

Source: CATT
Title: RRC connection re-establishment and resume procedures in NR
Agenda Item: 10.4.1.3.5
Document for: Discussion and Decision

1. Introduction

In RAN2#97bis meeting, some guidelines are agreed for the RRC messages and procedures [1].

Agreement

1 Aim to limit the number of RRC messages i.e. avoid introducing several messages with similar content/similar procedural handling (details can be discussed when more progress has been made on the individual procedures)

This contribution discusses the details of individual procedures for RRC connection re-establishment and resume.

2. Discussion

2.1. RRC connection re-establishment

In LTE, The purpose of this procedure is to re-establish the RRC connection, which involves the resumption of SRB1 operation, the re-activation of security and the configuration of only the PCell.

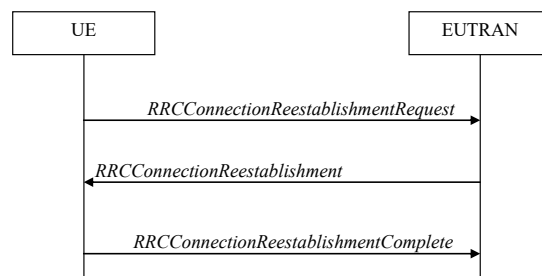


Figure 1 RRC connection re-establishment, successful

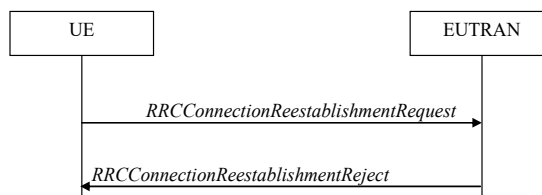


Figure 2 RRC connection re-establishment, failure

The function of re-establishing the RRC connection should naturally be supported in NR for UE in connected mode, including the successful and failure procedures.

Proposal 1: Support the successful and failure procedures for RRC connection re-establishment in NR.

The content of the RRC messages for RRC connection re-establishment are listed in the table 1.

Table 1 content of the RRC messages for RRC connection re-establishment

RRC message	Content in LTE	Proposed Content in NR
<i>RRCConnectionReestablishmentRequest</i>	● ue-Identity	● ue-Identity

	<ul style="list-style-type: none"> ● reestablishmentCause 	<ul style="list-style-type: none"> ● reestablishmentCause
<i>RRConnectionReestablishment</i>	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● radioResourceConfigDedicated (for SRB1) ● NextHopChainingCount 	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● radioResourceConfigDedicated (for SRB1) ● NextHopChainingCount
<i>RRConnectionReestablishmentComplete</i>	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● rlf-InfoAvailable-r9 ● logMeasAvailable-r10 ● connEstFailInfoAvailable-r11 ● logMeasAvailableMBSFN-r12 	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier
<i>RRConnectionReestablishmentReject</i>	<ul style="list-style-type: none"> ● No IE 	<ul style="list-style-type: none"> ● No IE

For *RRConnectionReestablishmentRequest*, *RRConnectionReestablishment* and *RRConnectionReestablishmentReject* messages, all parameters for LTE are also needed in NR.

For *RRConnectionReestablishmentComplete* message, the IEs *rlf-InfoAvailable-r9*, *logMeasAvailable-r10*, *connEstFailInfoAvailable-r11* and *logMeasAvailableMBSFN-r12* are related to MDT/SON which are not supported in NR phase I, so only IE *rrc-TransactionIdentifier* is needed in NR.

The RRC connection re-establishment procedure is used for SRB1 resumption and re-activation of security and the configuration of only the PCell, so the following parameters are proposed to support.

Proposal 2: Support the following parameters for the RRC messages in RRC connection re-establishment procedure, the details of each parameter can be discussed further:

- ***RRConnectionReestablishmentRequest*: UE ID, Re-establishment Cause**
- ***RRConnectionReestablishment*: Transaction ID, dedicated radio resource configuration for SRB1, NCC**
- ***RRConnectionReestablishmentComplete*: Transaction ID**

2.2. RRC connection resume

In LTE, the purpose of this procedure is to resume an RRC connection, which involves the resumption of all SRBs and DRBs, and the re-activation of security.

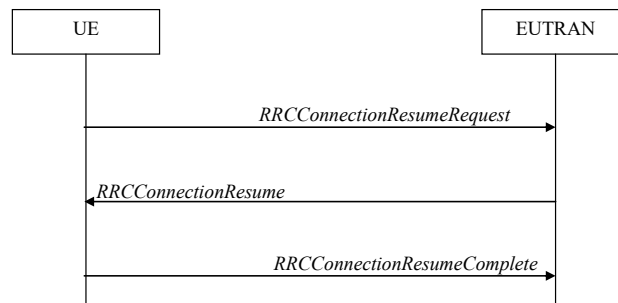


Figure 3 RRC connection resume, successful

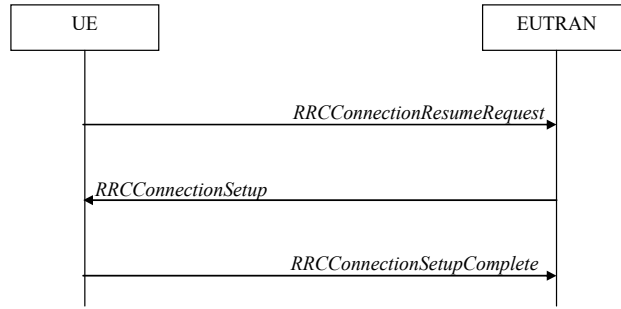


Figure 4 RRC connection resume fallback to RRC connection establishment, successful

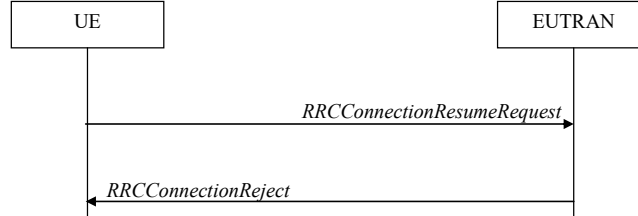


Figure 5 RRC connection resume, network reject or release

In RAN2#99, it is agreed that for INACTIVE to CONNECTED RRC transition, RRC connection resume request kind of message is sent over SRB0 carried by RACH MSG3. When RAN successfully retrieves and verifies the UE context, RRC connection resume kind of message is sent over SRB1 carried by RACH MSG4, and MSG5 is RRC connection resume complete kind of message over SRB1 [2]. Accordingly, the successful resume is supported for the UE in inactive mode in NR. Moreover, RAN2 agreed that when RAN cannot successfully retrieve and verify the UE context, RRC Connection Setup kind of message is sent over SRB0 (which would enable a fallback to establish a new RRC connection similar to Rel-13 LTE), i.e., fallback to RRC connection establishment is supported for the UE resuming from inactive mode in NR. In addition, in RAN2#98 it is agreed that “If the UE received a message suspending the UE on MSG4 on SRB1 then the UE remains in RRC inactive” [3], it can be realized by network reject or release procedure, which is under discussion of email discussion#29. Consequently, we expect that network reject or release procedures should be supported for the UE resuming from inactive mode in NR.

Proposal 3: Support the successful resume, fallback to RRC connection establishment and either network reject or release procedures for RRC connection resume in NR.

In RAN2#99, RAN2 also achieved some agreements on the information included in the above messages directly and indirectly. Specifically, for INACTIVE to CONNECTED RRC transition, RRC Connection Resume Request kind of message includes UE identity (or UE context identity), establishment (or resume) cause information and UE's security information (e.g. authentication token). FFS if MSG3 could also include other information. RRC Connection Resume kind of message can optionally include the dedicated radio resource configuration. FFS Whether RRC Connection Resume Complete includes NAS PDU, 5CN node selection information (e.g. selected PLMN identity or NSSAI).

The content of the RRC messages for RRC connection resume are listed in the table 1.

Table 2 content of the RRC messages for RRC connection resume

RRC message	Content in LTE	Proposed Content in NR
<i>RRCConnectionResumeRequest</i>	<ul style="list-style-type: none"> ● resumeIdentity-r13 ● shortResumeMAC-I-r13 ● resumeCause-r13 	<ul style="list-style-type: none"> ● resumeIdentity-r13 ● UE's security information (e.g. authentication token) ● resumeCause-r13
<i>RRCConnectionResume</i>	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● radioResourceConfigDedicated-r13(for all SRBs and DRBs) ● nextHopChainingCount-r13 	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● radioResourceConfigDedicated-r13(for all SRBs and DRBs)

	<ul style="list-style-type: none"> ● measConfig-r13 ● antennaInfoDedicatedPCell-r13 ● drb-ContinueROHC-r13 	<ul style="list-style-type: none"> ● nextHopChainingCount-r13 ● measConfig-r13 ● antennaInfoDedicatedPCell-r13 ● drb-ContinueROHC-r13
<i>RRConnectionResumeComplete</i>	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● selectedPLMN-Identity-r13 ● dedicatedInfoNAS-r13 ● rlf-InfoAvailable-r13 ● logMeasAvailable-r13 ● connEstFailInfoAvailable-r13 ● mobilityState-r13 ● mobilityHistoryAvail-r13 ● logMeasAvailableMBSFN-r13 	<ul style="list-style-type: none"> ● rrc-TransactionIdentifier ● selectedPLMN-Identity-r13 ● dedicatedInfoNAS-r13
<i>RRConnectionReject</i>	<ul style="list-style-type: none"> ● rrc-SuspendIndication-r13 	<ul style="list-style-type: none"> ● rrc-SuspendIndication-r13

For *RRConnectionResumeRequest*, *RRConnectionResume* and *RRConnectionReject* messages, all parameters for LTE are also needed in NR, except that in *RRConnectionResumeRequest* it is FFS whether the UE's security information is shortResumeMAC-I. As to *RRConnectionReject* message, although in light connection a new rrc-LightConnectionIndication is introduced to indicate that the UE should remain lightly connected and not release its stored context if present [4], whether MSG 4 can be a reject to idle is for further study in case of inactive state. If it is agreed that MSG 4 can be a reject to idle afterwards, this kind of indication should be added in Table 2.

For *RRConnectionResumeComplete* message, the IEs *rlf-InfoAvailable-r13*, *logMeasAvailable-r13*, *connEstFailInfoAvailable-r13* and *logMeasAvailableMBSFN-r13* are related to MDT/SON which are not supported in NR phase I. The IEs *mobilityState-r13* and *mobilityHistoryAvail-r13* are related to UE mobility history which is not supported in NR phase I. So only IEs *rrc-TransactionIdentifier*, *selectedPLMN-Identity-r13* and *dedicatedInfoNAS-r13* are needed in NR. The RRC connection resume procedure is used for all SRBs and DRBs resumption and re-activation of security and, so the following parameters are proposed to support.

Proposal 4: Support the following parameters for the RRC messages in RRC connection resume procedure, the details of each parameter can be discussed further:

- ***RRConnectionResumeRequest*: Resume ID, Resume Cause, UE's security information**
- ***RRConnectionResume*: Transaction ID, dedicated radio resource configuration for all SRBs and DRBs, NCC, measurement Configuration, antenna info, Continue ROHC for DRB**
- ***RRConnectionResumeComplete*: Transaction ID, selected PLMN ID, dedicated NAS info.**
- ***RRConnectionReject*: Suspend Indication**

2.3. Comparison of RRC connection re-establishment and resume

Comparison can be made based on the analysis of section 2.1 and 2.2. The details are shown below:

- RRC re-establishment is used for connected mode UE, and RRC resume is used for inactive mode UE. In these two cases, the network both has UE's AS context.
- They are both used to re-active the security.
- RRC re-establishment can resume SRB1, and RRC resume can resume all SRBs and DRBs.
- From the procedure point of view, the successful and reject procedures are similar. The RRC resume procedure has a fallback mechanism to RRC connection establishment, which is not supported by RRC re-establishment.
- From the content point of view:

- both *RRCCConnectionReestablishmentRequest* and *RRCCConnectionResumeRequest* have UE ID and cause, although the details are not the same. And the latter has just one more parameter, i.e. UE's security information.
- Both *RRCCConnectionReestablishment* and *RRCCConnectionResume* have Transaction ID, dedicated radio resource configuration and NCC, and the latter has more parameters for other purpose.
- Both *RRCCConnectionReestablishmentComplete* and *RRCCConnectionResumeComplete* have Transaction ID, and the latter has more parameters for other purpose.
- For reject case, only reject message for resume procedure has a Suspend Indication.

So there are many commonalities between RRC connection re-establishment procedure and RRC connection resume procedures. Thus it should be aim to combine the RRC messages used for RRC connection re-establishment procedure and RRC connection resume procedure.

Proposal 5: Aim to combine the following RRC messages for NR:

- *RRCCConnectionReestablishmentRequest* and *RRCCConnectionResumeRequest*
- *RRCCConnectionReestablishment* and *RRCCConnectionResume*
- *RRCCConnectionReestablishmentComplete* and *RRCCConnectionResumeComplete*
- *RRCCConnectionReestablishmentReject* and *RRCCConnectionReject*

3. Conclusion

In this contribution, we discuss the individual procedures for RRC connection re-establishment and resume, and propose:

Proposal 1: Support the successful and failure procedures for RRC connection re-establishment in NR.

Proposal 2: Support the following parameters for the RRC messages in RRC connection re-establishment procedure, the details of each parameter can be discussed further:

- *RRCCConnectionReestablishmentRequest*: UE ID, Re-establishment Cause
- *RRCCConnectionReestablishment*: Transaction ID, dedicated radio resource configuration for SRB1, NCC
- *RRCCConnectionReestablishmentComplete*: Transaction ID

Proposal 3: Support the successful resume, fallback to RRC connection establishment and either network reject or release procedures for RRC connection resume in NR.

Proposal 4: Support the following parameters for the RRC messages in RRC connection resume procedure, the details of each parameter can be discussed further:

- *RRCCConnectionResumeRequest*: Resume ID, Resume Cause, UE's security information
- *RRCCConnectionResume*: Transaction ID, dedicated radio resource configuration for all SRBs and DRBs, NCC, measurement Configuration, antenna info, Continue ROHC for DRB
- *RRCCConnectionResumeComplete*: Transaction ID, selected PLMN ID, dedicated NAS info.
- *RRCCConnectionReject*: Suspend Indication

Proposal 5: Aim to combine the following RRC messages for NR:

- *RRCCConnectionReestablishmentRequest* and *RRCCConnectionResumeRequest*
- *RRCCConnectionReestablishment* and *RRCCConnectionResume*
- *RRCCConnectionReestablishmentComplete* and *RRCCConnectionResumeComplete*
- *RRCCConnectionReestablishmentReject* and *RRCCConnectionReject*

4. Reference

[1] RAN2#97bis, Chairman notes.

[2] RAN2#99, Chairman notes.

[3] RAN2#98, Chairman notes.

[4] R2-1701689, Light Connection Feature specification in 36.331 - TP agreements and outcome of email discussion [96#66], RAN2#97.