

3GPP TSG RAN Meeting #84
Newport Beach California, US, June 3 - 6, 2019

RP-190977

Motivation for Rel-17 NR RF Repeater
Standards at RAN4

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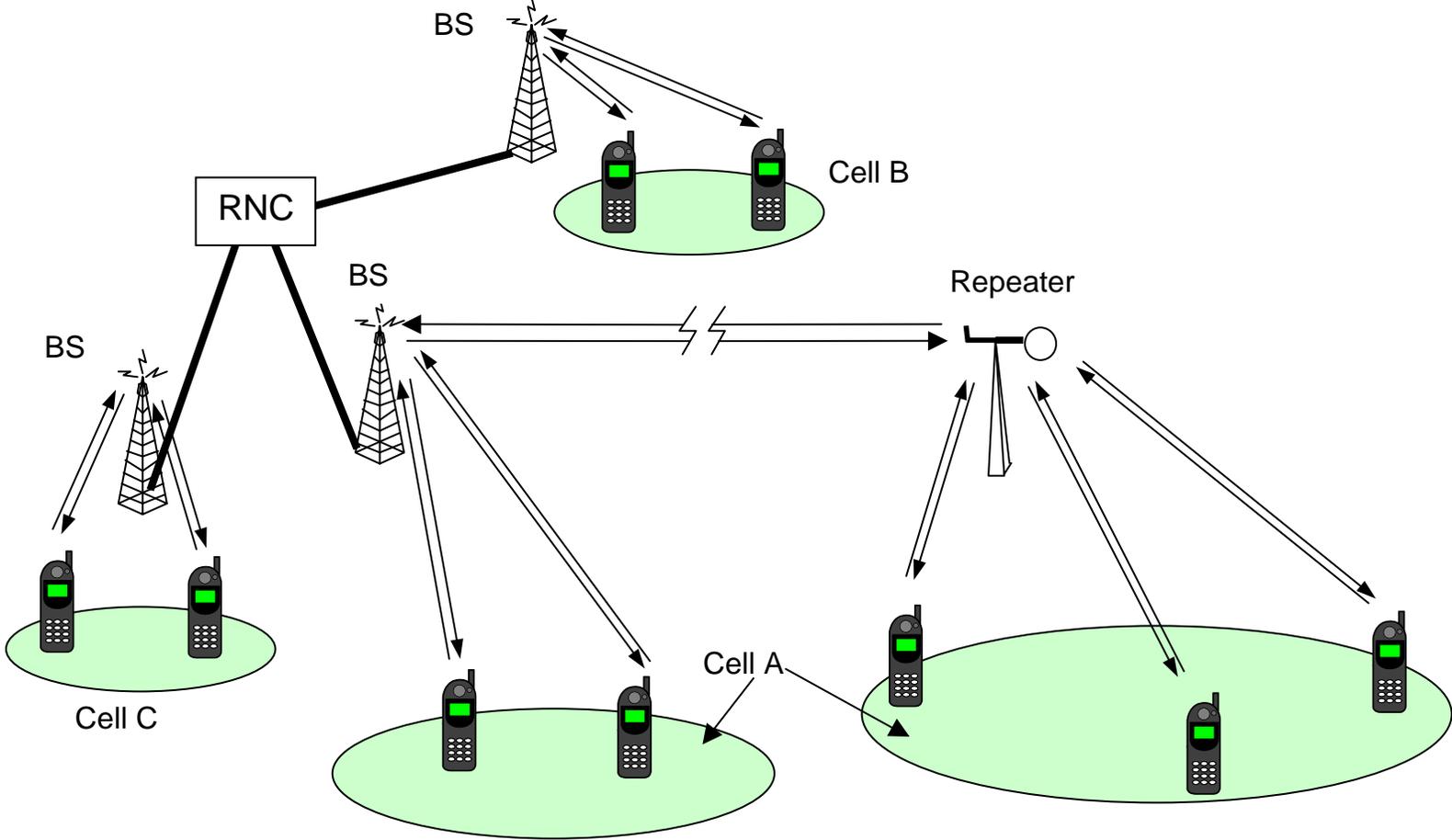
Introduction

- Definition:
A repeater is defined as a device that receives, amplifies and transmits the radiated or conducted **RF carrier** both in the downlink direction (from the Base Station to the mobile area) and in the uplink direction (from the mobile to the Base Station).
- The repeater works on the RF layer, it does not operate on the protocol layer.
- Repeaters are deployed to overcome both penetration attenuation and free space attenuation
- Types of Repeaters (examples):
 - Single- and multi channel/band channel- and band selective repeater
 - Over The Air repeater
 - Fiber optic repeater
 - Output power range from approximately up to 80W
- Locations Where Repeaters are Used (examples):
 - Stadium, Airports, Mall, High Rises
 - Campuses, Hospitals, ODAS/Transport, Offices

Background

- **Multi RAT, Non Stand Alone, Stand Alone:**
Each Channel/Band of repeater can be used for one or more RATs. Prior generation RATs (including GSM, UMTS, and LTE) have all had separate repeater standards defined. The goal is to establish a similar repeater standard for 5G NR.
- **RAT differences at the repeater level:**
From a repeater's perspective, the performance differences when advancing from LTE to 5G NR are similar to the performance differences when the repeater standards evolved from UMTS to LTE. With 5G NR there is a different modulation of the signals and larger signal bandwidths, so the performance requirements will evolve similarly.
- **Frequency range differences:**
Receiving, amplifying and transmitting is almost independent of the frequency range
- **Example for mmWave (FR2) Over The Air Repeater:**
 - Overcome penetration loss of buildings
 - Extend the outdoor coverage area
 - Redirect the wave propagation from main beam to black spots
- **Repeaters are a solution for most 5G NR use cases.**

Example for a Over The Air Repeater



Repeater consideration to ***What is 5G NR?***

- ***What is 5G NR?****
 - *Operation from low to very high bands: 0.4 – 100GHz; Suitable for repeater including standalone operation in unlicensed bands*
 - *Ultra wide bandwidth: Up to 100MHz in <6GHz; up to 400MHz in >6GHz Suitable for repeater*
 - *Set of different numerologies for optimal operation in different frequency ranges n.a. Repeaters are agnostic*
 - *Native forward compatibility mechanisms n.a. Repeaters are agnostic*
 - *New channel coding: LDPC for data channel, Polar coding for control channel n.a. Repeaters are agnostic*
 - *Native support for Low Latency and Ultra Reliability Latency depends on repeater type, Repeaters are reliable*
 - *Flexible and modular RAN architecture: split fronthaul, split control- and user-plane n.a. Repeaters operate on RF level*
 - *Native end-to-end support for Network Slicing (addressing needs of vertical markets) n.a. Repeaters operate on RF level*

* Source: RWS-180025_report_Workshop_on_3GPP_subm_towards_IMT-2020_Brussels_181126.doc

Market need for 5G Repeater

- Market research shows need for 5G Repeater
- For example
- Source:
- <https://www.grandviewresearch.com/press-release/global-distributed-antenna-systems-das-market>
- Excerpt:
- The global distributed antenna systems market size is expected to reach USD 13.78 billion by 2025, according to a study conducted by Grand View Research, Inc. Key factors driving the demand for Distributed Antenna Systems (DAS) include proliferation of connected devices in Internet of Things (IoT), mobile data traffic, and demand for extended network coverage and constant connectivity. Additionally, an increase in higher-bandwidth applications and in-building demand is also supporting the market growth.
- Increasing use of wireless data has been accompanied by the development of newer and faster mobile networks, such as 4G and 5G. These networks have become affordable due to their wide usage and availability of smartphones at affordable prices. Moreover, since the switching cost from one service provider to another is low, mobile network operators have to be extra cautious of the penetration and quality of their network. Increased emphasis on improving network performance has propelled service providers to opt for solutions such as DAS, to ensure round the clock availability of their network, thereby driving market growth.

Proposed WI Justification

- Justification

The Rel-15 Work Item NR_newRAT developed requirements and specifications for new radio (NR) systems but did not include requirements and specifications for repeaters.

Repeaters have been used in 2G, 3G (Rel-4 WI RInImp-REP, Rel-10 WI RANimp-Repeaters1.28TDD) and 4G networks (Rel-18 WI LTE-Repeaters) as a cost-effective solution for extending coverage in sparsely populated areas or in environments with particular propagation impairing conditions, for example buildings, tunnels, subways, stadiums, etc.

In GSM/UTRA/LTE repeaters have proven to be effective for coverage adjustments and interference mitigation.

Repeaters will be a cost effective solution to coverage problems in 5G NR just as they have been cost effective solutions for similar coverage problems in 2G, 3G, and 4G RATs. NR may pose new or different requirements on the repeaters that did not exist in prior generation RATs, so it is necessary to develop a suitable repeater standard for 5G NR.

Currently, there are standalone repeater standards for 2G/3G and 4G. A similar standard is needed for 5G NR.

The repeater is defined as a device that receives, amplifies and transmits the radiated or conducted **RF carrier** both in the downlink direction (from the Base Station to the mobile area) and in the uplink direction (from the mobile to the Base Station).

A repeater operates at the RF layer, and does not affect the protocol layer. Based on this, it is proposed to create a repeater standard for 5G NR. This standard can be independent of SA or NSA 5G NR.

Proposed WI Objective Timeline

- Objective

Develop a core specification and a conformance specification for NR repeaters for FR1 and FR2.

Add repeater to the NR EMC specification. (38.113)

The new NR repeater requirements can be developed based on the existing LTE repeater standards (36.113, 36.106, 36.143).

And in addition, as with UMTS and LTE, the base station transmitter requirements (for NR 38.104 and 38.141) can be considered, which are suitable for repeater as well.

- Timeline

- The Intention is to introduce the 5G NR Repeater Standards into Rel-17.

3GPP 36.106 and 36.143 LTE Repeater requirements
Output power
Frequency stability
Out of band gain
Operating band unwanted emissions
Spurious emissions
Error Vector Magnitude (EVM)
Input intermodulation
Output intermodulation
Adjacent Channel Rejection Ratio (ACRR)

Thank You

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