Enhanced network-controlled repeater

RP-233525
Agenda item: 9.1.2.5
3GPP TSG-RAN#102
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Background

- RAN#101 discussed the possibility of enhanced Network-controlled repeaters.
- The offline summary on RAN2 additional topics was provided [RP-232627]
  - As the starting point, the moderator provided the following potential enhancements.
  - However, there was no conclusion as the result of offline discussion.

> *Which topics/enhancements are considered critical to be part of the objective of WI (if strong support for NCR). From moderator's point of view the following potential enhancements can be considered, however, further downscoping maybe necessary given limited TU availability in RAN2, RAN1, and RAN3:*
>
> - *Specify signalling of side control information to assist NCR setting its amplification gain and/or output power in DL/UL [RAN1, RAN2]*
> - *Specify signalling and procedures where NCR-MT controlling an NCR-Fwd in a different carrier, band, and/or frequency range [RAN2, RAN1]*

Observation

- Number of operators expressed that NCR enhancement in Rel-19 is important.
- NCR complexity should be kept as simple as possible, but it's not the same for NW complexity.
- Whether to support NCR power control is contentious.

Rel-19 eNCR should support practical functionalities to encourage both NCR and FR2 deployments

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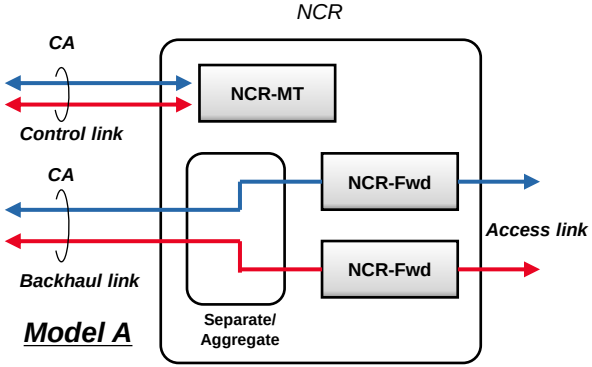
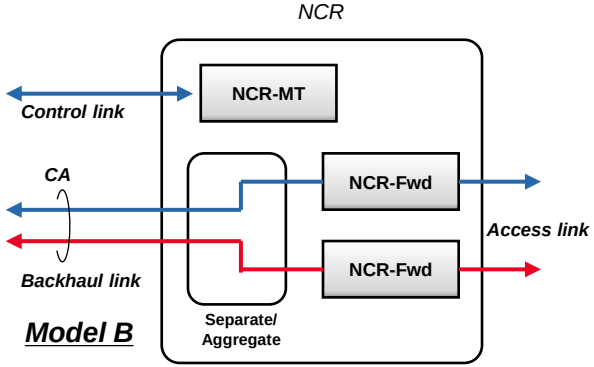
Multi-carrier operation – Full support of CA/DC deployments

- CA/DC are widely deployed in practice, which motivates NCR to support such deployments.
  - A typical deployment scenario for NCR is to forward FR2 Access/Backhaul links.
  - Access/Backhaul links may have more than one carriers for UEs, including inter-band CCs.
  - Control link on FR2 due to Rel-18 limitation is unstable, so robust link on FR1 is desirable.
- Two CA/DC setup models could be considered, i.e.,
  - Model A: Multiple Control links are associated with each Access/Backhaul links.
  - Model B: One Control link is associated with each Access/Backhaul links.





- **Note**: Multi-carrier support by NCR-MT in Model A and Multi-NCR-Fwds in both Models are cost-effective, compared to deploying multiple/separate NCR-nodes for different frequencies.

Multi-carrier forwarding should be fully supported, including inter-band CA/DC configuration for UEs

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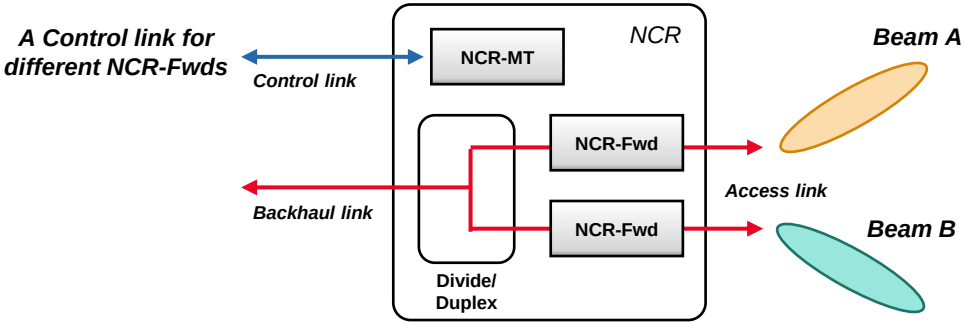
Multi-beam operation

- Multi-beam operation resolves several practical issues, such as:
  - Less scheduling flexibility due to limited FDM possibilities for multiple UEs at different locations.
  - Less efficiency due to the lack of SDM possibilities for multiple UEs among different locations.
  - Less efficiency for multiple NCR deployments enabling multi-beam operation by implementation, i.e., two physical NCRs, two control links, etc.

- Multi-beam operation can be enabled with small modifications based on the current NCR single-beam framework.
  - For example, it can be modelled as multiple NCR-Fwds controlled by one NCR-MT.
  - Specification efforts would be needed only to identify multiple NCR-Fwds on one control link.



Multiple NCR-Fwds for multi-beam control should be supported

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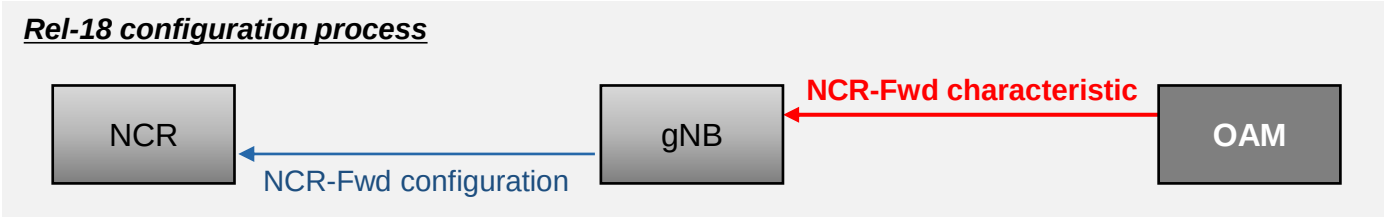
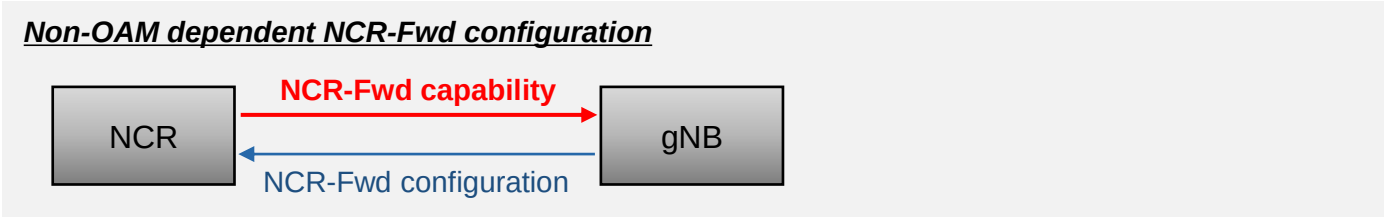
Non-OAM dependent NCR-Fwd configuration

- Non-OAM dependent NCR-Fwd configuration resolves practical issues which were seen in Rel-18.
  - High burden for operators to input NCR-Fwd characteristics manually via OAM.
  - High complexity for operators to deploy multi-vendor NCR-nodes
- Non-OAM dependent NCR-Fwd configuration provides automation of NCR operation and interoperability, and it would be enabled by introducing NCR-Fwd capability signalling.





- **Note**: Non-OAM dependent NCR-Fwd configuration would reduce OPEX (and possibly CAPEX.)

NCR-Fwd capability signalling should be supported

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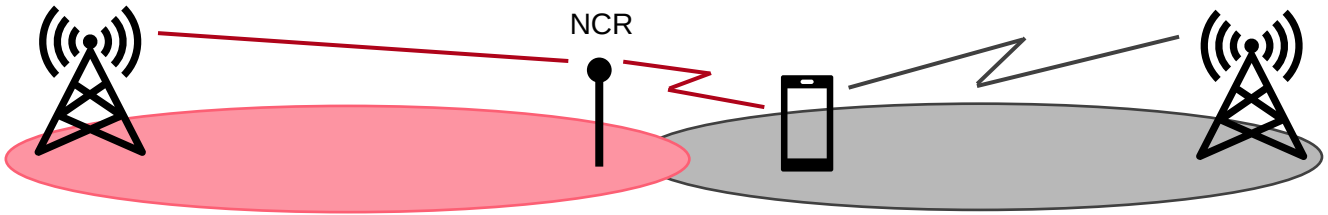
Power control

- NCRs are likely to be deployed at cell-edges, since NCRs provide extended coverage.
  - May cause interference to neighbour cells.
  - gNB's Tx power control is ineffective if NCR-Fwd is operating at maximum Tx power (i.e., due to NCR-Fwd's AGC.)
  - NCR Tx power reconfiguration by OAM is static, so it may not maximize system capacity.
- At least semi-static power control helps gNB with precise interference avoidance/coordination.
  - gNB may configure NCR with lower maximum Tx power to reduce inter-cell interference.
  - On the other hand, dynamic power control may be more complex with a small gain.



- However, Power control was discussed in Rel-18, and not agreeable for Rel-19 in terms of its gain.
  - So, we're acceptable to deprioritize this topic.

Semi-static power control would be useful but not agreed, so it would be discussed in later releases

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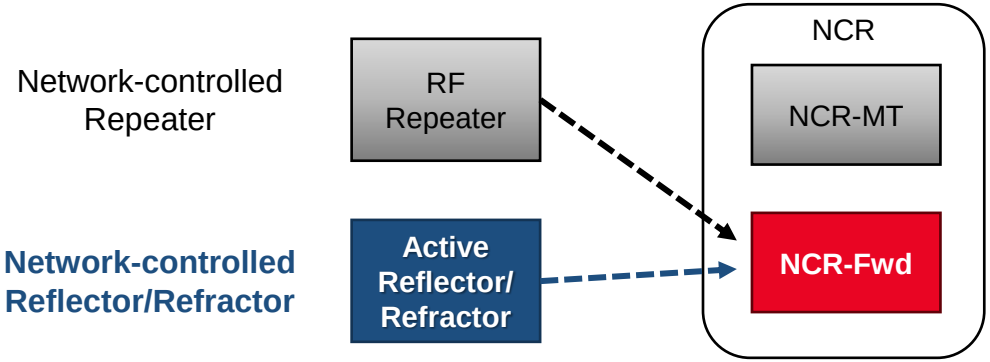
Early implementation of Reconfigurable Intelligent Surface

- Reconfigurable Intelligent Surface (RIS) is another attractive solution for FR2 coverage extension.
  - RIS is being discussed as a candidate Rel-19 study item.
  - On the other hand, early implementation of RIS may be possible by reusing NCR framework.

- In our view, Rel-18 NCR Framework can support Active reflector/refractor as NCR-Fwd.
  - NCR-Fwd characteristics can be configured by OAM, i.e., no impact to Uu interface.
  - Access link beam indication with Beam Index may be reused as is, while backhaul link beam Indication with TCI state may not be necessary.



Possibility of early implementation of RIS should be studied

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Potential objectives

- Specify necessary signalling for multi-carrier forwarding [RAN2]
  - As baseline, multiple NCR-Fwds forward each carriers and these NCR-Fwds are controlled via one Control link.
  - Aim to establish a common framework for both multi-beam and multi-carrier operations.
- Specify necessary signalling for multi-beam operation [RAN2]
  - As baseline, multiple NCR-Fwds and one NCR-MT are mounted on an NCR-node.
- Specify NCR-Fwd capability signalling [RAN2, RAN1]
  - This should remove the Rel-18 NCR Framework that OAM configures gNB with NCR-Fwd characteristics.
- Study early implementation of Active reflector/refractor (a.k.a. RIS) by reusing NCR framework [RAN1]
  - Optimal solution may be further handled under a study item dedicated to RIS in future.

eNCR enabling practical functionalities for simplifying real deployments should be approved for Rel-19

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