

3GPP TSG RAN Rel-18 workshop
Electronic Meeting, June 28 - July 2, 2021

RWS-210353



Motivation of study for Full Duplex in NR

Agenda Item: 4.3
Source: CMCC

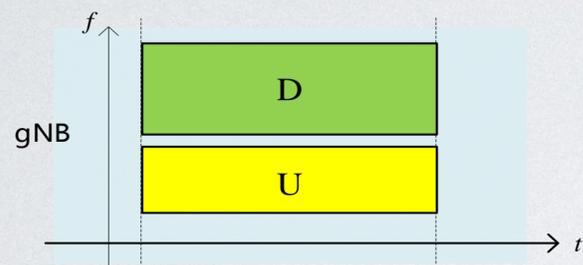
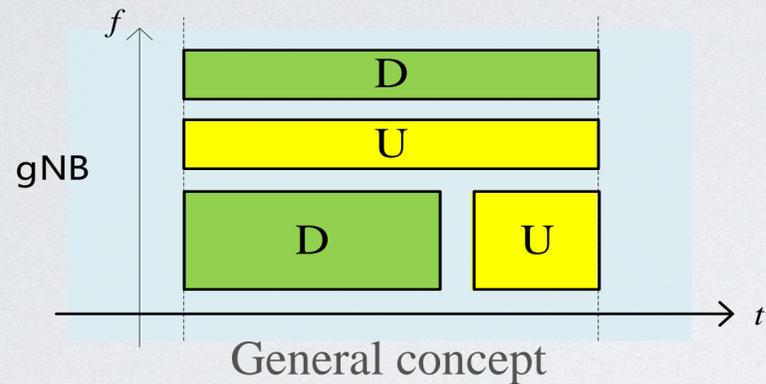


Motivation

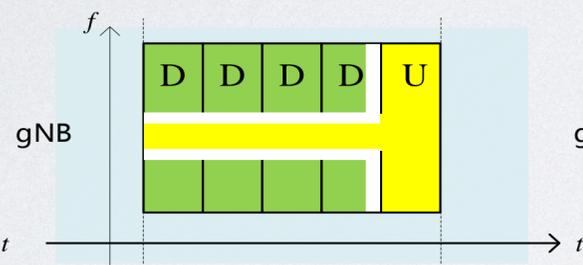
- **UL coverage needs further enhancement for TDD due to limited UL duty cycle**
- **UL heavy and/or latency sensitive applications are pervasive in ToC and ToB**
 - ToC: HD video calls, XR gaming
 - ToB: smart steel, smart coal mining, smart port, PLC in Industrial-IoT
 - Requirements: Up to >30Mbps UL data rate and/or ~ 4ms E2E latency
- **Full duplex is a promising solution for UL coverage improvement, UL capacity improvement and latency reduction**



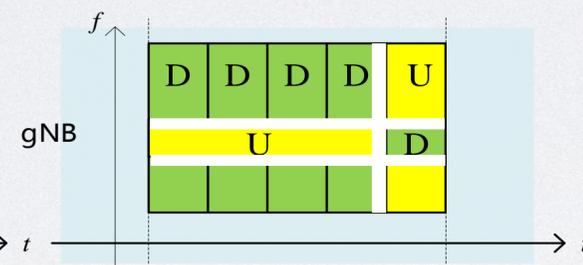
Full Duplex operations



Example 1



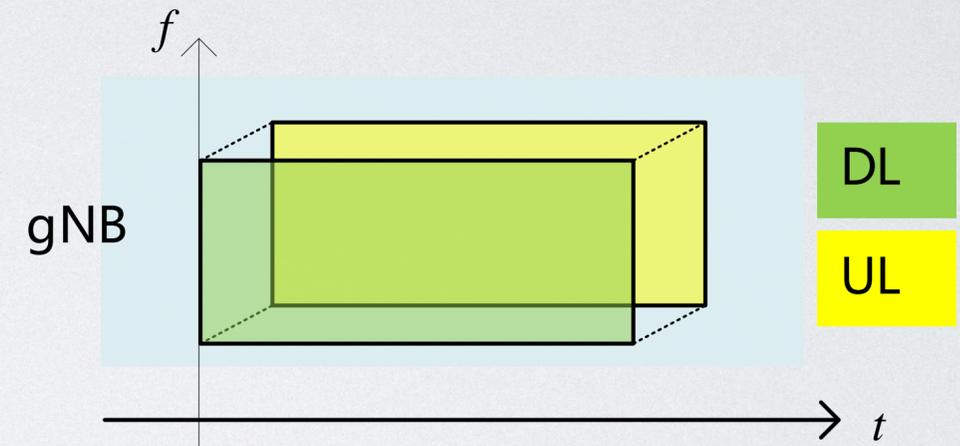
Example 2
(Reduced inter-operator interference)



Example 3

Type-1 FD (Sub-band wise full duplex)

- gNB: Simultaneous Tx and Rx in difference sub-bands
- UE: may not support simultaneous Tx and Rx
- UL-only/DL-only/TDD sub-bands can be configured in the TDD carrier

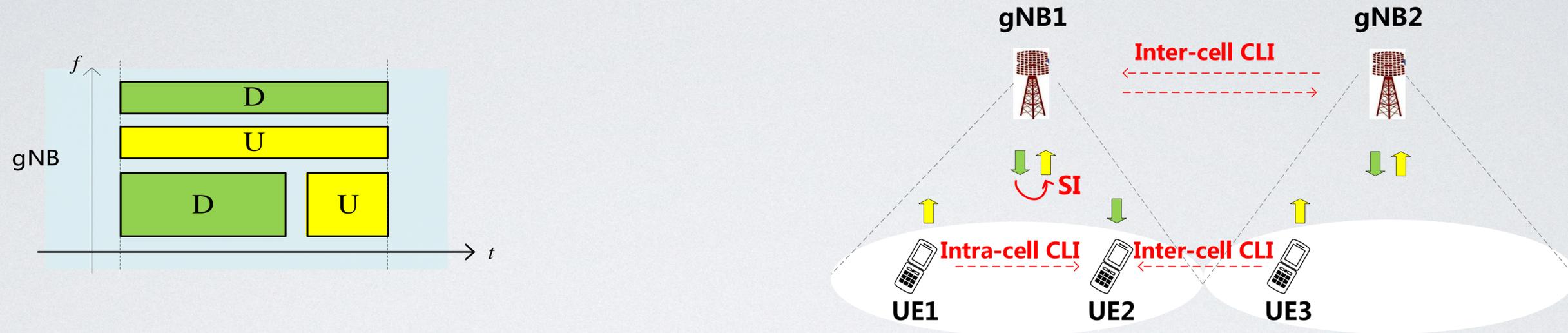


Type-2 FD (Frequency fully overlapped full duplex)

- gNB: Simultaneous Tx and Rx in the same frequency resources
- UE: may not support simultaneous Tx and Rx



Type-1 FD operation



Type-1 FD	UL/DL time-frequency resource partitioning among multiple cells	Interference at gNB	Interference at UE
Case 1	Same	<ul style="list-style-type: none"> Self-interference: moderate Inter-cell CLI: moderate 	<ul style="list-style-type: none"> Self-interference: No Intra & Inter-cell CLI: manageable (e.g., with scheduling restriction)
Case 2	Independent	<ul style="list-style-type: none"> Self-interference: moderate Inter-cell CLI: may be challengeable especially considering the DL/UL symbol boundary misalignment 	<ul style="list-style-type: none"> Self-interference: No Intra & Inter-cell CLI: may be manageable (e.g., with scheduling restriction)

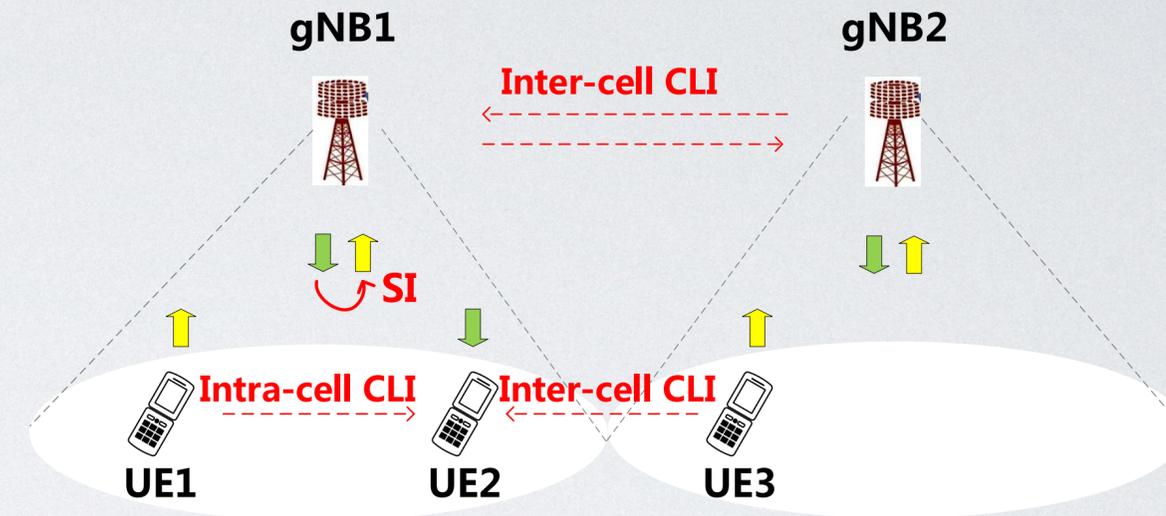
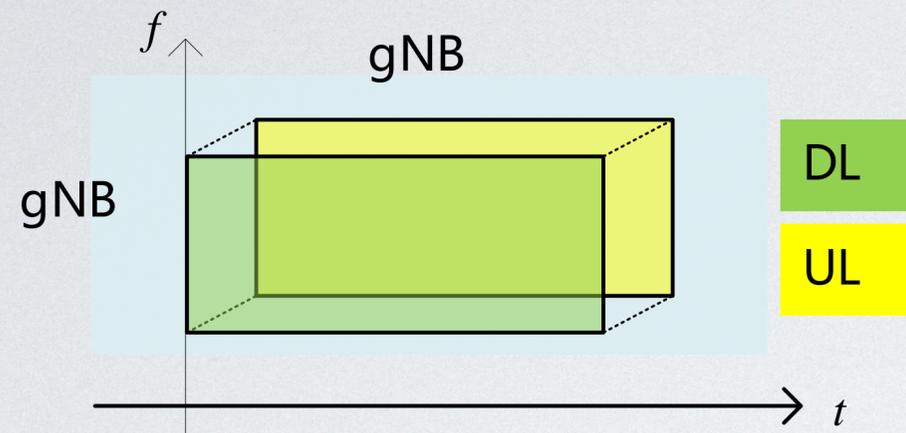
Note: Type-1 FD at gNB side and half-duplex at UE side are assumed

- **Observation:** At least for case 1 with type-1 FD operation, SI and CLI are moderate and manageable at both gNB and UE.
- **Benefits:**
 - Latency can be reduced for both UL and DL since both UL and DL resource can be available in more time slots
 - UL coverage can be improved since longer uplink transmission/repetition can be exploited
 - UL capacity can be improved based on configuration if more time-frequency resources are configured for UL





Type-2 FD operation



Type-2 FD	Interference at gNB	Interference at UE
Isolated scenario	<ul style="list-style-type: none"> Self-interference: possible to manage for gNB with limited level of Tx power and limited number of antennas (see Annex) 	<ul style="list-style-type: none"> Self-interference: No Intra-cell CLI: possible to manage based on careful scheduling restriction and interference measurement/report
Multi-cell scenario	<ul style="list-style-type: none"> Self-interference: same as for isolated scenario Inter-cell CLI: may be challengeable especially considering the DL/UL symbol boundary misalignment 	<ul style="list-style-type: none"> Self-interference: No Intra & Inter-cell CLI: may be challengeable to mitigate both even with scheduling restriction

Note: Type-2 FD at gNB side and half-duplex at UE side are assumed

- Observation:** For type-2 FD, at least we can first focus on isolated scenario and small cells with limited Tx power and limited number of antennas, which is possible for some indoor deployments.
- Benefits:** Type-2 FD operation may provide additional UL and DL performance gain in isolated scenario





Potential study objectives for full duplex in NR

- **General study on different variants of full duplex operation [RAN1/RAN4]**
 - Deployment scenarios (e.g., Isolated, Indoor, Urban, Rural) [RAN1]
 - Frequency range and regulation (e.g., FR1, FR2) [RAN1/RAN4]
 - Duplex mode (e.g., Sub-band wise/Frequency fully overlapped FD at gNB, Full-/Half- duplex at UE) [RAN1]
 - Antenna configuration (e.g., Single-/multi-panel, Co-located/distributed antennas, antenna scale) [RAN1]
- **Study on the feasibility of self-interference cancellation to enable full duplex [RAN1/RAN4]**
 - Techniques of self-interference cancellation [RAN1]
 - Requirement of self-interference cancellation capabilities for different deployments [RAN1/RAN4]
 - Evaluate the performance of full duplex [RAN1]
 - Evaluation methodology and performance metrics (e.g., spectrum efficiency, user perceived throughput, latency, coverage, etc.)
- **Coexistence study among different operators in adjacent channels [RAN4]**
- **Identify the potential standardization impact to support full duplex operation [RAN1, RAN2, RAN4]**

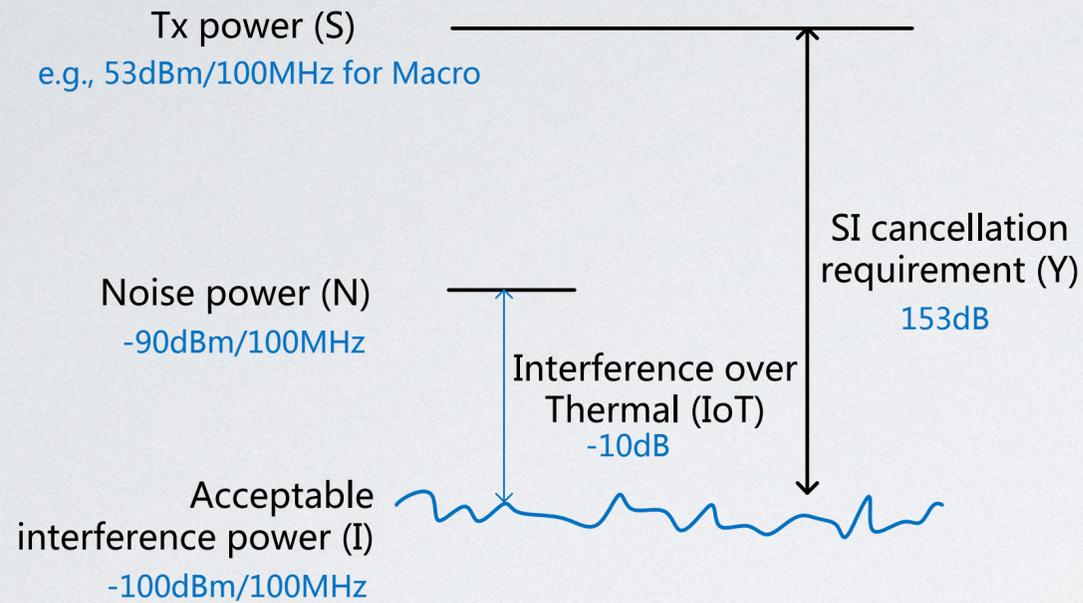


Thank You





Annex: Feasibility analysis for SI mitigation



$$\text{Requirement for SI cancellation (dB)} = S - N - \text{IoT}$$

$$\text{Receiver sensitive (dB)} = \underbrace{-174 + 10 \lg(\text{BW}) + \text{NF}}_{\text{Noise power}} + \text{SNR}$$

$$\text{Receiver sensitive reduction (dB)} = \text{SINR} - \text{SNR} = \left[\frac{1}{I/N+1} \right]_{\text{dB}}$$

	S: Tx power at gNB (dBm) @100MHz	Noise figure (dB)	N: Noise power (dBm) @100MHz	Requirement of SI cancellation (dB)	
				IoT (dB)	
				Receiver sensitive reduction (dB)	
Macro	53	4	-90	150	143
Micro	47	5	-89	143	136
Pico	31	7	-87	125	118

Observation: For gNB with limited level of Tx power and limited number of antennas (e.g., 31dBm per 100MHz and 2T2R), the required SI cancellation capability is about ~120dB. Based on our investigation on the industry status of self-interference cancellation capability, it is possible for gNB to mitigate ~120dB.

