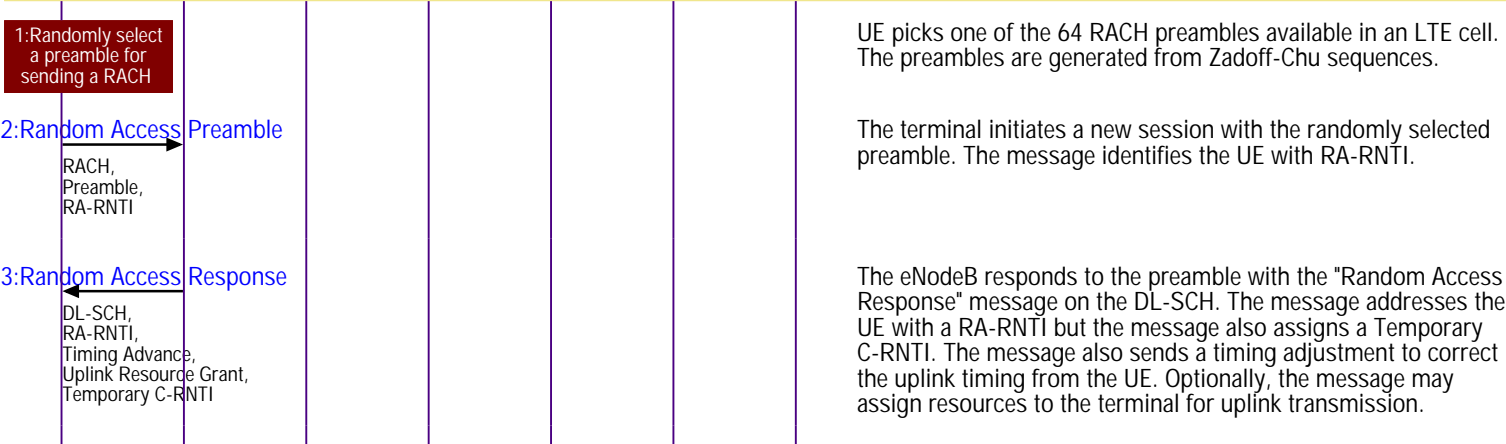| Cell	New E-UTRAN	New EPC			Old EPC	Databases
UE	eNodeB	New MME	Serving GW	PDN GW	Old MME	HSS

LTE Attach and Default Bearer Setup

Generated with EventStudio System Designer - https://www.EventHelix.com/EventStudio

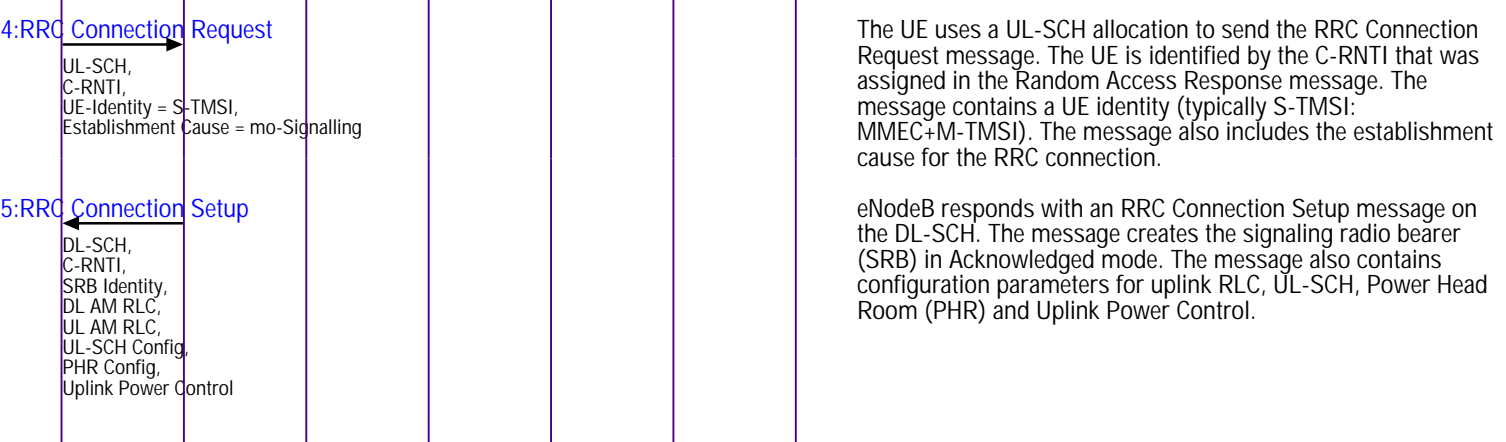This flow describes the setup of an LTE session. The connection establishment progresses through the following phases:

(1) RRC Connection Establishment: The Radio Resource Control layer establishes a connection between the UE and the eNodeB. This procedure is initiated with a random access with a preamble. This is followed up with RRC connection establishment signaling on the UL-SCH and DL-SCH.

(2) Attach and Authentication: The UE now attaches to the Core Network. MME and Serving Gateway also establish a context for the UE. This phase also involves authentication for the UE as well are the Network.

(3) Default Bearer Setup: Finally, the default bearer for data transfer is established. Default bearer session is established at the UE, eNodeB, MME, Serving GW and PDN Gateway. User data sessions is exchanged once the default bearer is setup.

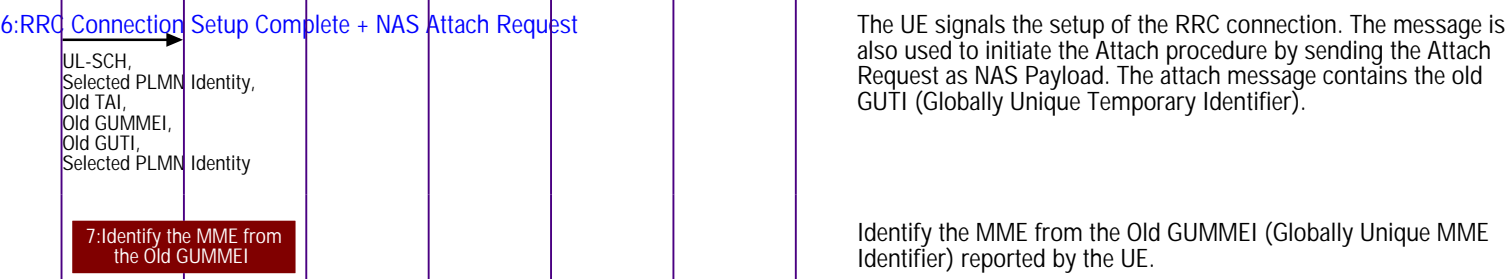Note: Click on messages with blue titles for more details about message structure.
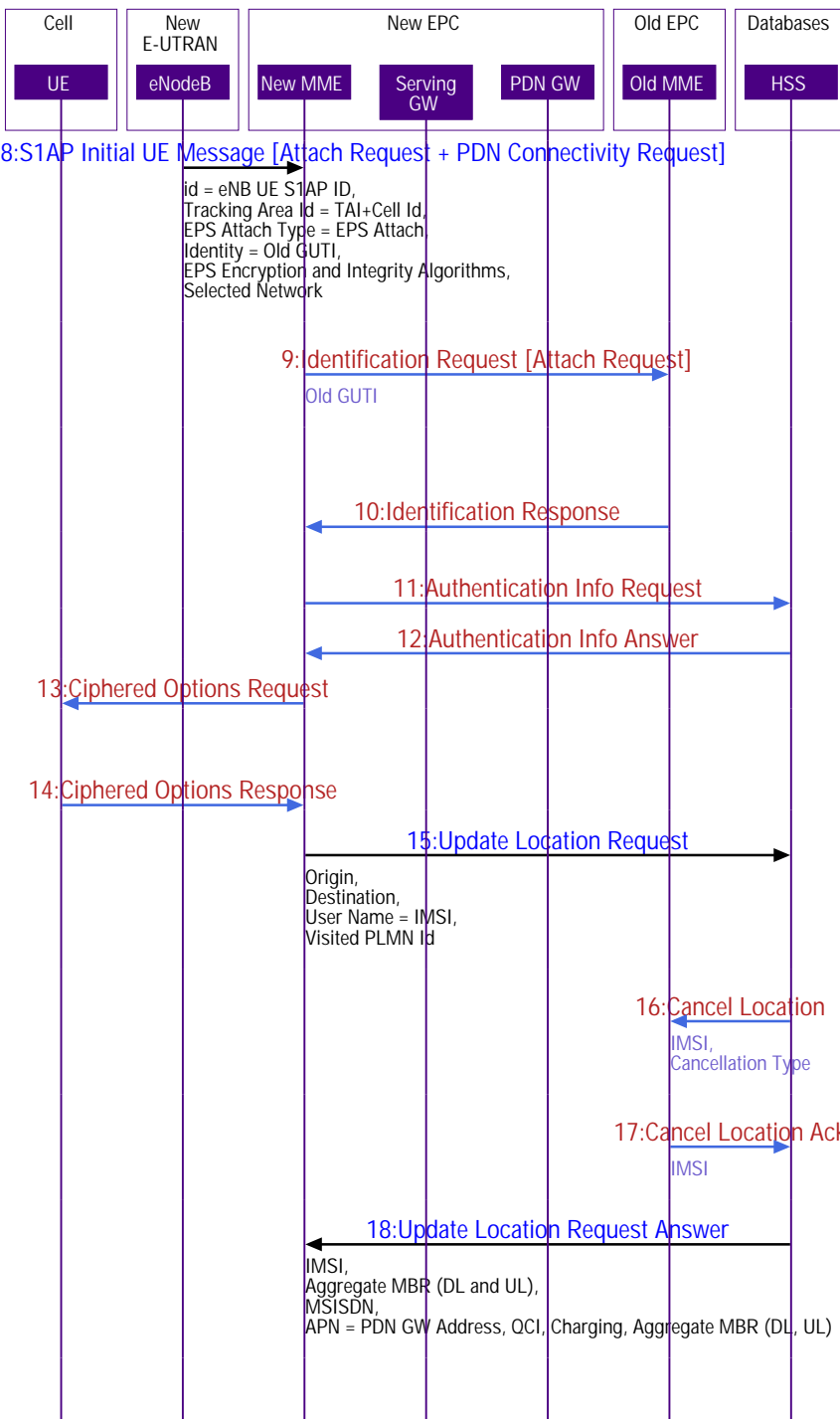
Random Access Procedure

1: Randomly select a preamble for sending a RACH

UE picks one of the 64 RACH preambles available in an LTE cell. The preambles are generated from Zadoff-Chu sequences.

2: Random Access Preamble
RACH,
Preamble,
RA-RNTI

The terminal initiates a new session with the randomly selected preamble. The message identifies the UE with RA-RNTI.

3: Random Access Response
DL-SCH,
RA-RNTI,
Timing Advance,
Uplink Resource Grant,
Temporary C-RNTI

The eNodeB responds to the preamble with the "Random Access Response" message on the DL-SCH. The message addresses the UE with a RA-RNTI but the message also assigns a Temporary C-RNTI. The message also sends a timing adjustment to correct the uplink timing from the UE. Optionally, the message may assign resources to the terminal for uplink transmission.

RRC Connection Establishment

4: RRC Connection Request
UL-SCH,
C-RNTI,
UE-Identity = S-TMSI,
Establishment Cause = mo-Signalling

The UE uses a UL-SCH allocation to send the RRC Connection Request message. The UE is identified by the C-RNTI that was assigned in the Random Access Response message. The message contains a UE identity (typically S-TMSI: MMEC+M-TMSI). The message also includes the establishment cause for the RRC connection.

5: RRC Connection Setup
DL-SCH,
C-RNTI,
SRB Identity,
DL AM RLC,
UL AM RLC,
UL-SCH Config,
PHR Config,
Uplink Power Control

eNodeB responds with an RRC Connection Setup message on the DL-SCH. The message creates the signaling radio bearer (SRB) in Acknowledged mode. The message also contains configuration parameters for uplink RLC, UL-SCH, Power Head Room (PHR) and Uplink Power Control.

Attach and Authentication

6: RRC Connection Setup Complete + NAS Attach Request
UL-SCH,
Selected PLMN Identity,
Old TAI,
Old GUMMEI,
Old GUTI,
Selected PLMN Identity

The UE signals the setup of the RRC connection. The message is also used to initiate the Attach procedure by sending the Attach Request as NAS Payload. The attach message contains the old GUTI (Globally Unique Temporary Identifier).

7: Identify the MME from the Old GUMMEI

Identify the MME from the Old GUMMEI (Globally Unique MME Identifier) reported by the UE.

Cell	New E-UTRAN	New EPC			Old EPC	Databases
UE	eNodeB	New MME	Serving GW	PDN GW	Old MME	HSS

8:S1AP Initial UE Message [Attach Request + PDN Connectivity Request]

id = eNB UE S1AP ID,
Tracking Area Id = TAI+Cell Id,
EPS Attach Type = EPS Attach,
Identity = Old GUTI,
EPS Encryption and Integrity Algorithms,
Selected Network

The Attach message is sent in the Initial UE message to the MME over the S1AP interface. The "Attach Request" is embedded in the Initial UE Message. The message also includes the PDN Connectivity Request message. The Tracking Area Identify (TAI) and E-UTRAN Cell Global Identifier (ECGI) are also included. Note that the eNodeB uses the eNB-UE-S1APID to uniquely identify the UE.

9: Identification Request [Attach Request]

Old GUTI

Since the UE identified itself with GUTI and the MME has changed since detach, the new MME uses the GUTI received from the UE to derive the old MME, and send an Identification Request (old GUTI, complete Attach Request message) to the old MME to request the IMSI.

10:Identification Response

The old MME responds with Identification Response (IMSI, unused EPS Authentication Vectors, KSIASME, KASME)

11:Authentication Info Request

12:Authentication Info Answer

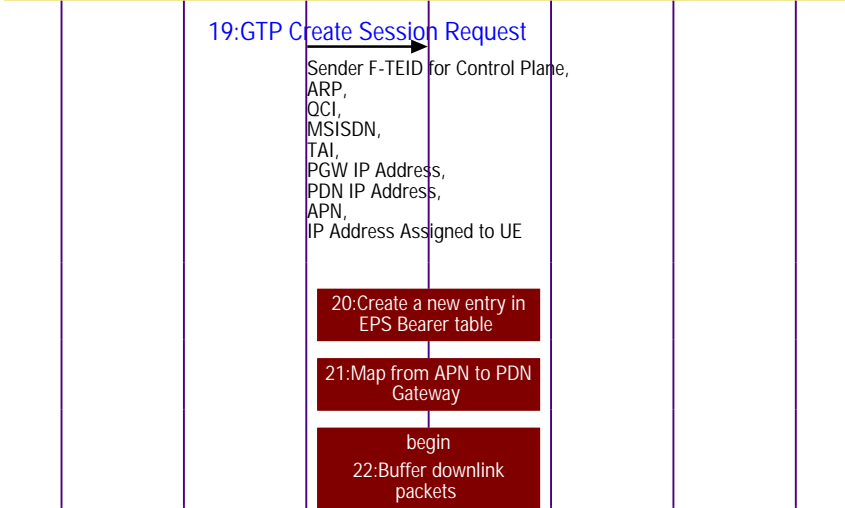**13:Ciphered Options Request**

Since the UE has set the Ciphered Options Transfer Flag in the Attach Request message, the ciphered Options i.e. PCO or APN or both, shall now be retrieved from the UE.

14:Ciphered Options Response

15:Update Location Request

Origin,
Destination,
User Name = IMSI,
Visited PLMN Id

Since the MME has changed since the last detach, the MME sends an Update Location Request message to the HSS. The MME capabilities indicate the MME's support for regional access restrictions functionality. Update Type indicates this is Attach procedure.
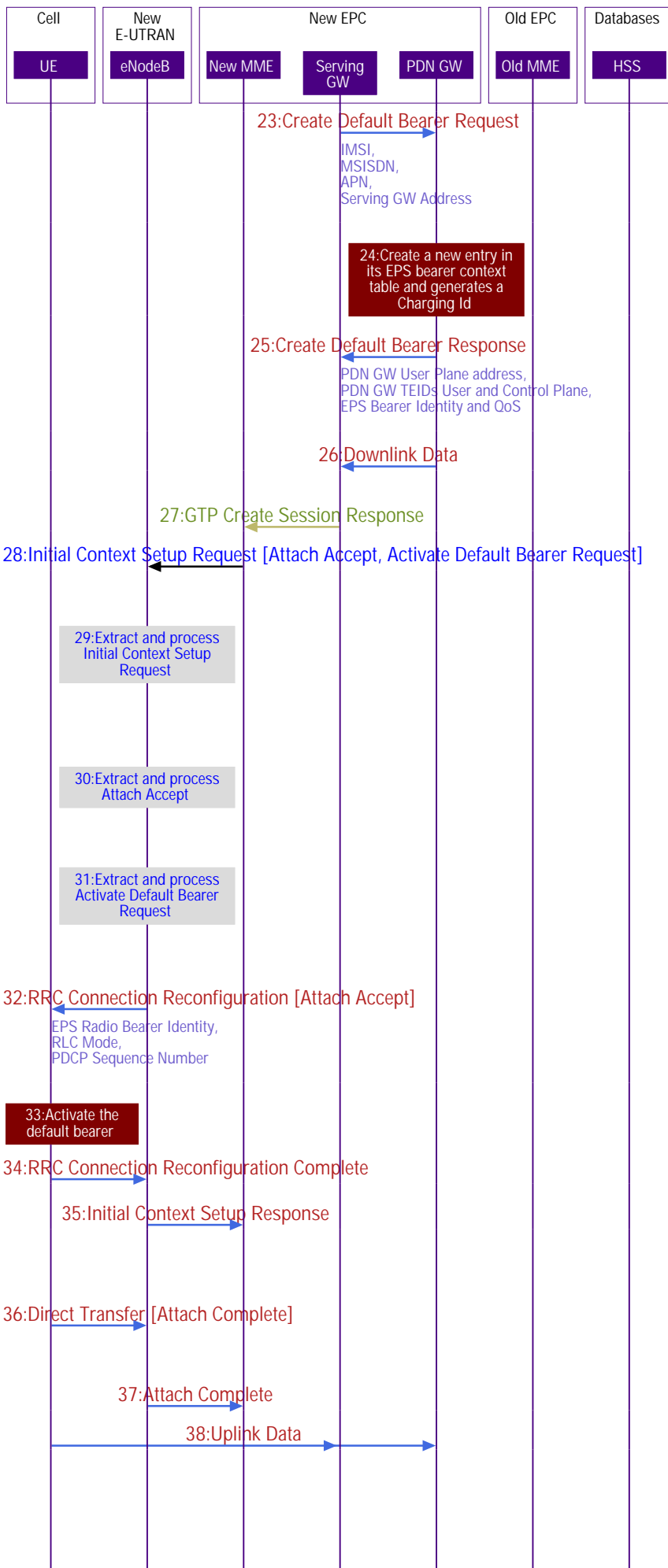
16:Cancel Location

IMSI,
Cancellation Type

The HSS sends Cancel Location to the old MME. The old MME acknowledges with Cancel Location Ack and removes the MM and bearer contexts.

17:Cancel Location Ack

IMSI

18:Update Location Request Answer

IMSI,
Aggregate MBR (DL and UL),
MSISDN,
APN = PDN GW Address, QCI, Charging, Aggregate MBR (DL, UL)

The HSS acknowledges the Update Location message by sending an Update Location Answer message to the new MME. The Subscription Data contains PDN subscription contexts. Each PDN subscription context contains an 'EPS subscribed QoS profile' and the subscribed APN-AMBR . The new MME validates the UE's presence in the (new) TA. If all checks are successful then the new MME constructs a context for the UE.

Default Radio Bearer Setup

19:GTP Create Session Request

Sender F-TEID for Control Plane,
ARP,
QCI,
MSISDN,
TAI,
PGW IP Address,
PDN IP Address,
APN,
IP Address Assigned to UE

MME initiates the default route establishment by asking the SGW to create a GTP tunnel. The APN specified by the UE is used for default bearer activation. The IP Address assigned to the UE is also included along with the downlink and uplink maximum data rates allowed at the APN level.

20:Create a new entry in EPS Bearer table

21:Map from APN to PDN Gateway

begin
22:Buffer downlink packets

Cell	New E-UTRAN	New EPC			Old EPC	Databases
UE	eNodeB	New MME	Serving GW	PDN GW	Old MME	HSS

23:Create Default Bearer Request

IMSI,
MSISDN,
APN,
Serving GW Address

Serving Gateway sends Create Default Bearer Request message to the PDN GW.

24:Create a new entry in its EPS bearer context table and generates a Charging Id

The new entry allows the P GW to route user plane PDUs between the S GW and the packet data network, and to start charging.

25:Create Default Bearer Response

PDN GW User Plane address,
PDN GW TEIDs User and Control Plane,
EPS Bearer Identity and QoS

26:Downlink Data

Serving Gateway receives the first downlink data block. This block is buffered at the Serving GW".

27:GTP Create Session Response

28:Initial Context Setup Request [Attach Accept, Activate Default Bearer Request]

MME responds back to the eNodeB with a message containing three messages: SIAP Initial Context Setup Request, NAS Attach Accept and Activate Default Bearer Request.

29:Extract and process Initial Context Setup Request

The message is identified by the S1AP id that was sent in the initial UE message. The message contains maximum bit rate information for the UE. Quality of service information for the new eRAB is also specified (QCI, maximum bit rate downlink and uplink). The information received in this message will be used to setup radio resources for the eNodeB.

30:Extract and process Attach Accept

The message is extracted from the NAS payload of the Initial Context Setup Request message. It signals the successful completion of attach. The message contains the GUTI and the TAI list. This message will be sent to the NAS layer on the UE.

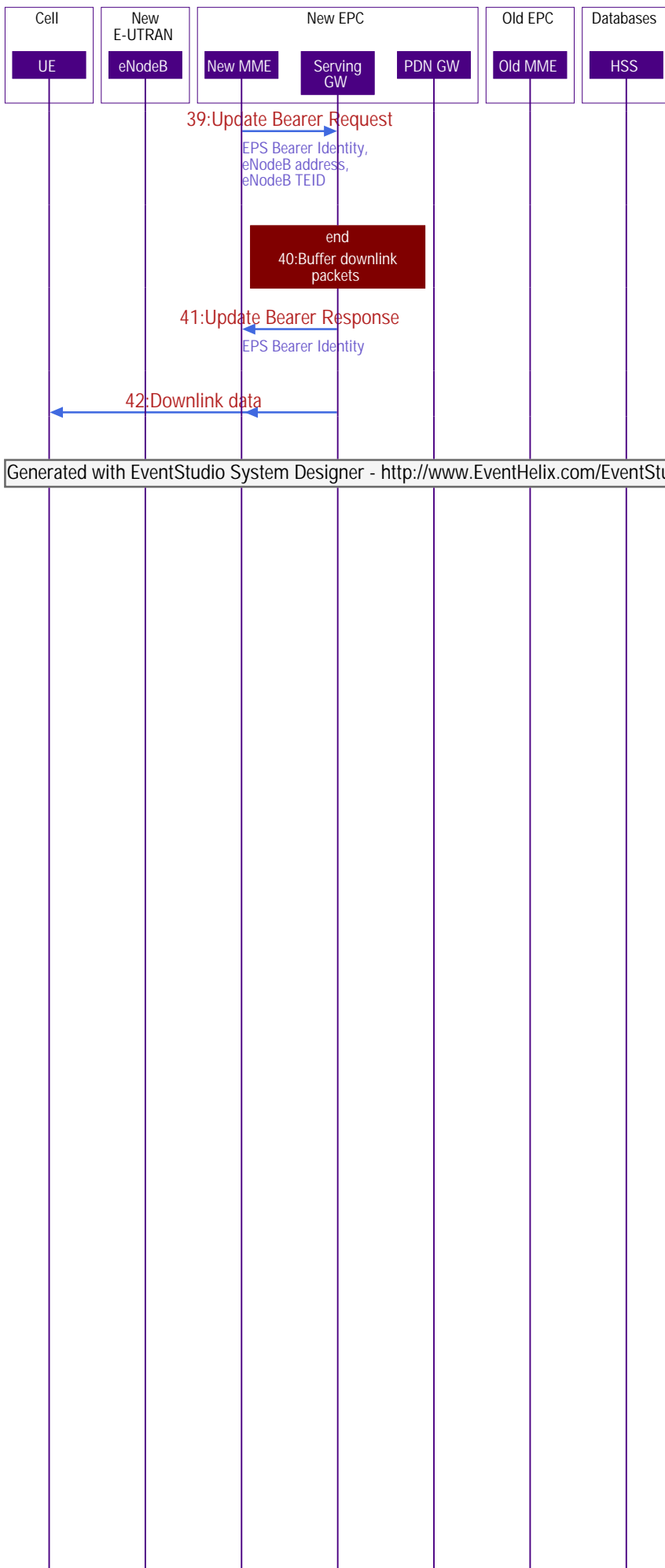**31:Extract and process Activate Default Bearer Request**

The message is extracted from the NAS payload of the Initial Context Setup Request message. The message contains quality of service information for the default RAB. The Access Point Name (APN) and PDN Address are also included. This message will be sent to the NAS layer on the UE.

32:RRC Connection Reconfiguration [Attach Accept]

EPS Radio Bearer Identity,
RLC Mode,
PDCP Sequence Number

The RRC Connection Reconfiguration message is sent to activate the default radio bearer. The message also carries the Attach Accept message as NAS Payload.

33:Activate the default bearer

34:RRC Connection Reconfiguration Complete

UE replies back to the eNodeB.

35:Initial Context Setup Response

The eNodeB sends the Initial Context Response message to the new MME. This Initial Context Response message includes the TEID of the eNodeB and the address of the eNodeB used for downlink traffic on the S1_U reference point.

36:Direct Transfer [Attach Complete]

The UE sends a Direct Transfer message to the eNodeB, which includes the Attach Complete (EPS Bearer Identity, NAS sequence number, NAS-MAC) message.

37:Attach Complete

38:Uplink Data

Cell	New E-UTRAN	New EPC			Old EPC	Databases
UE	eNodeB	New MME	Serving GW	PDN GW	Old MME	HSS

39:Update Bearer Request

EPS Bearer Identity,
eNodeB address,
eNodeB TEID

Upon reception of both, the Initial Context Response message and the Attach Complete message, the new MME sends an Update Bearer Request message to the Serving GW.

end
40:Buffer downlink packets

Packet buffering is ended.

41:Update Bearer Response

EPS Bearer Identity

The Serving GW acknowledges by sending Update Bearer Response message to the new MME. The Serving GW can then send its buffered downlink packets.

42:Downlink data

Buffered downlink data is forwarded to the UE.

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