3GPP TSG-RAN WG1#86 **R1-167977**

Gothenburg, Sweden, August 22 – 26, 2016

SOURCE: ERICSSON

TITLE: OVERHEAD REDUCTION FOR CLASS B CSI-RS

AGENDA ITEM: 7.2.4.1.2

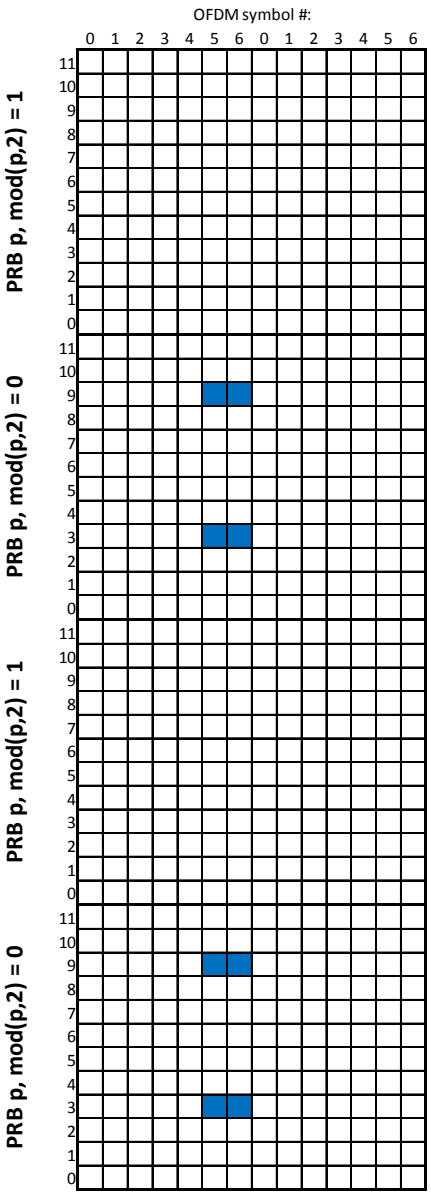
DOCUMENT FOR: DISCUSSION AND DECISION

BACKGROUND

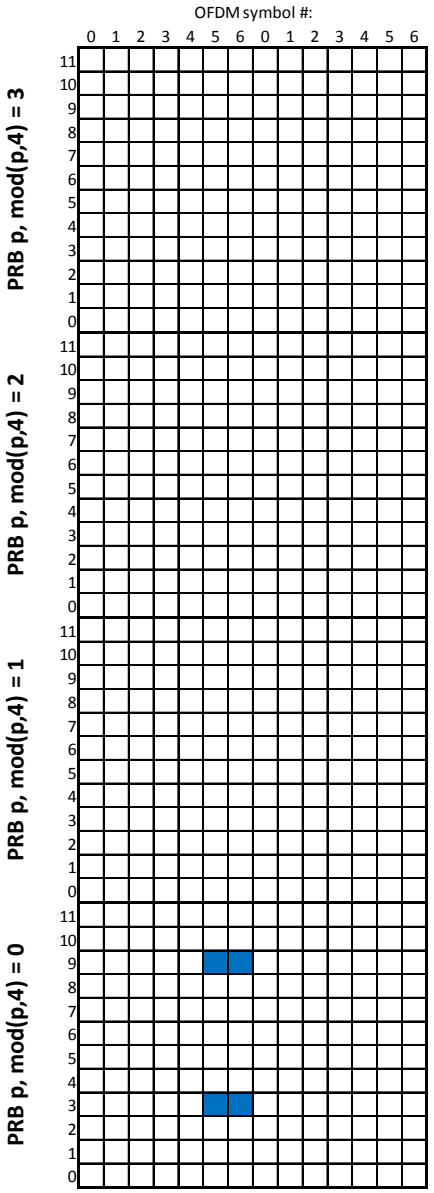
- In RAN1#85, the following conclusion was made with regards to overhead reduction for Class B CSI-RS
- Candidate schemes for CSI-RS overhead reduction for Class B eMIMO-Type (2, 4, and 8 ports):
  - Scheme 1: Configurable CSI-RS frequency-domain density
  - Scheme 2: Localized CSI-RS in frequency domain
  - Scheme 3: Configurable RPF pattern
  - Scheme 4: Frequency domain MR
- Companies are encouraged to study the following issues in the next meeting:
  - Backward compatibility
  - UE implementation restriction (for, e.g. channel estimation)
  - Impact on eNB scheduling
  - Impact on CSI reporting
  - PDSCH rate matching

- In this contribution, we present system simulation results and our views on the different candidate schemes identified above.
- Results are presented for different frequency domain overhead reduction (FDOR) configurations.

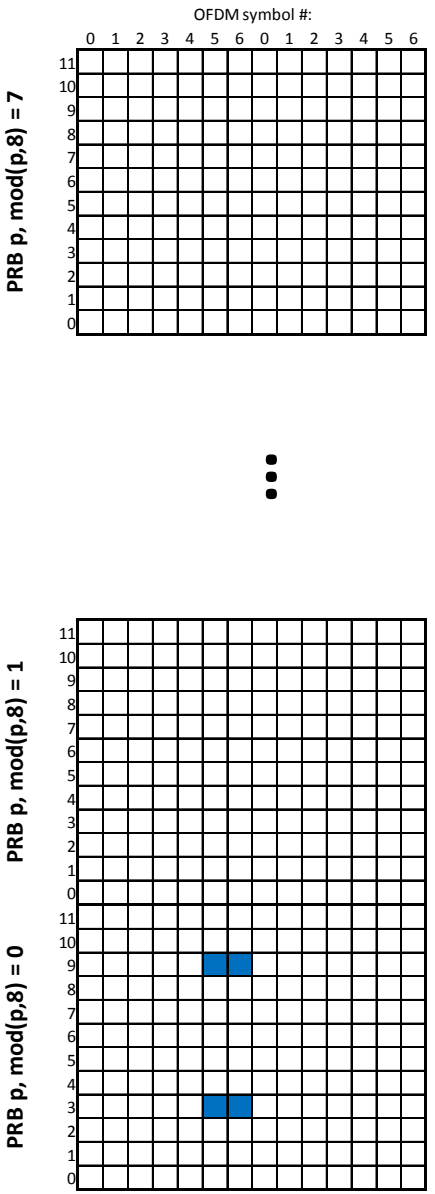
CLASS B CSI-RS WITH DIFFERENT DENSITIES



FDOR Config 1 0.5 RE/RB/port



FDOR Config 2 0.25 RE/RB/port



FDOR Config 3 0.125 RE/RB/port

- Three 4- port FDOR Config examples evaluated are shown here.
- All ports are assumed to be in the same set of PRBs in these FDOR Config examples.

COMPARISON WITH DIFFERENT DENSITIES

Reference RU [%]	20				43			
Reference offered traffic [bps/Hz/cell]	0.6624				1.1601			
	4-port BF CSI-RS with 1 RE/RB/port	**FDOR Config 1**	**FDOR Config 2**	**FDOR Config 3**	**4-port BF CSI-RS with 1 RE/RB/port**	**FDOR Config 1**	**FDOR Config 2**	**FDOR Config 3**
Cell edge throughput [bps/Hz/user]	1.2336				0.6416			
Mean throughput [bps/Hz/user]	3.6178				2.6302			
Cell edge gain [%]	0	0	-5	-16	0	-5	-16	-34
Mean throughput gain [%]	0	-1	-1	-5	0	-1	-6	-14

FDOR Config 1 **0.5 RE/RB/port**

FDOR Config 2 **0.25 RE/RB/port**

FDOR Config 3 **0.125 RE/RB/port**

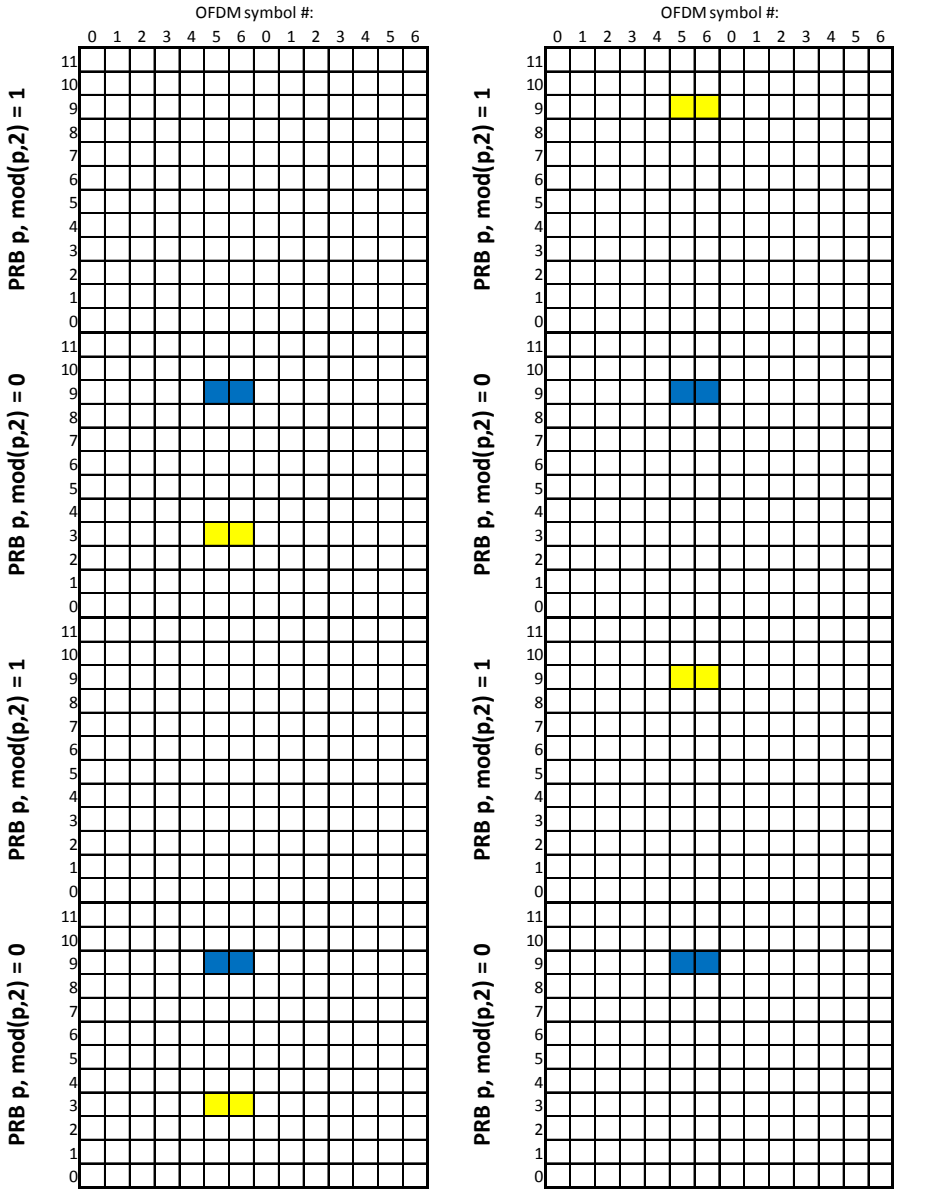
Sim Setup: 3D-UMa, 8x2 Array, Class B: 4 ports (1x2 Layout)

Observation 1: FDOR Config 1 with CSI-RS density 0.5 suffers very small losses compared to density 1.

Observation 2: FDOR Config 3 with CSI-RS density 0.125 suffers notable losses compared to density 1.

Note: To realize gains due to overhead reduction in Class B CSI-RS, there should be a sufficiently large number of UEs present in a cell at the same time. With current FTP Model 1, it is difficult to realize this. Hence, our results only show how much the performance degrades with different CSI-RS densities.

CLASS B CSI-RS WITH DIFFERENT PORT DISTRIBUTIONS



FDOR Config 1 **0.5 RE/RB/port** **FDOR Config 4** **0.5 RE/RB/port**

- Two different 4-port distributions with the same CSI-RS density are shown and compared.
- In FDOR Config 1, all ports are located in the same set of PRBs.
- In FDOR Config 4, different ports are located in different set of PRBs.

COMPARISON WITH DIFFERENT PORT DISTRIBUTIONS

Reference RU [%]	20			43		
Reference offered traffic [bps/Hz/cell]	0.6624			1.1601		
	4-port BF CSI-RS with 1 RE/RB/port	**FDOR Config 1**	**FDOR Config 4**	**4-port BF CSI-RS with 1 RE/RB/port**	**FDOR Config 1**	**FDOR Config 4**
Cell edge throughput [bps/Hz/user]	1.2336			0.6416		
Mean throughput [bps/Hz/user]	3.6178			2.6302		
Cell edge gain [%]	0	0	-10	0	-5	-19
Mean throughput gain [%]	0	-1	-2	0	-1	-7

FDOR Config 1	**0.5 RE/RB/port, All ports in same RB**
FDOR Config 4	**0.5 RE/RB/port, Ports distributed in different RBs**

Sim Setup: 3D-UMa, 8x2 Array, Class B: 4 ports (1x2 Layout)

Observation 3: FDOR configurations with all CSI-RS ports located in the same PRBs outperform FDOR configurations that distribute different set of ports in different PRBs.

- When different ports are distributed in different PRBs, there is phase drift between ports which causes performance degradation

DISCUSSION (1/3)

- One way to realize FDOR configurations 1-4 is to use FDM with a configurable reduction factor (i.e., Schemes 1 and 3 of conclusions in RAN1#85)

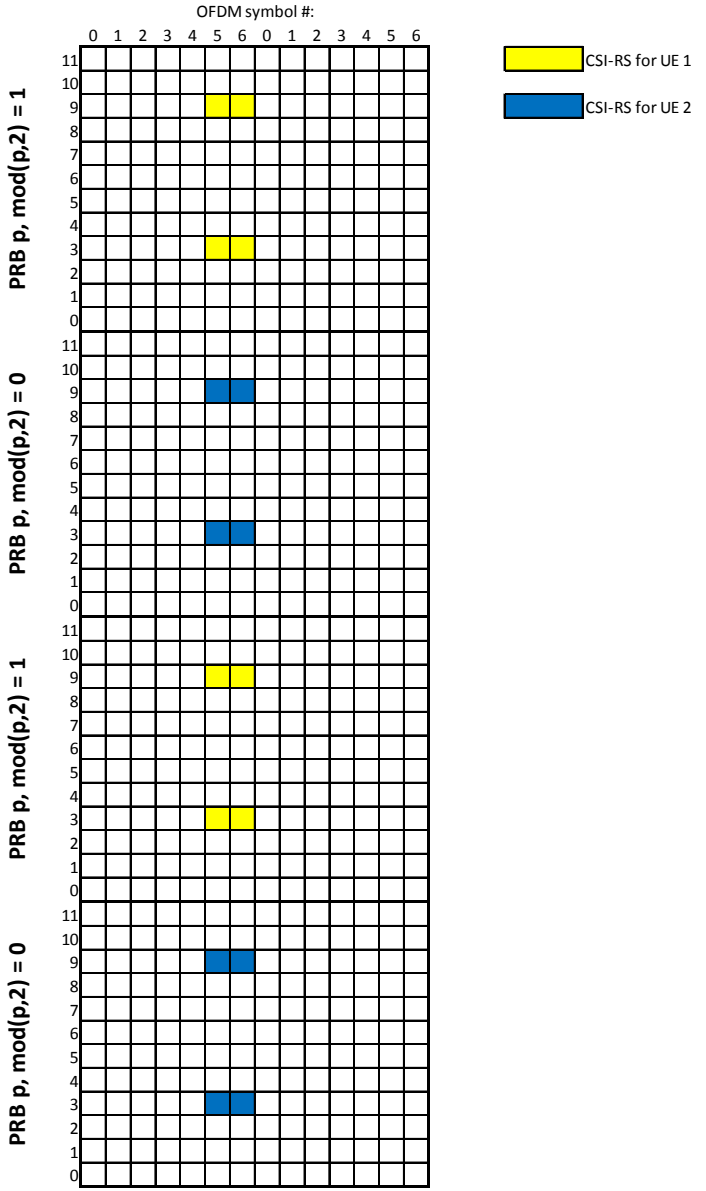
- For FDM configurations where all ports located in the same set of PRBs (e.g. FDOR Configs 1-3)
  - Pros: Outperforms FDM configurations where different ports are distributed in different set of PRBs (e.g. FDOR Config 4).
  - Cons:
    a) PDSCH rate matching requires the definition of new ZP-CSI-RS configurations
    b) When combined with Aperiodic NZP CSI-RS, may require additional bits in UL related DCI (depending on CSI-RS density)

DISCUSSION (2/3)

- For FDM configurations where different ports are distributed in different set of PRBs
  - Pros: For some configurations reduced density CSI-RS can be made to align with ZP CSI-RS of legacy UEs (as discussed in [1]).
  - Cons:
    a) Poorer performance than cases where all ports are located in the same set of PRBs due to phase drift issues.
    b) When combined with Aperiodic NZP CSI-RS, may require additional bits in UL related DCI (depending on CSI-RS density)

DISCUSSION (3/3)

- Scheme 4 based on Frequency domain measurement restriction (FDMR) can alleviate the drawbacks of the Configurable FDM variants.
- With FDMR, a UE can be requested to measure a set of CSI-RS ports on a set of PRBs, and where the UE assumes the CSI-RS occupies the full band.
  - Hence, complex PDSCH rate matching issues are not needed.
  - No need for defining reduced density ZP CSI-RS
  - Compatible with legacy Rel-10 ZP CSI-RS configurations.
- Example to the right shows, 4-port CSI-RS in even PRBs are measured by UE2 and 4-port CSI-RS in odd PRBs are measured by UE1.
  - Both UEs rate match around both sets of CSI-RS.



PROPOSAL:

- Based on the observations and discussion we make the following proposals:

- **Proposal 1: Overhead reduction for Class B CSI-RS should be considered in eFD-MIMO.**

- **Proposal 2: Consider Frequency Domain Measurement Restriction for overhead reduction of Class B CSI-RS.**

APPENDIX: SIMULATION PARAMETERS

Carrier frequency	2 GHz
Bandwidth	10 MHz
Scenarios	3D UMa 500m ISD
Antenna Configuration	8x2 with 2x1 virtualization (121 degree tilt), Hybrid setup with 16 ports for Class A and 4 ports for Class B
Cell layout	57 homogeneous cells
Wrapping	Radio distance based
UE receiver	MMSE-IRC
CSI periodicity	Class B: 5 ms, Class A: 80 ms
CSI delay	5 ms
CSI mode	Aperiodic mode 3-2
Outer loop LA	Yes, 10% BLER target
eNB Tx power	46dBm
Traffic model	FTP Model 1, 500 kB packet size
UE speed	3 km/h
UE noise figure	9dB
Scheduling	Proportional fair in time and frequency
Transmission Mode	TM10 with non-shifted CRS
DMRS overhead	2 antenna ports
CSI-RS	Overhead accounted for; channel estimation error modeled
HARQ	Max 5 retransmissions
Antenna spacing	0.8 lambda in vertical, 0.5 lambda in horizontal
Handover margin	3 dB

REFERENCES

[1] R1-166520, ‘Evaluation of CSI-RS overhead reduction for Class B using frequency decimation’, Intel Corporation, 3GPP TSG RAN WG1 Meeting #86, Gothenburg, Sweden, 22 - 26 Aug 2016.

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