



Agenda Item: 5
Source: Xiaomi
Document for: Discussion

Views on duplex evolution in Rel-19

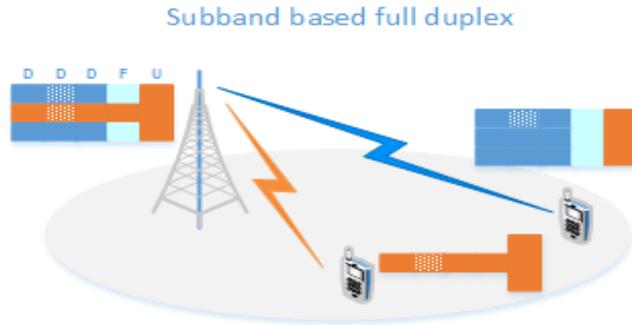
Xiaomi

Background and overall progress in Rel-18 duplex evolution SI

BACKGROUND

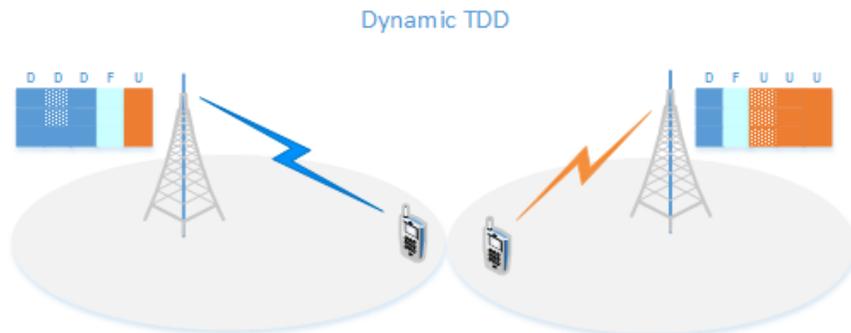
■ SBFDF operation

- RAN1 focuses on SBFDF within a carrier at gNB side
- UL subband is only visible to SBFDF aware UE



■ Dynamic TDD

- CLI mitigation is the major challenge on commercialization of DTDD



OVERALL PROGRESS

■ System-level simulation methodology and assumptions are almost ready for several deployment scenarios

- Plenty of simulation results for different scenarios with various assumptions have been submitted from companies

■ Link-level simulation methodology and assumptions are almost ready at least for coverage enhancement evaluation

- A few simulation results with different CE schemes have been submitted from companies

■ SBFDF operation

- Very good progress on SBFDF operation scheme, UE behavior, enhancement on UL transmission and DL reception on SBFDF symbol, etc.

■ Dynamic TDD

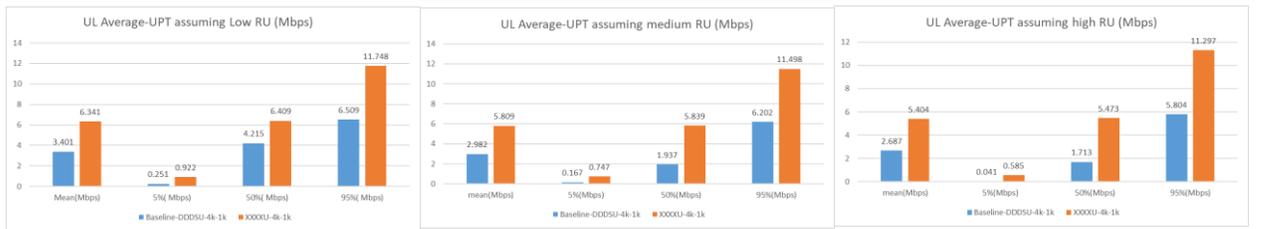
- Good progress on UE-to-UE CLI and gNB-to-gNB CLI mitigation



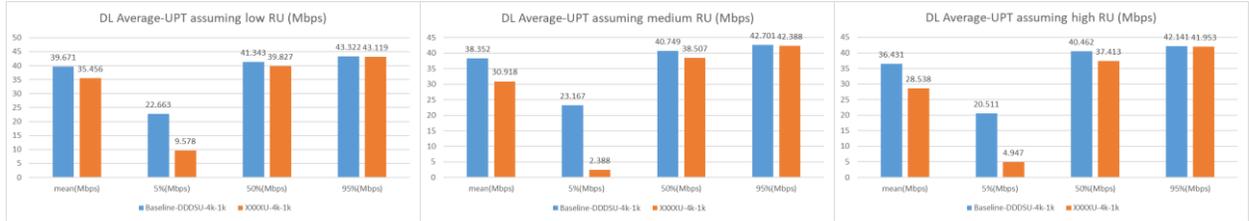
System-level evaluation results for Urban Macro scenario

Symmetric packet size with 4Kbytes for DL and 1Kbyte for UL

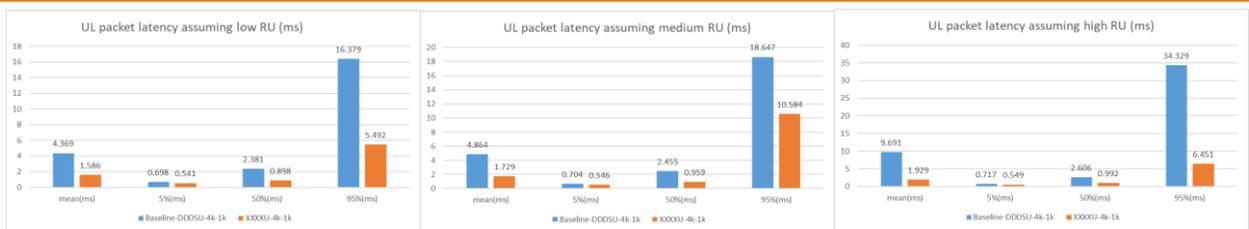
Observations for Urban Macro scenario



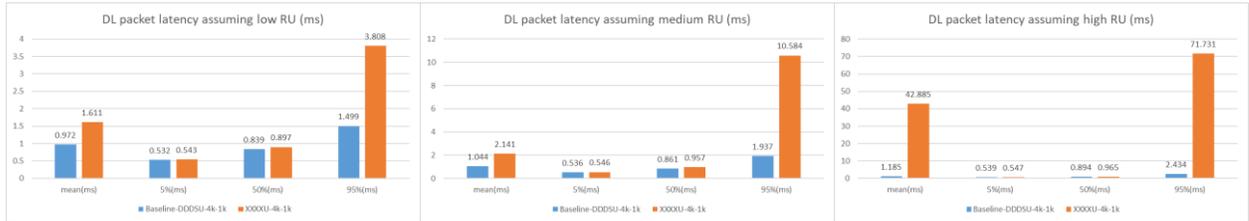
UL Average-UPT assuming different target RU for legacy TDD (small packet size)



DL Average-UPT assuming different target RU for legacy TDD (small packet size)



UL Packet-latency assuming different target RU for legacy TDD (small packet size)



DL Packet-latency assuming different target RU for legacy TDD (small packet size)

For DL Average-UPT:

- DL UPT is degraded once UL subband is configured in DL slots, no matter which kind of RU is assumed.
- Mean DL Average-UPT of SBF D decreases by about 20%, which is close to the DL resource reduction ratio.

For UL Average-UPT:

- UL UPT is improved with introduction of UL subband in SBF D slots.
- With increased transmission occasion for cell edge UEs, 5% UL Average-UPT for SBF D increased significantly.

In ratio, improvement of UL performance is much more than the degradation of DL performance.

For DL latency:

- DL latency is increased once UL subband is configured in DL slots, no matter which kind of RU is assumed.

For UL latency:

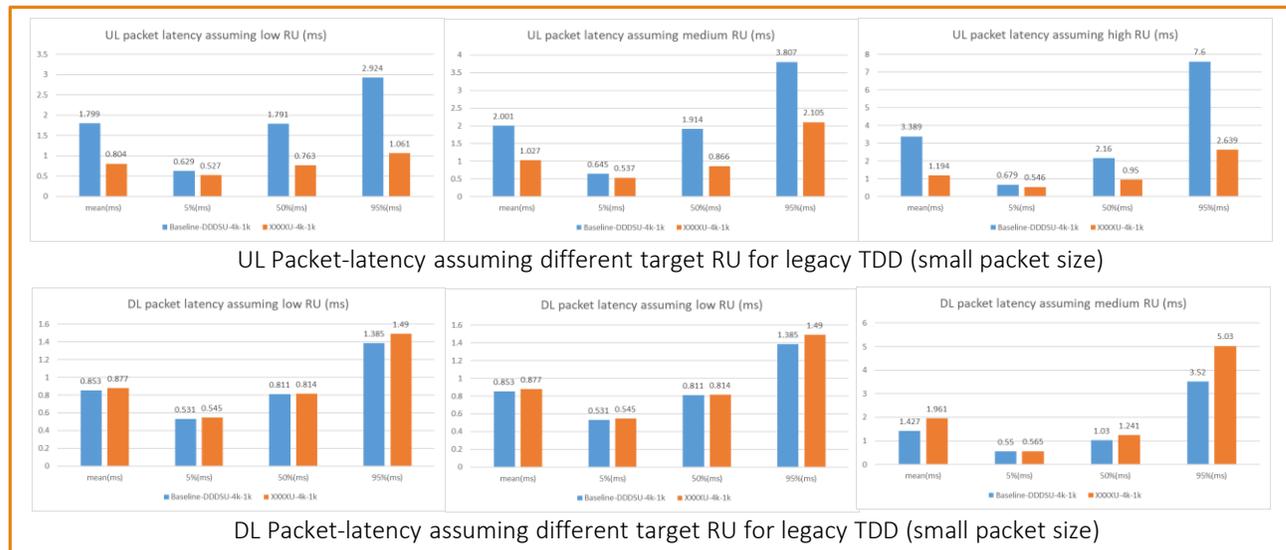
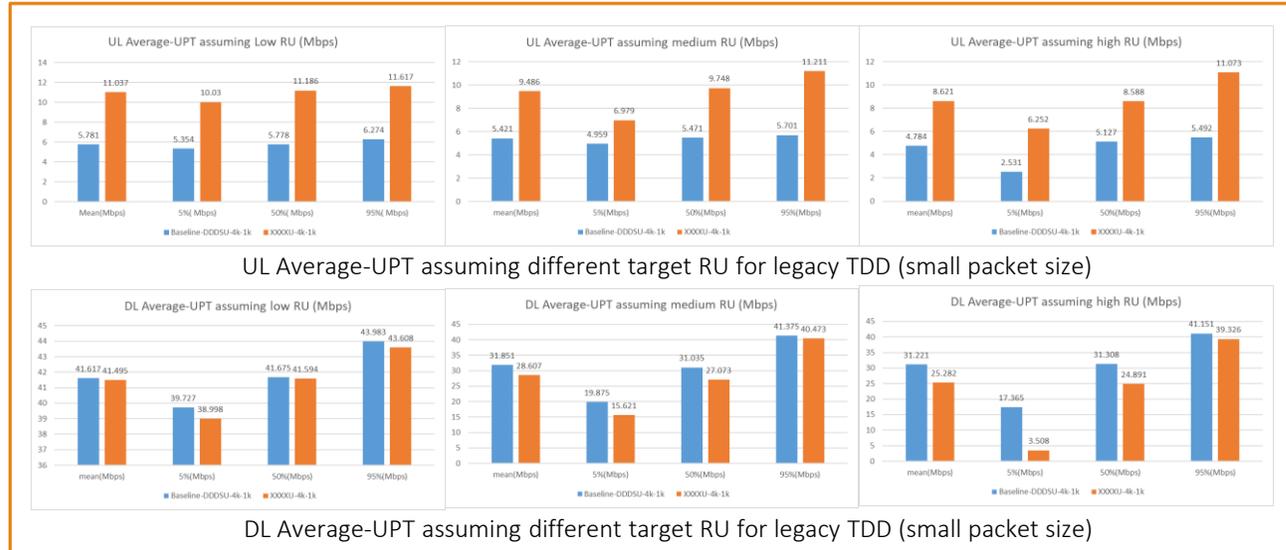
- UL latency is reduced with introduction of UL subband in SBF D slots.
- With increased transmission occasion for cell edge UEs, 5% UL latency for SBF D reduces significantly.



System-level evaluation results for InH scenario

Symmetric packet size with 4Kbytes for DL and 1Kbyte for UL

Observations for InH scenario



For DL Average-UPT:

- DL UPT is degraded once UL subband is configured in DL slots, no matter which kind of RU is assumed.

For UL Average-UPT:

- UL UPT is improved with introduction of UL subband in SBFDF slots.

In ratio, improvement of UL performance is much more than the degradation of DL performance.

For DL latency:

- DL latency is increased once UL subband is configured in DL slots, no matter which kind of RU is assumed.

For UL latency:

- UL latency is reduced with introduction of UL subband in SBFDF slots.

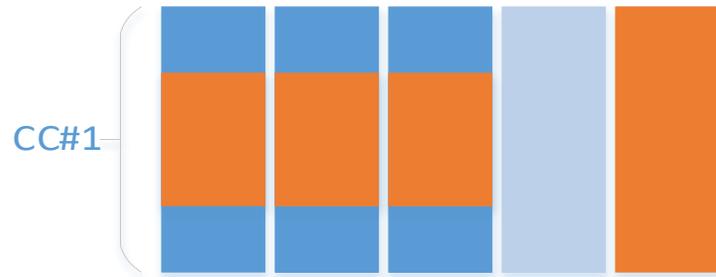
Observations from system-level simulation

- Thanks to the additional UL resources provided by UL subband
 - UL performance can be significantly improved, i.e. higher UPT and lower latency can be obtained.
- Due to less available DL resources
 - Degradation on DL performance can be observed as well.
 - However, the improvement on UL performance is much more significant than the degradation on DL performance.
- Self-interference at gNB side, Inter-subband UE-to-UE CLI and Inter-subband gNB-to-gNB CLI can be suppressed quite well based on current RAN4 assumption, i.e. from spatial domain, frequency domain, beam domain and digital IC.
- Generally speaking, subband non-overlapping full duplex at the gNB side within a conventional TDD band can improve the overall performance for TDD system.

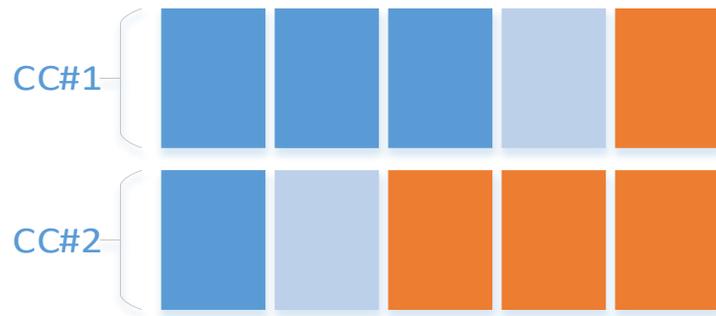
Accordingly, we have the following proposal:

Proposal 1: Subband non-overlapping full duplex at gNB side should be specified in Rel-19 and a work item should be assigned for duplex evolution.

SBFD operation schemes in Rel-19



a) SBFD operation within a carrier



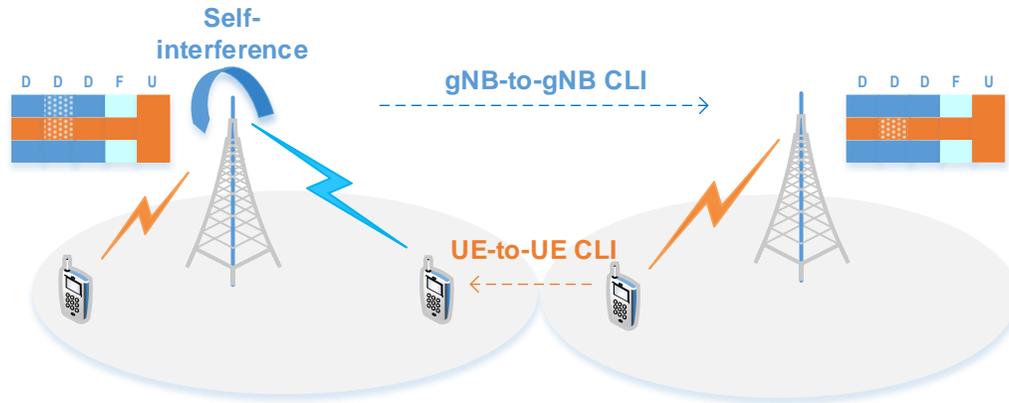
b) SBFD operation across carriers

- Case a is the baseline in RAN1 discussion which has been studied extensively and is pretty mature from study point of view
- Case b has not been discussed yet while the following shortages may bring uncontrollable standard efforts
 - How to define the priority among component carriers when collision happens
 - How to handle repetition and frequency hopping
 - How to handle the case if a UE doesn't support CA
- More importantly, there is no additional benefits by supporting HDCA-based SFBD compared to SBFD within a carrier.

Accordingly, we have the following proposal:

Proposal 2: Subband non-overlapping full duplex within a carrier is sufficient and the other full duplex schemes are not pursued in Rel-19.

Restrictions on SBFDD operation in Rel-19



Value range of RSIC

Parameter	FR1(Frequency Range 1)	FR2(Frequency Range 2)
Spatial isolation	50~80dBc	80-120 dBc
Frequency isolation	45 dBc	22.5~30 dBc
Beam nulling /isolation	0~40 dBc	0~40 dBc
Digital IC	0~50 dBc	0~50 dBc
Overall RSIC capability	95 ~185 dBc	102.5~ 205 dBc

Accordingly, we have the following proposal:

- Proposal 3:** Spectrum sharing full duplex at gNB side, i.e. overlapping UL subband and DL subband, is not pursued in Rel-19.
- Proposal 4:** Full duplex operation is confined at gNB side and there should be no impacts on UE hardware in Rel-19.

■ In Rel-18 Duplex evolution study item, the basic assumption is subband based non-overlapping full duplex operation happens **only at gNB side**. The following interference types need to be carefully suppressed:

- Self-interference at gNB side
- Inter-subband gNB-to-gNB CLI
- Inter-subband UE-to-UE CLI

■ In order to sufficiently mitigate the above interference, spatial isolation/frequency isolation/beam isolation/digital IC are needed which require advanced hardware capability.

■ Accordingly, subband non-overlapping full duplex should be assumed at gNB side in Rel-19.

■ Full duplex operation at UE side should **NOT** be assumed in Rel-19.

Potential specification impacts on SBFDD

- Non-transparent SBFDD operation in semi-static DL symbols and semi-static flexible symbols is the baseline in RAN1
 - SBFDD aware UE need to know the configuration of UL subband
- In order to support SBFDD operation as well as expedite commercialization, Rel-19 duplex enhancement should focus on **basic functionality** which provides solid performance gain.
 - Semi-static UL subband configuration and indication, including time domain and frequency domain **within a carrier**
 - UE behavior for SBFDD aware UE, including **the inter-action** with SFI and UE-dedicated TDD, collision handling, switching between DL reception and UL transmission, etc.
 - Enhancement on **DL reception** and **UL transmission**, including time domain enhancement and frequency domain enhancement
 - gNB-to-gNB CLI mitigation if justified
 - UE-to-UE CLI mitigation if justified

Accordingly, we have the following proposal.

Proposal 5: In the work item of Rel-19 duplex enhancement, at least the following objectives should be considered:

- Semi-static UL subband configuration and indication, including time domain and frequency domain within a carrier
- UE behavior for SBFDD aware UE, including the inter-action with SFI and UE-dedicated TDD, collision handling, switching between DL reception and UL transmission, etc.
- Enhancement on DL reception and UL transmission, including time domain enhancement and frequency domain enhancement
- gNB-to-gNB CLI mitigation if justified
- UE-to-UE CLI mitigation if justified



Potential specification impacts on dynamic/flexible TDD

■ RAN1 is heatedly discussing the potential enhancement for dynamic/flexible TDD. Whether/how to introduce advanced mechanisms to mitigate CLI is the key factor, including:

- UE-to-UE CLI mitigation
- gNB-to-gNB CLI mitigation

■ For UE-to-UE CLI mitigation, the following mechanisms were raised in RAN1 with limited evaluation results.

- L1/L2 based UE-to-UE CLI measurement and reporting
- UE power control
- Rx beam selection
- Coordinated scheduling

■ For gNB-to-gNB CLI mitigation, the following mechanisms were raised in RAN1 with few evaluation results

- L1/L2 based CLI measurement and reporting
- UL resource muting for improving accuracy of CLI measurement
- DL power control
- gNB Tx beam nulling
- UE power control
- Coordinated scheduling

Accordingly, we have the following observations:

Observation 1: In Rel-18 duplex enhancement, RAN1 works on the potential mechanism to mitigate UE-to-UE CLI and gNB-to-gNB CLI while the views among companies are still very divergent.

Observation 2: The mechanisms specified for dynamic/flexible TDD, if any, can be directly applied to SBFD so as to mitigate inter-subband CLI.

We therefore have the following proposal:

Proposal 6: Only mechanisms for CLI mitigation with solid benefits can be specified in the work item of Rel-19 duplex evolution.

Proposal 7: The mechanisms for CLI mitigation for dynamic/flexible TDD can be directly applied to SBFD hence dynamic/flexible TDD should be included in the same work item with SBFD if supported.



Conclusion(1/2)

Observation 1: In Rel-18 duplex enhancement, RAN1 works on the potential mechanism to mitigate UE-to-UE CLI and gNB-to-gNB CLI while the views among companies are still very divergent.

Observation 2: The mechanisms specified for dynamic/flexible TDD, if any, can be directly applied to SBFDD so as to mitigate inter-subband CLI.



Conclusion(2/2)

Proposal 1: Subband non-overlapping full duplex at gNB side should be specified in Rel-19 and a work item should be assigned for duplex evolution.

Proposal 2: Subband non-overlapping full duplex within a carrier is sufficient and the other full duplex schemes are not pursued in Rel-19.

Proposal 3: Spectrum sharing full duplex at gNB side, i.e. overlapping UL subband and DL subband, is not pursued in Rel-19.

Proposal 4: Full duplex operation is confined at gNB side and there should be no impacts on UE hardware in Rel-19.

Proposal 5: In the work item of Rel-19 duplex enhancement, at least the following objectives should be considered:

- Semi-static UL subband configuration and indication, including time domain and frequency domain within a carrier
- UE behavior for SBFDD aware UE, including the inter-action with SFI and UE-dedicated TDD, collision handling, switching between DL reception and UL transmission, etc.
- Enhancement on DL reception and UL transmission, including time domain enhancement and frequency domain enhancement
- gNB-to-gNB CLI mitigation if justified
- UE-to-UE CLI mitigation if justified

Proposal 6: Only mechanisms for CLI mitigation with solid benefits can be specified in the work item of Rel-19 duplex evolution.

Proposal 7: The mechanisms for CLI mitigation for dynamic/flexible TDD can be directly applied to SBFDD hence dynamic/flexible TDD should be included in the same work item with SBFDD if supported.



Thanks!