

5G NR 빔 관리 기법

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1. Agenda in 3GPP RAN1
2. Beam Measurement and Reporting
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1. Agenda in 3GPP RAN1

● RAN1 chairman's notes

- CSI acquisition and beam management
 - Beam measurement and reporting
 - QCL
 - Mechanism to recover from beam failure

● Technical specification (Basic and essential functionality)

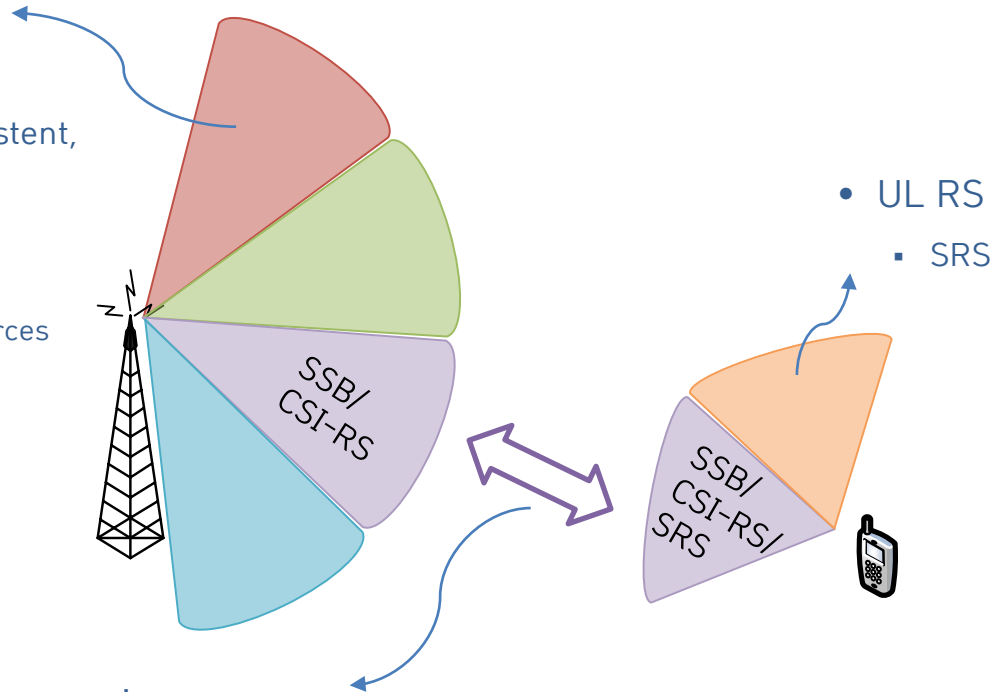
- TS 38.213
 - 6 Link reconfiguration procedures
 - 10 UE procedure for receiving control information
- TS 38.214
 - 5.1.5 Antenna ports quasi-colocation
 - 5.2.6.1.2 CSI-RS for L1-RSRP computation
 - 5.2.1 Channel sated information framework
 - 6.2.1 UE sounding procedure
- TS 38.321
 - MAC-CE parameters
- TS 38.331
 - RRC parameters

2. Beam Measurement & Reporting (1/3)

● Beam measurement and reporting

- DL RS

- SSB
- CSI-RS (Periodic, Semi-persistent, Aperiodic) for BM
 - K=64 resources/set
 - S=16 set
 - Max. 128 different resources
 - #port=1 or 2



- UL RS

- SRS

- Beam paring

- Beam measurement & reporting
 - L1-RSRP & CRI
- Beam refinement
 - CSI-RS/SRS repetition
- Spatial relation (Beam correspondence)
 - same spatial domain transmission filter used for the reception of the DL RS

2. Beam Measurement & Reporting (2/3)

● Beam measurement

- L1-RSRP and/or beam resource indicators (e.g. CRI or SSB index)
- SSB and/or CSI-RS
 - SSB
 - Configuration of SSB resources
 - L1-RSRP measurement on those configured resources
 - CSI-RS
 - 1 or 2 ports
 - a linear average of each port's RSRP for the 2-port CSI-RS

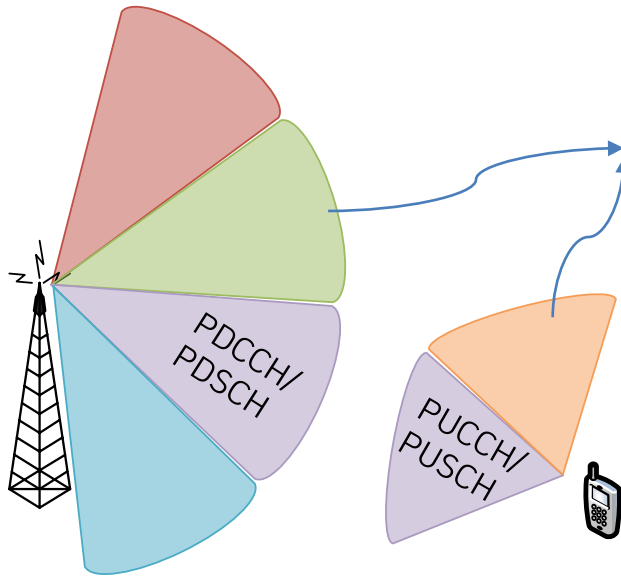
2. Beam Measurement & Reporting (3/3)

● Beam reporting

- L1-RSRP and/or beam resource indicators (e.g. CRI or SSB index)
 - Short/long PUCCH or PUSCH
 - Periodic
 - Short/long PUCCH
 - Semi-persistent
 - Short/long PUCCH and PUSCH
 - Aperiodic
 - Short PUCCH and PUSCH
- L1-RSRP
 - Max. 4 beams in one instance for non-group based beam reporting
 - Differential RSRP(4bits, 2dB quantization) with reference to the strongest reported RSRP(7bits, 1dB)

3. Beam Indication(QCL) (1/4)

● Beam indication



- Reference RS
 - SSB / CSI-RS / SRS
- Target RS
 - DL
 - TRS / CSI-RS / DMRS(PDCCH, PDSCH) / PTRS
 - UL
 - SRS / DMRS(PUCCH, PUSCH)
- Quasi co-location (QCL) Type
 - QCL Type A: {Doppler shift, Doppler spread, average delay, delay spread}
 - QCL Type B: {Doppler shift, Doppler spread}
 - QCL Type C: {average delay, Doppler shift}
 - QCL Type D: {Spatial Rx parameter}

- Transmission configuration indicator (TCI)
 - RRC configuration
 - MAC-CE activation/deactivation
 - DCI indication

3. Beam Indication(QCL) (2/4)

● TCI states

- RRC configuration
 - M states
 - {DL Reference RS1| QCL_type1, DL Reference RS2| QCL_type2} or {DL Reference RS1| QCL_type1}
- MAC-CE activation/deactivation
 - Max. 8 TCI states
- DCI indication
 - 3 bits
 - Associated DCI for PDSCH scheduling
- Update
 - Explicit approach
 - RRC or RRC + MAC-CE

3. Beam Indication(QCL) (3/4)

● TCI states

- PDCCH

- RRC configuration & indication
- The number of TCI states for PDCCH > 1
 - MAC-CE indication
- No RRC indication
 - SSB determined in the initial access procedure

- PDSCH

- After RRC configuration & MAC CE activation/deactivation
 - DCI indication (associated DCI for PDSCH scheduling)
- Between initial RRC configuration and MAC CE activation of TCI states
 - SSB determined in the initial access procedure
- No DCI indication
 - The TCI state used for CORESET
- Scheduling offset \leq Threshold
 - The TCI state used for CORESET
 - The lowest CORESET-ID in the latest slot

3. Beam Indication(QCL) (4/4)

● TCI states

- P-CSI-RS/P-SRS
 - RRC configuration
- SP-CSI-RS/SP-SRS
 - RRC configuration & MAC CE activation/deactivation
- AP-CSI-RS/AP-SRS
 - DCI(AP-CSI-report-triggering state indication)

4. Beam Failure Recovery (1/2)

● Procedure

- Beam failure detection
- Candidate beam selection
- Beam failure recovery request
- UE behavior for gNB response

● Beam failure detection

- Beam failure is determined
 - When all serving beams fail (all serving control channels fail)
- Periodic CSI-RS or SSB
 - Hypothetical BLER < BLER for RLM out-of-synch
 - QCL with PDCCH

● Candidate beam selection

- CSI-RS or SSB
 - L1-RSRP
 - Threshold for CSI-RS by RRC parameter

4. Beam Failure Recovery (2/2)

● Beam failure recovery request

- Trigger condition
 - Beam failure is detected and candidate beam is identified
- PRACH transmission, associated with SSB
 - Contention-free PRACH
 - CDM with other PRACH resources
 - Same sequence design with PRACH preambles

● UE behavior for gNB response

- After 4 slots from the slot of the PRACH transmission
 - UE monitors CORESET-BFR for PDCCH within a window for TCI states
- Until the reconfiguration/activation/re-indication of TCI state(s) for PDCCH
 - PDSCH DMRS is spatial QCL with DL RS of the UE-identified candidate beam for BFRQ

5. Next Step

● FFS

- Implicit TCI update
- Spatial relation across CCs and/or BWPs
- Partial beam failure mechanism, etc.

6. References

1. Chairman's Notes RAN1 #88b ~ #91
2. TS 38.213 v2.0.0
3. TS 38.214 v2.0.0
4. TS 38.321 v2.0.0
5. TS 38.331 v1.0.0

**“Your beginnings will seem humble,
so prosperous will your future be.”**



감사합니다