**3GPP TSG RAN Meeting #86 RP-22xxxx**

**eMeeting, March 17-23, 2022**

**Source: ZTE Corporation, Sanechips**

**Title: Summary for WI: NR small data transmissions in INACTIVE state (Rel-17)**

**Agenda item:** **9.5.2.7**

**Document for:** **Discussion and Decision**

# Introduction and justification for the work item

The work item for small data enhancements (NR\_SmallData\_INACTIVE) in Rel-17 enables transmission of small signalling and/or data packets whilst the UE remains in RRC\_INACTIVE state. Prior to Rel-17, NR supports RRC\_INACTIVE state and UEs with infrequent (periodic and/or non-periodic) data transmission are generally maintained by the network in the RRC\_INACTIVE state. Until Rel-16, the RRC\_INACTIVE state doesn’t support data transmission. Hence, the UE has to resume the connection (i.e. move to RRC\_CONNECTED state) for any DL (MT) and UL (MO) data. Connection setup and subsequently release to INACTIVE state happens for each data transmission however small and infrequent the data packets are. This results in unnecessary power consumption and signalling overhead.

Specific examples of small and infrequent data traffic include the following use cases:

* Smartphone applications:
	+ Traffic from Instant Messaging services (whatsapp, QQ, wechat etc)
	+ Heart-beat/keep-alive traffic from IM/email clients and other apps
	+ Push notifications from various applications
* Non-smartphone applications:
	+ Traffic from wearables (periodic positioning information etc)
	+ sensors (Industrial Wireless Sensor Networks transmitting temperature, pressure readings periodically or in an event triggered manner etc)
	+ smart meters and smart meter networks sending periodic meter readings

As noted in 3GPP TS 22.891, the NR system shall:

* be efficient and flexible for low throughput short data bursts
* support efficient signalling mechanisms (e.g. signalling is less than payload)
* reduce signalling overhead in general

Signalling overhead from INACTIVE state UEs for small data packets is a general problem and will become a critical issue with more UEs in NR not only for network performance and efficiency but also for the UE battery performance. In general, any device that has intermittent small data packets in INACTIVE state will benefit from enabling small data transmission in INACTIVE.

The key enablers for small data transmission in NR, namely the INACTIVE state, 2-step, 4-step RACH and configured grant type-1 have already been specified as part of Rel-15 and Rel-16. So, this work builds on these building blocks to enable small data transmission in INACTIVE state for NR.

# Summary of the SDT feature

The Small Data Transmission (SDT) feature allows data and/or signalling transmission while remaining in RRC\_INACTIVE (i.e. without transitioning to RRC\_CONNECTED state). SDT is enabled on a radio bearer basis and is initiated by the UE only if:

* less than a configured amount of UL data awaits transmission across all radio bearers for which SDT is enabled, and;
* the DL RSRP is above a configured threshold, and;
* a valid SDT resource (either RACH or Configured grant) is available

SDT procedure is initiated with either a transmission over RACH (referred to as RA-SDT) or over Type 1 CG resources (referred to as CG-SDT). The SDT resources can be configured on initial BWP (for both RACH and CG. RACH and CG resources for SDT can be configured on either or both of NUL and SUL carriers. The initial PUSCH transmission during the SDT procedure includes at least the CCCH message. While the SDT procedure is ongoing, if data appears in a buffer of any radio bearer not enabled for SDT, the UE initiates a transmission of a non-SDT data arrival indication using UE assistance information message to the network and, if available, includes the resume cause. The network may configure UE to apply ROHC continuity for SDT either when the UE initiates SDT in the cell where the UE received RRCRelease and transitioned to RRC\_INACTIVE state or when the UE initiates SDT in a cell of its RNA.

***Details of RA-SDT***

For RA-SDT, the network may configure 2-step and/or 4-step RA resources. The UE in RRC\_INACTIVE initiates RACH and requests RRC resume together with UL SDT data/signalling. If the UE accesses a gNB other than the last serving gNB, the UL SDT data/signalling is buffered at the receiving gNB, and then the receiving gNB triggers the XnAP Retrieve UE Context procedure. RA-SDT is supported with and without UE context relocation and these two mechanisms as depicted in Figure 1and Figure 2 below.

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| Figure 1: RA-SDT with UE context relocation | Figure 2: RA-SDT without UE context relocation |

***Details of CG-SDT***

The CG-SDT resources are valid only within the cell the UE receives the previous RRCRelease (i.e. only for the *no cell change* case). When using CG resources for initial SDT transmission, the UE can perform autonomous retransmission of the initial transmission if the UE does not receive confirmation from the network. The network can schedule subsequent UL transmissions using dynamic grants or they can take place on the following CG resource occasions. The DL transmissions are scheduled using dynamic assignments. The UE can initiate subsequent UL transmission only after reception of confirmation for the initial PUSCH transmission from the network. For subsequent UL transmission, the UE cannot initiate re-transmission over a CG-SDT resource. CG-SDT can only be initiated with valid UL timing alignment. The UL timing alignment is maintained by the UE based on a SDT-specific timing alignment timer configured by the network via dedicated signalling and, for initial CG-SDT transmission, also by DL RSRP of configured number of highest ranked SSBs which are above a configured RSRP threshold. Upon expiry of the SDT-specific timing alignment timer, the CG resources are released.

# References

1. RP-212594 Work Item on NR small data transmissions in INACTIVE state
2. RP-22xxxx Status Report TSG for WI: NR small data transmissions in INACTIVE state