

3GPP TSG RAN#104

June 17 – 21, 2024

Shanghai, China

RP-241364

Agenda Item 9.11

Device-collaborative MIMO

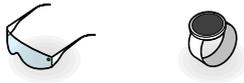
MediaTek Inc.

Motivation

Personal Area Network

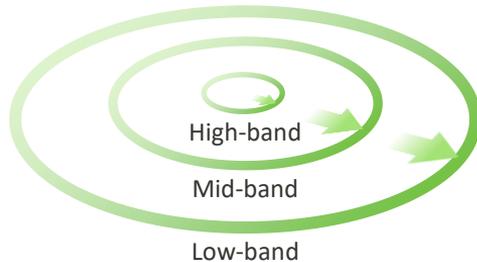
- **Issue 1: Device form-factor restrictions**

- Bottleneck of MIMO gain, due to physical limitations in the number of feasible Tx and Rx antennas



- **Issue 2: Worse propagation/coverage properties in higher frequencies**

- Limit maximizing MIMO gain even in case more device antennas are feasible



- **Users often carry a multiplicity of devices**

- Incl. smartphone, tablet, wearables, etc. – a trend we expect will strengthen (e.g. XR, new form-factors)
 - These devices often operate “together” e.g. via BT tethering (voice calls, remote phone camera shutter etc.)
- Such **personal network of devices** open some opportunity for greater collaboration that can address Issues 1 and 2.

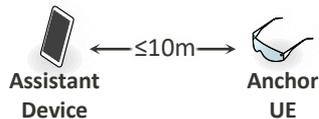
The collective PHY capability of devices in close proximity can offer much greater performance than with a single device, benefiting a) the 3GPP system and b) the end user



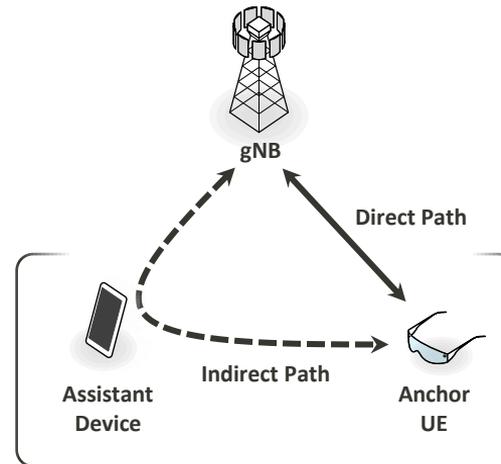
Target Scenario

General

- **Low-layer collaboration** between
 - Anchor UE: form-factor constrained e.g. XR glasses; and
 - Assistant Device/UE: e.g., smartphone, CPE



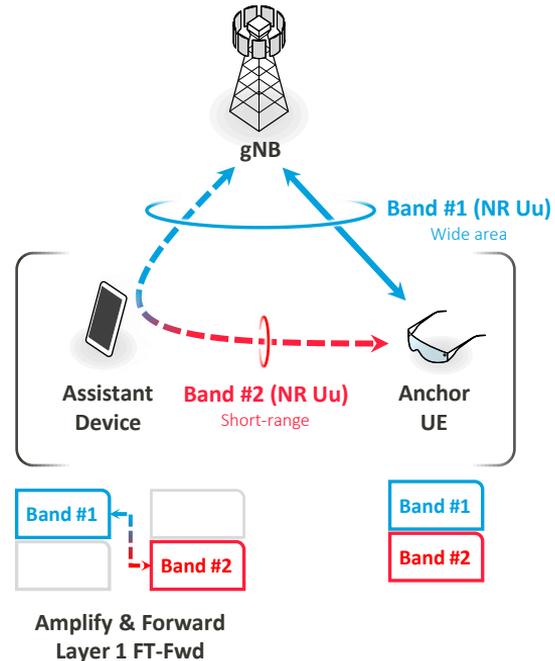
- To achieve high reliability/Tput
- Use cases
 - **Path combining:** Use both direct and indirect paths for data transfer to achieve high throughput (via higher rank)/reliability
 - **Path switching:** Use either direct path or indirect path for data transfer to achieve improved reliability or power saving



Device-collaborative MIMO

Antenna capability aggregation

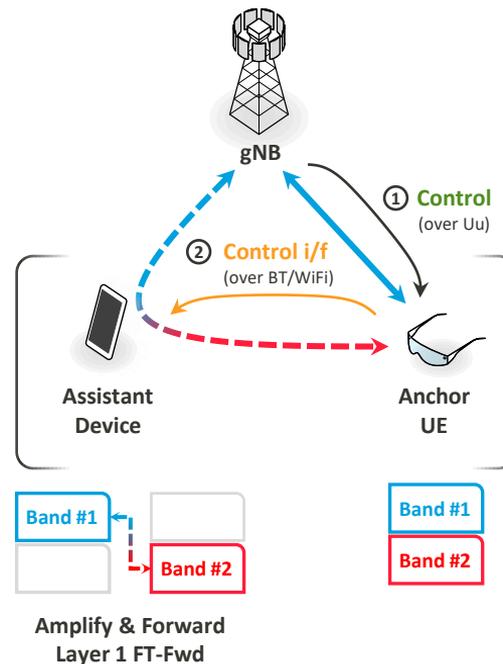
- Assistant device acts as an external antenna panel wirelessly connected to Anchor UE
 - Performs amplify-and-forward with frequency translation (*Layer-1 FT-Fwd*) between Bands #1 and #2 with ~zero latency
 - **Band #1:** e.g. wide area coverage for gNB deployment e.g. low-band or mid-band (2.5 or 3.5 GHz)
 - **Band #2** e.g. limited geographical coverage, e.g., mid-band (4.7 or 6 GHz)
 - Transparent to the gNB (when operating as such device)
 - gNB can be informed by the anchor UE of the intention to use the Assistance Device (“remote panel”)
 - Anchor UE still controls the Layer-1 FT-Fwd behavior based on configuration from the gNB (See this [slide](#) for control)
- The gNB/Anchor UE performs data transfer:
 - On a direct path <> directly to/from gNB on **Band #1**; and
 - On an indirect path <> indirectly to/from gNB via the collaborative device with A&F and Layer-1 FT-Fwd between Bands #1 and #2
 - See this [slide](#) for possible operating schemes



Device-collaborative MIMO

Control Interface (Anchor UE <> Assistant device)

- Anchor UE control of the Assistant Device Layer 1 FT-Fwd behavior under gNB constraints to mitigate interference
 - via **Layer-1 FT-Fwd control info**
- **Layer-1 FT-Fwd control info**
 - Includes: Layer-1 FT-Fwd on/off, Band#1 configuration info, Band#2 configuration info, Band#1 Tx power, Band#2 Tx power, DL/UL split, etc.
 - Determined from: **gNB control info**. (config./indication) incl. Band#2 max Tx power (e.g. 10 dBm), Band#2 candidate bands, TDD pattern config
 - NOTE
 - **Layer-1 FT-Fwd control info**: specified at min. @Stage 2 level
 - **gNB control info**: could be specified as side control information (similar to what was done for Rel-18 NCR)
- **Control Interface**
 - Operates over a paired connection (e.g., via BT, WiFi)

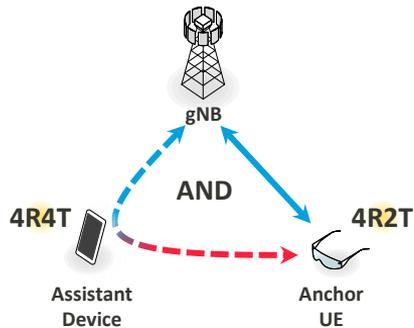


Device-collaborative MIMO

Tx/Rx schemes at the UE with aggregated antenna capability

- **Scheme #1: Path Combining – Rank Augmentation**

- Use both direct and indirect paths between gNB and anchor UE for data transfer with joint transmission/reception



Rank Augmentation

DL: 4Rx → 4Rx + 4Rx:

- Mean DL UPT **+~37%**;
- 40% UEs with RI≥4

UL: 2Tx → 2Tx + 2Tx :

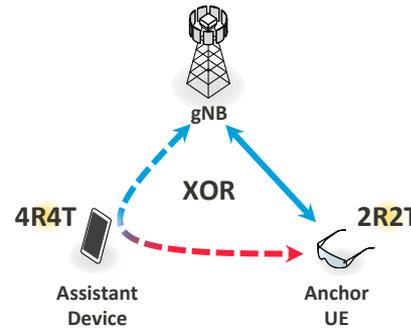
- Mean UL UPT **+~51%**;
- 90% UEs with RI>2



*Requires joint Tx/Rx operation
on Bands 1 & 2*

- **Scheme #2: Path Selection – Diversity Augmentation**

- Select either direct path or indirect path between gNB and anchor UE for data transfer at any one time



Diversity Augmentation

Path-selection:

- Mean DL UPT **+~14%**

Path-selection + Rx BF at UE:

- Mean DL UPT **+~28%**



*Does not require joint Tx/Rx
operation on Bands 1 & 2*

Proposal

Key Message: To support means in NR for a UE to aggregate its own antenna capability with the antenna capability of an assistant device in order to obtain UL/DL MIMO performance beyond the UE's own antenna capability, using Layer-1 forwarding (amplify-and-forward) with frequency-translation.

- The objective of this study is to identify and evaluate the potential mechanism(s) to support (joint) transmission/reception on a UE to/from a gNB using a direct path and an indirect path between the gNB and the UE, where
 - The direct path operates on a first frequency band (B1); and
 - The indirect path operates both on B1 between the gNB and an assistant device, and on a second frequency band (B2) between the UE and the assistant device; and
 - The indirect path is enabled by the assistant device performing amplify-and-forward Layer-1 forwarding with frequency-translation (Layer-1 FT-Fwd) of signals exchanged between the gNB and the UE, translating between B1 and B2; and
 - the DL and UL performance of the UE is improved by aggregating the antenna capabilities of the UE and of the assistant device
- The study includes the following aspects:
 - Develop an evaluation methodology to evaluate the performance gain as well as interference impact, and identify potential enhancement(s) to support this type of operation [RAN1]
 - To control the Layer 1 FT-Fwd behavior, identify the necessary control information to be transferred directly between the UE and the collaborative device, and the necessary side control information to be transferred from the gNB to the UE [RAN1]
 - Identify possible procedures/signaling to inform the gNB of the establishment/termination of collaboration with the assistant device [RAN2, RAN1]
 - Identify potential impact to RAN4 performance requirements to support this type of operation [RAN4]
- The following scenarios and assumptions are applied to focus the direction of the study:
 - The application scenario consists of an assistant device and a UE constrained in terms of Tx/Rx antennas
 - The UE and assistant device are assumed to be in close proximity (e.g. ≤ 10 meters) of each other to strictly limit the Tx power on the B2 for both UE and assistant device
 - The assistant device is connected to the UE using a non-3GPP UE-device connection*: establishing and managing this connection is not in scope of the Study. This connection is used by the UE to control the Layer-1 FT-Fwd behavior on the assistant device via exchange of necessary control information.
 - The assistant device is transparent to the gNB
 - The collaboration establishment/termination (including discovery, pairing, and unpairing) with the assistant device is always initiated by the UE
 - B1 and B2 are FR1 licensed bands
 - The gNB shall be able to control/restrict the usage and radio operation of the Layer 1 FT-Fwd (indirectly) on first and second frequency bands, by means of side control info sent from the gNB to the UE.
- Note: No SA/CT impact are expected

* Or NR Sidelink

Thank you!