AI/ML for air-interface

RP-233526
Agenda item: 9.1.1.1
3GPP TSG-RAN#102
Edinburgh, Scotland, December 11-15, 2023
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Background

- RAN#101 discussed the potential scope of Rel-19 normative work on AI/ML for air-interface.
  - The offline discussion summary was provided with the following observations [RP-232611]

Observations based on the input in this meeting

- Consider support single sided models for,
  - Positioning, further discuss whether to support all 5 sub use cases.
  - Beam management for DL Tx prediction in both UE-sided and NW sided model,
- Consider support of single sided model for CSI prediction, if it is recommended to proceed with normative work taken all WG's outcome in Q4-23 into account
- Consider support two-sided model for CSI compression, if it is recommended to proceed with normative work taken all WG's outcome in Q4-23 into account
- Consider support the necessary/recommended LCM components for selected sub use cases
- RAN4 requirements and test cases for AI/ML enabled features

- On the other hand, the additional RAN1 TUs until RAN#102 for Rel-18 study extension was agreed in RAN#101 [RP-232659]
  - RAN1 agreed the conclusions/recommendations for each use case, which should be respected.

Rel-19 eNCR should support practical functionalities to encourage both NCR and FR2 deployments

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Positioning (1/2)

- **Consider support single sided models for,**
  - **Positioning, further discuss whether to support all 5 sub use cases.**

- RAN1#115 agreed the following recommendation for positioning [Chair's notes]

Agreement

It is recommended to specify necessary measurement, signaling and procedure to facilitate training, inference, monitoring and/or other LCM operations for both direct AI/ML positioning and AI/ML assisted positioning

- specify necessary signaling of data collection; investigate the necessity of other information for supporting data collection, and if needed, specify during normative work
- investigate on the necessity and signaling details of measurement enhancements, and if needed, specify during normative work
- investigate on the necessity and signaling details of monitoring method(s), and if needed, specify during normative work

- Therefore, both direct and assisted positioning should be supported in Rel-19 normative work.

Both direct AI/ML positioning and AI/ML assisted positioning are in scope of Rel-19 normative work

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Positioning (2/2)

- TR 38.843 captured the following 5 sub-cases, which still need to be discussed whether to support all the sub-cases, whereby RAN1 does not provide any priority/recommendation on these sub-cases.

  - Case 1: UE-based positioning with UE-side model, direct AI/ML or AI/ML assisted positioning
  - Case 2a: UE-assisted/LMF-based positioning with UE-side model, AI/ML assisted positioning
  - Case 2b: UE-assisted/LMF-based positioning with LMF-side model, direct AI/ML positioning
  - Case 3a: NG-RAN node assisted positioning with gNB-side model, AI/ML assisted positioning
  - Case 3b: NG-RAN node assisted positioning with LMF-side model, direct AI/ML positioning

- In our view, all the sub-cases would be useful since different deployments need different case.
- So, the framework to support all the sub-cases should be specified in Rel-19, if TU allows.
  - A common framework, including measurements and signalling, for all sub-cases is desirable.

If possible, it's preferable to support all the 5 sub-cases for positioning in Rel-19

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Beam management

- **Consider support single sided models for,**
  - **Beam management for DL Tx prediction in both UE-sided and NW sided model,**

- RAN1#115 agreed the following recommendation for beam management [Chair's notes]

Agreement

Confirm the following working assumption (with modification in red) agreed in RAN1#114bis

Working Assumption

For AI-based beam management, from RAN1 perspective, at least the following are recommended for normative work

- Both BM-Case1 and BM-Case2
  - BM-Case1: Spatial-domain DL Tx beam prediction for Set A of beams based on measurement results of Set B of beams
  - BM-Case2: Temporal DL Tx beam prediction for Set A of beams based on the historic measurement results of Set B of beams
- DL Tx beam prediction for both UE-sided model and NW-sided model
- Necessary signaling/mechanism(s) to facilitate data collection, model inference, and performance monitoring for both UE-sided model and NW-sided model
- Signaling/mechanism(s) to facilitate necessary LCM operations via 3GPP signaling for UE-sided model

- Accordingly, beam management should be supported in Rel-19 normative work.

Beam management for DL Tx prediction in both UE-sided and NW sided model is supported in Rel-19

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CSI prediction

- **Consider support of single sided model for CSI prediction, if it is recommended to proceed with normative work taken all WG's outcome in Q4-23 into account**

- RAN1#115 agreed the following conclusion on CSI prediction with single-sided model [Chair's notes]

Agreement

Capture the following conclusion in section 8 of the TR 38.843

- From RAN1 perspective, there is no consensus on the recommendation of CSI prediction for normative work.
- The reason for the lack of RAN1 consensus on the recommendation of CSI prediction for normative work is due to
  - Lack of results on the performance gain over non-AI/ML based approach and associated complexity
- Other aspects that require further study/conclusion are captured in the summary.

- Therefore, it's natural that CSI prediction is out of Rel-19 normative work scope.
- On the other hand, in our view, CSI prediction will provide higher gain in the future, depending on e.g., a larger number of antenna ports. So, it should not be excluded from a potential future study.

CSI prediction with single-sided model is not supported in Rel-19 normative work

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CSI compression

- **Consider support two-sided model for CSI compression, if it is recommended to proceed with normative work taken all WG's outcome in Q4-23 into account**

- RAN1#115 agreed the following conclusion on CSI compression with two-sided model [Chair's notes]

> **Agreement**
> Capture the following as a conclusion in section 8 of the TR
> - From RAN1 perspective, there is no consensus on the recommendation of CSI compression for normative work.
> - At least the following aspects are the reasons for the lack of RAN1 consensus on the recommendation of CSI compression for normative work.
> - Trade-off between performance and complexity/overhead
> - Issues related to inter-vendor training collaboration
> - Other aspects that require further study/conclusion are captured in the summary

- Therefore, it's natural that CSI compression is out of Rel-19 normative work scope.
- On the other hand, in our view, CSI compression will provide higher gain in the future, depending on e.g., a larger number of antenna ports. So, it should not be excluded from a potential future study.

CSI compression with two-sided model is not supported in Rel-19 normative work

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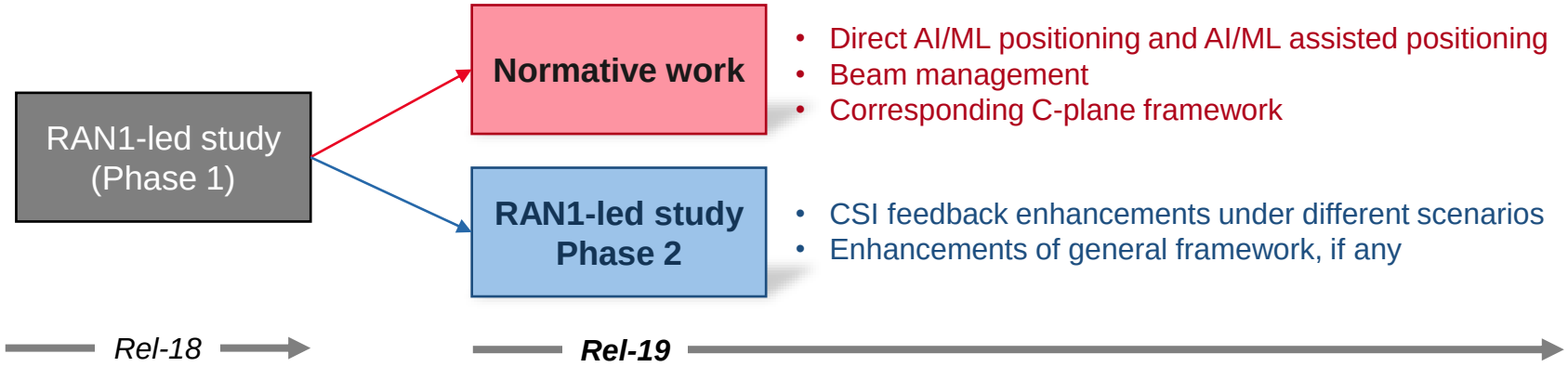
RAN1-led parallel study (Phase 2)

- As discussed, positioning and beam management are ready for normative work, which specifies the corresponding AI/ML for air-interface framework including signalling and procedures for e.g., LCM.
- On the other hand, CSI prediction and CSI compression didn't reach consensus in RAN1.
  - However, these CSI feedback enhancements are expected to have potential benefits under different deployment scenarios, e.g., larger number of antennal ports.
- Therefore, a RAN1-led parallel study (Phase 2) would be beneficial, in addition to the normative work.
  - Note: RAN1-led parallel study is RAN1-centric and different from RAN2-led study on AI/ML for mobility.



In Rel-19, a normative work and a follow-up RAN1-led study are considered for AI/ML for air-interface

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Potential objectives

- Specify general framework for model management [RAN2, RAN1]
  - Life Cycle Management (LCM), model transfer, data collection, etc.
  - Fallback mechanism to legacy operation.
- Specify necessary mechanism to support the following use cases [RAN1, RAN2]
  - Direct/Assisted-positioning, including Cases 1, 2a, 2b, 3a and 3b.
  - Beam management, including BM-Case1 and BM-Case2.
- Specify RAN4 requirements and test cases for AI/ML enabled features [RAN4]
- The specification should take security and privacy concern, if any, into account.

If RAN1-led study phase 2 is agreeable:

- Identify and evaluate different scenarios for CSI feedback enhancements [RAN1]
- Identify general framework enhancements, if any [RAN1, RAN2]

AI/ML for air-interface WI should be approved, and to discuss whether to have RAN1-led SI continuation

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