3GPP TSG RAN WG1 meeting #98 R1-1909289
Prague, Czech Republic, 26th – 30th August, 2019

Agenda Item : 7.2.14
Source : Qualcomm
Title : Proposals for NR Rel-16 TEI
Document for : Discussion and Decision

This document contains two sections related to the NR Rel-16 TEI A.I.

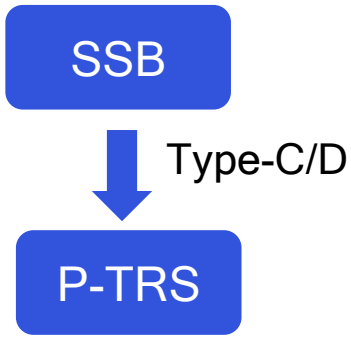
1. New TEI NR Rel-16 proposal by Qualcomm:
   - Introduction of ***Standalone Aperiodic TRS*** in NR Rel-16
     - Supported also by Ericsson

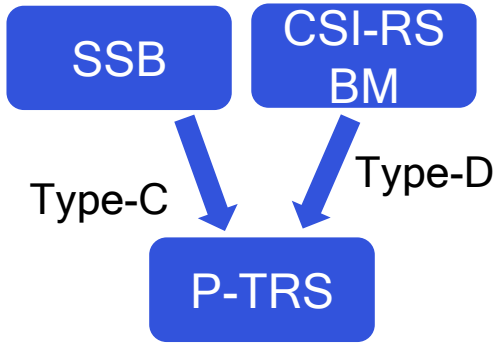
2. Qualcomm's views on the existing NR Rel-16 TEI on
   - DSS Enhancement between NR & LTE

- Introduction of *Standalone Aperiodic TRS* in NR Rel-16
    - Supported by Qualcomm, Ericsson

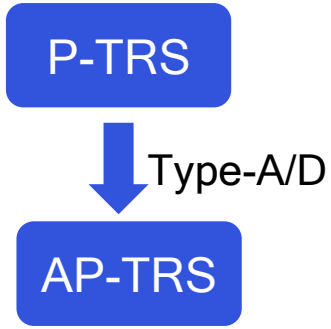
NR Rel-15 Periodic & Aperiodic TRS (AP-TRS) status

- NR Rel-15 supports the following options with regards to Tracking Reference Signal (TRS)
  - **Periodic TRS (P-TRS):** A CSIRS resource set for tracking configured in RRC with a semi-statically configured TCI state
    - The QCL source of the P-TRS can be:
      - SSB for Type-C/D
      - SSB for Type-C and CSI-RS for BM for Type-D





  - **Aperiodic TRS (AP-TRS) associated with a P-TRS**
    - The QCL source of a AP-TRS can ***only*** be another P-TRS for Type A/D



TS 38.214 Section 5.1.5

For a periodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a TCI-State indicates one of the following quasi-colocation type(s):

- 'QCL-TypeC' with an SS/PBCH block and, when applicable, 'QCL-TypeD' with the same SS/PBCH block, or
- 'QCL-TypeC' with an SS/PBCH block and, when applicable,'QCL-TypeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or

For an aperiodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a *TCI-State* indicates 'QCL-TypeA' with a periodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable,'QCL-TypeD' with the same periodic CSI-RS resource.

Why move beyond Rel-15's coupling of AP-TRS with a P-TRS?

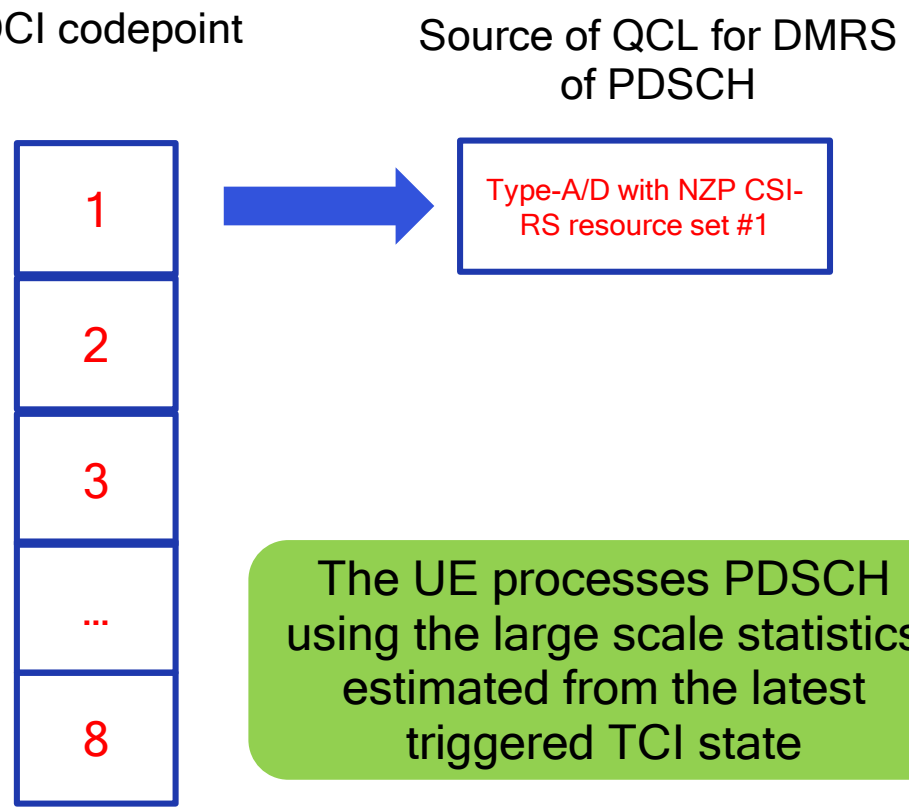
- An AP-TRS coupled with a P-TRS cannot provide a well-matched QCL reference for data
  - in cases of narrow UE-specifically derived beams
    - P-TRS beams might be wider beams (spatial, doppler, delay profile mismatch) compared to the ones that could be used if standalone AP-TRS was supported.
  - in cases of fast beam changes especially for scenarios of mobility
    - limited number of P-TRS can be configured in each CC
- Standalone AP-TRS would enable more dynamic and reliable beam selection
  - Frequent RRC re-configurations may be needed otherwise
- High system overhead in FR2 due to the need of configuring a large number of "cell-specific" P-TRS to be used as potential anchors for the AP-TRS
  - P-TRS in FR2 is costly with regards to overhead, e.g., it cannot be FDM'd with other TRS or PDSCH due to analog beamforming constraint

Example of P-TRS configuration in FR2	System overhead of P-TRSs in FR2 assuming full BWP and SCS=120 KHz and 20 msec periodicity
32 P-TRSs, single-slot*	2.9%
32 P-TRSs, double-slot	5.7%
64 P-TRSs, double slot	11.4%

*Single-slot TRS may result to worse Doppler parameter estimation than a double-slot TRS

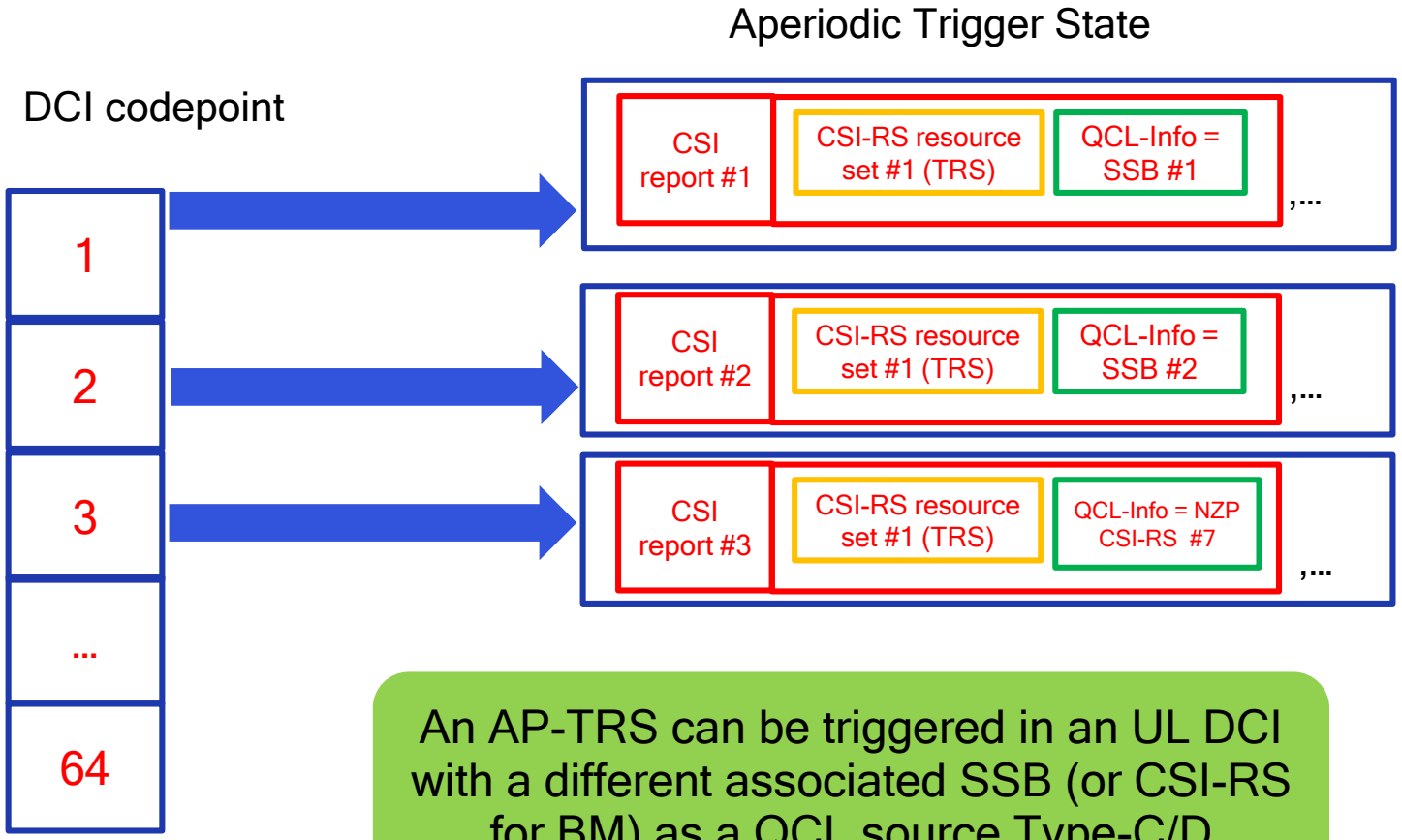
Standalone AP-TRS Proposal

DL DCI : TCI field



The UE processes PDSCH using the large scale statistics estimated from the latest triggered TCI state

UL DCI: CSI request field



An AP-TRS can be triggered in an UL DCI with a different associated SSB (or CSI-RS for BM) as a QCL source Type-C/D

Text Proposal (TP) for the standalone AP-TRS

- RAN1 change in Section 5.1.5 and 5.1.6.1.1 of TS 38.214

Section 5.1.5

For a periodic, or an aperiodic CSI-RS resource if the UE supports the *standaloneAperiodicTRS* included in Subclause 4.2.7.2 of [13, TS 38.306], -CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* , the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):

- 'QCL-TypeC' with an SS/PBCH block and, when applicable, 'QCL-TypeD' with the same SS/PBCH block, or
- 'QCL-TypeC' with an SS/PBCH block and, when applicable,'QCL-TypeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, otherwise~~or~~

~~F~~For an aperiodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info and if the UE supports the AperiodicTRS* included in Subclause 4.2.7.2 of [13, TS 38.306]., the UE shall expect that a *TCI-State* indicates 'QCL-TypeA' with a periodic CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable,'QCL-TypeD' with the same periodic CSI-RS resource.

Section 5.1.6.1.1

A UE configured with *NZP-CSI-RS-ResourceSet(s)* configured with higher layer parameter *trs-Info* may have the CSI-RS resources configured as:

- Periodic, with the CSI-RS resources in the *NZP-CSI-RS-ResourceSet* configured with same periodicity, bandwidth and subcarrier location
- Periodic CSI-RS resource in one set and aperiodic CSI-RS resources in a second set, with the aperiodic CSI-RS and periodic CSI-RS resource having the same bandwidth (with same RB location)and the aperiodic CSI-RS being 'QCL-Type-A' and 'QCL-TypeD', where applicable, with the periodic CSI-RS resources if the UE supports the *AperiodicTRS* included in Subclause 4.2.7.2 of [13, TS 38.306]. For frequency range 2, the UE does not expect that the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is smaller than the UE reported *ThresholdSched-Offset*. The UE shall expect that the periodic CSI-RS resource set and aperiodic CSI-RS resource set are configured with the same number of CSI-RS resources and with the same number of CSI-RS resources in a slot. For the aperiodic CSI-RS resource set if triggered, and if the associated periodic CSI-RS resource set is configured with four periodic CSI-RS resources with two consecutive slots with two periodic CSI-RS resources in each slot, the higher layer parameter *aperiodicTriggeringOffset* indicates the triggering offset for the first slot for the first two CSI-RS resources in the set.
- Aperiodic CSI-RS resources in the *NZP-CSI-RS-ResourceSet* configured with same periodicity, bandwidth and subcarrier location, if the UE supports the *standaloneAperiodicTRS* included in Subclause 4.2.7.2 of [13, TS 38.306]. For frequency range 2, the UE does not expect that the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is smaller than the UE reported *ThresholdSched-Offset*. For the aperiodic CSI-RS resource set if triggered, the higher layer parameter *aperiodicTriggeringOffset* indicates the triggering offset for the first slot for the first two CSI-RS resources in the set.

- UE capability in RAN2 specification:

Features	#	Feature group	Components	Prerequisite feature groups (listed in this sheet only)	Need for gNB to know whether the feature is supported by the UE (what happens if gNB does not know?)	Consequences if the feature is not supported by the UE	Type (see R2-1712078)	Need of FDD/TDD differentiation	Need of FR1/FR2 differentiation
		Standalone AP- TRS	Support of DCI triggered TRS without being associated to a periodic TRS			Standalone AP-TRS is not supported	Type 1	N.A.	N.A.

2. Qualcomm’s views on the existing NR Rel-16 TEI on

- DSS Enhancement between NR & LTE

3GPP TSG-RAN WG1 Meeting #98 **R1-1909289**
Aug. 26th – Aug. 30th, 2019
Prague, Czech

Agenda item: 7.2.14
Source: Qualcomm Incorporated
Title: On Dynamic Spectrum Sharing
Document for: Discussion and Decision

1. Introduction

In RAN Plenary #84, enhancement of Dynamic Spectrum Sharing between NR and LTE is approved as TEI-16 and expected to be completed in RAN1 #98 with the following scope.

- Introduce PDSCH Type B mapping of length 9 and 10 OFDM symbols where the positions of DMRS are defined or can be configured so they do not collide with symbols containing LTE CRS
- Extend the higher layer configuration of LTE-CRS rate matching pattern to multiple rate matching patterns to support multiple LTE carriers within an NR carrier
    - RAN1 will decide on a reasonable limit for the number of rate matching patterns to be supported
    - The LTE-CRS rate matching patterns are applicable to 15 kHz SCS
    - Signaling to be defined by RAN2

In this paper, we provide our analysis and views on the above scope.

2. Sharing Scenarios and Multiple CRS pattern

In the approved scope, it's proposed to define a multiple LTE CRS rate matching pattern in one NR carrier for 15KHz SCS. This scenario only covers the contiguous LTE carriers on a single band. Based on our knowledge, this multiple contiguous CC sharing scenario is only FDD matters as TDD operators only have 30KHz NR deployment for now. Hereby, we propose to the group clearly indicate this point. Furthermore, some of the TDD operators plans to use DSS to enable NR and LTE sharing on same spectrum before LTE is taken place by NR. However, the taking place period only last for one year after the NR initial deployment. In this sense, we don't see the need to further optimize the mixed numerology (30KHz NR + 15KHz LTE) FDM in the same carrier.

Observation 1: multiple contiguous CC sharing scenario is only for FDD, and no need to further optimize the mixed numerology (30kHz NR and 15kHz LTE) FDM in the same carrier.

For multiple carrier sharing case, we rely on RAN4 CA could hint us the potential combinations. When we come to LTE CA combination discussed in RAN4, for most cases, contiguous carriers owned by an oeprator in a single band is no more than 20MHz for FDD bands, although there can be exceptions. Therefore, we propose that a single pattern is still sufficient. If there are operators with FDD BW allocation larger than 20MHz then the following should be also established:

- Is it in an FDD band where more than 20MHz NR Channel BW is allowed (currently only Band 3 and Band 66)?
- Is multi-LTE carrier already deployed in the same band for the same operator?

Since there is no FDD channel bandwidth more than 40MHz in any case, more than 2 patterns would not be needed even for handling any exception cases.

For TDD bands, we notice some operators have larger bandwidth, but the NR SCS is typically 30kHz which is not suitable for CRS rate matching due to non-orthogonal issue.

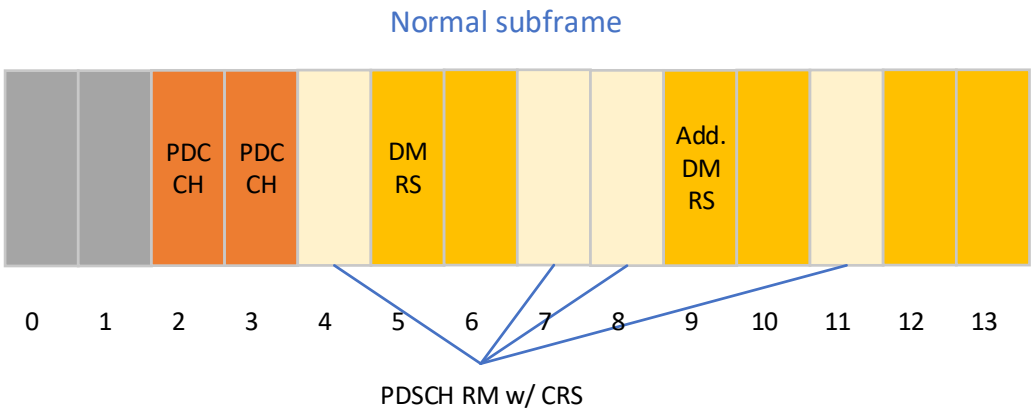
Proposal 1: Single LTE CRS pattern per NR carrier is sufficient.

2.2 Type B scheduling

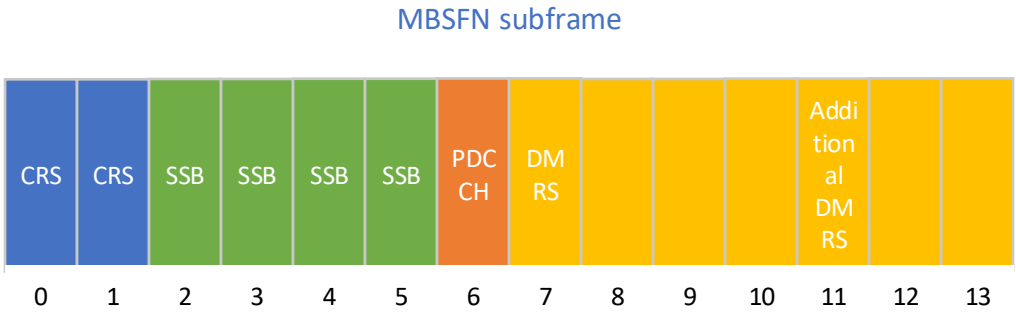
In R15 NR spec, type B allows the scheduling from any symbol expect the last symbol but with the limitation of only 2/4/7 symbols are supported. Figure 1 is the illustrative figure for LTE normal subframe and MBSFN subframe and both with 2 NR PDCCH symbols. For this case, if we support NR rate matching at LTE CRS symbols, we need to update Type B scheduling to support 9 symbols scheduling. Hereby, we don't think 10 symbol Type B scheduling is necessary compared with 9 symbols.

Furthermore, the network may need to configure MBSFN subframe. For MBSFN, 10 symbols could be in addition considered when only data is configured in the subframe. For MBSFN with SSB configuration, current Type B 7 symbols scheduling will be sufficient enough to support as in Figure 1.

Proposal 2: we propose to consider extending Type B scheduling to 9 symbols.



a) DSS with normal LTE subframe



b) DSS with LTE MBSFN subframe

Figure 1 DSS with LTE subframe

As per Observation 1, we don't believe any additional PDSCH format is necessary for the support of 30kHz NR + 15kHz LTE coexistence cases.

2.3 Additional DMRS

In R15 spec, Type B scheduling allows 1 additional DMRS to be configured when PDSCH is 7 symbols. As we are proposing to extend the scheduled PDSCH to 9 symbols, we suggest considering keeping one additional DMRS to be

configured. To keep consistency with Type A scheduling, the additional DMRS should be configured at symbol # 12 for normal subframe.

Proposal 3: with extended Type B scheduling, we suggest considering the additional DMRS to be configured at symbol #12.

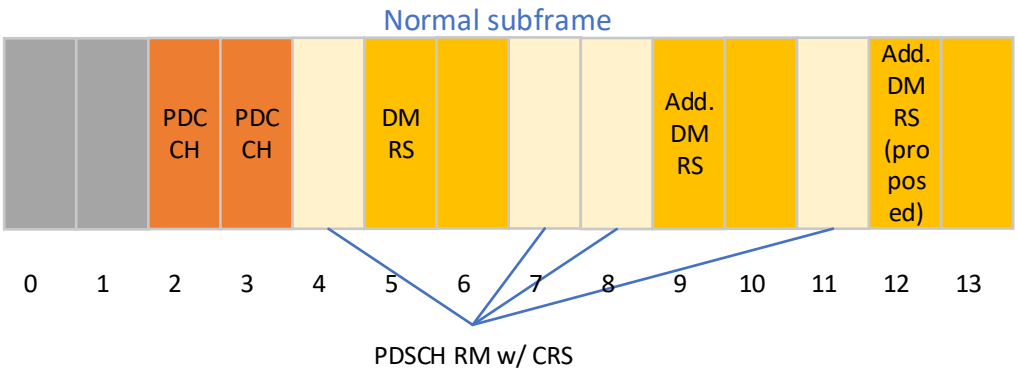


Figure 2 Additional DMRS configured at symbol #12

3. Conclusions

In this paper, we present our views on DSS and make the following observation and proposals.

Observation 1: multiple contiguous CC sharing scenario is only for FDD, and no need to further optimize the mixed numerology (30kHz NR and 15kHz LTE) FDM in the same carrier.

Proposal 1: Single LTE CRS pattern per NR carrier is sufficient.

Proposal 2: we propose to consider extending Type B scheduling to 9 symbols.

Proposal 3: with extended Type B scheduling, we suggest considering the additional DMRS to be configured at symbol #12.

References

[1]. RP-191599, Ericsson, Enhancements for dynamic spectrum sharing in Rel-16, RAN Plenary #84, June 2019