3GPP TSG RAN Meeting #76
Palm Beach, USA, June 5 - 8, 2017

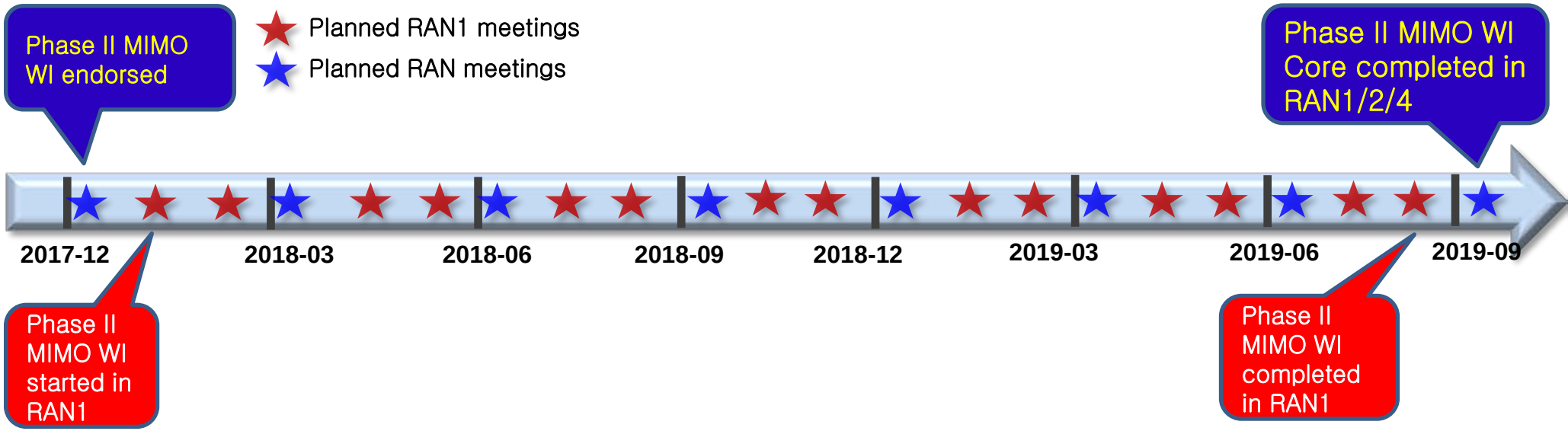
RP-171405

Source:	**Samsung, ZTE, CATT**
Title:	**Motivation for new WI: Enhancements on MIMO for NR**
Document for:	**Discussion**
Agenda Item:	**9.1**

Background: Phase I NR MIMO

- Expected **key features**
  - DL and UL TX schemes: DMRS-based precoding and diversity, dynamic 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 21-month WI, including proposals to:
  - *Support*: Specify proposed features
  - *Study*: Evaluate/study and, if needed, specify proposed features
- **Phase II WI** includes the following items:
  - Enhanced Type II CSI
  - Enhanced multi-TRP/panel support
  - Enhanced high-frequency support
  - Enhanced DL-UL channel reciprocity support (both DL and UL transmissions)
  - Miscellaneous enhancement

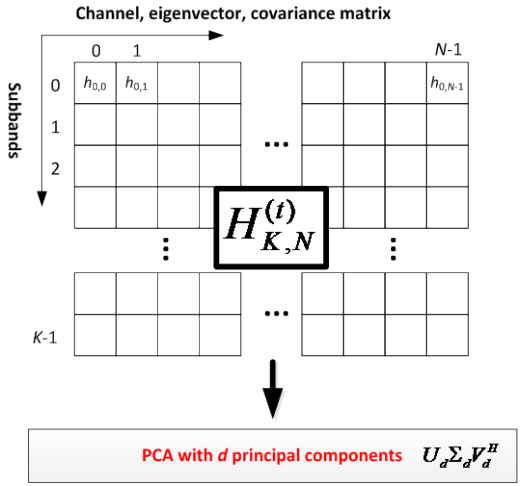
Enhanced Type II CSI

- 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 most likely supports Cat1 with L=2, 3, 4 and rank 1-2
  - Cat3 (hybrid) is naturally supported
  - Facilitate explicit feedback: major TP gain over Rel.14 LTE (at least ~30%) …
  - … but significant gap from near-ideal CSI
- **Possible enhancements**:
  - Support Cat1 L>4 with differential reporting (to distribute reporting payload)
  - Support Cat1 with rank 3-4 support (for UE capable of 8RX and light NW loading)
  - Study "Cat1+" utilizing spatial feedback compression scheme
  - Study Cat2 (covariance matrix)

Enhanced Type II CSI

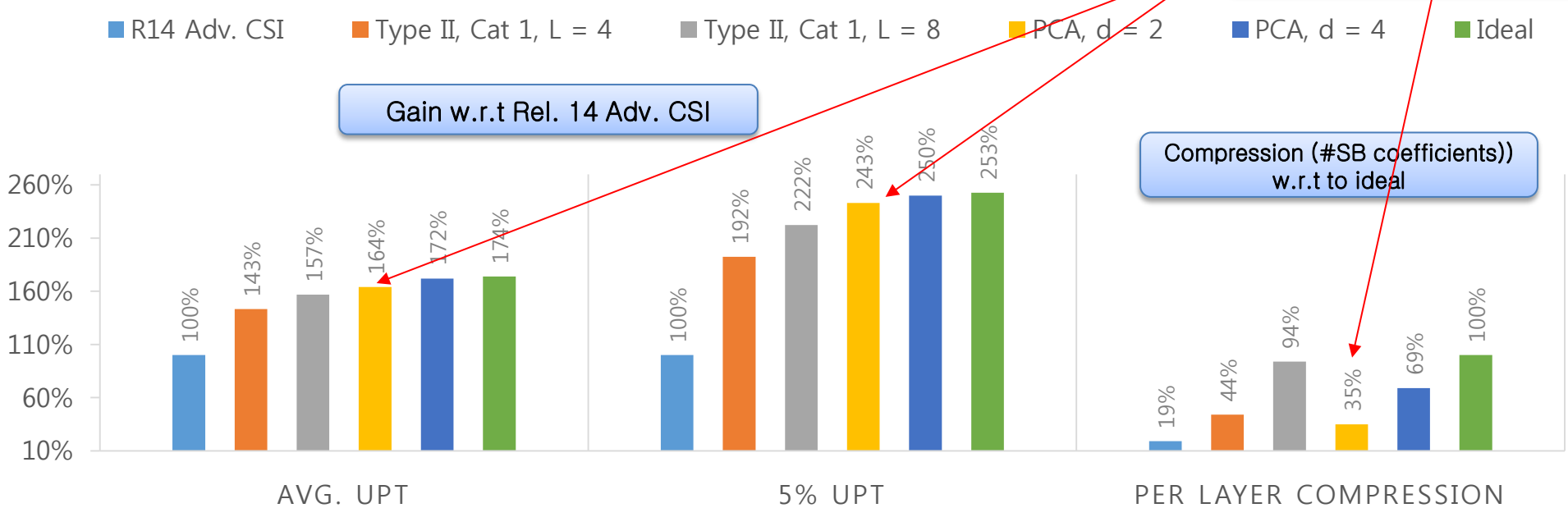
- Schemes

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



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

- 16 ports, (N1,N2) = (2,4), UMi, 50% RU, Rank 2

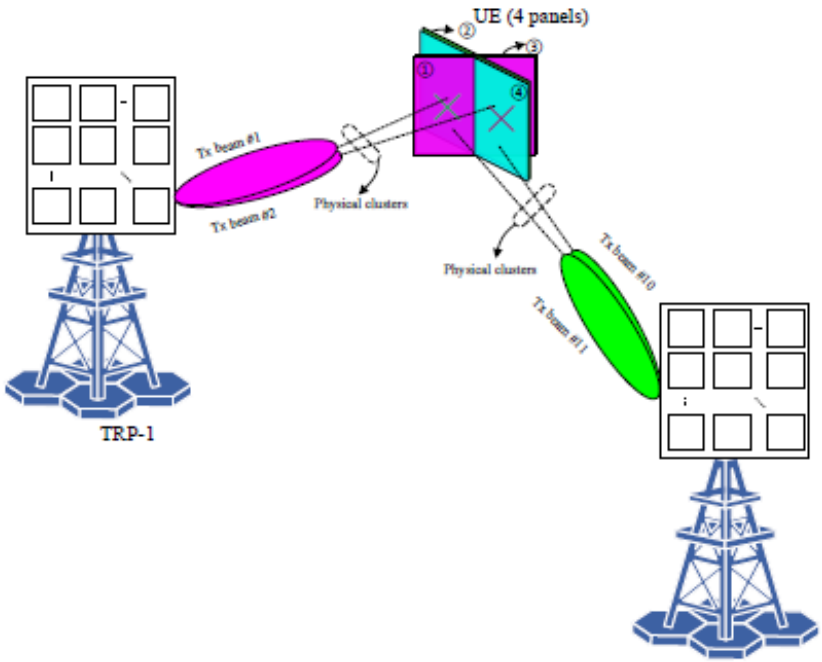


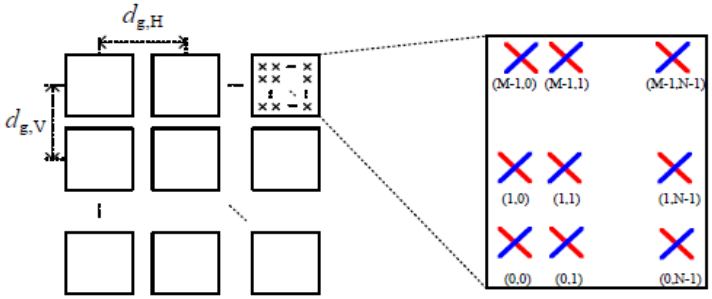
Enhanced multi-TRP/panel support

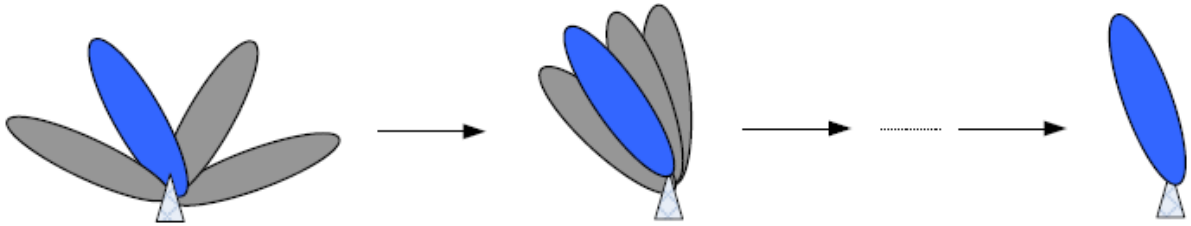
- Requirement for enhanced multi-TRP/panel support
  - Scalable: facilitate natural extension to >=2 transmit/receive points
  - Flexible: applicable for various operations, e.g. coherent/non-coherent, UL/DL, indoor/outdoor, joint transmission/coordinated beamforming/point selection
- Phase I most likely supports the following
  - Type I multi-TRP/panel CSI (co-phase) for coherent JT
  - Multi-assignment (multi-DCI) reception for non-coherent JT
- **Possible enhancements – transmission**:
  - Support DL/UL single-assignment for non-coherent JT using two-level DL control (e.g. “two-level DCI”)
  - Study multi-TRP/panel operation for control channel(s)

Enhanced multi-TRP/panel support

- **Possible enhancements – reporting:**
  - Support beam reporting (multi-TRP/panel context) schemes considering not only channel, but also interference measurement and/or transmission schemes
  - Study enhanced codebooks for DL/UL multi-panel scenarios
    - UL multi-panel codebooks: panel/port selection or combination
    - Differential/multi-level DL codebooks (progressive refinement of spatial resolution)







Enhanced high-frequency support

- Phase I most likely supports the following
  - Scenarios for up to 40GHz
  - DL and UL beam management based on SS block and CSI-RS/SRS
  - Context for >40 GHz:
    - 5G V2X may operate @63-64GHz and 76-81GHz
    - Fully analog architecture (as opposed to hybrid) is more commonly used
- **Possible enhancements**
  - Study optimization for DL/UL beam management for >40GHz
    - How Phase I UL/DL beam management can be extended/scaled to address this scenario
  - Study SC-FDMA-based DL/UL transmission for >40GHz
    - Single-layer or low-order DL/UL MIMO (e.g. 2-layer)

Enhanced DL-UL channel reciprocity support

- Phase I most likely supports the following
  - Limited spec feature (if any) to facilitate SRS usage for DL CSI acquisition and CSI-RS usage for UL CSI acquisition
- **Possible enhancements** [depending on Phase I outcome]
  - Study interference feedback
  - 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
  - Study verification of channel reciprocity accuracy for beam correspondence

Miscellaneous Enhancement

- UL MIMO:
  - Phase I most likely supports basic codebook-based UL SU-MIMO (cf. Rel.10 LTE) and max SRS ports per resource = 4
  - **Possible enhancements** [depending on Phase I outcome]
    - Support enhancement on UL frequency selective precoding based on, e.g. two-level DL control signaling
    - Support larger number of SRS ports per resource, e.g. [8]
    - Study UL Tx diversity scheme for DFT-S-OFDM
- RS efficiency:
  - 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