy with network energy saving and potential unified design for the ultra-low-power wake-up mechanism.**

30 – Guangdong OPPO Mobile Telecom.

OPPO we look the UE power saving as quite important issue to be study. Thus, a good UZP and AZP WUR/WUS should be included. We are fine to included it as a dedicated item to have better scheme to be supported.

31 – Everactive

Everactive supports including a wakeup signal for UE power savings in general, though we believe this feature can have a much more significant impact on IoT and RedCap use cases where average power is in general much lower, and energy is more scarce. We note that in the "RAN93e-R18Prep-07 - RedCap evolution" email discussion there is additional discussion and interest in a wakeup signal and ultra-low power wakeup receiver.

3.1.3 Enhancing and extending the support beyond 52.6 GHz

As noted in the initial round summary, companies' views on the need for further enhancements in Rel-18 is divided. Most importantly, multiple companies question whether the need for any enhancements is supported by market demand. If there is any relevant enhancement in Rel-18, the work scope would have to be compact as mentioned in the initial round. From moderator view, following are two possible alternatives:

- Focus only on 52.6GHz 71GHz and target critical areas to make existing specification support for 52.6GHz 71GHz more competitive in the market

- For example, enhancements on channel access, multi-beam operation, coverage (RAN1)

– Focus only on beyond 71GHz and study new waveforms and relevant regulatory landscape but without any normative work in Rel-18 (RAN1)

Companies are invited to provide their views on which of the above alternatives is preferable. Furthermore, companies are invited to provide further feedback on what they consider to be important areas of enhancements for 52.6GHz 71GHz (if not already included above). Any other comments are welcome for the final round.

Feedback Form 16:

1 – Futurewei Technologies

We generally agree with moderator's assessment and can be open for some focused work. For the 2 listed alternatives, key issues that are not addressed (maybe as leftover) in R17 WI can be considered for R18. On waveform study for beyond 71 GHz, we can also be open for future oriented work. However, a better planning from RAN considering the proper timeframe of work is needed. One possibility is to start at RAN level in R18 to easy the work load at WGs.

2 – Intel

We understand concerns of prioritization of the work. In order to assess which topics should be approved for rel-18 among all suggested items, we think it would be better to focus on the potential objectives at this stage considering realistic TU limitations that are expected rather than trying to down scope the work without looking at the objectives and required TU allocations. Therefore, we suggest the following objectives for the two alternatives suggested by the moderator.

1) 52.6GHz ~~71GHz and target critical areas to make existing specification support for 52.6GHz~~ 71GHz more competitive in the market. Some priority objective can be removed depending on TU allocations. It should be noted that many of the list still could be finalized in Rel-17, in such case the objective can be removed. We expect some of the listed enhancements should be able to be completed in Rel-17, but maybe not all of them. Therefore, actual objective is likely to be smaller than listed below.

Feature enhancements:

RAN1 Enhancements of channel access (if features are left out from Rel-17);

RAN1 Enhancements of multi-beam/panel/TRP operation (if features are left out from Rel-17);

RAN1 supporting coverage enhancements (feature was excluded from Rel-17 WID);

Performance enhancements:

RAN1 Enhancements to robustly sustain high peak rates (e.g DMRS/PTRS enhancements, non-uniform constellation, etc) (if feature(s) left out from Rel-17);

RAN1 capability for supporting lower PDSCH/PUSCH/CSI latency (if low latency capabilities are left out from Rel-17);

RAN4 enhancement to support faster transient times (if left out from Rel-17);

Any leftover RAN4 work:

RAN4 any core/performance requirements that might have been de-prioritized in Rel-17 and left incomplete (e.g. requirements for non-handheld UE power class, licensed band definition, etc)

2) beyond 71GHz and study new waveforms and relevant regulatory landscape but without any normative work in Rel-18 (RAN1). It should be noted that depending on the scope/objective and allocated TU budget the objective could be down-selected or alternatively multi-release study could be considered.

RAN1 use case and regulatory landscape study (that are not captured by TR38.807)

RAN1 study of waveforms and numerologies

RAN1 identify potential specification impact

RAN1 any updates to channel mode (if needed)

RAN4 RF impairment modeling (e.g. phase noise, PA modeling (if applicable))

3 – Samsung Electronics Co.

In general, we agree with moderator's assessment: including both topics into Rel-18 work scope may not be realistic considering the Tus and urgency of the two topics. Between the two topics, we believe the enhancement to 52.6 to 71 GHz may have more immediate market impact, although we do agree the study on beyond 71 GHz has an important long-term merit for 3GPP. Hence, we prefer to focus only on the enhancement to 52.6 to 71 GHz, with target to identify essential items for working scope and minimize the assigned TU. The final assessment of whether such a WI is needed for Rel-18 can be performed after Rel-17 WI on 52.6 to 71 GHz completes, e.g. in RAN#94-e.

4 – Qualcomm Incorporated

Between the two alternatives the moderator identified, we would prefer the 2nd (focus on beyond 71GHz) with a reduced scope (focusing on waveform study and may be a few key issues), to pave the way to introduce the FR in future releases of NR. For the first alternative, before deployment of FR2-2, it is hard to identify which areas need further enhancement.

5 – AT&T

Presented with a choice we prefer enhancements in 52.6-71 GHz. The proposed scope by the moderator is fine with us.

6 – Apple Benelux B.V.

We are fine with both proposals (although we may need to add down-scoped R17 items to proposal 1) and ideally, we would open to both the SI and WI in Rel-18. However, if we have to choose, we would rank the > 71 GHz SI slightly higher than the FR2-2 WI.

7 – NTT DOCOMO INC.

At this moment we think the second bullet seems to be deserving to have Rel-18 TU compared to the first bullet since what causes the lack of competitiveness of Rel-17 NR 52.6 - 71 GHz specification is not crystal clear yet. The aspects that Moderator has kindly captured except for coverage are not excluded yet from Rel-17. Since the number of TUs will be limited for this topic, waveform study for beyond 71 GHz as an investment for future specification will fit more for the limited TUs in Rel-18.

8 – Nokia Corporation

We agree with the moderator's assessment in general, and we think the discussion should focus on what a potential work on 52.6 - 71 GHz could look like, if needed at all. It should be noted that certain aspects that are raised above, e.g. coverage and multi-beam operation, can (and should) reuse what is already available

in FR2-1. In fact, this has been the approach taken in 3GPP, following the guidelines on the WID. Hence, this needs to be taken into account when evaluating if a dedicated WI for FR2-2 is required in Rel-18 or not. Moreover, we must remember that often in 3GPP many enhancements are proposed and some are not taken because the group could not reach consensus to support it, and not really due to lack of time. It is important to consider this distinction between these and the true critical leftovers.

9 – LG Electronics France

We are not certain yet whether beyond 52.6 GHz should be the most important topic for Rel-18. However, if we should choose one alternative under the assumption that we will have Rel-18 item for beyond 52.6, we prefer the second alternative (i.e., to study new waveforms and relevant regulatory landscape beyond 71 GHz) as the long-term investment in a higher frequency range.

10 – Huawei Tech.(UK) Co.. Ltd

We agree with the moderator's assessment and think it is better to understand the exact proposed scope of 52.6-71 GHz and above 71 GHz, then further discuss how to proceed with this area for Rel-18.

11 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility

In our view, both the topics are equally important and also in line with the general recommendation for Rel-18 to consider both short term and long term markets/commercial needs. Further consideration of the two topics should be independent of each other. However, if there is an absolute need to consider only one of the two topics, we would have slightly higher preference for the WI to further enhance NR operation between 52.6-71GHz considering short term needs.

We would suggest relatively a smaller work item for further enhancement of FR2-2 (52.6-71GHz) in comparison to on-going WI in Rel-17. We are fine with examples areas listed by moderator to allow for compact WI scope.

For extension of NR beyond 71GHz, we also expect only SI phase in Rel-18 to study new waveforms and evaluation methodology. We could even consider a later start for this potential SI in Rel-18.

12 – TELECOM ITALIA S.p.A.

Strong concern with both proposals, due to not clear technical improvement required, lack of market needs and major impact on RAN WG workload (please DO NOT forget RAN4).

It seems that only supporting companies are commenting, while in the first round a large number of companies indicated no need for activity in this area

13 – ETRI

Thank you for the summary, and sorry for joining this discussion lately. Considering both immediate and longer-term commercial needs, we think both alternatives are important. In case of the first alternative, it can be combined with the leftovers from Rel-17 (if any). Regarding the second alternative, it is worth to study with limited TUs for future specification similar to AI/ML and evolution of duplex.

14 – Guangdong OPPO Mobile Telecom.

In general, we agree with moderator's assessment. Between the two alternatives, we prefer the first alternative, i.e., focus on enhancements in 52.6-71 GHz.

15 – ZTE Corporation

We agree with moderator's assessment on the two possible directions. We are not sure if the down-selection is needed at this stage, but if it has to, we would slightly prefer the enhancement (including the left-overs) on 52.6 71GHz.

16 – Ericsson LM

As expressed by a number of other companies in the prior discussion rounds we do not support either alternative for a Rel-18 WI or SI.

Regarding potential enhancements in the 52.6 - 71 GHz range for Rel-18:

- We agree with the view expressed by several companies that enhancements should not be considered before there is market uptake and experience from the field can be used to focus what enhancements are needed (if any).
- A number of companies discuss potential Rel-17 leftovers, and at this point it is not clear if there will be leftovers from the currently defined WID, hence it is premature to conclude on a Rel-18 WI for leftover items.
- Regarding other items listed by the moderator:
  - Potential channel access enhancements
    - Here we do not see a need at all for enhancements when it has already been proven during the Rel-17 SI that channel access failures are rare events and do not affect system performance. Already many of the channel access topics being discussed in Rel-17 are optimizations and not strictly necessary.
    - Furthermore, there is only one harmonised standard(HS) out of the three ETSI standards for the 60 GHz band that require LBT as channel access. As long as 3GPP is compliant with that HS, it is not clear that further enhancements/optimizations would result in more competitive 3GPP based products.
  - Multi-beam operation
    - This is already discussed in Rel-17 in feMIMO. We do not see additional enhancements that would be specific to 52.6 - 71 GHz that would warrant a Rel-18 WI.
  - Coverage enhancements
    - Coverage enhancement is already considered in Rel-17 and is being discussed also for Rel-18. We do not see additional enhancements that would warrant a Rel-18 WI specifically for the 52.6 - 71 GHz band.
    - Furthermore, it is typical that such enhancements should be considered based on whether or not there are real coverage issues observed in the field. Given lack of deployments, it is completely unclear where to focus energy on coverage enhancements for the 52.6 - 71 GHz band. We note that two potential coverage bottlenecks have indeed been addressed already in Rel-17, namely uplink control (PUCCH) and PRACH. Currently, we don't see other control/data channels that are a bottleneck.

Regarding potential study of new waveforms in Rel-18:

- We understand that this is a potential long term investment; however, our view is that not only it is too early for such a study, but also such a study would require heavy RAN4 involvements.
- A better timeframe for studying the frequencies above 71 GHz would be 6G when the 3GPP technology has become more mature

17 – Sony Corporation We support focusing on 52.6GHz-71GHz and targeting critical areas to make existing specification support for 52.6GHz 71GHz more competitive in the market. We believe a refined specification in FR2-2 can benefit and accelerate the roll-out of the network in the future. In addtion, we also support focusing on the key areas listed by the moderators as examples.
18 – CEWiT We agree with the moderator. Completing the left over issues from Rel. 17 on NR between 52.6 to 71 GHz is important and should be given priority. However, we would also like to support study on NR beyond 71 GHz atleast from the waveform point of view.
19 – vivo Communication Technology We have similar understanding as QC, Apple and DOCOMO. We could carry out some pre-study on above 71GHz with limited TU allocation.

3.1.4 CA/DC enhancements

As noted in the initial round summary, companies' views on further enhancements for CA/DC were generally supportive. Of the two potential areas for enhancement in Rel-18, the following relevant work were identified:

- Cross carrier enhancement: Multi-cell scheduling with single DCI, FR2 Scell scheduling for PUSCH on FR1 Pcell, cross carrier HARQ (RAN1)
- MR-MC: Enhanced simultaneous UL transmissions and DL receptions with multiple cell group management (e.g. fast cell group switching, UL selective activation) (RAN2, RAN3, RAN1)

Compared to MR-MC, cross carrier enhancement has relative higher level of support. For MR-MC, while it had majority support, there were a number of companies who didn't see the need. Companies are invited to refine the relevant work necessary for both cross carrier enhancement and MR-MC.

In addition, it seems that I have missed the proposal on enhancements focused on FR2-specific aspects. For FR2-specific aspects, I would like to have the proponents provide some inputs on what needs to be done and which WG should be handling it.

All companies are invited to provide any other comments (if any) for the final round.

Feedback Form 17:

1 – Futurewei Technologies We support work on cross-carrier enhancement and think MR-MC work can be postponed.
2 – Beijing OPPO Com. corp. We are generally fine with the current scope. For cross carrier enhancement, we think RAN2 will also be involved, especially for cross carrier HARQ feature.

3 – Intel Corporation (UK) Ltd

Regarding Cross carrier scheduling enhancement, we are fine to consider following two enhancements based on R17 DSS, i.e..:

- o FR2 Scell scheduling for PUSCH on FR1 Pcell (extension of R17 DSS)
- o Multi-cell scheduling by single DCI (was discussed in R17 DSS)

For MR-MC enhancements, we support to use fast cell group switching to handle it. We consider similar solution as discussed under mobility, i.e. :

(1) Configuration and maintenance for multiple candidate cell groups [RAN2, RAN3];
(2) Dynamic switch mechanism among candidate cell groups [RAN2, RAN1];
In addition, to avoid the UE complexity, multiple candidate cell groups should not be activated simultaneously, i.e. only one of "candidate cell groups" is activated at a time.

4 – Samsung R&D Institute UK

Cross-carrier enhancements:

1) We are supportive for multi-cell scheduling with single DCI assuming that focus will be on scenarios with >2 cells in order to avoid repeating Rel-17 discussions.

2) There is no apparent need/deployment scenario to have FR2 SCell scheduling for PUSCH on FR1 PCell. It has at least the underlying assumptions that (a) an operator has no FR1 spectrum for NR only, (b) the FR2 coverage is large (e.g. within range of the FR1 coverage, including for providing Type-3 CSS), and (c) UEs have FR2 capability. There is no apparent need to address the combination of the above conditions (and there are also other restrictions such as the number of UEs that can be scheduled per slot in FR2). On a secondary level, it is strange to limit such scheduling to PUSCH. (We provided the same comment on DSS)

3) Cross-carrier HARQ will have substantial MAC impact and is not motivated for CA applications or CA capable UEs.

MR-MC:

MR-MC can achieve both throughput enhancement and mobility improvement without involvement of additional RRC reconfiguration. Although some of detail is slightly different among companies preference, all those have a large commonality and the different would not be so much. We see that both fast cell group switching and UL selective activation requires multiple cell group management with more than two configured cell groups, and dynamic control of part of configurations (entire cell group or uplink cell group). Thus we think a unified solution can be developed during the WI phase. Which features are used can be determined by operator's deployment and UE capability.

MR-MC with 3DL + 2UL does not have much difference from DC with 3DL + 2UL from RF perspective. We think this is an easier way to increase UE's peak throughput without complexity on UE implementation and without NW-side restriction on ideal backhaul. As mentioned by operators, more and more 5G frequency bands will be available soon, so 3GPP specification should be ready for this. A main feature of MR-MC is to allow the third cell group, which is clearly a connectivity issue, i.e. extension of DC to MC. We see MR-MC can be a separate WI apart from mobility.

5 – Apple Benelux B.V.

1. Huawei has mentioned that cross-carrier HARQ is under discussion in R17 URLLC. Given this information, we would prefer we wait till the conclusion of the discussion in Rel17 to make a decision on this element of the proposal.

2. For multi-cell scheduling with a single DCI and FR2 Scell scheduling for PUSCH on FR1 Pcell, a study on the potential gains compared with the increase in UE complexity is needed. We also agree with Qualcomm that any impacts should be kept as much as possible within RAN1.

3. For MR-MC, we do not see practical use-cases where the UE would be performing Rx/Tx on more than 2 cell-groups and again, UL would be the limiting aspects (practically and technically). Any enhancements then would be on fast switching etc., and to us, this is effectively mobility across different CGs and so the discussion in the mobility topic (including L1/L2 mobility) already handles this. As such we do not see a need for a separate item with >2 SCG with UL or DL for Rel-18. Note that if adopted, RAN4 may need to define requirement for the new procedure, such as latency for fast cell group switching and UL selective activation and as such should be listed in addition to the other working groups.

6 – QUALCOMM JAPAN LLC.

(For cross-carrier enhancement, we will not repeat the same comment over and over again. Our position is still the same.)

For MR-DC, we do not think the current way of discussion is very efficient. Many companies says it should be discussed in Mobility item, but we do not see many comments directly related to it in the Mobility thread. We suggest this email discussion concludes one way or another; MR-MC to be discussed in CA/DC or Mobility. RAN chairman could be consulted.

7 – NTT DOCOMO INC.

Cross carrier scheduling enhancement

For cross carrier scheduling enhancement, we support PDCCH scheduling multi-cell PDSCH/PUSCH as we mentioned in the previous round. It is ok to avoid having impact on other WGs than RAN1.

Enhancements focused on FR2-specific aspects

We have a motivation to reduce the SCell/SCG setup delay, considering the trade-off with UE power consumption. E.g., early measurement enhancement can be a solution worth discussing in Rel-18. [RAN2, RAN4]

8 – LG Electronics Inc.

In general, the focused objective should be extent to MR-MC, which itself would require quite large volume of discussion in RAN2.

MR-MC

As indicated in the intermediate round, we think scheduling enhancement utilizing multiple cell group also needs to be addressed in this item for resource efficient use of MR-MC. Thus, we kindly suggest to add 'scheduling enhancement' as an objective. Our suggestion is to rephrase the second bullet as follows:

MR-MC: Enhanced simultaneous UL transmissions and DL receptions with multiple cell group management (e.g. fast cell group switching, UL selective activation), enhanced scheduling considering mutiple cell groups (RAN2, RAN3, RAN1)

Cross carrier enhancement

1) Regarding cross-carrier HARQ, it has been discussed many times in RAN2 but not progressed well because the impact from protocol perspective is expected to be huge, which has not been justified by the

gain. In this discussion, cross-carrier HARQ has been proposed by only a few companies while the concern and questions were expressed by several companies. Thus, we propose not to have cross-carrier HARQ as an objective for CA/DC item for now or at least the concern/contentious point should be addressed in the report as well.

2) Regarding multi-cell scheduling, we are not convinced the essentiality of multi-cell scheduling in Rel-18 work since PDCCH burden on Pcell in DSS could be offloaded by Rel-17 cross-CC scheduling (from Scell to Pcell) and it would cause DCI overhead and gNB scheduling restriction compared to multi-TTI scheduling.

9 – Spreadtrum Communications

We agree with CMCC that the Rel-18 scope for CA/DC enhancements should focus on the enhancements with strong requirement. For FR2-specific aspects, the RLF enhancement such as MN/SN role switching needs to be supported, which is beneficial to improve robustness through minimizing RRC reestablishment caused by RLF. For this topic, RAN2 should be the leading WG and the RAN3 and RAN1 should be involved as the secondary WGs.

10 – China Telecomunication Corp.

MR-MC

Generally, we think MR-MC could not only help increase bandwidth and capacity significantly and but also guarantee service and user experience quality for new applications. Considering the future network deployment, MR-MC can be considered as an approach to provide operator with more flexible, effective and uniform network control and radio resource management. Since Rel-18 is the first release of 5G-advanced, we think MR-MC is worth discussing for future commercial requirements.

Regarding the objectives of MR-MC, we agree with other companies that MR-MC may have two potential areas including multi cell groups management and triple connectivity summarized by KDDI in the intermediate round. In our opinion, both areas are beneficial to network operator.

Regarding the organization of CA/DC enhancements topics, we prefer to have a dedicated WI on CA/DC enhancements to include MR-MC related issues. In our opinion, considering the work load to have a huge scope including many topics, it is better to have dedicated WI instead of putting MR-MC in Mobility topics, since the motivation and scenarios of MR-MC are not only related to mobility issues but also capacity issues.

11 – MediaTek Inc.

On cross-carrier scheduling

We are supportive on multi-cell scheduling with single DCI and cross carrier HARQ. But we do not see the need to have FR2 SCell scheduling for PUSCH on FR1 PCell. We have some concern on coverage of FR2 SCell. Network may need to reserve control resource in FR1 PCell in order to serve UEs out of FR2 coverage. In this regard, the benefit in reducing the control overhead in FR1 PCell may be limited in practice.

On MR-MC

We still think it is better to discuss fast cell group switching in mobility WI. It is not reasonable to have different service continuity mechanism for MCG handover and SCG change. Simultaneous activation for more than 2 DL CG or UL CG should be avoided due to high standardization complexity. Coordination between 3 different nodes request quite some discussion. Having 3 DL CG with 2 UL CG does not help too much (How does HARQ operated for CG without UL?). There is basically no throughput improvement on

MR-MC as MR-DC with CA could achieve same data rate. It is TRUE that from RF perspective, MR-MC is similar to MR-DC with CA, but there is much complicate on baseband control for asynchronous case. In short, we don't think the justification is strong enough have simultaneous activation for more than 2 CG.

12 – KDDI Corporation

We are ok with the current proposed work area for both Cross carrier enhancement and MR-DC. We also comment that MR-DC is a very attractive feature to operators. So if it's postponed to next release, then it's very unfortunate for us...

13 – Nokia Corporation

MR-MC: We agree with QC that there are some commonalities with MR-MC and mobility. As we stated before, the impact of MR-MC for protocol layers may be large (e.g. one more MAC entity, switching used SCGs and/or ULs, capability coordination between three network nodes, synchronization requirements, practical UE requirements, measurement procedures, etc.). **Having MR-MC as a separate study could help to focus the work** and also clarify the main scenarios (e.g. as Samsung points out, for some cases the impacts may be smaller but then the design should consider if those are all the cases) and impacts to all WGs.

FR2-specific enhancements: Same as NTT DOCOMO, we support (as we also proposed during the R18 WS) reducing the SCell/SCG setup delay, considering the trade-off with UE power consumption. E.g., early measurement enhancements in Rel-18. [RAN2, RAN4]

14 – Ericsson LM

Cross-Carrier Enhancements:

To get a reasonable work-load/scope, we suggest to remove cross carrier HARQ. It has been discussed several times before (since LTE days, if not even earlier) but the pain/gain analysis always resulted in that it was dropped due to unclear gains and high complexity.

MR-MC:

For best capacity in a network, all frequencies should be used by all nodes. However, an operator may have high and low frequencies where the low frequencies are used by a macro layer, and the high frequencies are used by a pico layer. Dual Connectivity enables a UE in such a deployment to use both the high and the low frequencies.

But to have three layers (one macro layer + two different pico layers (with their own frequencies)), would not be a very optimal or common deployment. Hence, we don't see the need for Multi-Connectivity with three cell groups.

It is deeply rooted in the specification of the Dual Connectivity feature that there are two cell groups. So, aside from it being for an uncommon deployment, to specify Multi-Connectivity would be a huge task which likely would result in a feature that will not be implemented. Note that with three cell groups, the UE would also have to support three uplinks.

15 – Lenovo (Beijing) Ltd

(1) For CA enhancement, we support cross-carrier scheduling enhancement in Rel-18 with focus on multi-carrier scheduling via a single DCI including both DL scheduling and UL scheduling and carriers in FR1 and FR2. Furthermore, to guarantee a reasonable DCI payload size and keep "3+1" DCI size budget, we think two-stage DCI for multi-carrier scheduling should be considered as two-stage SCI in Rel-16 V2X. For cross-carrier HARQ transmission, we don't see the need to specify this in RAN1 and we also have strong concern on RAN2 standard impact.

(2) Regarding MR-MC, we support the work listed by the moderator. Some companies raised that fast PSCell switch (e.g. if multiple SCG configurations are provided to UE in advance) could overlap with the scope in mobility enhancement. In our understanding they are relevant, while MRMC could focus on the issues in real multi connection scenario, e.g. configuration of multiple SCGs, the collaboration between MN and SN, and PSCell and SCell role change (if in the scope).

16 – China Mobile Com. Corporation

For the cross-carrier HARQ, we share similar view as Huawei and Apple to decide later whether to study this in URLLC or CA/DC enhancements until some conclusion made in Rel-17.

For the MR-MC, we think it has significant impacts on UE complexity and we don't see urgent and definite commercial needs. We suggest the study on MR-MC can be postponed.

17 – HuaWei Technologies Co.

Cross-carrier enhancements:

Regarding 2) FR2 SCell scheduling PDSCH/PUSCH on FR1 P(S)Cell: It is a corner case in practice since PDCCH resources in multiple FR1 carriers are typically available. There is no strong motivation to put PDCCH on FR2, especially considering the coverage of the scheduling carrier on FR2 may be much smaller than the scheduled carrier on FR1. We suggest not to consider this one.

Regarding 3) We support cross-carrier HARQ as in TDD+TDD CA with different UL/DL configurations, the mechanism brings benefits to reduce the latency and we think this belongs to CA/DC enhancements. The impact on MAC in our view is to support HARQ entities management across CCs, and the MAC impact can be a simplified modelling as long as the data for HARQ retransmission on a different carrier can be obtained from HARQ buffer. Thus the impact at MAC layer is not complicated.

MRMC

we suggest to postpone this discussion, as this seems not urgent. In addition according to the previous rounds of discussion, several companies mentioned that the solutions like CHO applied to DC can already fulfill the requirement, and thus the technical needs for this also require more justification.

Regarding FR2 specific enhancements, we are open to discuss this and we understand the major impacts are in RAN4 to improve RRM requirements. We observed in RAN4 email discussion this is already one candidate target for Rel-18 and probably this can be discussed mainly in RAN4.

18 – ZTE Corporation

MR-MC

Considering throughput will be mainly carried on SCG in many scenarios (e.g. FR2 is used as SCG), a more dynamic and efficient cell group management mechanism will be essential for the success of FR2. Therefore, we support MR-MC in Rel-18 and we prefer to prioritize the multiple cell group management with up to two active cell groups.

FR2 specific enhancement

In Rel-16, UL SRS transmission is not allowed in dormant state. Without UL SRS transmission, the RACH procedure has to be triggered to rebuild the beam tracking in FR2 cells, and the benefit for delay reduction in dormant state seems gone. Therefore, we prefer to enable SRS transmission in dormant state.

19 – RadiSys

We support cross carrier enhancements and we think MR-MC can be postponed. We think cross carrier enhancements will have RAN2 impacts as well.

20 – vivo Communication Technology

For MR-DC, we think it is important to clarify that up to two simultanoeous transmitted cell groups, even if UE may be configured with more tha two cell groups.

3.1.5 Flexible spectrum integration

Similar to the initial round, company views are divided on whether a new framework needs to be introduced to efficiently handle segmented frequency resources. One group of companies are claiming "obvious benefits" while another group of companies are saying that the benefits over the existing CA framework are not clear.

Although the views are divided, moderator's suggestion is to first identify what needs to be done under flexible spectrum integration. Based on this, RAN could continue discussions to better understand the proposal and what the potential benefits are.

Based on the companies' feedback, following relevant work were identified:

- Decoupling of uplink and downlink bands for UEs in CONNECTED, INACTIVE, IDLE mode for various cellular operations (initial/random access, paging, PDSCH/PUSCH transmission, etc) (RAN1, RAN2)
- Improved BWP switching and activation/deactivation procedure for non-contiguous frequency resources (RAN1, RAN2)

Proponent companies are invited to refine the above relevant work so that other companies can better understand the proposal and potential benefits. In addition, all companies are invited to provide any other comments (if any) for the final round.

Feedback Form 18:

1 – Futurewei Technologies

We support this work and are open to alternatives that are based on / extension of CA framework or a new design. It can also be part of the study.

2 – Intel Corporation (UK) Ltd

We don't think that there is any impact to RAN1 in supporting decoupling of uplink and downlink based on the discussion. Main WG should be RAN4 and sub-WG should be RAN2 to check if there is any signaling impact.

Regarding improved BWP switching, does it mean that non-contiguous frequency resource is supported within a single BWP or multiple BWPs corresponding to each chunk of frequency resources? In our understanding, it is the latter case and the wording can be clarified. And we think RAN4 aspects should be assessed as we expect longer BWP switching delays if the switching is performed across non-contiguous fre-

quency resources (e.g. between different bands) since it could be equivalent to carrier activation/deactivation. In conclusion, our suggested wording for the second objective is "Improved BWP switching including simultaneous activation of multiple BWPs for non-contiguous frequency resources. (RAN1,RAN2,RAN4)"

3 – Samsung Electronics Co.

1) Decouple of uplink and downlink bands would have an implication on regulatory and RAN4 RF aspects. We ask for the proponents to clarify this.

2) The only difference from CA/DC seems to the operation in IDLE/INACTIVE state. However, it would incur backward compatibility issue. It is not only that the legacy UE cannot enjoy this feature but also that the system performance enhancement (overhead reduction, UL coverage, …) is limited.

4 – Apple Benelux B.V.

We agree with Qualcomm that a lot of the issues raised so far can be addressed by utilizing the existing CA framework and would prefer that the feature be based on the existing CA framework. Any change to the framework would need to define what the gains are and show significant gains compared with results based on using the existing CA framework (both with and without enhancements) and also account for impact on UE/gNB implementation complexity due to the change in the framework.

5 – QUALCOMM JAPAN LLC.

We agree with moderator that we can further discuss what cannot be realized by CA framework. We are not convinced that any issue raised so far justifies introducing a completely new framework. As the baseline, for any necessary enhancements, 3GPP should first try to accommodate based on the existing CA framework.

6 – Nokia Corporation

We agree with the moderator that we should further discuss what are the desired functionalities that cannot be integrated to the CA framework, and what benefits those features bring over the complexities of a new aggregation paradigm. We should also discuss what features that can be integrated to the CA framework and if those should be agreed, and then in a later phase whether they'd be integrated in the CA/DC enhancement work. We agree with Qualcomm that the baseline assumption should be to use the existing CA framework as the baseline.

7 – Spreadtrum Communications

1) The first bullet needs RAN4 involvement when considering to decouple DL band and UL band.

2) For the second bullet, we are not clear about 'Improved BWP switching'. We are not sure what should be enhanced.

3) After reviewing the clarification from proponents of single cell with non-continuous spectrum in the intermediate round, we still have not seen the additional benefit over CA framework. Unless obvious benefits of single cell with non-continuous spectrum identified, otherwise as UE vendor we support CA framework, which is more backward compatibility.

8 – Huawei Tech.(UK) Co.. Ltd

We agree with moderator's suggestion of identifying what enhancements are beneficial under flexible spectrum integration. We support the relevant work summarized by the moderator but noticed that overhead reductions are missing. The benefits and motivations were clarified by companies including us in previous discussion.

Since many companies have proposed overhead reduction, we think it should be included as follows. We also provide additional suggested revisions:

- Decoupling of uplink and downlink bands for UEs in CONNECTED, INACTIVE, IDLE mode for various cellular operations (initial/random access, paging, PDSCH/PUSCH transmission, etc) (RAN1, RAN2, **RAN4**)

- Improved BWP switching and activation/deactivation procedure for non-contiguous frequency resources **in different bands** (RAN1, RAN2, **RAN4**)

- Overhead reduction including PDCCH in one band scheduling multiple bands, SSB/SIB in one band providing synchronization and system information for multiple bands (RAN1, RAN2)

9 – Ericsson LM

We share many of the concerns expressed above regarding the objectives. The first objective (Decoupling of uplink and downlink bands) will have impacts on backward compatibility and many regulatory and RAN4 aspects. We also commented earlier that existing CA framework can be used in RRC connected state. In IDLE/INACTIVE state anyway the benefits of decoupling of uplink and downlink bands will be very limited with significant impact on legacy operation and legacy UEs.

The benefits of the second objective (improved BWP switching and activation/deactivation procedure) are not clear since there are fundamental aspects with switching and activation/deactivation for non-contiguous frequency resources that need to be taken into account whether the switching is done with bandwidth parts or carriers. It has significant impact also in RAN4 because it will require new requirements and delay will be much longer than current BWP switching e.g. due to sync, AGC etc. BWP switching is more useful if BWP switching delay is short. We think existing procedures (e.g. UE-specific CBW change) can be used for non-contiguous carriers instead.

10 – ZTE Corporation

After two rounds of discussion, it seems companies are still NOT on the same page on what flexible spectrum integration is. We agree with Moderator that we should first identify what needs to be done.

Regarding the two bullets proposed by moderator, we have the following detailed comments.

1. "Decoupling of uplink and downlink bands" seems not clear to us. If the intention is to say that DL carrier and UL carrier of one cell can come from different bands, then we suggest to update it like "flexible association of DL carrier and UL carrier from different bands".

2. Regarding the 2nd bullet "Improved BWP switching and activation/deactivation procedure for non-contiguous frequency resources", we think it is too premature to call it as "improved BWP switching". Because if existing CA framework is reused, then the existing BWP framework can be reused without any particular enhancement. Thus, we suggest to delete it for now.

11 – Guangdong OPPO Mobile Telecom.

We agree with moderator that we can discuss further to better understand the proposal and what the potential benefits are.

12 – Lenovo (Beijing) Ltd

We are OK to further investigate what benefit the existing CA and further enhancement can't provide. We don't support multiple active BWPs as it is against NR framework and leads to high implementation effort for UE.

13 – China Mobile Com. Corporation As one of the proponents, we would like to make some clarification. The wording "decouple" seems causing some misunderstanding. From RAN4 point of view, our intention is to reuse existing CA/SUL RAN4 framework and the RF requirements. The proposed BWP like switching and activation can work under CA/SUL framework as much as possible, which only impact on RAN1 and RAN2, no or little impact on RAN4.
14 – CAICT We support moderator's proposal and identifying what enhancements is benifitial.
15 – CATT We agree with Huawei that a single DCI scheduling PDSCH/PUSCH across multiple bands and common signals/messages on one band for multiple bands should be added.
16 – MediaTek Inc. Agree with moderator's proposals. It's better to clarify first what issues can't be solved by existing CA framework and what's additional benefits new framework can bring, compared to CA framework.
17 – China Unicom We are fine with moderator's proposal on the potential scopes, but the overhead reduction is missing. We agree with Huawei's proposal to add the bullet "Overhead reduction including PDCCH in one band scheduling multiple bands, SSB/SIB in one band providing synchronization and system information for multiple bands" into the scope.
18 – vivo Communication Technology We are in general fine with further discussion on the potential scopes listed by moderator.
19 – China Telecom Corporation Ltd. We agree with moderator's proposal and as we commented in 2nd round, the overhead reduction shall be targeted here, which is different from CA/DC enhancement.

3.1.6 RIS (Reconfigurable Intelligent Surfaces)

As noted in the summary of initial round, there are quite a number of companies who do not think RIS is mature enough for Rel-18. And compared to the other candidate topics, the level of support does not seem strong. Given the situation, moderator view is that RIS be considered as a low priority item. If 3GPP does decide to work on RIS in Rel-18, it should be with a very limited work scope without normative work. For example,

- Study potential use cases, evaluation methodology including channel/device modeling, etc (RAN1, RAN4)

Proponent companies are invited to refine the above work scope. In addition, all companies are invited to provide any other comments (if any) for the final round.

Feedback Form 19:

1 – Samsung Electronics Benelux BV

As previously commented, what RIS can support can be supported by repeaters or IAB. Hence, the gain of studying RIS is unclear.

2 – OPPO

We are supportive to have a light-weight Rel-18 SI for RIS. As for the scope, besides what the moderator provided (as example), the following could be also of interest:

- Identify the commonality and differentiation in relative to smart repeater.

3 – Futurewei Technologies

We agree to de-prioritize this work.

4 – China Telecommunications

We are supportive to have a SI in Rel-18 for RIS. The listed scope is fine with us.

5 – Verizon UK Ltd

Agree with moderator's approach

6 – Motorola Mobility UK Ltd.

Lenovo, Motorola Mobility

We are supportive of the Moderator's view of low priority for RIS in Rel-18.

7 – Apple Benelux B.V.

We are fine with the moderator's proposal

8 – Ericsson LM

Thanks for the good summary. We agree that this area is pre-mature and of low priority in Rel-18.
For the final summary, the final sentence should be removed "Proponent companies are invited to refine the above work scope...". We strongly think that the 3GPP discussion after this week should focus on high prio items.

9 – TELECOM ITALIA S.p.A.

Same view as Ericsson. And again there is a strong impact on RAN4 for a low priority item

10 – Orange

We think RIS is a promising feature for the future. While it is not urgent to start any work in 3GPP, we believe a scope restricted to use cases and evaluation methodology would be reasonable in Rel-18.

11 – ZTE Corporation

Regarding the moderator's summary, in addition to the use case and evaluation methodology, we still prefer to enable the discussion on the other impacts including side control information, e.g., beam information, which is common to the other technique, but more benefits can be expected for RIS due to its merits on power consumption and signal quality (SINR) improvement with less complexity.

Moreover, after setup of evaluation methodology, study on the additional enhancements, e.g., beam management, can be performed with consideration on the feature of RIS including larger beam numbers and near-field deployment. Whether to specify it in Rel-18 or later is depending on the progress.

W.r.t the assessment to take this item with lower priority due to the argument on maturity, we still have concern on it. As mentioned in previous discussion, this solution is ready to be deployed in commercial network based on the justification from multiple trails. Initializing the corresponding efforts in Rel-18 is needed to satisfy the needs.

12 – China Unicom

We agree with moderator's proposal on the scope of R18 RIS study item. In the first round and intermediate round discussion, a number of companies, including operators and vendors show their interests to deploy RIS in 5G commercial network. From our view, an individual study item can be started in R18 with limited impact on RAN1 TU.

13 – Huawei Technologies France

We still think RIS is a pre-mature technology to be studied in Rel-18. Given limited resources and more important topics under discussion in RAN for Rel-18, RIS should be considered in future releases.

14 – Philips International B.V.

We are supportive of a lightweight Rel-18 SI for RIS. The scope should also include a similarity analysis compared with smart repeater. As a compromise we can accept to treat RIS together with Smart Repeaters in the same SI.

15 – MediaTek Inc.

Agree with moderator's proposals. This item should be lower priority in Rel-18.

16 – CEWiT

Agree with the moderator's proposal.

17 – ROBERT BOSCH GmbH

We agree with a very limited study scope for RIS in Rel-18. We encourage also to have a joint signaling and control (when possible) with smart repeaters.

18 – Sony Group Corporation

We support the proposal of the moderator to "Study potential use cases, evaluation methodology including channel/device modeling, etc. (RAN1, RAN4)" in Rel-18. A potential refinement of the above scope may be as follow:

1. Simulation scenarios and network layout

a. Indoor and outdoor scenarios for frequency ranges FR1 and FR2, according to bullet 1 above.

2. RIS device modeling

a. Sizes and topologies under consideration.

b. Radiation pattern of unit cells, codebook design, polarization properties, amplitude/phase shift quantization, state-dependent radiation efficiency.

3. Propagation aspects

a. Whether near-field and spherical-wave propagation effects need to be modeled.

b. Modeling of gNB-RIS, RIS-UE links, including association of paths in delay-angle, pathloss, NLOS/-LOS, large-scale parameters (DS, AS, SF, K).

c. Modifications to statistical channel models, e.g., CDL models, to account for RISs deployment density.

The study use cases can also include deployment assumptions such as RIS transparency to UEs, support of legacy UEs, etc.

Our preference would be to also include beam management and the interface of between the gNB and the RIS in the scope of the SI. In our opinion, this investigation is needed as well for the smart repeaters, discussed in thread #4, if approved. Therefore, if smart repeaters and RIS are discussed jointly, which we propose, standardization effort can be saved.

19 – KDDI Corporation

We are basically supportive of the moderator's proposal regarding work scope. In addition, if we can discuss signallings between gNB and RIS, then we think it is beneficial to jointly discuss them together with the side information discussed in smart repeater.

3.1.7 Others (RAN1-led)

As noted in the summary of initial round, DSS received strong level of support from operators and vendors alike. Some candidate areas identified on DSS from the intermediate round are

- Improved NR spectral efficiency for LTE-NR coexistence (RAN1)
- More efficient NB-IoT and eMTC coexistence on NR carriers (RAN1)
- Coexistence with non-3GPP radio technology (RAN1)

Of the three candidate areas, enhancements for improved NR spectral efficiency for LTE-NR coexistence received the largest support. On the other hand, some companies questioned the necessity of additional specification support. For example, why dynamic rate matching around CRS when CRS is not a dynamically varying signal.

However, given the positive feedback from companies, moderator recommendation is to take DSS as one of the higher priority items in Rel-18 targeting at least improved NR spectral efficiency for LTE-NR coexistence.

All companies are invited to provide any other comments (if any) for the final round.

Feedback Form 20:

1 – Verizon UK Ltd

We agree with the moderator.

2 – AT&T

We think eMTC coexistence on NR carriers without DSS can and needs to be improved but this is okay for now.

3 – Qualcomm Incorporated

Agree with moderator's evaluation of the situation. The RIS should be considered as low priority and a serious study is needed before any normative work.

4 – Samsung Electronics Co.

1) We do not support the recommendation of the moderator.

2) First, it is not even clear what the relevance of DSS is to some of the proposals such as for "dynamic CRS RM pattern" or for "rate matching PDCCH". Second, both feasibility and possible benefits are unclear. For example, how can a gNB have instantaneous accurate knowledge of the best "CRS RM pattern" for each UE in order to provide the dynamic indication? For example, even if few additional REs from a "CRS RM pattern" could be used with perfect accuracy for PDSCH to the proper UE each time, the SE gains are marginal as the power of those REs can be used for power boosting – the proposal is just trading off power for few REs/BW but, even under ideal operating conditions, that trade-off would have practically no impact on SE. Similar arguments for feasibility and benefits apply for the "rate matching PDCCH".

3) Finally, scheduling an FR1 PCell from an FR2 SCell has at least the underlying assumptions that (a) an operator has no FR1 spectrum for NR only, (b) the FR2 coverage is large (e.g. within range of the FR1 coverage, including for providing Type-3 CSS), and (c) UEs have FR2 capability. There is no apparent need to address the combination of the above conditions (and there are also other restrictions such as the number of UEs that can be scheduled per slot in FR2). On a secondary level, it is strange to limit such scheduling to PUSCH. (We provided the same comment on CA/DC)

For the above reasons, we cannot agree to consider the above proposals for further study in Rel-18. They also seem more appropriate for consideration in TEIs instead of a SI/WI.

5 – Intel Corporation (UK) Ltd

We are fine with more general formulation of DSS objective as proposed by moderator without mentioning of the specific solutions. Since several companies expressed concerns on some proposed solutions, it seems more reasonable to discuss them directly in RAN1. In summary we support only the following DSS enhancement for Rel-18

- Improved NR spectral efficiency for LTE-NR coexistence (RAN1)

6 – Telia Company AB

We agree with moderator's way forward proposal giving DSS enhancements a higher priority in Release 18.

7 – Nokia Corporation

We are OK to continue discussions on DSS under the proposed categorization.

8 – ZTE Corporation

We are OK to continue discussions on DSS under the proposed categorization considering that operators have strong interests on these areas.

As commented previously, once we identifies the potential solutions, it would be good if we can make these solutions more general and thus they can be applied to other non-DSS scenarios as well.

9 – TELENOR ASA

Telenor agree with moderator that DSS enhancements should be given high priority in Release 18.

10 – Ericsson LM

We are fine with the moderator's proposal of discussing DSS using the proposed categorization

11 – vivo Communication Technology

Although we are interested in DSS, the 3 bullets listed by moderator seem more like DSS scenarios to be consdiered rather than technical enhancements. We suggest to focus on the specific techniques and some of them are not fully discusssed to address companies questions. We are fine to have further discussion.

Regarding moderator suggestion "take DSS as one of the higher priority items in Rel-18", does it mean that DSS has higher priority than any other project that might be included in Rel-18, or it just intended to say "improved NR spectral efficiency for LTE-NR coexistence." has higher priority than the other two scenario, i.e. DSS with NB-IOT/eMTC and non-3GPP system.

12 – MediaTek Inc.

As mentioned in previous round, we don't see much additional benefits to have further enhancements on DSS in Rel-18 after the works in Rel-15 17. Considering the commercialization timeline of Rel-18 (2024 or 2025), the specified features may be too late to be deployed. If really necessary, we're okay to consider "Improved NR spectral efficiency for LTE-NR coexistence" with single objective only.

13 – VODAFONE Group Plc

It is not clear to us what is included in "the Improved NR spectral efficiency for LTE-NR coexistence (RAN1)", but assuming it covers the topics we have previously highlighted then it would be acceptable.

14 – HUAWEI TECHNOLOGIES Co. Ltd.

We have strong concern on the proposal. The scope and the corresponding motivations/benefits are not clear.

1. The scope is not clear. All the three candidate areas listed here are too general, and it is very difficult to tell what exactly the scope would be for each candidate area.

2. The motivations/benefits are not clear/justified either. For the first candidate area "improved NR spectral efficiency for LTE-NR coexistence", as we commented before, the gain we can get from the proposed candidate solutions for this area on top of what we have in Rel-15/16/17 seems questionable. Our previous comments are included here again to emphasize it.

- Regarding dynamic adaptation of rate-matching around LTE CRS pattern(s): Not sure why RRC-based configuration is not enough. It is not clear how much more gain can be achieved on top of Rel-17 CRS-IC, which is being specified especially for this scenario. We should avoid specifying multiple options for the same target. Furthermore, dynamic CRS rate-matching may sound simple to specify in terms of signaling, but if the network also needs dynamic feedback to properly perform this dynamic adaptation then this could be very complex. Typically which cell creates strong CRS interference will not change dynamically but is rather gradually changing with the UE position in the cell. Semi-static configuration among multiple CRS patterns is already specified. How much gain can a more complex solution provide?

- Regarding NR PDCCH reception in symbols overlapping with LTE CRS: Our understanding is that the minimum necessary standard work would be to remove the constraint that a UE cannot receive PDCCH in a symbol where some REs belong to a CRS rate-matching pattern configured for the UE. Then, scheduling the UE with a sufficiently large aggregation level would help the UE decode the PDCCH in spite of the punctured PDCCH symbols. We should also note that Rel-17 already specifies a method to increase the capacity for scheduling a NR UE on a DSS carrier, with SCell scheduling PCell. In our view this might already be sufficient and it is not clear why Rel-18 UEs could not simply implement the Rel-17 technique instead of specifying yet another technique for sending PDCCH in symbols with LTE CRS. This way the capacity in DSS carrier can still be used for NR PDSCH, where the NR PDSCH can be mapped to the first symbol after the LTE control region (instead of the proposal to use that symbol for PDSCH) by shifting the PDSCH DMRS to a later symbol (as already supported by the NR specs).

- Regarding FR2 SCell scheduling PDSCH/PUSCH on FR1 P(S)Cell: It is a corner case in practice since PDCCH resources in multiple FR1 carriers are typically available. There is no strong motivation to put PDCCH on FR2, especially considering the coverage of the scheduling carrier on FR2 may be much smaller than the scheduled carrier on FR1.

3. For the second and third candidate areas, only a few companies proposed it and it is even not clear what the issues are from the email discussion here. It needs more time to understand better the issue and the corresponding motivation and benefits.

4. In our understanding, the email discussion here is to understand the potential scope and see if there is any consensus on the potential scope, instead of deciding the priority. Since there are several companies who still have concern, we think further discussion is still needed.

15 – RadiSys

We agree with moderator's proposal

16 – ROBERT BOSCH GmbH

We highly support prioritizing the coexistence with non-3GPP radio technology for Uu and SL.

4 Final summary & proposals

4.1 Summary of company views

UE power savings: Companies are generally positive on UE power savings but there are few companies questioning the need of a separate SI/WI. Majority preferred a separate SI/WI. Proposal to introduce enhancements based on ultra-low power UE receiver and wake up signal has received strong support. However, there were a number of companies questioning the benefit/feasibility of this proposal.

Enhancing and extending the support beyond 52.6 GHz: Companies have divided views on the need for further enhancements to support spectrum beyond 52.6GHz. A number of companies have questioned whether

there is market demand and noted that if work is to be done in Rel-18, the work scope should be compact.

CA/DC enhancements: Companies are generally positive on the need for CA/DC enhancements. However, the views are not fully converged on what kind of enhancement to focus on. Enhancement on cross carrier operation, MR-MC, and FR2-specific aspects were proposed.

Flexible spectrum integration: Companies have divided views on the need for introducing a new framework to efficiently/flexibly utilize spectrum. One group of companies are claiming "obvious benefits" while another group of companies are saying that the benefits over the existing CA framework are not clear. The following items were proposed for flexible spectrum integration during the email discussions.

Decoupling of uplink and downlink bands for UEs in CONNECTED, INACTIVE, IDLE mode for various cellular operations (initial/random access, paging, PDSCH/PUSCH transmission, etc) (RAN1, RAN2, RAN4)

Improved BWP switching and activation/deactivation procedure for non-contiguous frequency resources in different bands (RAN1, RAN2, RAN4)

Overhead reduction including PDCCH in one band scheduling multiple bands, SSB/SIB in one band providing synchronization and system information for multiple bands (RAN1, RAN2)

RIS (Reconfigurable Intelligent Surfaces): Companies have divided views on whether RIS technology is mature enough for 3GPP to start work on. Majority of companies in final round commented that RIS should either be deprioritized or that the technology is premature. Few companies even commented that RIS should not be discussed any further. It is clear that RAN1 will not be able to reach consensus to include RIS as part of Rel-18.

Others (RAN1-led): DSS received strong level of support especially from the operators in all three rounds. However, a number of companies have expressed negative views or questioned the benefits of DSS enhancements in different rounds. Other than DSS, wireless sensing was proposed but the level of support was not as strong.

The following items were proposed for DSS during the email discussions (provided for information purposes only).

- Improved NR spectral efficiency for LTE-NR coexistence (RAN1)
- More efficient NB-IoT and eMTC coexistence on NR carriers (RAN1)
- Coexistence with non-3GPP radio technology (RAN1)

Note that the first item received the most support among the three but also received strong concerns from two companies.

4.2 Moderator proposals

The moderator proposals below are based on the comments received during the three rounds of discussions on [RAN93e-R18Prep-14] Additional RAN1/2/3 candidate topics, Set 1. From moderator point of view, the proposals should be non-controversial.

Proposal 1 (non-controversial): For UE power savings, focus further RAN discussions on enhancements based on ultra-low power UE receiver and wake up signal.

- Including whether the enhancement targets general purpose use cases or targets specific use cases such as REDCAP, XR.
- If included as part of Rel-18, relevant work should start with a study item to verify the benefits, feasibility, and applicable scenarios.
- The following is provided as a starting point for further discussions in determining the relevant work scope on UE power savings
    - Performance evaluation UE power savings based on ultra-low power UE receiver and wake up signal (RAN1)
    - Hardware feasibility evaluation (RAN4)
    - Design of wake up signal for ultra-low power UE receiver (RAN1)
    - Relevant procedures (RAN1, RAN2)

Proposal 2 (non-controversial): Continue RAN discussions to converge on the need for further enhancement to support spectrum beyond 52.6GHz. Consider one of the following alternatives in the interest of having a reasonable work scope.

- Focus only on 52.6GHz 71GHz and target critical areas to make existing specification support for 52.6GHz 71GHz more competitive in the market (RAN1)
- Focus only on beyond 71GHz and study new waveforms and relevant regulatory landscape but without any normative work in Rel-18 (RAN1)

Proposal 3 (non-controversial): For CA/DC enhancement, continue RAN discussions on the following potential enhancements to determine whether or not to include as part of Rel-18.

- Cross carrier operation enhancement (RAN1, RAN2)
    - For example, multi-cell scheduling with single DCI, FR2 SCell scheduling for PUSCH on FR1 PCell, cross carrier HARQ
- Multi-RAT Multi-Connectivity, MR-MC (RAN2, RAN3, RAN1):
    - For example, enhanced simultaneous UL transmissions and DL receptions with multiple cell group management
- FR2-specific aspects (RAN2, RAN4)
    - For example, SCell/SCG setup delay reduction with early measurement enhancement

Proposal 4 (non-controversial): For flexible spectrum integration, continue RAN discussions to converge on the need for introducing a new framework in addition to the existing CA framework.

Proposal 5 (non-controversial): Conclude that there is no consensus in RAN to include RIS as part of Rel-18.

Proposal 6 (non-controversial): For Others (RAN1-led), focus further RAN discussions on enhancements for DSS.