

# NR-URLLC for Rel-16: Email discussion summary

RP-180973

RAN#80

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Source: Nokia, Nokia Shanghai Bell (moderator)

## Release 16 NR-URLLC work

### Selected Industry Automation use cases with diverse requirements

- Two tracks considered based on the first phase of RAN drafts email discussion inputs:
  - Release 15 enabled use case improvements
    - Such as AR/VR (Entertainment industry)
  - New Release 16 use cases with higher requirements\*
    - Factory automation
    - Transport Industry
    - Electrical Power Distribution
  - New requirements include higher reliability/availability than Release 15, time synchronization with short latency in the order of 0.5 to 1 ms.

\*Detailed requirements to be referenced from SA1 Release 16 documentation at start of the study

# Release 16 NR-URLLC work: Technical items to be studied

## Collecting of technical proposals

- Next phase of the discussions identified the technical enhancements to be studied  
The proposal were invited for the following areas:
  - L1 improvements to study
  - L2/3 improvements to study
    - Time Sensitive Networking (TSN) was assumed as one proposal based on requirements
- There was large number of proposals submitted (see next slides)

# Release 16 NR-URLLC work: Technical items to be studied

## Collecting of technical proposals – RAN1 related

- **Further improved reliability/latency for L1 channels**
- The following options have been proposed:
  - **PDCCH enhancements**
    - Example solutions such as Compact DCI, PDCCH repetition, increased PDCCH monitoring capability, UE recommendation about repetition factor ...
  - **PUCCH enhancements**
    - Example solutions such as Enhanced HARQ methods, CSI enhancements, new MCS/CQI design, Tx diversity
  - **PDSCH Enhancements**
    - Example solutions like, reliable transmission/retransmission
  - **PUSCH Enhancements**
    - Example solutions like increased PDCCH monitoring capability, mini-slot level hopping, retransmission enhancements
  - **Enhancements to scheduling/HARQ/CSI processing timeline (UE and gNB)**

# Release 16 NR-URLLC work: Technical items to be studied

## Collecting of technical proposals – RAN1 related

- **Sharing URLLC with eMBB**
- **The following options have been proposed:**
  - UL intra-UE Tx prioritization/multiplexing and power reductions (for simultaneous URLLC & eMBB), cover e.g. UL pre-emption,
  - UL inter UE Tx prioritization/multiplexing (for simultaneous URLLC & eMBB)
  - DL inter UE prioritization/multiplexing (enhanced DL pre-emption)
  - Support for multiple active BWPs
  - SR enhancement (SR latency reduction for simultaneous URLLC & eMBB)

Release 16 NR-URLLC work: Technical items to be studied

## Collecting of technical proposals – RAN1 related

- **Enhanced UL grant-free transmissions**
  - There has been various approaches suggested to improve grant free operation (such as enhancements for collision resolution between multiple UEs):
- **Outer Encoding Techniques**
- **Robust beam management and beam failure recovery for URLLC**
- **Radio Link monitoring enhancements for URLLC**
- **Multi-carrier URLLC across FDD & TDD**

## Release 16 NR-URLLC work: Technical items to be studied

### Collecting of technical proposals – L2/L3 enhancements (RAN2/RAN3/RAN1)

- **Data duplication enhancements**
  - The following options have been proposed:
  - Lower layer multi-connectivity (Multiple Transmission points, ...) (Note: Being discussed as part of the NR MIMO enhancements discussion)
  - Higher layer multi-connectivity (proposals such as redundant PDU sessions, L2/L3 duplication activation de-activation..)
- **Mobility improvements for higher reliability**
  - This has been raised both related to URLLC and wireless Ethernet
- **Interference management for higher reliability**
  - Examples such as join multi-cell scheduling
- **Network coding at L2/L3**
  - Examples such as outer codes for more efficient path redundancy
- **Radio link monitoring for URLLC (L2 part)**
- **2-step RACH**

Release 16 NR-URLLC work: Technical items to be studied

## Collecting of technical proposals – Time Sensitive Networking (RAN2/RAN3/RAN1)

- **TSN enablers**
- **The following options have been proposed:**
  - **Accurate reference timing: Delivery & related process (Proposal include: SIB delivery or RRC delivery to UEs, Multiple Transmission points, ...)**
  - **Scheduling enhancements / traffic patterns / QoS for wireless Ethernet, Enhancements to support of cyclic traffic**
  - **Header compression for wireless Ethernet**
  - **Ethernet broadcast packets over 5G RAN**

# Release 16 NR-URLLC work: Technical items to be studied

## Collecting of support for technical proposals

- **Feedback obtained from some 25 companies (detailed feedback in RP-180974)**
  - The ones with majority support were selected for the study item proposal in RP-180975
- **This allows relatively reasonable scope, typically 2-3 TUs per meeting (RAN1/RAN2/RAN3)**
  - PDCCH, PUCCH, PDSCH & PUSCH enhancements
  - Enhancements to scheduling/HARQ/CSI processing timeline (UE and gNB) (no new TTI duration)
  - Sharing URLLC with eMBB for uplink (intra/inter-UE)
  - Enhanced UL grant-free transmissions
  - Multi-carrier URLLC across FDD & TDD
  - Data duplication enhancements (Higher layer)
  - Interference management for higher reliability, including joint multi-cell scheduling
  - 2-step RACH
  - Time Sensitive Networking :
    - Accurate reference timing: Delivery & related process
    - Scheduling enhancements / traffic patterns / QoS for wireless Ethernet, Enhancements to support of cyclic traffic

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