3GPP TSG-RAN Meeting #84
Newport Beach, USA, June 3 - 6, 2019

RP-190944

Views on intra-UE prioritization in IIoT WI

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Introduction

- Objectives for intra-UE prioritization/multiplexing in IIoT WID RP-190728 are copied below

2. The detailed objectives for NR intra-UE prioritization/multiplexing are:

- **Specify enhancements to address resource conflicts between dynamic grant (DG) and configured grant (CG) PUSCH and conflicts involving multiple CGs [RAN2, RAN1].**
  - **Specify PUSCH grant prioritization based on LCH priorities and LCP restrictions for the cases where MAC prioritizes the grant [RAN2].**
- **Address UL data/control and control/control resource collision by:**
  - **specifying a method to address resource collision between SR associating to high-priority traffic and uplink data of lower-priority traffic for the cases where MAC determines the prioritization [RAN2].**
  - **specifying prioritization and/or multiplexing behaviour among HARQ-ACK/SR/CSI and PUSCH for traffic with different priorities, including the cases with UCI on PUCCH and UCI on PUSCH [RAN1, RAN2].**

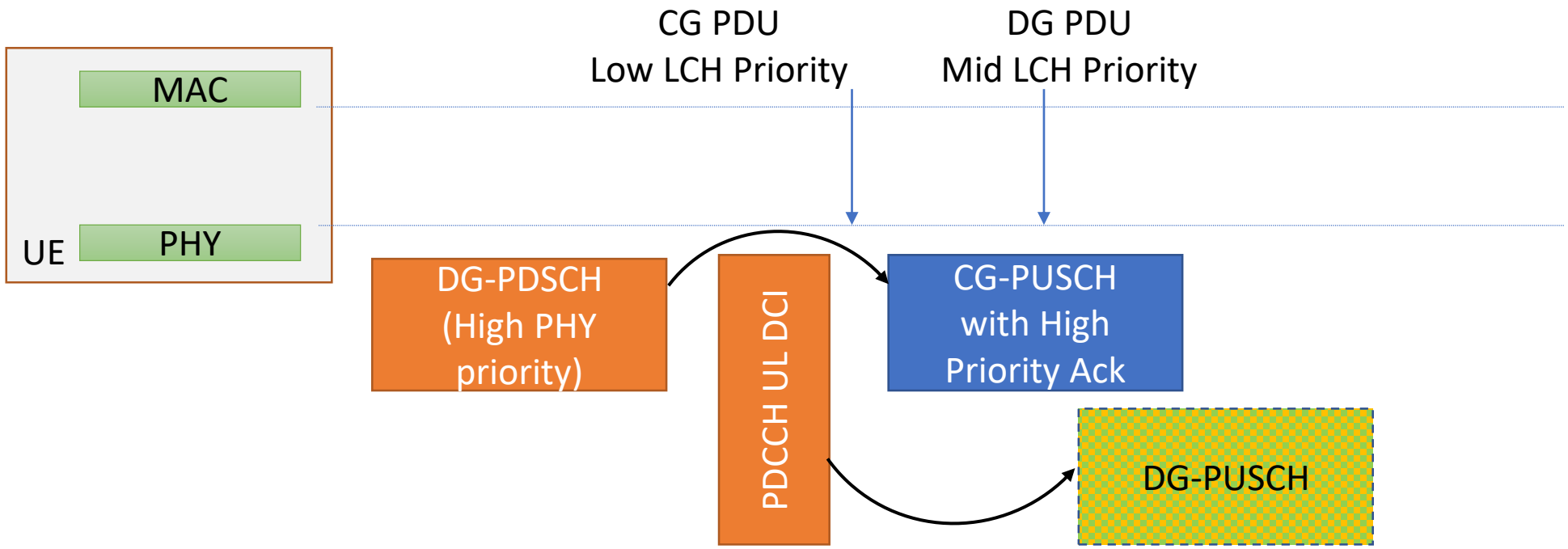
- **Observation 1: the objectives include RAN1-led items (e.g., prioritization between UCI and PUSCH) and RAN2-led items (e.g., prioritization between DG and CG)**

Proposed RAN1-RAN2 coordination

- Observation 2: Addressing conflicts between grants is a RAN2-led agenda item. But, it has significant RAN1 impacts since
  a. de-prioritization of a grant could require pre-emption of an ongoing PUSCH and the ongoing PUSCH may even carry UCI for high priority downlink traffic (see slide 4)
  b. de-prioritization of a grant without considering aspects like partial (CBG) transmission (see figure (a) in slide 5) and UCI prioritization (see figure (b) in slide 5) leads to sub-optimal performance
  c. prioritization of a grant based on (dynamic) LCH priorities of the grant's PDU increases possible dropping/multiplexing outcomes at the gNB (see slide 6)

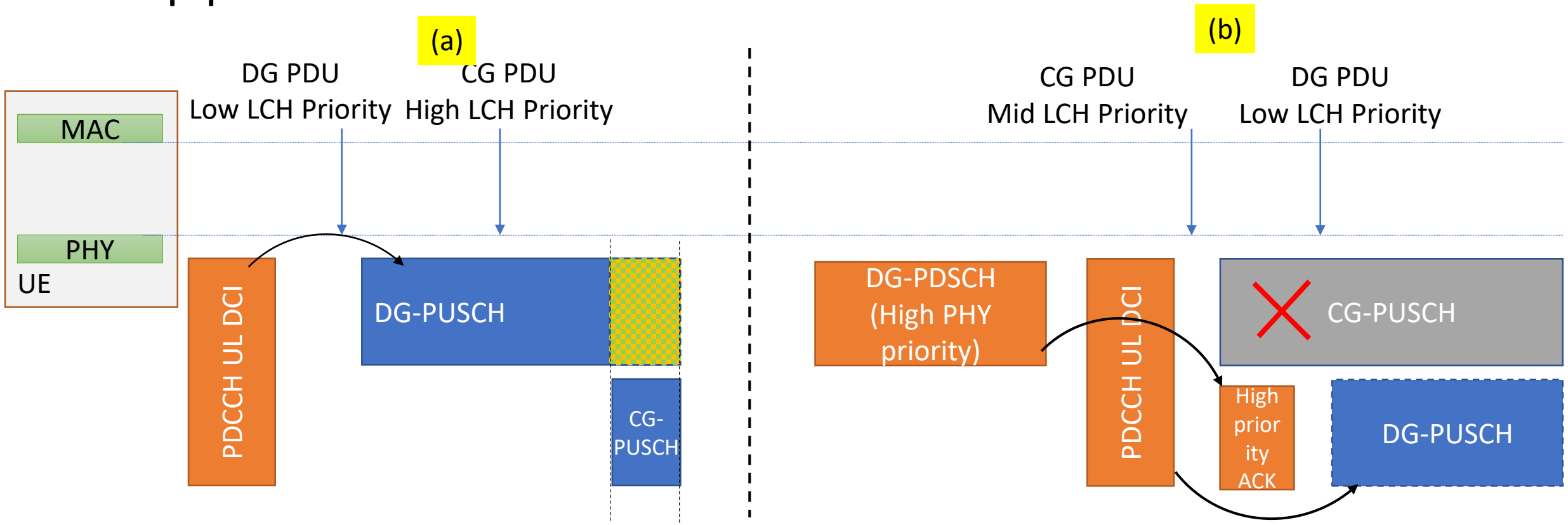
- **Proposal 1: RAN requests RAN2 to work jointly with RAN1 on the intra-UE prioritization feature, and not adopt or eliminate solution options without getting input from RAN1**

Pre-emption of ongoing transmissions



- In above example, PHY knows that CG-PUSCH has high priority UCI, and should be prioritized
  - Otherwise, high priority UCI (ACK) lost
- **Observation 3: When PHY receives a PDU from MAC, and another ongoing PUSCH transmission is overlapping, then PHY has the option of**
  - **interrupting the ongoing transmission, or**
  - **ignoring the PDU based on priority determination at PHY**

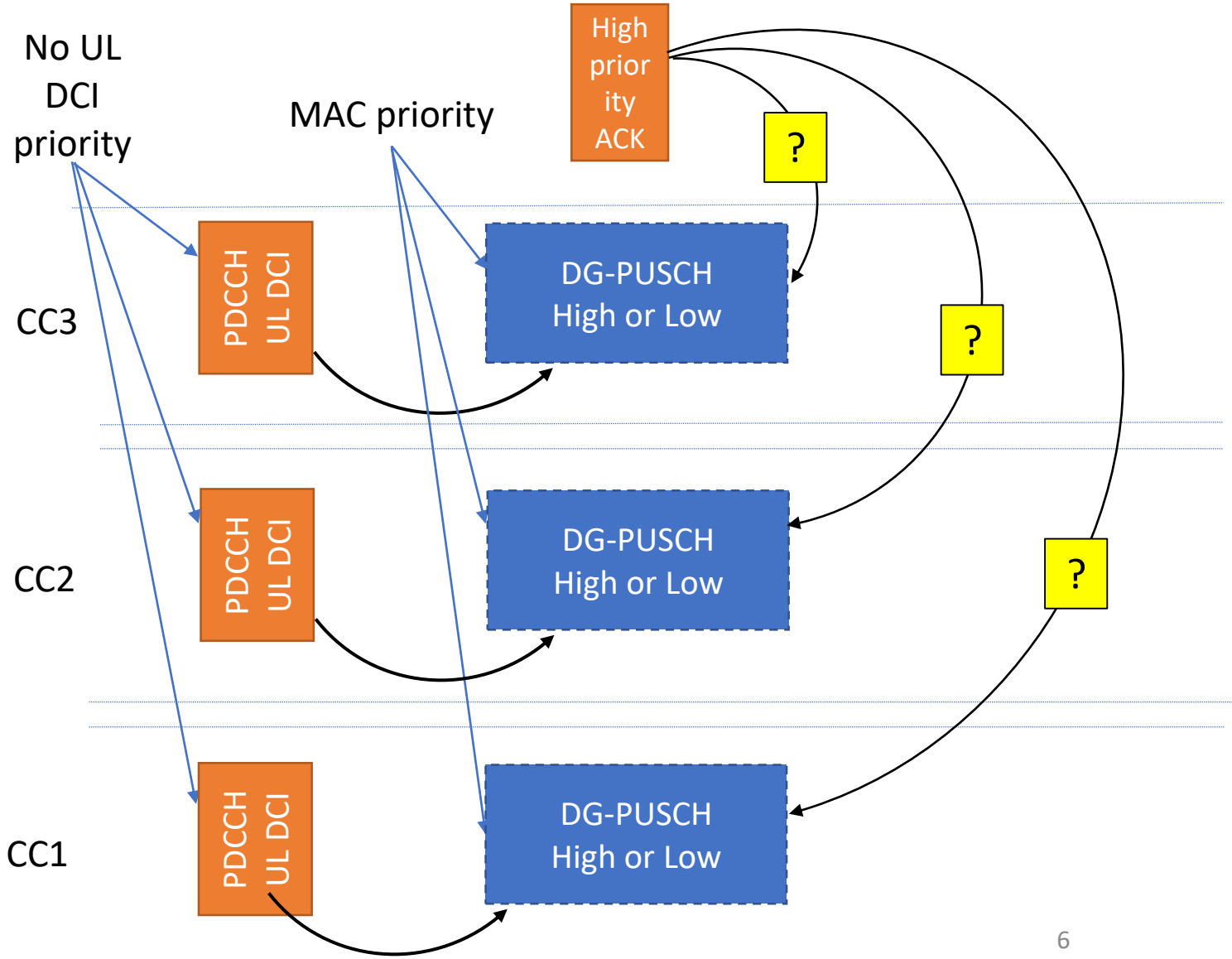
Suppression of PDUs at MAC



- For a DG PUSCH, MAC should not suppress delivering PDU to PHY irrespective of whether DG PUSCH overlaps with a CG PUSCH with higher priority PDU, because PHY may be able to
  - partially transmit the DG PUSCH (e.g., using CBGs) even if it overlaps with CG PUSCH (figure (a)), or
  - fully transmit the DG PUSCH if CG PUSCH was deprioritized to send a high priority UCI (figure (b)), or
  - not transmit the DG PUSCH, and rely on HARQ retransmission
- **Observation 4: For a DG PUSCH, MAC should not suppress delivering PDU to PHY since MAC does not have full knowledge to makes this decision**

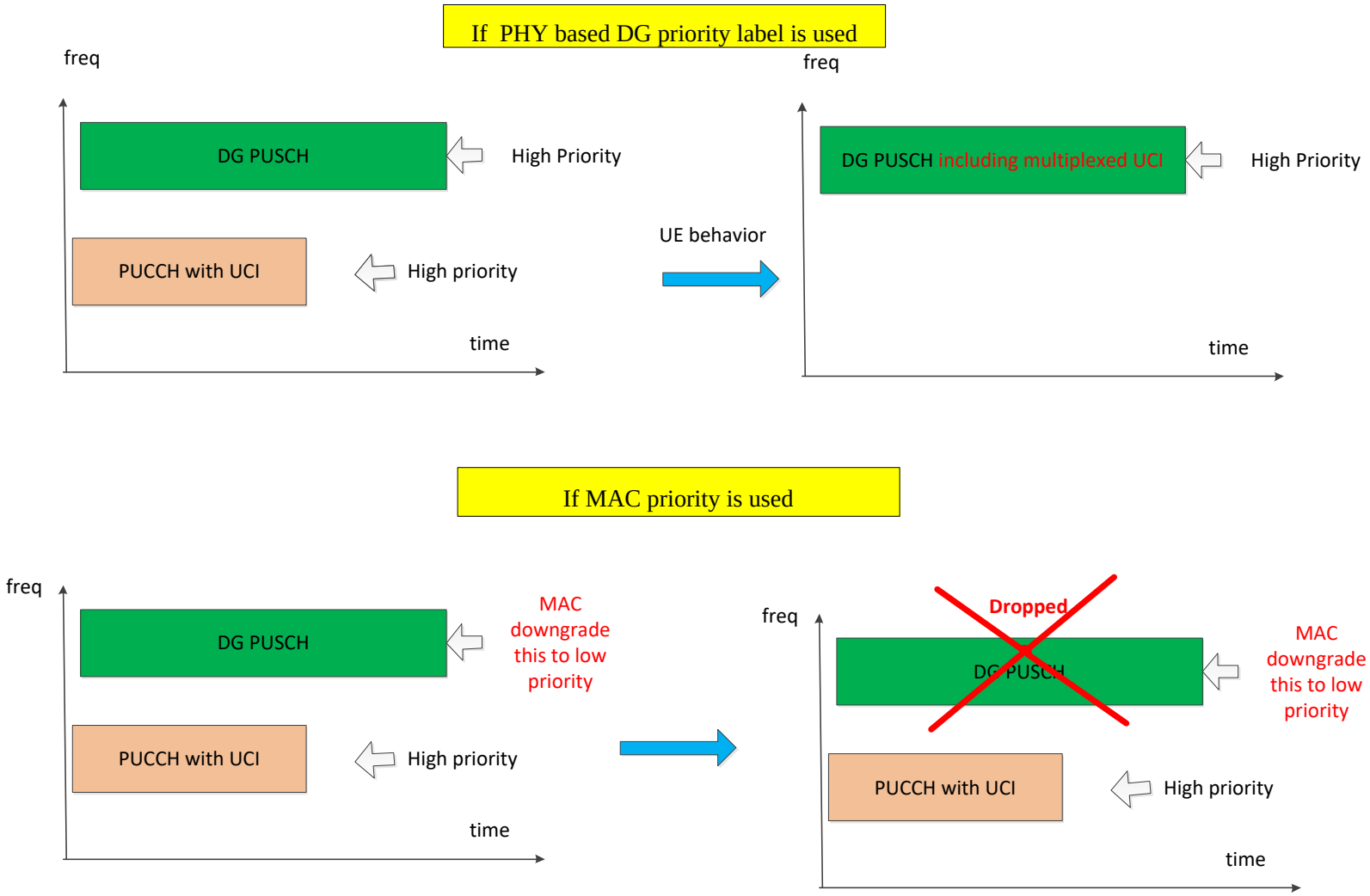
Physical layer use of priorities for UCI multiplexing

- Control information (HARQ-ACK) is multiplexed in a PUSCH with matching priority
- Suppose there is no UL DCI-based priority indication and priority is determined by MAC
- The gNB will not know what the PUSCH priority is before decoding it, so the gNB does not know where the control is
- From the gNB's perspective, there are 2^N (N is the number of CCs) possible channel prioritizations, with various possible dropping/multiplexing outcomes unknown at the gNB



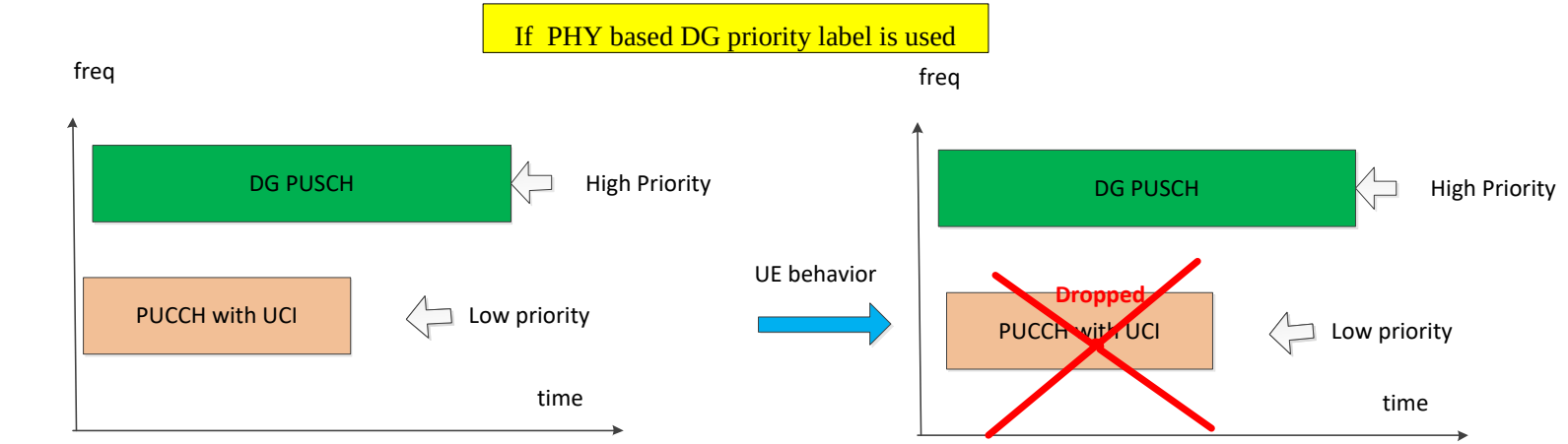
Thank you

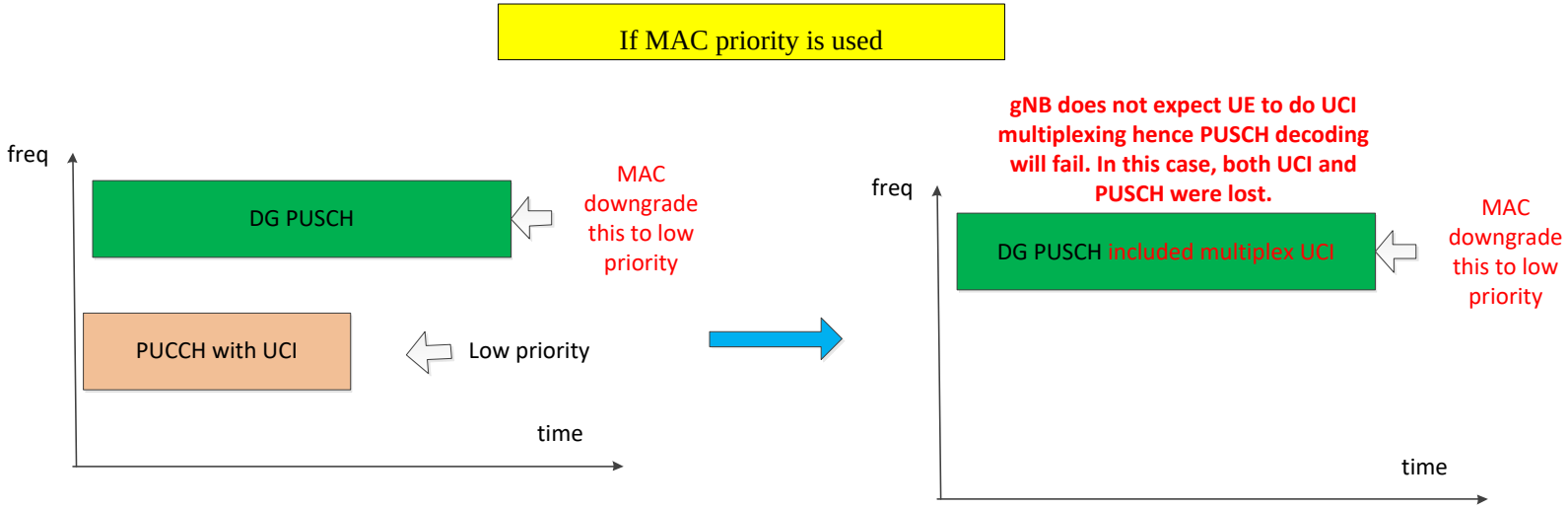
Example 1: Value of PHY priority label in UCI multiplexing vs dropping decision



- **Setting: High priority UCI collides with a DG**
  - **with high PHY based DG priority label and**
  - **low MAC priority (due to absence of high priority LCHs)**
- Desired behaviour: high priority UCI multiplexed in DG PUSCH and delivered reliably
  - PUSCH grants parameters were determined by gNB to enable reliable delivery of high priority UCI
- Outcome if (high) **PHY** based DG priority label is used,
  - Desired behaviour
- Outcome if (low) **MAC** priority is used
  - low priority PUSCH unnecessarily dropped in favour of UCI, leading to poor resource utilization

Example 2: Value of PHY priority label in UCI multiplexing vs dropping decision





- **Setting: Low priority UCI collides with a DG**
  - **with high PHY based DG priority label**
  - **low MAC priority (due to absence of high priority LCHs)**
- Desired behaviour: gNB expects UCI to be dropped.
- Outcome if (high) **PHY** based DG priority label is used,
  - the low priority UCI is dropped as expected; data from the low priority logical channel will be sent on PUSCH without UCI.
- Outcome if (low) **MAC** priority is used,
  - UCI multiplexed onto PUSCH
  - gNB decodes PUSCH with wrong rate-matching assumptions and will fail decoding