

Views on Smart Repeaters for Rel-18



Moderator's Summary of Email Discussions

Moderator's recommendations on Smarter Repeater are listed as below:

The investigation on smart repeater is considered with following assumptions:

- 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

With following guidance on the technical related aspect:

- The **side control information** design including **beamforming information** configuration, **timing and TDD** configuration is the starting point
- More discussion is needed on others, e.g., **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 repeater and RIS.
- In addition to the side control information, the need of standardization on management of smart repeater (e.g. including **authentication/authorization** and interference management) can also be investigated.

We generally agree with the moderator's recommendations.

In what follows, we provide our views on some of the aspects (especially those **highlighted**).

Rel-18 Smart Repeaters

Rel-18 smart repeaters = Rel-17 NR repeaters + side control info

- **Side control info** = beamforming configuration, timing and TDD info, and **ON-OFF information**.
- Indication of **ON-OFF** info is beneficial for reducing interference, and energy consumption of the repeaters.
 - Note. benefit of ON-OFF info, along with other side control info, is shown by our initial system analysis. Please see the next slide.
- We believe spec should support **dynamic** indication of side control info with a time **granularity of symbol-level**.
- Just like any other network nodes, smart repeaters needs to be **authorized/authenticated**.
 - This is essentially needed to address security concerns and allow for interoperability.
 - Legacy procedures (e.g., for IAB-nodes) can be leveraged. Hence, specification should be simple and straightforward.
- **Smart repeater (SR) vs IAB:**
 - In our view, SR and IAB offer different services and have different use-cases. SR extends the coverage of an existing cell (or get around a blockage), while IAB adds new cells.
 - As such, SR and IAB do not compete, rather can complement each other.
 - More on comparison of IAB and SR in a later slide.
- **WG involvements:** RAN1 is the leading WG, RAN2/RAN3 may also get involved (esp. for integration of SR). Rel-17 requirements of NR repeaters may need to be revisited by RAN4 for smart repeaters.

Performance Analysis of Smart Repeaters

Sim assumptions

$F_c = 28\text{GHz}$, $\text{DL_BW} = 800\text{MHz}$

gNB: 4-sector, 16X4 each

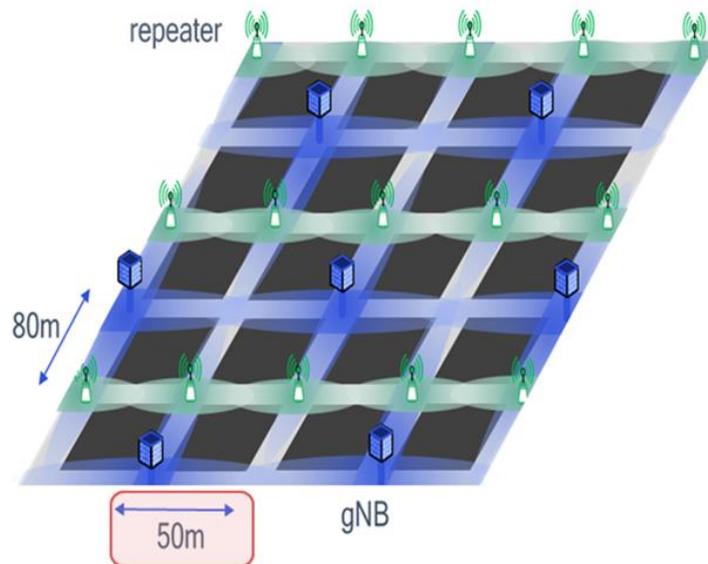
Repeater: 2 FH sectors, 2 AL sectors, 16X4 each

PA=7dBm, peak element pattern gain=4dB

Repeater Type	Max amp gain	BF loss factor
Class A (traditional)	50 dB	-8 dB
Class A+ (TDD-aware)	70 dB	-8 dB
Class B (smart)	70 dB	0

With smart/adaptive beamforming, the repeater can be indicated to adopt a proper/narrow beam towards the scheduled UE and hence provide higher beamforming gain.

TDD awareness allows amplifying in the relevant direction of DL or UL. Without this info, repeater may do "bidirectional" forwarding. In such a case, the max amplification gain in each direction may have to be reduced to ensure stability.



Repeater Type	DL Outage Prob.	Median DL SINR
Class A Repeater = RF repeater	19%	5.8 dB
Class A+ = Class A Repeater + TDD awareness	8.8%	10.4 dB
Class A++ = Class A + On/off information	3%	12.2 dB
Class B = Class A++ + spatial info (UE-side TX/RX beams)	0.18%	23.3 dB

IAB vs Smart Repeater

	IAB	Smart Repeater
Use case	Provide coverage in absence of fiber backhaul	Extend cell coverage into shadow areas Provide a secondary path
Means of coverage extension	By adding cells	By extending cell coverage
Control layer (protocol)	Layer 3 (RRC, F1AP)	L1/2 (DCI or MAC CE)
Control node	gNB-CU	gNB-DU
U-plane operation mode	Decode & Forward	Amplify & Forward
Node complexity	Relatively high (forwarding on L2)	Relatively low (forwarding on RF)
Radio-resource multiplexing between BH/FH and access	Half duplex TDM, FDM, SDM	Full duplex
U-plane latency	At least a few slots (decoding and re-encoding)	Smaller than CP (RF-layer forwarding only)
Max number of BH/FH hops	No principal upper limit; typically, around 4	Typically, 1
Utilization of link capacity	Full utilization since each link applies its own MCS	Link utilization based on worst link in chain since MCS is based on min SINR
Control-plane latency	Uncritical	Critical



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