

**[RAN94e-R18Prep-03] Additional topological improvements - smart repeater - Version 0.0.10**  
**RAN**

**3GPP TSG RAN Meeting #94-e RP-212663**

**Electronic Meeting, December 6 - 17, 2021**

**Source: RAN1 Chair (Samsung)**

**Title: Moderator's summary for discussion on [RAN94e-R18Prep-03] Additional topological improvements - smart repeater**

**Document for: Discussion and Decision**

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## 1 Introduction

Please note some of the general guidelines provided by the RAN Chair in RP-212657.

*The goal of the email discussion is to focus on potential scope/areas for each potential WI or SI, with NO intention to update the set and the organization of the topics as endorsed in RP-212608.*

1. *Aim to identify whether a topic should be a SI, or WI (including possibly a study phase for some scope(s))*
2. *Aim to identify on the leading WG (including if any change compared with those in RP-212608) and the secondary WG(s)*
3. *Aim to identify on the potential interaction with SA/CT*
4. *All companies are expected to provide comments including detailed justification for areas/scopes for each topic in discussion*

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## 2 Initial Round

According to the guidelines provided by the RAN Chair in RP-212657 for the initial round, the goal is to summarize proposals for further discussion, including those for areas/objectives. For the initial round discussion on smart repeater, RP-211654 from RAN#93-e will be used as a starting point. The following was captured in RP-211654 for potential areas/objectives for smart repeaters:

- Side control information design for smart repeaters
  - As baseline, beamforming information configuration, timing, and TDD configuration
  - Other information (e.g. on-off, bandwidth information, power control, co-channel related issues/RF requirement
  - Need for joint study on side control information for both smart repeater and RIS
- Other specification support on management of smart repeater (e.g. including authentication/authorization and interference management)

Furthermore, the following assumptions were considered for smart repeater operation:

- Smart repeater should be transparent to UE
- FR2 with TDD and both outdoor and O2I scenarios are prioritized, other scenarios can be investigated but optimizations for these scenarios may not be considered
- Only single hop stationary repeater is considered

## 2.1 Collection of company views

### 2.1.1 General views

Companies are invited to provide general high-level views on '[RAN94e-R18Prep-03] Additional topological improvements - smart repeater' (if any). Any views on the following aspects are also welcome:

- Whether this work should be a SI, or WI
- Leading WG (including if any change compared with those in RP-212608) and the secondary WG(s)
- Whether there is need for potential interaction with SA/CT

#### **Feedback Form 1:**

##### **1 – Kyocera Corporation**

We prefer to start with SI since Side control information is a new concept and needs to be studied.

We assume the leading WG is RAN1, while RAN2 and RAN3 are the secondary WGs for Side control information as well as RAN4 is the secondary WG for RF performances.

We assume at least some interaction with SA2 and CT1 may be needed e.g., for authorization of UEs for Side control, but in general Smart Repeater is RAN functionality.

##### **2 – Apple Computer Trading Co. Ltd**

Our view is as follows:

- SI or WI: SI first
- Leading WG: RAN1
- Interaction with SA/CT: No

##### **3 – Sumitomo Elec. Industries**

SI or WI:

We prefer to start with SI first. If we start with WI, at least study phase is needed to identify useful side control information.

Leading WG: RAN1

Interaction with SA/CT: No clear view

#### **4 – NTT DOCOMO INC.**

We think smart repeater is beneficial and necessary for better/flexible coverage of especially FR2. Regarding SI or WI, we think a SI may be needed to justify the benefit of potential enhancement, then the SI can be followed by a WI to specific the justified enhancement. Leading WG can be RAN1.

#### **5 – Samsung Electronics Benelux BV**

Smart repeater (SR) is cost effective coverage enhancement solution for FR2 frequency range. We expect SR to be FR2 repeater with beamforming, while keeping low-complexity and transparency to any legacy device. For standardization, we prefer starting with SI first. We think Ran1 and/or Ran4 should conduct performance evaluation first, and consider the impact on other WGs.

#### **6 – ZTE Corporation**

The necessity and benefits are clear for the smart repeater with the following proposals:

- SI or WI: We prefer to take it as WI directly as first priority with a focus on the specification of essential side control information, e.g., beam information. A short SI phase may also be possible if companies prefer to check the needs of others.
- Leading WG: It should be led by RAN1 with potential impacts on RAN2 and RAN4. No action is expected for RAN3, SA/CT.
- Interaction with SA/CT: No activity is expected with SA/CT since regarding the management of smart repeater, the implementation-based solution is preferred.

#### **7 – Fujitsu Limited**

In our views, a study item phase of smart repeaters is necessary. Release 18 is the first release for smart repeaters. Some basic principles of smart repeaters need to be discussed and agreed at the study item phase, such as the assumptions of the application scenarios, the basic requirements for smart repeaters and the structure of smart repeaters.

We support WG1 as the leading WG of smart repeater items, if approved.

Regarding to whether there is a need for potential interaction with SA/CT, it could depend on further discussions on the management of smart repeaters. If smart repeaters are agreed to be treated as network nodes, some interactions with SA/CT should be necessary. If smart repeaters are agreed to be treated as UE-like devices, there may be no need to involve SA/CT in the relevant discussions in RAN.

#### **8 – Motorola Mobility UK Ltd.**

##### **Lenovo/ Motorola Mobility:**

At this stage, we think, a short phase SI followed by a WI is more suitable and should be led by RAN1. Currently we haven't seen necessity for interaction with SA/CT.

#### **9 – KDDI Corporation**

As for smart repeater, it would be better to start from SI. This will make it possible to identify the contents of side control information that should be specified. RAN1 should be the leading WG.

#### **10 – vivo Mobile Communication Co.**

We prefer to add SI phase at least for the valuable topics, e.g., conditional on-off, operational bandwidth control, power control, beam control to justify the link/system level benefit from smart repeater w.r.t these features. It is fine to have one unified SI to study all these topics to identify the framework of the potential solutions.

The leading group should be RAN1, since smart repeater is typical L1 relay. There is no need to include SA/CT in SI phase, since the major workload is in RAN groups. RAN P can include SA/CT after the SI phase, if necessary.

#### **11 – Philips International B.V.**

Regarding the different bullets, we prefer the following:

- (1) Start with SI and then WI;
- (2) leading RAN1;
- (3) interactions with SA2 might be required.

#### **12 – China Mobile Group Device Co.**

1  **This work should be a WI.** We do not see the motivation to have a SI or study phase for the whole item. The performance gain is obvious compared with the scenarios without smart repeater. If there is a need, please clarify.

We have deployed 2G, 3G and 4G repeater in our network for the past 20 years and these repeaters does help to achieve seamless network. In fact, some of these repeaters already have demode/decode module inside and they may be regarded as “smart repeater” and some operators have already start smart repeater’s technical testing in realistic network. From this point of view, the standardization of smart repeater is very essential and it’s emergency to complete such standardization to drive commercial deployment. Therefore, a WI instead of SI is more suitable because the motivation of smart repeater is clear enough and the standardization is essential to achieve seamless coverage.

2  **Leading WG: RAN1, secondary WG: RAN 4.**

For RAN4 we are afraid RAN4 hasn’t consider beamforming related RF requirements in R17 spec.

3  **SA/CT**  **We do not have strong motivations to interact with SA/CT.**

Based on 4G Relay experiences, at least, the smart repeaters in current version should be able to work without the upgrade of core network.

The motivation of smart repeater is to enhance coverage with less cost. This requires smart repeater easy to be deployed and be low price. And any updating of existing NR core network should be limited as little as possible.

#### **13 – Ericsson France S.A.S**

The nature of the proposed signaling and implications of any signaling on Uu procedures should be clarified. For these reasons, we think that the first step should be a SI.

Assuming that the scope is focused on FR2, single hop, stationary deployment (as discussed below) then the main focus of the study is the Uu signaling aspects, and RAN1 should be the leading WG. The need for involvement of other WGs depends on the scope of the study. If the scope is strictly on the potential Uu beamforming/TDD signaling and its’s benefits, then the SI can be carried out by RAN1. If the scope includes to clarify aspects of the network control of the repeater relating to interfaces and/or architecture,

then RAN2 and/or RAN3 will need to be involved. From our point of view, it would be acceptable to keep the scope of the study to the PHY control signaling and mechanism (i.e., no RAN2/3 involvement), but it should then be clear that presumptions in regard to management and interfaces are not considered as part of the study phase.

RAN4 needs to be involved but the extent of the involvement in the SI may depend on the frequency/deployment assumptions. To clarify the RAN4 involvement, the considered deployment scenarios should be explicitly listed in the scope so that the need for RAN4 study can be clarified.

#### **14 – Ericsson France S.A.S**

We assume that the relay is deployed and under the control of the operator and is logically part of the gNB. Assuming this is the case, SA/CA involvement may not be needed, at least for a SI.

#### **15 – CEWiT**

We feel that SI phase is needed to identify the required side control information . So, SI can be followed by WI and leading WG can be RAN1.

#### **16 – Intel Korea**

Regardless of the scope we suggest that this item should start from a **study** since there are clearly uncertain perspectives with respect to what to specify. For example, the need for any listed side control information needs to be investigated, since in some cases it can be detected by the repeater w/o indication. In summary, we consider a study item followed by a work item in Release 18 for this topic.

The leading group is expected to be **RAN1**, since the currently identified areas for study are mostly RAN1 related. For the part of authentication / authorization, RAN2 is expected to lead, but since similar work has been done in IAB, we don't expect large RAN2 scope. RAN4 needs to be involved providing inputs on repeater operation aspects such as repeater latency, RF impacts based on their work in Release 17. If this topic is agreed to be a WI, we expected explicit RAN4 performance objectives and TUs to be allocated as well.

Interaction with SA/CT in relation to authentication / authorization may be needed.

#### **17 – Nokia Italy**

Smart repeater should begin as a SI. Leading WG is RAN 1. Depending on the SR architecture, RAN 2 may be the secondary WG. Interaction with SA/CT is not expected.

It is first important to define what is meant by a smart repeater. We propose: “A smart repeater is a beam-forming repeater with a control channel, that is managed by the network.

#### **18 – Sony Group Corporation**

Our view on this is the following:

- Whether this work should be a SI, or WI: We prefer to start with an SI. As other companies have pointed out, side control information needs to be understood better. We are also okay with having a WI preceded by a short SI phase.
- Leading WG: We prefer RAN1 to lead the SI; secondary WGs are RAN2 and RAN3, as well as RAN4.
- Whether there is need for potential interaction with SA/CT: It is not clear to us whether such an interaction is needed.

## **19 – HUAWEI TECHNOLOGIES Co. Ltd.**

We are still wondering whether there is strong motivation to introduce smart repeater in Rel-18, especially compared to IAB nodes. It is not clear whether the claimed benefit of low cost can be achieved or not. Firstly, the cost saving of a smart repeater node compared to an IAB mode may be not that much, since the smart repeater would require the capability similar as IAB MT to enable smartness, which would reduce the potential cost saving compared to an IAB node. Secondly, the overall cost of deploying smart repeaters in the network may not be lower than that of deploying IAB nodes, because it is expected that the number of sites would be increased to achieve similar performance as deploying IAB nodes, since smart repeater requires full duplexing mode which would result in lower capability of smart repeater, e.g. lower EIRP. In addition, it is expected that the increased number of sites would increase the deployment difficulty also. If companies really insist it for Rel-18, clearly it should not be a WI, and study is needed to show the potential benefits and the corresponding applicable scenarios first.

It is expected that the study of smart repeater may need interaction with SA/CT, e.g. on authentication/authorization. That's also one aspect we have concern, it may require much effort from many working groups while the potential gain it can bring may be small.

## **20 – ROBERT BOSCH GmbH**

It is recommended to start Smart Repeater with a SI phase, thus we can understand the interface and side control.

We believe that RAN1 should be in the leading WG.

Even though most of the comments here don't see a direct relation to SA/CT, we still prefer to involve (at least) SA2 in the SR architecture.

## **21 – OPPO**

First, we agree on the potential benefit that can be brought in by the proposed smart-repeater enhancement. However, with more comprehensive IAB features introduced since Rel-16, such as simultaneous Tx/Rx, various duplex modes, and mobility support (in Rel-18), the gain of smart repeater seems not to sufficiently justify this work in Rel-18, especially in parallel with Rel-18 IAB.

For questions from moderator:

1) SI or WI: We share the views from other companies and think a SI phase is needed, at least to validate the gain for introducing new spec impacts and to investigate the potential issues (if any) on coexistence between the normal Uu link and "repeated Uu link" (e.g., if the repeater works with ON/OFF pattern in L1, what is the impact to legacy UE operation if the fading profiles may change quickly in different time duration).

2) leading WG: RAN1 or RAN4. We do not have strong preference in between. However, we believe it is important for RAN4 to verify whether the existing RAN4 requirements for legacy UE could still remain the same in an environment with Rel-18 repeater. This seems to be more critical than simply designing a new L1 DCI in RAN1.

3) Interaction with SA/CT: If the smart-repeater is considered a L1-IAB node, i.e., it is anyway a gNB-alike transmitter that may or may not "loyally" clone everything from its parent gNB, we are not sure whether the traditional higher layer procedures like authorization/security are still needed. This may need answer from SA/CT.

## **22 – Verizon UK Ltd**

Smart repeater technology would greatly benefit coverage extension for operators, especially for FR2. So it is important for 3GPP to specify related standards. To get full benefits of smart repeater, signaling of

key information such as beamforming capability, TDD/FDD config, targeted beam information and other useful info needs to be specified. A SI is required to understand how to reap the full potential performance benefits including identification of all useful side information. This would make the subsequent WI much more efficient than being caught up in controversies

### **23 – MediaTek Inc.**

- We think it clearly makes sense to start from a SI, as the "side control information" is really new territory and needs some investigation to understand what makes sense.
- RAN1 should be the lead group, with RAN2/RAN4 as secondary. RAN2 involvement will be necessary for the signalling of the control information.
- We don't foresee SA/CT interaction in the SI. For a future WI, some topics like authorisation could conceivably have SA/CT implications, but we agree with the comments from others that CN impact should be minimised, and the study can be done without involving them.

### **24 – CableLabs**

1. It should start with a SI.
2. RAN1 should be the lead WG.
3. Dependent on the SI outcome, further collaboration with SA may or may not be required.

### **25 – Futurewei**

- In our view the benefits of smart repeater in terms of agreed performance objectives, under relevant deployment scenarios/modeling assumptions/configuration settings, must first be demonstrated via a study item.
- RAN1 should lead the study item
- At the onset we do not see such need.

### **26 – AT&T GNS Belgium SPRL**

We agree that it should start as a SI and be RAN1-led. Depending on the complexity of the "smart" repeaters RAN2/RAN3 would also potentially need to be involved. RAN4 would get involved during any follow-up WI. The SI should leverage the existing specifications/requirements as much as possible (i.e. IAB) to minimize the level of effort.

### **27 – InterDigital Communications**

- A1. We believe that this work should be a SI.
- A2. Leading WG should be RAN1 and RAN4 can participate as a secondary WG.
- A3. We don't see any potential interaction with SA/CT.

### **28 – Qualcomm Incorporated**

#### **SI vs. WI:**

The main objective is the specification of side-control signaling which is rather straightforward and can be handled in a WI. Other aspects related to repeater management will certainly leverage existing signaling framework and can be handled in a WI. A SI is therefore not needed. Interference-related aspects are already addressed by RAN4 in Rel-17 and can be further addressed via adaptive beamforming and on-off.

**Leading WG:**

The leading WG should be RAN1 since the information carried in the side signaling primarily relates to the PHY layer. The secondary WG should be RAN2 for upper layer signaling support, e.g., repeater configuration, authentication, access barring, etc. This is based on the assumption that the repeater holds a UE function to connect to the network.

**Whether there is need for potential interaction with SA/CT**

Interaction with SA/CT is unlikely.

**29 – LG Uplus**

- SI is needed.
- Leading WG is RAN1 and Secondary WG is RAN3 (for wired RF repeater) and RAN4.
- We don't see the necessity of SA/CT engagement so far.

### 2.1.2 Side control information design for smart repeaters

Companies are invited to provide their views on the side control information for smart repeaters. In RP-211654, information on beamforming information configuration, timing, and TDD configuration were listed as non-controversial. Companies are encouraged to provide technical/commercial justification on their preferences. Additional information such as objectives and responsible working groups for each objective would also be useful for the discussions.

#### Feedback Form 2:

**1 – Kyocera Corporation**

We're fine to study the beamforming information configuration, timing and TDD configuration, since these could be considered as basic functions/characteristics of Smart Repeater.  
 In addition, we assume the feedback mechanisms (i.e., from Side control UE to gNB) and the control of other Smart Repeater characteristics (e.g., Tx power) should be studied/identified.  
 We assume L1-based control is studied by RAN1, while L2/L3-based control/configuration is studied by RAN2.

**2 – Apple Computer Trading Co. Ltd**

We agree that beamforming information configuration, timing and TDD configuration should be considered. Currently we have not seen the necessity for other control information, but we are open to study other aspects.

**3 – Sumitomo Elec. Industries**

We agree to study the non-controversial part: beamforming information configuration, timing and TDD configuration.  
 In addition, Tx on-off at least in FR1 could be studied for interference management since interference avoidance in FR1 by beam management will be difficult. We are open to study other information.

**4 – NTT DOCOMO INC.**

For justification, side control information is necessary so that smart repeater works as gNB intended. For

FR2 in TDD band, where beam-based operation is essential, gNB should control smart repeater to communicate with intended UE by using appropriate beam/TDD config/etc.

Regarding objectives, we think at least ON/OFF, bandwidth information, power control should be included in the objectives, which can be beneficial to reduce interference in the network, and sufficient study should be done. Responsible working group is RAN1.

#### **5 – Samsung Electronics Benelux BV**

Considering FR2 repeater with beamforming capability, beamforming information configuration is one of key side control information. Regarding other information such as timing and TDD configuration, we do not see any strong need to support side control information considering current TDD repeater deployment and also fixed UL/DL configurations used in real network.

#### **6 – ZTE Corporation**

For the side control information design, at least the beam indication information should be directly specified since it's beneficial to improve the coverage and UE's throughput. Regarding other aspects, e.g., timing and TDD-awareness, on/off, power control, study on the necessity/detailed way for indication can be considered.

In general, the following objectives led by RAN1 can be considered.

- Specify the L1/L2 signaling to enable the dynamic delivery of beamforming information configuration from gNB to smart repeater [RAN1/RAN2]
- Study to identify the additional features (e.g., timing and TDD-awareness, on/off and power control information) for side control between gNB-SR with the following assumptions [RAN1]:
  - o Only single-hop stationary repeater
  - o FR2 with TDD

#### **7 – Fujitsu Limited**

Not sure 'side control information' is a good terminology in SID. Somehow, 'side control information' may raise a confusion with 'sdielink control information'. Probably, 'control information' is preferable in SID.

We support the scopes that a gNB should be able to control the forwarding beams/forwarding timing/forwarding directions of a smart repeater by sending control information to the smart repeater.

Except for the scopes related to the control information, the structure of smart repeaters should be studied in SI as well. This is a fundamental and important scope. The study can clarify what the smart repeaters are. It can make sure that companies will be on the same page about the smart repeaters after the SI completes and accordingly avoid unnecessary diverse discussions in the following WI.

In our point of view, the relevant objectives are:

- Study the structure of smart repeaters (RAN1/RAN4)
- Study the forwarding beam management mechanism of smart repeaters, including the measurement of forwarding beams by UEs (RAN1/RAN2). (Reuse the existing beam management as much as possible)
- Study the forwarding timing control for smart repeaters (RAN1/RAN2)
- Study the forwarding direction control for smart repeaters (RAN1/RAN2).

## **8 – Rakuten Mobile**

We support ZTE's comprehensive proposal.

## **9 – Motorola Mobility UK Ltd.**

### **Lenovo/ Motorola Mobility:**

We think that, at first a clarification might be needed on the nature of the channel that carries the side control information. Whether the control configurations are carried by a dedicated control channel or reuse existing channels on the Uu link.

We agree that timing /TDD and beamforming information can be the starting point. However, we also think that the study should include on/off information, bandwidth information and power control. The reason is that time/spatial/frequency/power domain can be combined for coordination of links associated with the smart repeater, so that inference can be reduced, and system performance can be improved compared to the case without side control information.

## **10 – vivo Mobile Communication Co.**

Besides the mentioned non-controversial topics, at least repeater on-off and power control can be listed as objectives.

On-off control and operational bandwidth adaptation can be used for NW interference management or NW power saving.

Power control/gain control can be used to maintain the NW coverage. Since FR2 is the target band, channel condition between donor and repeater unit may change rapidly, power control/gain control may help to compensate the associated pathloss variation.

The leading group for the side control information design should be RAN1, and at least RAN2 and RAN3 are the 2nd group for the design of the associated signaling exchange between donor and repeater.

## **11 – KDDI Corporation**

For the side control information listed in RP-211654, such as beamforming information configuration, timing, and TDD configuration, it is considered that consensus has been reached, so it is acceptable to include them for study in objectives.

On the other hand, for side control information that is not listed in RP-211654, the objectives should also include studying them. For example, on/off control is, in our opinion, beneficial in terms of interference management. We think it is desirable to study other side control information including it, in order to obtain a common understanding of quantitative performance in RAN1.

## **12 – Philips International B.V.**

We agreed that beamforming information configuration, timing, ON/OFF control and TDD configuration should be studied. Note that also security requirements for the configuration should be considered.

## **13 – China Mobile Group Device Co.**

Besides beamforming information configuration, timing, and TDD configuration, ON/OFF control and power/gain control are preferred.

- ON/OFF control is used to avoid the interference amplified by smart repeater when there is no wanted signal at input port. This information could be implicitly expressed though other information e.g.

beamforming, and/or timing (when smart repeater should carry out forwarding and amplifying). So this information may be an implicit indication. At least from both gNB and smart repeater side, they should have a clearly common understanding of the time when the data should be amplified and forwarded. We suggest to keep on/off information explicitly in the WID and whether it is implicit or explicit indication could be left for further study.

- For FR1, the same scheme of TDD configuration and ON/OFF indication could also be reused without specific optimization. UL interference would be more severe due to without beamforming. Then ON/OFF indication is essential for FR1.
- To further reduce the interference to gNB, UE and other repeaters, power control or amplifying gain control should be studied.

Leading group: RAN1

#### **14 – CEWiT**

We are fine to support study on side control information related to beam forming, timing and TDD. We also feel that ON/OFF and power control should be part of the study because

- ON/OFF information can improve the energy efficiency
- Power control/sharing between BS-smart repeater link and smart repeater-UE link is essential for interference management
- Power control at smart repeater to manage interference

#### **15 – Ericsson France S.A.S**

Apart from clarifying what information is needed (above information that can already be obtained or configured proprietary), the impacts on PHY scheduling channels and timing of fast control information needs to be elaborated. Regarding TDD, the range of deployment scenarios where TDD patterns of gNB (and accordingly the repeater) can be dynamically changed is rather limited so beamforming information may be higher priority than TDD information (beyond the basic TDD pattern).

#### **16 – Intel Korea**

For beamforming information, the group needs to consider two different cases: (1) beamforming on a TRP-Repeater link, and (2) beamforming on a Repeater-UE link. The control information may need to handle both cases.

The timing information is also needed to align transmission / reception boundaries.

TDD configuration may be assumed to be semi-static. In this case, it can be in many cases determined by the repeater w/o special side control. However, we are open to study this aspect for all potential situations.

In frequency domain, it is important to have mechanisms of configuring amplification of at least a given carrier/BWP. Further study on benefits of selective repeating within the BWP may also be needed.

As for power control, there are also two cases: (1) PC on TRP-Repeater link, (2) PC on Repeater-UE link. In the second case, current specification is already transparent for the UE assuming the proper reference signals are configured to measure RSRP for pathloss compensation. For the first case, the Repeater transmission power needs to be determined separately, that requires additional control signaling.

In summary, we have the following justification and objectives:

#### **Justification:**

Deployment of smart repeaters in FR2 unpaired spectrum may require providing side control information to the repeater for efficient scheduling of UEs. Such information may at least include beamforming for TRP-Repeater and Repeater-UE links, timing and TDD pattern information, band/bandwidth, transmit power control for TRP-Repeater links, and other necessary information, which cannot be detected by the Repeater on its own.

**Objectives:**

- Study and identify which side control information is necessary for smart repeaters [RAN1, RAN4], including at least:
  - o Beamforming information configuration for TRP-Repeater and Repeater-UE links
  - o Timing synchronization and UL-DL TDD configuration
  - o Band/bandwidth information
  - o Power control for TRP-Repeater links

**17 – Nokia Italy**

It is important to agree on what essential functionalities of the control framework (i.e., baseline for TDD control, beam management, etc. ) are to be studied in the SI that could show expected gains for the smart repeater, so as to avoid too large a scope for study.

**18 – Sony Group Corporation**

We are okay to study the non-controversial parts of the side control information for smart repeaters, which includes beamforming information configuration, timing and TDD configuration. Additionally, we are also open to study other technical aspects, such as on-off, bandwidth information, power control co-channel related issues/RF requirement, and the need of joint study on side control information for both smart repeaters and RIS.

**19 – HUAWEI TECHNOLOGIES Co. Ltd.**

In our view, the benefits of smart repeater over already supported features such as IAB and RF repeater is still debatable, thus we are not convinced a smart repeater item should be considered for Rel-18. Further evaluation/discussion on beamforming is needed to see if any potential benefits can be achieved by smart repeater.

As to timing and TDD configuration, it seems the definition is not clear. In the question above, it looks like that timing and TDD configuration are two separate thing, however based on the discussion in the previous meetings, at least some of companies think that timing and TDD configuration refer to DL/UL split, which means they are the same thing. Therefore, clarification is needed here.

In our understanding, there is no need to study TDD configuration (i.e. DL/UL split). Similar as RF repeater, the TDD configuration can be up to implementation, e.g. smart repeater can get the TDD configuration via system information from the gNB and thus no need to be delivered by side control information. Some company proposed dynamic TDD configuration with finer granularity, however we don't see strong need for it, since it can be expected that only part of UEs may be in the coverage hole and thus need the help from smart repeater, which means that it should be sufficient to enable smart repeater work on the semi-static DL/UL, and meanwhile flexible symbols can be used for users not in the coverage hole. In addition, at least in the current real network, the TDD configuration is usually fixed.

**20 – ROBERT BOSCH GmbH**

For FR2, beamforming and beam management is/are important side control information. TDD and specific configuration for smart repeater may be considered as well.

We also support on/off and SR power control information.

**21 – OPPO**

We would like the following concepts to be clarified first:

- 1). Whether the "side control information" refers to DCI on PDCCH only, or it also includes certain feedback information on PUCCH as well (say a PUCCH sent from repeater back to gNB)?
- 2). Given certain "control information" is to be sent by gNB specifically to repeater on Uu link, the repeater may somehow take the behavior/role that is currently defined for UE. Then, our question is: what is the cut-off line per specification wise to frame such UE role for the repeater? Would there be a concept like repeater-MT?

**22 – Verizon UK Ltd**

Smart repeater technology would greatly benefit coverage extension for operators, especially for FR2. So it is important for 3GPP to specify related standards. To get full benefits of smart repeater, signaling of key information such as beamforming capability, TDD/FDD config, targeted beam information and other useful info needs to be specified. A SI is required to understand how to reap the full potential performance benefits including identification of all useful side information. This would make the subsequent WI much more efficient than being caught up in controversies.

**23 – MediaTek Inc.**

The listed non-controversial aspects from RP-211654 seem like a suitable basis for study, and as suggested in some of the preceding comments, on/off would also be reasonable for interference management. The identification of the needed control information (RAN1-led) can be largely independent from the study of a signalling approach to transfer the control information (RAN2-led), and we anticipate that these would be separate objectives.

**24 – CableLabs**

The SI should study the TDD information support, Timing and beam forming information.

Also power control and BW information should be of interest.

We agree with Lenovo that further clarifications should be provided on how the control information is handled (via existent control channels or a new entity supporting fast signaling).

The last but not the least, since smart repeaters are intended to be 'light' IABs, an economics dimension should be added, at the very least what would the cost ratio vs. a reference IAB configuration, dependent on the number of smart repeater features.

**25 – Futurewei**

We are ok to have beamforming information configuration, timing, and TDD configuration to be part of side control information, as an initial set for study. On-Off control could also be considered/evaluated for study since such optimized muting has been known to be effective for interference management. At a later stage, the gNB-smart repeater channel for carrying such control information needs to be discussed along with timelines expected for delivering such control information.

RAN1 should be the leading WG.

## **26 – InterDigital Communications**

A. We are fine to study side control information related to beamforming, timing and TDD configuration.

## **27 – Qualcomm Incorporated**

Further aspects to be included for side control information:

- On-off should be included in side-control information
- Side-control information should be signaled via DCI.
- Side-control information should have symbol-level granularity.

Justifications:

- Providing on-off information is needed for efficient interference management and is helpful for energy-efficient operation.
- Other side control information, such as bandwidth, is good to have, but may not be necessary (e.g., they can be preconfigured).
- For a smart repeater to offer its best service, it needs to adapt its configurations (e.g., in terms of service-side beamforming) dynamically and flexibly, in response to mobility of the users and/or gNB's dynamic scheduling. Therefore, the side control information should be provided dynamically and with fine granularity.

## **28 – LG Uplus**

ZTE's option seems good to us.

### 2.1.3 Specification support on management of smart repeater

Companies are invited to provide their views on the need for support of smart repeater management (e.g. including authentication/authorization and interference management). Companies are encouraged to provide technical/commercial justification on their preferences. Additional information such as objectives and responsible working groups for each objective would also be useful for the discussions.

#### **Feedback Form 3:**

### **1 – Kyocera Corporation**

We assume the authentication/authorization is led by RAN2 and the interference management is led by RAN1.

### **2 – Apple Computer Trading Co. Ltd**

We are open to consider aspects like interference management for the support of smart repeater management.

### **3 – NTT DOCOMO INC.**

We think authentication/authorization needs to be considered so that smart repeaters can be under control of network. Whether specification effort is needed can be discussed in SI. We are also fine to consider interference management. It is beneficial to study how to manage interference brought by smart repeater. Whether enhancement is needed based on exiting interference management solutions can be discussed in the SI.

#### **4 – Samsung Electronics Benelux BV**

The smarter repeater management is related to the protocol stack support at the smart repeater side, i.e., whether full protocol stack or only partial protocol stack (e.g., MAC/PHY).

The authentication/authorization normally belongs to core network functionality, the partial protocol stack cannot achieve this purpose. Moreover, this function depends on the interests from the operator, i.e., whether operators are willing to implement the smart repeater in a safe way via a standardized method or a private method.

For the interference management, we understand smart repeater is just a simple device for signaling processing. All interference management can be realized via gNB.

#### **5 – ZTE Corporation**

In our view, the implementation-based solution without spec impacts/efforts is enough to support this feature with less complexity on the protocol design for standardization. If there is majority support for it, we are open to studying it without impacts on RAN3 and SA/CT.

#### **6 – Fujitsu Limited**

In our understanding, a smart repeater can be treated as either a network node or a UE-like device. Either way is feasible. But they may lead to different paths in the discussions on the authentication/authorization procedure of smart repeaters. We believe that more discussions are necessary. This part of work can be done in RAN3/RAN2.

Regarding to the interference management issues, it may include two aspects. One aspect is the mechanisms in L1/L2 which can alleviate the interference caused by smart repeaters, such as the on/off function and the power control mechanism of forwarded signals. The discussion on the on/off of smart repeaters, if any, could be led by RAN2. RAN1 needs to be involved. The discussion on the power control of forwarded signals, if any, could be led by RAN1. RAN2 needs to be involved. Another aspect is the interference coordination between gNBs, e.g., the coordination of forwarding beams of smart repeaters respectively belonging to the gNBs. This discussion may be led by RAN3, if any. RAN2 needs to be involved.

In our point of views, the relevant objectives of SI are:

- Study the authentication/authorization procedures for smart repeaters (RAN3/RAN2).
- Study the interference management (e.g., on/off, power control of forwarding beams, and interference coordination between gNBs) of smart repeaters (RAN1/RAN2/RAN3).

#### **7 – Rakuten Mobile**

We support Authentication/authorization but it needs to be handled by RAN3/RAN2.

#### **8 – Motorola Mobility UK Ltd.**

##### **Lenovo/ Motorola Mobility:**

We are open to consider repeater interference management.

**9 – vivo Mobile Communication Co.**

From our view, smart repeater should be managed by RAN and is transparent to CN. The authentication depends on the architecture design of smart repeater, e.g. whether there is full-functional MT integrated in smart repeater similarly as in IAB node. We can include authentication/ authorization as an object for this SI.

Moreover, interference management is definitely the issue in the scope of the study.

**10 – Philips International B.V.**

Authenticated/authorized management and secure configuration is an essential requirement. Lead by RAN2, but might/will require interactions with SA3.

**11 – China Mobile Group Device Co.**

The motivation of smart repeater is to enhance coverage with less cost.

The smart repeater itself should be low price and easy to deployed. Based on the experience of 4G relay deployments, the upgrade of core network is one of the difficulties. Considering the workload and complexity of upgrading core network, the willingness of operators to deploy relays was decreased.

We share the similar views that the smart repeater should be manageable and controllable. But the authentication/authorization based on core network may not be the only solution. OAM based solutions could also work.

We do not have strong opinions on the authentication/authorization of the core network.

But, from our perspective, the smart repeater should be allowed to operate WITHOUT core network upgrade or the smart repeater specific authentication/authorization from the core network.

**12 – CEWiT**

Specification support on management of smart repeater should include

- authentication/authorization
- activation of smart repeater, which will allow the smart repeater to be used on a demand basis
- Exchange of capability information, which can be used by the gNB for determining the beam forming configuration efficiently
- interference management, as smart repeater can introduce additional interference in the network

**13 – Ericsson France S.A.S**

The smart repeater should be considered as a smart “beam bender” relative the gNB. As such, it is part of the gNB for all management purposes, once acknowledged as a smart repeater. Our understanding is that smart repeaters will be operator installed, logically part of the gNB and managed from the gNB. There is no need for SA/CT involvement, but during the SI or at the start of a WI RAN3 could clarify if there are any interface/gNB architecture implications. RAN2 will need to be involved in the WI. See response to 2.1.1 for more detailed comments on involved WGs.

#### **14 – Intel Korea**

Deployment of smart repeaters in FR2 unpaired spectrum is expected to be managed by network. Authentication and authorization of the repeaters may follow similar procedures as defined for IAB nodes, with necessary deviations to be studied and identified.

Furthermore, controlled operation of the repeaters from perspective of interference management is required. Fixed semi-static TDD configuration and proper power control may be sufficient to keep the interference under control, but additional study on necessity of other interference management techniques may be organized.

##### **Objectives:**

- Study the following aspects of Smart Repeater integration and management [RAN2, RAN1]
  - o Mechanism for identification and set-up/release of smart repeater [RAN2]
  - o Mechanism for configuration of smart repeater [RAN2]
  - o Mechanism for information exchange between gNBs for interference management [RAN2, RAN1]

#### **15 – Nokia Italy**

It is necessary to understand what capability a smart repeater is expected to have in support of device management. This will also clarify the expected scope of side control enhancement that will be necessary. Re-use of existing control framework for TDD and beam management may require capabilities that are not well differentiated from an IAB node. On the other hand, a significantly different architecture may require significant effort to achieve what is already possible with existing technologies.

#### **16 – Sony Group Corporation**

We are okay to study authentication/authorization of smart repeaters in a SI to determine whether specification support is needed. We also think that interference management is an important aspect and should be part of the SI. In addition, aspects such as exchanged of capability information, proposed by CEWiT, as well as mechanisms for discovery and configuration of smart repeaters, proposed by Intel, can also be studied.

#### **17 – HUAWEI TECHNOLOGIES Co. Ltd.**

As described above authentication/authorization are related to SA and thus at least SA needs to be involved. As to interference management, discussion should be done first on whether the interference is serious or not, especially the EIRP would be low for smart repeater. Maybe proponent can clarify why the interference is a problem and thus some enhancements needed here.

#### **18 – OPPO**

In our view, authentication/authorization/security should be considered and the corresponding study should be handled in RAN2/RAN3 with potential involvement from SA/CT. The interference issue should be handled in RAN4/RAN1.

#### **19 – Verizon UK Ltd**

Authentication/authorization is essential to deployment of smart repeaters. Specification requirements and interaction with other WGs can be determined in the SI phase.

<p>Interface management for smart repeater is also beneficial to consider. This would likely involve also SA groups (SA5 etc) to specify any NRM models. Requirements/solutions to interference management solutions can be discussed in the SI phase.</p>
<p><b>20 – MediaTek Inc.</b></p> <p>We are not immediately sure how much smart repeater management needs to be specified, and the previous comments seem to show that reasonable people can differ on this. It would need to be clarified as part of the SI how much impact is expected from this area, and whether SA/CT need to be involved.</p>
<p><b>21 – CableLabs</b></p> <p>Authentication/Authorization support for the smart repeater is a must, but without a clear understanding of the IP stack capability of this device, it may be challenging to make a recommendation. We expect that this recommendation should be an outcome of the Study Item.</p> <p>Interference Management is related to beam, power and TDD configuration control. Adding more intelligence on this node is appealing but it should be balanced against any potential cost increase.</p>
<p><b>22 – Futurewei</b></p> <p>In our understanding that smart repeaters will essentially be managed by gNB as another feature to optimize with the repeaters being transparent to the users. We are open to study interference management aspects.</p>
<p><b>23 – InterDigital Communications</b></p> <p>Interference management should be considered as a part of SI. We are open to discuss potential scope for authentication/authorization, however, we believe that this item should be led by RAN3 or RAN2.</p>
<p><b>24 – Qualcomm Incorporated</b></p> <p>The repeater is assumed to hold a UE function for network integration, to receive side control information, and to connect to OAM via PDU session. Repeater-specific functionality to be supported includes:</p> <ul style="list-style-type: none"> <li>- Network authorization for repeater support</li> <li>- Reduced mandatory features for UE functionality on repeater (e.g., need not support all frequency bands)</li> <li>- The repeater may not be subject to the same access barring as UEs.</li> </ul> <p>The repeater could leverage the solutions developed for IAB, which already address these issues.</p> <p>Regarding interference management, we believe through support of adaptive beamforming (especially on the service-side) and turning on-off repeaters (on demand and based on the gNB’s scheduler/decision), interference can be properly handled. Moreover, interference-related aspects (such as interference on adjacent channels) are already being addressed by RAN4 in Rel-17 NR repeaters. Therefore, in our view, no additional work is needed for this aspect.</p>
<p><b>25 – LG Uplus</b></p> <p>We align with Verizon’s opinion.</p>

#### 2.1.4 Need for a joint study on smart repeater & RIS

Companies are invited to provide their views on the need for a joint study on smart repeater and RIS (Reconfigurable Intelligent Surface). Companies are encouraged to provide technical/commercial justification

on their preferences. Additional information such as objectives and responsible working groups for each objective would also be useful for the discussions.

#### **Feedback Form 4:**

##### **1 – Kyocera Corporation**

We see many commonalities between Smart Repeater and RIS, especially in terms of Side control information. So, we think the interface for controlling Smart Repeater should ensure the forward compatibility and future extensibility, taking into account the characteristics of RIS. In this sense, we prefer to include (at least some of) RIS aspects in this SI/WI.

##### **2 – Apple Computer Trading Co. Ltd**

We support the joint study on smart repeater and RIS. Smart repeater is a steppingstone for RIS. At least, we would like to study the common aspects for both features, for example, the study of side control information (beamforming information and timing related configuration).

##### **3 – NTT DOCOMO INC.**

We prefer to study/work on RIS as well as smart repeater. But at the same time, the definition/modeling of RIS is not clear so far. For example, we need to study categories of RIS (e.g., passive/active RIS, RIS with different subarray structures and beamforming schemes), new channel modeling for RIS, etc., which are different from smart repeater and needs to be additionally studied. If this joint study means that study of these aspects are included, we are fine with the direction while workload should be well-limited. Otherwise, we suggest not to include RIS, and try to include RIS-specific study in future release.

##### **4 – China Unicom**

We support to study RIS and smart repeater together, especially interface definition, side control information and other common aspects.

##### **5 – Samsung Electronics Benelux BV**

From the perspective of specification, we agree that smart repeater and RIS are somewhat related. TDD repeaters are already verified for commercialization, but RIS has not yet been verified. In particular, RIS is only meaningful in the environment in which LOS is guaranteed, and considering these parts, it is considered to be a special case of smart repeater, and it might be no urgent commercialization needs if considered the other use cases. Therefore, the study itself prefer to limit the smart repeater. However, the standard itself is likely to be used for RIS as well.

##### **6 – ZTE Corporation**

We think some of the side control information can be applicable to both SR and RIS although there are SR-specific enhancements. We are fine to design the side control information of SR by taking into account the common part first. For enhancements more related to RIS, it is also important in our view. We are supportive to do it in Rel-18 as well but we are open to do it after the smart repeater WI given the limited TU especially for the first half of Rel-18.

##### **7 – Fujitsu Limited**

RIS is indeed an attractive technique to solve/alleviate some coverage problems, e.g., coverage holes. However, in our understanding, RIS may not get enough mature yet for being applied in the deployment of a practical network. We don't see any urgent need to support RIS in Release 18.

We prefer this item could focus on smart repeaters only, if approved.

#### **8 – Rakuten Mobile**

Enhancements specific to RIS should also be studied in Rel-18.

#### **9 – Motorola Mobility UK Ltd.**

##### **Lenovo/ Motorola Mobility:**

Some control parameters can be common for both smart repeater and RIS such as spatial information and on/off information. We believe the study (or the potential specification afterwards) should not limit the use case to either smart repeater or RIS. However, we believe the study should be optimized for smart repeater deployments, which are more mature in terms of implementation and functionality assumptions. We prefer that the study item phase focuses on one set of deployment assumptions for better efficiency

#### **10 – vivo Mobile Communication Co.**

We are fine to have a joint study on smart repeater and RIS. Although smart repeater and RIS are different type of devices, there could be certain similarity from side control information design perspective, e.g., both devices need beam control. Therefore, it is preferable to design a repeater control mechanism which is forward compatible to RIS. However, there is no need to study RIS-specific aspect, e.g. RIS architecture, networking, channel model, interference control, to save time for smart repeater design.

#### **11 – Philips International B.V.**

Similar to Apple and others, we support the joint study on smart repeater and RIS. We would like to study the common aspects for both features, for example, the study of (the distribution of) side control information (beamforming information and timing related configuration).

#### **12 – China Mobile Group Device Co.**

We are open for the joint study with RIS.

If it is agreed, the commonality of both features should be identified first. And the study of the RIS should not impact the progress of smart repeater, which should be directly into the WI phase.

#### **13 – Ericsson France S.A.S**

Specification wise, a smart repeater is likely a superset of an RIS whereas deployment wise, the RIS may be more demanding (e.g. co-existence in RAN4). At this point, we should leverage RAN4 experience from the Rel-17 repeater and focus on RAN1 specification of smart repeaters, much of which is likely to be reusable for RIS, without involving RIS.

#### **14 – Intel Korea**

Since RIS item is not included into the list of prioritized topics for R18 package, we don't think any specific consideration needs to be made related to RIS as part of smart repeaters item to keep the scope reasonable.

#### **15 – Nokia Italy**

We do not see a need to discuss RIS in the context of smart repeater and feel that RIS is not sufficiently mature for consideration in Rel-18.

**16 – Sony Group Corporation**

Our view is that RIS and smart repeaters share many common aspects and it therefore makes sense to include RIS in a smart repeater SI. In particular, the need for side control information is shared by both RIS and smart repeaters and such an interface can be designed jointly. A common framework can be designed which can accommodate side control information aspects common to both RIS and smart repeaters, as well as being able to accommodate side control information aspects specific to each of RIS and smart repeaters.

**17 – HUAWEI TECHNOLOGIES Co. Ltd.**

As discussed in [RAN93e, R18Prep-14], the maturity of RIS is not there yet to start the study at this stage.

**18 – ROBERT BOSCH GmbH**

We prefer to study RIS separately to identify use case, feasibility, channel modeling, etc.

However, we also see the commonality between RIS and SR; we are also aligned to Ericsson comment that SR is a super-set of RIS.

**19 – Verizon UK Ltd**

Signaling for smart repeater and RIS might share a lot of commonality. While RIS needs to mature more for commercial deployment, the momentum for RIS is pretty strong. Smart repeater needs to be positioned as a super set for RIS. The signaling specified for smart repeater should also be extensible for RIS. So it is beneficial to study them together from a signaling perspective.

**20 – MediaTek Inc.**

We see the potential long-term usefulness of RIS, but it is a somewhat immature area and we think it would expand the smart-repeater SI too much in an open-ended way. As discussed in [RAN93e-R18Prep-14], we prefer to leave this topic for future releases, when we have a better understanding of what the existing coverage extension solutions are capable of addressing and what problems we need RIS to address.

**21 – CableLabs**

The common side between RIS and smart repeater should be identified by the Study item. But beyond this point, investing more efforts into RIS as part of the Smart Repeater SI, should delay the completion of the SI.

**22 – Futurewei**

We see that there can be commonalities between smart repeater and RIS control that could be exploited. However, RIS architecture choices (for instance whether to use all passive elements or a few chosen active elements etc.) and modeling approaches (considering mutual coupling among closely spaced RIS elements, lossy elements) are still evolving. We thus believe the study item should mainly focus on smart repeaters.

**23 – InterDigital Communications**

Although we think there are a lot of similarity between smart repeater and RIS in terms of specification support, studying smart repeater would be good enough for Rel-18 and the outcome of the smart repeater can be used as a baseline when we study RIS in the later release.

**24 – Qualcomm Incorporated**

Since RIS is a rather recent technology the requirements are not clear and need further discussion. Support for RIS would therefore justify a study item which is outside the smart repeater effort.

We should further note it was already understood that RIS would be a separate item that requires and deserves its own study, especially to investigate RIS propagation characteristics and specify a proper channel model. However, there were discussions about similarities in the way a RIS or a smart repeater is controlled (in terms of side information and the associated signaling). Therefore, if there is any question here it should be about whether there is a need of joint study on **side control information** for both smart repeater and RIS. This is indeed what was captured in RP-211654.

Now on whether we need a joint study/design of side control information for RIS and repeaters, we believe designing side control for RIS naturally requires understanding how RIS really works. In that sense, we believe this item should focus on design of side control information for repeaters only.

**25 – LG Uplus**

We prefer to study smart repeater in this release and RIS is later. RIS have different aspects such as cut-off filter shaping comparing with smart repeater. Careful study is needed.

2.1.5 Target application scenario / assumption for smart repeaters

Companies are invited to provide their views on the target application scenarios and/or assumptions for smart repeaters. Please refer to Section 2 of this document or slide 3 of RP-211654 for a list of scenarios / assumptions listed as non-controversial. Companies are encouraged to provide technical/commercial justification on their preferences. Additional information such as objectives and responsible working groups for each objective would also be useful for the discussions.

**Feedback Form 5:**

**1 – Apple Computer Trading Co. Ltd**

We support current assumptions for smart repeaters. In addition, we suggest we clarify whether the smart repeater works in a full duplex mode or not. If RIS is considered, we think more study is needed on whether it should be transparent to UE or not.

**2 – NTT DOCOMO INC.**

Considering that the control of beamforming/TDD config. is more beneficial for FR2 and TDD, we are fine with the assumption that FR2 with TDD is prioritized. However, we think the framework and solutions designed based on FR2 TDD should be also applicable to FR1 and FDD so that smart repeater can also be deployed in FR1 and FDD.

And we also agree that smart repeater is transparent to UE, so that smart repeater can serve legacy UE and will not bring negative impact to legacy UEs.

**3 – Samsung Electronics Benelux BV**

We do not see any need to list deployment scenarios for smart repeater and we can discuss after starting SI in WG level. Other than that, we think in general ok to conclude current assumptions as baseline.

#### **4 – ZTE Corporation**

Although the enhancement is generic for all applicable scenarios, the potential restriction on the scenarios for evaluation is preferred to identify the critical issue efficiently. Then, in our view, the current assumption listed in section 2 should be supported.

Moreover, since the SR is mainly for the coverage-limited scenarios, at least, some typical layouts (e.g., Manhattan grid, indoor office) for FR2 should be prioritized for potential evaluation.

#### **5 – Fujitsu Limited**

The scopes of the item on smart repeaters should be deliberated to guarantee that the item can be completed on schedule. We support the assumptions listed in RP-211654.

Moreover, in our understanding, to alleviate the interference caused by smart repeaters, the on/off function and the power control of forwarded signals should be studied in SI.

#### **6 – Motorola Mobility UK Ltd.**

##### **Lenovo/ Motorola Mobility:**

We agree with the current assumption that outdoor and outdoor-2-indoor scenarios should be considered for both FR1 and FR2 with prioritizing FR2.

#### **7 – vivo Mobile Communication Co.**

We agree with the assumption in section 2

#### **8 – Philips International B.V.**

We agree with Apple.

#### **9 – China Mobile Group Device Co.**

We suggest to clarify the assumptions of protocol stack before the WI, which may have impacts on the discussion of side control information.

The same “smart” schemes could also apply for FR1 which is the essential spectrum for 5G.

#### **10 – CEWiT**

We are fine with the assumptions listed by moderator.

#### **11 – Ericsson France S.A.S**

As mentioned above, we assume (when commenting on involved WG etc.) that the relays are operator deployed and managed and logically part of the gNB. Our understanding is that the main benefit of beam-forming and smartness will be for FR2. Also, the previously discussed assumption of stationary deployment and single hop are appropriate to keep the scope focused and so that the resulting specification is likely to be compatible with the RAN4 requirements developed in Rel-17. It is not helpful to have the “other scenarios not precluded” bullet in an Objective analysis as this adds uncertainty as to whether there are other scenarios that, for example would need further investigation in RAN4 (co-existence with other operators); it would be preferable to list scenarios in the scope. The current proposal is OK (but remove the part about other scenarios or avoid any implication of RAN4 analysis)

**12 – Intel Korea**

FR2 deployments are the main target of this item. It is well studied and already confirmed in 5G deployments that FR2 is characterized by challenging propagation environment which motivates much denser TRP deployments. Usage of cost-effective repeaters is expected to enable wider FR2 deployment adoption.

Since FR2 spectrum is mostly unpaired, i.e., TDD, the study can focus on TDD only. As a reasonable assumption, semi-static TDD configurations may be considered for this study.

FR1 can also be added for consideration of side control information to handle TDD spectrum, while there is no motivation to consider beamforming aspects in FR1.

As it was discussed in prior rounds, it is important to make the deployment of (smart) repeaters transparent to UEs, and we support this assumption.

**13 – Nokia Italy**

Smart repeater SI should consider stationary repeater deployments with a priority for FR2. Topology assumptions should be limited to single hop scenarios.

**14 – Sony Group Corporation**

Our view is that for the SI we should not restrict to only FR2 TDD, but FR1 and/or FDD scenarios can also be considered at least during an SI phase, if approved. Furthermore, we are open to consider non-UE transparency if gains can be shown.

**15 – HUAWEI TECHNOLOGIES Co. Ltd.**

As discussed above, the potential performance benefits over IAB should be clarified first assuming FR2, then can be further discussed whether it is beneficial to extend to other application scenarios. If even for FR2 the gain is very marginal, then there is no point to study other application scenarios.

**16 – ROBERT BOSCH GmbH**

In addition to IAB, we may see a relation to Sidelink UE relay to network. Therefore, we need to differentiate of SR compared to UE relay to network. This will be very important if Sidelink discussion has FR2 enhancements, i.e., which impacts also UE-to-Net relay. Therefore, a comparison between SR (Uu) and U2N SL-relay in FR2 is important.

**17 – OPPO**

We are fine with the assumed scenarios that are listed at the beginning of section 2. We are also ok to limit the optimizations to specific scenarios. However, given we are more concerned about impacts to UE (e.g., the one that may observe signals from both gNB and repeater), those concerns may need to be checked for any scenario.

**18 – Verizon UK Ltd**

We are fine with the moderator's assumptions. Further refinements can be made for the WI phase based on SI conclusions. Both FR1 and Fr2 should be considered with FR2 prioritized.

**19 – MediaTek Inc.**

We are OK with the assumptions/scenarios from RP-211654.

<p><b>20 – CableLabs</b></p> <p>FR2 TDD should be prioritized. Dependent on the work load of the smart repeater SI, FR1 scenarios could be also acommodated.</p>
<p><b>21 – Futurewei</b></p> <p>We think the baseline assumptions are a reasonable starting point. Depending on the progress of the study FR1 could also be considered as suggested by CMCC.</p>
<p><b>22 – InterDigital Communications</b></p> <p>We believe that the identified application scenarios can be a starting point, however we prefer to open possible application scenarios for the SI. In the SI, we can identify the required application scenarios for the WI.</p>
<p><b>23 – Telstra Corporation Limited</b></p> <p>FR2 TDD should be prioritised for the stationary scenario. Also agree with support for legacy UE's.</p>
<p><b>24 – Qualcomm Incorporated</b></p> <p>The main application scenario of the smart repeater is range extension for FR2. Propagation in FR2 bands is subject to pronounced shadowing. Repeaters provide a rather low complexity solution to enhance the cell footprint into such shadow areas. Repeaters provide a rather low complexity solution to enhance the cell footprint into such shadow areas. Operation in FR2 bands, however, requires support of narrow beams. Further, UE mobility implies that beam steering needs to be supported at the repeater's access side and fronthaul side. For TDD bands, the repeater should be able to operate unidirectionally and to dynamically switch between UL and DL mode. In this manner, the repeater's amplification gain can be significantly higher. Finally, since the repeater applies amplify and forward, any noise &amp; interference at its input will be amplified and transmitted. For this reason, the repeater should only operate when it is supposed to transmit a signal and stay silent for the remainder of the time.</p>
<p><b>25 – LG Uplus</b></p> <p>FR2 is prioritized but FR1 is still open especially for O2I scenario.</p>

## 2.2 Moderator proposals and observations

### 2.2.1 Proposals / Observations with reference to general views

Super majority of companies indicated preference to start with a study item. Given there is also at least one company who is not convinced on the need for smart repeaters, it seems fair to start with a study item rather than a work item.

**Proposal 1:** For smart repeaters, start with study item to validate performance gains, identify applicable scenarios, and study design of "side control information".

There was a converged view that RAN1 should be the primary working group with RAN2, RAN3, RAN4 as secondary working groups.

**Proposal 2:** For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4.

**Observation 1:** No strong necessity identified at this point on the need for interaction with SA/CT.

## 2.2.2 Proposals / Observations with reference to side control info

**Proposal 3:** Study and identify which side control information is necessary for smart repeaters. [RAN1, RAN2, RAN4]

- Beamforming information configuration
- Timing information to align transmission / reception boundaries
- UL-DL TDD configuration
- Power control information for efficient interference management
- ON-OFF information for efficient interference management and improved energy efficiency

## 2.2.3 Proposals / Observations with reference to smart repeater management

**Proposal 4:** Study the following aspects of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]
- Interference management for smart repeaters [FFS: responsible WG]

## 2.2.4 Proposals / Observations with reference to RIS

**Observation 2:** Company views on whether or not to include RIS as part of the Rel-18 smart repeater work are divided. Moderator view is to focus Rel-18 efforts on smart repeater and re-consider RIS once this work is completed.

## 2.2.5 Proposals / Observations with reference to target scenario / assumption

**Proposal 5:** Focus Rel-18 smart repeaters work on the following scenario / assumptions:

- Prioritizing FR2 TDD deployments for both outdoor and O2I scenarios
- For only single hop stationary smart repeaters
- Assuming smart repeaters are transparent to UEs

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# 3 Intermediate Round

## 3.1 Collection of company views

### 3.1.1 General views

Companies are invited to provide their views on Proposal 1 and Proposal 2 from the initial round.

**Proposal 1:** For smart repeaters, start with study item to validate performance gains, identify applicable scenarios, and study design of "side control information".

**Proposal 2:** For smart repeaters, RAN1 is the primary working group. Details on the secondary working groups to be discussed after the objectives are more converged.

**Feedback Form 6:**

**1 – AT&T GNS Belgium SPRL**

Proposal 2 above in 3.1.1 does not match the Proposal 2 in 2.2.1. We prefer Proposal 2 in 2.2.1 as below. We are OK with Proposal 1 as shown.

**Proposal 2:** For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4.

**2 – Intel Korea**

Both proposals 1 and 2 are agreeable to us and reflect well our initial assessment.

**3 – Samsung Electronics Co.**

**(Moderator)** Seems there was some copy and paste error from my set. Proposal 2 in section 3.1.1 should be as follows:

**"Proposal 2: For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4."**

**4 – SHARP Corporation**

We agree with AT&T GNS Belgium SPRL regarding "the older proposal 2."

Also, we agree that it should be a study item, especially since there are solutions present in this space already, albeit of limited functionality compared to solutions that could take advantage of NR signaling and side control information.

**5 – Qualcomm Incorporated**

We agree with **Proposal 2**.

Regarding **Proposal 1**,

- Proposal 5 already talks about the relevant scenarios (with higher priorities). Hence, there is no need for the P1 to include "identify applicable scenarios".
- We believe a short SI is sufficient to validate the benefits and study the design of the side control information. The SI should then be followed by a WI to specify the design of the identified side control information.

Given above, we suggest the following modification.

**Proposal 1:** For smart repeaters, start with study item to validate ~~performance gains~~ benefits, ~~identify applicable scenarios~~, and **to study design of network-based "side control information". The SI is followed by a work item to specify the identified signaling and/or management procedures.**

<p><b>6 – InterDigital Communications</b></p> <p>We support Proposal 1 and Proposal 2.</p>
<p><b>7 – Apple Computer Trading Co. Ltd</b></p> <p>We support both proposal 1 and 2.</p>
<p><b>8 – Kyocera Corporation</b></p> <p>We agree with Proposal 1 and Proposal 2.</p>
<p><b>9 – Futurewei</b></p> <p>We are ok with Proposal 2 (with moderator’s correction). We are fine with Proposal 1 with the understanding that validation of performance gains over applicable scenarios should be prioritized and performance gains should be demonstrated over appropriate baseline (such as one including IAB nodes). Design study of how control information is conveyed should be taken up once the gains are established.</p>
<p><b>10 – OPPO</b></p> <p>We are fine with Proposal 1 and Proposal 2.</p> <p>In our view, the scenarios discussed in Proposal 5 are originated from non-IAB study, therefore are not the sufficient ones to replace what Proposal 1 may say for IAB scenario. For example, the scenario that can be identified in proposal 1 may include consideration for:</p> <ul style="list-style-type: none"> <li>– scenario A, where the UEs served by the repeater do not observe the signals that are received by the repeater.</li> <li>– scenario B, where the UEs served by the repeater also observe the signals that are received by the repeater.</li> </ul> <p>Therefore we prefer to keep ”identify applicable scenarios” in proposal 1.</p>
<p><b>11 – NTT DOCOMO INC.</b></p> <p>support proposal 1 and proposal 2</p>
<p><b>12 – ZTE Corporation</b></p> <p>For proposal-1, it’s fine to have a SI phase for this topic to identify the gain of additional side control information and potential solution for management-related discussion. But we still need to highlight that the WI is also needed for beam information and others based on the output of SI phase.</p> <p>Meanwhile, the applicable scenarios with gain are clear based on discussion, e.g., in section 3.1.5. There is no need to further check it in SI phase.</p> <p>We are supportive of proposal 2.</p>
<p><b>13 – MediaTek Inc.</b></p> <p>We support both proposals.</p>
<p><b>14 – Nokia Italy</b></p> <p>We are fine with proposal 2, but still do not have a clear understanding on the role of smart repeaters. Are performance gains expected to be against IAB as a baseline?</p>

<p><b>15 – vivo Mobile Communication Co.</b></p> <p>Support the proposals. Besides the design of "side control information", solution for "repeater management" can be studied, especially for the interference management.</p>
<p><b>16 – Motorola Mobility UK Ltd.</b></p> <p><b>Lenovo/ Motorola Mobility:</b></p> <p>We agree with Proposal 1 and Proposal 2 with Moderator's correction</p>
<p><b>17 – Ericsson France S.A.S</b></p> <p>Agree to both P1 and P2. Regarding P1, it is clear from the Round 1 discussions that there are differing views on control information etc.. An SI would allow us to come to a common understanding of scenarios and functionality of the smart repeater.</p>
<p><b>18 – Samsung Electronics Benelux BV</b></p> <p>Support Proposal 1 and 2</p>
<p><b>19 – CEWiT</b></p> <p>We support both the proposals.</p>
<p><b>20 – Fujitsu Limited</b></p> <p>We support proposal 1 and 2.</p>
<p><b>21 – NEC Corporation</b></p> <p>We are ok with proposal 2. For proposal 1, we think the performance gains are unclear on both the performance metric and the baseline. Smart repeater is proposed as a low cost solution for coverage hole. So we think the gain of cost when compared with IAB, and/or Rel-17 RF repeater should be included in the performance gains.</p>
<p><b>22 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>As commented with detailed analysis in the initial round, the claimed benefit of low cost for smart repeater is still questionable compared to IAB, and it may bring additional deployment difficulty due to the need of increased number of sites. Therefore, further study is needed to show the potential benefits first. From this perspective, the proposals above suggested by the moderator seems the way to go. However, we want to clarify that whether to set up a SI for smart repeater in Rel-18, in the end would depend on the overall Rel-18 package to see if any capacity for it.</p>
<p><b>23 – Sony Group Corporation</b></p> <p>We support proposal 1 with the following comments: we are open to have a Rel18 WI immediately following the SI; by reasons similar to OPPO, we also prefer to keep the the "identify applicable scenarios" in proposal 1.</p> <p>We also support proposal 2 with the understanding that determining which the secondary groups are is still FFS.</p>

**24 – Philips International B.V.**

We agree with both proposals

**25 – China Mobile Group Device Co.**

We are fine with the proposal 2 (with moderator’s correction) and also fine with the modified Proposal 1 from Qualcomm.

For proposal 1, the performance gain is obvious when the coverage hole is covered by a newly deployed smart repeater. For the study phase, the focus should be on the function of side control information.

For the two scenarios proposed by OPPO, the scenario A should be prioritized. Smart repeater should cover the area where no signal or very low signal can be received. That is the target deployment scenario. The scenario B, where the original signal from gNB could also be received, may happen occasionally. Interference from the gNB to the forwarded signals could be studied, but as 2nd priority. And if it is studied, there should be a limitation on the received power level from gNB, which is more close to the real deployment. As if the smart repeater is deployed by operators, the repeater definitely will be deployed for the coverage hole, not the well signaled area.

Also, a WID is suggested after SID to specify the signaling procedures and mechanism.

3.1.2 Side control info design

Companies are invited to provide their views on Proposal 3 from the initial round.

**Proposal 3:** Study and identify which side control information is necessary for smart repeaters. [RAN1, RAN2, RAN4]

- Beamforming information configuration
- Timing information to align transmission / reception boundaries
- UL-DL TDD configuration
- Power control information for efficient interference management
- ON-OFF information for efficient interference management and improved energy efficiency

**Feedback Form 7:**

**1 – AT&T GNS Belgium SPRL**

We are OK with Proposal 3. Should we add a line item for "Others" to account for any items that are later determined as necessary during the study?

**2 – Intel Korea**

Since this aims to be a study, and it may reveal additional necessary side control information not included into the bullets in current P3, suggest modifying the main bullet as follows:

- Study and identify which side control information is necessary for smart repeaters [RAN1, RAN2,

**RAN4] including at least:**

Regarding the list of example side control information, we prefer to add “**band/bandwidth**” related information. At least it should be studied whether dynamic indication is required, or semi-static configuration of carriers/BWP is enough.

**3 – SHARP Corporation**

In particular, on “Beamforming information configuration,” it would be useful to study beamforming (across 2 pairs of beams in principle), beam failure, etc. compared to a solution without specification impact. Alternatively, we could go with AT&T GNS Belgium SPRL’s suggested wording, but it would probably be better to have definite things included in the scope.

**4 – Qualcomm Incorporated**

There is already a clear majority view on the baseline side control information, i.e., beamforming, timing and TDD configurations, that should be available to a smart repeater. It is then appropriate to narrow down the scope of the study. Therefore, we propose the following:

**Proposal 3:** Focus on study ~~and identify which~~ of the baseline side control information and consider other useful side control information for efficient operation of ~~is necessary for~~ smart repeaters. [RAN1, RAN2, RAN4]

**Baseline side control information:**

- Beamforming information configuration
- Timing information to align transmission / reception boundaries
- UL-DL TDD configuration

**Other useful side control information:**

- Power control information for efficient interference management
- ON-OFF information for efficient interference management and improved energy efficiency

**5 – InterDigital Communications**

We support proposal 3.

**6 – Apple Computer Trading Co. Ltd**

We support proposal 3.

**7 – Kyocera Corporation**

We agree with Proposal 3.

**8 – Futurewei**

We think beamforming information should have the highest priority whereas UL-DL TDD configuration (which is expected to be largely static) can be de-prioritized compared to the remaining ones in Proposal 3.

## 9 – OPPO

We think RAN-P should not try to do the WG's job for a SI, for example, to determine a list of candidate techniques for the latter normative work. So we prefer to the following wording:

- Study and identify **which what** side control information is necessary for smart repeaters, **for example:** [RAN1, RAN2, RAN4]

## 10 – NTT DOCOMO INC.

Fine with proposal 3. Meanwhile, we share similar view with AT&T that “other side control information” can be added in case any other control information may also be identified as necessary during the study item

## 11 – ZTE Corporation

Regarding this proposal, based on the inputs, we prefer to categorize all potential side control information into 3 levels as below:

- Beam configuration information: Directly for WI
- Timing information and TDD configuration: 1st priority for SI phase
- Others: 2nd priority for SI phase

Then, we can focus on the 1st two aspects and the items as the second level priority can be considered if essential once the TU is available.

## 12 – MediaTek Inc.

We are OK with the proposal and think this list is a reasonable baseline for the study.

## 13 – Nokia Italy

Beamforming and TDD/timing synchronization seem to be essential functionality for operation of a smart repeater. On/Off control and power control appear to be features that only optimize performance, particularly if the goal is extending coverage. Additionally, these features still appear to be controversial and should therefore not be prioritized in Rel-18.

Given the potential list of Rel-18 items, we feel it is necessary to focus objectives on only those enhancements that are essential to operation.

## 14 – vivo Mobile Communication Co.

Support the proposals.

## 15 – Motorola Mobility UK Ltd.

### Lenovo/ Motorola Mobility:

We are generally fine with the objective. And we prefer “configuration” to be deleted. The reason is that there may be also a feedback to enable efficient configuration. Alternatively, we can also capture configuration and feedback explicitly.

: *Study and identify which side control information is necessary for smart repeaters. [RAN1, RAN2, RAN4]*

- *Beamforming information **configuration***
- *Timing information to align transmission / reception boundaries*
- ***UL-DL-Semi-static and dynamic TDD information configuration***
- *Power control information for efficient interference management*
- *ON-OFF information for efficient interference management and improved energy efficiency*

We also think that **Bandwidth** information should be considered.

#### **16 – Ericsson France S.A.S**

Partly agree. As we mentioned above, **timing requirements or assumptions regarding decoding** of DL control information should be added to the objectives. Considering the functionality of a repeater, we **question the use for power control** since it risks introducing another degree of freedom that present gNBs are not designed for. On-Off functionality should be obvious to reduce interference but is also required to allow for separating the gNB's "bent beams" via the repeater from its other beams in the same direction.

#### **17 – Samsung Electronics Benelux BV**

We are generally fine with Proposal 3, but the proposal seems unclear. It sounds like there is already (at this moment in time) a requirement to choose the specific elements of side control information to be studied further (during the actual SI)? In any case, the wording of Proposal 3 is such that – even if all the bullet points are agreed – the outcome of the SI might be that some of them will not move to the WI stage. In our point of view for the bullet points, beamforming information configuration is a key side control information, so it should be studied. Mechanism of indication of beamforming control information via gNB-to-SR, and feedback via SR-to-gNB needs to be clarified. As we commented in the previous round, we do not see any strong need to support side control information for timing and TDD configuration. Legacy TDD repeaters already receive synchronization information to align tx/rx boundaries, and fixed UL/DL configurations are used in real network. However, we are open to study timing/TDD configuration, if majority of company prefer to study. Regarding power control and on/off information, it may be required to reduce interference due to nature of amplify-and forward mechanism, so we are open to study power control and on/off information.

#### **18 – CEWiT**

We support the proposal.

#### **19 – Fujitsu Limited**

Support proposal 3.

#### **20 – NEC Corporation**

We are ok with the proposal in general. For the second side control information, do the transmission and reception boundaries both refer to the timing of the smart repeater?

#### **21 – HUAWEI TECHNOLOGIES Co. Ltd.**

In general agree with the direction of the proposal from the moderator. However, we still have some comments below for some of the sub-bullets:

1. The meaning of "Timing information to align transmission/reception boundaries" is still not clear. Does it mean aligning the transmission/reception boundaries between gNB and smart repeater? If the

answer is yes, it can be achieved by just directly detecting the SSB from the gNB in an implementation manner. Maybe the proponents of this bullet should clarify what needs to be studied here.

2. We don't see the necessity to study UL-DL TDD configuration either. As commented in the initial round, smart repeater can get the TDD configuration via system information from the gNB and thus no need to be delivered by side control information. No strong motivation observed/clarified to study dynamic TDD configuration either, as we commented with details in the initial round, it should be sufficient to operate smart repeater on the semi-static DL/UL symbols for the UEs in the coverage hole, especially considering that typically only fixed DL/UL configuration is used in real network.

3. Both power control and ON-OFF are claimed for efficient interference management. It is not necessary to study both. With appropriate beam management and potential power control mechanism, the interference can be under control, therefore we don't see the necessity to study ON-OFF either.

#### **22 – Sony Group Corporation**

We support Proposal 3. We also share similar views to those of AT&T, Intel and NTT DOCOMO and propose adding a “other side control information” bullet for critical functionality that may potentially be identified during the SI.

#### **23 – Philips International B.V.**

We support proposal 3

#### **24 – China Mobile Group Device Co.**

We support moderator's proposal.

At least the ON/OFF information which could be used to depress the interference from the amplified unwanted signals and noise.

### 3.1.3 Management of smart repeater

Companies are invited to provide their views on Proposal 4 from the initial round.

**Proposal 4:** Study the following aspects of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]
- Interference management for smart repeaters [FFS: responsible WG]

#### **Feedback Form 8:**

##### **1 – Intel Korea**

Proposal 4 looks good to us. Regarding the interference management, it is our understanding that study should be done in RAN1 and RAN4, while specification, if agreed, may be confined to RAN2/RAN3.

##### **2 – SHARP Corporation**

Proposal 4 looks good to us.

### 3 – InterDigital Communications

We support proposal 4.

### 4 – Apple Computer Trading Co. Ltd

Support this proposal and we think responsible WG for proposal 4 should be RAN1, but we are open for further discussion.

### 5 – Qualcomm Incorporated

As commented before, there is no need for interference management since this is handled by the gNB, which schedules the UE and controls the repeater activity via side-control signaling, also RAN4 specifications for Rel-17 NR repeaters already addresses some of the interference concerns. Therefore, we still think this aspect can be deprioritized to narrow down the scope.

In general, and aligned with our previous comments, it seems necessary to agree on prioritization across different items. This will help with future discussions on the actual scope of the SI/WI given the allocated TUs.

We propose the following:

**Proposal 4:** Study the following aspects of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]
- ~~Interference management for smart repeaters [FFS: responsible WG]~~

### 6 – Kyocera Corporation

We agree with Proposal 4. Regarding the interface for the identification and authorization as well as Side control information, we're wondering if the air interface between Smart Repeater and the network would reuse the existing Uu, i.e., it may define a new UE type like IAB-MT. If so, we prefer it should be clearly stated in the SID.

### 7 – Futurewei

We are ok with Proposal 4. We are open to study interference management in RAN1/RAN4. While uncoordinated amplification by the repeaters can inject interference into the network, the level of such interference needs to be assessed to see if enhanced interference management schemes will be required.

Identification and authorization of smart repeaters is required for Network control of smart repeaters.

### 8 – OPPO

We are fine with Proposal 4. Meanwhile, we share the view from Kyocera that some clarification is needed for whether the smart repeater should be designed as a new network node type characterized by, e.g., holding of repeater-MT.

### 9 – NTT DOCOMO INC.

Support proposal 4. We think the responsible WG of interference management can be RAN1.

### 10 – ZTE Corporation

We prefer to remove the 2nd bullet in proposal 4 since the interference-related study has already been covered by the item listed in proposal 3, i.e., power control and on-off. Moreover, for the 1st bullet, we prefer to highlight that the implementation based solution should be the baseline and in our view, with

additional spec impacts, the protocol for smart repeater will be complicated and no impacts on higher layer is preferred since the SR can be taken as an extension of existing RAN node.

**Proposal 4:** Study the following aspects of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]
- **Note: The implementation-based solution should be the baseline.**
- ~~Interference management for smart repeaters [FFS: responsible WG]~~

#### **11 – MediaTek Inc.**

We support P4. For a study phase, it seems not necessary to pre-select a baseline solution or exclude the interference management topic—we may conclude that it is not necessary to do as a management function, but it seems OK to study the question.

#### **12 – Nokia Italy**

Our concerns about smart repeater architecture and capabilities were not included in the summary, but we still feel that clarification on these issues is essential to understand the role of smart repeaters and the baseline for comparison. A control framework currently exists for beam management and TDD config in the context of IAB. If the IAB framework is expected to be re-used, then it is unclear how smart repeaters serve a substantially different role than IAB. If the existing framework is not intended to be re-used, it would be helpful to understand what is lacking as further prioritization of work objectives may be necessary.

Additionally, the scope of interference management for smart repeaters is not clear. We understand that RAN 4 would be expected to evaluate co-existence for smart repeaters. If this is understood to be related to RAN 1/2/3 enhancement it seems contingent on potential work objectives which are currently controversial and maybe not aligned with smart repeater deployment scenarios. We would propose that this should be down-prioritized as well.

#### **13 – vivo Mobile Communication Co.**

Support the proposal, leading group for interference management should be RAN1, RAN3/2 is response for design of the associated signaling exchange.

#### **14 – Ericsson France S.A.S**

Partly agree. Identification and authorization are OK. Regarding interference, it is not clear what needs to be done that is not already supported in NR. The repeater is essentially a beam extender/bender for an existing beam and there is already an existing interference management framework in place for handling that.

#### **15 – Motorola Mobility UK Ltd.**

**Lenovo/ Motorola Mobility:**

We are fine with proposal 4

#### **16 – Samsung Electronics Benelux BV**

The major impact on RAN2 – side control information – is according to Proposal 4 going to be studied further while taking into account any performance gains, so it does not feel like Ran2 are committing to much at this stage, and the impact on RAN2 is difficult to gauge.

For the management, we think the main discussion should be started from the architecture/protocol stack of smart repeaters. Once this is clear, how to perform the identification and authorization would be easy for discussion. In this sense, we would suggest to add another bullet for Proposal 4, which needs RAN2/RAN3 involvement, i.e.,

**Proposal 4:** Study the following aspects of smart repeater management.

- Architecture/protocol stack of smart repeaters [RAN2, RAN3]
- Identification and authorization of smart repeaters [RAN2, RAN3]
- Interference management for smart repeaters [FFS: responsible WG]

#### 17 – CEWiT

We support the proposal.

#### 18 – Fujitsu Limited

Support proposal 4. In our understanding, the leading WG of the second bullet could be either RAN1 or RAN2.

#### 19 – NEC Corporation

For authorization, maybe interaction with SA2/CT1 is needed. So we suggest a revision shown as follow:

**Proposal 4:** Study the following aspects of smart repeater management.

Identification and authorization of smart repeaters [RAN2, RAN3, FFS: SA2/CT1]

Interference management for smart repeaters [FFS: responsible WG]

#### 20 – VODAFONE Group Plc

”identification and authorisation” seems useful and might require some coordination with SA?

#### 21 – HUAWEI TECHNOLOGIES Co. Ltd.

1. For “Identification and authorization of smart repeaters”, SA should be involved as we commented in the initial round, since it belongs to the normal work of SA group. If we cannot achieve consensus, at least SA3 should be involved and we can let SA3 to further decide whether the work should be done by RAN or SA.

2. For interference management, we think that both RAN1 and RAN4 can be involved to give a complete study on the interference issue. For example, RAN4 would need to study the appropriate maximum transmission power for smart repeater considering interference management. Then once the maximum transmission power is decided, RAN1 can also further evaluate the performance of smart repeater.

3. As describe above in point 2, RAN4 would need to study the maximum transmission power. In addition, it would be good to involve RAN4 to study other RF requirements for smart repeater also, in order to check the feasibility/benefits for smart repeater. Therefore, we suggest to add the following bullet to proposal 4:

- **RF requirements for smart repeater, including max transmission power and other applicable RF requirements[RAN4]**

## 22 – Sony Group Corporation

We support Proposal 4. In our understanding, the leading group for interference management should be RAN1, with support from RAN4 and RAN2/3 as needed. Similar to MediaTek, we do not believe that at this stage it is necessary to define a baseline solution or to exclude interference management; those can follow from the SI.

## 23 – Philips International B.V.

We support proposal 4.

## 24 – China Mobile Group Device Co.

- for identification and authorization

From our point of view, repeater has two functions the UE function and network function. Both require authorization and authentication. For UE part, the same procedure and mechanism as normal UE could be reused and core network is required to help to finish such operations. But for the network function, it is not suggested to touch core network, other solutions are not precluded such as OAM based or implementation based solution.

We want to emphasize again that any update of core network may decrease operators' willingness of deployment and **reuse of the same authorization scheme as IAB is not suggested.**

- for interference management

The interference issue for higher power repeater is not carefully analyzed in R17 RAN4 spec but only assuming that interference could be avoided by planned deployment. Therefore, RAN1 and RAN4 are suggested as the responsible WG.

Therefore, the proposal is modified as below:

Proposal 4: Study the following aspects of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]

**Other RAN based or implementation based authorization and authentication solutions for repeater's network function are not precluded without touching core network spec.**

- Interference management for smart repeaters [RAN1, RAN4]

### 3.1.4 Joint study on smart repeater & RIS

Given the views are divided on RIS, there will not be any further discussion on this issue in the final round. If there are any final comments on RIS with regards to Observation 2 from the initial round, please provide them below.

**Observation 2:** Company views on whether or not to include RIS as part of the Rel-18 smart repeater work is divided. Moderator view is to focus Rel-18 efforts on smart repeater and re-consider RIS once this work is completed.

#### Feedback Form 9:

### 1 – KT Corp.

KT observes strong needs to include RIS in the scope of smart repeater. We would like to see the inclusion of RIS having the same beam management scheme as smart repeater (at least for FR2 considering the form

factor of RIS).

**2 – AT&T GNS Belgium SPRL**

We prefer to focus the Rel-18 study on the smart repeater part and take RIS at a later time to minimize the scope of the study.

**3 – Intel Korea**

We support the moderator's view expressed in Observation 2. We also agree with initial round comments that RIS technology is not mature enough for studying it in relation to smart repeaters and side control information.

**4 – SHARP Corporation**

We strongly agree with the moderator's view re: RIS, especially since it's not immediately clear to us what the specification impact of RIS is compared to smart repeaters that form beams.

**5 – InterDigital Communications**

We support observation 2.

**6 – Qualcomm Incorporated**

We agree with Moderator's view.

**7 – Apple Computer Trading Co. Ltd**

We understand the situation. In our view, it is better that work of smart repeater can consider future extension to RIS.

**8 – Kyocera Corporation**

We're fine that the performance aspects of RIS will be studied in future releases. However, for the control/interface aspects, we still think Rel-18 study should take into account a common framework and forward compatibility for Side control information which is applicable to not only Smart Repeater but also RIS in the future. In this case, we think a NOTE could be added in the SID to clarify the forward compatibility is required to be considered.

**9 – Futurewei**

We agree with the moderator's observation.

**10 – OPPO**

Given this is an SI anyway, we support to include RIS in the study scope, e.g. to at least identify the common parts and non-common parts between smart repeater and RIS.

**11 – NTT DOCOMO INC.**

Agree with moderatoer view to focus on Smart repeater in Rel-18 though we prefer to have RIS study including RIS category/channel model etc., if time allows. RIS can be reconsiderd in the next release after the work for smart repeater is completed.

**12 – ZTE Corporation**

Although some of the side control information can be applicable to both SR and RIS and prefer to take into account the common part first, we are fine with the moderator's proposals. And additional RIS-related aspects can be considered after the smart repeater WI.

**13 – MediaTek Inc.**

We agree with the moderator. RIS is an interesting future topic, but not at the same level of maturity, and we think it shouldn't be mixed with the smart repeater study.

**14 – Nokia Italy**

Agree with moderator that RIS should not be included as part of Rel-18 study. RIS is not sufficiently mature to begin standardization. Additionally, as previously noted, RIS may likely be viewed as a subset smart repeater control and could be enhanced in a later release, if it is clear that the current framework is insufficient.

**15 – Ericsson France S.A.S**

Agree with Moderator's view

**16 – Motorola Mobility UK Ltd.****Lenovo/ Motorola Mobility:**

We are fine with Moderator's view

**17 – Samsung Electronics Benelux BV**

We share the view with moderator. We prefer not to include RIS as part of the Rel-18 and focus on smart repeater.

**18 – CEWIT**

We support the proposal.

**19 – Fujitsu Limited**

We agree with the moderator's observation.

**20 – NEC Corporation**

We agree with it, and think the study of RIS can take the framework of smart repeater as a reference, until its definition is clear enough.

**21 – HUAWEI TECHNOLOGIES Co. Ltd.**

Agree no need to discuss RIS in Rel-18.

**22 – Sony Group Corporation**

We understand the position of the Moderator. We believe, however, that at least identifying the common and non-common parts between RIS and smart repeaters fits well within the scope of a R18 Study Item, anyway. The aim should be to come up with a control interface design that is sufficiently broad to ensure forward compatibility with RIS. We therefore also support adding a note to the SID, as suggested by Kyocera: “NOTE could be added in the SID to clarify the forward compatibility is required to be considered.”

**23 – Rakuten Mobile**

We think RIS and Repeaters are two completely different topics.

Although, we would like to discuss RIS within Rel-18 but it seems there is not much enthusiasm within community to support RIS.

So we are fine with Moderators Proposal.

**24 – Philips International B.V.**

We agree with other companies that RIS needs to be included in the scope of smart repeater so that some aspects, e.g., beam management, can be co-designed to ensure forward compatibility.

**25 – China Mobile Group Device Co.**

We agree with moderator’s observation.

**26 – ETRI**

Smart repeater and RIS have many common research issues. Therefore, it would be better to include a study on which of the solutions for smart repeater can be applied to RIS.

**3.1.5 Target scenario / assumption**

Companies are invited to provide their views on Proposal 5 from the initial round.

**Proposal 5:** Focus Rel-18 smart repeaters work on the following scenario / assumptions:

- Prioritizing FR2 TDD deployments for both outdoor and O2I scenarios
- For only single hop stationary smart repeaters
- Assuming smart repeaters are transparent to UEs

**Feedback Form 10:****1 – AT&T GNS Belgium SPRL**

We agree with previous Verizon comment that both FR1 and FR2 should be considered with FR2 prioritized. Therefore, we would like to see the first sub-bullet of Proposal 5 modified as below.

- Consider FR1 (FDD and TDD) and FR2 (TDD) bands. Prioritizing FR2 TDD deployments for both outdoor and O2I scenarios.

<p><b>2 – Intel Korea</b></p> <p>The listed assumptions are agreeable. We also support FR1 inclusion, while FR2 may be a higher priority for study.</p>
<p><b>3 – SHARP Corporation</b></p> <p>We agree with AT&amp;T GNS Belgium SPRL and Verizon, especially prioritizing FR2.</p>
<p><b>4 – InterDigital Communications</b></p> <p>We prefer to keep the issue “whether smart repeaters are transparent or not “ open for the SI. For other issues, we are fine.</p>
<p><b>5 – Qualcomm Incorporated</b></p> <p>We agree with Proposal 5.</p>
<p><b>6 – Apple Computer Trading Co. Ltd</b></p> <p>We support proposal 5 in principle. But we would like to clarify whether the smart repeater works in full-duplex mode or not.</p>
<p><b>7 – Kyocera Corporation</b></p> <p>We agree with Proposal 5.</p>
<p><b>8 – Futurewei</b></p> <p>We are ok to take these scenario/assumptions as the initial ones for the study item</p>
<p><b>9 – OPPO</b></p> <p>We are fine with Proposal 5. We share the same question as from Apple regarding to duplex mode, and would like to propose to limit Rel-18 smart repeater to half duplex between backhaul link and access link.</p>
<p><b>10 – NTT DOCOMO INC.</b></p> <p>We are fine to prioritize FR2 TDD, but we think the framework and solutions designed for FR2 TDD can be also applicable to FR1 and FDD. We suggest to add a note to mention the applicability to FR1 and FDD.</p>
<p><b>11 – ZTE Corporation</b></p> <p>We are supportive of the moderator’s proposal. Although from a technical perspective, the SR can be applicable for all interesting cases up to the deployment, it’s still preferred to focus on <b>the prioritized case for evaluation</b>. Regarding the duplex-related issue, in our view, only the amplify-and-forwarding functionality is expected at the repeater side without additional capability, e.g., data-storing. Then, simultaneously operation of the links (i.e., gNB-SR link and SR-UE link) is expected.</p>
<p><b>12 – MediaTek Inc.</b></p> <p>We agree with P5.</p>

<p><b>13 – Nokia Italy</b></p> <p>It is not clear what about the current deployment scenario and assumptions are unique to smart repeaters. The role/purpose of smart repeaters also needs to be captured. Several companies have noted that the role of smart repeaters is coverage extension, but it is not clear if this is the consensus view.</p>
<p><b>14 – vivo Mobile Communication Co.</b></p> <p>Support the proposals.</p>
<p><b>15 – Motorola Mobility UK Ltd.</b></p> <p><b>Lenovo/ Motorola Mobility:</b></p> <p>In general, we are fine with the proposal. Furthermore, FR1 should also be considered.</p>
<p><b>16 – Ericsson France S.A.S</b></p> <p>We generally agree. We think that it is important to focus on FR2 as this is the important scenario and to keep the RAN1 and RAN4 scope reasonable.</p>
<p><b>17 – Samsung Electronics Benelux BV</b></p> <p>We are generally fine with current scenario/assumptions as baseline.</p>
<p><b>18 – CEWiT</b></p> <p>We support the proposal.</p>
<p><b>19 – Fujitsu Limited</b></p> <p>We support proposal 5.</p>
<p><b>20 – NEC Corporation</b></p> <p>We agree with this proposal.</p>
<p><b>21 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>Ok to further check whether smart repeater is beneficial with the above assumption.</p>
<p><b>22 – Sony Group Corporation</b></p> <p>Similar to other companies, we believe that FR1 (TDD and FDD) should also be covered by the SI/WI. Also, at this stage we think that the assumption in the third bullet, i.e., “Assuming smart repeaters are transparent to UEs”, is not needed and can rather be treated in the SI.</p>
<p><b>23 – Rakuten Mobile</b></p> <p>Agree with NTT Docomo’s suggestion.. Please add that FR1 (TDD and FDD) will also be covered.</p>
<p><b>24 – China Mobile Group Device Co.</b></p> <p>We agree with that FR1 should also be considered, especially TDD. We could focus on FR2 and reuse the same procedures or mechanisms as much as possible.</p>

## 3.2 Moderator summary and recommendationv

### 3.2.1 Proposals / Observations with reference to general views

The following two proposals seem non-controversial from moderator point of view. Note that text elaborating the purpose of the study item has been removed.

**Proposal 1 (non-controversial):** For smart repeaters, start with study item.

**Proposal 2 (non-controversial):** For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4.

### 3.2.2 Proposals / Observations with reference to side control info

Minor change has been made to Proposal 3. While there were a number of comments suggesting some prioritization, the following seems more acceptable to the interested companies. From moderator's point of view, the proposal seems agreeable.

**Proposal 3:** Study and identify which side control information is necessary for smart repeaters including at least [RAN1, RAN2, RAN4]

- Beamforming information
- Timing information to align transmission / reception boundaries of smart repeater
- Semi-static and dynamic TDD information
- Power control information for efficient interference management
- ON-OFF information for efficient interference management and improved energy efficiency

### 3.2.3 Proposals / Observations with reference to management of smart repeater

The bullet on interference management has been removed based on comments that it is already covered by Proposal 3. Also, there was a suggestion to add "FFS: SA/CT" in addition to RAN2, RAN3 for identification and authorization of smart repeaters. However, since it is an FFS anyway, it can be added on later if things become clearer. From moderator's point of view, the proposal seems agreeable.

**Proposal 4:** Study the following aspect of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]

### 3.2.4 Proposals / Observations with reference to joint study on smart repeater & RIS

It's clear the situation has not changed. No further discussions on RIS in final round.

### 3.2.5 Proposals / Observations with reference to target scenario / assumption

Proposal 5 has been revised to allow the consideration of FR1 but with a lower priority compared to FR2. Furthermore, based on comment from Nokia, it is clarified the smart repeaters are for coverage extension. From moderator's point of view, the proposal seems agreeable.

**Proposal 5:** Focus Rel-18 smart repeater work on the following scenario / assumptions:

- Consider smart repeaters used for extension of network coverage on FR1 (FDD and TDD) and FR2 (TDD) bands. Prioritizing FR2 TDD deployments for both outdoor and O2I scenarios.
- For only single hop stationary smart repeaters
- Assuming smart repeaters are transparent to UEs

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## 4 Final Round

### 4.1 Collection of company views

#### 4.1.1 General views

**Proposal 1 (non-controversial):** For smart repeaters, start with study item.

**Proposal 2 (non-controversial):** For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4.

Companies are invited to provide their views with respect to the above Proposal 1 and Proposal 2.

#### Feedback Form 11:

<p><b>1 – OPPO</b></p> <p>We are fine with the Proposal 1 and Proposal 2, assuming the later RAN-P discussion would come up with a full list of SID objectives, some of which maybe contained in the earlier Proposal 1 but all removed from the latest Proposal 1. We suppose what are listed in other sections of 4.1.x do not automatically construct the full SID objectives.</p>
<p><b>2 – NTT DOCOMO INC.</b></p> <p>Support proposal 1 and proposal 2.</p>
<p><b>3 – Charter Communications</b></p> <p>Support both proposals</p>
<p><b>4 – Qualcomm Incorporated</b></p> <p>We support proposals 1 and 2.</p>
<p><b>5 – InterDigital Communications</b></p> <p>We support Proposal 1 and Proposal 2.</p>

<p><b>6 – AT&amp;T GNS Belgium SPRL</b></p> <p>Support proposals 1 and 2.</p>
<p><b>7 – Samsung Electronics Benelux BV</b></p> <p>Support Proposal 1 and Proposal 2</p>
<p><b>8 – Apple Computer Trading Co. Ltd</b></p> <p>Support both proposal 1 and 2.</p>
<p><b>9 – MediaTek Inc.</b></p> <p>We support proposals 1 and 2.</p>
<p><b>10 – Futurewei</b></p> <p>We are ok with Proposal 2. With regards to proposal 1 while we agree on starting with a study item, we are concerned on why any reference to validating performance gains (over appropriate Rel. 17 baseline) during the study item has not been included.</p>
<p><b>11 – ZTE Corporation</b></p> <p>We support proposals 1 and 2.</p>
<p><b>12 – China Mobile Group Device Co.</b></p> <p>we support proposal 1 and 2</p>
<p><b>13 – CEWiT</b></p> <p>Support proposal 1 and 2.</p>
<p><b>14 – Nokia Italy</b></p> <p>Support proposal 1 and 2.</p>
<p><b>15 – Ericsson France S.A.S</b></p> <p>We support the proposals</p>
<p><b>16 – NEC Corporation</b></p> <p>We agree Proposal 1 and Proposal 2.</p>
<p><b>17 – Verizon UK Ltd</b></p> <p>We support Proposals 1 and 2.</p>
<p><b>18 – Fujitsu Limited</b></p> <p>We support proposal 1 and proposal 2.</p>

<p><b>19 – Motorola Mobility UK Ltd.</b></p> <p><b>Lenovo /Motorola Mobility:</b></p> <p>We support Proposal 1 and Proposal 2</p>
<p><b>20 – Intel Korea</b></p> <p>We are still supportive of these proposals</p>
<p><b>21 – vivo Mobile Communication Co.</b></p> <p>We support the proposal</p>
<p><b>22 – Sony Group Corporation</b></p> <p>We support proposals 1 and 2.</p>
<p><b>23 – Philips International B.V.</b></p> <p>We support both proposals</p>
<p><b>24 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>For proposal 1, we prefer the version provided by the moderator in the intermediate round, which makes it clearer the high level scope of the study item.</p> <p><b>Proposal 1:</b> For smart repeaters, start with study item to validate performance gains, identify applicable scenarios, and study design of "side control information".</p> <p>In the intermediate round, there were some comment on proposal 1 that "identify applicable scenarios" is not needed because proposal 5 already provides the scenarios. In our understanding proposal 5 only provides a list of scenarios to further study, to identify whether any of them is beneficial with smart repeater, therefore the study item still needs to identify the applicable/beneficial scenarios if any. To make it clearer if really needed, we can consider to modify proposal 1 in the intermediate round as below:</p> <p><b>Proposal 1:</b> For smart repeaters, start with study item to validate performance gains, identify applicable/<b>beneficial</b> scenarios, and study design of "side control information".</p> <p>In addition, as commented in the intermediate round, whether to set up a SI for smart repeater in Rel-18, in the end would depend on the overall Rel-18 package to see if any capacity for it.</p>

#### 4.1.2 Side control info design

**Proposal 3:** Study and identify which side control information is necessary for smart repeaters including at least [RAN1, RAN2, RAN4]

- Beamforming information
- Timing information to align transmission / reception boundaries of smart repeater
- Semi-static and dynamic TDD information
- Power control information for efficient interference management

- ON-OFF information for efficient interference management and improved energy efficiency

Companies are invited to provide their views with respect to the above Proposal 3.

**Feedback Form 12:**

<p><b>1 – OPPO</b></p> <p>We do not see it necessary and helpful to have a "at-least recommendation list" for a SI. But if the majority of companies think the list is necessary, we can be ok to have it in SID.</p>
<p><b>2 – NTT DOCOMO INC.</b></p> <p>Support proposal 3.</p>
<p><b>3 – KDDI Corporation</b></p> <p>We support Proposal 3 by the moderator.</p>
<p><b>4 – Qualcomm Incorporated</b></p> <p>We support Proposal 3.</p>
<p><b>5 – InterDigital Communications</b></p> <p>We support Proposal 3.</p>
<p><b>6 – AT&amp;T GNS Belgium SPRL</b></p> <p>Support proposal 3.</p>
<p><b>7 – Samsung Electronics Benelux BV</b></p> <p>We are fine with Proposal 3. We are open to study whether side control information other than beamforming is beneficial or not</p>
<p><b>8 – Apple Computer Trading Co. Ltd</b></p> <p>Support proposal 3.</p>
<p><b>9 – MediaTek Inc.</b></p> <p>We support proposal 3, bearing in mind that this is a list of the topics that had enough interest in the discussion that they fairly clearly need to be evaluated. We have some sympathy for OPPO's view that an explicit list may not be necessary (companies will anyway bring the topics they think are important), but OK with the list if it helps to focus the study.</p>
<p><b>10 – Futurewei</b></p> <p>We are ok with proposal 3.</p>

<p><b>11 – ZTE Corporation</b></p> <p>We are fine with proposal 3, and listing these potential candidates is beneficial for the study since some of them have already got sufficient interests and supports.</p>
<p><b>12 – China Mobile Group Device Co.</b></p> <p>we support proposal 3</p>
<p><b>13 – CEWiT</b></p> <p>We support proposal 3</p>
<p><b>14 – Ericsson France S.A.S</b></p> <p>We support the proposal in general, but think that as well as necessity impact/feasibility should be considered for the signaling (for example, whether the beamforming information has an impact on scheduling procedures and efficiency)</p>
<p><b>15 – NEC Corporation</b></p> <p>We are ok to this proposal.</p>
<p><b>16 – Verizon UK Ltd</b></p> <p>We support Proposal 3.</p>
<p><b>17 – Fujitsu Limited</b></p> <p>Support proposal 3.</p>
<p><b>18 – Intel Korea</b></p> <p>Thanks for the updated proposal and adding “including at least”. We are mostly fine, although our preferred “band/bandwidth” information is not included.</p> <p>For the third sub-bullet “Semi-static and dynamic TDD information”, we have concern on explicit mentioning of “dynamic TDD”. As it was commented by companies, dynamic TDD deployments are not typical and mature due to challenges in cross-link interference. We are worried that adding dynamic TDD information objective may complicate the study and work substantially w/o clear applicability to realistic deployments. The previous version of this bullet is more acceptable.</p> <p>Regarding the comments mentioning prioritization of some control information over the other, we think it should be avoided. The study item has the goal of careful consideration of all the aspects and drawing conclusions on which information is essential and which is not.</p>
<p><b>19 – Motorola Mobility UK Ltd.</b></p> <p><b>Lenovo/ Motorola Mobility:</b></p> <p>We are fine with the proposal.</p>
<p><b>20 – vivo Mobile Communication Co.</b></p> <p>We support the proposal</p>

<p><b>21 – Sony Group Corporation</b></p> <p>Support proposal 3.</p>
<p><b>22 – Philips International B.V.</b></p> <p>We support the proposal.</p>
<p><b>23 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>As we commented in the intermediate round, we don't think some of the bullets are necessary. However, looking at the comments/views from different companies, it seems the current proposal 3 suggested by the moderator is the only way to go at this moment.</p>

#### 4.1.3 Management of smart repeater

**Proposal 4:** Study the following aspect of smart repeater management.

- Identification and authorization of smart repeaters [RAN2, RAN3]

Companies are invited to provide their views with respect to the above Proposal 4.

#### **Feedback Form 13:**

<p><b>1 – OPPO</b></p> <p>We are not sure whether the interference management can be in general covered by "power control" issue in Proposal 3. Power control is just one candidate technique to handle interference. In addition, there is no guarantee that power control in Proposal 3 would survive after SI or it can survive but its effectiveness turns out not to fully handle interference issue with smart repeater. So the interference management may still need to be standalone in SID.</p>
<p><b>2 – NTT DOCOMO INC.</b></p> <p>Support proposal 4.</p>
<p><b>3 – Qualcomm Incorporated</b></p> <p>We support Proposal 4.</p>
<p><b>4 – InterDigital Communications</b></p> <p>We support Proposal 4.</p>
<p><b>5 – AT&amp;T GNS Belgium SPRL</b></p> <p>Support proposal 4.</p>
<p><b>6 – Samsung Electronics Benelux BV</b></p> <p>Support Proposal 4</p>

<p><b>7 – Apple Computer Trading Co. Ltd</b></p> <p>Support proposal 4.</p>
<p><b>8 – MediaTek Inc.</b></p> <p>Support proposal 4.</p>
<p><b>9 – Futurewei</b></p> <p>We are ok with proposal 4.</p>
<p><b>10 – ZTE Corporation</b></p> <p>We prefer to add the note <b>”Note: The implementation-based solution should be the baseline.”</b> to this proposal. Then, any new/complicated design should be well justified since one key advantage of the smart repeater is the simplified protocol.</p>
<p><b>11 – China Mobile Group Device Co.</b></p> <p>We still suggest to add following note <b>“Other RAN based or implementation based authorization and authentication solutions for repeater’s network function are not precluded without touching core network spec.”</b></p> <p>The prominent advantage of smart repeater is its cost-efficiency. The price of device itself only occupies part of total deployment cost. Other cost comes from the updating of network device, which is also costly and can’t be ignored. We should minimize the update of core network and this is one of the main differences from IAB.</p> <p>For interference issue, power control is only one of candidate solutions. Other solutions are not precluded. Besides, RAN4 may need to be involved to help evaluate interference issue. It’s better to explicitly list interference management in the objective.</p>
<p><b>12 – CEWiT</b></p> <p>Support proposal 4</p>
<p><b>13 – Nokia Italy</b></p> <p>We are still unclear on the scope of this proposal, and whether aspects related to smart repeater management are to be included. We still are unclear on what the architecture of a smart repeater is and what baseline assumptions are to be considered.</p>
<p><b>14 – Ericsson France S.A.S</b></p> <p>We support the proposal.</p>
<p><b>15 – NEC Corporation</b></p> <p>We can accept it, if SA/CT can be added when the type or role of smart repeater is clearer.</p>
<p><b>16 – Verizon UK Ltd</b></p> <p>We support Proposal 4.</p>

<p><b>17 – Fujitsu Limited</b></p> <p>Support proposal 4.</p>
<p><b>18 – Motorola Mobility UK Ltd.</b></p> <p>We support Proposal 4</p>
<p><b>19 – Intel Korea</b></p> <p>We can accept this proposal and not explicitly mention interference management if the study of necessary control information can take the interference management aspects into account.</p>
<p><b>20 – vivo Mobile Communication Co.</b></p> <p>We support the proposal.</p>
<p><b>21 – Sony Group Corporation</b></p> <p>We have similar views to OPPO and China Mobile and believe that the interference management bullet “Interference management for smart repeaters [FFS: responsible WG]” should be kept. The leading group for interference management should be RAN1, with support from RAN4 and RAN2/3. As explained by OPPO and China Mobile, power control is just one technique for interference management, and other candidate techniques may be discussed in the SI.</p>
<p><b>22 – Philips International B.V.</b></p> <p>We support the proposal.</p>
<p><b>23 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>1. As we commented in the intermediate round, for “Identification and authorization of smart repeaters”, SA should be involved since it belongs to the normal work of SA group. At least SA3 should be involved and we can let SA3 to further decide whether the work should be done by RAN or SA. Therefore, we suggest to make the following change:</p> <p>Identification and authorization of smart repeaters [<b>SA3</b>, RAN2, RAN3]</p> <p>2. We also think that it is better to keep the bullet “Interference management for smart repeaters” in the scope also, since it is not clear yet which contents will be included in side control information and thus not sure whether/how to solve interference by side control information. In addition, even power control and/or ON-OFF will be included in side control information, it is not clear yet whether those are the only/better way from interference management perspective.</p> <p>3. Suggest to add the following bullet to proposal 4 also. As commented in intermediate round, in order to check the feasibility/benefits for smart repeater, RAN4 needs to be involved to study RF requirements, e.g. the maximum transmission power.</p> <p><b>- RF requirements for smart repeater, including max transmission power and other applicable RF requirements[RAN4]</b></p>

#### 4.1.4 Joint study on smart repeater & RIS

No further discussion on RIS in final round

#### 4.1.5 Target scenario / assumption

**Proposal 5:** Focus Rel-18 smart repeater work on the following scenario / assumptions:

- Consider smart repeaters used for extension of network coverage on FR1 (FDD and TDD) and FR2 (TDD) bands. Prioritizing FR2 TDD deployments for both outdoor and O2I scenarios.
- For only single hop stationary smart repeaters
- Assuming smart repeaters are transparent to UEs

Companies are invited to provide their views with respect to the above Proposal 5.

#### **Feedback Form 14:**

##### **1 – OPPO**

We wonder whether this new wording of "extension of coverage" is intentionally made different from "enhancement of coverage", where the "extension of coverage" means a coverage from none to normal while the "enhancement of coverage" may additionally include the coverage from occasionally weak to normal. This relates to our earlier comment of two scenarios A and B in section 3.1.1. Unless it is intentional to rule out one specific scenario, our suggestion is to use "enhancement of coverage" to be more generic or to say nothing relating to coverage.

##### **2 – NTT DOCOMO INC.**

Support proposal 5.

##### **3 – Charter Communications**

Generally fine with proposal 5; the SI should strive for a unified design for both FR1 and FR2.

##### **4 – Qualcomm Incorporated**

We support Proposal 5.

##### **5 – InterDigital Communications**

As we commented in the intermediate round, we slightly prefer to keep the issue that "whether smart repeaters are transparent or not" open for the SI.

For now, we are not fully convinced that the scopes in Proposal 3 could be supported in a UE transparent manner.

However, if majority companies prefer spec transparent support, then we can accept it as a compromise.

For other issues, we are fine.

#### **6 – AT&T GNS Belgium SPRL**

Support Proposal 5. Concerning UE transparent manner assumption, we think that this is a good assumption to start with and any possible impact to Proposal 3 can be addressed if needed based on the study.

#### **7 – Samsung Electronics Benelux BV**

Although we don't see a strong necessity on FR1 band, we are fine with Proposal 5

#### **8 – Apple Computer Trading Co. Ltd**

Support proposal 5 in principle. However, from the comments in last round (From OPPO and ZTE), we see different views on whether smart repeater would work in full duplex mode or not. We feel this would be an important assumption for further work. Based on the comments from ZTE, the smart repeater would not be able to store data, it seems reasonable that it should work in full duplex mode. Then can we add a bullet about it as follows. If it is too late, we are also open to decide it later.

- Smart repeater can maintain the gNB -repeater link and repeater-UE link simultaneously

#### **9 – MediaTek Inc.**

We support proposal 5. We think transparency to the UE is quite important; it would undercut the usefulness of the smart repeater if there were extra UE requirements to benefit from it.

#### **10 – Futurewei**

We agree with proposal 5.

#### **11 – ZTE Corporation**

We support proposal 5. We share the view that SR should be transparent to all UEs since it's just one step enhancement compared to the legacy RF repeater. Moreover, it's also fine to add the clarification from Apple that as one additional bullet:

- Smart repeater can maintain the gNB -repeater link and repeater-UE link simultaneously

#### **12 – CEWiT**

We support proposal 5

#### **13 – China Mobile Group Device Co.**

We support proposal 5.

The SR should be transparent to UEs to ensure all UEs could still work without any update.

About duplex issue, we could assume that except for new control information dedicated for repeater, all the other signals from gNB or UE just pass through smart repeater without any store and regeneration. However, the DL and UL directions doesn't work simultaneously. There is switching delay between the time when the end of the DL(or UL) transmissions reaches the input port of the repeater until the repeater starts the UL(or DL) transmission on the output port. The sentence "Smart repeater can maintain the gNB -repeater link and repeater-UE link simultaneously" doesn't include the UL direction. How about change it to "**Smart repeater can maintain backhaul link and access link simultaneously for each direction (UL or DL)**"

<p><b>14 – Nokia Italy</b></p> <p>Support the proposal.</p>
<p><b>15 – Telstra Corporation Limited</b></p> <p>We support Proposal 5</p>
<p><b>16 – Ericsson France S.A.S</b></p> <p>FR1 beamforming procedures differ from FR2 since digital beamforming can be assumed, and also propagation and interference properties are different. For low bands and FDD, there is already a repeater spec in Rel-17 and smart repeaters would be large, bulky and without advantage in the lower FDD bands. For mid-band TDD, due to different beamforming approaches and building practices, the RAN1 and RAN4 work would be different due to the digital beamforming techniques likely to be employed at the BS. Therefore, we much propose to keep the scope on FR2, where the need and benefits are much clearer. In any case, it would be preferable to not work on low band FDD. We can support single hop and UE transparency</p>
<p><b>17 – NEC Corporation</b></p> <p>We agree Proposal 5.</p>
<p><b>18 – Fujitsu Limited</b></p> <p>Support proposal 5.</p>
<p><b>19 – Verizon UK Ltd</b></p> <p>We agree Proposal 5. We support UE transparency and single hop assumptions. It is desirable to have unified design for FR1 and FR2 TDD bands. We support prioritization of FR2.</p>
<p><b>20 – Motorola Mobility UK Ltd.</b></p> <p><b>Lenovo/ Motorola Mobility:</b></p> <p>We support Proposal 5</p>
<p><b>21 – Intel Korea</b></p> <p>Support. Minor suggestion for the first sub-bullet: prioritizing -&gt; prioritize</p>
<p><b>22 – vivo Mobile Communication Co.</b></p> <p>We support the proposal. Additionally, we think smart repeater can maintain BH and AL simultaneously even without any further clarification.</p>
<p><b>23 – Sony Group Corporation</b></p> <p>We support Proposal 5. In our view, a smart repeater does not regenerate data, but simply amplifies and forwards. Moreover, it works in full duplex mode, meaning that both UL and DL directions can be supported simultaneously, including the backhaul link and access link. We are okay to add a bullet explaining this understanding.</p>

**24 – Philips International B.V.**

Enhancement of coverage is a better wording.

**25 – HUAWEI TECHNOLOGIES Co. Ltd.**

We still think that the study should focus on FR2, then can be further discussed whether it is beneficial to extend to other application scenarios. If even for FR2 the gain is very marginal, then there is no point to study other application scenarios like FR1.

For FR1, in addition to FDD and TDD, we have other duplex modes also, e.g. SDL and SUL. There is no point to preclude any of them at this stage if FR1 will be studied, therefore if FR1 is to be studied, then we need to make the following changes:

Consider smart repeaters used for extension of network coverage on FR1 (~~FDD and TDD~~) and FR2 (~~TDD~~) bands. Prioritizing FR2 TDD deployments for both outdoor and O2I scenarios.

4.1.6 Justification on Rel-18 smart repeater

*Coverage is a fundamental aspect of cellular network deployments. Mobile operators rely on different types of network nodes to offer blanket coverage in their deployments. Deployment of regular full-stack cells is one option but it may not be always a possible (e.g., no availability of backhaul) or economically viable.*

*As a result, new types of network nodes have been considered to increase mobile operators' flexibility for their network deployments. For example, Integrated Access and Backhaul (IAB) was introduced in Rel-16 and enhanced in Rel-17 as a new type of network node not requiring a wired backhaul. Another type of network node is the RF repeater which simply amplify-and-forward any signal that they receive. RF repeaters have seen a wide range of deployments in 2G, 3G and 4G to supplement the coverage provided by regular full-stack cells. While a RF repeater presents a cost effective means of extending network coverage, it has its limitations. An RF repeater simply does an amplify-and-forward operation without being able to take into account various factors that could improve performance.*

*A smart repeater is an enhancement over conventional RF repeaters with the capability to receive and process side control information. Side control information could allow a smart repeater to perform its amplify-and-forward operation in a more efficient manner. Benefits could include mitigation of unnecessary noise amplification, transmissions with better spatial directivity, and autonomous network integration.*

Companies are invited to provide their views on the above justification for Rel-18 NR smart repeater.

**Feedback Form 15:**

**1 – SHARP Corporation**

We are OK with this proposal although, the last sentence might also be *"Benefits could include mitigation of unnecessary noise amplification, transmissions with better spatial directivity, and autonomous network integration and spectrum management."*

**2 – OPPO**

We are fine with the justification. One typo: *"to perform its amplify-and-forward operation is in a more efficient manner"*.

### 3 – NTT DOCOMO INC.

We are fine with the justification.

### 4 – Qualcomm Incorporated

There is no reference to Rel-17 NR repeater. The scope and shortcoming of Rel-17 NR repeater should be mentioned, and it should be clarified smart repeaters are effectively Rel-17 NR repeaters plus additional side control information. This further implies RAN4 requirements/specifications for NR repeaters should be used for smart repeaters, when applicable.

Apart from that, we are fine with most of the justification. We propose the following minor rewording in the last two sections for clarification:

*An RF repeater simply does an amplify-and-forward operation without being able to take into account various factors that could improve performance. Such factors **may** include information on **semi-static and/or dynamic** downlink/uplink configuration, **adaptive** transmitter/receiver spatial beamforming, ON-OFF status, etc.*

*A smart repeater is an enhancement over conventional RF repeaters with the capability to receive and process side control information **from the network**. Side control information could allow a smart repeater to perform its amplify-and-forward operation **is in** a more efficient manner. Benefits could include mitigation of unnecessary noise amplification, transmissions **and receptions** with better spatial directivity, and autonomous network integration.*

### 5 – InterDigital Communications

We are fine with the justification.

### 6 – Samsung Electronics Benelux BV

We are fine with justification.

### 7 – Apple Computer Trading Co. Ltd

Support the justification.

One minor comment, we think the following editorial change is needed:

*”Deployment of regular full-stack cells is one option but it may not be always ~~a~~ possible (e.g., no availability of backhaul) or economically viable.”*

### 8 – MediaTek Inc.

We are OK with the justification. Very minor editorial comment:

*While an RF repeater presents a cost effective means of extending network coverage, it has its limitations.*

### 9 – Futurewei

We agree with the description but note that all benefits stated are potential benefits and it remains to be validated whether these benefits can indeed be achieved by feasible deployments of low-cost smart repeaters with limited capability. We believe a key objective of the study item should be to assess and validate the latter aspect.

<p><b>10 – ZTE Corporation</b></p> <p>We are in general fine with the justification and regarding the ”<i>autonomous network integration</i>”, we prefer to update it as ”simplified network integration”.</p>
<p><b>11 – CEWiT</b></p> <p>We are fine with the justification</p>
<p><b>12 – Nokia Italy</b></p> <p>We are fine with justification.</p>
<p><b>13 – China Mobile Group Device Co.</b></p> <p>The wording ”autonomous network itegration” is not very clear. we havn’t discuss any integration related issue. As stated before, minimum core network impact is one of the main difference from IAB and could obviously reduce deployment cost. so we prefer to change it into ”minimum core network impact”</p>
<p><b>14 – Verizon UK Ltd</b></p> <p>We are in general fine with the justifications. We also support Qualcomm’s comments to add a couple of sentences to differentiate with R-17 NR repeaters and editorial corrections.</p>
<p><b>15 – Fujitsu Limited</b></p> <p>We are basically fine with the justification. The only concern is the ’autonomous’ in the last sentence seems not clear enough. There seems no common understanding on what is the ’autonomous network integration’ among companies yet. We suggest to remove the ’autonomous’ and change this phrase to ’the network integration simpler than that of IAB nodes’.</p>
<p><b>16 – Motorola Mobility UK Ltd.</b></p> <p><b>Lenovo/ Motorola Mobility:</b></p> <p>We are fine with the justification</p>
<p><b>17 – Intel Korea</b></p> <p>Overall agree with the justification part. There are several typos, which may need to be fixed in the final version.</p>
<p><b>18 – Sony Group Corporation</b></p> <p>We are okay with the justification.</p>
<p><b>19 – Philips International B.V.</b></p> <p>We are fine with the justification</p>
<p><b>20 – HUAWEI TECHNOLOGIES Co. Ltd.</b></p> <p>Whether smart repeater is beneficial or not still depends on further study in the study phase, therefore it is not appropriate at this stage to include descriptions that kind of concluding smart repeater is beneficial. Therefore, we suggest to make the following changes:</p>

*While a RF repeater presents a cost effective means of extending network coverage, it has its limitations, since a RF repeater simply does an amplify-and-forward operation ~~without being able to take into account various factors that could improve performance. Such factors include information on downlink/uplink configuration, transmitter/receiver spatial beamforming, ON-OFF status, etc.~~*

*A smart repeater is an enhancement over conventional RF repeaters with the capability to receive and process side control information. Side control information ~~could~~may allow a smart repeater to perform its amplify-and-forward operation ~~in~~is a more efficient manner. Benefits ~~could~~may include mitigation of unnecessary noise amplification, transmissions with better spatial directivity, and autonomous network integration. **In order to achieve the above potential benefits, smart repeater requires the capability similar as IAB MT, and the number of sites to be deployed may increase compared to deploying IAB nodes, due to full duplexing mode which may result in smart repeater with lower capability.***

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## 5 Conclusion

### 5.1 General observations and recommendations from moderator

Based on the company comments over the three rounds of discussions, moderator view is that there is convergence to start the work on smart repeaters with a study item. The proposals have been revised to address some of the comments in the final round. From moderator point of view, all the proposals can be endorsed with the understanding that additional details may be added later. If RAN cannot formally endorse the proposals (for some reason) these proposals should at least be taken as the starting point for the next round of RAN discussions to finalize the Rel-18 SID on smart repeaters.

Moderator's estimate for Rel-18 smart repeaters assuming the all proposals from the moderator are endorsed is 1 TU in RAN1.

**Proposal 1 (should be agreeable):** For smart repeaters, start with study item.

For Proposal 1, other than Huawei, all other companies are fine. And even for Huawei, considering what they commented is already reflected in the other proposals, should be fine with Proposal 1. Proposal 2 is non-controversial. Moderator view is to endorse Proposal 1 and Proposal 2.

**Proposal 2 (non-controversial):** For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4.

For Proposal 3, Proposal 4, and Proposal 5, the proposals have been revised based on company comments in the final round but should be agreeable.

For Proposal 3, "Semi-static and dynamic TDD information" is revised to "Information on UL-DL TDD configuration". From moderator point of view, either expression seems fine but since there is concern from Intel, the change has been made.

**Proposal 3 (should be agreeable):** Study and identify which side control information is necessary for smart repeaters including at least [RAN1, RAN2, RAN4]

- Beamforming information

- Timing information to align transmission / reception boundaries of smart repeater
- Information on UL-DL TDD configuration
- Power control information for efficient interference management
- ON-OFF information for efficient interference management and improved energy efficiency

For Proposal 4, companies are generally fine with the proposal. CMCC and ZTE proposed to add some text emphasizing the importance of cost-efficiency of smart repeaters. This is addressed in Proposal 5. A bullet to address Huawei's comments on RF requirement has been added which seems reasonable from moderator point of view. For Huawei's comment to add SA3 for identification and authorization, moderator suggests further discussion.

**Proposal 4 (should be agreeable):** Study the following aspect of smart repeater

- Identification and authorization of smart repeaters [RAN2, RAN3]
- RF requirements for smart repeater, including max transmission power and other applicable RF requirements [RAN4]

For Proposal 5, two additional bullet points have been added. One bullet is to address the comment from CMCC and ZTE with reference to Proposal 4 on cost efficiency of smart repeaters. Another bullet is to clarify the simultaneous operation of repeater-gNB and repeater-UE links. Both bullets seem underlying assumptions on smart repeater discussions. From the moderator point of view the two new bullets should be common understanding already. The proposal should be agreeable to all companies.

**Proposal 5 (should be agreeable):** Focus Rel-18 smart repeater work on the following scenario / assumptions:

- Consider smart repeaters used for extension of network coverage on FR1 (FDD and TDD) and FR2 (TDD) bands. Prioritize FR2 TDD deployments for both outdoor and O2I scenarios.

For the proposal on justification, companies are generally fine and the revised version is provided in an attempt to address the comments received.

## 5.2 Summary of proposals

**Proposal 1 (should be agreeable):** For smart repeaters, start with study item.

**Proposal 2 (non-controversial):** For smart repeaters, RAN1 is the primary working group. Secondary working groups are RAN2, RAN3, and RAN4.

**Proposal 3 (should be agreeable):** Study and identify which side control information is necessary for smart repeaters including at least [RAN1, RAN2, RAN4]

- Beamforming information
- Timing information to align transmission / reception boundaries of smart repeater

- Information on UL-DL TDD configuration
- Power control information for efficient interference management
- ON-OFF information for efficient interference management and improved energy efficiency

**Proposal 4 (should be agreeable):** Study the following aspect of smart repeater

- Identification and authorization of smart repeaters [RAN2, RAN3]
- RF requirements for smart repeater, including max transmission power and other applicable RF requirements [RAN4]

**Proposal 5 (should be agreeable):** Focus Rel-18 smart repeater work on the following scenario / assumptions:

- Consider smart repeaters used for extension of network coverage on FR1 and FR2 bands. Prioritize FR2 TDD deployments for both outdoor and O2I scenarios.
- For only single hop stationary smart repeaters
- Assuming smart repeaters are transparent to UEs
- Smart repeater can maintain the gNB-repeater link and repeater-UE link simultaneously
- Cost efficiency is a key consideration point for smart repeaters

**Proposal on justification:**

*Coverage is a fundamental aspect of cellular network deployments. Mobile operators rely on different types of network nodes to offer blanket coverage in their deployments. Deployment of regular full-stack cells is one option but it may not be always possible (e.g., no availability of backhaul) or economically viable.*

*As a result, new types of network nodes have been considered to increase mobile operators' flexibility for their network deployments. For example, Integrated Access and Backhaul (IAB) was introduced in Rel-16 and enhanced in Rel-17 as a new type of network node not requiring a wired backhaul. Another type of network node is the RF repeater which simply amplify-and-forward any signal that they receive. RF repeaters have seen a wide range of deployments in 2G, 3G and 4G to supplement the coverage provided by regular full-stack cells. In Rel-17, RAN4 specified RF and EMC requirements for such RF repeaters for NR targeting both FR1 and FR2.*

*While an RF repeater presents a cost effective means of extending network coverage, it has its limitations. An RF repeater simply does an amplify-and-forward operation without being able to take into account various factors that could improve performance. Such factors may include information on semi-static and/or dynamic downlink/uplink configuration, adaptive transmitter/receiver spatial beamforming, ON-OFF status, etc.*

*A smart repeater is an enhancement over conventional RF repeaters with the capability to receive and process side control information from the network. Side control information could allow a smart repeater to perform its amplify-and-forward operation in a more efficient manner. Potential benefits could include mitigation of unnecessary noise amplification, transmissions and receptions with better spatial directivity, and simplified network integration.*