

3GPP TSG RAN Meeting #78

Lisbon, Portugal, December 18 - 21, 2017

RP-172767

Source: Samsung, CATT, ZTE, Nokia

Title: Motivation for new WI: Enhancements on
MIMO for NR

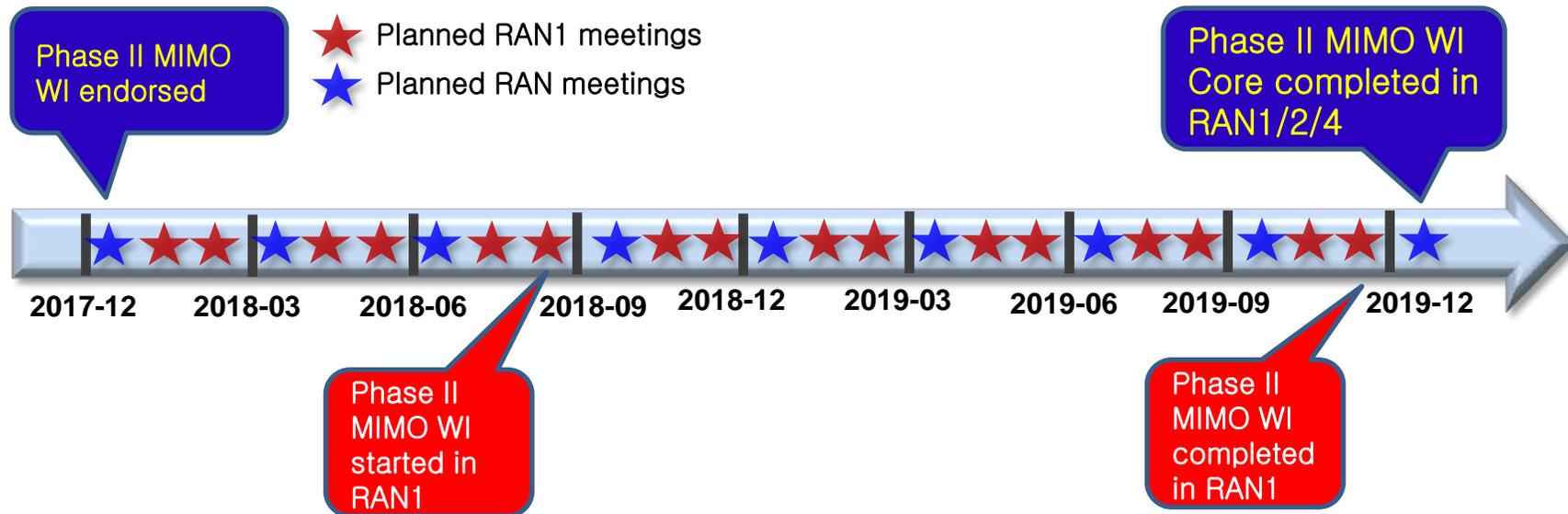
Document for: Discussion

Agenda Item: 9.1.1

Background: Phase I NR MIMO

- Expected **key features**
 - DL and UL TX schemes: DMRS-based precoding and diversity, dynamic L1 switching
 - Limited support for multi-TRP/panel
 - Modular CSI acquisition including Beam Management
 - Type I (low resolution) and II (high resolution) CSI: 2 to 32 antenna ports
 - Flexible RS: DMRS, CSI-RS, SRS, ...
- **Key differentiation** from LTE:
 - Type II CSI: at least 30% average TP gain over LTE Rel.14 (eFD-MIMO)
 - Modular CSI acquisition & flexible RS → scalable to, e.g. multi-TRP/panel
 - Accommodate high-frequency (>6GHz) operation
- **Phase I** will be finalized in Dec 2017 (**basic** MIMO functionalities)
 - Unrealized/latent MIMO potentials in Phase I → Need to be **unlocked in Phase II**

Timeline and items of interest



- Approximately 15-month WI in RAN1, including proposals to:
 - Support: Specify proposed features
 - Study: Evaluate and, if needed, specify proposed features → to be summarized in a TR
- **Phase II WI** includes the following items:
 - Enhanced Type II CSI
 - Enhanced multi-TRP/panel support
 - Evaluation of enhanced DL-UL channel reciprocity support (both DL and UL transmissions)
 - Evaluation of spec support(s) for interference cancellation based on non-linear precoding
 - Miscellaneous enhancements to be evaluated (e.g. UL, RS)

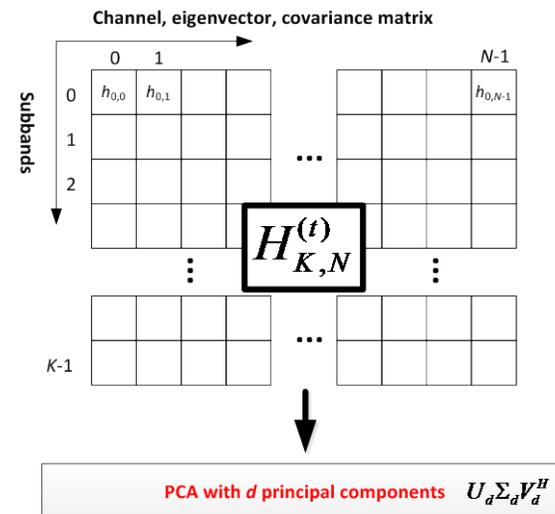
Enhanced Type II CSI

- Type II CSI is the most promising feature of NR MIMO in terms of NW performance
 - The *only* feature offering large TP gain over LTE under the same scenario
 - “Long” term extension to achieve near-ideal CSI performance
- Phase I supports Cat1 (eigenvector feedback) with $L=2, 3, 4$ and rank 1-2
 - Cat3 (for hybrid CSI-RS) is naturally supported
 - Facilitate explicit feedback: major TP gain over Rel.14 LTE (at least $\sim 30\%$) ...
 - ... but significant gap from near-ideal CSI
- **Possible enhancements:**
 - Support Cat1 $L>4$ with, e.g. differential reporting (to distribute reporting payload)
 - Support Cat1 with rank 3-4 support (for UE capable of 8RX and light NW loading)
 - Study “Cat1+” (channel feedback) utilizing spatial feedback compression scheme
 - Study enhancements on multi-panel codebook(s)

Enhanced Type II CSI

- Schemes

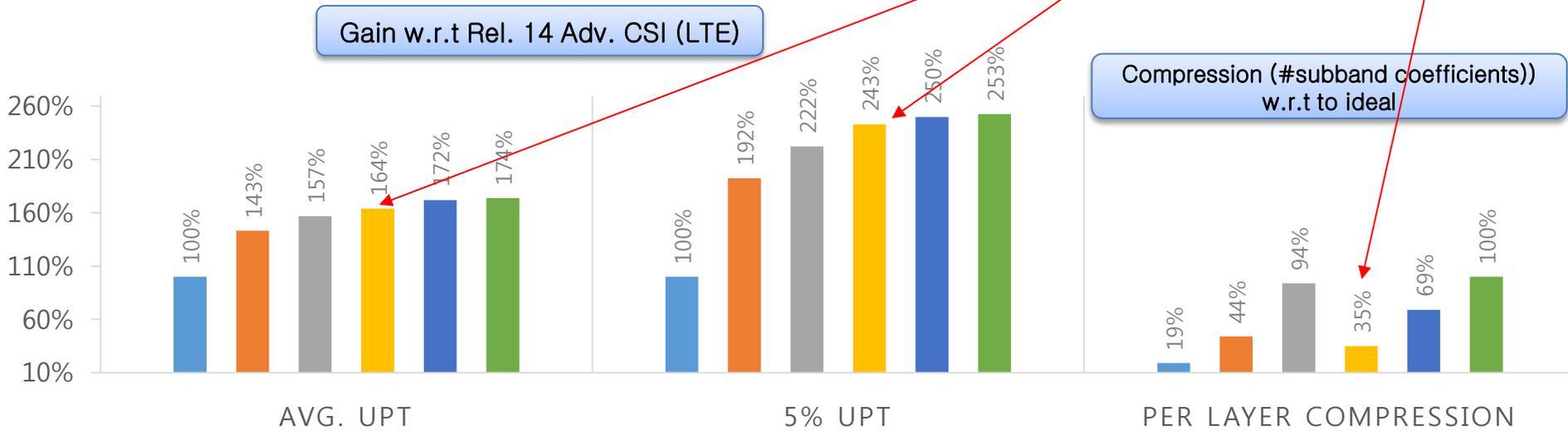
	<i>Scheme</i>	#coefficients (9 SBs)	Per layer compression
Rel.14 Adv. CSI	L = 2 beams	$9 \times 3 = 27$	0.19
Type II, Cat 1	L = 4 beams	$9 \times 7 = 63$	0.44
	L = 8 beams	$9 \times 15 = 135$	0.94
Principal component analysis (PCA)	d = 2 principal components	$(9+16) \times 2 = 50$	0.35
	d = 4 principal components	$(9+16) \times 4 = 100$	0.69
Ideal	Un-quantized eigenvectors	$9 \times 16 = 144$	1 (uncompressed)



- 16 ports (2D 2x4 dual-polarized array), UMi, 50% RU, Rank 2

PCA, d=2, the **best** in terms of performance gain and compression

■ R14 Adv. CSI ■ Type II, Cat 1, L = 4 ■ Type II, Cat 1, L = 8 ■ PCA, d = 2 ■ PCA, d = 4 ■ Ideal

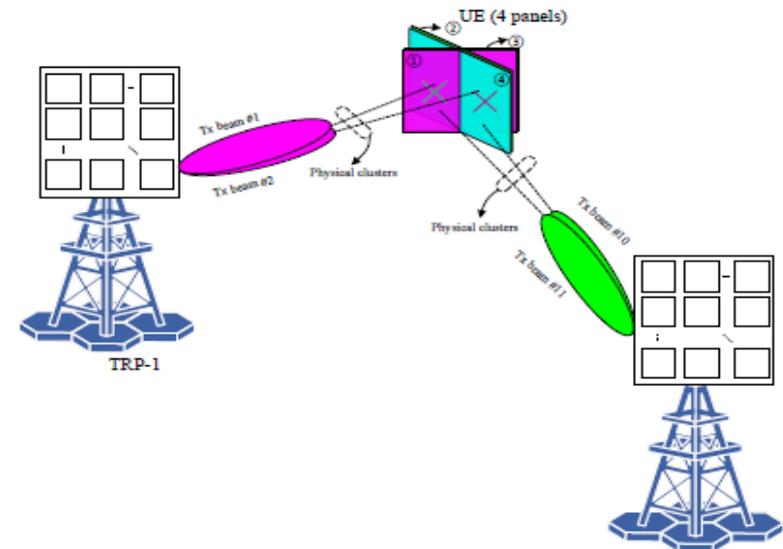


Enhanced multi-TRP/panel support

- Requirement for enhanced multi-TRP/panel support
 - Scalable: facilitate natural extension to ≥ 2 transmit/receive points
 - Flexible: applicable for various operations, e.g. coherent/non-coherent, UL/DL, indoor/outdoor, joint transmission/coordinated beamforming/point selection
- Phase I supports the following
 - Type I multi-TRP/panel CSI (co-phase) for coherent JT
 - Multi-assignment (multi-DCI) reception (over *multiple slots*) for non-coherent JT

- **Possible enhancements:**

- Support DL/UL single-assignment (over a *single slot*) for non-coherent JT using two-level DL control (e.g. “two-level DCI”)
- Support beam reporting optimized for multi-TRP/panel scenarios

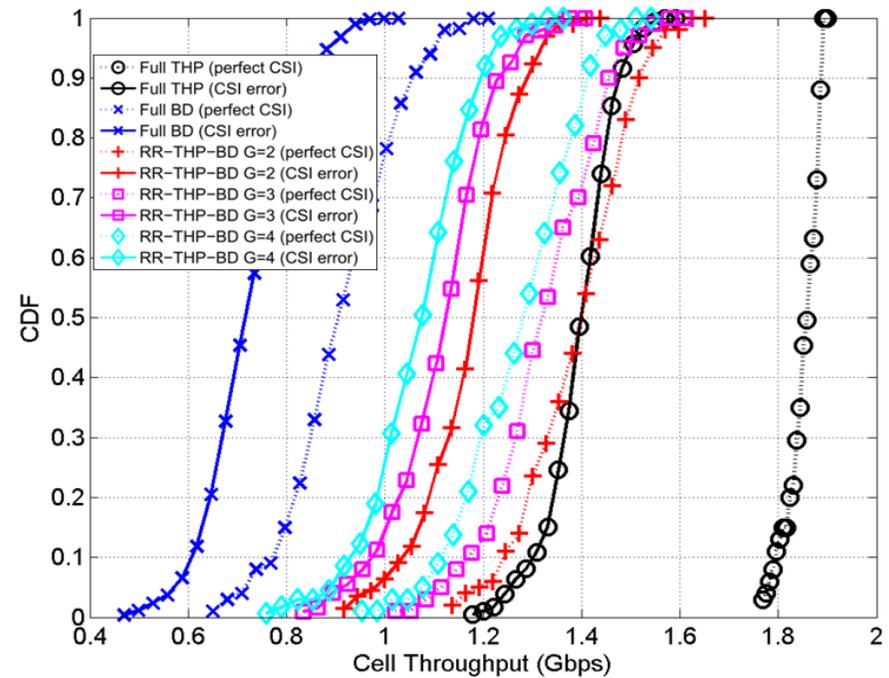
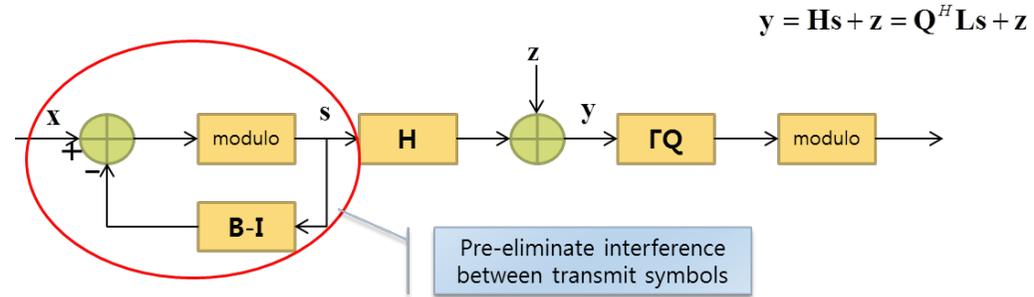


Enhanced DL-UL channel reciprocity support

- Phase I supports the following
 - Limited spec feature to facilitate SRS usage for DL CSI acquisition and CSI-RS usage for UL CSI acquisition
- **Possible enhancements**
 - Study DL CSI acquisition based on SRS and UL CSI acquisition based on CSI-RS (e.g. DL control signaling, joint triggering)
 - Study transmission scheme for partial reciprocity scenarios

Interference cancellation based on non-linear precoding

- Non-linear precoding (NLP) can improve MU-MIMO multiplexing capacity and performance over linear precoding
 - Especially in highly-loaded scenarios where typical beamforming fails to spatially multiplex co-located UEs
- **Possible enhancements**
 - Study spec supports that facilitate NLP (for MU-MIMO single/multi-TRP/panel) such as RS, CSI, and other signaling enhancements



[R1-1701087, Nokia]

- UL MIMO:
 - Phase I supports basic codebook-based UL SU-MIMO (cf. Rel.10 LTE) and max SRS ports per resource = 4
 - **Possible enhancements**
 - Study enhancement for UL frequency selective precoding based on, e.g. two-level DL control signaling
 - Study enhanced spatial multiplexing, e.g. enhanced UL codebook, 8-port SRS
- RS efficiency:
 - **Possible enhancements**
 - Study SRS with enhanced coverage and reduced overhead
 - Study CSI-RS and DMRS overhead reduction via, e.g. pattern sub-sampling, non-orthogonal multiplexing, resource sharing between DMRS and CSI-RS, time-domain bundling/aggregation