

3GPP TSG RAN Meeting #88e
Electronic Meeting
June 29 - July 3, 2020

RP-201140

Qualcomm

Smart Repeaters

Motivation

AI: 9.1.2

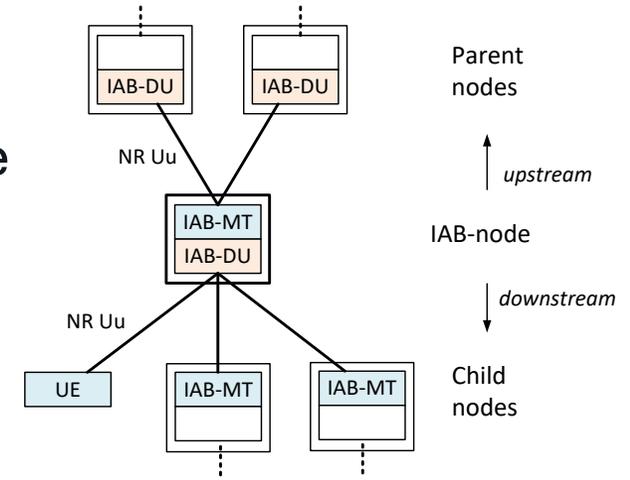
Background

- Coverage is a fundamental aspect of cellular network deployments
- NR operation heavily relies on
 - New spectrum:
 - Majority of new bands are **TDD** and at higher frequencies
 - ~4GHz for FR1 and above 24GHz for FR2
 - Multi-antenna **beamforming** techniques:
 - Massive MIMO for FR1
 - Analog beamforming for FR2
- Network nodes:
 - Full-stack gNBs
 - **IAB nodes** enabling in-band self-backhauling
 - **RF repeaters**

IAB

Overview

- IAB nodes are a type of relay node building over the front-haul architecture
- Dual personality consisting of:
 - Distributed Unit (**DU**) component
 - It makes possible for IAB node to appear as a regular cell to the UEs it serves
 - Mobile Terminal (**MT**) component
 - Connects to its donor parent node(s) inheriting many properties of a regular UE
- IAB node is based on a **Layer 2** architecture with end-to-end PDCP layer from donor IAB node to the UE for CP and UP
- IAB nodes can also be classified as **regenerative relays**
 - Every packet traversing backhaul-link has to be properly decoded and re-encoded for transmission on the access link.
- Rel-16 IAB assumes **half duplex** operation between access and backhaul for Tx and Rx
 - Rel-17 IAB will enable **full duplex** implementations of IAB nodes



RF Repeaters

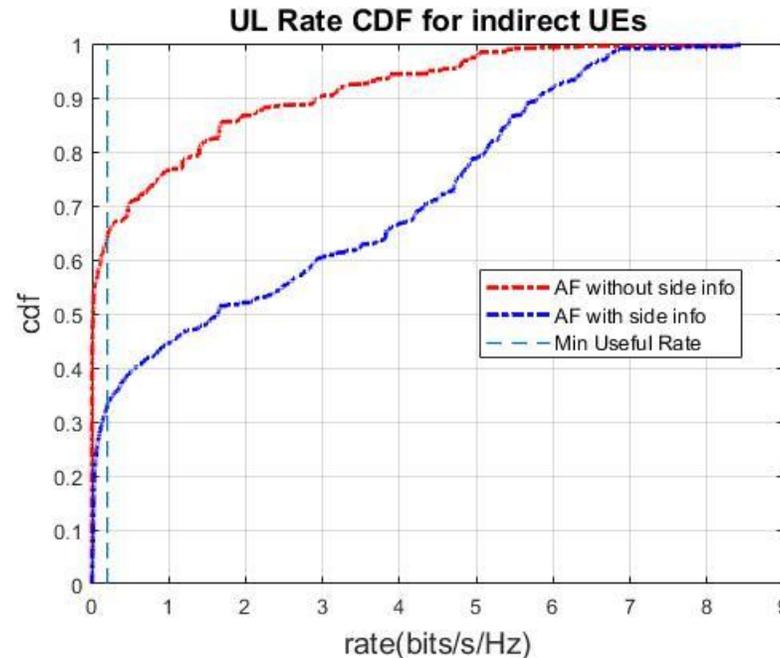
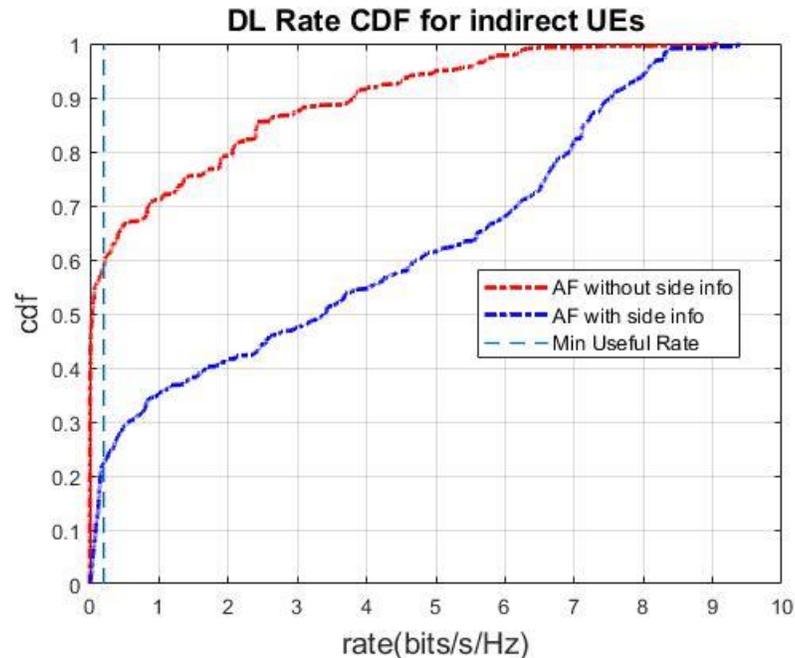
Overview

- **RF repeaters** are **non-regenerative** type of relay nodes that simply *amplify-and-forward* everything that they receive
 - Different categories depending on:
 - Power characteristics and spectrum that they are configured to amplify (e.g., single band, multi-band, etc.)
 - Typically **full-duplex** capable not differentiating UL and DL
- Main **advantages** of RF repeaters are their low-cost, their ease of deployment and the fact that they do not increase latency
 - Simplest and most cost-effective way to improve network coverage
- Main **disadvantage** is that they amplify signal and noise and, hence, may contribute to an increase of interference (pollution) in the system
- There is no definition of RF repeaters for NR as of yet

Observation

Importance of side information availability

- Prelim evaluations indicate that **substantial performance advantages** over RF repeaters can be attained if **side control information** becomes available, namely:
 - **Timing information**: DL/UL split (slot and symbol level)
 - **Spatial Tx/Rx information**: Tx/Rx beam information



Legend:

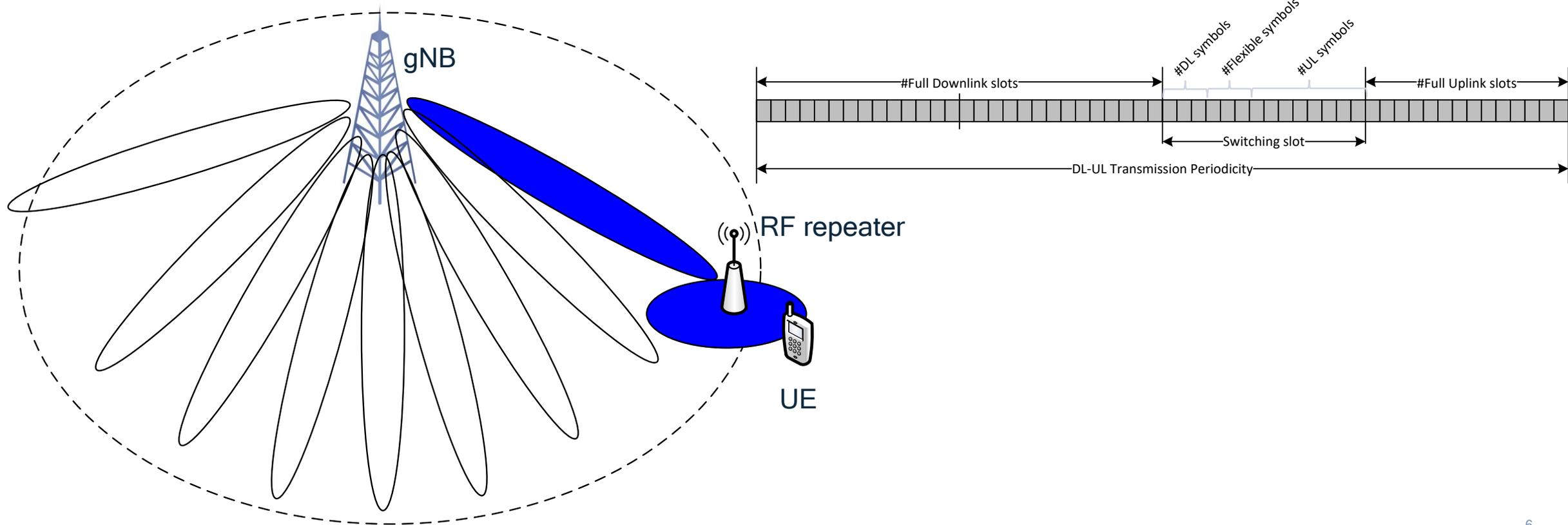
AF: Amplify and Forward

indirectUE: UEs served by Repeater

RF Repeater

In context of TDD and multi-beam operation

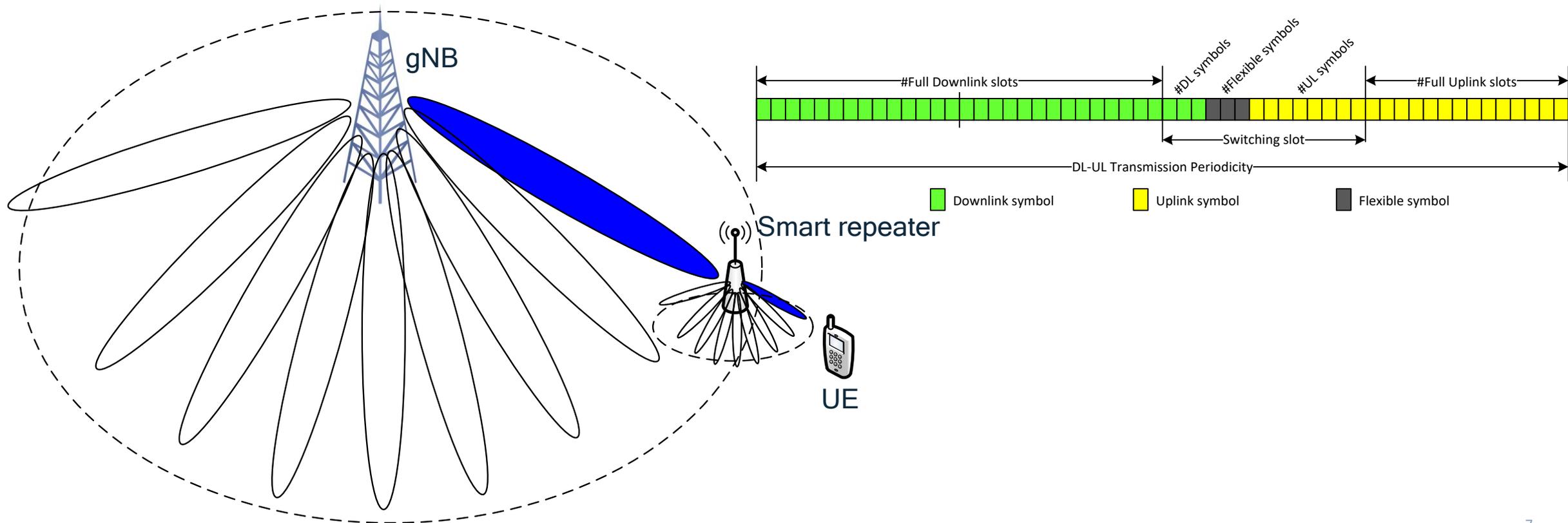
- Typically omni or fixed directional Tx/Rx (not adaptive over time)
- Typically no distinction between UL/DL (high complexity, implementation based if possible)



Smart Repeater

In context of TDD and multi-beam operation

- Multi-beam adaptive over time capable
- Fully aware of DL/UL split

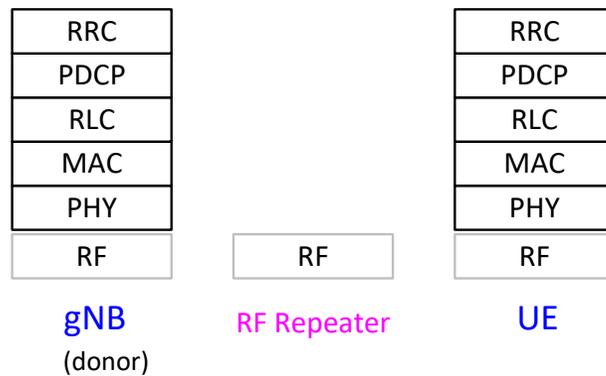


RF Repeaters vs. Smart Repeaters

Protocol Stacks

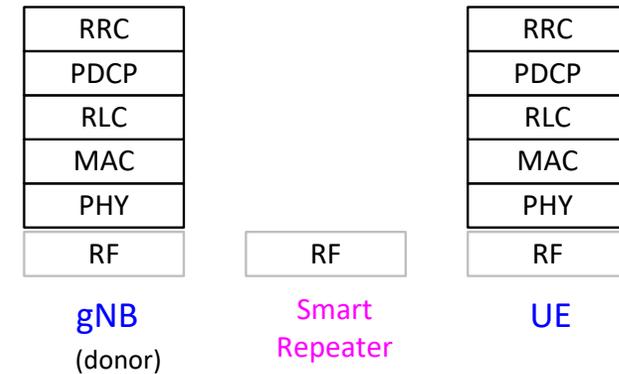
- Protocol stack for RF repeater:

User and Control Plane:

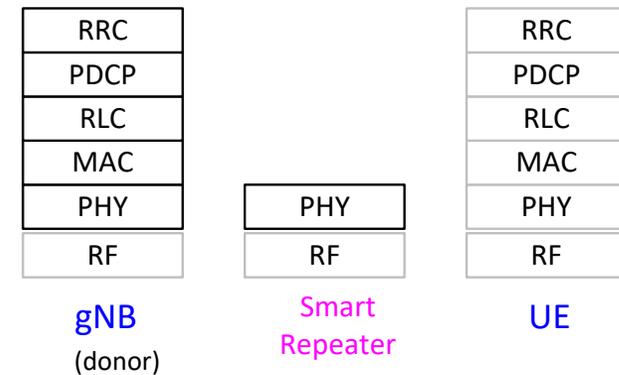


- Protocol stack for Smart Repeater:

User Plane:



Control Plane:



Proposed Objectives

SID objectives (RAN4 primary, RAN1/2/3 secondary)

- Assess the performance advantages of having side control information to intelligently apply amplify-and-forward relay operation assuming availability of the following [RAN4]:
 - Timing information, i.e., slot and symbol UL/DL configuration
 - Transmitter and receiver spatial information, i.e., beam information
- Assess required capacity and feasibility to convey side control information related to timing and spatial characteristics as required by RAN4 [RAN1]
- Assess air-interface and inter-gNB protocol impact to support this type of network node [RAN2, RAN3]



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