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Motivation for New WID:
L2 UE-to-Network Relay for Wearable and IoT Devices

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Background in 3GPP

- **FeD2D study item has now completed**

- **Achieved good results in studying a Layer 2 based UE-to-network relay architecture and related sidelink enhancements**
  - The studied architecture in RAN2 allows the network to manage the remote device as a full participant in the 3GPP ecosystem (“identify, address, and reach”)
  - Enhancements to the sidelink are investigated in both RAN1 and RAN2, with a focus on enhanced reliability, and suitability for unicast communication
  - RAN1 also determined it is feasible to enhance the sidelink for UEs with a 1 PRB bandwidth limitation

- **These results on relaying architecture and sidelink enhancements are in condition to be specified in a work item**

Assumptions of SA2

- **In their related study item, SA2 declared 95% completion, pending confirmation of some assumptions from RAN**

- **Our understanding is that the assumptions can be confirmed based on RAN1 and RAN2 work already performed**
  - Thus the SI already addresses the SA2 assumptions
  - See annex to this document for details of the specific assumptions

- **SA2 conclusion pending those assumptions**
  - **If the RAN WGs are able to support the assumptions in subclause 7.0, the above identified solutions meet those SA1 requirements identified by the above Key Issues with the impact as identified in the related evaluation subclauses.**

Justification of SI/WI

- The burgeoning population of IoT devices and especially wearables stand to benefit from relaying
  - Conserve battery power while maintaining network connectivity
  - Should offer services in a manner comparable to direct communication
  - E.g. reliable communication at a data rate suitable for the application
  - Data security should be guaranteed end to end between device and network, as it is today between a UE and the network
  - And corresponding control and signalling procedures would be needed
- The existing support for L3/IP relaying by PC5 or non-3GPP short range technologies does not meet these criteria
  - The remote device appears to the eNB as a bearer of the relay device, without its own separate identity
  - Switching between direct and indirect paths is disruptive to services (change of IP address)
  - Security cannot be assured between the network and the remote device (the relay UE has visibility into the remote UE's data)
- Thus there is a need to specify a layer 2 based architecture that addresses these deficiencies, as studied in the FeD2D study item

Justification of SI/WI

- To support the unicast communication for relay, sidelink requires some enhancements
  - As studied under FeD2D
  - Reliability requires ARQ on sidelink
  - Further efficiency enhancements including DRX, link adaptation
  - Efficiency for unicast requires power control instead of constant power broadcast transmission
  - As low-cost/-complexity UEs are a significant use case for relaying, there should be support for bandwidth limited remote UEs
  - RAN4 needs to specify core and performance requirements

Objectives of SI/WI

- **The detailed objectives of the work item are to specify support for the following functionalities:**
  - **Specify a layer 2 based UE-to-network relaying architecture including methods for E-UTRAN to identify, address, and reach an evolved Remote UE (i.e. eRemote UE) via an evolved ProSe UE-to-Network Relay UE (i.e. eRelay UE).**
    - To support PC5 and non-3GPP sidelink
    - Protocol stacks for relaying, including adaptation layer
    - Signalling and procedures for the needed functionalities (security, connection management, mobility, access control)
    - Service continuity on switching between direct and indirect communication, and group mobility
    - QoS support for indirect 3GPP communication
  - **Specify LTE sidelink enhancements to support the relaying architecture with efficient sidelink operation and low complexity/cost & low energy eRelay/eRemote UEs including eRemote UEs with a single RX chain and/or bandwidth limitation to 6 PRBs.**
    - Synchronisation and discovery enhancements
    - Unicast communication including reliablility and efficiency enhancements
    - Support of remote UEs with bandwidth limitation to 6 PRBs or 1 PRB
    - RAN4 core and performance requirements

Annex: SA2 assumptions, Key Issue 1

- PC5 Signalling Protocol is re-used between eRemote-UE and eRelay-UE; i.e., PDCP is required over PC5;
  - We understand that for Key issue 1, SA2's concern is PDCP is required over PC5 for PC5 signaling transmission.
  - For PC5 connection establishment between eRemote UE and eRelay UE, RAN2 has agreed that ""PC5 Signalling Protocol" is assumed to be used for establishing a secure connection and the legacy connection establishment procedure is assumed to be used". This implies that current PC5 signaling protocol, which includes PDCP, can be reused between eRemote UE and eRelay UE.
  - In this sense, this assumption can be fulfilled with the current RAN2's conclusion.

- The eRelay-UE's AS layer is able to differentiate packets received over PC5 from the eRemote UEs, i.e. whether it is PC5-SP, PDCP packets towards eNB for different bearers (e.g. SRBs, DRBs), and indicate such to the eNB via the Adaptation layer;
  - These assumptions can be fulfilled with the current RAN2's conclusion.
    - RAN2 determined that the mapping of bearers is configured in the eRelay UE by the eNB
    - Identification of the bearer is an agreed function of the adaptation layer
    - PC5-S signalling is already differentiated by the LCID of the SL-SCH

Annex: SA2 assumptions, Key Issue 3

- PC5 Signalling Protocol is re-used between eRemote-UE and eRelay-UE;
  - RAN2 has the same assumption during the SI. The agreement is ““PC5 Signalling Protocol" is assumed to be used for establishing a secure connection and the legacy connection establishment procedure is assumed to be used”
  - Same assumption as in Key Issue 1
  - This assumption can be fulfilled with the current RAN2’s conclusion.

Annex: SA2 assumptions, Key Issue 4

- The eRelay-UE's PC5 AS layer is able to differentiate packets from different bearers (SRBs, DRBs) from a particular eRemote-UE;
  - Same assumption as in Key Issue 1 and same analysis is applicable

- The adaptation layer between eRelay-UE and eNB is able to differentiate bearers (SRBs, DRBs) of a particular UE and apply QoS accordingly.
  - For the eRemote UE's DL data transmission, the Adaptation layer at the eNB is able to differentiate bearers (SRB, DRB) of a particular UE;
  - The QoS parameters of the Uu bearer between the eRelay UE and the eNB are configured by the eNB, and the eNB also know the QoS requirement of a particular eRemote UE's bearers. So as long as the eNB configures suitable mapping between the eRemote UE's bearers and the Uu bearers, the corresponding QoS of the Uu part can be guaranteed.
  - This assumption can be fulfilled with the current RAN2's conclusion.

Annex: SA2 assumptions, Key Issue 5

- For direct to indirect UE-initiated path switch request the eNB allows HO triggered by an RRC message from the eRemote-UE.
  - RAN2 have discussed this issue and have two options on the table
  - Both options meet the SA2 assumption.

- For handover of eRelay-UE with eRemote-UE(s), the eNB handles the handover signalling of the eRelay-UE and eRemote-UE independently. The eNB ensures the handover signalling of the eRemote-UE is handled before the eRelay-UE signalling.
  - Both RAN2 and RAN3 has studied the group HO, i.e. handover of eRelay UE with eRemote UE(s).
  - For the "group HO command" method, the eNB generate the HO command of the eRelay UE and the eRemote UE independently. To save the Uu signalling, they are transmitted together by grouping into one message.
  - Moreover, this method require that eRelay UE needs to forward the eRemote UE's HO command first before it executes HO. Although this is not aligning with the assumption that "The eNB ensures the handover signalling of the eRemote-UE is handled before the eRelay-UE signalling", their effects are the same, i.e. guarantee that eRemote UE can receive the HO command via the eRelay UE before eRelay UE changes the eNB.
  - Based on the above analysis, the group HO command method can guarantee 1) no impact on the EPC and 2) eRemote UE executes HO reconfigurations before the eRelay HO to the target eNB. Although this is not totally aligning with the wording of this assumption, however, the effects are what SA2 desires.

- The eNB is able to handle measurement reports in all scenarios including when eRM-UE is out of coverage of the eNB and when the eRM-UE is under the coverage of another cell.
  - RAN2 analysis of handover has already assumed this. The eNB receives measurement reports through eRL-UE and processes them as usual.

Annex: SA2 assumptions, Key Issue 6

- The DRX feature on PC5 is used to forward Uu paging messages
  - During SI, RAN2 has studied the DRX over PC5 and agreed that “DRX on PC5 should be supported for the evolved ProSe Remote UE in L2 relaying for all RRC states.”

- Forwarding of relevant SIB information and synchronization signals are used by the eRemote-UE in idle mode.
  - For the system information, both of these aspects are aligning with the RAN2’s conclusions as below.
    - The evolved ProSe UE-to-Network Relay UE supports relaying of system information for the linked evolved ProSe Remote UEs located in-coverage of E-UTRAN coverage as well as out of E-UTRAN coverage
    - The linked evolved ProSe Remote UE utilizes the system information of the serving cell of the evolved ProSe UE-to-Network Relay UE.
  - For the synchronization signals, RAN1 has agreed that “In-coverage Relay UE can serve as a synchronization source for in-coverage evolved ProSe Remote UE”， which means that Relay UE needs to transmit SLSS to the eRemote UE. So, the synchronization between the eRelay UE and eRemote UE can be guaranteed.

- Paging messages forwarded on PC5 is performed after but in conjunction with the eRemote-UE PO on Uu.
  - Based on the option 2, the relay UE definitely needs to forward the eRemote UE’s paging over PC5 after the eRemote UE’s PO on Uu since the eRelay UE needs to process the received paging message.

Annex: SA2 assumptions, Key Issue 7

- Multiple priority bearers are multiplexed over the same eRelay-UE's DRB.
  - The designed Layer 2 relay protocol (including both UP and CP protocol) are service agnostic. Multiplexing of bearers can take place without any effect from the priority.

- The access stratum layer between eRelay-UE and eRemote-UE is able to provide priority treatment for the emergency and eMPS bearers.
  - RAN1 has studied the sidelink resource scheduling enhancement for the eRemote UE, and proposed three options. At least for option 1, the priority treatment for the emergency and eMPS bearers over PC5 can be guaranteed since the eNB has full context of the eRemote UE with respect to the bearer priority.
  - The other two options involve some assistance from the UEs but should still allow for the eNB to control the scheduling for priority if needed.

Thank you !