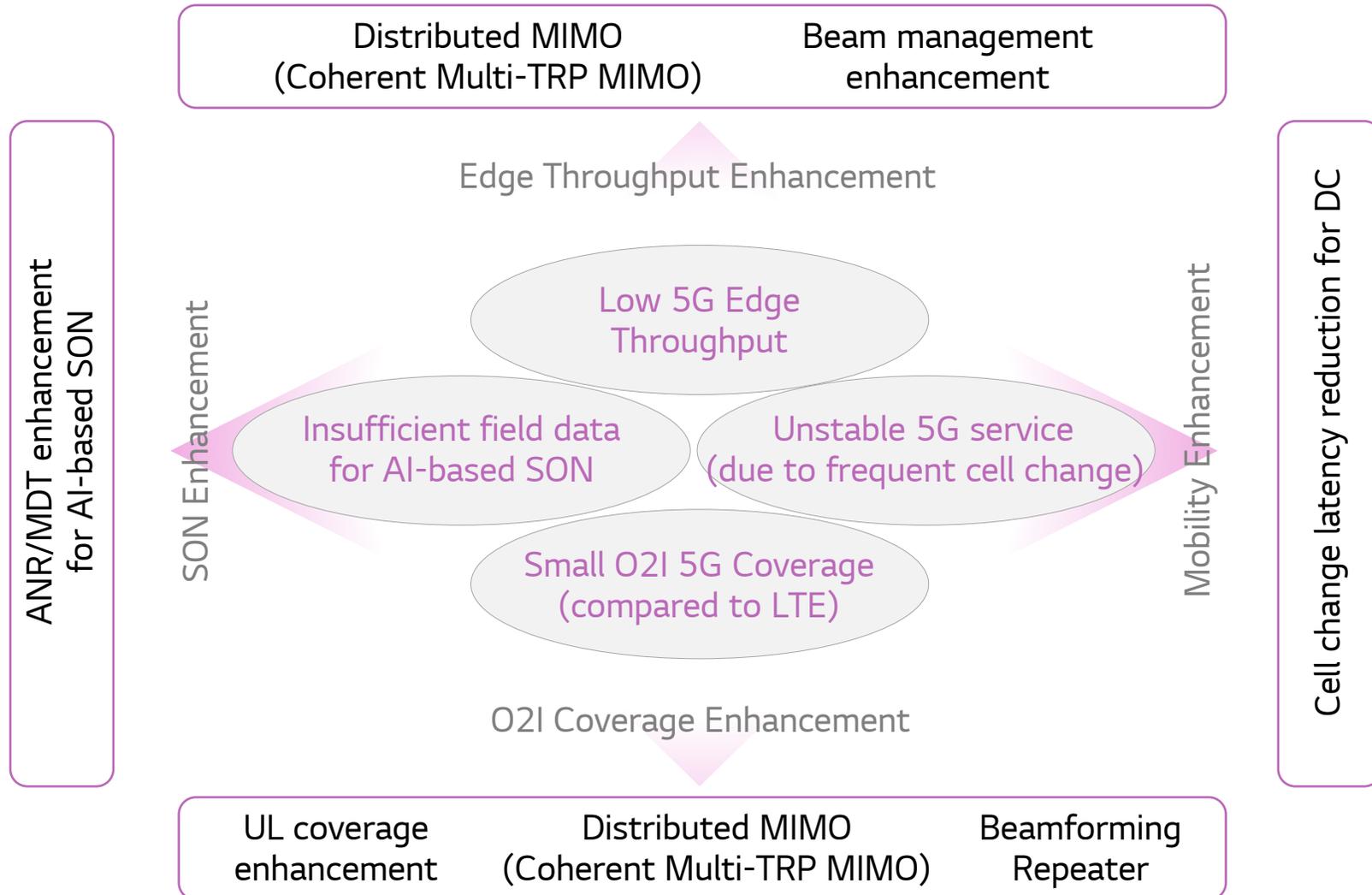


# 5G eMBB Evolution To 5G-Advanced

# What is trouble in 5G eMBB? and How to go?

## Issues on 5G eMBB

- Customer's complaint: Low 5G Edge throughput, Unstable 5G service with data stalling, Small coverage of 5G
- Operator's pain point: Too complex network management and optimization.



# Edge Throughput Enh.: Distributed MIMO & Beam management enh.

## □ In Low/Mid band,

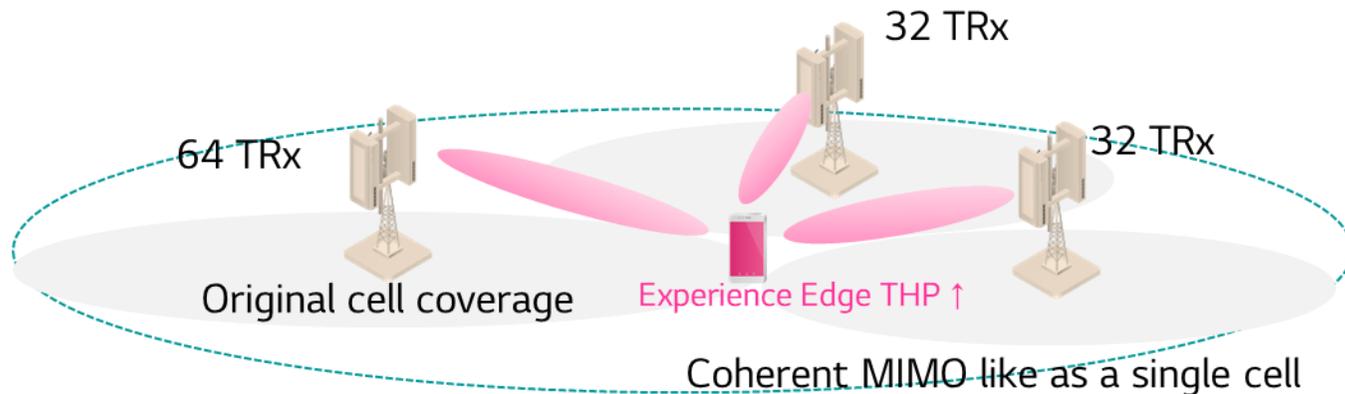
- The number of layers in single RU (Radio Unit) or AU (Antenna Unit) cannot increase since many antenna elements cannot be constructed with long separation distance restriction due to long wavelength.
- To apply new type of RU/AU with more antenna elements is expensive because the existing Rus/AUs are almost discarded.

## □ In High band,

- The radio coverage is very small due to big pathloss by high band spectrum characteristics.
- The number of layers of an RU/AU is limited due to fronthaul capacity deficiency.

## □ Distributed MIMO (Coherent Multi-TRP MIMO)

- Reusing existing RUs and AUs is desired
- Combination of RUs with various number of antennas is desired.
- Coherent MIMO operation of multiple distributed RUs/AUs as a single cell over broad region is required.
- For FDD, overhead reduction of CSI report might be needed for the number of layers increasing.

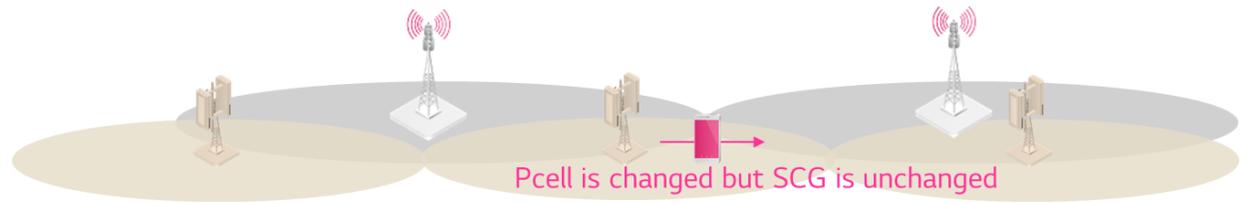


# Mobility Enh.: Cell change latency reduction for DC

## Issues on mobility in DC

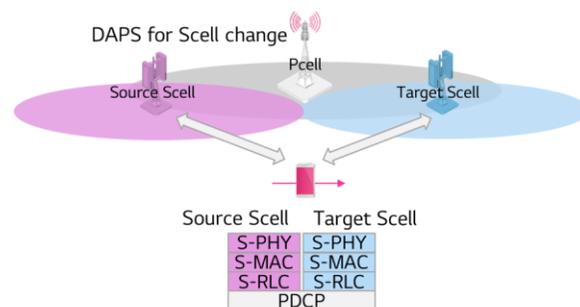
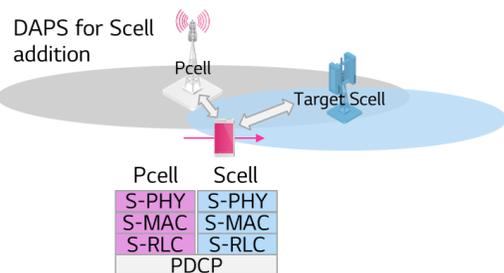
- The coverages of sites in different spectrum are not aligned. Assuming MR-DC including NR-DC, the coverage mismatch induces frequent SCG change.
- In high band spectrum, the coverage is very small. When standalone mode is conducted, Pcell change would be too often. Even for MR-DC, the frequent SCG change would be severe.
- Current SCG change of DC induces data throughput degradation due to long interruption time with RACH and path change (backhaul path change).
- Currently, even though SCG is the same, when Pcell is changed, RACH procedure should be conducted for the same SCG and consume around 40ms latency.

[Site coverage mis-alignment according to spectrum]



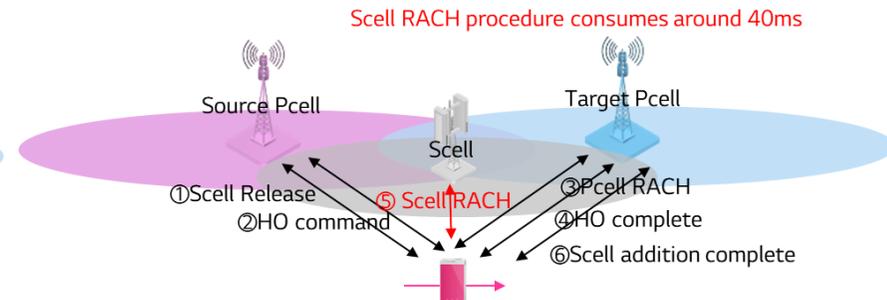
## MR-DC DAPS

- In current spec, DAPS can be applied only to Pcell change case.
- It is desired that DAPS will be also applied to Scell addition/change.



## Enhancement on HO without SCG change

- For the case of HO without SCG change, RACH-less change is desired.



# O2I Coverage Enh.: UL Coverage enhancement

## Issues on UL Coverage

- When carrying out 5G standalone mode in mid band spectrum, UL PUSCH coverage is the bottle neck of the actual service coverage which means that sufficient UL throughput (L Mbps) must be satisfied to support minimum DL throughput (M Mbps) with consideration of TCP.
- In high band spectrum, short coverage of PUCCH/SRS would be problematic for DL performance coverage when EN-DC or NR-DC is applied.

[Coverage Comparison according to channel and spectrum]

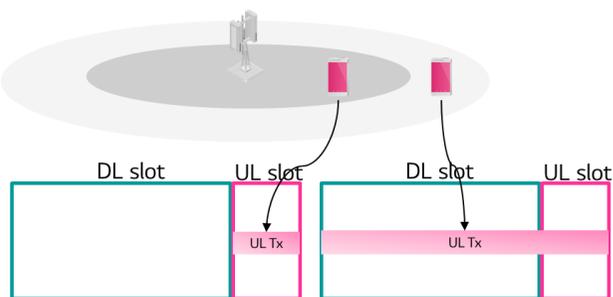


- Mid-band PUSCH ( L Mbps)
- Mid-band PDSCH ( M Mbps)
- Low-band PUSCH ( L Mbps)
- Low-band PDSCH ( M Mbps)



## Sub-band Duplex

- Sufficient uplink throughput for cell edge device is needed.



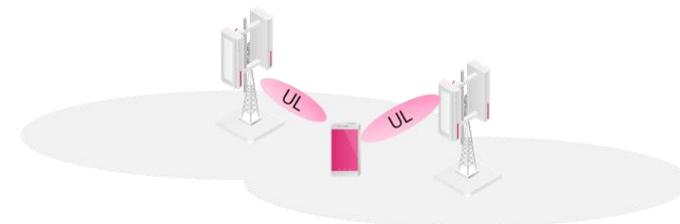
## PUCCH/SRS enhancement

- PUCCH/SRS coverage enhancement is required for high band spectrum.
- Repetition, Antenna diversity, Prolonged sequence and so on.



## Multi-TRP UL

- Multi-TRP joint UL reception could improve UL channel quality.



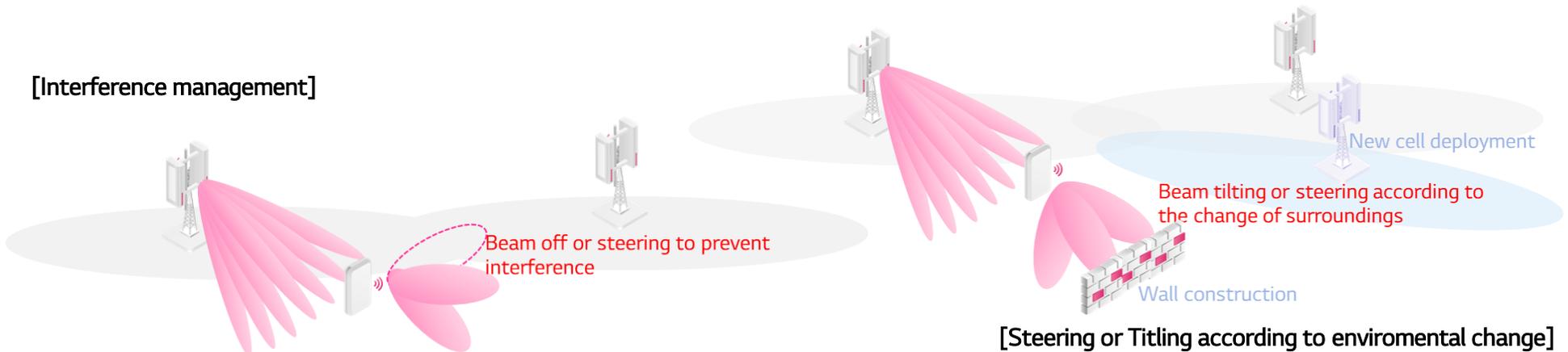
## O2I Coverage Enh.: Beamforming Repeater

- ❑ In current 5G band spectrum except for low band spectrum, there are many coverage holes due to the radio characteristics, where pathloss and penetration loss are big. Repeater system is required to extend coverage.
- ❑ IAB could be stable and controllable coverage-extension solution. However, it seems expensive to install prevalently.
- ❑ Legacy RF repeater generally has static beam shape and is managed manually. When interference occurs, it is hard to resolve.

### ❑ Beamforming repeater

- Controllable beam of repeater could prevent unintended interference easily.
- As surroundings change, beam of repeater could be adjustable without manually steering or tilting.

[Interference management]

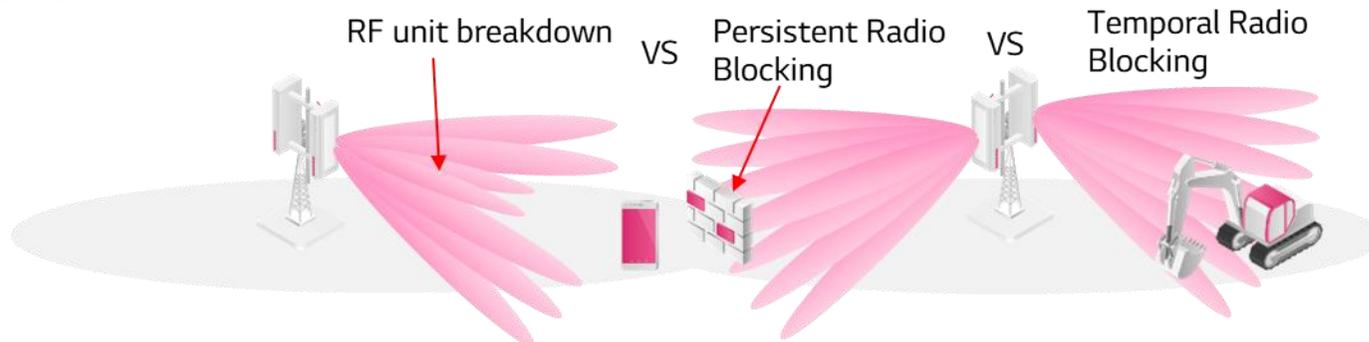


# SON Enh.: ANR/MDT enhancement AI-based SON

- ❑ **Complex 5G system asks autonomous network management and optimization.**
- ❑ **In our statistics, in order to enable AI-based SON with reasonable accuracy, it takes too long period to gather the data. Driving test is very laborious and impossible over the wide area.**
- ❑ **MDT is essential for AI-based SON. However, current commercialization step is very slow since the implementation is deprioritized by vendors.**
- ❑ **Current beam measurement report is only for best beams in order. However, it does not help erroneous beam detection.**



- ❑ **In order to boost up AI-based SON, MDT/ANR feature should be mandatory and prioritized for implementation.**
- ❑ **Measurement configuration to enable individual beam measurement would be desired to improve beam error detection.**



More flexible measurement report per beam would help AI based beam error detection.

Thank you!

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