3GPP TSG RAN1 Meeting #96
Athens, Greece, February 25th – March 1st 2019

R1-1902121

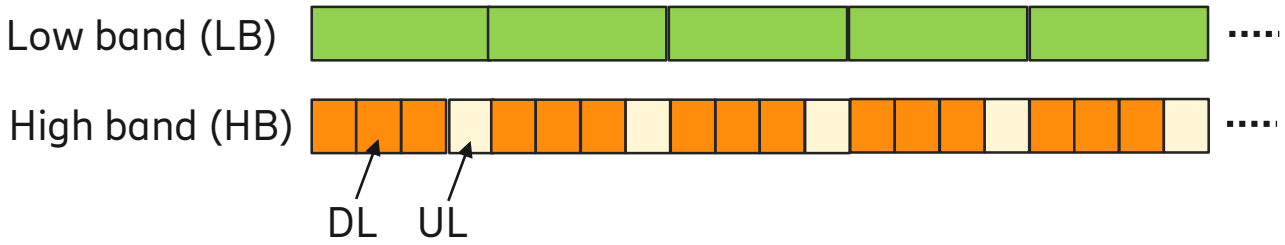
Agenda Item: 7.1.2
Source: Ericsson
Document for: Discussion, Decision

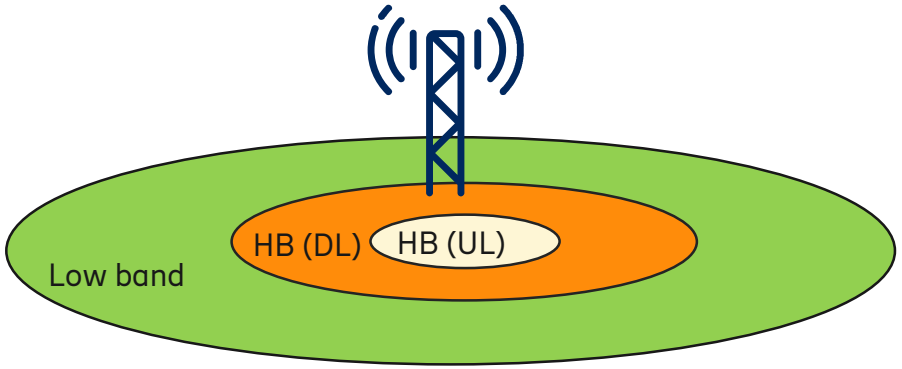
Motivation for correction to aperiodic CSI-RS triggering with different numerology between PDCCH and CSI-RS

Background

- In Inter-band CA between low-band and high-band:
  - Beam / CSI measurements on high-band are crucial for meaningful DL throughput
    - Aperiodic CSI-RS operation only realistic solution to provide channel measurements for high-band
  - Uplink coverage in high-band is limited

For Inter-band CA operation between low-band and high band, beam/CSI measurements on high-band should be reported via low band



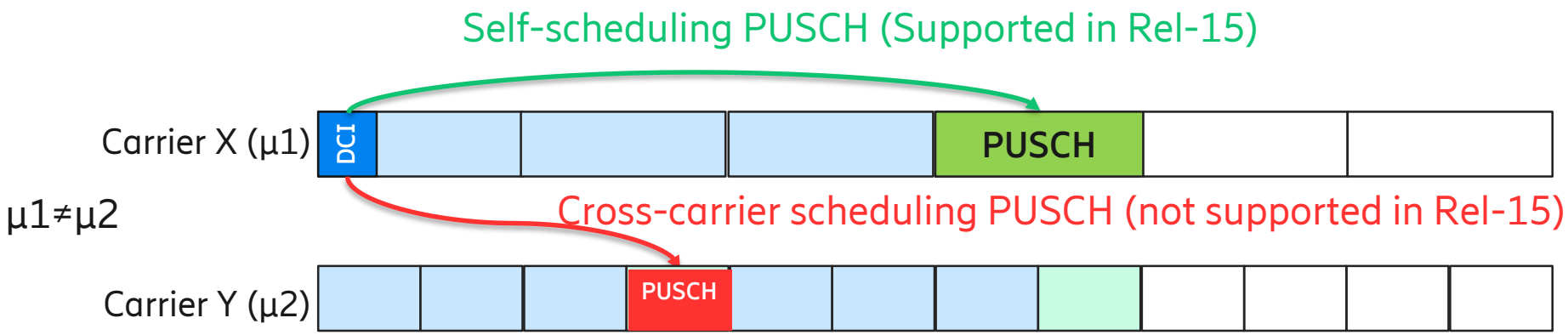


Beam/CSI report on low band enabled by inter-band CA can drastically improve coverage for mmWave deployments

Background

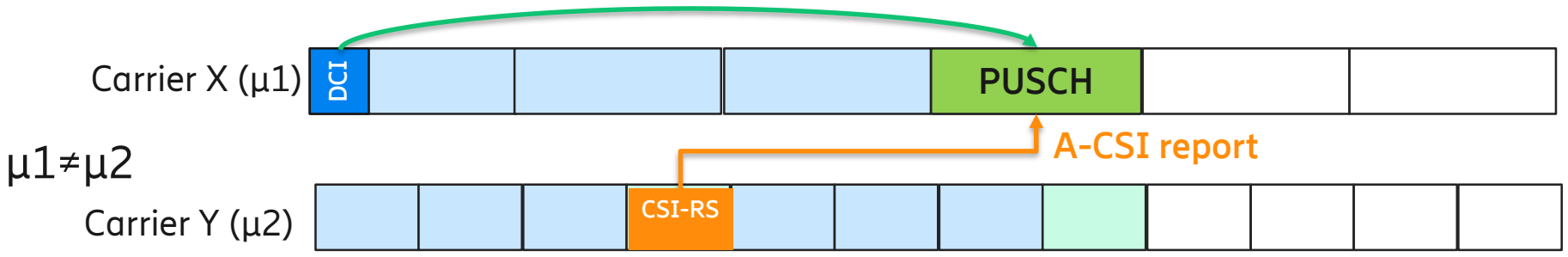
- Cross-carrier scheduling with mixed numerologies
  - At RAN plenary #81, cross-carrier scheduling with mixed numerologies was postponed to the Rel-16 WI on MR/DC (RP-182014)

> **"Cross-carrier scheduling with different numerologies is postponed to Rel-16. Already-agreed functionality for cross-carrier scheduling with different numerologies will not be removed from the Rel-15 specs, but will have a note added that the behaviour does not apply in this release."**



Background

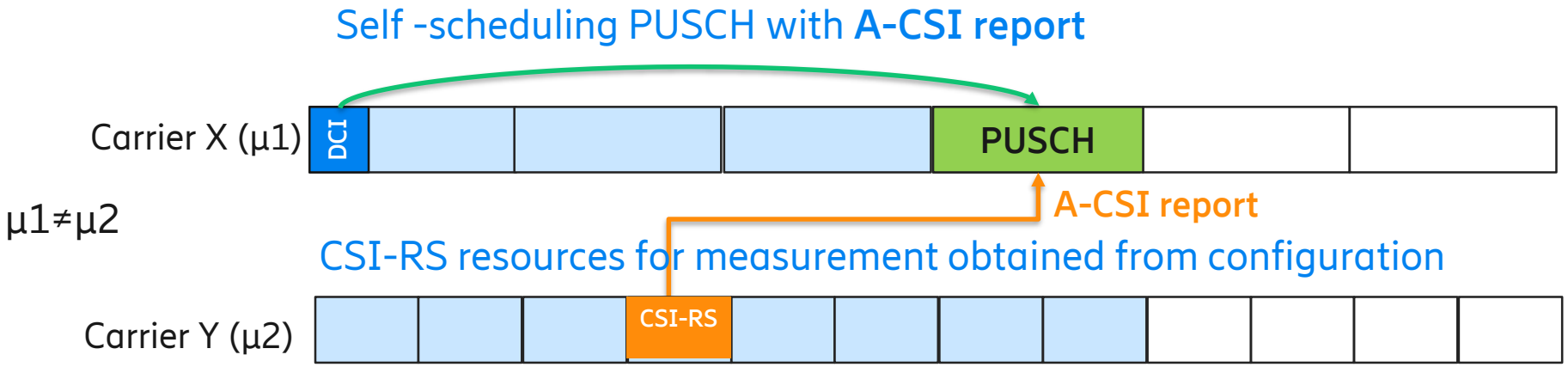
- In RAN1#92bis, open issues for CSI measurement for the following scenario were discussed:
  - DCI on Carrier X scheduling PUSCH on Carrier X with aperiodic CSI report for Carrier Y based on aperiodic CSI-RS



- In that discussion, the RAN plenary agreement was mis-interpreted due to the use of incorrect terminologies and incorrect association of measurement features to scheduling features
  - Triggering measurement resources on a different carrier <u>was mis-interpreted as</u> scheduling on a different carrier
- Hence, the following was concluded:
  - "Triggering A-CSI reports whose measurement resources are with different numerology from that with PDCCH is not supported in Rel-15. "

Triggering and Scheduling Clarifications

- In this scenario, the DCI achieves the following
  - Self-carrier scheduling: DCI on Carrier X schedules PUSCH on Carrier X to carry "A-CSI report"
  - Triggering "A-CSI report": Provides link to a CSI-RS configuration for measurements
    - Occasion of CSI-RS is obtained from the configuration (*DL BWP* and *Offset*)



This scenario does not involve "cross-carrier scheduling"

Proposals

Adopt the following proposals:

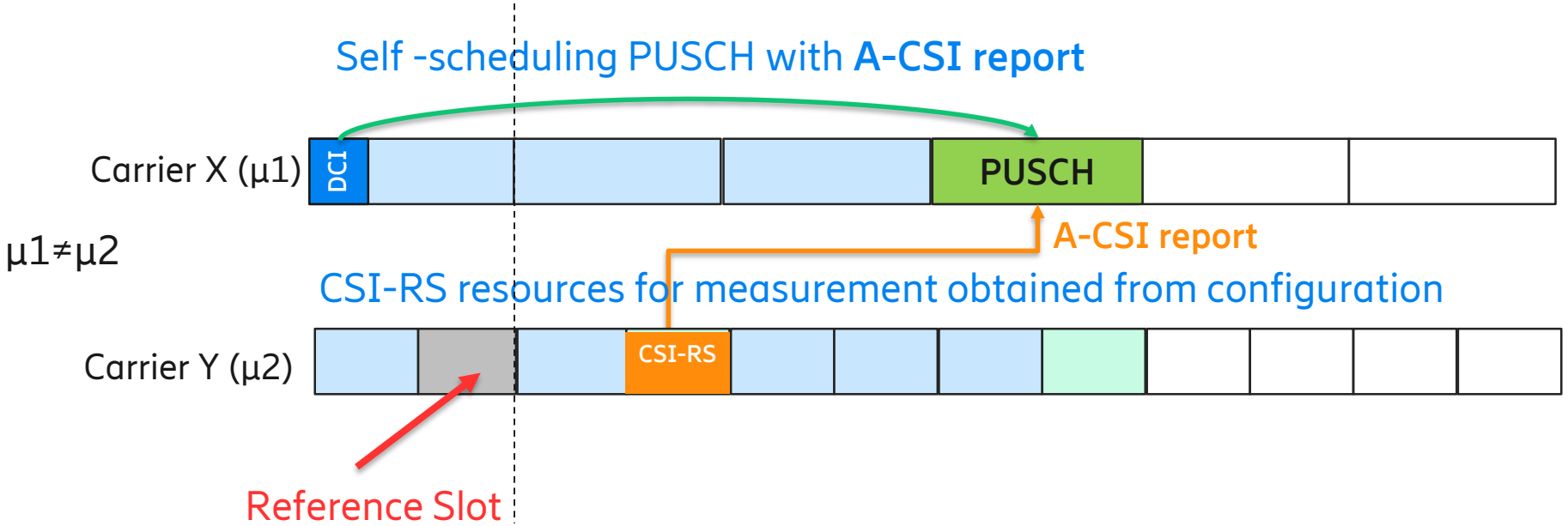
- **Proposal:**
  - Clarify that scheduling PUSCH on Carrier X carrying an aperiodic CSI report for Carrier Y with carriers X and Y having different numerologies is not considered cross-carrier scheduling
    - This feature is not excluded from Rel-15

- **Proposal:**
  - Adopt the companion CR (R1-1902120) correcting aperiodic CSI-RS slot offset and aligning the procedure for determining CSI-RS resource for measurement with already existing behavior in Rel-15 (e.g. PDCCH and PUCCH with different numerologies)
    - Whether UE supports aperiodic CSI-RS triggering with different numerology from PDCCH is indicated as new UE capability per band combination
      - Send an LS to RAN2 (R1-1902927) to inform them about this new UE capability

CR for Determination of CSI-RS Resource (R1-1902120)

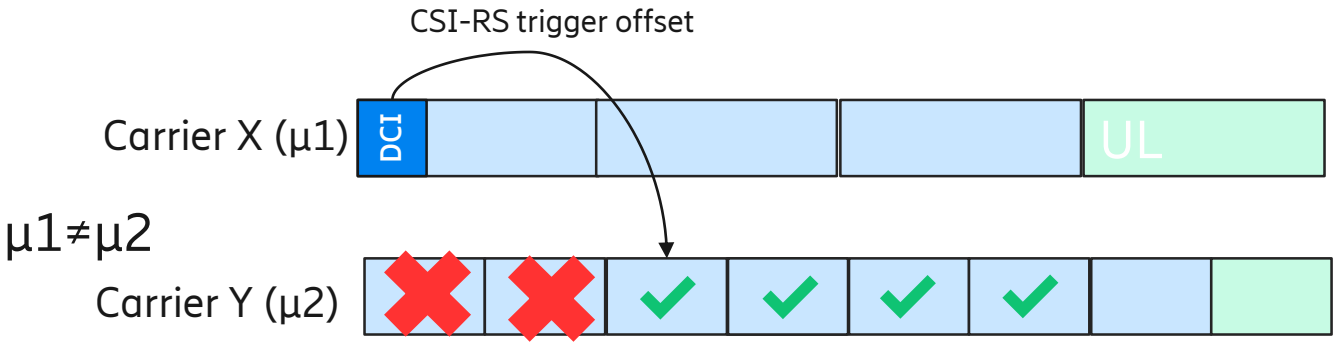
- Determination of the CSI-RS resource needs clarification on the reference slot from which the slot offset obtained from CSI-RS configuration is to be applied

- The CR aligns the procedure for determining the reference slot with the already existing behaviour in Rel-15 (e.g. PDCCH and PUCCH with different numerologies)
  - The reference slot on the carrier with CSI-RS resources is the latest slot that overlaps with the slot containing DCI
  - The slot offset is based on the numerology of the carrier with CSI-RS

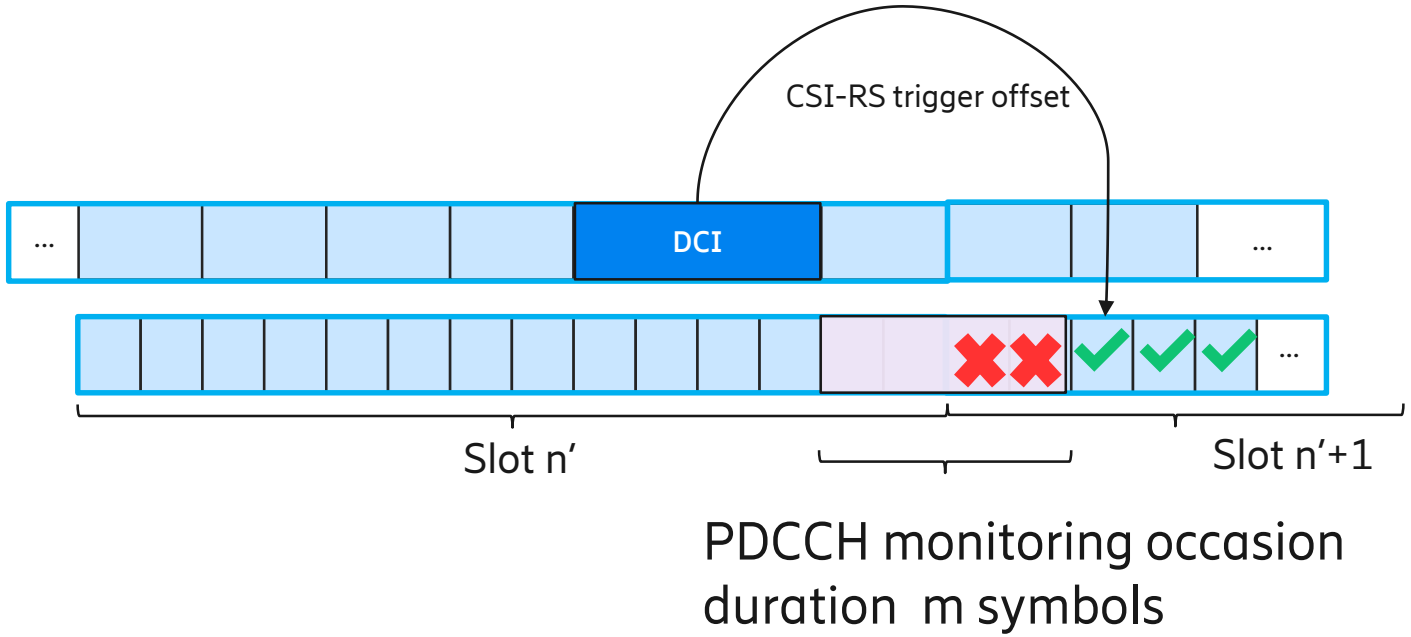


UE processing relaxations

- In order to not require UE to buffer data for slots in a higher numerology in anticipation of potential aperiodic CSI-RS trigger from a lower numerology, the proposal limits possible CSI-RS triggering offsets to only occur in later slots than the last slot overlapping the PDCCH slot



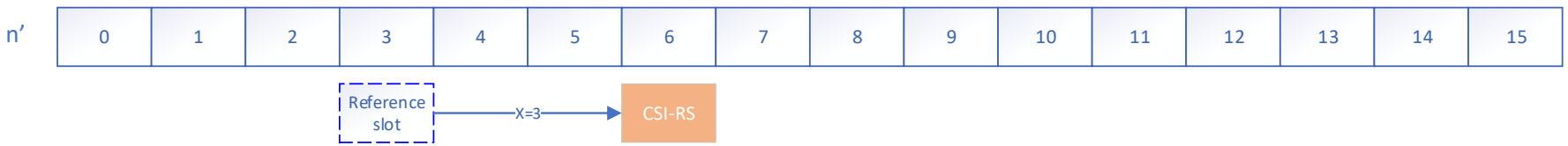
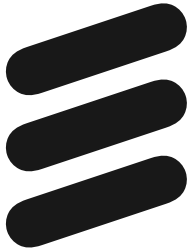
- To avoid too short time between DCI decoding and presence of triggered CSI-RS, which could happen in case DCI is received in CORESET located at the end of the slot which triggers CSI-RS in early symbols of subsequent slot
  - UE is not required to process aperiodic CSI-RS triggered within *m* symbols of last symbol of PDCCH
  - UE beam switching time is relaxed with *m* symbols
  - *m* is equal to span of the PDCCH monitoring occasion and approximates DCI decoding time



Example of slot offset calculation

$$n' = \left\lceil (n+1)\frac{2^{\mu_{CSIRS}}}{2^{\mu_{PDCCH}}} - 1 \right\rceil \qquad n' = \left\lceil (n+1)\frac{2^{\mu_{CSIRS}}}{2^{\mu_{PDCCH}}} - 1 \right\rceil + X$$

Carrier Y ($\mu_2 = 3$)



Carrier X ($\mu_1 = 1$)