Joint Proposal on enabling LTE CRS puncturing of NR PDCCH for Rel18 DSS Enhancements WI

A.I. 9.9.1

Ericsson, Nokia, Nokia Shanghai Bell, NTT DOCOMO, Softbank, […]

Introduction

- RAN1 should conclude discussion on Rel18 DSS Enhancements WI in RAN1#110
  - 1st objective: Enabling LTE CRS puncturing of NR PDCCH
    - Proposal for RAN1 agreement and background provided in later slides
  - 2nd objective: enable overlapping CRS RM patterns regardless of M-TRP config
    - Relevant agreements/WAs for RRC signaling already made in RAN1#109-e

WID Objectives (RP-213575)

The following objectives shall be included for improvement of NR spectrum efficiency for LTE-NR co-existence (RAN1):
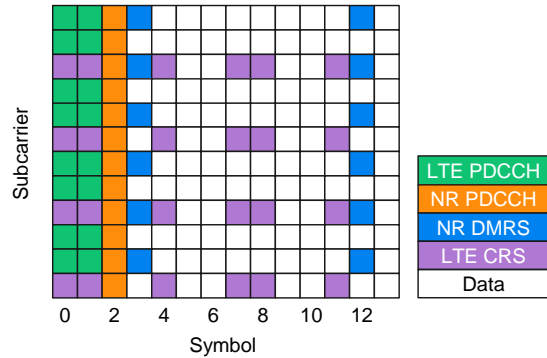
- Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs. [RAN1]
  - o Investigate enabling LTE CRS to puncture NR PDCCH, including the impact to NR PDCCH DMRS if there is the performance gain from the additional PDCCH resources.
- Allow a UE to support, and be configured with, two overlapping CRS rate matching patterns regardless of support or configuration of multi-TRP [RAN1, RAN2]
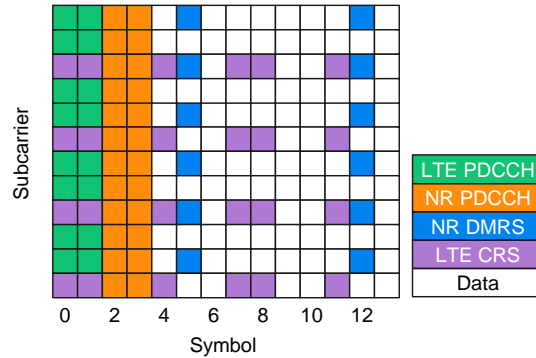
Notes on time plan

- Per agreed time plan in RP-213469 and RP-213697
  - RAN1 has TUs in RAN1#109-e and RAN1#110
    - Specifications/UE capabilities to be finalized with other Rel18 items towards end of Rel18.
  - RAN4 TUs start in Q4 2023
  - RAN2 handles as part of Misc. items with other WG impact
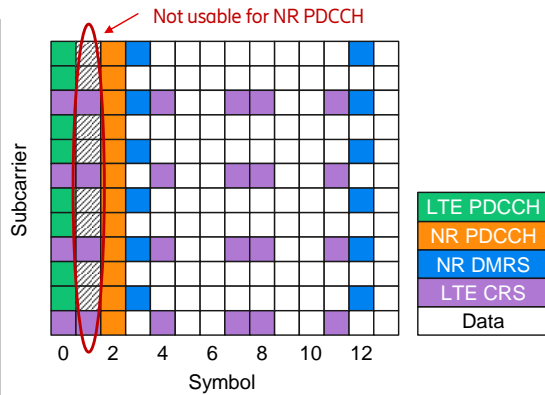
Background

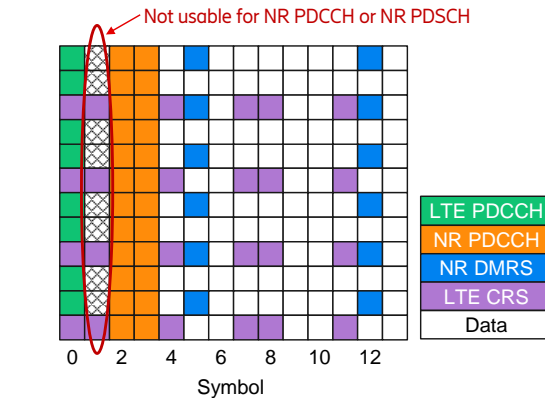**2sym LTE PDCCH (Legacy)**

All legacy UEs

Rel16 UEs supporting FG 3-2/FG 22-12 and FG 14-2

Legend: LTE PDCCH, NR PDCCH, NR DMRS, LTE CRS, Data

1sym LTE PDCCH (Legacy)

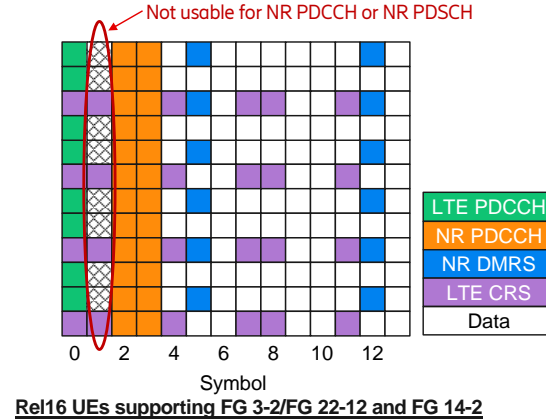Not usable for NR PDCCH

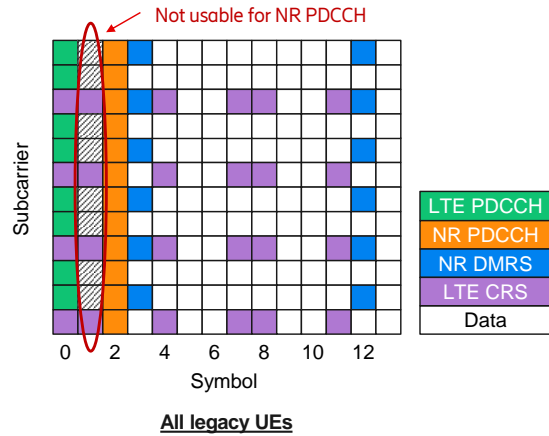Not usable for NR PDCCH or NR PDSCH

All legacy UEs

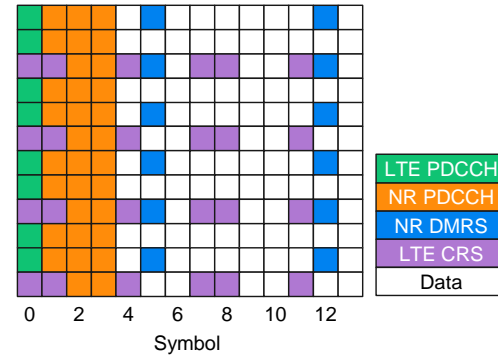Rel16 UEs supporting FG 3-2/FG 22-12 and FG 14-2

- **Current spec restriction**: UE not required to monitor NR PDCCH candidates overlapping with CRS => NR PDCCH can only start with symbol #2 (s2) when 4 port CRS used for LTE

- Lower LTE load and higher NR load expected in future => s1 may not be needed for LTE PDCCH in many instances

- **Without Rel18 Enhancement**, when LTE has 4-port CRS and PDCCH not in s1,
  - only 1sym for NR PDCCH if (s2, s3-s13) used for (NR PDCCH, NR PDSCH) split
    - RBs overlapping with CRS in s1 cannot be used for PDCCH
  - PDSCH limited to 10syms if (s2-s3, s4-s13) used for (NR PDCCH, NR PDSCH) split
    - RBs overlapping with CRS in s1 cannot be used for PDCCH or PDSCH

Rel18 Enhancement

1sym LTE PDCCH (Legacy)

Not usable for NR PDCCH

Subcarrier / Symbol
0 2 4 6 8 10 12

Legend: LTE PDCCH, NR PDCCH, NR DMRS, LTE CRS, Data

All legacy UEs

Not usable for NR PDCCH or NR PDSCH

Subcarrier / Symbol
0 2 4 6 8 10 12

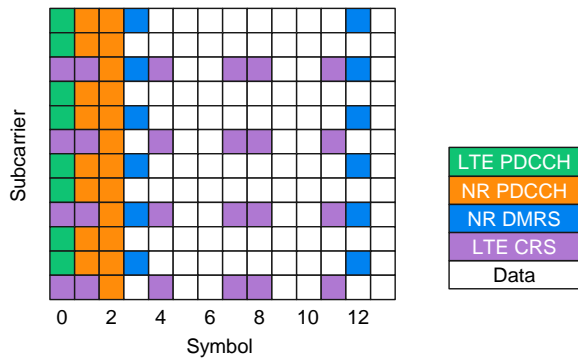Legend: LTE PDCCH, NR PDCCH, NR DMRS, LTE CRS, Data

Rel16 UEs supporting FG 3-2/FG 22-12 and FG 14-2

1sym LTE PDCCH (Rel 18 Enh.)

Subcarrier / Symbol
0 2 4 6 8 10 12

Legend: LTE PDCCH, NR PDCCH, NR DMRS, LTE CRS, Data

Subcarrier / Symbol
0 2 4 6 8 10 12

Legend: LTE PDCCH, NR PDCCH, NR DMRS, LTE CRS, Data

- **With Rel18 Enhancement** enabling UE reception of NR PDCCH candidates that overlap with LTE CRS REs,
  - below split enabled for (NR PDCCH sym, NR PDSCH sym) when s1 not used for LTE
    - (s1-s2, s3-s13) : 2sym NR PDCCH+11sym PDSCH
    - (s1-s3, s4-s13) : 3sym NR PDCCH+10sym PDSCH
  - NR PDCCH resources increased without reducing PDSCH syms

- More PDCCH resources improve DSS performance, e.g.,
  - PDCCH does not become bottleneck for scheduling UL traffic (incl. A-CSI requests, TCP ACKs) on low band carrier for LB-MB NR CA with DSS carrier in low band
  - offloading PDCCHs to s1 from s3 (or s2) can free up more resources for PDSCH => improved DL tput for DSS carrier

- Evaluations show PDCCH capacity is improved with minimal RAN1 spec impact
  - E.g. R1-2207439 (E///), [...], [...]

Proposals

- Proposal 1
  - Reception of NR PDCCH candidates that overlap with LTE CRS REs is supported by Rel18 UEs
    - Reception supported at least for UESS, and CSS(s) with dedicated RRC configuration
    - It is RAN1 understanding that the feature can be supported even if UE receiver uses legacy channel estimation (i.e., no change to UE assumption on PDCCH DMRS RE positions/pattern in a symbol)
      - RAN4 is requested to take the above into account when specifying UE performance requirements
    - UE capability details will be finalized during overall Rel18 UE capabilities discussion phase

- Proposal 2
  - Continue discussing the following to converge during RAN1 #110
    - Application of CRS puncturing/not on a PDCCH candidate configured per PDCCH aggregation level
    - Providing UE with the PDCCH/CRS relative power setting that the receiver may use in the demodulation/decoding process when puncturing is not applied
    - Introducing following new RE mapping in symbol with CRS
      - PDCCH candidates in the CORESET assumed to have DMRS REs in OFDM symbol(s) where LTE cell-specific reference signals as indicated by the higher-layer parameter lte-CRS-ToMatchAround or LTE-CRS-PatternList is not present
    - Additional restrictions(if any)/capability signaling on allowed CORESET duration(s) for NR PDCCH candidates that overlap with LTE CRS REs
    - TPs to RAN1 specs for consideration by editors