3GPP TSG RAN #102
Edinburgh, Scotland, December 11-15, 2023

RP-233534

Source: NTT DOCOMO, INC.
Agenda item: 9.1.1.3
Document for : Discussion

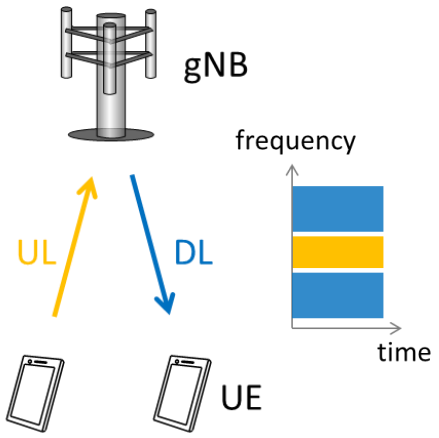
Views on Rel-19 evolution of NR duplex operation

NTT DOCOMO, INC.

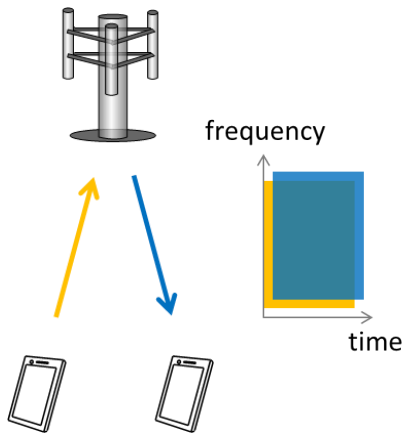
Background

- Full Duplex (FD) realizes efficient and flexible UL and DL resource configuration with providing following benefits, and hence it can be one of advanced features as “a bridge to 6G”
  - FD is beneficial for adaptation to DL and UL traffic fluctuation, e.g., UL heavy traffic
  - FD is beneficial for lower latency and coverage improvement by exploiting increased UL time resources

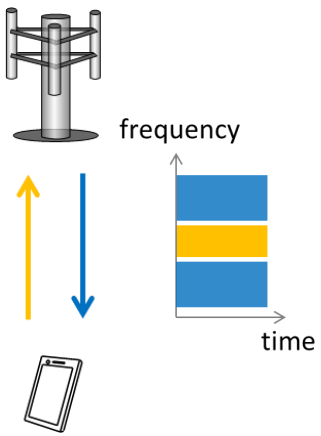
- Following options can be considered for duplex evolution, and Sub-Band non-overlapping Full Duplex (SBFD) at gNB, which is the initial step toward the realization of FD, and RAN1 study of duplex evolution including SBFD (Study on evolution of NR duplex operation) in Rel-18 is completed



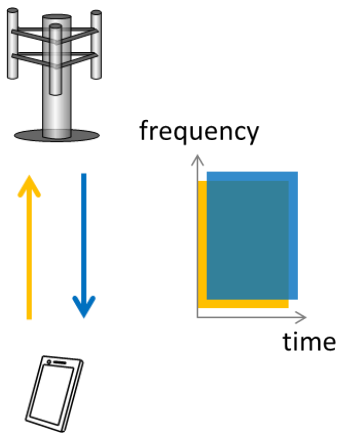
SBFD at gNB



Overlapping FD at gNB



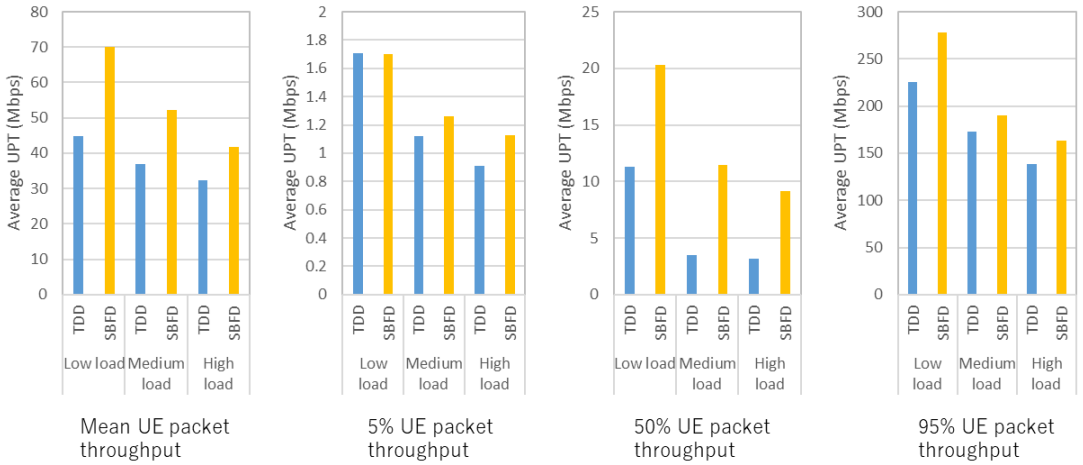
SBFD at gNB/UE



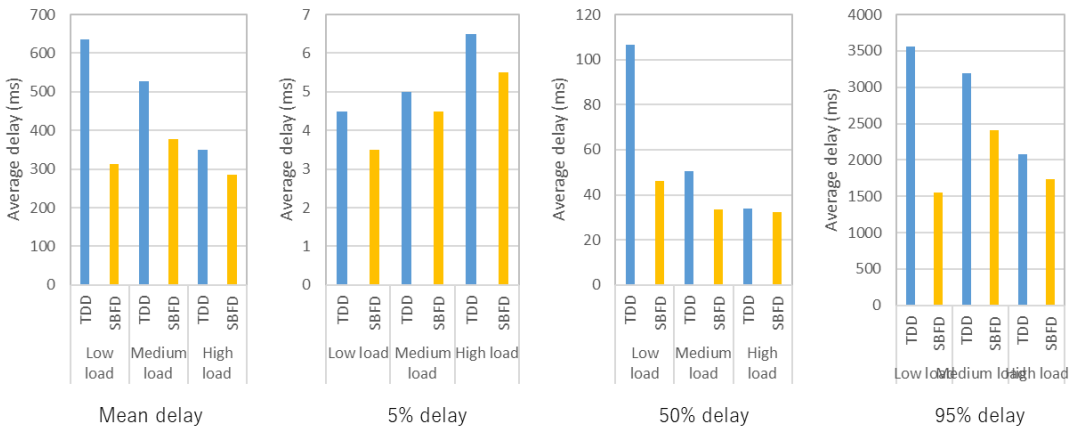
Overlapping FD at gNB/UE

Motivations for SBFD at gNB and CLI handling enhancements

- **We have observed benefits of SBFD operation based on Rel-18 study, and hence we propose to start the normative work on SBFD at gNB including enhancements for interference handling in Rel-19**
  - Based on the evaluation results on SBFD operation, interference modeling/handling (e.g., self-interference, inter-sector CLI, inter-site CLI and UE-to-UE CLI) and corresponding performance are essential factors to determine the target scenario/use case of SBFD operation
    - » In certain conditions (e.g., Indoor scenario, low traffic load and large inter-sector isolation),
      - – Performance gain of UL/DL comes from more UL/DL transmission opportunities compared to TDD
      - – Performance gain of UL is further increased by increasing UL resources instead of DL resources
- **We have also observed benefits of introduction of gNB-to-gNB CLI measurement/reporting and enhancements of UE-to-UE CLI measurement/reporting, especially for SBFD operation at gNB**



(a) UL UE packet throughput



(b) UL delay

Examples of SLS evaluation results in FR1 Urban macro

[Reference: RP-232745]

Evolution of duplex operation WI

- References: RWS-230488, RP-231540, RP-232613
- Potential objectives:
  - For subband non-overlapping full duplex (SBFD) operation at gNB side within a TDD carrier
    - [Semi-static/dynamic] indication of time location of SBFD subbands to UEs [in RRC_CONNECTED mode]
    - Semi-static indication of frequency domain location of SBFD subbands to UEs [in RRC_CONNECTED mode]
    - UE transmission and reception behavior and procedures in SBFD symbols and/or non-SBFD symbols
    - Note: followings are assumed based on TR 38.858
      - SBFD operation Option 4
      - Coexistence between legacy UEs and SBFD aware UEs in the cell operating SBFD at gNB side
      - SBFD scheme within a single configured DL and UL BWP pair with aligned center frequencies
      - Up to one UL subband for SBFD operation in an SBFD symbol (excluding legacy UL symbol/slot) within a TDD carrier
    - At least adjacent channel coexistence between two operators should be considered as a minimum.
  - Specify enhancements for CLI handling:
    - Support both the gNB-to-gNB co-channel CLI handling scheme(s) and UE-to-UE co-channel CLI handling scheme(s) (the detailed schemes are to be down-selected from those in TR38.858)
    - The SBFD operation drives the CLI enhancements, which are expected to be applicable to the dynamic/flexible TDD operation but without dedicated optimization
  - RF requirements for SBFD operation at gNB

[Reference: RP-232745]

Evolution of duplex operation WI

	1Q 2024	2Q 2024	3Q 2024	4Q 2024	1Q 2025	2Q 2025	3Q 2025	Total
RAN1	2	4	2	4	2	4		18
RAN2			0.5	1	0.5	1.5	0.75	4.25
RAN3				0.5	0.5	1	0.5	2.5
RAN4 RF		0.5	1.5	3	1.5	2.5	1	10

Proposed objectives for Evolution of duplex operation WI

- **Introduction of mechanisms and requirements for SBFD operation at gNB within a TDD carrier [RAN1, RAN2, RAN4]**
  - **Semi-static** indication of time and frequency domain locations of SBFD subbands to UEs **in RRC_CONNECTED mode**
    - » **Note: Dynamic SBFD is not supported in Rel-19**
  - UE transmission and reception behavior and procedures in SBFD symbols and/or non-SBFD symbols related to SBFD operation at gNB
    - » Potential enhancements for physical channel/signal and procedure, including PDCCH/PDSCH/CSI-RS/PUCCH/PUSCH/SRS/CSI reporting
    - » Collision handling between DL reception and UL transmission in SBFD symbol
    - » Random access using SBFD subbands by UE in RRC_CONNECTED mode
  - RF requirements for SBFD operation at gNB
  - Note: followings are assumed based on TR 38.858
    - » SBFD operation option 4 where both time and frequency locations of subbands for SBFD operation are known to SBFD aware UEs
    - » Coexistence between legacy UEs and SBFD aware UEs in the cell operating SBFD at gNB side
    - » SBFD scheme within a single configured DL and UL BWP pair with aligned center frequencies
    - » Up to one UL subband for SBFD operation in an SBFD symbol (excluding legacy UL symbol/slot) within a TDD carrier, with considering adjacent channel coexistence between two operators
    - » Mechanisms/enhancements captured in TR 38.858 are considered as a starting point
- **Enhancements of CLI handling for SBFD operation [RAN1, RAN3]**
  - UE-to-UE co-channel CLI handling schemes for SBFD operation and gNB-to-gNB co-channel CLI handling schemes for SBFD operation
    - » Note: the detailed schemes are to be down-selected from those in TR38.858

Views on potential discussion points

- Dynamic SBFD
  - Dynamic SBFD may increase gNB implementation complexity, may incur loss of resources due to transition time, may increase inter-gNB CLI as well as inter-UE CLI, may increase scheduling complexity, and can result in additional specification impact on top of semi-static SBFD.
  - If dynamic/flexible adaptation of DL/UL resources based on DL/UL traffic is necessary, dynamic TDD can be applied.
- SBFD for UEs in RRC_IDLE/INACTIVE mode
  - If resources to be used during initial access are used as SBFD symbols, the initial access related procedures would suffer from CLI, and CLI caused by UL transmission during initial access may be large as it would be out of gNB's control.
- CLI handling enhancements
  - Specifying both gNB-to-gNB and UE-to-UE CLI handling enhancements for SBFD operation is ok, while down-selection of detailed mechanism(s) is necessary in early phase of the WI (at WGs). In addition, any optimization for dynamic/flexible TDD should be deprioritized/precluded, as main target of this WI is to specify necessary mechanisms/requirements for SBFD operation at gNB.
- RRM impact
  - RRM impact should be avoided, and it should be considered for UE behavior in SBFD and/or non-SBFD symbols.
- Adjacent channel coexistence between two operators
  - SBFD operation in legacy UL symbol/slot shall be avoided, and UL subband should be located at middle of the carrier(s).

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