3GPP TSG RAN Rel-18 Workshop
June 28th – July 2nd 2021

RWS-210103
Agenda Item 4.3

[x-area] AI/ML Integration

MediaTek Inc.

eMBB consumer

MIMO
- CSI enh.
- BM: [subject to R17]
- Stationary: 8Rx, overhead redux
- UL sub-band precod.
- UL 4+ layers

DC/CA Enh.
- X-carrier HARQ: feedback & re-Tx
- Fast re-Tx split bearer
- Temporal RS PScell act
- Scalable x-carrier sch.

XR/CG Enh.
- QoS+, x-layer opt.

MBS
- SFN+
- QoS+ (Tput, reliab.)
- TV (ATSC3.0 ref)

NW Topology

Sidelink LLeMBB
- SL-U esp. <7GHz, FR2
- Low latency 1Gbps
- SL-U RedCap

Sidelink Relay
- U2U relay
- UE scheduling UE
- mPath, mHop
- Mobility (Remote, Relay)
- Network coding

Smart Repeaters
- Beamforming
- Interf. Mgmt (T/F DD)
- Integration (UE authorization)

NTN Evolution

NTN NR
- Mobility
- Regenerative arch
- HD-FDD, VoNR, MBS
- R17 leftovers

NTN IoT
- Mobility (connected)
- R17 leftovers

SID Spectr. sharing
- Study scenarios, target spectrum and regulation status

Long-term explor.

SID AI/ML integr.
- NG-RAN/AS integrat.
- DMRS ch. est., Rx noise suppress, CSI-RS overhead, CSI feedback
- (UE-based) Mobility predict., Pos. enh.
- NW functions (load balancing, radio resource planning..)

SID AI traffic
- Split learning
- Non-split learning

SID >71GHz
- Spectrum charac.

Common tech.

[FR2] Mobility
- L1/L2 trig. CHO
- Inter-/intra-cell beam switching delay redux
- RRC DAPS HO mPanel

System Energy
- DCI-based pwr sav mTRP and mPanel
- gNB/TRP dormancy (UE -trig. / -imposed)
- Eval. Methodology (Pwr. Cons. Models)

POS (NR, SL, RedCap)
- cm-level (Tx + meas related to signal ϕ)
- SL (-based, -assisted)
- RedCap UE
- R17 leftovers

SID gNB Full Duplex
- Partitioning, scenarios, interf.

Verticals

URLLC
- DL control efficiency
- NR-U enh

RedCap
- PA-less
- (POS)
- NO LPWA

(UAV: neutral)

SID = SID only Others: SI+WI / WI

Sorting for 3GPP RAN#92e Rel-18 Workshop

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- SL-U RedCap

XR/CG Enh. [SA-led]
- QoS+, x-layer opt.

NTN NR
- R17 leftovers
- Mobility
- Regenerative arch
- VoNR, MBS, HD-FDD

MBS
- SFN+
- QoS+ (Tput, reliab.)
- TV (ATSC3.0 ref)

(may also be seen as non-eMBB)

Non-eMBB

URLLC
- DL control efficiency
- NR-U enh

RedCap
- PA-less
- (POS)
- NO LPWA

NTN IoT
- R17 leftovers
- Mobility (connected)

(UAV: neutral)

X-areas New areas

System Energy
- DCI-based pwr sav mTRP and mPanel
- gNB/TRP dormancy (UE -trig. / -imposed)
- Eval. Methodology (Pwr. Cons. Models)

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Study AI/ML Integration
RAN2-led

3GPP TUs (Total w/ 9 meetings)			
RAN1	RAN2	RAN3	RAN4
4	8	6	-

SA/CT Dependency: No

To investigate the benefits of selective AI/ML integration into NG-RAN/AS functions

Objective I: Study AI-assisted AS layer functions for decision quality and/or overhead redux [RAN2, 1]
- RS overhead reduction and optimization with AI-assisted algorithms [RAN1]
- Mobility predictions, Positioning enhancements [RAN2]

Objective II: Study AI-assisted network functions [RAN3, 2]
- Predictive traffic management for load balancing across the network
- Network energy saving
- Radio resource planning and optimizations

Existing works on network intelligence

- From ITU FG ML5G, network intelligence can be dimensioned into Action, Data collection, Analysis, Decision, Demand mapping. They also identify the intelligence levels from L0 manual to L5 full intelligence.
- In 3GPP, there are at least following WID to address some of mentioned dimensions
  - Rel-16 SON and MDT support for NR (NR_SON_MDT SON)
  - Rel-17 Enhancement of data collection for SON/MDT in NR
  - Rel-16 Enablers for Network Automation for 5G (eNA)
  - Rel-17 Enablers for Network Automation for 5G – phase 2 (eNA_Ph2)

Network intelligence level chart

Network intelligence levels		Dimensions of intelligence				
		Action implementation	Data collection	Analysis	Decision	Demand mapping
L0	Manual operation	Human	Human	Human	Human	Human
L1	Assisted operation	Human and System	Human & System	Human	Human	Human
L2	Preliminary intelligence	System	Human & System	Human & System	Human	Human
L3	Intermediate intelligence	System	System	Human & System	Human & System	Human
L4	Advanced intelligence	System	System	System	System	Human & System
L5	Full intelligence	System	System	System	System	System

Source: ITU-T Y.3173: Framework for evaluating intelligence levels of future networks including IMT-2020

AI/ML Integration Study Strategy

- For AI/ML integration
  - Potential benefits:
    - Less traditional control signaling/complexity,
    - Less standardization/testing/verification,
    - Improve performance in the long run
  - Potential problems:
    - More signaling/complexity for learning/training,
    - Longer training delay,
    - Lack of performance evaluation methodology to verify/guarantee AI/ML integration quality
- **Observation:** *Extensive* study is needed to identify suitable RAN/AS functions for AI/ML integration and to understand how to ensure the quality of AI/ML integration.

- Study strategy options
  1) Study methodology to evaluate benefit of AI/ML integration of *all* RAN/AS functions, or
  2) Study methodology to evaluate benefit of AI/ML integration of *selective* RAN/AS functions

- **Proposal 1:** RAN WGs start with option 2)
  - Impossible for RAN WGs to study all functions in one release
  - Allocate reasonable TU in each core WG to start the study from Rel-18

Selective Study for AI/ML Integration

- Channel Characteristics (RAN1)
  - Wireless channel estimations involve complicated mathematical operations, incurring frequent computation overhead
  - AI/ML can be an efficient tool to learn and predict the channel characteristics (e.g. CSI of next slots, CSI feedback) with reduced overhead (e.g. using less CSI-RS ports)

- Predictive Mobility (RAN2)
  - Next generation wireless networks with dense beams, emerging new applications (e.g. XR, gaming, uRLLC) and high frequency bands will make mobility and beam management more challenging.
  - Efficient learning and prediction of user mobility can improve handover performance (e.g. HO interruption time, service disruption) and beam management

Proposal2: RAN1 to study CSI-RS overhead reduction and optimization with AI/ML integration.

Proposal3: RAN2 to study predictive mobility with AI/ML integration.

Selective Study for AI/ML Integration

- Network Management Optimization (RAN3)
  - Next generation wireless networks envision ultra-dense coverage involving a wide number of cells and diverse application traffic.
  - Deploying a wide number of dense cells will increase network energy consumption and operating expenditure (opex).
  - AI/ML can be efficiently used to learn wireless traffic patterns and predict the future traffic across different gNBs in the network.
  - Accurate AI-based traffic forecast improve
    - Predictive traffic management for load balancing across the network
    - Network energy reduction by learning the traffic patterns and reducing the power of lightly loaded gNBs
    - Radio resource planning and optimizations of the network by efficient learning of network traffic patterns
  - Continue current MDT/SON work items

Proposal 4: RAN3 to continue network management optimization with AI/ML integration.

Selective Study for AI/ML Integration

- AI/ML integration for improving AS layer functions in Network
  - Predictive traffic management for load balancing across the network
  - Network energy reduction by learning the traffic patterns and reducing the power of lightly loaded gNBs
  - Radio resource planning and optimizations of the network by efficient learning of network traffic patterns
- AI/ML integration for improving AS layer functions in Device
  - Study different MAC/PHY layer optimizations using AI/ML
  - Learning and prediction of mobility for improving handover performance
  - AI/ML capability become standard equipment for almost all applications on all platforms, no exception for mobile

Proposal 5: Study AI/ML integration in both network and device.

Conclusion

Observation: *Extensive* study is needed to identify suitable RAN/AS functions for AI/ML integration and to understand how to ensure the quality of AI/ML integration.

Proposal 1: For Rel-18, RAN WGs study methodology to evaluate benefit of AI/ML integration of *selective* RAN/AS functions.

Proposal 2: RAN1 to study CSI-RS overhead reduction and optimization with AI/ML integration.

Proposal 3: RAN2 to study predictive mobility with AI/ML integration.

Proposal 4: RAN3 to continue network management optimization with AI/ML integration.

Proposal 5: Study both AI/ML integration in network and in device.

Thank You!

MediaTek TDocs to RAN Rel-18 Workshop

RWS-210092	MediaTek Views on Rel-18 content	MediaTek Inc.
RWS-210093	[eMBB] MIMO Enhancements	MediaTek Inc.
RWS-210094	[eMBB] DC/CA Enhancements	MediaTek Inc.
RWS-210095	[eMBB] XR/CG Enhancements	MediaTek Inc.
RWS-210096	[eMBB/Other] MBS Enhancements	MediaTek Inc.
RWS-210097	[eMBB] Sidelink Enhancements - LLeMBB	MediaTek Inc.
RWS-210100	[eMBB] NTN NR Enhancements	MediaTek Inc.
RWS-210101	[non-eMBB] NTN IoT Enhancements	MediaTek Inc.
RWS-210108	[non-eMBB] URLLC Enhancements	MediaTek Inc.
RWS-210109	[non-eMBB] NR RedCap Enhancements	MediaTek Inc.
RWS-210098	[x-area] Sidelink Relay Enhancements	MediaTek Inc.
RWS-210099	[x-area] Smart Repeaters Enhancements	MediaTek Inc.
RWS-210102	[x-area] NTN/TN Spectrum Sharing	MediaTek Inc.
RWS-210103	[x-area] AI/ML Integration	MediaTek Inc.
RWS-210104	[x-area] AI/ML Traffic	MediaTek Inc.
RWS-210105	[x-area] Mobility Enhancements	MediaTek Inc.
RWS-210106	[x-area] System Energy Enhancements	MediaTek Inc.
RWS-210107	[x-area] Positioning Enhancements	MediaTek Inc.
RWS-210197	[x-area] Sub-band Full-duplex for gNB	MediaTek Inc.
RWS-210110	Draft WID: System Energy Enhancements	MediaTek Inc.
RWS-210111	Draft WID: Mobility Enhancements	MediaTek Inc.
RWS-210112	Draft WID: DC/CA Enhancements	MediaTek Inc.
RWS-210113	Draft WID: NTN IoT Evolution	MediaTek Inc.