

A Study of the Radio Resource Control Connection Re-establishment Procedure on the UE side in 3GPP

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Abstract— The RRC(Radio Resource Control) protocol belongs to the 3GPP protocol stack and handles the control plane signalling of Layer 3 between the UE(User Equipment) and the eNB(Evolved Node B). The RRC Connection Re-establishment is one of the RRC main functions and re-establishes which involves the resumption of SRB1(Signalling Radio Bearer) operation, the re-activation of security and the configuration. In this paper, we proposes the RRC Connection Re-establishment procedure on the UE side when the RLF(radio link failure) is detected or handover failure occurs, etc.

Keywords— RRC, Radio Resource Control, Connection Re-establishment, 3GPP

I. INTRODUCTION

In the 3GPP, RRC Protocol layer exists in UE and eNB and handles the control plane signaling of Layer 3. The main services and functions of the RRC protocol include broadcast of system information, paging, establishment/release of an RRC connection, transfer of NAS(Non-Access Stratum) information, security configuration, transfer of UE radio access capability, radio resource configuration, measurement configuration and reporting, mobility control, recovery from failures of AS layers by re-establishment of an RRC connection, and so on.

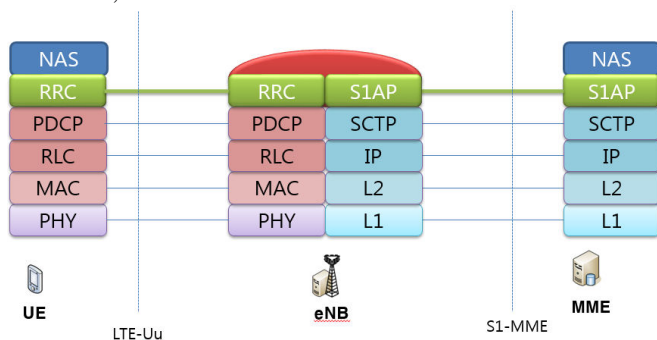


Figure 1. 3GPP Protocol Stack of the Control Plane

One of the main functions of RRC protocol is RRC Connection Re-establishment which is to re-establish the RRC connection between the UE and the eNB from various failures on the radio interface. Also, it helps to resume the SRB1 operation and re-activate the security.

In this paper, we explain when RRC connection re-establishment procedure is triggered and how it works, also propose detailed RRC Connection Re-establishment procedure on the UE side.

II. RRC CONNECTION RE-ESTABLISHMENT

2.1 Overview

RRC connection re-establishment procedure on the UE side initiates when one of the following conditions is met:

- upon detecting radio link failure
- upon handover failure
- upon mobility from E-UTRA failure
- upon integrity check failure indication from lower layers
- upon an RRC connection reconfiguration failure

The UE considers that the RLF is detected when one of the following cases occurs.

- when out-of-synchronization occurs in the Physical layer
- when the random access problem occurs in the MAC layer
- when the maximum number of retransmissions is reached in the RLC layer

A UE in RRC_CONNECTED can initiate the RRC Connection Re-establishment procedure in order to keep the RRC connection while security is activated. If security has not been activated, the UE does not initiate the procedure but goes directly into RRC_IDLE.

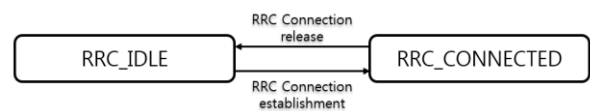


Figure 2. RRC States

2.2 Procedure

While security is activated, UE initiates the RRC connection re-establishment procedure when detecting failure such as radio link failure, or etc. If UE detects failures, UE transmits RRCConnectionReestablishmentRequest message to eNB. The eNB which received RRCConnectionReestablishmentRequest message initiates the RRC connection re-establishment procedure.

mentRequest message from UE, sends RRCConnection Reestablishment or RRCConnection ReestablishmentReject message to UE depending on whether or not the eNB has been prepared with a UE context. When the UE receives the RRCConnectionReestablishment from eNB, the RRC Connection Re-establishment procedure is successfully finished by sending RRCConnectionReestablishmentComplete message to eNB. Also, when the UE receives the RRCConnectionReestablishmentReject message, it is finished in failure.

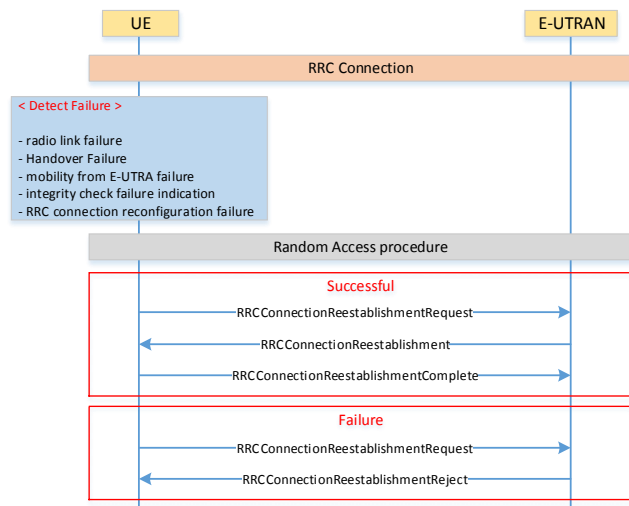


Figure 3. RRC Connection Re-establishment Procedure

2.3 Messages

1) RRCConnectionReestablishmentRequest

This message is used to request the reestablishment of an RRC connection.

- Signalling radio bearer: SRB0
- RLC-SAP: TM
- Logical channel: CCCH
- Direction: UE to E-UTRAN

2) RRCConnectionReestablishment

This message is used to re-establish SRB1.

- Signalling radio bearer: SRB0
- RLC-SAP: TM
- Logical channel: CCCH
- Direction: E-UTRAN to UE

3) RRCConnectionReestablishmentComplete

This message is used to confirm the successful completion of an RRC connection reestablishment.

- Signalling radio bearer: SRB1
- RLC-SAP: AM
- Logical channel: DCCH
- Direction: UE to E-UTRAN

4) RRCConnectionReestablishmentReject

This message is used to indicate the rejection of an RRC connection reestablishment request.

- Signalling radio bearer: SRB0
- RLC-SAP: TM

- Logical channel: CCCH
- Direction: E-UTRAN to UE

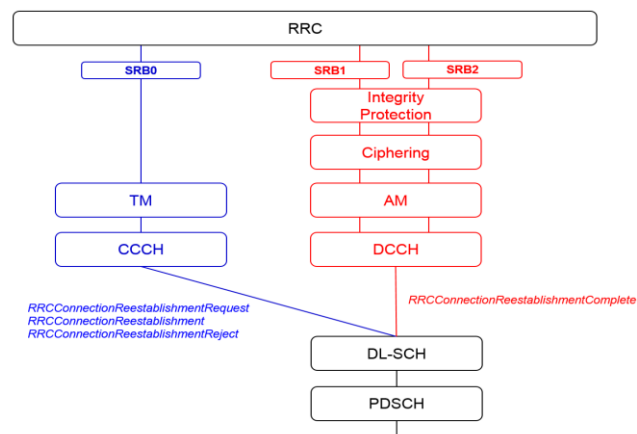


Figure 4. RRC Connection Re-establishment message flow

III. RRC CONNECTION RE-ESTABLISHMENT OPERATION ON THE UE SIDE

The UE shall initiate the RRC Connection Re-establishment procedure as shown in Figure 5 when one of the failure conditions mentioned above is met. If the procedure is initiated, the UE shall stop timer T310, T312, T311 and suspend all RBs except SRB0, reset MAC and apply the default configuration for L1/L2.

Next, the UE performs cell selection procedure where the UE searches for a suitable cell and accordingly acquires the MIB and SIB of cells that are broadcasted by the eNB.

After cell selection procedure is successfully finished and MIB/SIB information is also successfully received, the UE submits RRCConnectionReestablishmentRequest message including c-RNTI, physCellId, shortMAC-I and re-establishmentCause to low layers for transmission. At this moment, the low layers perform the random access procedure in which the network for the first time knows that some UE is trying to get access.

The next step of the UE is to process the received RRCConnectionReestablishment or RRCConnectionReestablishmentReject message from eNB. When the UE receive RRCConnectionReestablishment message, the UE stops timer T301, re-establishes PDCP and RLC for SRB1, performs the radio resource configuration procedure, resumes SRB1, configures low layers to activate integrity protection and ciphering and re-activates the AS security without changing algorithm. The UE transmits RRCConnectionReestablishmentComplete message to eNB after received RRCConnectionReestablishment message is normally processed. If the UE received RRCConnectionReestablishmentReject message from eNB, the UE performs the actions upon leaving RRC_CONNECTED. Then, the UE resets MAC, stops all timers that are running except T320, T325, T330 and releases all radio resources including release of the RLC entity, the MAC configuration and the associated PDCP entity for all established RBs. And finally, the UE enters RRC_IDLE and the procedure ends.

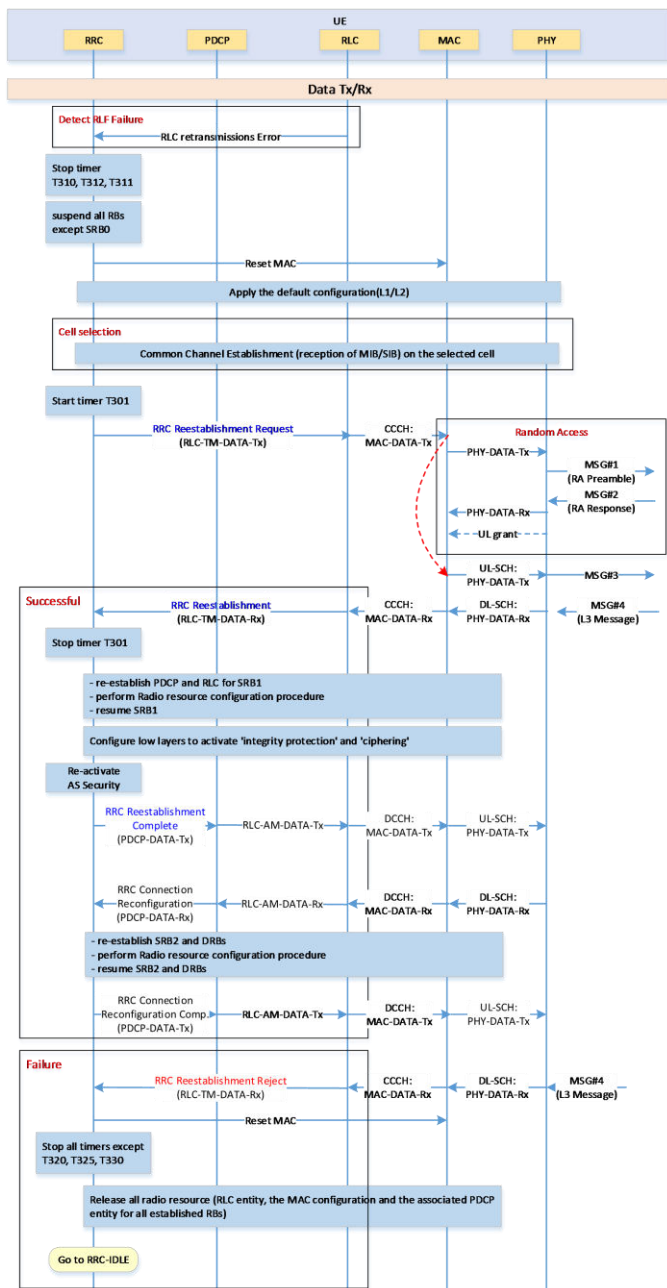


Figure 5. RRC Connection Re-establishment Procedure on the UE side

IV. CONCLUSIONS

The RRC Connection Re-establishment is a kind of mechanism to make a RRC Connection recovery when radio link got broken for some reason. It is very important in the aspects of maintaining the reliability of radio link and ensuring continuity of service.

In this paper, we proposed the detailed operation procedure of the RRC Connection Re-establishment and used message structure in this procedure on the UE side. We look forward to helping someone try to research and develop the RRC protocol.

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