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PATENT DISCLOSURE FORM

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1. Please suggest a descriptive title for your invention:

Design and Signaling of PDSCH Muting For LTE-Advanced

2. This invention supports strategy: (check 1 or more)

- | | |
|--|---|
| ☐ DLP | DSPS |
| ☐ Materials | ☒ Wireless |
| ☐ Fab/Processes | ☐ Video |
| ☐ Assembly/Test/Packaging | ☐ Set Top |
| ☐ TSV (Through Silicon Via) | ☐ Application Specific |
| ☐ Qual/Reliability/Failure Analysis | ☐ Remote/Access/Networking |
| ☐ Media Technologies | ☐ Emerging Markets |
| ☐ Other | ☐ Mixed Signal & Logic |
| | ☐ Mass Storage |
| | ☐ Other |

3. What is the problem solved by your invention?

PDSCH muting over CSI-RS is being studied in RAN1 for inter-cell Channel State Information (CSI) measurement for Rel-10 LTE (and beyond). When muting is configured, PDSCH of the serving cell is muted on RE positions corresponding to non-serving cell CSI-RS. As a consequence, inter-cell CSI can be measured free from PDSCH interference from the serving cell.

Our invention describes signaling schemes for communicating the PDSCH muting configuration from the eNodeB to its UEs so that they can measure inter-cell CSI if configured.

4. What is your solution to the problem?

Our invention describes signaling schemes for communicating PDSCH muting configuration from the eNodeB to its UEs so that they can measure inter-cell CSI if configured. See the attached file PDSCH muting signaling – V3.doc for more information.

5. When was your solution first conceptually or mentally complete?
Please include a complete date (mm/dd/yyyy).

Date: July 11, 2010

6. What is the first tangible evidence of such completion?
Please include a complete date (mm/dd/yyyy).

July 11, 2010

7. What is different about your solution, compared with other solutions to the same problem?

8. What are the advantages of your solution?

9. What TI products, processes, projects or operations currently implement your invention?

Not applicable

10. What is the date of the first implementation?
Please include a complete date (mm/dd/yyyy).

Date: July 11, 2010

11. What record exists to prove this date?

MS-Word document and email record on July 11, 2010

12. Is there any future implementation planned?

Yes ☐ No ☒

If so, please furnish the TI PART No. or project name

13. Has the invention been published or disclosed to anyone outside of TI?

Yes ☐ No ☒

When?

If planned - when? (Catalog, advertising, data book, application note, conference paper, magazine article, TI TJ, proposal document.)

Was there a nondisclosure agreement (NDA)?

Yes ☐ No ☐

14. Has a TI product incorporating the invention been publicly introduced, quoted, sampled or shipped?

Yes ☐ No ☒

When? If planned--when? .

15. Was the invention conceived or first implemented in the performance of a government contract or subcontract?

Yes ☐ No ☒

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Has this disclosure been previously sent to the Patent Department electronically (unsigned)?

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Design and Signaling of PDSCH Muting For LTE-Advanced

V. Chandrasekhar and R. Chen

Communications Infrastructure, Texas Instruments

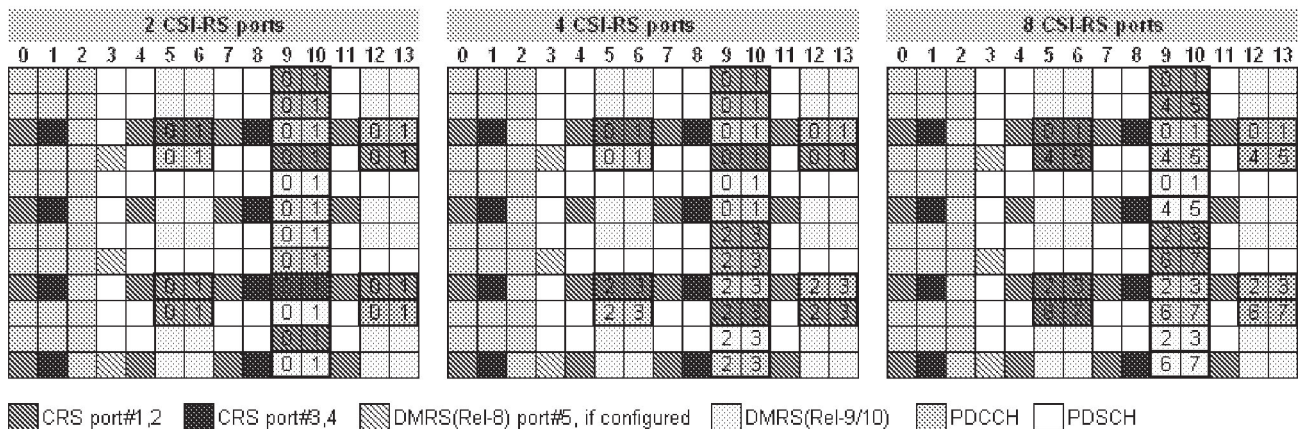
July 16, 2010

1. Introduction

PDSCH muting over Channel State Information Reference Symbol (CSI-RS) is being studied in RAN1 for inter-cell Channel State Information (CSI) measurement. When muting is configured, PDSCH of the serving cell is muted on RE positions corresponding to non-serving cell CSI-RS. As a consequence, inter-cell CSI can be measured free from PDSCH interference from the serving cell.

PDSCH RE muting is closely related to the CSI-RS pattern design. The following CSI-RS design for 8Tx has been agreed for Rel-10 LTE.

- A re-use factor of N, where $N = 5$ for frame structure 1 (FDD) and normal CP, and $N < 5$ otherwise.
- Each serving cell may choose one of N orthogonal CSI-RS base patterns. A well-planned network should configure adjacent cells to use different orthogonal CSI-RS pattern in the set of N base patterns, whereas non-adjacent cells at further distance may configure the same CSI-RS pattern as their co-channel interference is substantially lower due to path loss.
- 2Tx and 4Tx CSI-RS patterns are a nested subset of the 8Tx CSI-RS pattern, and hence have a higher reuse factor (20 for 2Tx and 10 for 4Tx).



It has been agreed that the eNodeB shall rate match its PDSCH REs around its CSI-RS. In the case of PDSCH muting for inter-cell CSI measurement, it is natural to rate match PDSCH around serving-cell CSI-RS as well as inter-cell CSI-RS where PDSCH muting will be performed.

Proposal

- When PDSCH muting is configured, PDSCH of the serving cell is rate matched around the serving cell CSI-RS as well as the muted RE (which in theory shall correspond to non-serving cell CSI-RS). As a consequence, no PDSCH transmission occurs on RE corresponding to CSI-RS of serving and non-serving cells.

2. PDSCH Muting

A UE needs to know the PDSCH mapping position in order to correctly interpret the code rate and decode its PDSCH. In Rel-8 LTE, this requirement is met since all cell-specific symbols such as PBCH, PHICH, PCFICH, PDCCH, CRS, and UE-specific DMRS in case of transmission mode 7, are known a priori to the UE.

In Rel-10, in addition to the symbols mentioned above,

- In case UE is configured in single-cell (non-CoMP) transmission, PDSCH is rate matched around the serving cell CSI-RS. Therefore the CSI-RS of serving cell uniquely determines the PDSCH mapping.
- Preferably for UE configured in CoMP coordinated beamforming, PDSCH is rate matched around the serving cell CSI-RS.
- Preferably for UE configured in CoMP joint processing, PDSCH should be rate matched around CSI-RS of all cells within the CoMP transmission/measurement set associated with the UE. In other words, PDSCH on CSI-RS RE of the associated CoMP transmission/measurement set is muted.

2.1. Interference Estimation

A UE uses the CSI-RS of its serving cell for intra-cell CSI measurement, and may use CSI-RS of a non-serving cell for inter-cell CSI-RS measurement and for estimating interference. Inter-cell CSI estimation accuracy is improved by PDSCH muting which removes the PDSCH interference on CSI-RS. However, muting PDSCH on inter-cell CSI-RS prevents the UE from obtaining accurate estimate of its interference from non-serving cells – note that an accurate interference estimate on CSI-RS is vital for PDSCH demodulation.

As a consequence, ongoing studies on standardizing PDSCH muting should take into account the intra/inter-cell CSI-RS pattern as well as provision for interference estimation on intra-/inter-cell CSI-RS on non-muted CSI-RS subframes. A more detailed discussion on PDSCH RE muting and its trade-offs with interference estimation are covered in the accompanying document [1].

In [1], the following detailed proposals were made regarding configurations for PDSCH muting:

Proposal 1: To minimize legacy impact, PDSCH muting should be carried out in intra-cell CSI-RS subframes only.

Proposal 2: Interference estimation on CSI-RS should be factored in while standardizing muting aspects.

- “Partial” subframe level PDSCH muting can facilitate CSI estimation and interference estimation on CSI-RS.

Proposal 3: Muting should be carried out (across entire bandwidth) on a subset of configured CSI-RS subframes. The muting duty cycle should be configured separately from the CSI-RS duty cycle.

Proposal 4: Muting pattern(s) should be determined by the network and communicated to the UEs on a cell-specific basis.

Proposal 5: Muting pattern(s) will specify the following:

- Pattern index (indices) on which PDSCH RE muting will be carried out.
- Optionally whether or not CSI estimation is carried out on the REs corresponding to the pattern index (indices) on which PDSCH RE muting is carried out.
- Subframe offset (relative to the starting subframe on each frame) on which intra-cell CSI-RS is transmitted. This is identical to the subframe offset on which muting is carried out.
- The Intra-cell CSI-RS duty cycle and PDSCH RE muting duty cycle. Both duty cycle values lie in the set {5 ms, 10 ms, and 20 ms}.

Proposal 6: Muting configuration is communicated to the UE semi-statically, for example using either UE-specific RRC signaling on its PDSCH or as cell-specific signaling on SIB1 (PBCH).

In the following sections, we provide further details regarding UE configuration for muting.

2.2. Configuration of PDSCH Muting and CSI-RS measurement

We make the below definitions (based on Proposals 5 and 6 in the preceding section):

- PDSCH muting (whether enabled or not) is signaled by higher-layer parameter *PDSCHmutingenabled*. The UE uses this parameter for determining the CSI-RS pattern RE positions around which its PDSCH is rate-matched.

- CSI-RS pattern for intra and inter-cell CSI measurement is signaled by higher-layer parameters *CSIRSpattern*. This shall include both the CSI-RS of the serving cell as well of the non-serving cells. However it's not precluded that *CSIRSpattern* only communicates the inter-cell CSI pattern configuration, while CSI-RS of serving cell is communicated separately, e.g., tied to cell identification number or with a separate higher-layer signal.
- Intra-cell CSI-RS subframe offset is signaled by higher-layer parameter *CSIRSoffset*. The same parameter implicitly equals the subframe offset on which PDSCH RE muting is carried out.
- Intra-cell CSI-RS duty cycle is signaled by higher-layer parameter *CSIRSpatterndutycycle*.
- PDSCH RE muting duty cycle is signaled by higher-layer parameter *PDSCHmutingdutyCycle*.

PDSCHmutingenabled and *CSIRSpattern* can be jointly or separately signaled.

- **Joint signaling:** A UE may assume that PDSCH muting/rate-matching pattern and CSI-RS pattern for intra/inter-cell measurement are equivalent, and hence they are signaled jointly. In such a case, only *CSIRSpattern* is needed. For example, the higher layer informs the UE to perform CSI-RS measurement for CSI_RS pattern 1, 2, 3. Correspondingly, PDSCH on CSI-RS RE of pattern 1 – 3 are muted. One exemplary use case for this configuration is for CoMP joint processing.
- **Separate signaling:** The parameters for enabling PDSCH RE muting and the CSI-RS patterns for intra/inter-cell measurement are separately signaled. For example, the *CSIRSpattern* may inform to the UE to perform channel estimation on CSI-RS pattern 1, 2, 3, whereas parameter *PDSCHmutingenabled* is activated (enabled) only for CSI-RS pattern 1. This may be beneficial, for example for a UE configured in coordinated beamforming among CoMP set (cell 1, 2, 3) whereas cell 1 is the anchor cell.

2.3. Power Usage of Muted PDSCH REs

[FFS]

3. Claims : Proposed Signaling Schemes

We proceed to describe the proposed signaling scheme during eNodeB configuration of the UE to receive its CSI-RS including the subframe offset and duty cycle periodicity. We also present signaling schemes to communicate the muting patterns for intra-/inter-cell CSI estimation and for determining the RE positions around which its PDSCH is rate-matched.

3.1. CSI-RS Offset Configuration

The higher-layer parameter *CSIRSoffset* is designed as follows:



Three bit parameter

The *CSIRSoffset* is signaled as a three-bit message wherein the three bits correspond to a subframe index belonging to the set {1, 2, 3, 6, 7, 8}. Note that subframes 0 and 5 may be used for transmitting broadcast information while subframes 4 and 9 may carry paging channels. An exemplary usage of *CSIRSoffset* is given below:

<i>CSIRSoffset</i>	Subframe offset
0 0 0	1
0 0 1	2
0 1 0	3
0 1 1	6
1 0 0	7
1 0 1	8
1 1 0	Reserved

1 1 1	Reserved
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3.2. Duty Cycle Configuration

The higher-layer parameter *CSIRSpatterndutycycle* – which communicates the duty cycle (ms) for intra-cell CSI-RS – is signaled as a two bit parameter wherein the two bits correspond to a duty cycle value belonging to the set {5 ms, 10 ms and 20 ms}. Note that this parameter is used to determine the periodicity (in ms) on which intra-cell CSI-RS pattern is transmitted.

CSIRS Duty cycle

Two bit parameter

An exemplary usage of *CSIRSpatterndutycycle* is given below:

<i>CSIRSpatterndutycycle</i>	Duty cycle (ms)
0 0	5
0 1	10
1 0	20
1 1	Reserved

Given N CSI-RS patterns within the CSI-RS subframe whose relative position is given by *CSIRSoffset*, the parameter *PDSCHmutingdutycycle* is used to signal the duty cycle periodicity corresponding to each cell for which PDSCH muting is applied.

The higher-layer parameter *PDSCHmutingdutyCycle* is communicated through one of the following three schemes:

Alternative 1: The *PDSCHmutingdutycycle* is signaled as a two bit value (assuming potential duty cycle values in the set {5ms, 10ms and 20 ms}) for configuring PDSCH muting periodicity corresponding to **CSI-RS pattern indices (cells) for non-serving cells only**.

If the *PDSCHmutingenabled* parameter – given in Section 3.3 – is enabled for that corresponding pattern (cell), then the PDSCH REs shall be muted on the CSI-RS locations for that pattern (cell) with muting periodicity given by *PDSCHmutingdutycycle*. The corresponding subframe offset is determined by the parameter *CSIRSoffset*.

Note that the UE ascertains the periodicity of its intra-cell CSI-RS from the parameter *CSIRSpatterndutycycle* as described above.

PDSCH muting duty cycle

Two bit parameter

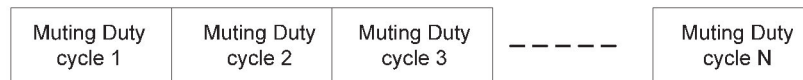
An exemplary usage of *PDSCHmutingdutycycle* is given below:

<i>PDSCHmutingdutycycle</i>	Duty cycle (ms)
0 0	5
0 1	10
1 0	20
1 1	Reserved

Alternative 2: Given N CSI-RS patterns within the CSI-RS subframe whose relative position is given by $CSIRSOffset$, the parameter $PDSCHmutingduty$ is used to signal the duty cycle periodicity corresponding to each cell for which PDSCH muting is applied.

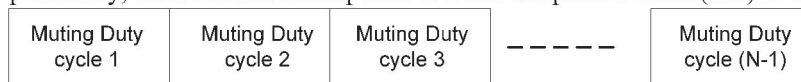
- In one possibility, the $PDSCHmutingduty$ is signaled as a bit map containing N elements, each of which takes a two bit value as shown below. Each element corresponds to a CSI-RS pattern index (cell) and equals the muting duty cycle periodicity for that particular pattern (cell). By default, the first element corresponds to the duty cycle of the serving (anchor) cell and should therefore equal $PDSCHmutingduty$.

If the $PDSCHmutingenabled$ parameter – given in Section 3.3 – is enabled for that corresponding pattern (cell), then the PDSCH REs shall be muted on the CSI-RS locations for that pattern (cell) with muting periodicity given by $PDSCHmutingduty$. The corresponding subframe offset is determined by the parameter $CSIRSOffset$.



"N" refers to the reuse factor (number of available orthogonal CSI-RS patterns) within the subframe carrying CSI-RS. Given Q possible values for each element (muting duty cycle), each field requires $\lceil \log_2(Q) \rceil$ bits

- In the second possibility, the $PDSCHmutingduty$ is signaled as a bit map containing $N-1$ elements, each of which takes a two-bit value (assuming potential duty cycle values in the set {5ms, 10ms and 20 ms}) as shown above. Unlike the first possibility, each element corresponds to a CSI-RS pattern index (cell) of a non-serving cell.



"N" refers to the reuse factor (number of available orthogonal CSI-RS patterns) within the subframe carrying CSI-RS. Given Q possible values for each element (muting duty cycle), each field requires $\lceil \log_2(Q) \rceil$ bits

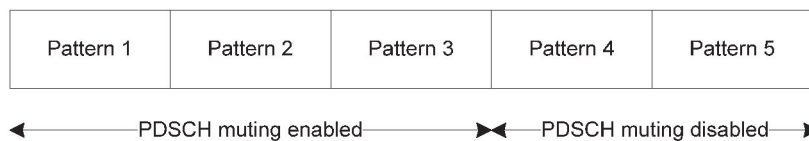
3.3.CSI-RS Pattern and PDSCH Muting Configuration

The higher-layer parameters $PDSCHmutingenabled$ and $CSIRSpattern$ may be designed as follows.

Alternative 1: A bitmap of length N , where N is the re-use factor, signals the PDSCH muting pattern (e.g. $PDSCHmutingenabled$) for that particular cell. In the above statement, we make it clear that the association between pattern and the cell to which it corresponds is implicit and need not be separately communicated to the UE. By convention, we assume that the first pattern (cell) corresponds to the serving (anchor) cell to the UE of interest.

A bit value 1 on the k -th bit position indicates that PDSCH is muted on the RE corresponding to the k -th CSI-RS pattern, whereas a bit value 0 indicates that PDSCH is not muted on the corresponding CSI-RS pattern.

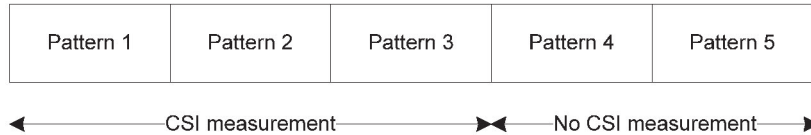
Bit map 1 1 1 0 0



Similarly, such a bit map may be used to signal the pattern (cell) corresponding to which the UE performs CSI measurement (e.g. $CSIRSpattern$). In the above statement, we make it clear that the association between pattern and the cell to which it corresponds is implicit and need not be separately communicated to the UE. By convention, we assume that the first pattern (cell) corresponds to the serving (anchor) cell to the UE of interest.

- A bit value 1 on the k -th bit indicates that CSI measurement shall be done for the k -th CSI-RS pattern, whereas a bit value 0 indicates that CSI measurement is not needed for the k -th CSI-RS pattern.

Bit map 1 1 1 0 0



- Alternatively, both *CSIRSpattern* and *PDSCHmutingenabled* can be reduced to $N-1$ bits, corresponding to the $N-1$ CSI-RS base patterns other than the one associated with the serving cell.
- It is possible to apply length- N bit map to indicate the CSI-RS measurement configuration, and length- $(N-1)$ bit map for PDSCH muting. PDSCH of the serving cell is by default muted.
- A 1-bit message can be signaled by higher layer to indicate the equivalence of *PDSCHmutingenabled* and *CSIRSpattern*. If to 1, UE may assume that PDSCH muting and CSI-RS pattern for measurement occur on the same set of RE. Otherwise if the bit is set to 0, PDSCH muting and CSI-RS pattern for measurement occur on different set of RE.

Alternative 2:

- Given N CSI-RS patterns, Higher layer informs the UE a symbol sequence $\{L_1, L_2, \dots, L_M\}$ where $L_1 \in [1, N]$ is the CSI-RS pattern index of the serving cell, and $L_k \in [0, N]$ ($k > 1$) is the CSI-RS pattern index of the k -th non-serving cell. If $L_k=0$, CSI-RS estimation on the k -th CSI-RS pattern is not performed. M denotes the number of total cells to perform CSI estimation.
- Optionally, a length N bit map indicates PDSCH muting corresponding to the N CSI-RS patterns. Or it's possible to use a length $(N-1)$ bit map where PDSCH on the serving cell is by default muted on CSI-RS.
- Since there are only N CSI-RS base pattern corresponding to the available reuse factor of N , a reasonable choice is to assume that $M = N$.
- [UE Reporting]

4. References

1. "Considerations on Muting and Interference Estimation", TI Internal Document

Considerations on Muting and Interference Estimation

July 16, 2010

1. Introduction

Muting serving cell PDSCH REs which collide with neighboring cell CSI-RS is being studied in RAN1 for performing inter-cell CSI estimation at the UE. The idea is as follows: Serving cell mutes its PDSCH REs on CSI-RS locations corresponding to a set of non-serving cell (s). Muting offers a two-fold benefit: First the UE increases CSI accuracy to its serving cell since neighboring cells silence their PDSCH transmissions on colliding REs. Next, UE increases its CSI accuracy to non-serving cells, which is potential useful for example in techniques for increasing coverage (e.g. CoMP) or spatial reuse (e.g. het-nets).

This document takes a closer look at various aspects of PDSCH RE muting, interference estimation and identifies high-level design guidelines while standardizing muting for Rel-10 LTE and beyond.

2. CSI Measurement and Interference Estimation

This section examines muting impact on CSI measurement and interference estimation aspects.

2.1. Occurrence of muting

It has generally been recognized that legacy UE (Rel-8/Rel-9 LTE) performance degrades because it is unaware that its PDSCH is punctured at RE positions on which intra-cell CSI-RS is transmitted. Further work has shown that PDSCH RE muting over inter-cell CSI-RS locations additionally degrades legacy UE operation [1][2]. This suggests that PDSCH RE muting should preferably be restricted to intra-cell CSI-RS subframes only, while noting that legacy UE performance is anyway compromised due to intra-cell CSI-RS.

2.2. Interference estimation

While muting support is certainly desirable for CoMP, associated impact on interference estimation should be factored in ongoing studies in RAN1. Interference estimation is carried out at the UE for ascertaining the “true” levels of interference experienced on its data REs. Accurate interference estimation should be representative of the *true interference* experienced over the PDSCH and crucial for providing accurate CQI feedback [3] – [6].

2.3. Case studies

Case study A [CoMP]: Say PDSCH RE muting on inter-cell CSI-RS locations is simultaneously carried out within all CoMP clusters. In such a scenario, the interference estimated by the CoMP UE over the muted PDSCH REs arises only from CSI-RS transmissions from neighboring cells. Consequently, its interference estimate is not indicative of the “true” interference as experienced over its PDSCH REs.

Case study B [CoMP-CBF]: Suppose CoMP with coordinated beam forming (CBF) is carried out. For accurate beam-forming, the CoMP UE potentially requires measures PDSCH interference from coordinating cells (in addition to non-CoMP cells). It may be preferable to disable muting on inter-cell CSI-RS resources.

Case study C [Het-Net Scenarios]: In het-net scenarios employing range expansion, a UE may connect to a pico-cell even though macro. eNodeB transmission may be received with higher power. Thus, pico. UEs (PUEs) will likely experience deteriorated SINRs due to PDSCH transmissions of the aggressor macro. eNodeB. The resultant CSI estimate at the victim UE to its serving pico cell eNodeB may not be accurate. Identical SINR deterioration will likely occur at victim macro. UEs (MUEs) in co-channel macro-femto deployments.

For reducing interference on PDSCH/control/reference symbols, proposed time-domain coordination approaches in the het-net discussions propose scheduling victim PUEs [resp. MUEs] on interference-free subframes where the coordinating macro. eNodeB [resp. CSG HeNB] do not carry PDSCH (e.g. “Almost-blank” subframes). Thus, victim UEs can estimate their channels on their intra-cell CSI-RS on such interference-free subframes.

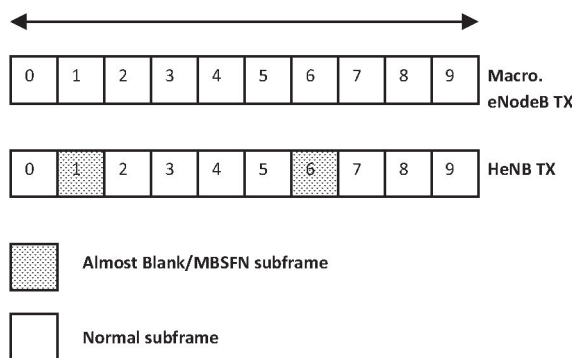


Figure 1: Time-domain partitioning in het-nets

2.4. Partial Muting Considerations

In Rel-8 LTE, a UE first estimates its serving cell channel over CRS. Thereafter, the UE estimates interference by subtracting the contribution of its serving cell from the received signal over CRS locations. Similarly, Rel-10 LTE UEs may estimate interference by subtracting off their serving cell signal from the received signal over intra-cell and/or inter-cell CSI-RS positions. However, the comparatively low measurement RE density of CSI-RS (1 RE/PRB/port and transmitted at most twice in each radio frame) implies limited number of opportunities available for interference estimation and CSI estimation on CSI-RS.

Note that the above conflicts occur mainly for 8 TX antenna port eNodeBs for which CRS is not available on all antenna ports. At least for 2 TX and 4 TX antenna port eNodeBs, the UE may use the CRS for interference estimation. However, mandating different reference symbols for interference estimation depending on the eNodeB antenna port configuration increases the UE channel estimator complexity and complicates RAN4 testing.

As pointed out in [4], if there is no PDSCH muting on inter-cell CSI-RS, the UE can obtain reasonably good interference estimate, considering the large available reuse factor of 5 for normal CP transmission. That is, on average, 1/5th of interference as seen on inter-cell CSI-RS arises from CSI-RS transmissions, while the remaining 4/5th of interference arises from PDSCH transmissions of non-serving cells

The above case studies suggest partial PDSCH RE muting on inter-cell CSI-RS locations will provide an acceptable compromise for enabling inter-cell CSI estimation without compromising interference estimation. Two approaches have been suggested in on-going studies: The first approach is based on time-domain muting where PDSCH REs on inter-cell CSI-RS positions are muted over a subset of the CSI-RS bearing subframes.. The second approach [7] advocates frequency domain muting wherein the PDSCH is selectively muted on certain RBs across the entire resource grid.

In summary, we prefer time-domain (subframe level) partial PDSCH muting on intra-cell CSI-RS carrying subframes. Inter-cell CSI estimation occurs on CSI-RS subframes with muting. Interference estimation occurs in CSI-RS subframes without muting. The duty cycle for PDSCH muting should preferably be configured separately from the CSI-RS duty cycle (e.g. PDSCH muting can occur once in two frames while CSI-RS transmissions can occur twice a frame).

3. Conclusions

Based on above discussion, we have the following proposals:

Proposal 1: To minimize legacy impact, PDSCH muting should be carried out in intra-cell CSI-RS subframes only.

Proposal 2: Interference estimation on CSI-RS should be factored in while standardizing muting aspects.

- “Partial” subframe level PDSCH muting can facilitate CSI estimation and interference estimation on CSI-RS.

Proposal 3: Muting should be carried out (across entire bandwidth) on a subset of configured CSI-RS subframes. The muting duty cycle should be configured separately from the CSI-RS duty cycle.

Proposal 4: Muting pattern(s) should be determined by the network and communicated to the UEs on a cell-specific basis.

Proposal 5: Muting pattern(s) will specify the following:

- Pattern index (indices) on which PDSCH RE muting will be carried out.
- Optionally whether or not CSI estimation is carried out on the pattern index (indices) on which PDSCH RE muting is carried out.
- Subframe offset on which intra-cell CSI-RS is transmitted. This also corresponds to the subframe on which muting is carried out.
- The Intra-cell CSI-RS duty cycle and PDSCH RE muting duty cycle. Both duty cycle values lie in the set {5 ms, 10 ms, and 20 ms}.

Proposal 6: Muting configuration is communicated to the UE semi-statically, for example using either UE-specific RRC signaling on its PDSCH or as cell-specific signaling on SIB1 (PBCH).

4. References

1. R1-103697, “PDSCH muting for inter-cell CSI estimation: Rel-8 UE performance”, Texas Instruments.
2. R1-103698, “PDSCH muting: N-MSE for inter-cell CSI estimation”, Texas Instruments.
3. R1-103843, “Views on Muting”, Ericsson, ST-Ericsson.
4. R1-103940, “Muting, Interference Estimation and Reuse Factors for CSI RS”, Motorola.
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