Nokia Academy

LTE Optimization Principles [RL70]

Module 06

Call Setup Optimization

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Document Change History

Date	Version	Name	Change comment

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Module Objectives
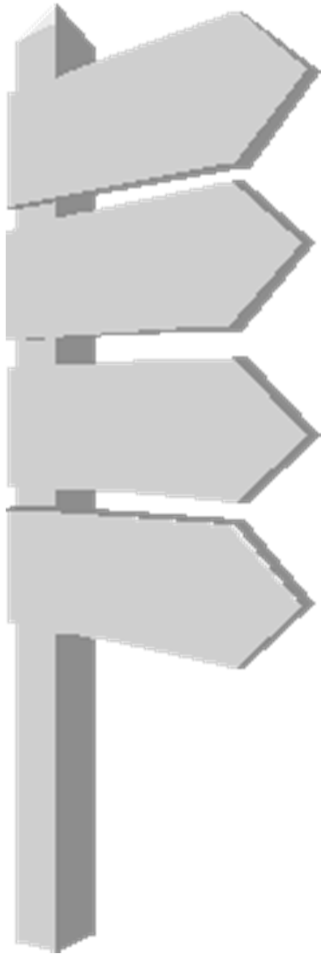
- After completing this module, you will be able to:
  - Describe related network and field KPIs
  - Discuss call setup signaling from S1 and air IF perspective
  - Describe the related trigger points
  - Give an overview about problem fixing
  - Summarize features and parameters
  - Discuss examples via means of field mesurement and UE trace
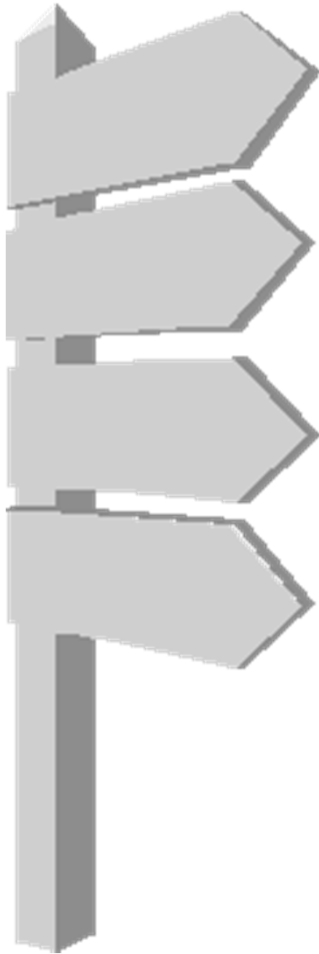
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Top Level KPIs – Category: Accessibility

- Initial E-RAB Accessibility: LTE_5060h

- Total E-UTRAN RRC Connection Setup Success Ratio: LTE_5218e

- Initial E-RAB Setup Success Ratio: LTE_5112c

Note that the probability to access a service is covered in accessibility.

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The Most Important Call Setup KPIs – RRC Connetion Setup Success Ratio

• LTE_5218e Total E-UTRAN RRC Connection Setup Success Ratio

• **Formula:** (Logical)
RRC Con SSR=(RRC connection setup completions / RRC connection requests)*100%

• **Formula:** (NE names)
100*sum([Signaling Connection Establishment completions]) / sum([Signaling Connection Establishment attempts due to MO-Signaling]+[Signaling Connection Establishment attempts due to MT-Access]+[Signaling Connection Establishment attempts due to MO-Data]+[Signaling Connection Establishment attempts for delay tolerant access]+ [Signaling Connection Establishment attempts for high priority calls]]+[Number of Signaling Connection Establishment attempts for emergency calls]+[Signaling Connection Establishment attempts due to others])

• **Description:** The KPI shows the setup success ratio for the elementary procedure "RRC connection establishment" used to set up a radio connection from UE to eNB (involves SRB1 establishment).

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The Most Important Call Setup KPIs – E-RAB Setup Success Ratio

- LTE_5017a E-RAB Setup Success Ratio

- **Formula:** (Logical)
E-RAB SSR=(E-RAB setup successes / E-RAB setup attempts)*100%

- **Formula:** (NE names)
100*sum([EPS Bearer setup completions]) / sum([EPS Bearer setup attempts])

- **Formula:** (NetAct names)
100*sum(EPS_BEARER_SETUP_COMPLETIONS) /
sum(EPS_BEARER_SETUP_ATTEMPTS)

The Most Important Call Setup KPIs – RACH success rate

LTE_1056d Complete RACH Setup Success Rate (from Jump)

- **Formula:** (NetAct names)

100 * SUM(RRC_CON_RE_ESTAB_ATT +

SIGN_CONN_ESTAB_ATT_MO_S +

SIGN_CONN_ESTAB_ATT_MT +

SIGN_CONN_ESTAB_ATT_MO_D +

SIGN_CONN_ESTAB_ATT_OTHERS +

SIGN_CONN_ESTAB_ATT_EMG +

SIGN_CONN_ESTAB_ATT_HIPRIO +

SIGN_CONN_ESTAB_ATT_DEL_TOL)

/ SUM(RACH_STP_ATT_SMALL_MSG + RACH_STP_ATT_LARGE_MSG)

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LTE_5569a E-UTRAN RACH Setup Completion Success Rate

LTE_5569a E-UTRAN RACH Setup Completion Success Rate

- START RELEASE: RL40

Formula: (NetAct names)

100* sum(RACH_STP_COMPLETIONS)

/sum

(RACH_STP_ATT_SMALL_MSG + RACH_STP_ATT_LARGE_MSG + RACH_STP_ATT_DEDICATED)

Formula: (Counter ids)

100* sum([M8001C8])/sum([M8001C6] + [M8001C7] + [M8001C286])

Field KPIs
Service Request Time: Network Initiated

It is the time taken by the LTE network to set up an EPS bearer on request by the P-GW. The EPS bearer has to be created before IP packets can be sent (DL) to the UE if the UE has no proper EPS bearer for the given IP packet flow. The network initiated Service Request Time includes a Paging Time (ref. to Paging Time) if the UE is idle. The EPS Bearer Setup procedure is based on the Paging and Service Request procedures according to [3GPP36.331] and 3GPP23.401].

Mean value and 95% from all measured samples

Formula: Service Request Time [s] = $t_{RRC\_Reconfig} - t_{RRC\_Request}$

Related E-UTRAN Counters (same as UE Initiated)

- Mean EPS Setup Time: *SAEB.EstabTimeMean.QCI SAEB.EstabTimeMean.QCI*
- Max EPS Setup Time: *SAEB.EstabTimeMax.QCI*

Field KPIs
Service Request Success Rate

- This KPI is defined as the ratio between successfully established EPS bearers compared to the overall number of EPS bearer establishment attempts. It corresponds to the probability that a user or the LTE network can establish an EPS bearer at any moment in time.

- Requests that are terminated by timer expiry (due to the non-accessibility of some LTE resource) are considered as unsuccessful attempts. Authentication errors (requests rejected by the MME) are included in the total number of failures.

- Only the first *RRC CONNECTION REQUEST is to be considered, since counting* retries of the same message would increase the overall number of bearer establishment attempts, and thus reduce the success ratio.

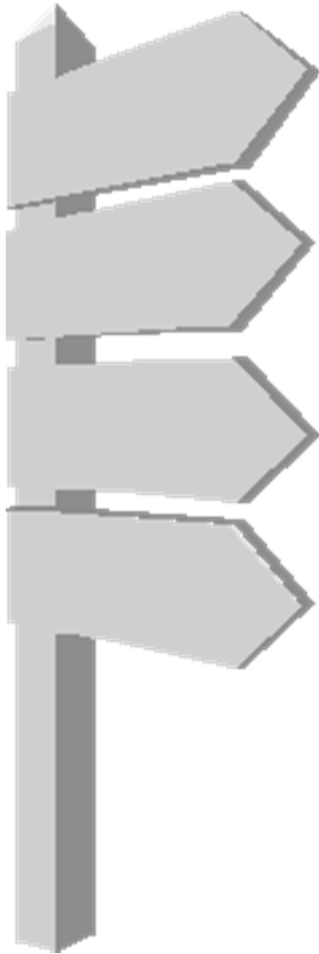**NOKIA**

Field KPIs
Service Request Success Rate Continued

Formula:

$$\text{EPSSR} = \frac{\text{number\_of (RRC\_CONN\_RECONFIGURATION\_COMPLETE)}}{\text{number\_of (RRC\_CONNECTION\_REQUEST)}} \times 100\%$$

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- Project Example

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Reference values

Performance Benchmarker for PLMN KPI comparison

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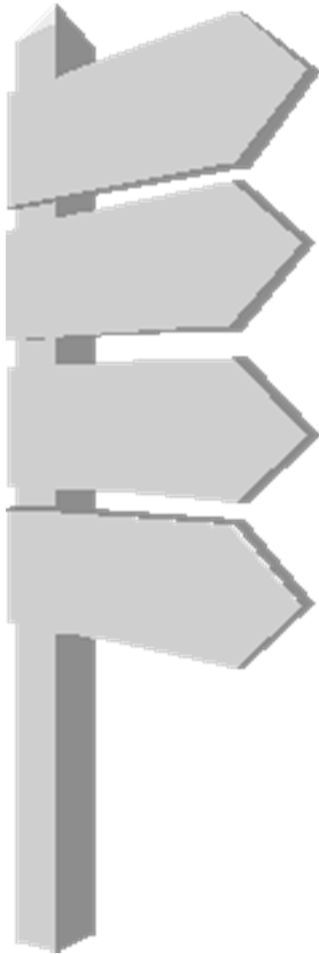
KPI Reference Values

Example values only!!

Network average from different networks (A, B, C,…)

KPI	A	B	C	D	E
RRC Setup Success Rate [%] (LTE_5218e)	99.98	99,96	99,96	99.94	99.92
eRAB Setup Success Ratio [%] (LTE_5017a)	99,98	99,98	99,97	99.97	99.96

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Call Setup Phases

- RRC and E-RAB phases
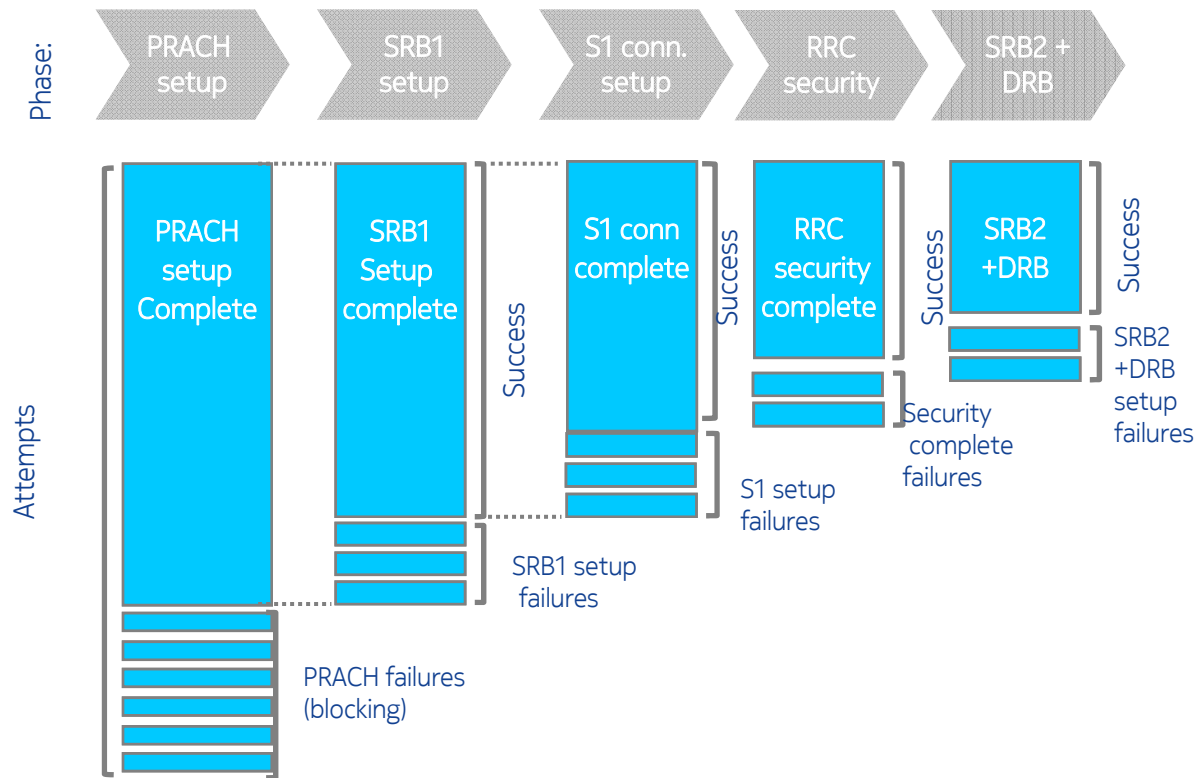
PRACH + Msg3
   Initial network access process between UE and eNB

SRB1 setup
   eNB resources are reserved for signaling connection between UE and eNB

NAS security
   UE has RRC connection. If dropped, also active
   RAB is dropped.

RRC security + UE capability enquiry

SRB2 + DRB setup
   UE has RAB connection

Call setup is affected if any of the followings take place.
- PRACH setup failures
- SRB 1 setup failures
- S1 connection failures
- RRC security + UE cap failures
- SRB2 & DRB setup failures

Connection Setup

The call setup has five phases

1. PRACH phase (also applies to handover)

2. SRB1 setup

3. NAS security setup

4. RRC security + UE Capability Enquiry (UE Cap Enquiry optional)

5. SRB2 + DRB setup

- Success of phases 1-2 must be monitored from PRACH and RRC signaling counters

- Success of phases 3-5 is monitored from S1AP and E-RAB counters → *"S1 view"*

S1 Context Setup, Successful
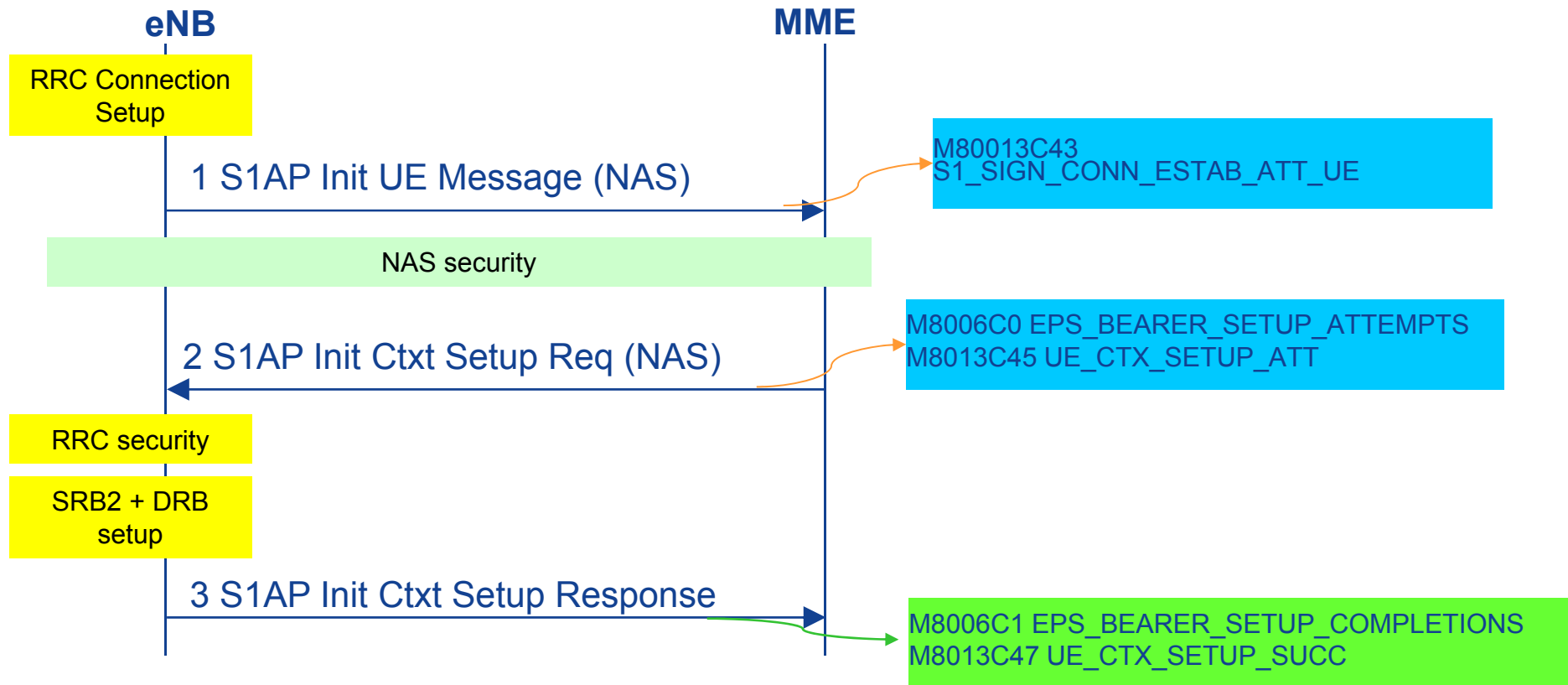
Analysis:

- LTE_5009b S1 Initial Context Setup Success Ratio
- LTE_5017a E-RAB Setup Success Ratio

S1 Context Setup, Unsuccessful 1

eNB

MME

RRC Connection
Setup

1 S1AP Init UE Message (NAS)

M80013C43
S1_SIGN_CONN_ESTAB_ATT_UE

NAS security

2 S1AP Init Ctxt Setup Req (NAS)

M8006C0 EPS_BEARER_SETUP_ATTEMPTS
M8013C45 UE_CTX_SETUP_ATT

RRC security

SRB2 + DRB
setup

M8013C49 UE_CTX_SETUP_FAIL_RADIO_INT

failure

3 S1AP Init Ctxt Setup Failure
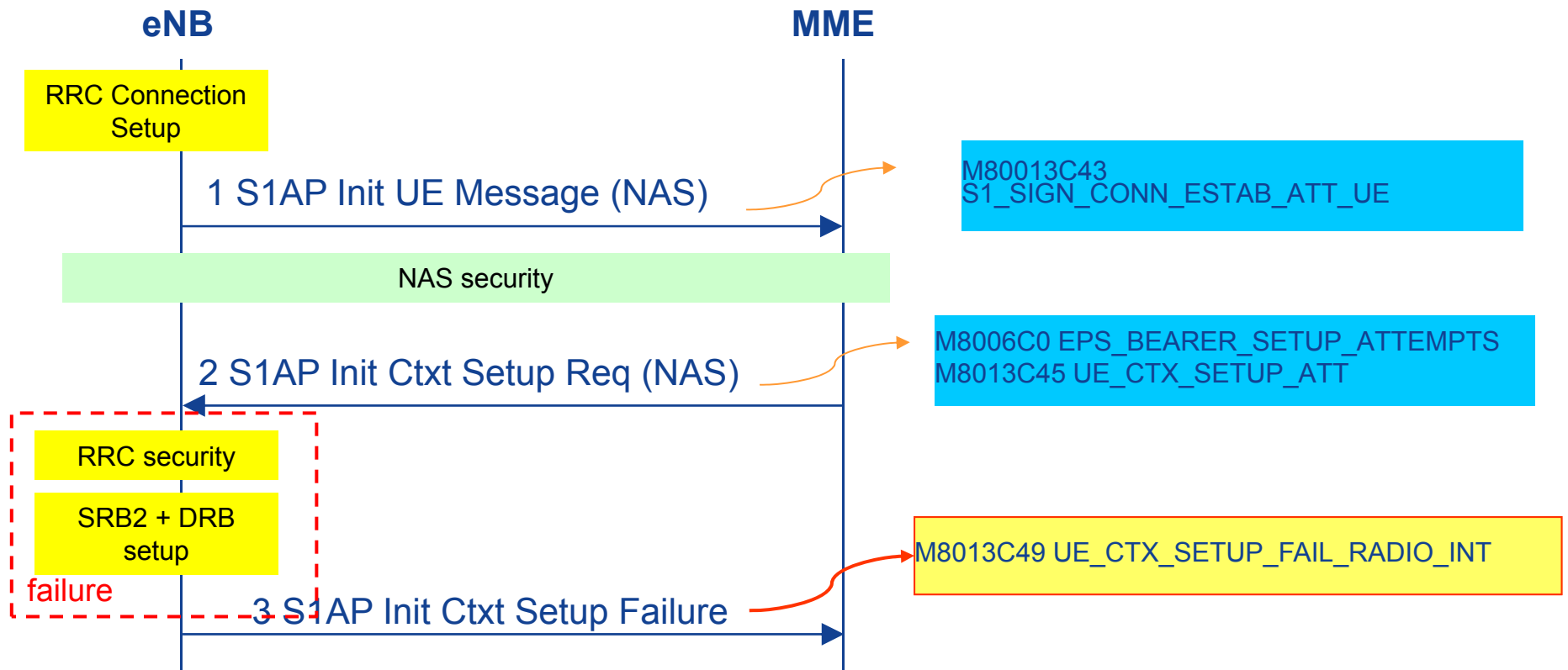
Analysis:

• LTE_5522a E-UTRAN Initial Context Setup Failure Ratio due to Failed Radio Interface Procedure

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S1 Context Setup, Unsuccessful 2

eNB

MME

RRC Connection Setup

1 S1AP Init UE Message (NAS)

M80013C43
S1_SIGN_CONN_ESTAB_ATT_UE

eNB receives no response from MME for time period defined by *tEstS1Con* → S1 + SRB1 released

- non-modifiable parameter `<p name="tEstS1Con">16000</p>`
- unit: milliseconds
- timer stopped when any subsequent S1AP message for this UE is received
- *no eNB counter triggered if timer expires*
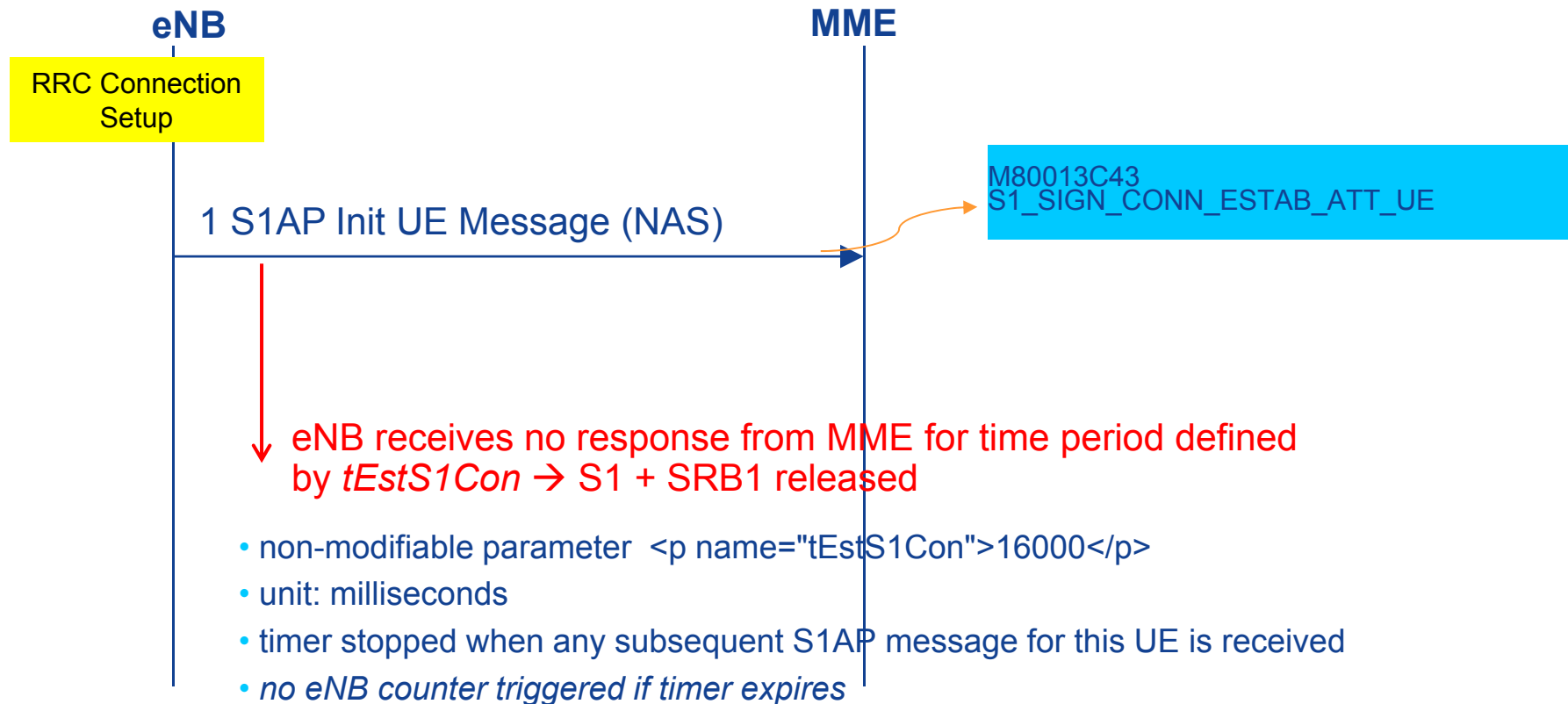
Analysis:
- no counter available for the number of S1 connection setup timer expires

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S1 Context Setup, Unsuccessful 3

eNB

MME

RRC Connection Setup

1 S1AP Init UE Message (NAS)

M80013C43
S1_SIGN_CONN_ESTAB_ATT_UE

NAS security

Call drops at air interface
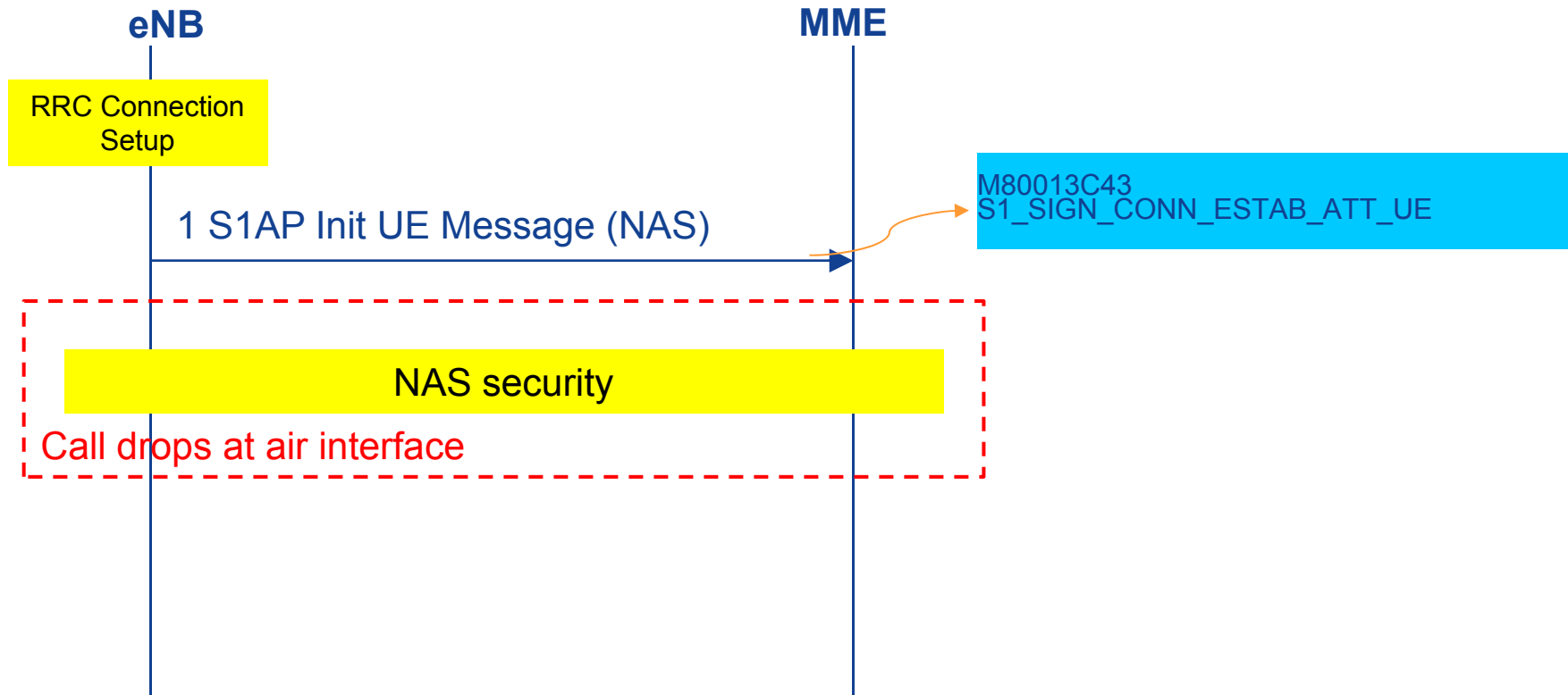
Analysis:

• no eNB counters available for RRC layer success of NAS security messaging.

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S1 Context Setup, Unsuccessful, Emil Example

Order	Message	Message Name	User data	Time	Time diff
1	23B7	MGMT_RACH_USER_SETUP_RESP	eNB PDCCH/DCI (Msg2): RandomAccess-RNTI, Preamble 31, CRNTI: 54135	15:37:13.51	00:00:00.00
2	23B0	MGMT_INIT_SHARED_USER_DATA_RESP	UE ID: -1, CRNTI: 54135, Cell ID: 40961	15:37:13.51	00:00:00.00
3	23A9	MSR_RARESPONSEIND	eNB PDSCH/DL-SCH/CCCH (Msg2): RandomAccessResponse, CRNTI: 5413!	15:37:13.51	00:00:00.00
4	235E	MAC_CCCH_DATA_RECEIVE_IND_MSG	UE PUSCH/UL-SCH/CCCH (Msg3): RrcConnectionRequest, CRNTI: 54135, C	15:37:13.54	00:00:00.03
5	2221	MAC_USER_SETUP_REQ_MSG	UE ID: 39, CRNTI: 54135, Trans ID: 3, Cell ID: 40961	15:37:13.54	00:00:00.03
6	23A2	MGMT_USER_RECONFIG_REQ	UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
7	23A2	MGMT_USER_RECONFIG_REQ	UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
8	23A3	MGMT_USER_RECONFIG_RESP	UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
9	23A3		UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
10	23B0		UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
11	23C8		UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
12	23C9		UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
13	23CA		UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
14	23CB		UE ID: 39, CRNTI: 54135, Cell ID: 40961	15:37:13.54	00:00:00.03
15	2222		UE ID: 39, CRNTI: 54135, CRNTI: 9123, Trans ID: 3, Cell ID: 40961	15:37:13.54	00:00:00.03
16	2353	TUP_USER_SETUP_REQ_MSG	UE ID: 39, UE ID: 0, CRNTI: 54135, Trans ID: 2, Cell ID: 40961	15:37:13.54	00:00:00.03
17	2354	TUP_USER_SETUP_RESP_MSG	UE ID: 39, CRNTI: 54135, Trans ID: 2, Cell ID: 40961	15:37:13.54	00:00:00.03
18	235F	MAC_CCCH_DATA_SEND_REQ_MSG	eNB PDSCH/DL-SCH/CCCH: RrcConnectionSetup, CRNTI: 54135, Cell ID: 4(	15:37:13.54	00:00:00.03
19	234E	TUP_SRB_RECEIVE_IND_MSG	UE PUSCH/UL-SCH/DCCH: RrcConnectionSetupComplete + EMM:SERVICE	15:37:13.59	00:00:00.07
20	232E	ENBC_ID_ALLOCATION_REQ_MSG	UE ID: 39, MME S1AP ID: 0, Cell ID: 40961	15:37:13.59	00:00:00.07
21	232F	ENBC_ID_ALLOCATION_RESP_MSG	UE ID: 39, MME S1AP ID: 0, L3 Link ID: 1	15:37:13.59	00:00:00.07
22	2241	TUP_L3_CONN_SETUP_REQ_MSG	UE ID: 39, Conn ID: 33, L3 Link ID: 1	15:37:13.59	00:00:00.07
23	2242	TUP_L3_CONN_SETUP_RESP_MSG	UE ID: 39, Conn ID: 33, L3 Link ID: 1	15:37:13.59	00:00:00.07
24	27DF	TUPC_L3S1_MESSAGE_REQ_MSG	eNB S1AP: InitialUEMessage + EMM:SERVICE REQUEST, UE ID: 39, MME S	15:37:13.59	00:00:00.07
25	275A	MAC_RADIO_LINK_STATUS_IND_MSG	UE ID: 39, CRNTI: 54135, Cell ID: 40961 RadioLinkState: CqiRlf_ON	15:37:19.65	00:00:06.14
26	275A	MAC_RADIO_LINK_STATUS_IND_MSG	UE ID: 39, CRNTI: 54135, Cell ID: 40961 RadioLinkState: TatExpiry	15:37:21.48	00:00:07.96
27	234F	TUP_SRB_SEND_REQ_MSG	eNB PDSCH/DL-SCH/DCCH: RrcConnectionRelease, UE ID: 39, CRNTI: 541	15:37:29.90	00:00:16.39
28	2351	TUP_USER_DELETE_REQ_MSG	UE ID: 39, CRNTI: 54135, Trans ID: 2, Cell ID: 40961	15:37:30.54	00:00:17.03

Callout (rows 10–15): UE timer T3417 (fixed, 5seconds) expires after receiving no response to Service Request → UE silently disappears.

Callout (row 27): *tEstS1Con* timer expires after 16 sec → RRC release
(or maybe caused by CQI fail??)

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Call Setup Phases, Air Interface Messages

UE	eNB	MME

PRACH RANDOM ACCESS

PRACH RANDOM ACCESS RESPONSE

PUSCH (Msg3) RRC: Connection Request

random access procedure

1. PRACH phase

RRC: Connection Setup

RRC: Connection Setup Complete + EMM ATT_REQ + ESM PDN CONN_REQ

S1AP: INITIAL UE MESSAGE + EMM ATT_REQ + ESM PDN CONN_REQ

2. SRB1 setup

NAS Security Establishment (Authentication + NAS security start)

3. NAS security

S1AP: INITIAL CONTEXT SETUP REQUEST + EMM ATT_ACC + ESM ACT_DEF_BEAR_REQ

RRC: Security Mode Command

RRC: UECapabilityEnquiry

AS security set up

RRC: Security Command Complete

RRC: UECapabilityInformation

4. RRC security + UE Capability Enquiry

UE radio capabilities available
→ DRB can be established

RRC: RRCConnectionReconfiguration + EMM ATT_ACC + ESM ACT_DEF_BEAR_REQ

DRB and SRB2 Configuration

RRC: RRCConnectionReconfigurationComplete

5. SRB2/DRB setup

S1AP: INITIAL CONTEXT SETUP RESPONSE

S1AP: UE CAPABILITY INFO INDICATION

RRC: UL NAS INFO TRANSFER (EMM ATT_COMPLETE + ESM ACT_DEF_BEAR_SUCC

S1AP: UL NAS TRANSPORT (*EMM ATT_COMPLETE + ESM ACT_DEF_BEAR_SUCC*)

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Message Legend For This Section

→ Message mandatory

⇢ Message optional
or conditional

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1. PRACH Phase, Including Msg3

UE eNB

1 PRACH MAC Random Access Preamble

M8001C6:RACH_STP_ATT_SMALL_MSG
M8001C7:RACH_STP_ATT_LARGE_MSG
M8001C286:RACH_STP_ATT_DEDICATED

2 PDCCH MAC RA-RNTI

2 PDSCH MAC Random Access Response

M8001C8: RACH_STP_COMPLETIONS

NOTE: includes also RAR sent to ded preambles

3 PUSCH RLC TM SRB0
RRC-ConnectionRequest

4 PDSCH RRC Conn Setup (Contention Resolution)

M8013C17:SIGN_CONN_ESTAB_ATT_MO_S
M8013C18:SIGN_CONN_ESTAB_ATT_MT
M8013C19:SIGN_CONN_ESTAB_ATT_MO_D
M8013C20:SIGN_CONN_ESTAB_ATT_OTHERS
M8013C21:SIGN_CONN_ESTAB_ATT_EMG
M8013C31:SIGN_CONN_ESTAB_ATT_HIPRIO
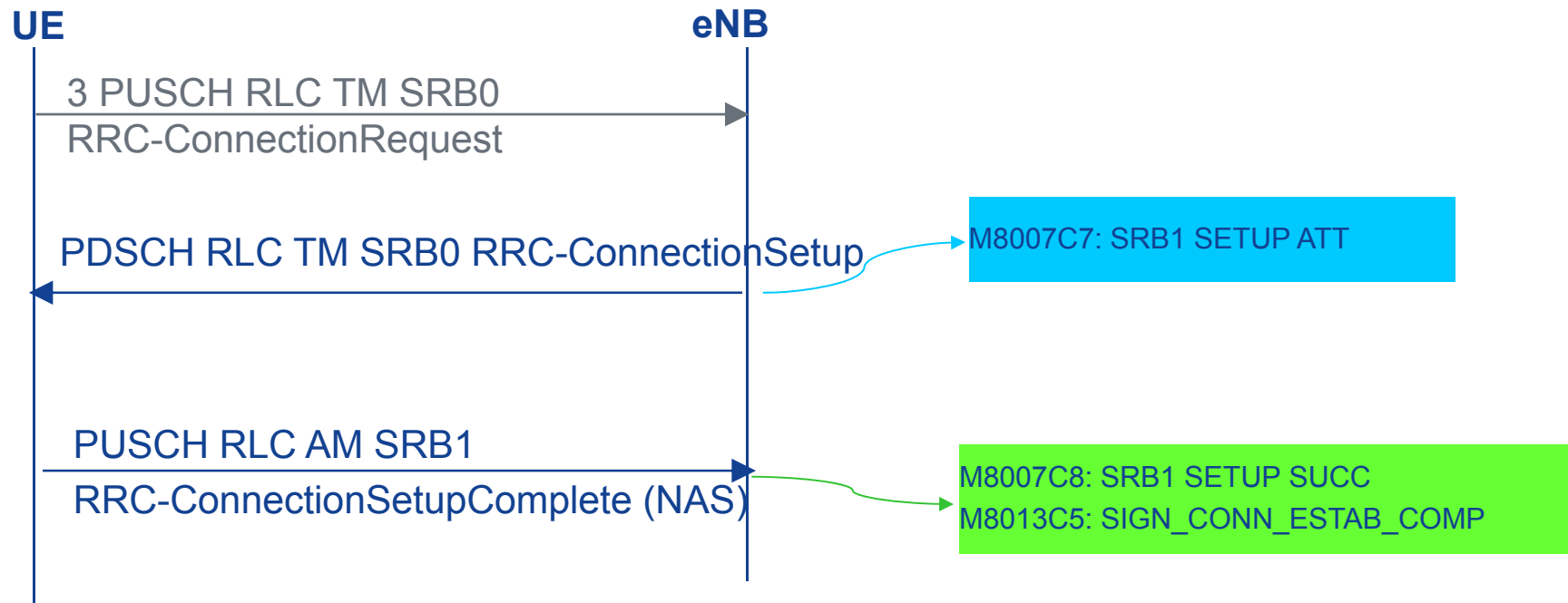M8013C34: SIGN_CONN_ESTAB_ATT_DEL_TOL

Analysis:
LTE_5569a RACH Setup Completion Success Rate (RA_Responses/RA_Preambles)

- Compare drive test logs to Cell trace logs if Msg2 heard by UE
- Compare drive test logs to Cell trace logs if Msg3 heard by eNB

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2. SRB1 Setup Phase, Successful

UE   eNB

3 PUSCH RLC TM SRB0
RRC-ConnectionRequest

PDSCH RLC TM SRB0 RRC-ConnectionSetup

M8007C7: SRB1 SETUP ATT

PUSCH RLC AM SRB1
RRC-ConnectionSetupComplete (NAS)

M8007C8: SRB1 SETUP SUCC
M8013C5: SIGN_CONN_ESTAB_COMP

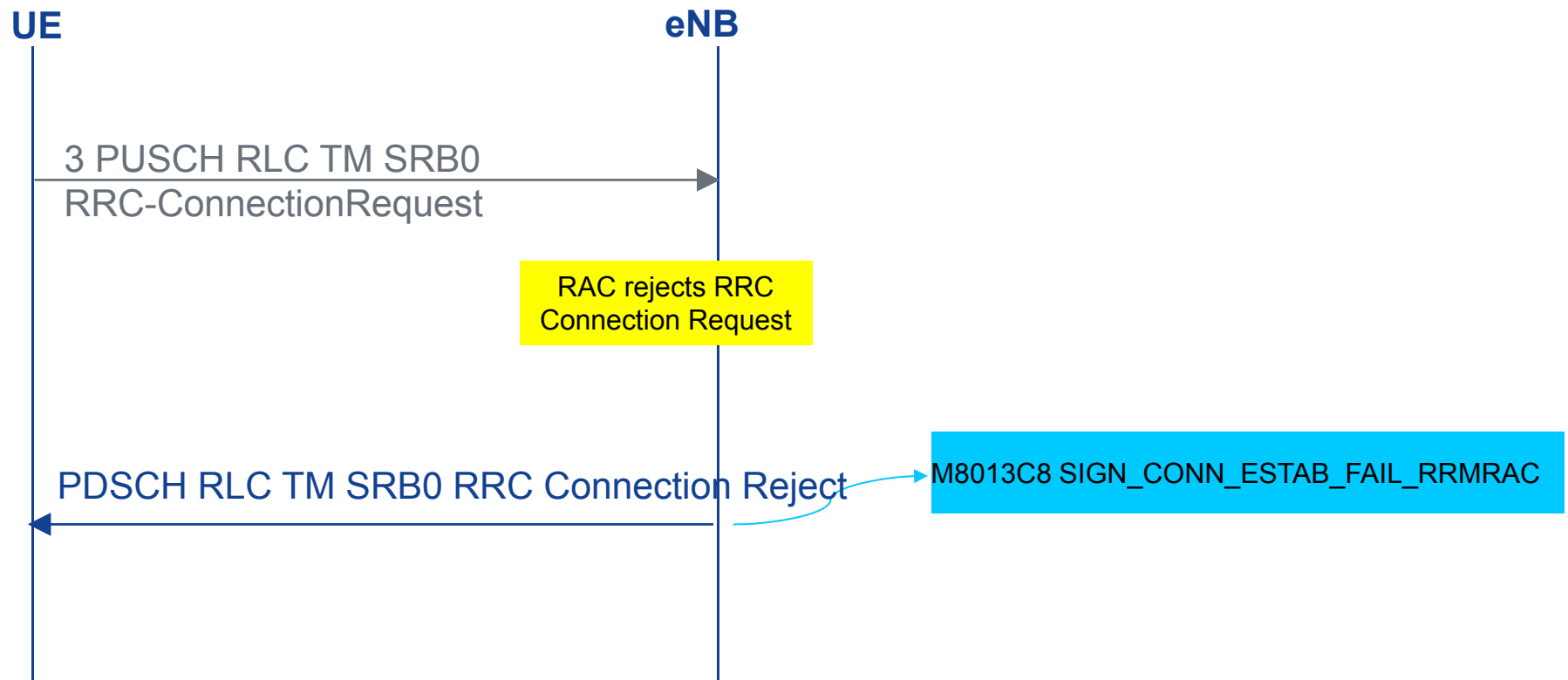NOTE: no RLC layer DL retransmissions in RRC Conn Setup. Default MCS and default number of PRBs used.
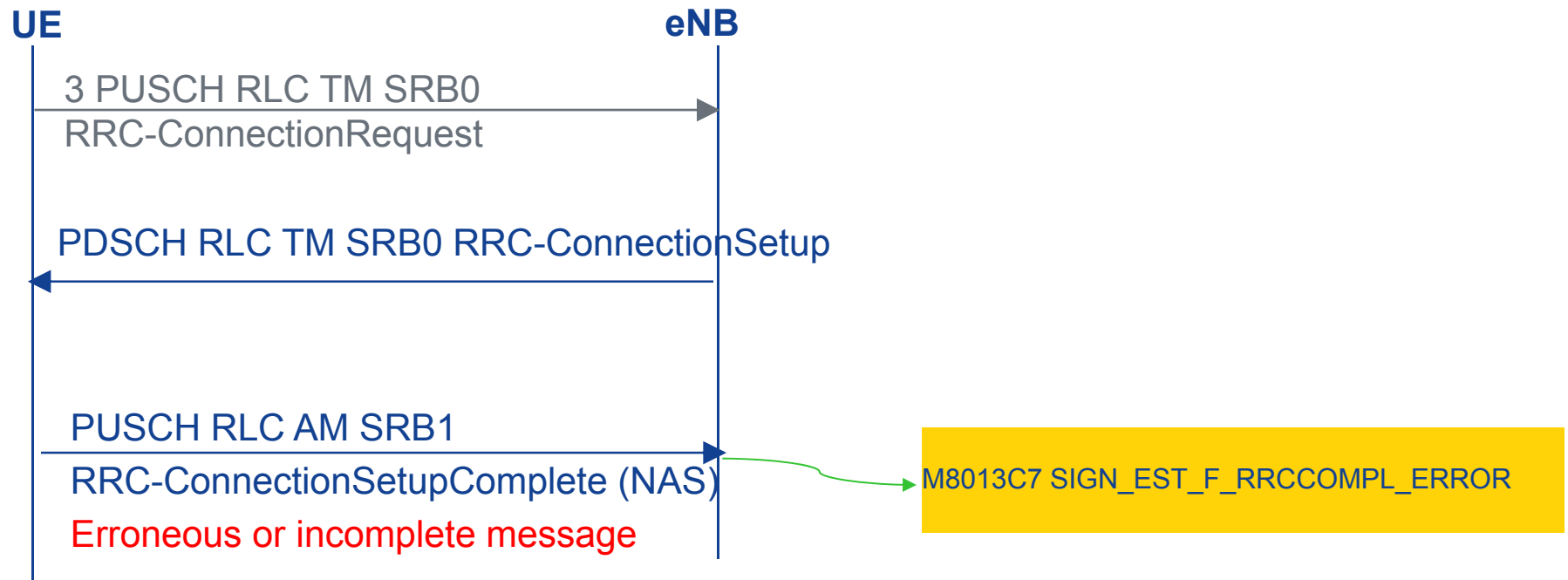
Analysis:

• LTE_5a SRB1 setup Success Ratio

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2. SRB1 Setup Phase, Unsuccessful 1

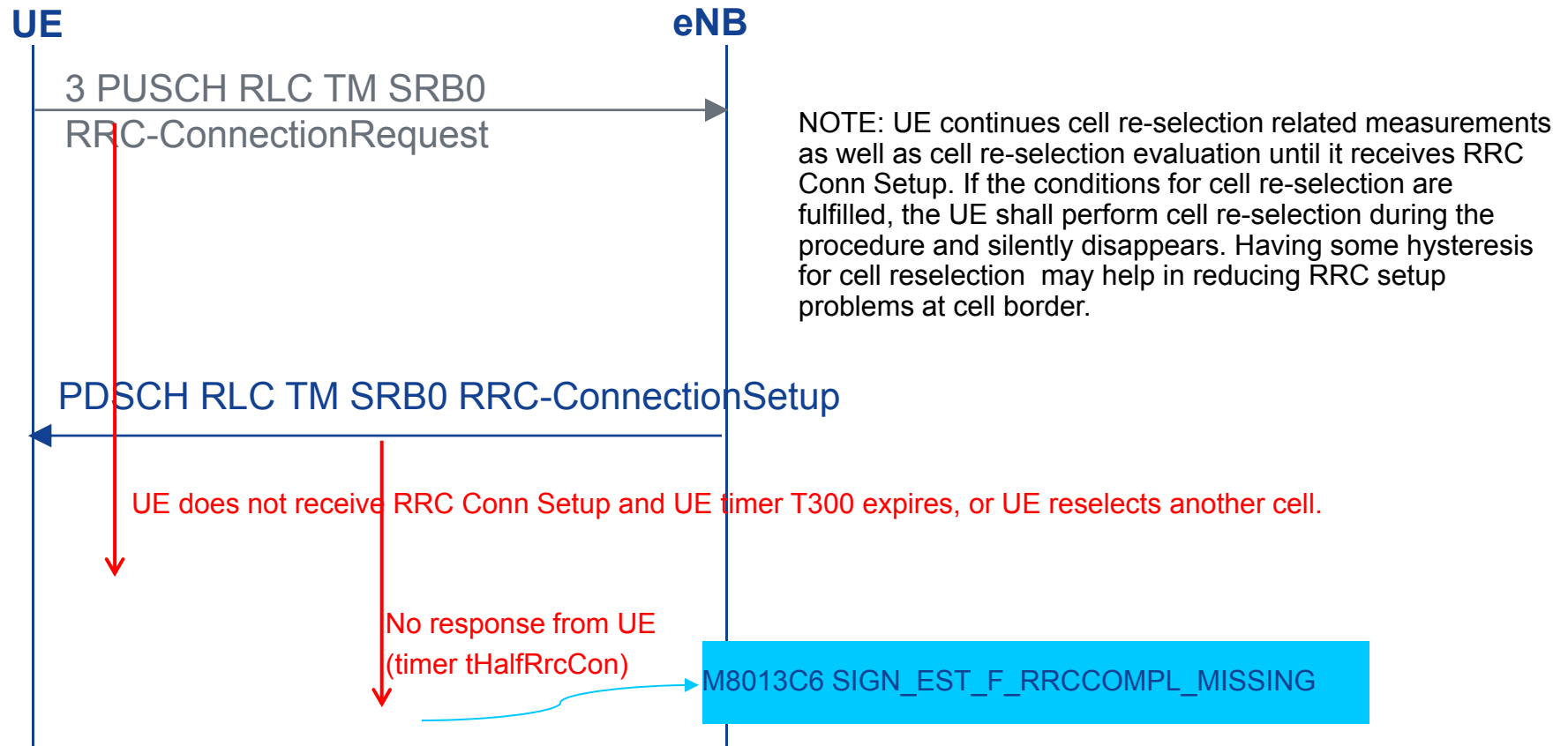**UE**   **eNB**

3 PUSCH RLC TM SRB0
RRC-ConnectionRequest

> RAC rejects RRC
> Connection Request

PDSCH RLC TM SRB0 RRC Connection Reject   M8013C8 SIGN_CONN_ESTAB_FAIL_RRMRAC

SRB1 may be rejected due to:

- insufficient PUCCH resources
- max number of RRC connected users exceeded

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2. SRB1 Setup Phase, Unsuccessful 2

UE   eNB

3 PUSCH RLC TM SRB0
RRC-ConnectionRequest

PDSCH RLC TM SRB0 RRC-ConnectionSetup

PUSCH RLC AM SRB1

RRC-ConnectionSetupComplete (NAS)

Erroneous or incomplete message

M8013C7 SIGN_EST_F_RRCCOMPL_ERROR

2. SRB1 Setup Phase, Unsuccessful 3

UE   **eNB**

3 PUSCH RLC TM SRB0
RRC-ConnectionRequest

NOTE: UE continues cell re-selection related measurements as well as cell re-selection evaluation until it receives RRC Conn Setup. If the conditions for cell re-selection are fulfilled, the UE shall perform cell re-selection during the procedure and silently disappears. Having some hysteresis for cell reselection may help in reducing RRC setup problems at cell border.

PDSCH RLC TM SRB0 RRC-ConnectionSetup

UE does not receive RRC Conn Setup and UE timer T300 expires, or UE reselects another cell.

No response from UE
(timer tHalfRrcCon)

M8013C6 SIGN_EST_F_RRCCOMPL_MISSING

- UE timer T300 (def=400ms) may expire if DL RRC Conn Setup reception fails
- eNB has a non-modifiable timer parameter for half-open RRC connections *tHalfRrcCon* (2000ms) to wait for RRC Conn Setup Complete from UE

2. SRB1 Setup Phase, Unsuccessful 3, Emil Example

Order	Message	Message Name	User data	Time	Time diff
1	23B7	MGMT_RACH_USER_SETUP_RESP	eNB PDCCH/DCI (Msg2): RandomAccess-RNTI, Preamble 22, CRNT	09:58:06.43	00:00:00.00
2	23B0	MGMT_INIT_SHARED_USER_DATA_RESP	UE ID: -1, CRNTI: 56804, Cell ID: 3564	09:58:06.43	00:00:00.00
3	23A9	MSR_RARESPONSEIND	eNB PDSCH/DL-SCH/CCCH (Msg2): RandomAccessResponse, CRN	09:58:06.43	00:00:00.00
4	235E	MAC_CCCH_DATA_RECEIVE_IND_MSG	UE PUSCH/UL-SCH/CCCH (Msg3): RrcConnectionRequest, CRNTI:	09:58:06.47	00:00:00.03
5	2221	MAC_USER_SETUP_REQ_MSG	UE ID: 472, CRNTI: 56804, Trans ID: 3, Cell ID: 3564	09:58:06.47	00:00:00.03
6	23A0	MGMT_USER_SETUP_REQ	UE ID: 472, CRNTI: 56804, Trans ID: 3, Cell ID: 3564	09:58:06.47	00:00:00.03
7	23A2	MGMT_USER_RECONFIG_REQ	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
8	23A3	MGMT_USER_RECONFIG_RESP	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
9	23A1	MGMT_USER_SETUP_RESP	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
10	23B0	MGMT_INIT_SHARED_USER_DATA_RESP	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
11	23C8	DLSCH_UE_RECONFIG_REQ	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
12	23C9	DLSCH_UE_RECONFIG_RESP	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
13	23CA	ULSCH_UE_RECONFIG_REQ	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
14	23CB	ULSCH_UE_RECONFIG_RESP	UE ID: 472, CRNTI: 56804, Cell ID: 3564	09:58:06.47	00:00:00.03
15	2222	MAC_USER_SETUP_RESP_MSG	UE ID: 472, CRNTI: 56804, CRNTI: 9163, Trans ID: 3, Cell ID: 3564	09:58:06.47	00:00:00.03
16	2353	TUP_USER_SETUP_REQ_MSG	UE ID: 472, UE ID: 0, CRNTI: 56804, Trans ID: 2, Cell ID: 3564	09:58:06.47	00:00:00.03
17	2354	TUP_USER_SETUP_RESP_MSG	UE ID: 472, CRNTI: 56804, Trans ID: 2, Cell ID: 3564	09:58:06.47	00:00:00.03
18	235F	MAC_CCCH_DATA_SEND_REQ_MSG	eNB PDSCH/DL-SCH/CCCH: RrcConnectionSetup, CRNTI: 56804, (	09:58:06.47	00:00:00.03
19	2351	TUP_USER_DELETE_REQ_MSG	UE ID: 472, CRNTI: 56804, Trans ID: 2, Cell ID: 3564	09:58:08.51	00:00:02.07
20	2352	TUP_USER_DELETE_RESP_MSG	UE ID: 472, CRNTI: 56804, Trans ID: 2, Cell ID: 3564	09:58:08.51	00:00:02.07
21	221C	MAC_USER_DELETE_REQ_MSG	UE ID: 472, CRNTI: 56804, Trans ID: ... 564	09:58:08.51	00:00:02.07

tHalfRrcCon expires after 2sec, TUP deletes user. NOTE: there is no RRC Connection to release

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3. NAS Security, Successful

UE   MME

PDSCH RLC AM SRB1 NAS transfer (AUTH REQ)   start T3460 MME timer

PUSCH RLC AM SRB1 NAS transfer (AUTH RSP)   stop T3460 MME timer

PDSCH RLC AM SRB1 NAS transfer (SEC CMD)   start T3460 MME timer

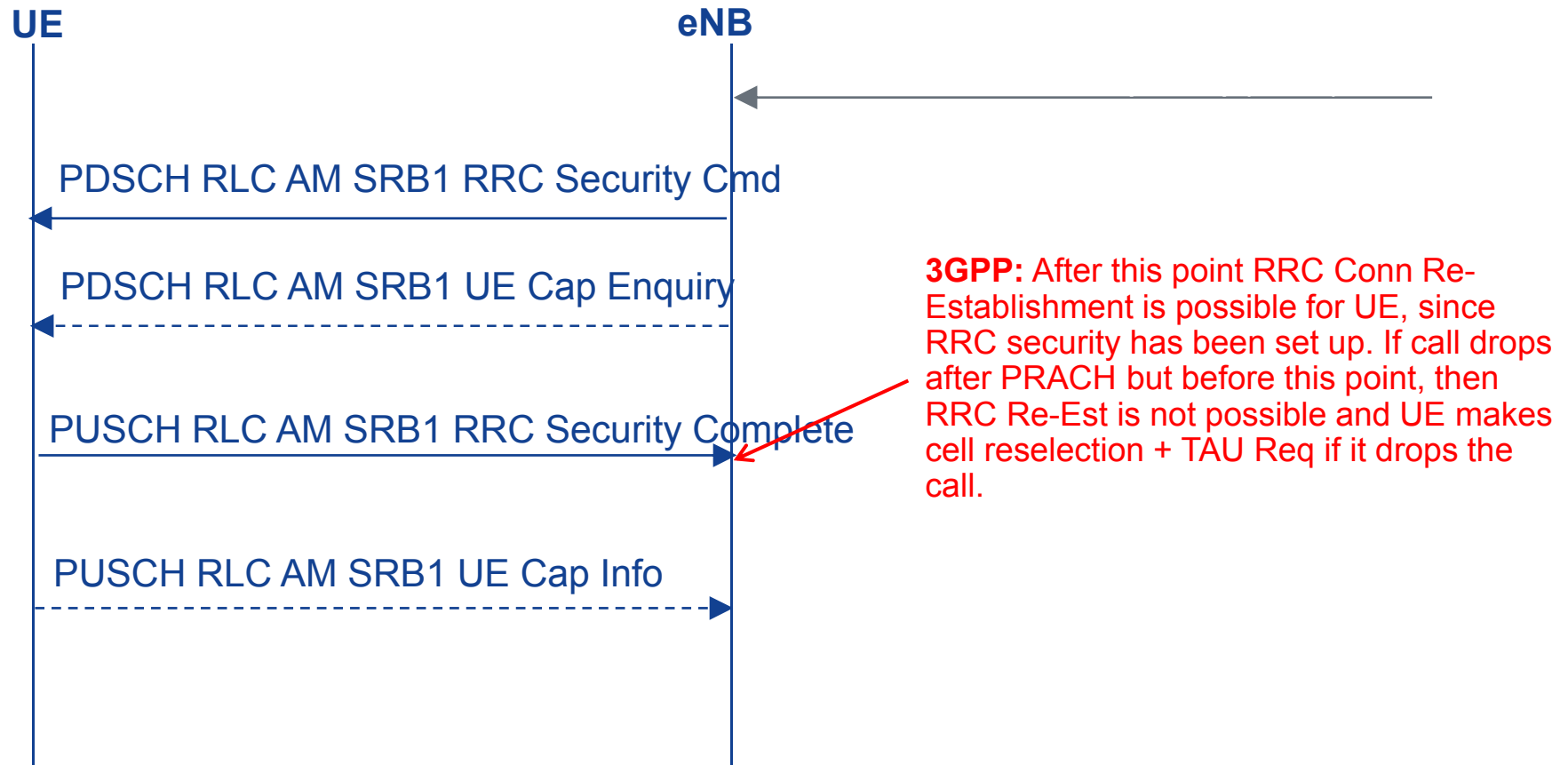PUSCH RLC AM SRB1 NAS transfer (SEC CMP)   stop T3460 MME timer
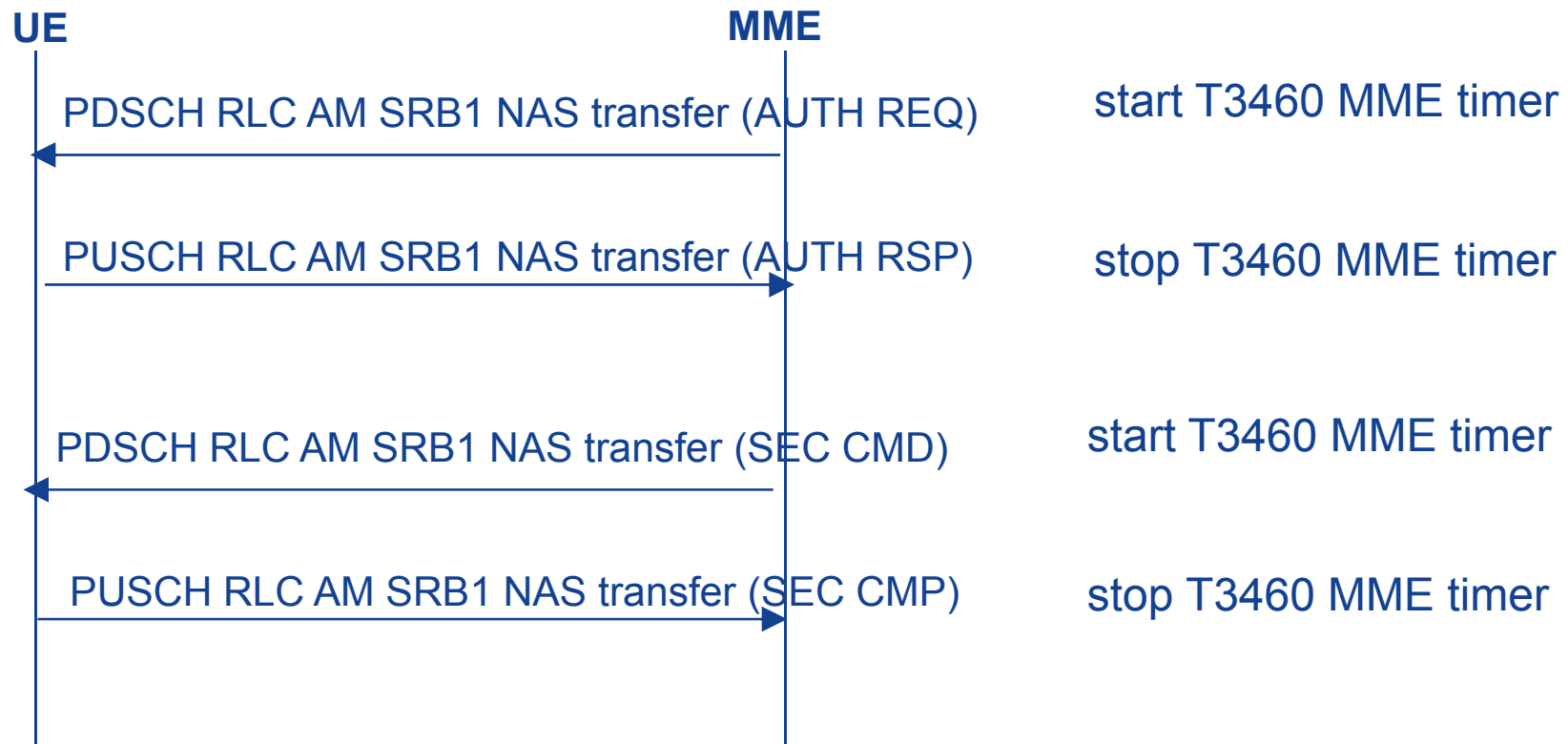
No RRC counters for NAS procedure failures

Even if Auth or SecMod NAS procedure fails on NAS layer, it can still be successful from RRC point of view.

Default T3460 is usually larger than radio link fail timers (3GPP default = 6sec),after which MME retransmits the message.

NAS security phase should not take longer than *tEstS1Con* timer (def=16sec)

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4. RRC Security, Successful + Unsuccessful

UE   **eNB**

PDSCH RLC AM SRB1 RRC Security Cmd

PDSCH RLC AM SRB1 UE Cap Enquiry

3GPP: After this point RRC Conn Re-Establishment is possible for UE, since RRC security has been set up. If call drops after PRACH but before this point, then RRC Re-Est is not possible and UE makes cell reselection + TAU Req if it drops the call.

PUSCH RLC AM SRB1 RRC Security Complete

PUSCH RLC AM SRB1 UE Cap Info

No RRC counters for this phase

Nokia implementation may send UE Capability Enquiry (if required) and RRC Connection Reconfiguration before receiving RRC Security Complete

4. RRC Security, Unsuccessful

UE   eNB

PDSCH RLC AM SRB1 RRC Security Cmd

rrcGuardTimer

PDSCH RLC AM SRB1 UE Cap Enquiry

- *rrcGuardTimer* expires
- eNB triggered RLF
- RRC Conn Re-Est Reject

rrcGuardTimer

If RRC Conn Re-Est Req received from UE before S1 context has been succesfully set up, eNB shall abort the Initial Context Setup procedure by the S1AP message INITIAL CONTEXT SETUP FAILURE with cause "Radio Connection With UE Lost". The RRC Conn Re-Establishment is rejected by eNB.

RRC Guard Timer supervises

- RRC Security Mode Command
- UE Capability Enquiry
- RRC Connection Reconfiguration
- NOTE: no specific RRC counter for expiry, except normal S1 Init Setup Failure RNL cause

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5. SRB2/DRB Setup, Successful

UE   eNB

PDSCH RLC AM SRB1 RRC Conn Reconf

M8007C0 DATA_RB_STP_ATT
M8007C10: SRB2 SETUP ATT

NOTE: M8007C0 also triggered by incoming HO attempt

PDSCH RLC AM SRB1 RRC Conn Reconf Complete

M8007C1 DATA_RB_STP_COMP
M8007C11 SRB2 SETUP SUCC

NOTE: M8007C1 also triggered by successful incoming HO
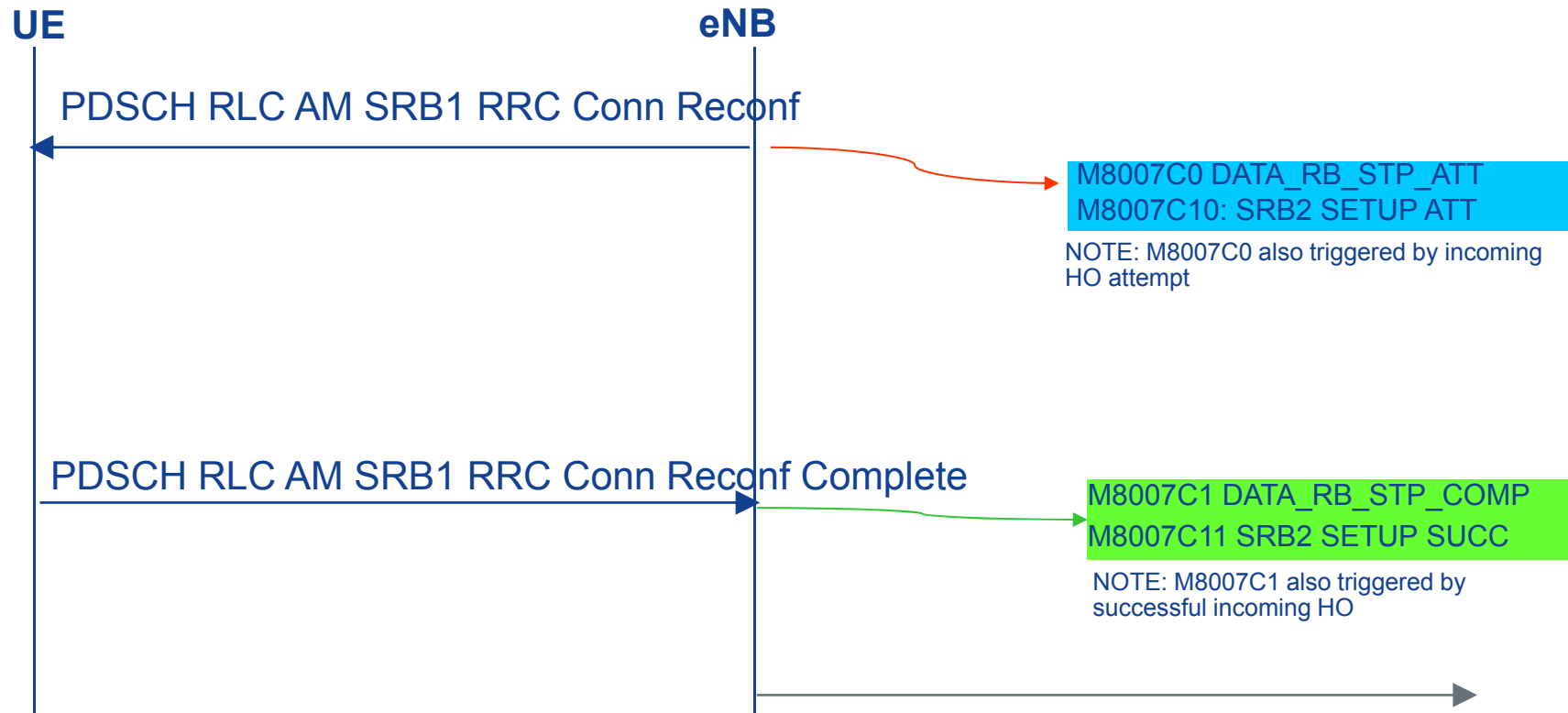
Analysis:

• LTE_5003a Data Radio Bearer Setup Success Ratio

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5. SRB2/DRB Setup, Unsuccessful

UE **eNB**

PDSCH RLC AM SRB1 RRC Conn Reconf

M8007C0 DATA_RB_STP_ATT
M8007C10: SRB2 SETUP ATT

NOTE: M8007C0 also triggered by incoming HO attempt

rrcGuardTimer, default =2000ms

- *rrcGuardTimer* expires
- eNB triggered RLF
- UE RRC Conn Re-Est Reject

M8007C2 DATA_RB_STP_FAIL
M8007C12 SRB2_SETUP_FAIL

NOTE: M8007C2 also triggered by incoming HO attempt
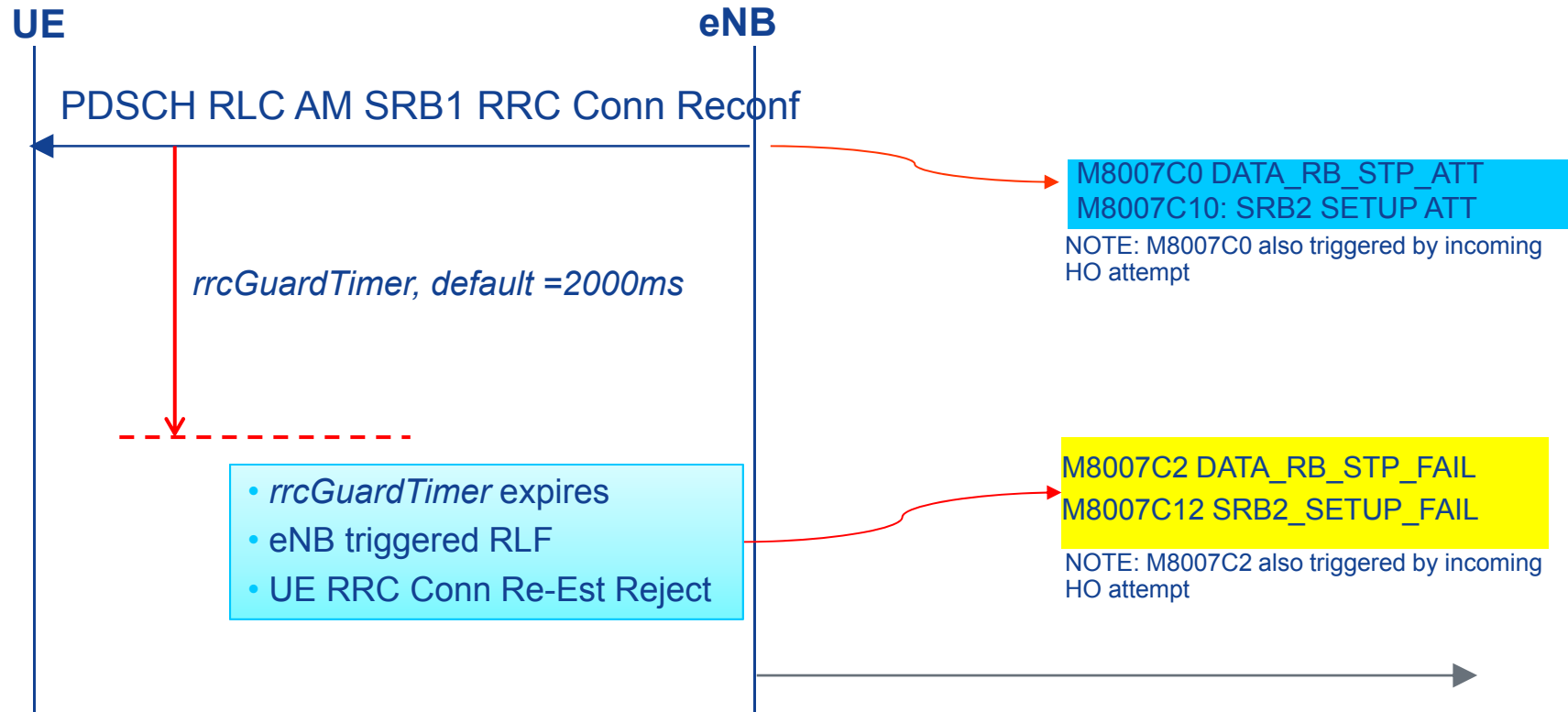
• M8007C0 is triggered for incoming Handover in case of a successful handover preparation procedure indicated e.g. by the transmission of the HANDOVER REQUEST ACKNOWLEDGE message.

• M8007C2 triggered also when Data Radio Bearers failed to setup during incoming Handover at the target cell, unsuccessfully completed Handover Execution phase at the target eNB (e.g. expiration of TS1Relocexec/Tx2Relocexec).

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Systematic Approach

1. Is RACH Preamble heard by eNB?

2. Is Random Access Response message heard by UE?

3. Is Msg3, RRC Connection Request message heard by the eNB?

4. Is Msg4, RRC Connection Setup message heard by the UE?

UE   Target_eNB

Preamble on PRACH

RAR: UL Allocation + TA

RRC Connection Req (Msg3)

RRC Connection Setup (Msg4)

Msg3 and Msg4 *not* in contention-free PRACH

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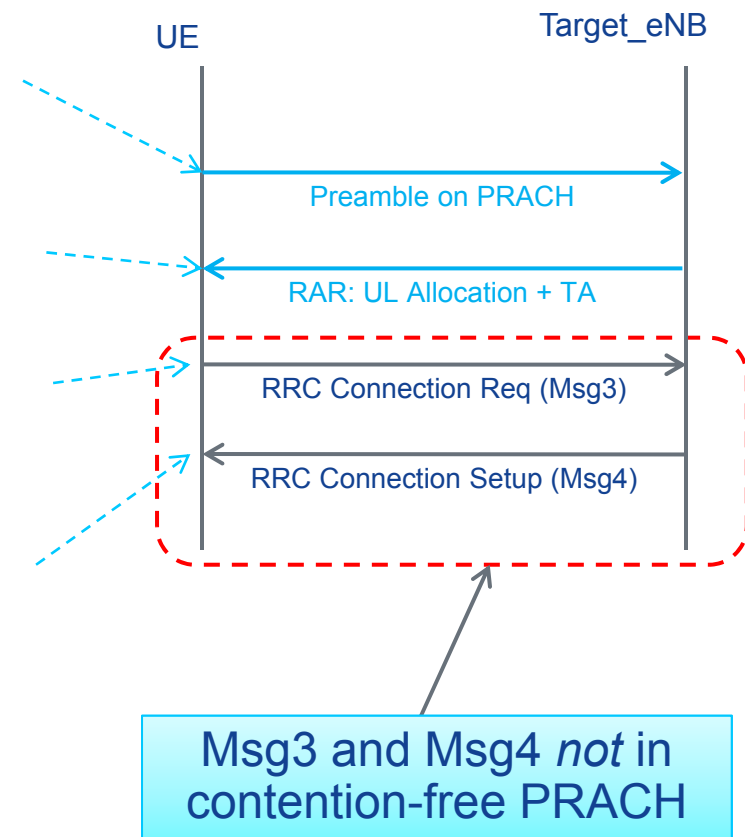
Preamble (Msg1)

The Random Access Procedure by UE
sending the contention-based RA
Preamble

LTE ML1 random access request (MSG1)

Version : 4
Preamble_Sequence : 39
Physical_root_Index : 84
Cyclic_Shift : 138
PRACH_Tx_Power(dBm) : -12
Beta_PRACH : 242
N_ra_prb : 1
Preamble_Format : 0
Duplex_Mode : FDD
Random_access_request_timing
 Starting_subframe_number : 4
 Starting_system_frame_number : 409
Random_access_response_window_start
 Starting_subframe_number : 7
 Starting_system_frame_number : 409
Random_access_response_window_end
 Starting_subframe_number : 7
 Starting_system_frame_number : 410
RA_RNTI : 5

UE   Target_eNB

Preamble on PRACH

RAR: UL Allocation + TA

RRC Connection Req (Msg3)

RRC Connection Setup (Msg4)

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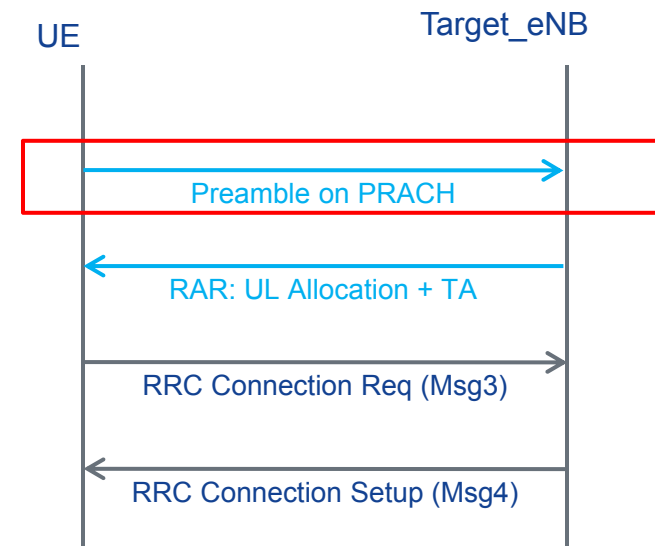
Preamble (Msg1)

- UE sends preamble and if it does not receive RAR, after a backoff time it tries again.

- Preamble power is set using open-loop power control and hence is not capable of taking into account strong UL interference.

- *Analysis:* have to compare Cell trace/UE trace logs and drive test logs to see if eNB receives preamble.

UE   Target_eNB

Preamble on RACH

RAR: UL Allocation + TA

RRC Connection Req (Msg3)

RRC Connection Setup (Msg4)

NOKIA
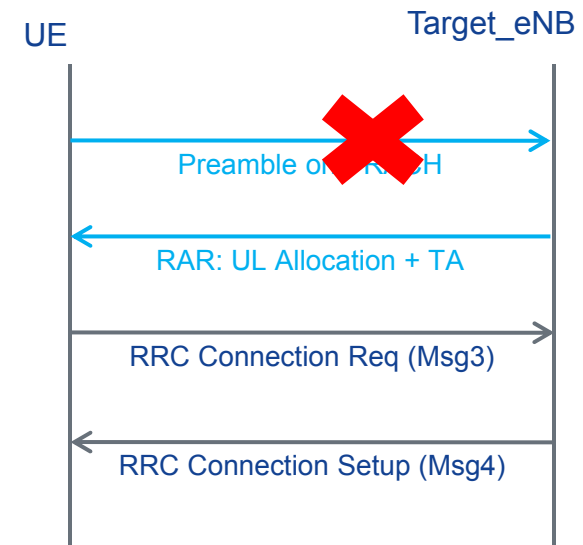
Preamble (Msg1)

RACH preamble power can be adjusted by tuning 3 parameters:

LNCEL: ulpcIniPrePwr
3gpp Name:preambleInitialReceivedTargetPower
Description: The parameter defines the initial power for Random Access preamble transmission
Range And Step:-120 dBm (0), -118 dBm (1),…, -90 dBm (15) **Default Value:**-96 dBm (12)

LNCEL: prachPwrRamp
3gpp Name: powerRampingStep
Description: The power ramping step size parameter defines the power increment step size for Random Access preamble transmission.
Range And Step: 0dB (0), 2dB (1), 4dB (2), 6dB (3) **Default Value:** 2dB (1)

LNCEL: preambTxMax
3gpp Name: preambleTransMax
Description: The preamble transmission maximum defines the maximum number of Random Access transmissions.
Range And Step: 3 (0), 4 (1), 5 (2), 6 (3), 7 (4), 8 (5), 10 (6), 20 (7), 50 (8), 100 (9), 200 (10) **Default Value:** 10 (6)

UE   Target_eNB

Preamble on RACH

RAR: UL Allocation + TA

RRC Connection Req (Msg3)

RRC Connection Setup (Msg4)

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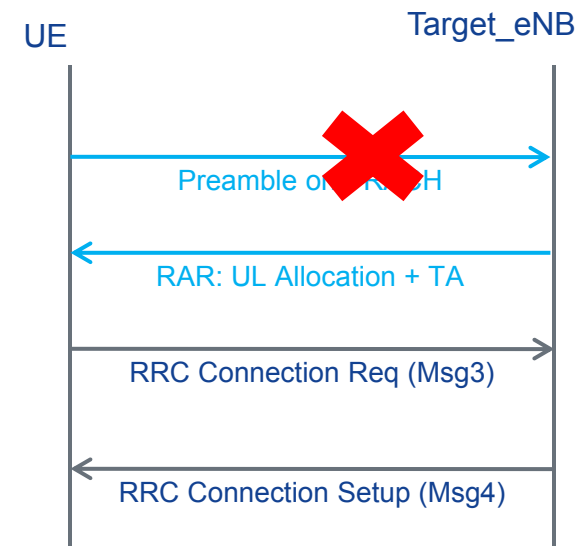
Preamble (Msg1)

PreambleTxP =

$\min\{P_{CMAX},$ *preambleInitialReceivedTargetPower* + DELTA_PREAMBLE + (preamble# - 1) x *powerRampingStep* + PL$\}$

For example:

preambleInitialReceivedTargetPower = -96dBm

DELTA_PREAMBLE = 0dB (Format 1)

powerRampingStep = 2dB

preambleTransMax = 8

Cell RS Transmitting Power = 10dBm

RSRP = -95dBm

$P_{CMAX} = 23dBm$

=> PL = 10dBm – 95dBm = 105dB

**Initial Power =
min{23dBm, -96dBm + 0dB +105 dB } =
9dBm**

Preamble TX Power

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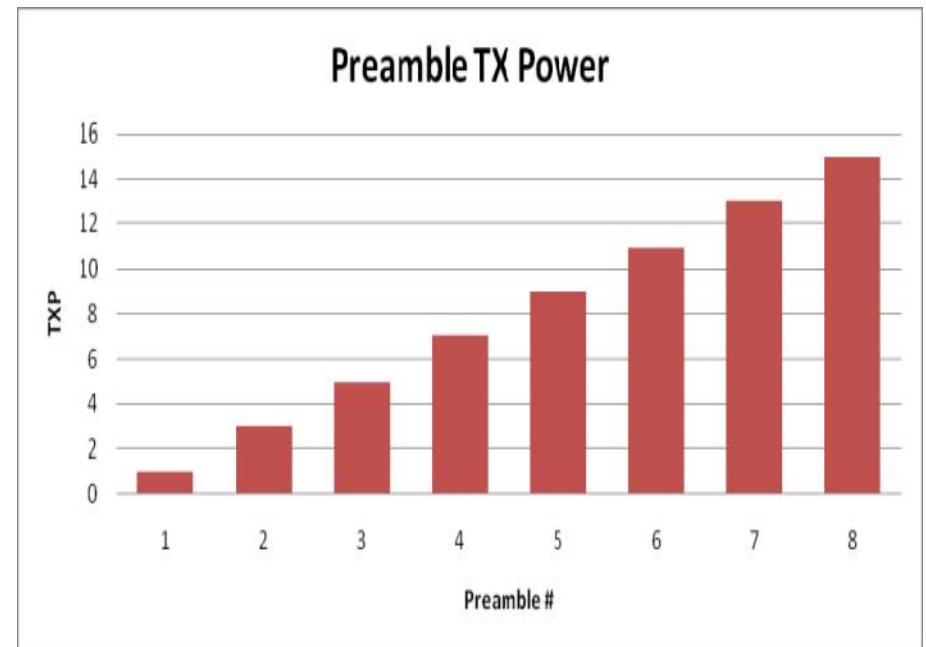
Preamble (Msg1)

The wait period is defined with *ResponseWindowSize.*

If no response is received within RAR window, power is adjusted and preamble gets sent again.

Last preamb

3 TTIs

ResponseWindowSize

New preamb

Preamble TX Power

TXP

Preamble #

The RAR window

• starts at the last subframe containing the end of the previous preamble + 3 subframes

• ends at the last subframe containing the end of the previous preamble + 3 + *ResponseWindowSize*

If there is no RAR received by the time *preambleTransMax* has been reached, the RA process will be stopped and higher layers will be informed.

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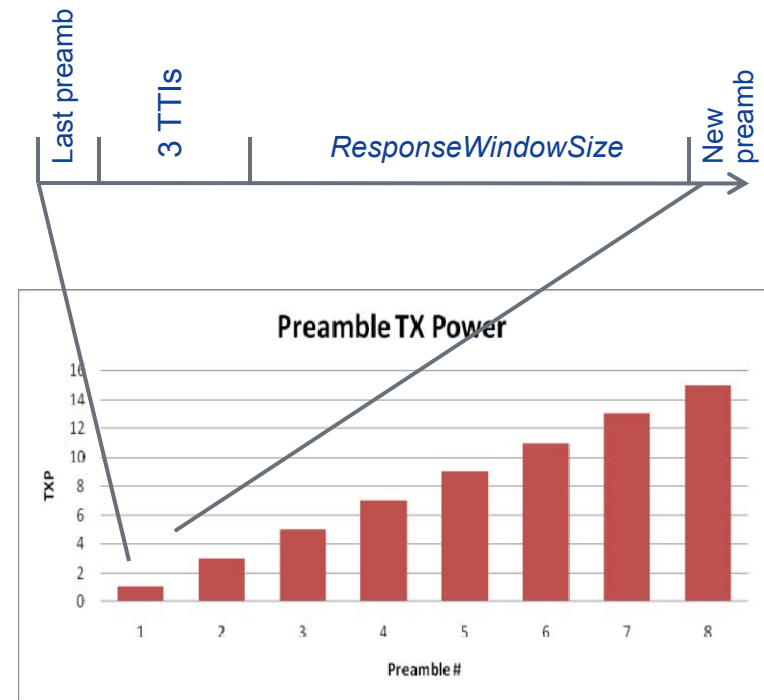
Random Access Response (Msg2)

After receiving the preamble, the eNB send RAR to the UE where it informs about i.e. TA, TPC & allocates PUSCH resources.

Random Access Response (Msg2)

Even if eNB receives the preamble and sends RAR, UE may not be able to hear the RAR due to DL interference or bad RF conditions.
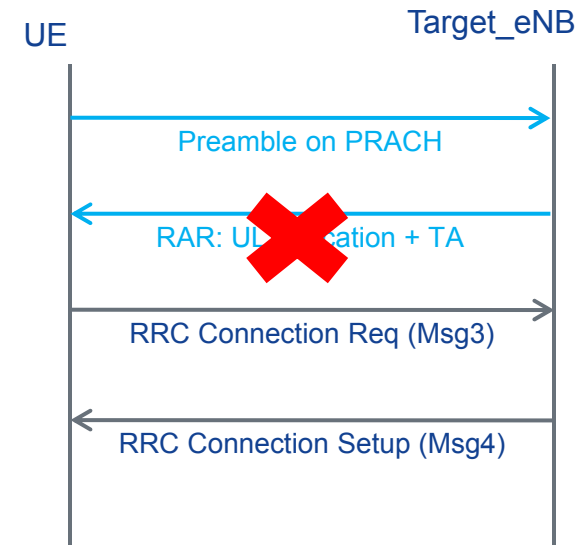
RAR power level itself cannot be changed, but as it is scheduled on PDCCH, its aggregation level can be adjusted by parameter *pdcchAggRaresp* (4,8), default 4.

The PDSCH message for RA Response is sent using QPSK modulation and default coding rate set by parameter *maxCrRaDl = 0.12* (default)

NOTE: value 8 will consume more PDCCH capacity

NOTE: RAR will cancel measurement gap.

.

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PRACH Example From XCAL


```
07:18:01.638   UL CCCH           v930   LTE rrcConnectionRequest
07:18:01.638   RACH              4G     LTE MAC RACH Trigger(0xB061) - Connection request
07:18:01.638   RACH              4G     LTE MAC RACH Attempt(0xB062) - Failure at MSG2
07:18:01.669   RACH              4G     LTE MAC RACH Attempt(0xB062) - Success
07:18:01.669   DL CCCH           v930   LTE rrcConnectionSetup
07:18:01.669   UL DCCH           v930   LTE rrcConnectionSetupComplete - LTE Attach request / LTE F
07:18:01.701   DL DCCH           v930   LTE dlInformationTransfer - LTE Authentication request
```

```
Version : 1
Number_subpackets : 1

Subpacket_ID : MAC RACH attempt subpacket (0x6)
 Subpacket_version : 2
 Subpacket_size : 36
 RETX_COUNTER : 1
 RACH_RESULT : Failure at MSG2
 CONTENTION_PROCEDURE : Contention Based RACH procedure
 RACH_MSG_BMASK
  MSG 1 present
  MSG 2 present
 MSG1
  PREAMBLE_INDEX : 14
  PREAMBLE_INDEX_MASK : invalid
  RACH_MSG1_PREAMBLE_POWER_OFFSET (dB) : -104
 MSG2
  BACKOFF_VAL : 0
  RESULT : False
  TA_VALUE : N/A
```

```
Version : 1
Number_subpackets : 1

Subpacket_ID : MAC RACH attempt subpacket (0x6)
 Subpacket_version : 2
 Subpacket_size : 36
 RETX_COUNTER : 2
 RACH_RESULT : Success
 CONTENTION_PROCEDURE : Contention Based RACH procedure
 RACH_MSG_BMASK
  MSG 1 present
  MSG 2 present
  MSG 3 present
 MSG1
  PREAMBLE_INDEX : 29
  PREAMBLE_INDEX_MASK : invalid
  RACH_MSG1_PREAMBLE_POWER_OFFSET (dB) : -102
 MSG2
  BACKOFF_VAL : 0
  RESULT : True
  TCRNTI : 64928
  TA_VALUE : 0
 MSG3
  GRANT_RAW : 0x0E0000
  GRANT (Bytes) : 18
  HARQ_ID : 2
  MAC_PDU : 0x20061F5149835A88E601
```
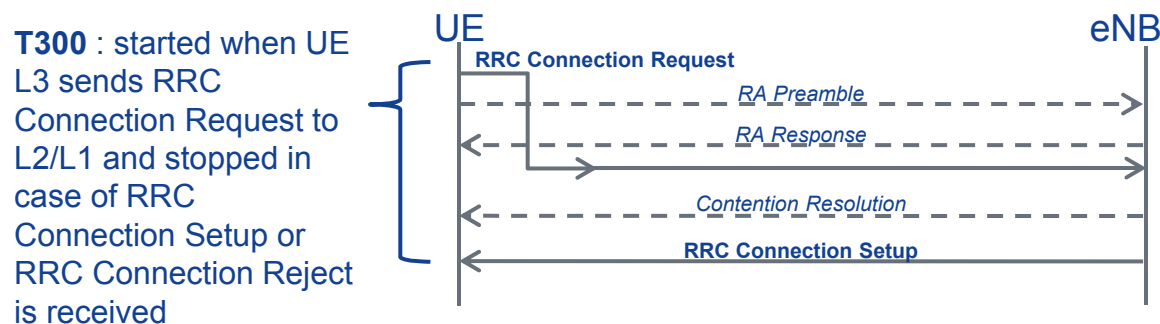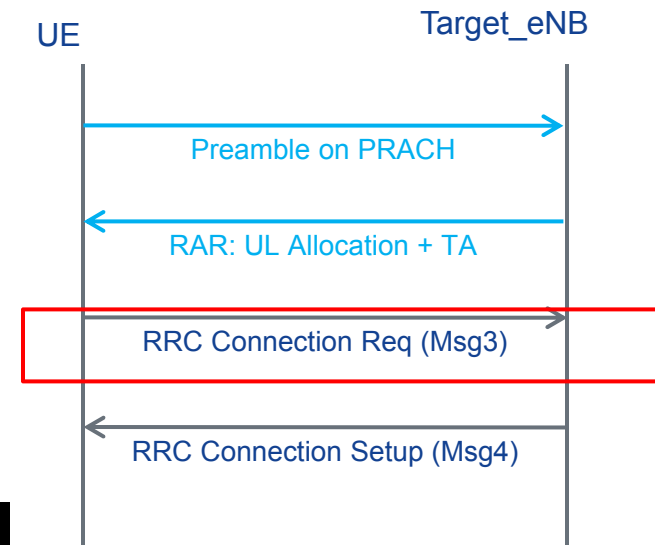
Power ramping

14bytes

RRC Connection Establishment Procedure – T300

- The UE initiates the RRC connection establishment procedure when upper layers request establishment of an RRC connection while the UE is in RRC_IDLE state.

- UE L3 sends RRC Connection Request to lower layers (L2/L1) which are responsible for preamble sending and RA response monitoring and starts timer T300 which supervises the RRC connection establishment procedure.

  - Start: Transmission of RRCConnectionRequest.

  - Stop: Reception of RRCConnectionSetup or RRCConnectionReject message, cell re-selection and upon abortion of connection establishment by upper layers.

  - In case of **T300** (400ms) expiry the UE will stop RRC Connection Establishment procedure and informs higher layer about failed procedure.

T300 : started when UE L3 sends RRC Connection Request to L2/L1 and stopped in case of RRC Connection Setup or RRC Connection Reject is received

UE   eNB

RRC Connection Request

RA Preamble

RA Response

Contention Resolution

RRC Connection Setup

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RRC Connection Request (Msg3)

- The power of Msg3 is based on the power of the last transmitted RA Preamble, the one which UE received RAR for + two adjustable settings that can be used for offsetting the power.

- Also the number of retransmissions can be adjusted separately for Msg3, LNCEL/harqMaxMsg3 and LNCEL/harqMaxTrUl in case of HO PRACH.

UE   Target_eNB

Preamble on PRACH →

← RAR: UL Allocation + TA

RRC Connection Req (Msg3) →

← RRC Connection Setup (Msg4)

```
value UL-CCCH-Message ::=
  message c1 : rrcConnectionRequest :
    criticalExtensions rrcConnectionRequest-r8 :
      ue-Identity randomValue : '00010100 10011000 00110101 10101000 10001110'B,
      establishmentCause mo-Signalling,
      spare '0'B


Encoded Data :
  51 49 83 5A 88 E6
```

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RRC Connection Request (Msg3)

Path loss, estimated from RSRP

PUSCH transport format, MCS dependend

$$P_{tx,msg3} = P_{rxPwrIni} + PL + 10\lg(M_{msg3}) + \Delta_{delta,msg3} + \Delta_{TF} + \delta_{rampUp} + \delta_{msg2}$$

ulpcIniPrePwr

Number of allocated resource blocks

deltaPreambleMsg3

Total power ramp-up during Msg1 transmission

deltaMsg2

- **DeltaPreambleMsg3** is Used for the calculation of P0_NOMINAL_PUSCH(j=2) for PUSCH (re)transmission corresponding to the random access response grant. *deltaPreMsg3* (-2 dB to 12 dB), default 1dB

- **deltaMsg2** is the TPC command indicated in the Random Access response related to Random Access message 3 or 1st scheduled uplink transmission. *ulpcRarespTpc* (-6...8 dB, step 2 dB), default 4dB

- **harqMaxMsg3** Indicates the maximum number of HARQ transmissions used for message 3 of the contention-based random access procedure *harqMaxMsg3* (1...8, step 1), default 5

- **raLargeMcsUl** Defines MCS to be used for the large size random access msg3, default 5

- **raSmallMcsUl** Defines MCS to be used for the small size random access msg3, default 5

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RRC Connection Establishment Call Flow

Msg 4 :

- PDDCH Aggregation level (pdcchAggMsg4) def=4

- PDSCH Coding Rate (maxCrRa4Dl) def=0.12

- Lowest possible DL MCS is selected based on message size and coding rate

- Number DL PRB Allocated to meet coding rate requirements

UE   Target_eNB

Preamble on PRACH

RAR: UL Allocation + TA

RRC Connection Req (Msg3)

RRC Connection Setup (Msg4)

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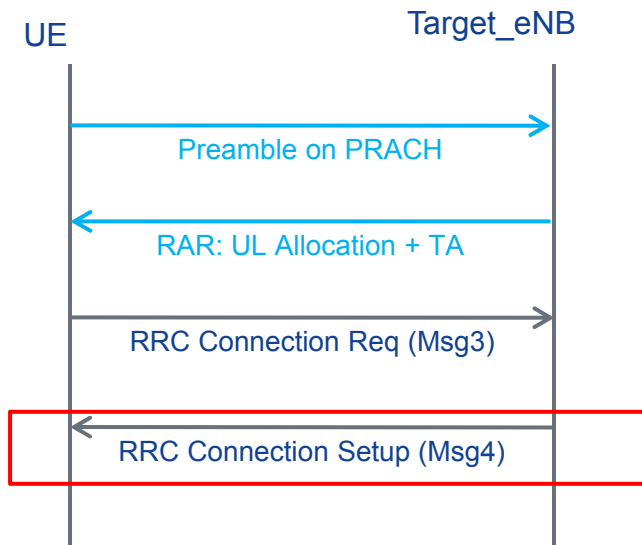
Contention Resolution (Msg4)

- Once RRC Connection Request (msg3) has been transmitted, the UE starts *Contention Resolution Timer* and restart timer at each HARQ retransmission.

  – the maximum content resolution timer parameter defines the maximum amount of time allowed for contention resolution, raContResoT (64ms).

  – harqMaxTrDl (5) indicates the maximum number of HARQ transmissions in DL. The HARQ delay is 8ms including some 0.6ms UE processing delay so 5 retransmissions equal 5*9ms=45 ms.

UE   eNB

7 TTI (7 ms) waiting time for the RA response

RA Preamble

RA Response

RRC Connection Request

3TTI processing delay by 3GPP 36.321

Once RRC Connection Request (msg3 of RA Procedure) has been transmitted, the UE starts Contention Resolution Timer raContResoT (64ms)

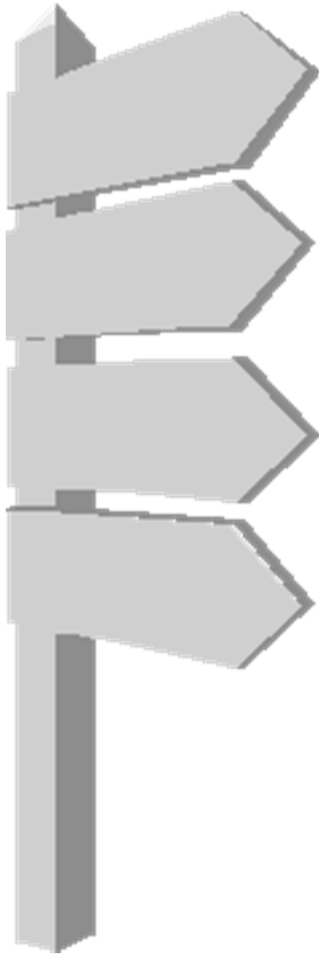Contention Resolution

NOKIA
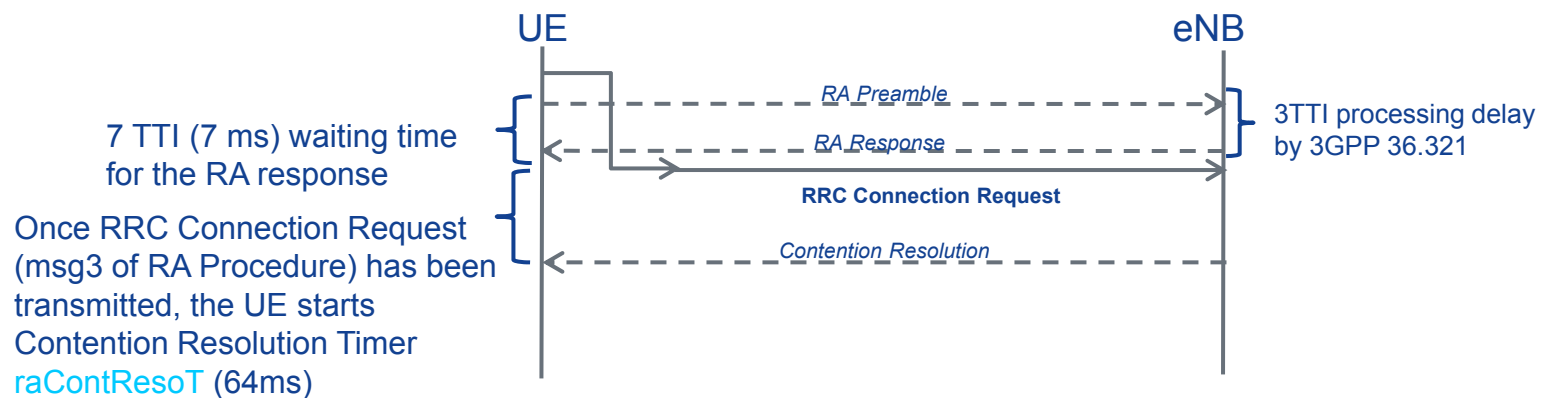
PRACH Problems, Analysis Summary

Analysis of Msg3 problems during call setup and RRC Connection Re-establishment:
- Compare
  - M8001C8 RACH_STP_COMPLETIONS
  - M8007C7 SRB1_SETUP_ATT
  - M8013C17 SIGN_CONN_ESTAB_ATT_MO_S
  - M8013C18 SIGN_CONN_ESTAB_ATT_MT
  - M8013C19 SIGN_CONN_ESTAB_ATT_MO_D
  - M8013C20 SIGN_CONN_ESTAB_ATT_OTHERS
  - M8013C21 SIGN_CONN_ESTAB_ATT_EMG
  - M8013C31 SIGN_CONN_ESTAB_ATT_HIPRIO
  - M8013C34 SIGN_CONN_ESTAB_ATT_DEL_TOL
  - M8007C8: SRB1 SETUP SUCC
  - M8013C5: SIGN_CONN_ESTAB_COMP
- Compare drive test logs to Cell trace logs if Msg2 heard by UE
- Compare drive test logs to Cell trace logs if Msg3 heard by eNB
- For PRACH phase in handover access, the retransmission parameter is *LNCEL/harqMaxTrUl*
  - Other than this, the optimization of handover PRACH is the same as call setup PRACH

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  - In post-PRACH phase
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RRC Setup Failures – MSG5

- MGS5 i.e. RRC Connection Setup Complete message is the first message that is sent by the UE following exactly the given power control scheme
  - The UE sends the MSG5 with the power given by :

Open loop part   Closed loop part

$$P_{PUSCH}(i) = \min\{P_{CMAX}, 10\log(M_{PUSCH}(i)) + P_{O\_PUSCH}(j) + \alpha(j)\cdot PL + \Delta_{TF}(i) + f(i)\}$$

Tx power for PUSCH in Subframe i in dBm

Number of allocated resource blocks

Cell-specific parameter configured by L3

PUSCH transport format

Maximum allowed UE power in this particular cell, but at maximum +23 dBm, 36.101)

Combination of cell- and UE-specific components configured by L3

Downlink path loss estimate

Power control adjustment derived from TPC command received in subframe (i-4)

- Where i=subframe number and for PUSCH (re)transmissions corresponding to the dynamic scheduling (j=1)

$$P_{0\_PUSCH}(j) = P_{0\_NOMINAL\_PUSCH}(j) + P_{0\_UE\_PUSCH}(j)$$

$$j = \{0,1\}$$

- $P_{0\_NOMINAL\_PUSCH}(j)$ has range of -126 … +24dBm indicating from full pathloss compensation (-126) to no pathloss compensation (+24)

- $P_{0\_UE\_PUSCH}(j)$ with the range of -8 … 7dB is used by the eNB to compensate any systematic offsets in the UE's transmission power settings arising from a wrongly estimated pathloss

- α(j) is used as path-loss compensation factor as a trade-off between total uplink capacity and cell-edge data rate

RRC Setup Failures – MSG5

- The closed loop part f(i) is adjusted by the BTS PC decision algorithm shown below depending on the lower and upper SINR and RSSI parameters given for the matrix below. Note, CLPC is an optional feature. Furthermore, from RL60 onwards Interference Aware PC is available as an alternative.
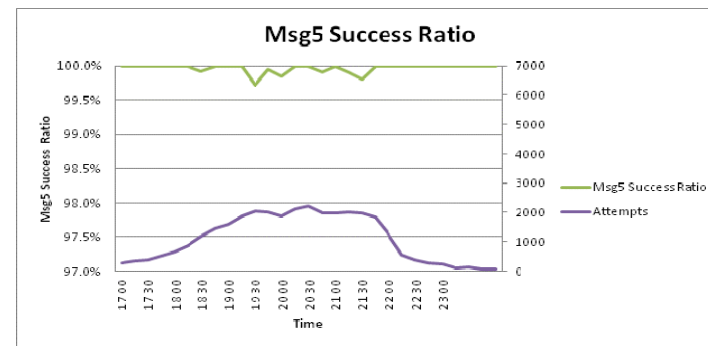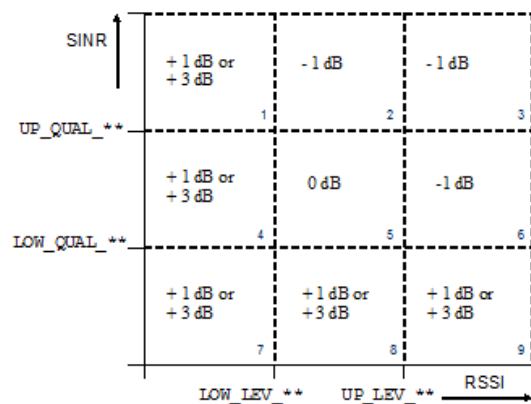
- It should be noted that the TPC commands for closed loop PC can be delivered to the UE in DCI 0 (UL allocation grant) or with DCI3/3A (not supported in the current release) and therefore at the time of MSG5 transmission the UL PC is mostly done by OLPC (MSG5 is the first DCI0 scheduled message).

- Therefore -when modifying the OLPC settings- it is recommended to monitor the RRC setup success rate and particularly the success rate of reception of the RRC setup complete message as well as successful reception of MSG4 on UE side.

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Post-PRACH, after S1AP Initial Context Setup Request is received

•After S1AP Init Ctx Setup, can check S1AP failure cause from signaling logs.

•Bearer-independent failure causes in the table

Cause	Explanation	S1AP Cause Value
Unsupported QCI	The QCI of the S1AP message cannot be accepted (e.g. QCI 1-4 for GBR bearers)	"Invalid QoS combination"
Unsupported Bearer Combination	The bearer combination is not allowed (e.g. max number of EPS bearers per UE).	"Invalid QoS combination"
S1 Bearer Setup Failure	The S1 bearer cannot be established.	"Transport Resource Unavailable"
Handling of RRM rejection cases	Radio admission control has rejected the establishment of a data radio bearer.	"Radio resources not available"
No PUCCH resources for CQI Reporting available	The UE cannot be configured properly because no PUCCH resources for CQI reporting are available.	"Radio resources not available"
No SRS resources available	The UE cannot be configured properly because no SRS resources for UL Sounding are available.	"Radio resources not available"
Handling of failure of AS security mode command procedure	UE has not successfully activated AS security.	"Failure in the Radio Interface Procedure"
The determination of AS security algorithms failed	The eNB is unable to support any of the encryption and/or integrity protection algorithms supported by the UE.	"Encryption and/or integrity protection algorithms not supported"
EUTRAN radio capabilities not available	UE has not provided the UE radio capabilities for EUTRAN in the RRC message *UECapabilityInformation* though eNB has requested the EUTRAN radio capabilities in the RRC message *UECapabilityEnquiry*.	"Failure in the Radio Interface Procedure"
Timeout of UE Capability Enquiry	The timer *RRCGuardTimer RadioBearerManagement* has expired without receiving the RRC message *UECapabilityInformation*.	"Failure in the Radio Interface Procedure"
Handling of *RRCConnection ReestablishmentRequest*	The UE has rejected the establishment of a radio bearer by the RRC message *RRCConnectionReestablishmentRequest*.	"Failure in the Radio Interface Procedure"
Timeout of *RRCConnection Reconfiguration*	The timer *RRCGuardTimer RadioBearerManagement* has expired without receiving the RRC message *RRCConnectionReconfigurationComplete*.	"Failure in the Radio Interface Procedure"
Invalid RRC Transaction Id in *RRC Connection ReconfigurationComplete*	The RRC transaction Id in the in *RRCConnectionReconfigurationComplete*. is not identical to the Id sent in the *RRCConnectionReconfiguration*.	"Failure in the Radio Interface Procedure"

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Post-PRACH, after S1AP Initial Context Setup Request is received

• After S1AP Init Ctx Setup, can check S1AP failure cause from signaling logs.

• NOTE: In case of no response from the UE (timeout of RRC message, rejected reestablishment, radio link failure), eNB shall send subsequently the S1AP message UE CONTEXT RELEASE REQUEST with cause "Radio Connection With UE Lost".

Cause	Explanation	S1AP Cause Value
Unsupported QCI	The QCI of the S1AP message cannot be accepted	"Not supported QCI value"
UE-AMBR 0	The UE-AMBR in DL and UL direction are both 0.	"Semantic Error"
Unsupported Bearer Combination	The bearer combination is not allowed.	"Invalid QoS combination"
Handling of RAC rejection cases	Radio admission control has rejected the establishment of the UE (REJECT_UE).	"Radio resources not available"
	Radio admission control has rejected the establishment of the new DRB(s) (REJECT_DRB).	"Not enough User Plane Processing Resources"

Cause	Explanation	S1AP Cause Value
Handling of *RRCConnection ReestablishmentRequest*	S1AP procedure aborted because of RRC Connection Reestablishment Request	"Radio Connection With UE Lost"

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Post-PRACH, after E-RAB Setup Req for dedicated bearer has been received

• After E-RAB setup Req fails, can check failure cause from signaling logs.

Cause	Explanation	S1AP Cause Value
Unsupported QCI	The QCI of the S1AP message cannot be accepted (e.g. QCI 2-4 for GBR bearers)	"Not supported QCI value"
Unsupported Bearer Combination	The bearer combination is not allowed.	"Invalid QoS combination"
UE-AMBR 0	The UE-AMBR in DL and UL direction are both 0.	"Semantic Error"
E-RAB ID already existing	The E-RAB SETUP REQUEST contained an E-RAB ID for which a DRB already exists.	"Multiple E-RAB ID Instances"
Multiple identical E-RAB ID in S1AP request.	The E-RAB SETUP REQUEST contained several times the same E-RAB ID.	"Multiple E-RAB ID Instances"
Handling of RAC rejection cases	Radio admission control [RRM SFS] has rejected the establishment of the new DRB(s) (REJECT_DRB).	"Not enough User Plane Processing Resources"
S1 Bearer Setup Failure	The S1 bearer cannot be established.	"Transport Resource Unavailable"
eNB has detected an inter-dependency to handover procedures	The E-RAB SETUP REQUEST cannot be executed because eNB has detected the need for an inter system S1 handover..	"S1 Inter system Handover triggered"
	The E-RAB SETUP REQUEST cannot be executed because eNB has detected the need for an X2 handover.	"X2 Handover triggered"
	The E-RAB SETUP REQUEST cannot be executed because eNB has detected the need for a redirect to GSM or WCDMA.	"Inter-RAT redirection"
	The E-RAB SETUP REQUEST cannot be executed because eNB has detected the need for an intra-LTE redirect.	"Release due to E-UTRAN Generated Reason"
Handling of *RRCConnection ReestablishmentRequest*	The UE has rejected the establishment of a radio bearer by the RRC message *RRCConnectionReestablishmentRequest*.	"Radio Connection With UE Lost"
Timeout of *RRCConnection Reconfiguration*	The timer *RRCGuardTimer RadioBearerManagement* has expired without receiving the RRC message *RRCConnectionReconfigurationComplete*.	"Failure in the Radio Interface Procedure"
Invalid RRC Transaction Id in *RRC Connection ReconfigurationComplete*	The RRC transaction Id in the in *RRCConnectionReconfigurationComplete*. is not identical to the Id sent in the *RRCConnectionReconfiguration*.	"Failure in the Radio Interface Procedure"

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Post-PRACH, after E-RAB Setup Req for dedicated bearer has been received for GBR bearer

After E-RAB setup Req fails, can check failure cause from signaling logs.

Cause	Explanation	S1AP Cause Value
Missing GBR information	MME sends an E-RAB SETUP REQUEST with a GBR related QCI, but missing GBR QoS information.	"Protocol Cause – Semantic Error"
GBR above limit	The GBR value for QCI1 is above the eNB internal limit	"Invalid QoS Combination"
UE /eNB does not support voice	MME request the setup for an E-RAB with QCI 1, but UE or eNB does not support voice.	"Not supported QCI"
Handling of RAC rejection cases	Radio admission control has rejected the establishment of the new GBR DRB(s) (REJECT_GBR).	"Radio resources not available"

Cause	Explanation	S1AP Cause Value
GBR bearer not admitted by TAC	MME request the setup for an E-RAB with GBR QCI, but TAC does not admit setup of a GBR bearer.	"Transport Layer Cause – Transport Resource Unavailable".

TAC = Transport Admission Control

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Non-LTE subscriber trying to do LTE network attach

- Attach reject received from core network
⇒ Counter M8013C12 EPC_INIT_TO_IDLE_OTHER trigged

RRC Rel Cause = Other ➔ ENB PM Counter

S1 Release with failure cause
"UEContextReleaseCommand with nas: unspecified"

```
eNB S1AP: InitialUEMessage + EMM:ATTACH REQUEST, UE ID: 339, MME S1AP ID: 0, Conn ID: 1269, L3 Link ID: 1          12:16:57.174474
EPC S1AP: DownlinkNASTransport + EMM:EPS AUTHENTICATION REQUEST, UE ID: 339, MME S1AP ID: 28318724, L3 Link ID: 1  12:16:57.569133
eNB PDSCH/DL-SCH/DCCH: DlInformationTransfer + EMM:EPS AUTHENTICATION REQUEST, UE ID: 339, CRNTI: 26060, Trans I   12:16:57.569766
UE PUSCH/UL-SCH/DCCH: UlInformationTransfer + EMM:EPS AUTHENTICATION RESPONSE, UE ID: 339, CRNTI: 26060, Cell ID   12:16:57.745696
eNB S1AP: UplinkNASTransport + EMM:EPS AUTHENTICATION RESPONSE, UE ID: 339, MME S1AP ID: 28318724, Conn ID: 1269   12:16:57.746210
EPC S1AP: DownlinkNASTransport + EMM:SECURITY MODE COMMAND, UE ID: 339, MME S1AP ID: 28318724, L3 Link ID: 1       12:16:57.873006
eNB PDSCH/DL-SCH/DCCH: DlInformationTransfer + EMM:SECURITY MODE COMMAND, UE ID: 339, CRNTI: 26060, Trans ID: 2,   12:16:57.873226
UE PUSCH/UL-SCH/DCCH: UlInformationTransfer + EMM:RETRIEVE ACKNOWLEDGE, UE ID: 339, CRNTI: 26060, Cell ID: 2       12:16:57.897813
eNB S1AP: UplinkNASTransport + EMM:RETRIEVE ACKNOWLEDGE, UE ID: 339, MME S1AP ID: 28318724, Conn ID: 1269, L3 Linl 12:16:57.898293
EPC S1AP: DownlinkNASTransport + EMM:ATTACH REJECT, UE ID: 339, MME S1AP ID: 28318724, L3 Link ID: 1               12:16:58.055630
EPC S1AP: UEContextReleaseCommand, Cause : nas : unspecified, UE ID: 339, MME S1AP ID: 28318724, L3 Link ID: 1     12:16:58.055983
eNB PDSCH/DL-SCH/DCCH: DlInformationTransfer + EMM:ATTACH REJECT, UE ID: 339, CRNTI: 26060, Trans ID: 2, Cell ID: 2 12:16:58.056015
eNB PDSCH/DL-SCH/DCCH: RrcConnectionRelease, UE ID: 339, CRNTI: 26060, Trans ID: 3, Cell ID: 2                     12:16:58.056824
```

```
Decoded NAS message: EMM:ATTACH REJECT
PROTOCOL DISCRIMINATOR          ----0111   EPS MOBILITY MANAGEMENT
Security header type            0000----   Not security protected
MESSAGE TYPE                    01000100   ATTACH REJECT
EMM CAUSE
 EMM Cause value                00001111   No Suitable Cells In tracking area
ESM MESSAGE CONTAINER IE        01111000   OPTIONAL IE
 Length                         00000000
 Length                         00000100   4
PROTOCOL DISCRIMINATOR          ----0010   EPS SESSION MANAGEMENT
EPS bearer identity             0000----
PTI                             00000001   1
MESSAGE TYPE                    11010001   PDN CONNECTIVITY REJECT
ESM CAUSE
 ESM Cause value                01101111   Protocol error, unspecified
```

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Non-LTE subscriber trying to do LTE network attach

LTE capable UE will try to attach to LTE network, even if the user doesn't have LTE subscription.

5.3.2   Lists of forbidden tracking areas

The UE shall store a list of "forbidden tracking areas for roaming", as well as a list of "forbidden tracking areas for regional provision of service". These lists shall be erased when the UE is switched off or when the USIM is removed, and periodically (with a period in the range 12 to 24 hours). One or more tracking areas is removed from the "forbidden tracking areas for roaming" in the UE, as well as the list of "forbidden tracking areas for regional provision of service" if, after a subsequent procedure e.g. attach procedure, tracking area update procedure and GUTI reallocation procedure, one or more tracking areas in the lists is received from the network.

In S1 mode, the UE shall update the suitable list whenever an ATTACH REJECT, TRACKING AREA UPDATE REJECT, SERVICE REJECT or DETACH REQUEST message is received with the EMM cause #13 "roaming not allowed in this tracking area", #12 "tracking area not allowed", or #15 "no suitable cells in tracking area".

Each list shall accommodate 40 or more TAIs. When the list is full and a new entry has to be inserted, the oldest entry shall be deleted.
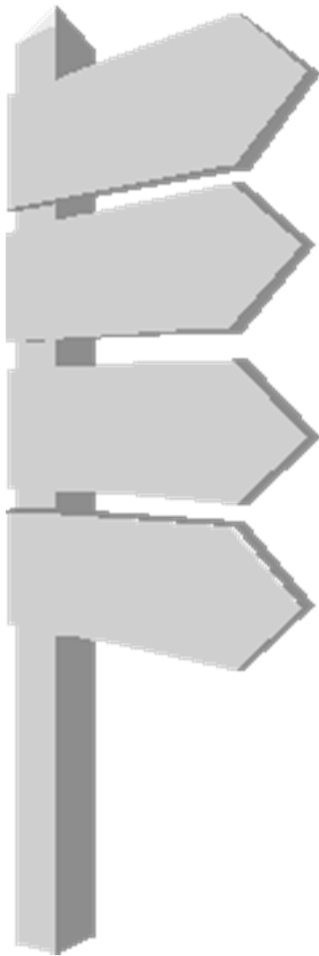
3GPP

According to 3GPP, this forbidden network information would be erased when…
1. UE is switched off
2. USIM is removed
3. Periodically (12 to 24 hours)

So same problem IMSI number will keep generating this failure again and again at least 2 times per day.
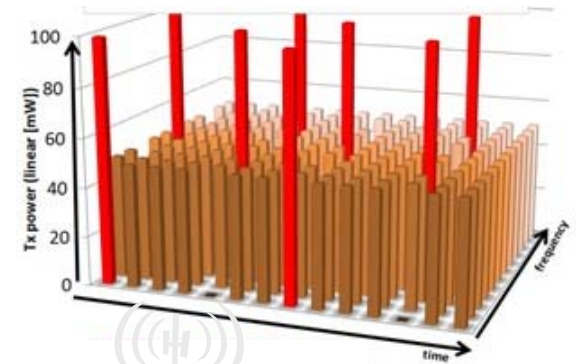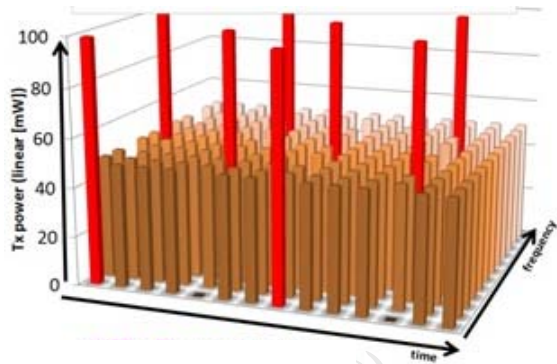
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Features Related to Call Setup

- Any feature that improves link budget with/without interference will help

  - Example: IRC and 4-RX diversity, ULCOMP

- Physical RF optimization will always help.

- To reduce uplink interference, power control can be made less aggressive

- IAW PC

- Cell tracing and PM counters (from RL70 onwards) provide TA information to evaluate faraway attempts and overshooting cells.

- LTE1894: introduced with RL70: Reference signal power de-boosting (see below)

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LTE1894: Reference signal power de-boosting

Reference Signal power

Poor RSRQ = mobility issues

Bad DL channel estimation = Poor DL throughput

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LTE1894: Reference signal power de-boosting

- There are two types of OFDM symbols
  Symbol A does not carry the cell-specific Reference Signal

  Symbol B carries the cell-specific Reference Signal

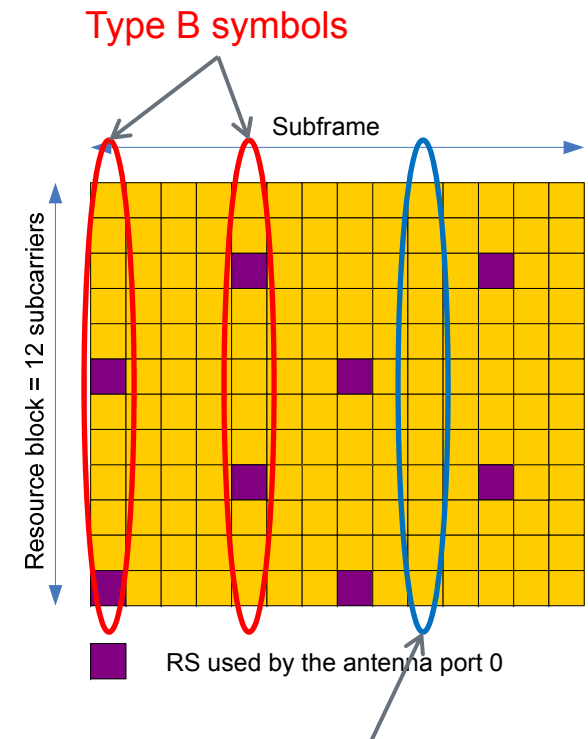- The ratio of PDSCH EPRE to RS EPRE is defined by ρ_A and ρ_B for each OFDM symbol

$$P\_PDSCH\_B = P\_PDSCH\_A * \rho_A / \rho_B$$

- ρ_A refers to type A symbols (w/o RS)

- ρ_B refers to type B symbols (with RS)

allowPbIndexZero
Allow cell specific PB ratio zero
LNCEL: 0 (false), 1 (true); **false**

Type B symbols

Subframe

Resource block = 12 subcarriers

■ RS used by the antenna port 0

Type A symbol

P_B	ρ_A / ρ_B	
	One Antenna Port	**Two and Four Antenna Ports**
0	1	5/4
1	4/5	1
2	3/5	3/4
3	2/5	1/2

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LTE1894: Reference signal power de-boosting

dlRsBoost
Downlink reference signals transmission power boost
LNCEL: -3dB (700), 0dB (1000), 1.77dB (1177), 3dB (1300), 4.77dB (1477), 6dB, (1600); **0dB**

Type B symbols
$P\_PDSCH\_B = P\_PDSCH\_A * \rho_{A/}\rho_B$

Subframe

Resource block = 12 subcarriers

$P\_CRS = EPRE\_0 + dlRSboost$

RS used by the antenna port 0

```
==============================================
 Channel Type = BCCH_DL_SCH, Message Length = 32
 Interpreted PDU:
value BCCH-DL-SCH-Message ::=
{
 message c1 : systemInformation :
    {
      criticalExtensions systemInformation-r8 :
        {
          sib-TypeAndInfo
          {
            sib2 :
            {
.
.
.
pdsch-Config
            {
              referenceSignalPower 15,
              p-b 0
```
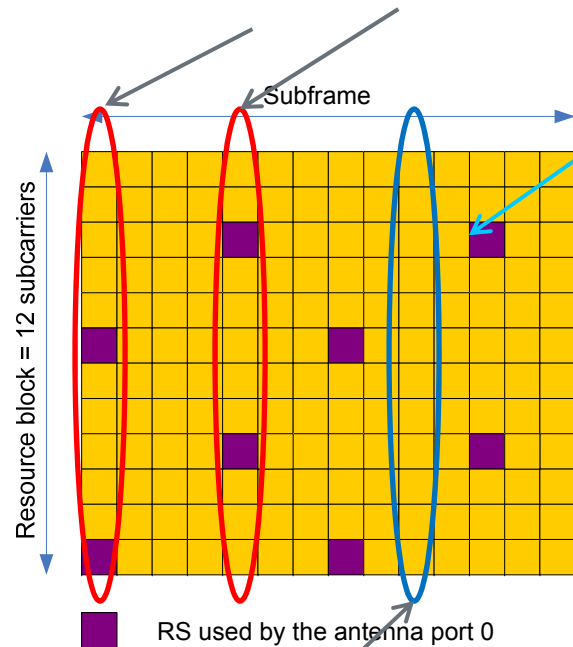
Type A symbol
$P\_PDSCH\_A = EPRE\_0 - mimoComp$

$EPRE\_0 = (pmax - dlCellPwrRed) - 10\log(\#PRB * 12)$

LTE1894: Reference signal power de-boosting Example

dlChBw=10MHz (50 PRBs), dlMimoMode= Dynamic Open Loop MIMO, pMax=39dBm, dlCellPwrRed=0dB, dlpcMimoComp=0dB, dlRsBoost=-3dB

The even energy per Resource Element for 1 antenna system (1 TX Mode) is

$EPRE\_0 = (pmax - dlCellPwrRed) - 10 \log (\#PRB*12)$

$EPRE\_0 = (39dBm - 0dBm) - 10*\log10 (50*12) = 11.21dBm$

The power of the Cell-specific Reference Symbols.

$P\_CRS = EPRE\_0 + dlRSboost$

$P\_CRS = 11.21dBm -3dB = 8.21dBm$

The power of PDSCH on OFDMsymbols without CRS.

For 2 antenna system (MIMO TX diversity or Spatial Multiplexing) the parameter MIMO compensation has to be subtracted from the even energy per Resource Element.

$P\_PDSCH\_A = EPRE\_0 - dlcpMimoComp$

$P\_PDSCH\_A = 11.21dBm - 0dB = 11.21dBm$

p-a is the ratio between P_PDSCH_A to P_CRS

$p\text{-}a = 11.21dBm - 8.21dBm = 3dB$

The power of PDSCH on OFDMsymbols with CRS.

With **dlRsBoost** index *p-b* is 0. From table we find ρ_A/ρ_B = 5/4.

$P\_PDSCH\_B = PSD\_UE\_PDSCH\_A + 10* \log10 (\rho_A/\rho_B)$

$P\_PDSCH\_B = 11.21 + 10 * \log10 (5/4) = 12.18dBm$

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LTE1894: Reference signal power de-boosting Example configurations

	Input Parameters						Signaling		result: Power PDSCH RE	
	Max_TX_Pwr	MAX TX Pwr	BW	Cell PWR RED	MIMO COMP	RS BOOST	RS Power	Pa/Pb	P_PDSCH (0,4)	P_PDSCH (1,2,3,5,6,)
	W	dBm	PRB	dB	dB	dB	dBM		dBm	dBm
1	8	39.0	50	0	0	-3	8.2	1.25	12.2	11.2
2	8	39.0	50	0	0	0	11.2	1.00	11.2	11.2
3	8	39.0	50	0	3	-3	8.2	1.00	8.2	8.2
4	8	39.0	100	0	3	-3	5.2	1.00	5.2	5.2
5	60	47.8	100	0	0	0	17.0	1.00	17.0	17.0
6	60	47.8	100	0	0	3	20.0	1.00	17.0	17.0
7	60	47.8	100	0	3	0	17.0	1.00	14.0	14.0
8	60	47.8	100	0	3	3	20.0	1.00	14.0	14.0
9	60	47.8	100	0	0	6	23.0	1.00	17.0	17.0
10	60	47.8	100	0	0	-3	14.0	1.00	17.0	17.0

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Parameters Related to Call Setup

LNCEL	Maximum number of HARQ transmission in UL	harqMaxTrUl	Indicates the maximum number of HARQ transmissions in UL that is configured for each UE at initial access to a specific cell.	1...7, step 1
LNCEL	Maximum code rate for random access message 2	maxCrRaDl	The parameter defines the maximum code rate for random access procedure messages 2 (RA response). This maximum coderate is taken into account during PDSCH scheduling.	0.05...0.5, step 0.01
LNCEL	Maximum number of RRC connections	maxNumRrc	Maximum number of UEs in the cell with an established RRC connection.	0...840, step 1
LNCEL	Maximum number of out-of-sync indications	n310	This is the maximum number of consecutive "out of sync" indications received from lower layers. n1 corresponds to 1 and so on.	n1 (0), n2 (1), n3 (2), n4 (3), n6 (4), n8 (5), n10 (6), n20 (7)
LNCEL	Maximum number of in-sync indications	n311	Maximum number of consecutive "in-sync" indications received from lower layers. n1 corresponds to 1 and so on.	n1 (0), n2 (1), n3 (2), n4 (3), n5 (4), n6 (5), n8 (6), n10 (7)
LNCEL	PDCCH LA UE default aggregation	pdcchAggDefUe	The parameter defines default aggregation for UE to be used in PDCCH Link Adaptation when enableAmcPdcch has been disabled or when enableAmcPdcch has been	1 (0), 2 (1), 4 (2), 8 (3)

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Parameters Related to Call Setup

|				
LNCEL	PDCCH aggregation for RA msg4	pdcchAggMsg4	The parameter defines the reserved number of Control Channel Elements (CCEs) for dedicated Random Access Message 4 assingment on PDCCH.	4…8, step 4
LNCEL	PDCCH aggregation for random access response message	pdcchAggRaresp	PDCCH aggregation for Random Access response message defines how many CCEs are used for one PDCCH.	4…8, step 4
LNCEL	PRACH cyclic shift	prachCS	Preamble cyclic shift defines the configuration which is used for preamble generation. The configuration determines how many cyclic shifts are needed to generate preamble. Unrestricted set is supported.	0…15, step 1
LNCEL	Power ramping step	prachPwrRamp	The power ramping step size parameter defines the power increment step size for Random Access preamble transmission.	0dB (0), 2dB (1), 4dB (2), 6dB (3)
LNCEL	Preamble transmission maximum	preambTxMax	The preamble transmission maximum defines the maximum number of Random Access transmissions. Note: The values n50, n100 and n200 should not be used.	3 (0), 4 (1), 5 (2), 6 (3), 7 (4), 8 (5), 10 (6), 20 (7), 50 (8), 100 (9), 200 (10)
LNCEL	Large size random access MCS in uplink	raLargeMcsUl	Defines the Modulation and Coding Scheme (MCS) to be used for large size random access message 3 in case of initial access or handover.	0…15, step 1
LNCEL	RA message power offset for group B selection	raMsgPoffGrB	Path loss threshold in dB required for selecting one of the two groups of Random Access preambles. The UE will only use preambles from group B if it needs to send a large Msg3 AND its measured path loss is less	–infinity (0), 0 dB (1), 5 dB (2), 8 dB (3), 10 dB (4), 12 dB (5), 15 dB (6), 18 dB (7)

Parameters Related to Call Setup

LNCEL	Number of random access preambles	raNondedPreamb	This parameter determines the total number of non-dedicated RA preambles that a UE can select from (i.e. for contention based RA). The minimum cannot be zero.	4 (0), 8 (1), 12 (2), 16 (3), 20 (4), 24 (5), 28 (6), 32 (7), 36 (8), 40 (9), 44 (10), 48 (11), 52 (12), 56 (13), 60 (14), 64 (15)
LNCEL	Random access preambles group A size	raPreGrASize	Defines the size of the Random Access preambles Group A.	4 (0), 8 (1), 12 (2), 16 (3), 20 (4), 24 (5), 28 (6), 32 (7), 36 (8), 40 (9), 44 (10), 48 (11), 52 (12), 56 (13), 60 (14)
LNCEL	Random access response window size	raRespWinSize	Random Access Response Window Size parameter defines the window size for the random access response in TTIs.	2 (0), 3 (1), 4 (2), 5 (3), 6 (4), 7 (5), 8 (6), 10 (7)
LNCEL	Small size random access MCS in uplink	raSmallMcsUl	Defines the Modulation and Coding Scheme (MCS) to be used for the small size random access message 3 in case of UL or DL data arrival.	0…15, step 1
LNCEL	Small size random access data volume in uplink	raSmallVolUl	Defines the data volume to be used for small size Random Access message 3 in case of UL or DL data arrival.	56 bits (0), 144 bits (1), 208 bits (2), 256 bits (3)
LNCEL	Timer T300	t300	Timer T300 supervises the RRC connection establishment procedure. Start: Transmission of RRCConnectionRequest Stop: Reception of RRCConnectionSetup or	100ms (0), 200ms (1), 300ms (2), 400ms (3), 600ms (4), 1000ms (5), 1500ms (6), 2000ms (7)
LNCEL	Timer T310	t310	Timer T310 supervises the recovery from physical layer problems.	0ms (0), 50ms (1), 100ms (2), 200ms (3), 500ms (4), 1000ms (5), 2000ms (6)

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Parameters Related to Call Setup
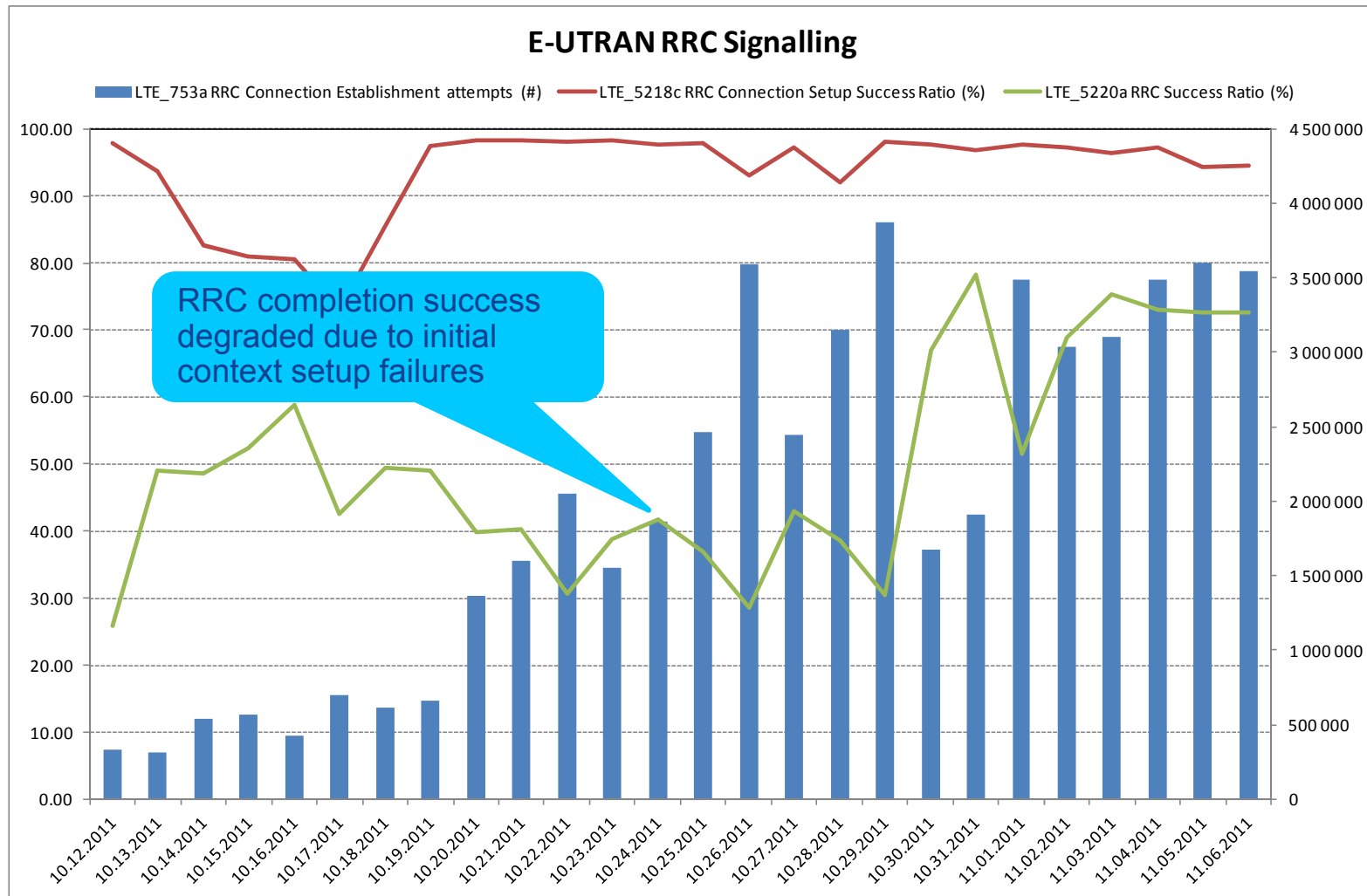
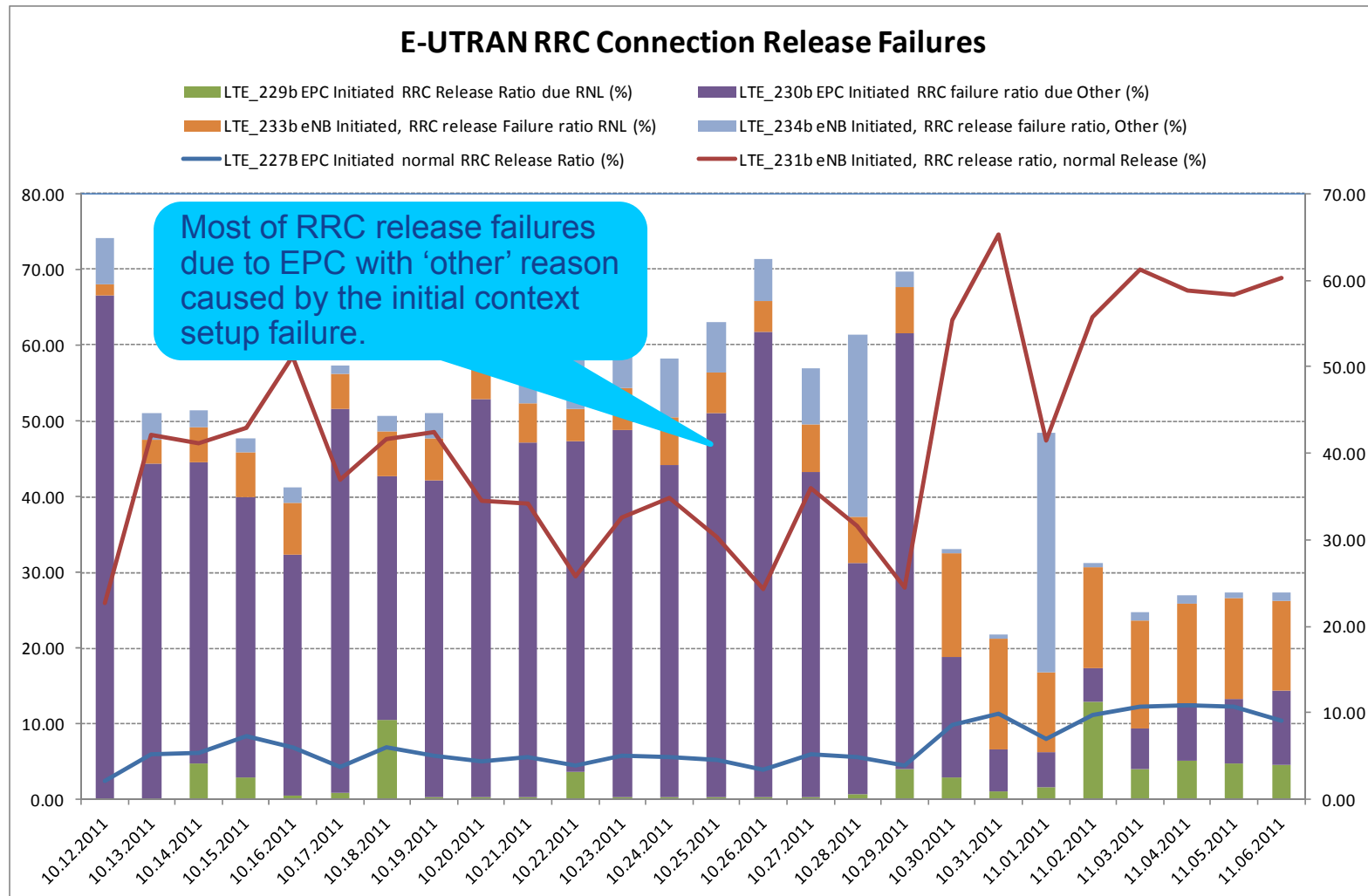|				
LNCEL	PRACH cyclic shift	prachCS	Preamble cyclic shift defines the configuration which is used for preamble generation. The configuration determines how many cyclic shifts are needed to generate preamble. Unrestricted	0…15, step 1
LNCEL	Power ramping step	prachPwrRamp	The power ramping step size parameter defines the power increment step size for Random Access preamble transmission.	0dB (0), 2dB (1), 4dB (2), 6dB (3)
LNCEL	Preamble transmission maximum	preambTxMax	The preamble transmission maximum defines the maximum number of Random Access transmissions. Note: The values n50, n100 and n200 should not be used.	3 (0), 4 (1), 5 (2), 6 (3), 7 (4), 8 (5), 10 (6), 20 (7), 50 (8), 100 (9), 200 (10)
LNCEL	Large size random access MCS in uplink	raLargeMcsUl	Defines the Modulation and Coding Scheme (MCS) to be used for large size random access message 3 in case of initial access or handover.	0…15, step 1
LNCEL	RA message power offset for group B selection	raMsgPoffGrB	Path loss threshold in dB required for selecting one of the two groups of Random Access preambles. The UE will only use preambles from group B if it needs to send a large Msg3 AND its measured path	-infinity (0), 0 dB (1), 5 dB (2), 8 dB (3), 10 dB (4), 12 dB (5), 15 dB (6), 18 dB (7)
LNCEL	Number of random access preambles	raNondedPreamb	This parameter determines the total number of non-dedicated RA preambles that a UE can select from (i.e. for contention based RA). The minimum cannot be zero.	4 (0), 8 (1), 12 (2), 16 (3), 20 (4), 24 (5), 28 (6), 32 (7), 36 (8), 40 (9), 44 (10), 48 (11), 52 (12), 56 (13), 60 (14), 64 (15)

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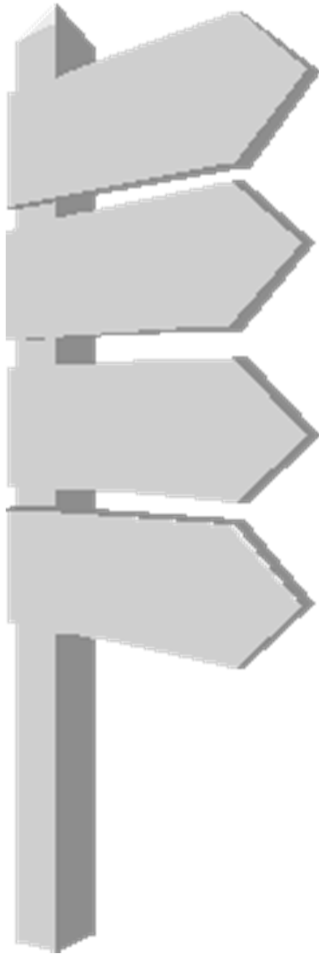
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- Call Setup Signaling + Counter Triggers (Uu)
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  - SRB1 setup
  - NAS security
  - RRC security + UE capability enquiry
  - SRB2 + DRB setup
- Fixing Problems
  - In PRACH phase *(including handover access)*
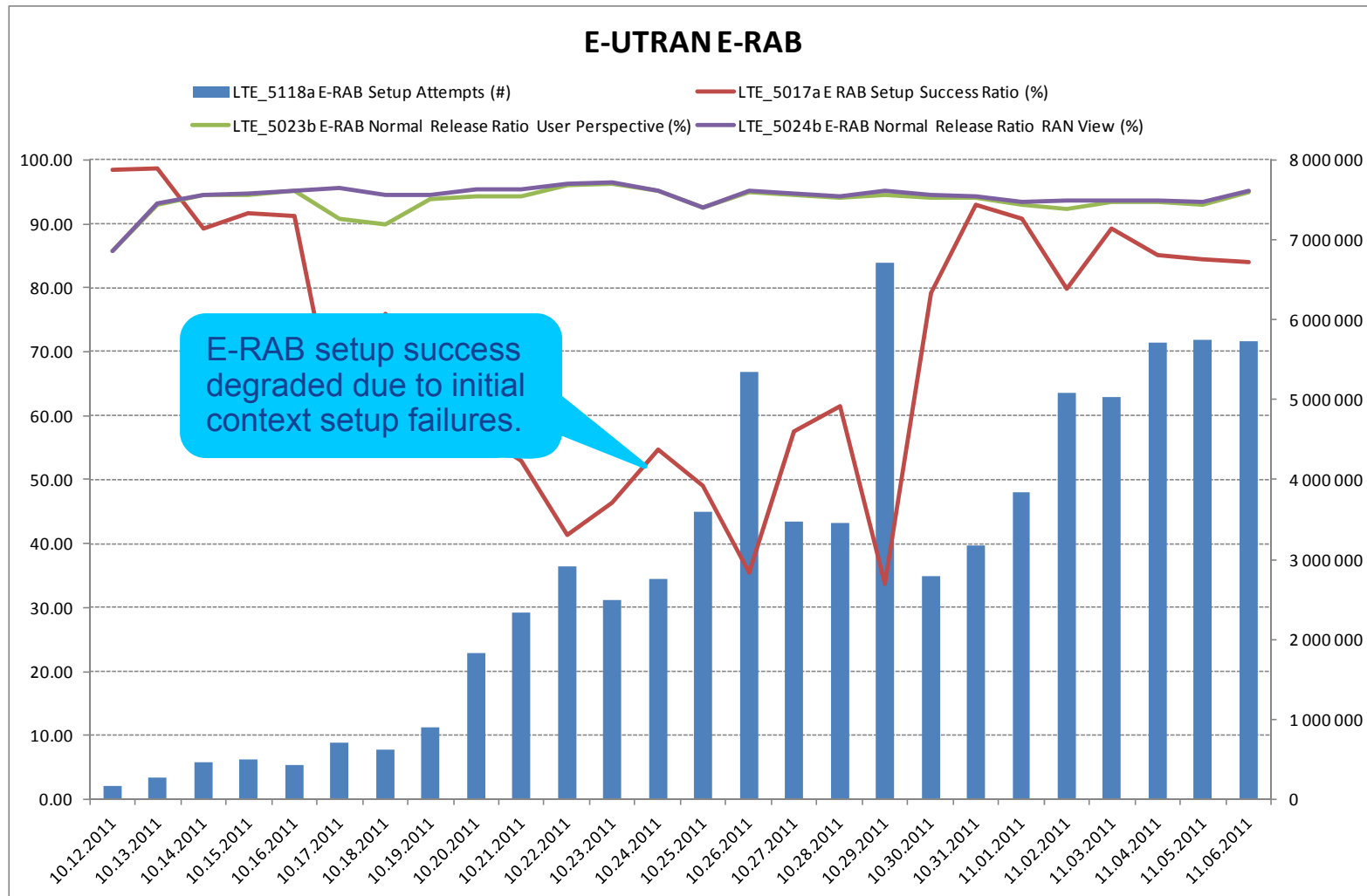 - In post-PRACH phase
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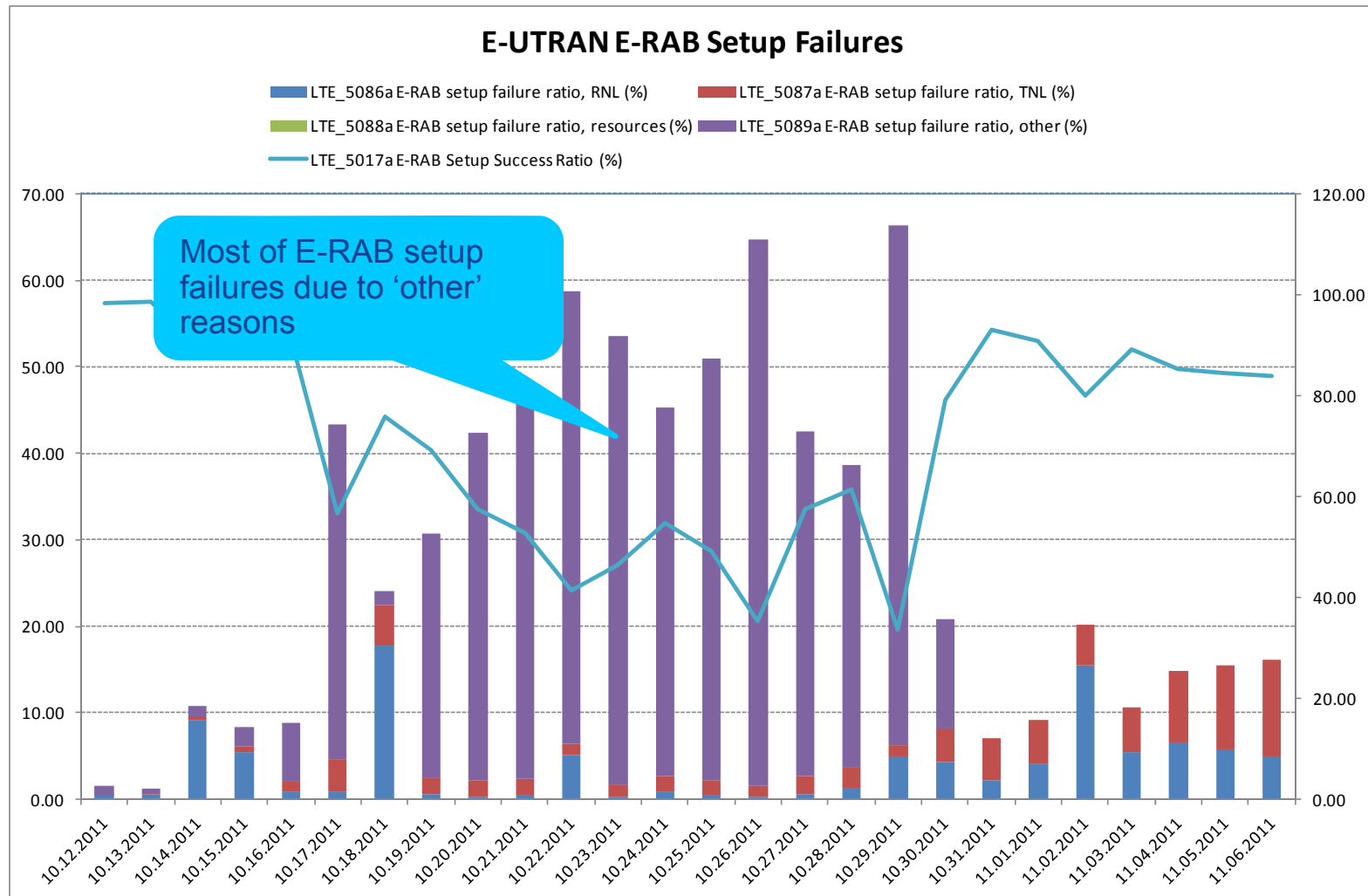
Operator A Example: RRC Performance

E-UTRAN RRC Signalling

Legend: LTE_753a RRC Connection Establishment attempts (#) — LTE_5218c RRC Connection Setup Success Ratio (%) — LTE_5220a RRC Success Ratio (%)

RRC completion success degraded due to initial context setup failures

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Operator A Example: RRC Connection Release Failures

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Operator A Example: E-RAB Performance

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Operator A Example: E-RAB Setup Failures

Operator A Example: Initial Context Setup Failure – Scenario

User data	Target time
UE ID: 607, UE ID: 0, CRNTI: 30594, Trans ID: 2, Cell ID: 1673	20:49:31.108966
UE ID: 607, CRNTI: 30594, Trans ID: 2, Cell ID: 1673	
eNB PDSCH/DL-SCH/CCCH: RrcConnectionSetup, CRNTI: 30594, Cell ID: 1673	
UE PUSCH/UL-SCH/DCCH: RrcConnectionSetupComplete + EMM:SERVICE REQUEST, UE	
UE ID: 607, MME S1AP ID: 0, Cell ID: 34645763	20:49:31.127456
UE ID: 607, MME S1AP ID: 0, L3 Link ID: 2	
UE ID: 607, Conn ID: 1, L3 Link ID: 2	
UE ID: 607, Conn ID: 1, L3 Link ID: 2	
eNB S1AP: InitialUEMessage + EMM:SERVICE REQUEST, UE ID: 607, MME S1AP ID: 0, Conn ID: 1	
EPC S1AP: InitialContextSetupRequest, UE ID: 607, MME S1AP ID: 87639, L3 Link ID: 2	
eNB S1AP: InitialContextSetupFailure, Cause : protocol : semantic-error, UE ID: 607, MME S1AP ID: 8	
EPC S1AP: DownlinkNASTransport + EMM:SERVICE REJECT, UE ID: 607, MME S1AP ID: 87639, L	
EPC S1AP: UEContextReleaseCommand, Cause : protocol : semantic-error, UE ID: 607, MME S1AP	
eNB PDSCH/DL-SCH/DCCH: DlInformationTransfer + EMM:SERVICE REJECT, UE ID: 607, CRNTI:	
eNB PDSCH/DL-SCH/DCCH: RrcConnectionRelease, UE ID: 607, CRNTI: 30594, Trans ID: 3, Cell ID	
eNB S1AP: UEContextReleaseComplete, UE ID: 607, MME S1AP ID: 87639, Conn ID: 1, L3 Link ID: 2	
UE PUCCH/UCI: RlcAck, UE ID: 607, CRNTI: 30594, Trans ID: 3, Cell ID: 1673	

```
value UEAggregateMaximumBitrate
    uEaggregateMaximumBitRateDL 0,
    uEaggregateMaximumBitRateUL 0
```

```
value InitialContextSetupFailure : {
    protocolIEs {
        {
            id 0,
            criticality ignore,
            value MME-UE-S1AP-ID : 87639
        },
        {
            id 8,
            criticality ignore,
            value ENB-UE-S1AP-ID : 1
        },
        {
            id 2,
            criticality ignore,
            value Cause : protocol : semantic-error
```

• The initial context setup failure due to incorrect UE-AMBR = 0 setting.

• The eNB rejects the S1AP: INITIAL CONTEXT SETUP REQUEST message because the both UE-AMBR in UL and UE-AMBR in DL have been set to 0 and thus, EPC initiates UE context release (RRC release) with cause "Semantic Error".

Summary

- The RRC connection completion success rate has improved due to reduced EPC initiated RRC release failures caused by initial context setup failures.

  o However, EPC release failures still remain relatively high (although this could be caused by failed Path Switch procedure in MME).

- E-RAB success rate was significantly improved after he initial context setup failure due to incorrect UE-AMBR = 0 setting was removed.

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Example2 : RRC Connection Establishment Flow with parameters

- (some parameter values are not up to date)

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# RRC Connection Establishment Call Flow
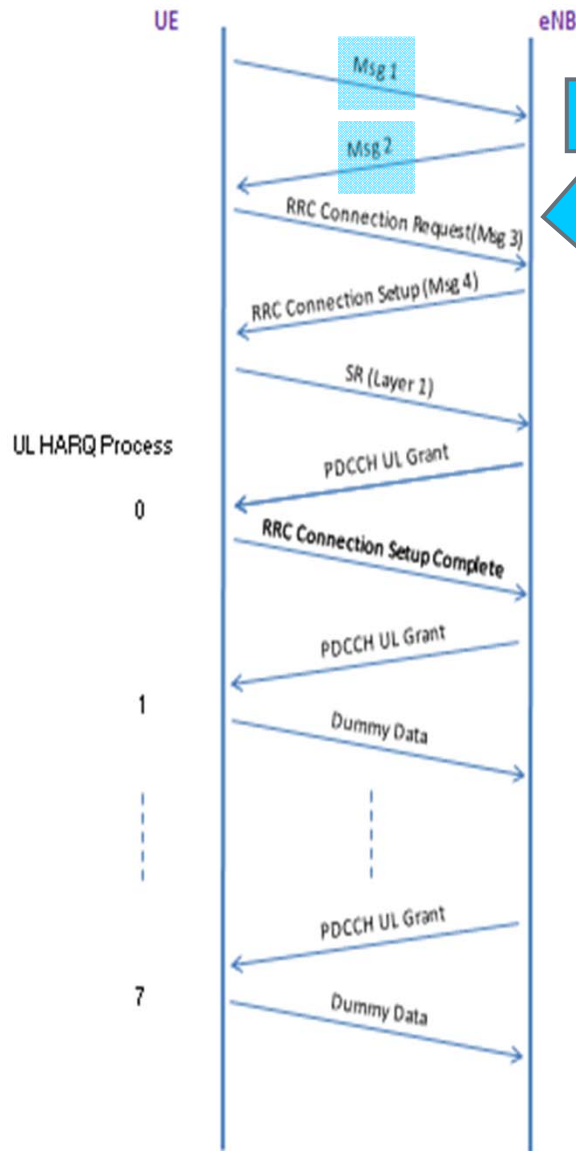
- **Msg 1** : RACH Preambles
  - RACH Preamble Format 0
  - PRACH configuration Index (prachConfIndex)=3,4,5
  - RACH periodicity= 10ms

Msg 2 :

- PDDCH Aggregation level (pdcchAggRaresp) =8
- Coding Rate(maxCrRaDl) =0.12
- Lowest possible DL MCS is selected based on message size (80bits) and coding rate
- Number DL PRB Allocated to meet coding rate requirements
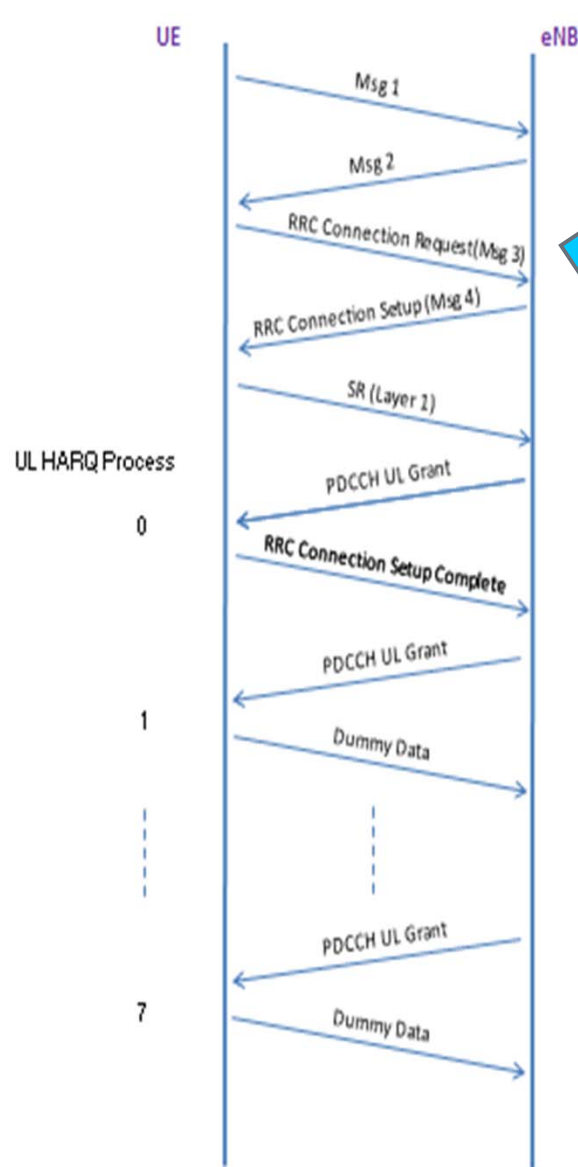
- In current configuration: PRB=4, DL MCS=0

RRC Connection Establishment Call Flow
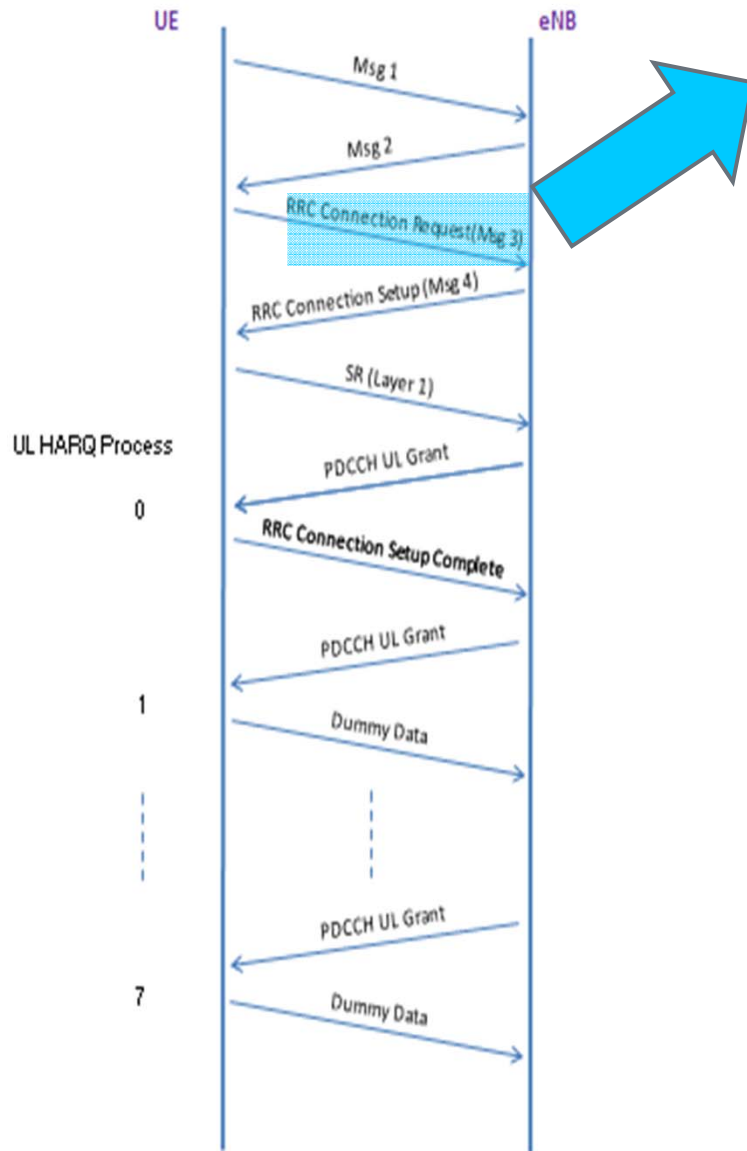
- **Msg 3** : RRC Connection Request

  - UL MCS defined by raSmallMcsUl or raLargeMcsUl =5

  - Small Msg 3 size : raSmallVolUl= 144 bits or raLargeVolUl = 512 bits (non-modifiable)

  - In a coverage limited scenario the UE will select a preamble for a small Msg3

  - In this case the number of PRB's defined by MCS 5 and TBS size (144 bits): PRB=2

  - Message 3 is the first message sent over the PUSCH and therefore has a special Power control formula specified by 3GGP

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RRC Connection Establishment Call Flow

Msg 4 :

- PDDCH Aggregation level (pdcchAggMsg4) =4

- Coding Rate(maxCrRa4Dl) =0.39

- Lowest possible DL MCS is selected based on message size (44B) and coding rate

- Number DL PRB Allocated to meet coding rate requirements

- In current configuration: PRB=4, DL MCS=5

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RRC Connection Establishment Call Flow

RRC Connection Setup Complete :
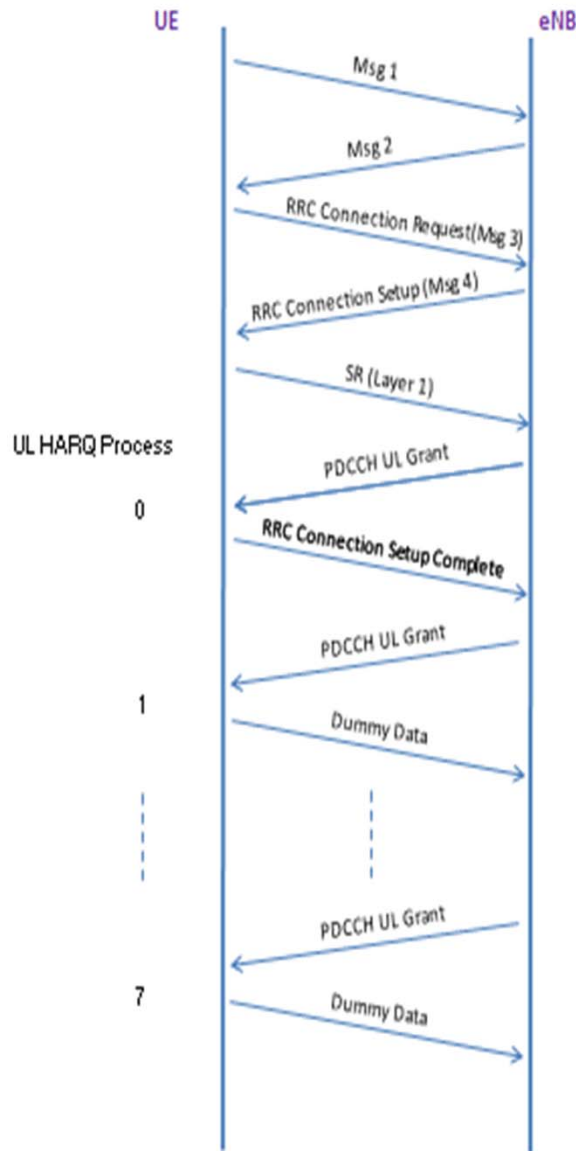
- Grant for this message is received via SR

- Number of PRB's allocated for SR are defined by non-modifiable parameter maxNumPrbSr =4

- PDDCH Aggregation level will initially be defined be pdcchdefAggLevel =4.

- After this the PDCCH Adaptive Modulation and Coding(AMC) Algorithm will decide Aggregation and power level required for the PDCCH

- UL MCS is defined by iniMcsUI=5

- UL PRB Allocated= Calculated based on Message Size and UL MCS

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RRC Connection Establishment Call Flow
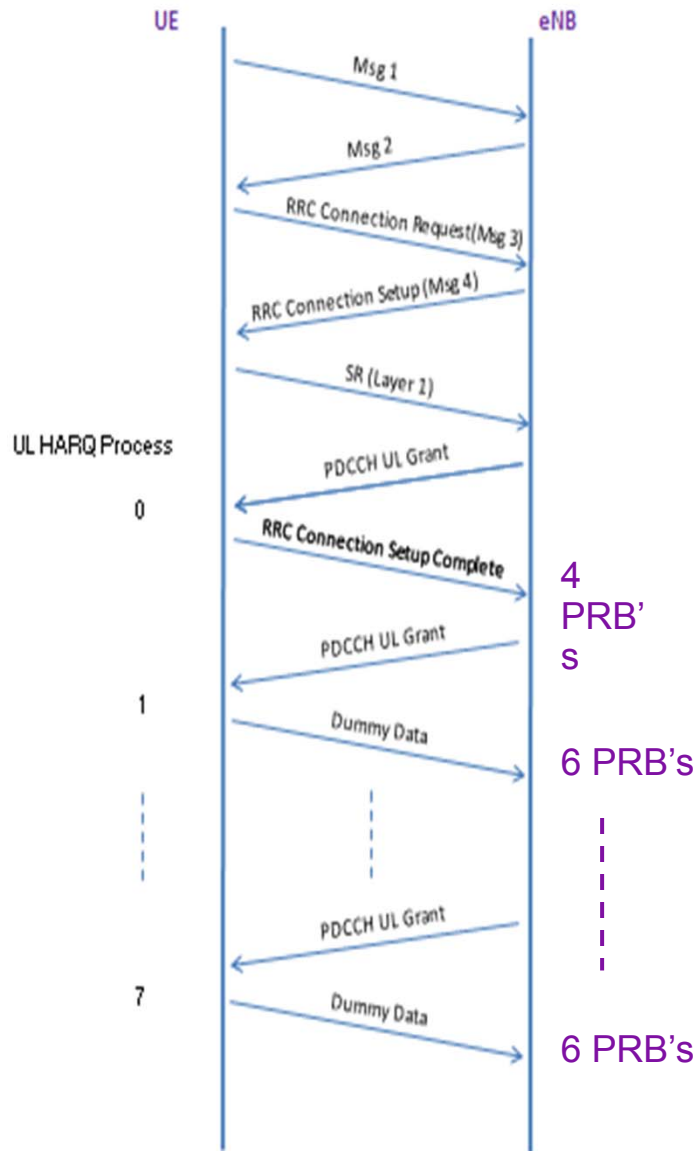
RRC Connection Setup Complete (Cont):

- Proactive Scheduling Feature grants UL resources which will be used to send dummy data if the RRC Connection Setup Complete payload fits in the initial PRB grant

- The number of PRB's for these grants is defined via the parameter iniPrbsUl =6

- UE will send Dummy data(padding) in the additional grants received

- UL Power control from here onwards is based on 3GPP power control for PUSCH

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Example:Korea optimization results

- Note that the "golden" parameter set is defined to provide best possible performance during low loaded traffic conditions maximizing the cell and user throughputs – therefore when the traffic in the network grows this "golden" parameter set might not always provide the best possible performance

- "platinum" parameter set is defined for moderate loaded,100% smart phone Korean networks

Paramter Name	"Golden" / Current Parameter Set	"Platinum" Parameter Set
harqMaxTrDl**	4	7
harqMaxTrUl	5	7
raContResoT	32ms	64ms
T300	200ms	600ms
harqMaxMsg3	3	5
pdcchAggRaresp*	4	8
maxCrRaDl*	0.12	0.05
pdcchAggMsg4	4	8
maxCrRa4Dl	0.12	0.05
ilReacTimerUl	1500ms (200ms)	0ms
deltaPreMsg3	2dB	2dB
ulpcRarespTpc*	8dB	4dB
ulpcIniPrePwr	-104dBm	-104dBm
prachPwrRamp	2dB	2dB
cqiPerNp	20ms	40ms
T311	3000ms	5000ms
T301	200ms	600ms (set equal to T300)
p0NomPucch	-100	-115
ulpcLowlevCch	-103	-117
ulpcUplevCch	-98	-112
pagingNb	quarterT	oneT

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Example 3:Korea optimization results
Performance Improvement

- LTE Optimization …
  - HO success rate
  - RRC setup success rate

Strong Correlation → Dropped Call Rate
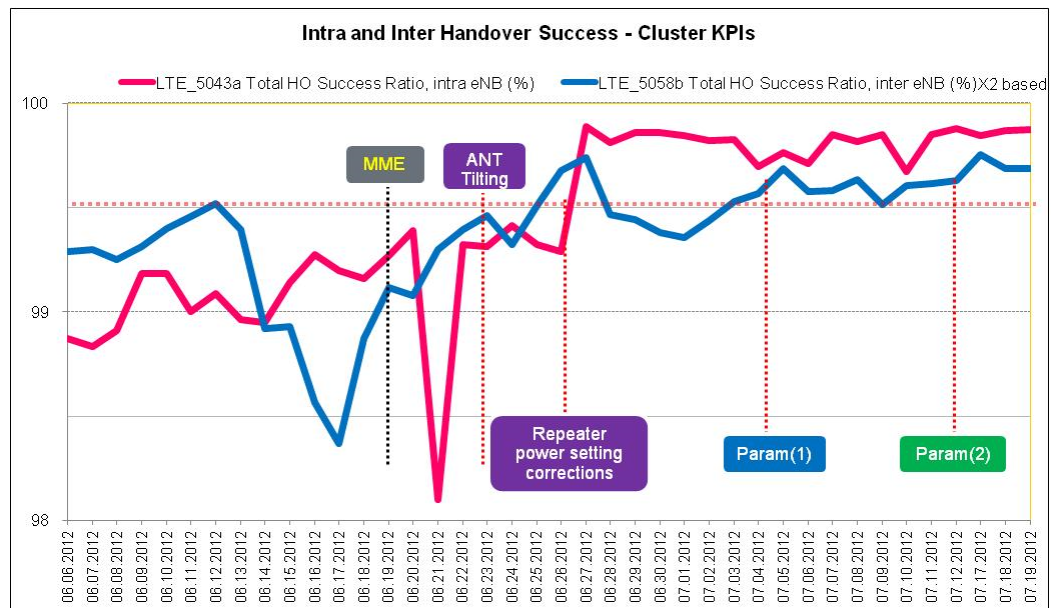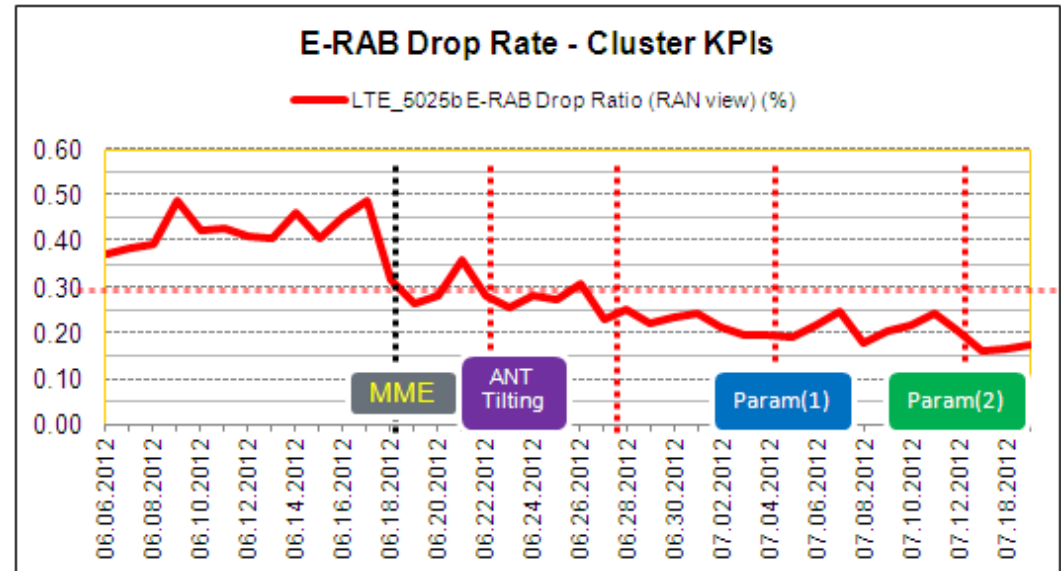

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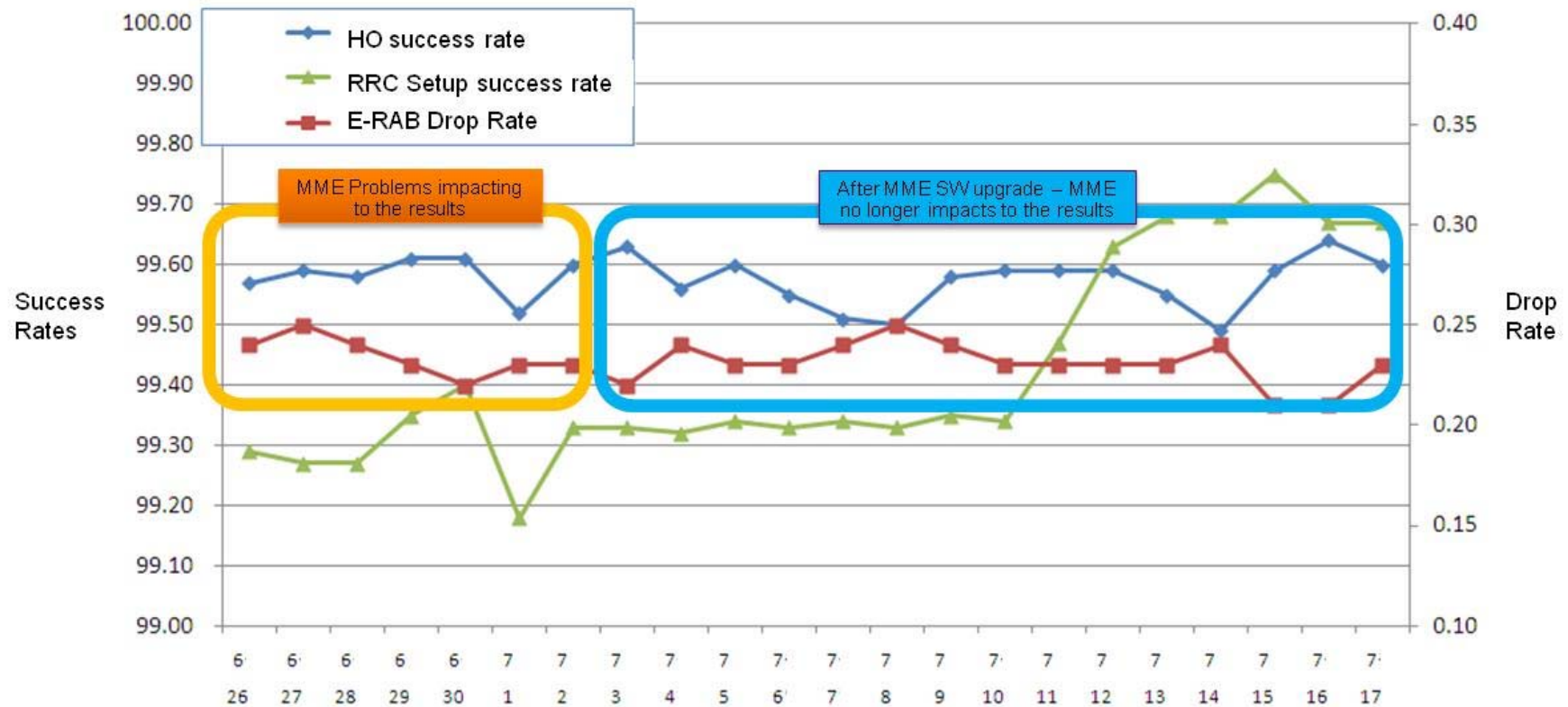
Example 3:Korea optimization results Performance Improvement

- NEVER underestimate the basic L1 optimization – even 4G (LTE) relies on the fact that L1 must be optimized properly

- Massive improvement in the performance by basic L1 optimization in a cluster

Cluster level drive test results

Drive Test Result (Antenna Tilting)	Unit	Diff. Experienced improvement
DL Throughput	(Mbps)	5 Mbps ↑
Handover Attempts	(#)	33 % ↓
Average SINR	(dB)	2.3 dB ↑
Average CQI		0.5 ↑

E-RAB Drop Rate - Cluster KPIs

LTE_5025b E-RAB Drop Ratio (RAN view) (%)

MME   ANT Tilting   Param(1)   Param(2)

Intra and Inter Handover Success - Cluster KPIs

LTE_5043a Total HO Success Ratio, intra eNB (%)   LTE_5058b Total HO Success Ratio, inter eNB (%)X2 based

MME   ANT Tilting   Repeater power setting corrections   Param(1)   Param(2)

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- **Exercises**

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Call setup analysis exercise

- Files:
  - KPI report: KPI_Report_LTE-2
  - Nemo log: Nemo log 6 call setup exercise.1.nmf
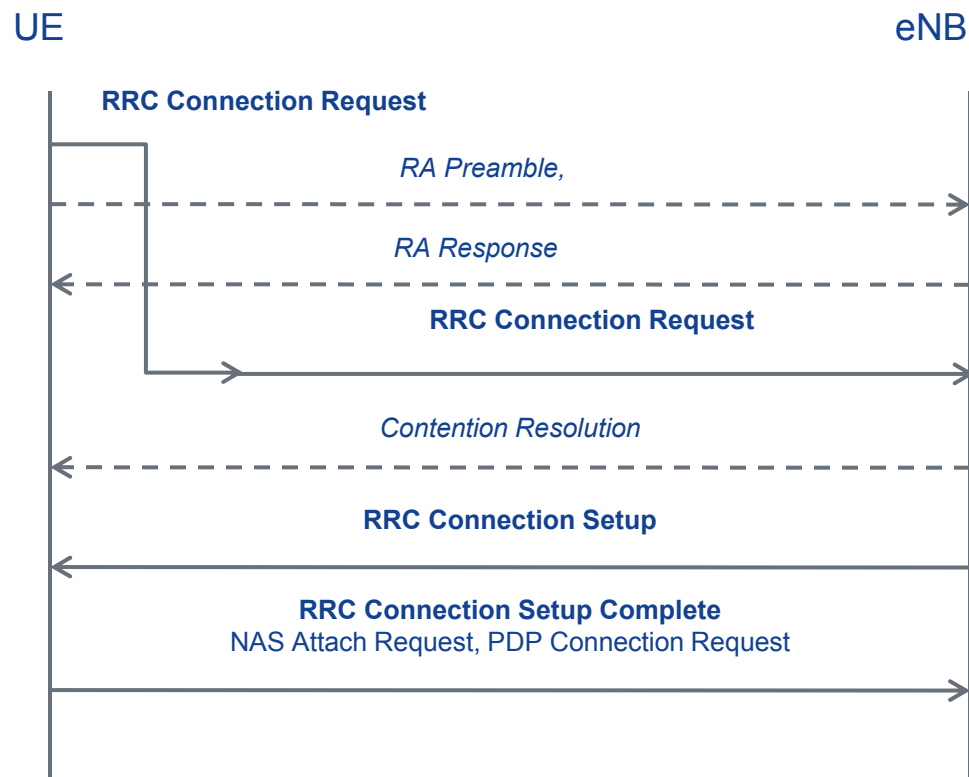
1. Check the KPI report:
  - Can you find any connection setup problems in KPI stats?
  - Based on the KPIs, in which phase of the connection setup the problems appear?

2. Check the Nemo log:
  - Can you find any connection setup problems in the drive test log?
  - Can you tell the reason for failures?

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Exercise

- Write the key parameter controlling the transmission power/CR for each message in RRC Connection Setup Flow

UE   eNB

RRC Connection Request

RA Preamble,

RA Response

RRC Connection Request

Contention Resolution

RRC Connection Setup

RRC Connection Setup Complete
NAS Attach Request, PDP Connection Request

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Call setup exercise

- Analyze following RRC Setup failures (Emil logs).

- What message (UL or DL) is the most probable failure reason?

Mon_0A39_52023_RRC_setup1.emil

Mon_8F99_48654_RRC_setup2.emil

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