eNodeB

MME

S1AP View of LTE Attach & EPS Bearer Setup

This sequence diagram looks at the UE signaling from the S1AP vantage point. The following signaling is covered:

(1) UE Attach, authentication and security signaling

(2) Setup of two EPS Bearers (RAB id 5 and 6)

(3) Release of UE context due to inactivity

(4) Reestablishment of the UE context with a Service Request.

Click on any message title in this flow to see the complete message details.

Generated with EventStudio (http://www.eventhelix.com/eventstudio/) and VisualEther (http://www.eventhelix.com/visualether/)

Note: You can click on any message title in this flow to see complete field level details.

LTE Attach and Default EPS Bearer Establishment on a PDN

Register the UE with the Core Network and initiate the data service by setting up the default EPS Bearer.

allocate
ENB-UE-S1AP-ID: 1

The eNodeB allocates 1 as the ENB-UE-S1AP-ID for the new session.

Initial UE Message {ATTACH REQUEST, PDN CONNECTIVITY REQUEST}

1 →

ENB-UE-S1AP-ID: 1,
.000 .... = NAS key set identifier: (0),
MME Group ID: 32769,
MME Code: 1,
M-TMSI: 0x00000001,
NAS EPS session management messages: PDN connectivity request (0xd0),
Protocol or Container ID: Internet Protocol Control Protocol (0x8021),
Code: Configuration Request (1),
Protocol or Container ID: DNS Server IPv4 Address Request (0x000d),
Protocol or Container ID: IP address allocation via NAS signaling (0x000a),
Protocol or Container ID: IPv4 Link MTU Request (0x0010),
Location Area Code (LAC): 0x0001 (1),
tAC: 0001,
RRC-Establishment-Cause: mo-Signalling (3)

Initial UE Message contains an Attach Request and PDN Connectivity Request. The message contains UE specific information like the PLMN and Tracking Area. The message also contains information about the requested services. UE also sends ESM information transfer flag in the PDN CONNECTIVITY REQUEST message to signal that the APN will be sent after the encryption has been established.

allocate
MME-UE-S1AP-ID: 211

The MME allocates 211 as the MME-UE-S1AP-ID for the session.

Authenticate and Setup Encryption

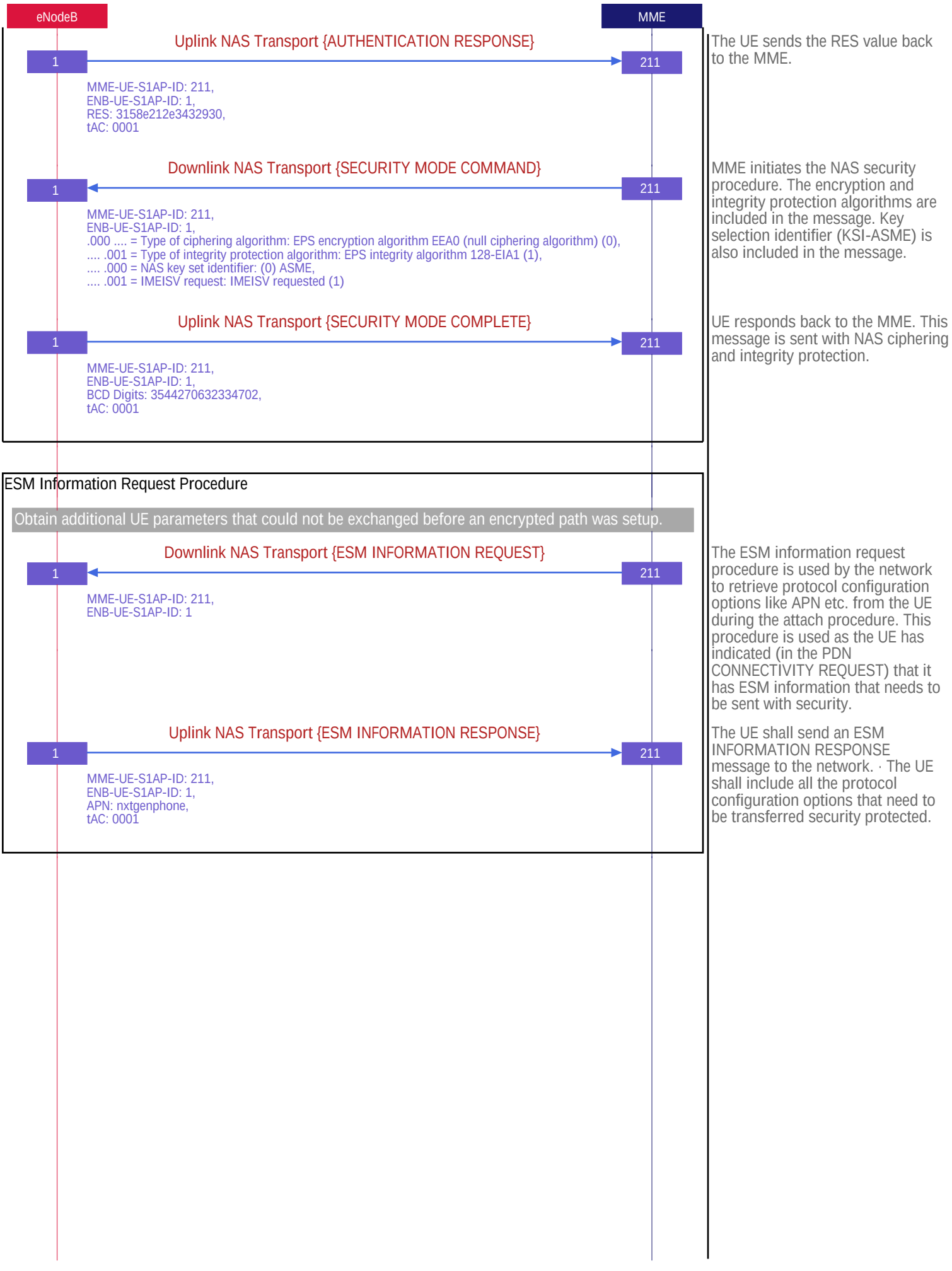
The UE and the Network mutually authenticate each other. This is followed by setting up encryption.

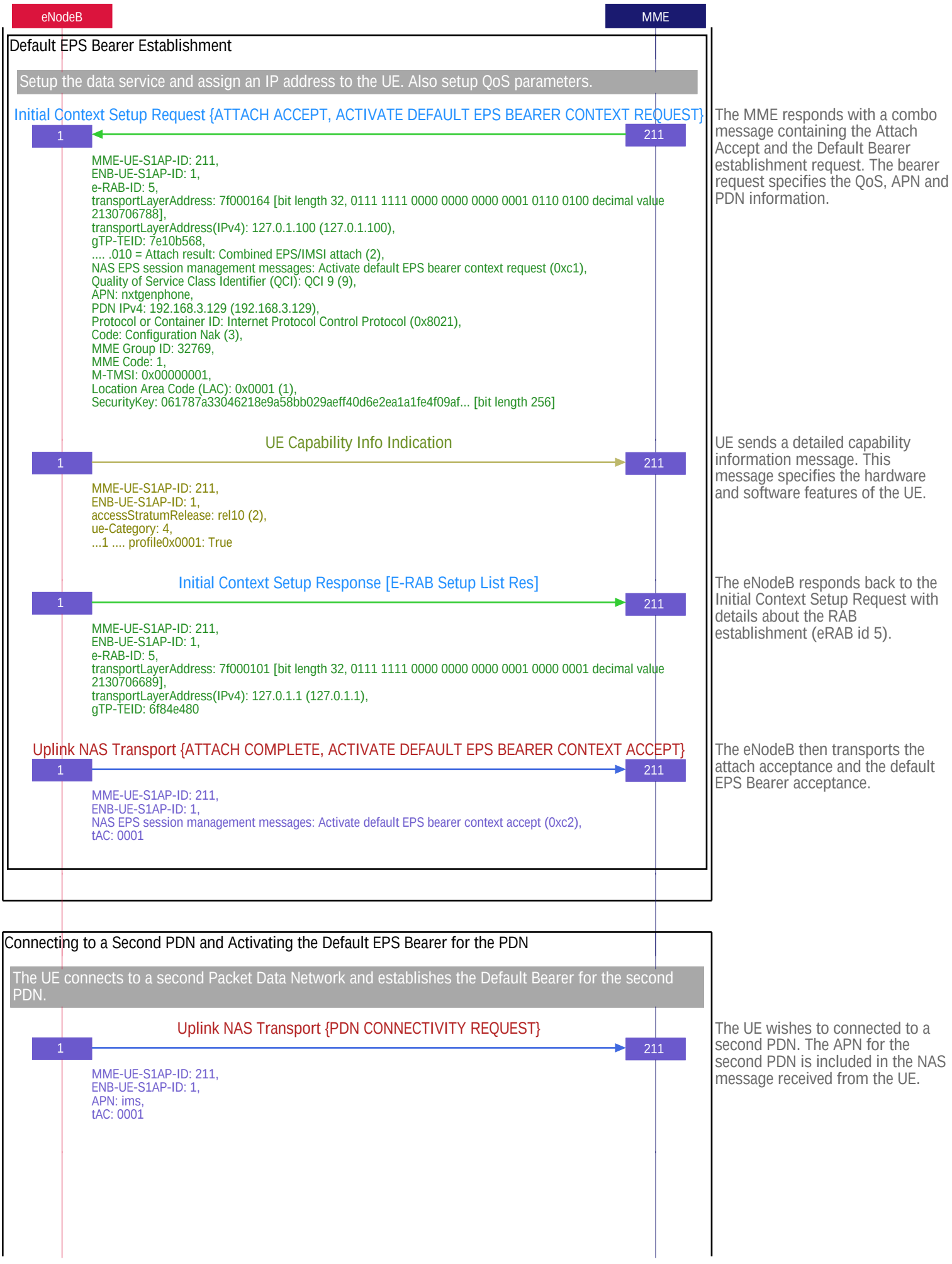
Downlink NAS Transport {AUTHENTICATION REQUEST}

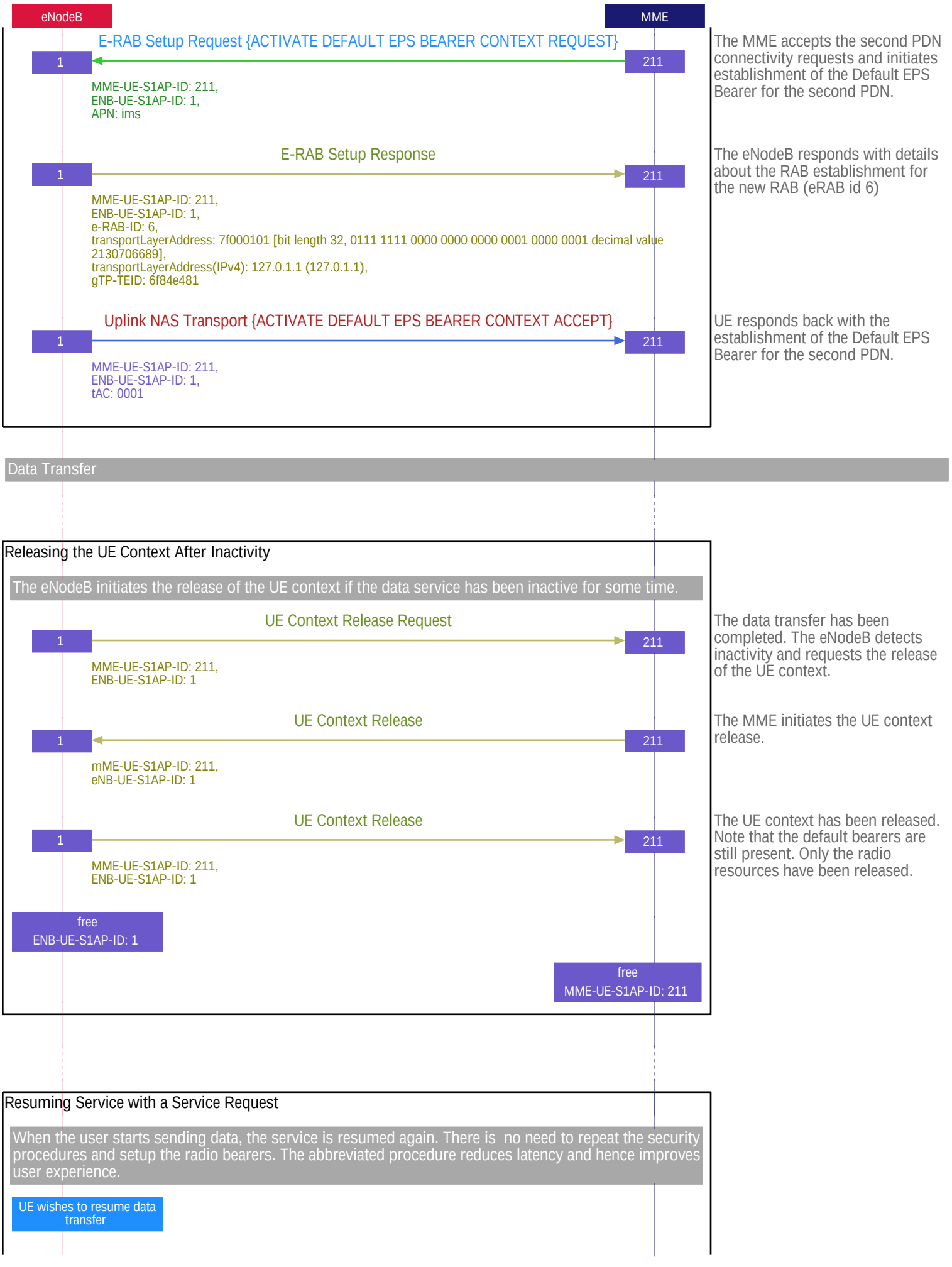
← 1 211

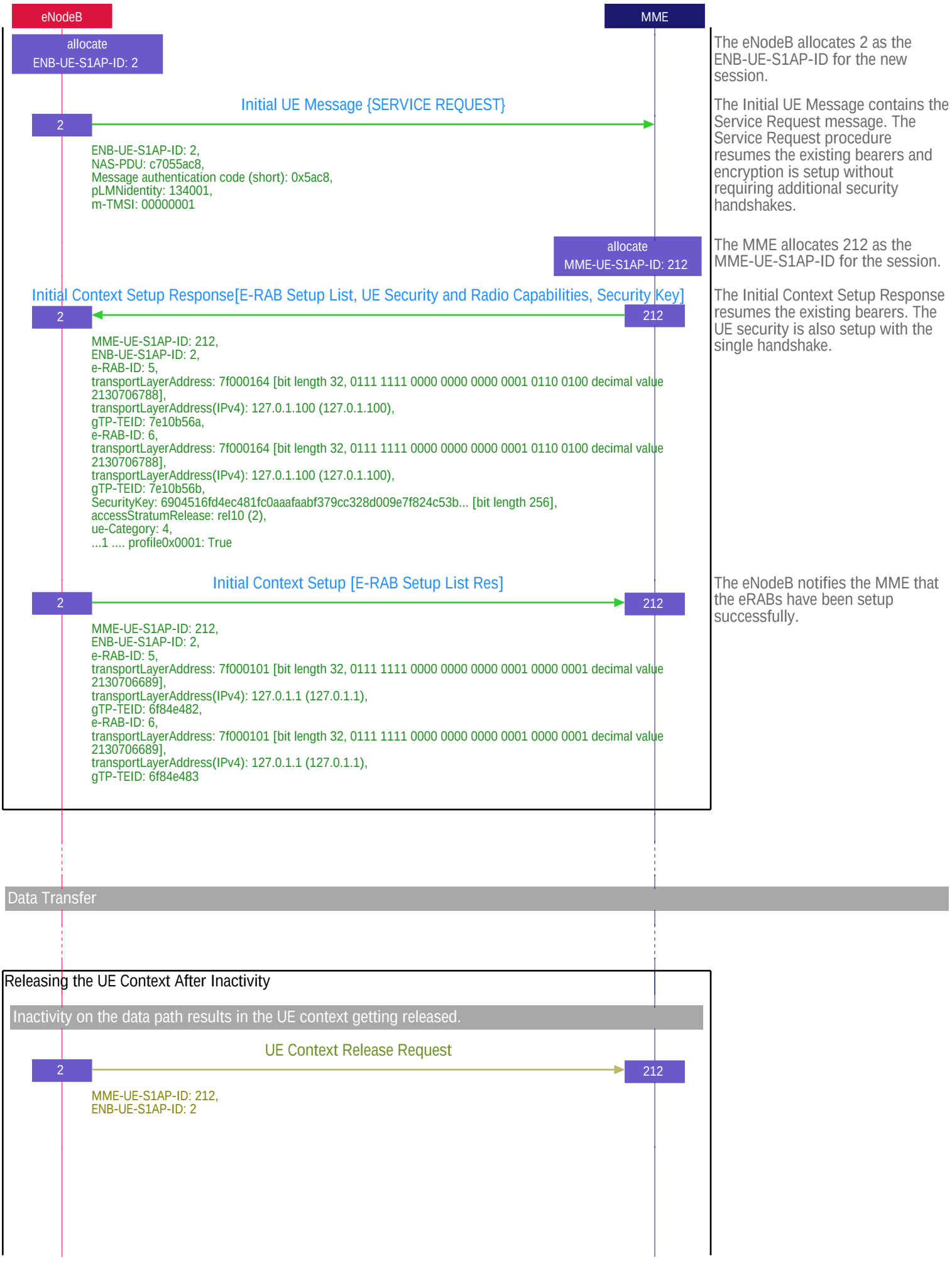
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
.... .000 = NAS key set identifier: (0) ASME,
RAND value: e80526e22caab2fc9a4dda558c612e6a,
SQN xor AK: 9113c6e1085c,
AMF: 9001,
MAC: df93421ca180ebe5

The MME sends an Authentication Request to the UE. The message contains the RAND and AUTN numbers. Key selection identifier (KSI-ASME) is also included in the message. This message is sent in the clear.


eNodeB
MME
Uplink NAS Transport {AUTHENTICATION RESPONSE}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
RES: 3158e212e3432930,
tAC: 0001
The UE sends the RES value back to the MME.
Downlink NAS Transport {SECURITY MODE COMMAND}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
.000 .... = Type of ciphering algorithm: EPS encryption algorithm EEA0 (null ciphering algorithm) (0),
.... .001 = Type of integrity protection algorithm: EPS integrity algorithm 128-EIA1 (1),
.... .000 = NAS key set identifier: (0) ASME,
.... .001 = IMEISV request: IMEISV requested (1)
MME initiates the NAS security procedure. The encryption and integrity protection algorithms are included in the message. Key selection identifier (KSI-ASME) is also included in the message.
Uplink NAS Transport {SECURITY MODE COMPLETE}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
BCD Digits: 3544270632334702,
tAC: 0001
UE responds back to the MME. This message is sent with NAS ciphering and integrity protection.
ESM Information Request Procedure
Obtain additional UE parameters that could not be exchanged before an encrypted path was setup.
Downlink NAS Transport {ESM INFORMATION REQUEST}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1
The ESM information request procedure is used by the network to retrieve protocol configuration options like APN etc. from the UE during the attach procedure. This procedure is used as the UE has indicated (in the PDN CONNECTIVITY REQUEST) that it has ESM information that needs to be sent with security.
Uplink NAS Transport {ESM INFORMATION RESPONSE}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
APN: nxtgenphone,
tAC: 0001
The UE shall send an ESM INFORMATION RESPONSE message to the network. · The UE shall include all the protocol configuration options that need to be transferred security protected.


eNodeB
MME
Default EPS Bearer Establishment
Setup the data service and assign an IP address to the UE. Also setup QoS parameters.
Initial Context Setup Request {ATTACH ACCEPT, ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
e-RAB-ID: 5,
transportLayerAddress: 7f000164 [bit length 32, 0111 1111 0000 0000 0000 0001 0110 0100 decimal value 2130706788],
transportLayerAddress(IPv4): 127.0.1.100 (127.0.1.100),
gTP-TEID: 7e10b568,
.... .010 = Attach result: Combined EPS/IMSI attach (2),
NAS EPS session management messages: Activate default EPS bearer context request (0xc1),
Quality of Service Class Identifier (QCI): QCI 9 (9),
APN: nxtgenphone,
PDN IPv4: 192.168.3.129 (192.168.3.129),
Protocol or Container ID: Internet Protocol Control Protocol (0x8021),
Code: Configuration Nak (3),
MME Group ID: 32769,
MME Code: 1,
M-TMSI: 0x00000001,
Location Area Code (LAC): 0x0001 (1),
SecurityKey: 061787a33046218e9a58bb029aeff40d6e2ea1a1fe4f09af... [bit length 256]
The MME responds with a combo message containing the Attach Accept and the Default Bearer establishment request. The bearer request specifies the QoS, APN and PDN information.
UE Capability Info Indication
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
accessStratumRelease: rel10 (2),
ue-Category: 4,
...1 .... profile0x0001: True
UE sends a detailed capability information message. This message specifies the hardware and software features of the UE.
Initial Context Setup Response [E-RAB Setup List Res]
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
e-RAB-ID: 5,
transportLayerAddress: 7f000101 [bit length 32, 0111 1111 0000 0000 0000 0001 0000 0001 decimal value 2130706689],
transportLayerAddress(IPv4): 127.0.1.1 (127.0.1.1),
gTP-TEID: 6f84e480
The eNodeB responds back to the Initial Context Setup Request with details about the RAB establishment (eRAB id 5).
Uplink NAS Transport {ATTACH COMPLETE, ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
NAS EPS session management messages: Activate default EPS bearer context accept (0xc2),
tAC: 0001
The eNodeB then transports the attach acceptance and the default EPS Bearer acceptance.
Connecting to a Second PDN and Activating the Default EPS Bearer for the PDN
The UE connects to a second Packet Data Network and establishes the Default Bearer for the second PDN.
Uplink NAS Transport {PDN CONNECTIVITY REQUEST}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
APN: ims,
tAC: 0001
The UE wishes to connected to a second PDN. The APN for the second PDN is included in the NAS message received from the UE.


eNodeB
MME
E-RAB Setup Request {ACTIVATE DEFAULT EPS BEARER CONTEXT REQUEST}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
APN: ims
The MME accepts the second PDN connectivity requests and initiates establishment of the Default EPS Bearer for the second PDN.
E-RAB Setup Response
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
e-RAB-ID: 6,
transportLayerAddress: 7f000101 [bit length 32, 0111 1111 0000 0000 0000 0001 0000 0001 decimal value 2130706689],
transportLayerAddress(IPv4): 127.0.1.1 (127.0.1.1),
gTP-TEID: 6f84e481
The eNodeB responds with details about the RAB establishment for the new RAB (eRAB id 6)
Uplink NAS Transport {ACTIVATE DEFAULT EPS BEARER CONTEXT ACCEPT}
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1,
tAC: 0001
UE responds back with the establishment of the Default EPS Bearer for the second PDN.
Data Transfer
Releasing the UE Context After Inactivity
The eNodeB initiates the release of the UE context if the data service has been inactive for some time.
UE Context Release Request
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1
The data transfer has been completed. The eNodeB detects inactivity and requests the release of the UE context.
UE Context Release
1
211
mME-UE-S1AP-ID: 211,
eNB-UE-S1AP-ID: 1
The MME initiates the UE context release.
UE Context Release
1
211
MME-UE-S1AP-ID: 211,
ENB-UE-S1AP-ID: 1
The UE context has been released. Note that the default bearers are still present. Only the radio resources have been released.
free
ENB-UE-S1AP-ID: 1
free
MME-UE-S1AP-ID: 211
Resuming Service with a Service Request
When the user starts sending data, the service is resumed again. There is no need to repeat the security procedures and setup the radio bearers. The abbreviated procedure reduces latency and hence improves user experience.
UE wishes to resume data transfer


eNodeB
MME
allocate
ENB-UE-S1AP-ID: 2
The eNodeB allocates 2 as the ENB-UE-S1AP-ID for the new session.
Initial UE Message {SERVICE REQUEST}
2
ENB-UE-S1AP-ID: 2,
NAS-PDU: c7055ac8,
Message authentication code (short): 0x5ac8,
pLMNidentity: 134001,
m-TMSI: 00000001
The Initial UE Message contains the Service Request message. The Service Request procedure resumes the existing bearers and encryption is setup without requiring additional security handshakes.
allocate
MME-UE-S1AP-ID: 212
The MME allocates 212 as the MME-UE-S1AP-ID for the session.
Initial Context Setup Response[E-RAB Setup List, UE Security and Radio Capabilities, Security Key]
2
212
MME-UE-S1AP-ID: 212,
ENB-UE-S1AP-ID: 2,
e-RAB-ID: 5,
transportLayerAddress: 7f000164 [bit length 32, 0111 1111 0000 0000 0000 0001 0110 0100 decimal value 2130706788],
transportLayerAddress(IPv4): 127.0.1.100 (127.0.1.100),
gTP-TEID: 7e10b56a,
e-RAB-ID: 6,
transportLayerAddress: 7f000164 [bit length 32, 0111 1111 0000 0000 0000 0001 0110 0100 decimal value 2130706788],
transportLayerAddress(IPv4): 127.0.1.100 (127.0.1.100),
gTP-TEID: 7e10b56b,
SecurityKey: 6904516fd4ec481fc0aaafaabf379cc328d009e7f824c53b... [bit length 256],
accessStratumRelease: rel10 (2),
ue-Category: 4,
...1 .... profile0x0001: True
The Initial Context Setup Response resumes the existing bearers. The UE security is also setup with the single handshake.
Initial Context Setup [E-RAB Setup List Res]
2
212
MME-UE-S1AP-ID: 212,
ENB-UE-S1AP-ID: 2,
e-RAB-ID: 5,
transportLayerAddress: 7f000101 [bit length 32, 0111 1111 0000 0000 0000 0001 0000 0001 decimal value 2130706689],
transportLayerAddress(IPv4): 127.0.1.1 (127.0.1.1),
gTP-TEID: 6f84e482,
e-RAB-ID: 6,
transportLayerAddress: 7f000101 [bit length 32, 0111 1111 0000 0000 0000 0001 0000 0001 decimal value 2130706689],
transportLayerAddress(IPv4): 127.0.1.1 (127.0.1.1),
gTP-TEID: 6f84e483
The eNodeB notifies the MME that the eRABs have been setup successfully.
Data Transfer
Releasing the UE Context After Inactivity
Inactivity on the data path results in the UE context getting released.
UE Context Release Request
2
212
MME-UE-S1AP-ID: 212,
ENB-UE-S1AP-ID: 2