

Agenda item: 7.3.3.1.2

Source: Samsung

Title: Specification impact of aperiodic CSI-RS

Document for: Discussion and Decision

1 Introduction

One of the objectives for Rel.14 WI on enhanced FD-MIMO (eFD-MIMO) is to specify the following three enhancements on reference signal [1]:

- *Specify enhancements on reference signal in the following areas [RAN1]*
 - *Non-precoded CSI-RS, extending the existing numbers {1, 2, 4, 8, 12, 16} of CSI-RS antenna ports for support of {20, 24, 28, 32} CSI-RS ports with mechanism for reducing the overhead for CSI-RS transmission*
 - *Beamformed CSI-RS, supporting CSI-RS resource utilization with improved efficiency for UE-specific beamformed CSI-RS including specifying support for aperiodic CSI-RS*
 - *Evaluate and, if needed, specify enhancement on uplink DMRS to support (more than 2) orthogonal DMRS for MU-MIMO with partially overlapping BWs allocation*

This contribution presents Samsung's view on the second RS enhancement, that is, aperiodic CSI-RS for UE-specific beamformed CSI-RS [2]. In particular, possible specification enhancements on this item will be discussed.

2 Aperiodic CSI-RS

Although UE-specific beamformed (BF) CSI-RS is beneficial in reducing the number of CSI-RS ports a UE needs to measure and at the same time increasing CSI-RS penetration (due to UE-specific beamforming gain), the total amount of CSI-RS overhead per cell increases with the number of serviced UEs. This increase in overhead is primarily caused by the semi-static and periodic CSI-RS resource allocation per UE. It is expected that such total/cumulative CSI-RS overhead exceeds that of non-precoded (NP) CSI-RS when the number of UEs is sufficiently large.

To circumvent this drawback, CSI-RS resource allocation can be performed dynamically. That is, CSI-RS is transmitted by the eNB and measured by the UE only when needed, i.e. aperiodically. By using such mechanism, the total amount of CSI-RS overhead can be kept lower while maintaining the key benefit of BF CSI-RS: lower CSI measurement complexity and higher CSI measurement reliability due to beamforming gain. In addition, the potential reduction in CSI-RS overhead from aperiodic CSI-RS increases cell throughput and decreases inter-cell interference. Given the potential benefits, both from UE and network perspectives, the support of aperiodic CSI-RS is beneficial for Rel.14 eFD-MIMO.

It should be noted, however, that Ap-CSI-RS can also be applied to NP CSI-RS. While the motivation is not as strong as UE-specific BF CSI-RS, some overhead and inter-cell interference reduction may be attainable.

1.1 Aperiodic CSI-RS (Ap-CSI-RS) operation

Targeted towards improving CSI-RS resource utilization for UE-specific BF CSI-RS, aperiodic CSI-RS (Ap-CSI-RS) can be illustrated in Figure 1. Here, a shared pool of Ap-CSI-RS resources is available where an eNB assigns a CSI-RS resource to each UE either dynamically or semi-statically (to be discussed in section 1.3). When configured with Ap-CSI-RS, a UE receives a CSI request through an UL grant accompanied with CSI-RS within a same DL subframe n . Upon decoding the CSI request field in a corresponding DCI, the UE measures the CSI-RS within that subframe and reports aperiodic CSI (A-CSI) in subframe $n+L$. Therefore, Ap-CSI-RS is linked with A-CSI reporting.

The main benefit of this linkage is to avoid any unnecessary CSI measurement and reporting latency. It is also synergistic with TDD/LAA operations where DL and UL subframes are not always available in any given instance. In such scenarios, complex priority rules are to be avoided.

Proposal: *Ap-CSI-RS operation is linked with A-CSI reporting*

- *DL subframe containing the UL grant with CSI request also carries Ap-CSI-RS*

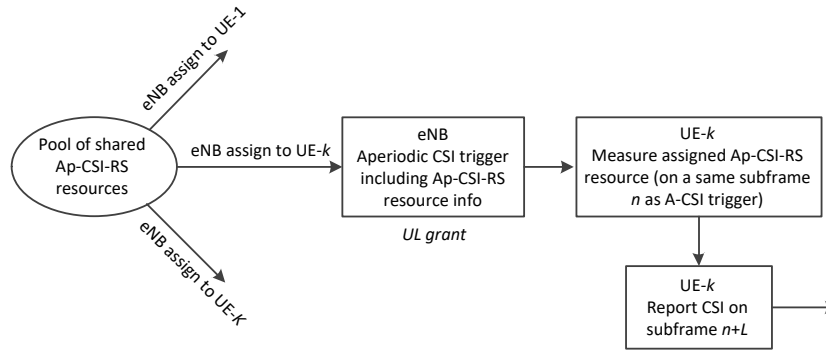


Figure 1 Aperiodic CSI-RS: operation from eNB and UE perspective

1.2 CSI-RS resource definition

To ensure maximum resource allocation efficiency, CSI-RS resource configuration needs to be streamlined for Ap-CSI-RS. First, configuration parameters specific to periodic CSI-RS resource configuration are removed. Such parameters include CSI-RS periodicity and subframe offset.

Among other CSI-RS-related parameters, three parameters are especially relevant for resource allocation.

- Number of antenna ports N_{PORT}
- Time-frequency pattern (also known as CSI-RS configuration in Table 6.10.5.2-1 of [3])
- Subset of port numbers: if the set of port numbers from Rel.13 $\{15, 16, \dots, 30\}$ is used, a subset $\{Port(0), Port(1), \dots, Port(N_{PORT} - 1)\} \subset \{15, 16, \dots, 30\}$. The allowable set of port numbers can follow a certain restriction but can also be made more flexible than Rel.13 port set (which always starts with 15 and follows a consecutive numbering).

Proposal: *Streamlined CSI-RS resource configuration for Ap-CSI-RS*

- *Remove CSI-RS subframe configuration, i.e. periodicity and subframe offset*
- *Three key parameters for resource configuration: number of ports, T-F pattern, and port subset*

1.3 DL signalling support

Any of the three resource configuration parameters in section can be configured either semi-statically (via RRC signalling) or dynamically (via UL grant). In addition, it is possible to use a “semi-persistent” mechanism for reconfiguration. For instance, a CSI-RS resource parameter can be reconfigured periodically (using DL control channel, with large periodicity).

The trade-off between flexibility (hence efficiency in resource allocation) and DCI overhead (more flexibility results in higher DCI overhead) for each of the three parameters should be further studied.

Proposal: *Study trade-off between flexibility and DCI overhead for configuring/reconfiguring each of the 3 resource-related parameters:*

3 Conclusions

In this contribution, the benefits of aperiodic CSI-RS (Ap-CSI-RS) are discussed along with its possible specification impacts. Our **proposal** can be summarized as follows:

- *Ap-CSI-RS operation is linked with A-CSI reporting*
 - *DL subframe containing the UL grant with CSI request also carries Ap-CSI-RS*
- *Streamlined CSI-RS resource configuration for Ap-CSI-RS*
 - *Remove CSI-RS subframe configuration, i.e. periodicity and subframe offset*
 - *Three key parameters for resource configuration: number of ports, T-F pattern, and port subset*
- *Study trade-off between flexibility and DCI overhead for configuring/reconfiguring each of the 3 resource-related parameters*

References

- [1] RP-160623, New WID Proposal: Enhancements on Full-Dimension (FD) MIMO for LTE, Samsung
- [2] 3GPP, TR36.897v1.0.1, “Study on Elevation Beamforming/Full-Dimension (FD) MIMO for LTE”
- [3] 3GPP, TS36.211v13.0.1, “E-UTRA Physical Channels and Modulation”