



Motivation for new WID proposal on enhancements of LTE services with low latency

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Motivation

- **To enhance system efficiency and coverage of URLLC services targeting SA1 requirements [1,2] with consideration of multiple UEs**
 - with $1-10^{-5}$ reliability and with a user plane latency of 1ms (IMT-2020 requirement)
 - with less stringent requirements, e.g. $1-10^{-4}$ reliability and with a user plane latency of 10ms (agreed in RAN1 for Rel-15 HURLLC before down-scoping in March 2018)
 - with other SA1 requirements
- **To further enhance C-Plane (CP) latency based on short TTI**
- **To identify Rel-16 URLLC use cases, taking into account ongoing SA2 studies on FS_5G_URLLC [3] and FS_EPS_URACE [4].**
 - a study phase to identify the solutions and standard impacts
- **To accommodate the requirement of latency measurement agreed in SA5**

System efficiency enhancements for URLLC

- Rel-15 WI on URLLC was focused on fulfilling IMT-2020 requirements, i.e., one transmission of a packet is with $1-10^{-5}$ reliability for 32 bytes with a user plane latency of 1ms. Due to the tight schedule of Rel-15, not much physical layer enhancements were introduced, and there is room to enhance the system efficiency when multiple users are considered. In addition, SA1 requirements in [1] with reference to [2] also needs to be considered. The following objectives can be used for system efficiency and coverage enhancements.
 - DL control channel enhancements, such as compact DCI and multi-TTI scheduling
 - $1-10^{-5}$ reliability cannot be achieved by 8-CCE PDCCH carrying normal DCI without power boosting. However, power boosting does not always work and could impact the performance of other channels. Thus compact DCI is needed [5].
 - Multi-TTI scheduling can reduce DL control overhead, which was not adopted in sTTI due to the limited time [6].
 - UL control channel enhancement, such as subslot-SPUCCH repetition, HARQ-ACK bundling and power control enhancement
 - With less stringent requirements such as $\{10^{-4}, 10\text{ms}\}$, HARQ-ACK based retransmission can be supported to provide just enough redundancy, which is more efficient than HARQ-less repetitions.
 - Others, including dynamic UL repetition and efficient resource sharing with legacy or non-URLLC UEs, etc.
 - Common solutions between LTE and NR if possible.

Further short TTI based latency enhancements

- Rel-15 WI on shortened TTI and processing time for LTE has provided a useful tool for the services requiring low latency, where mainly user plane latency was considered. Even with Rel-15 CP latency reduction, for UL data transmission, LTE TDD cannot achieve the IMT-2020 latency requirement for typical TDD configuration 2.
- With subslot-based RACH procedure, LTE TDD configuration 2 can achieve IMT-2020 latency requirement. Furthermore, it doesn't need RRC signaling to enable sTTI function, which can speed up sTTI transmission.
 - support sTTI-based CP latency reduction, e.g. sTTI based msg2/3/4

	enh.1ms based scheme	sTTI based scheme
Average TD-LTE CP Latency for UL Data Transmission (config. 2)	24.8ms	18ms

Others

- **A study phase on new Rel-16 URLLC use cases and solutions**
 - To identify Rel-16 URLLC use cases, taking into account ongoing SA2 studies on FS_5G_URLLC [3] and FS_EPS_URACE [4].
- **Latency measurement**
 - It has been agreed in SA5 [7] to support separately monitoring UL and DL user plane latency for URLLC services. Such mechanism needs to be reflected in RAN work.

Objectives

The detailed objectives of this work item include:

- System efficiency and UL coverage enhancements to support URLLC services to target the fulfilment of SA1 requirements in TS 22.278 [RAN1, RAN2]
 - DL control channel enhancements, such as compact DCI, aggregation level of 16 CCEs, and PDCCH repetition
 - UL control channel enhancement, such as PUCCH repetition, HARQ-ACK bundling and PUCCH power control enhancement
 - Data channel enhancements and scheduling procedure, such as dynamic grant based UL repetition
 - Efficient resource sharing between URLLC services and non-URLLC services with e.g. pre-emption indication
- CP latency reduction based on shortened TTI [RAN2, RAN1]
 - New RACH preamble(s) to support sTTI-based RACH procedure
 - shortened TTI based msg2 and msg3
- For the identified further Rel-16 URLLC use cases in TS 22.278 which refers to the use cases in TS 22.261, a study phase can be applied, including e.g., Ethernet Header Compression, and also taking into account ongoing SA2 studies on FS_5G_URLLC and FS_EPS_URACE.[RAN1, RAN2]
- If not covered by other Release 16 work items:
 - Specify support of more practical solutions to allow 0ms interruption time for mobility
 - Specify RAN support of separately monitoring UL and DL user plane latency for URLLC services [RAN2]

References

1. 3GPP TS 22.278 V15.2.0, “Service requirements for the Evolved Packet System (EPS)”.
2. 3GPP TS 22.261 V16.3.0, “Service requirements for the 5G system”.
3. S2-182905, “New SID on enhancement of URLLC supporting in 5GC”, Huawei, China Telecom, CATR, Telecom Italia, InterDigital, CATT, China Mobile, China Unicom, HiSilicon, III, Deutsche Telekom, NEC, Orange, NTT Docomo, Sprint, AT&T, Verizon, KDDI, ITRI, Oppo, LG Electronics, Nokia, Nokia Shanghai Bell, ZTE.
4. S2-182910, “New SID: Study on enhancement of systems using EPS for Ultra Reliability using commodity equipment”, SA WG2.
5. R1-1805322, “Blind/HARQ-less Repetition for Scheduled DL-SCH Operation”, Huawei, HiSilicon.
6. R1-1719858, “Summary of email approval [90b-LTE-07] on details of sDCI formats”, LG Electronics.
7. 3GPP TS 28.552 V0.2.0 "NR and NG-RAN performance measurements and assurance data".



Thank you !