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3GPP TSG-RAN Meeting #93-e
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Source: Samsung

Motivation for new WI on enhanced NR support for high speed train scenario in frequency range 2 (FR2)

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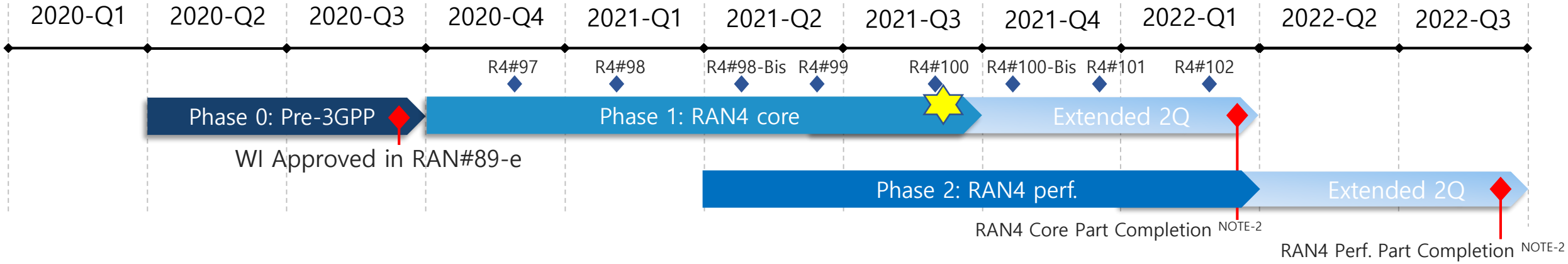
Background for Rel-17 NR Support for HST in FR2

- NR support for HSR in Frequency Range 2 (FR2)
  - Rel-17 RAN4-led Work Item NOTE-1
  - Highlights from the scope in WID:
    - NR SA single carrier scenario in FR2
    - Focused on train roof-mounted high-power devices
    - Single panel, *i.e.,* only one active antenna panel at a time, as baseline antenna assumption
    - Study on supporting speeds of up to a maximum of 350km/h, with Rel-15/16 NR design limitation.



- NOTE-1: RP-210800, the updated work item description.
- NOTE-2: 3GPP Rel-17 Overall Timeline is extended for 2Q due to the impact of COVID-19.

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Rel-18 Proposal for NR FR2 HST Enhancement

- Study and specify the requirements for the following deployment scenario [RAN4]:
  - Focused on train roof-mounted high power devices with target applicable carrier frequency up to 30GHz;
  - Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements;
  - Specify the requirements for intra-band carrier aggregation (CA) scenario;
  - Specify the requirements to support the scenario with mixed near-to-track (*i.e.*, Scenario-A with D_s = 700m and D_{min} = 10m) and far-from-track (*i.e.*, Scenario-B with D_s = 700m and D_{min} = 150m) RRH deployment;
  - Study the feasibility of supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz.

	Large-Scale Pathloss Model (for System-Level Evaluation)	**Channel Modeling for performance requirement**
Open Space, Scn.-A/B	TS38.901 RMa LoS Validated	DPS(Dynamic Point Selection)-based, Scn.-A/B, Uni/Bi-directional
Tunnel Scenario	*Not studied in Rel-17 WI (due to low priority and limited RAN4 TU)*	

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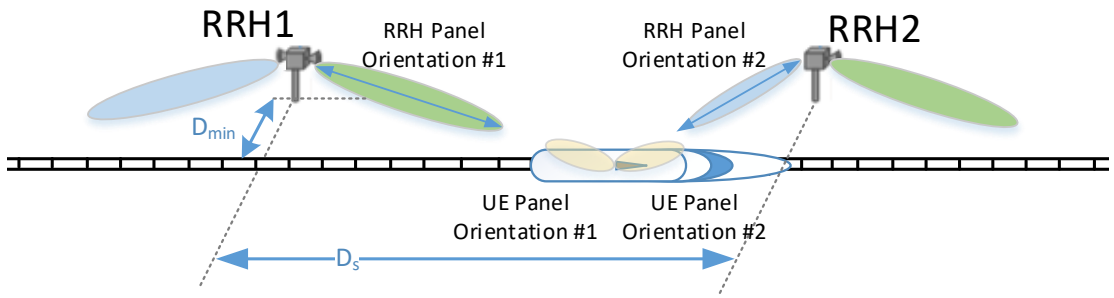
Rel-18 Proposal for NR FR2 HST Enhancement

- Specify the requirement for multi-panel operation for train roof-mounted FR2 high power devices [RAN4]
  - Maximum 2 active panels supporting the multi-panel simultaneous reception.



Multi-panel reception in Bi-directional RRH Deployment

- Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE [RAN1, RAN4]

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Thank You

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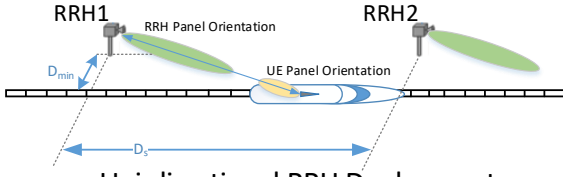
Annex – Conclusion from Rel-17 NR Support for HST in FR2

▸ Deployment Scenario

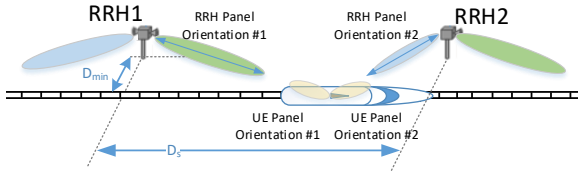
- Both Scenario-A and B, with both uni-directional RRH and bi-directional RRH deployment have been investigated:
  - Extensive analysis on deployment scenarios was conducted in Rel-17;
  - For both uni-/bi-directional deployment: Only one active antenna panel at a time;
  - Conclusion on the number of beams per RRH and per UE from deployment scenario:

	D_s (m)	D_{min} (m)	Note	Sub-Scenario	# of Beams per RRH	# of Beams per UE
Scenario-A	700	10	Near-to-Track; More dedicated to FR2	Uni-directional	1 beam/panel (1 panel per RRH site)	1 beam/panel (1 active panel, 2 panels implemented)
				Bi-directional	1 beam/panel (2 opposite panels per RRH site)	1 beam/panel (2 panels per UE)
Scenario-B	700	150	Far-From-Track; Compatible with existing LTE deployment	Uni-directional	2 beams/panel (1 panel per RRH site)	1 beam/panel (1 active panel, 2 panels implemented)
				Bi-directional	2 beams/panel (2 opposite panels per RRH site)	1 beam/panel (2 panels per UE)

Note: For Scenario-B, other options for beam number not precluded, due to different understanding of the tradeoff on more/less beams per RRH/UE panel.



Uni-directional RRH Deployment



Bi-directional RRH Deployment

- Maximum speed feasibility study on 350km/h:
  - Feasibility study on uplink: It is feasible to support maximum speed with 350km/h for uplink with PTRS or DMRS+PTRS configuration used for frequency offset tracking with 120KHz SCS.

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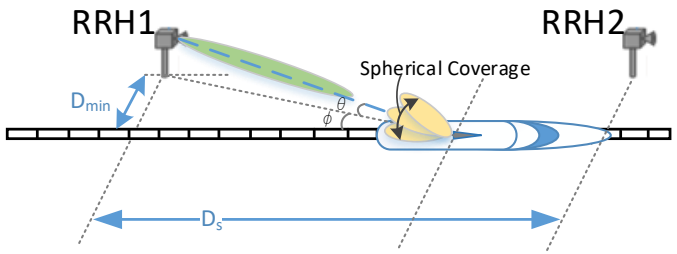
Annex – Conclusion from Rel-17 NR Support for HST in FR2

- Channel Modeling (based on deployment scenario)

	Large-Scale Pathloss Model (for System-Level Evaluation)	Channel Modeling for performance requirement
Open Space, Scn.-A/B	TS38.901 RMa LoS Validated	DPS(Dynamic Point Selection)-based, Scn.-A/B, Uni/Bi-directional
Tunnel Scenario	**Not studied in Rel-17 WI (due to low priority and limited RAN4 TU)**	

- UE RF requirement:
  - TX Requirement for FR2 HST UE: minimum peak EIRP and spherical coverage



Metrics	Handhold UE (Power Class 3)	High power non-handhold (Power Class 4)	FR2 HST UE
Peak EIRP	20.6dBm	34dBm	**30.x dBm**
TX Spherical Coverage	11.5dBm@50%-tile	25dBm@20%-tile	**TBD (based on new Spherical Coverage framework)**

  - RX Requirement for FR2 HST UE;
  - Beam Correspondence for FR2 HST UE:
    - Rel-15 BC: mandatory support; Rel-16 SSB-based BC: mandatory support; Rel-16 CSI-RS-based BC: optional support by FR2 HST UE.

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Annex – Conclusion from Rel-17 NR Support for HST in FR2

- RRM: Large difference in propagation delays from different RRHs to UE
  - Problem is for Uni-directional case and Some Schemes in Bi-directional RRH deployment:
    - Up to 2.5us, much larger than CP length.
  - DL Timing:
    - Autonomous timing adjust step T_q for FR2 in high-speed scenario is [4.5] T_s;
    - PSS/SSS detection is robust enough to handle the ISI and time difference.
  - UL Timing:
    - UL TA command: RAN4 agree still follow Rel-15/16 RAN1 design
    - RAN4 method to address uplink timing issues:
      - Option 1: One shot UE autonomous large uplink timing adjustment;
      - Option 2: Other implementation/deployment based solution;
      - Note: above two options are based on RAN4#100-e agreement.

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