

# S1AP View of Inter MME S1 Handover in LTE

Here we look at the S1 handover that involves an MME change. The S1 handover is analyzed at the S1AP interface.

S1AP messages involved in S1 handover are shown just before the message. The messages show a high level structure of the complex messages involved in the interaction.

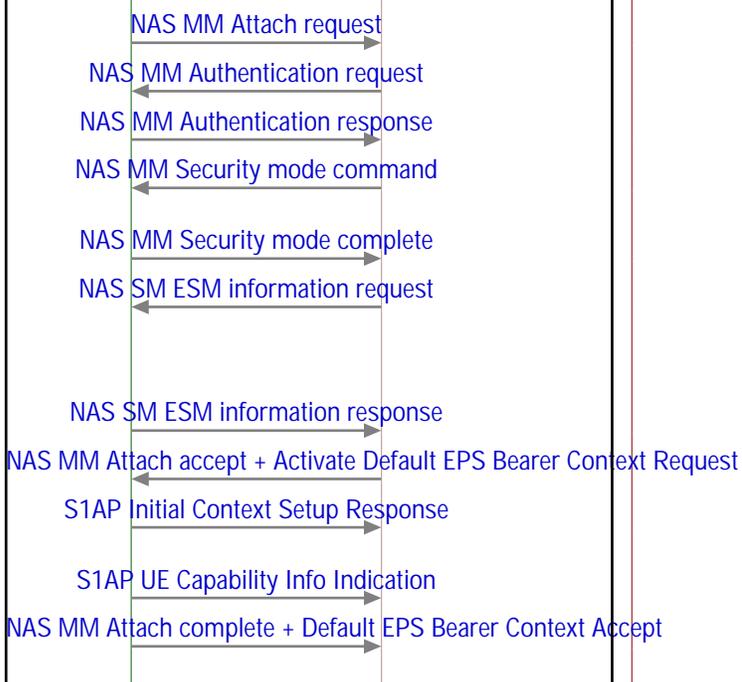
Additionally, you can click on any S1AP message to see the complete field level details.

Generated with EventStudio (<https://www.eventhelix.com/EventStudio/>) and VisualEther (<https://www.eventhelix.com/VisualEther/>).

Precondition: UT attaches to Source MME

The UE attach to MME1 and performs the security procedure. This is followed by the default bearer setup.

The interactions between the eNode and the MME1 are shown here.



UE initiates an attach to the network.

The EPC requests authentication.

UE responds back to the authentication request.

The MME then initiates the NAS security procedure.

The NAS security procedure is successful.

The MME requests protocol information from the UE. This happens when UE had signaled that it needs to send the APN and other information only after security establishment.

UE responds with protocol information.

The MME accepts the attach.

The eNodeB acknowledges the default bearer request.

UE provides capability information to the MME.

The UE responds with an Attach Accept and signals the completion of default bearer setup.

The target eNodeB is selected based on the measurement report from the UT.

Source eNodeB chooses a target eNodeB to handover the user

X2 handover is not possible, so an S1 handover needs to be triggered

## S1AP Handover Required [Handover Preparation] (Source eNodeB -> Source MME)

```

MME-UE-S1AP-ID
ENB-UE-S1AP-ID
Handover Type
Cause
Source To Target Transparent Container:
  RRC Container:
    Handover Preparation message:
      UE Category
      PDCP parameters
      PHY Parameters
      Supported Bands
  RAB Information List:
    Element 0:
      RAB Id
      DL Forwarding flag
  Target Cell Id (PLMN, MCC, MNC, Cell Id)

```

Source eNodeB

Source MME

Target MME

Target eNodeB

```

UE History Information:
  Last Visited Cell:
    Global Cell Id
    Cell Size
    Time Stayed in Cell

```

### S1AP Handover Required [Handover Preparation]

The source eNodeB sends a "Handover Required" message to the MME. The message carries a "Source to Target Transparent Container" that has to be passed to the target eNodeB. The transparent container carries RRC parameters, Radio Bearer information and UT history information. This information will assist the target eNode in allocating resources for the UE.

The message includes a data forwarding flag for every RAB. In this scenario, the flag is set to 0. This tells the MME that X2 interface is not available for data forwarding, the data needs to be tunneled from the source eNodeB to the target eNodeB via SGW.

The target TAI is sent to MME to facilitate the selection of a suitable target MME.

The source MME selects the target MME and since it has determined to relocate the MME, it sends a Forward Relocation Request. The target TAI is sent to the target MME to help it to determine whether S GW relocation is needed.

The message includes the MME context for the UE. The MME UE context includes IMSI, ME Identity, UE security context, UE Network Capability, AMBR (Aggregate Maximum Bit Rate), Selected CN operator ID, APN restriction, Serving GW address and TEID for control signaling, and EPS Bearer context(s).

### Forward Relocation Request

```

MME UE context, Source to Target
transparent container,
RAN Cause,
target eNodeB Identity,
CSG ID,
CSG Membership Information,
target TAI,
UE Time Zone,
Direct Forwarding Flag

```

### S1AP Handover Resource Allocation [Handover Request] (Target MME -> Target eNodeB)

```

MME-UE-S1AP-ID
Handover Type
Cause
UE Aggregate Maximum Bitrate:
  DL (Downlink aggregate rate)
  UL (Uplink aggregate rate)
ERAB To Be Setup List Handover Request:
  Element 0:
    RAB Id
    Transport Layer Address
    GTP TEID
    RAB Level QoS Parameters:
      QCI
      Allocation Retention Priority:
        Priority Level
        Preemption Capability
        Preemption Vulnerability
Source To Target Transparent Container:
  RRC Container:
    Handover Preparation message:
      UE Category
      PDCP parameters
      PHY Parameters
      Supported Bands
  RAB Information List:
    Element 0:
      RAB Id
      DL Forwarding flag
Target Cell Id (PLMN, MCC, MNC, Cell Id)
UE History Information:
  Last Visited Cell:

```

Source eNodeB

Source MME

Target MME

Target eNodeB

```

Global Cell Id
Cell Size
Time Stayed in Cell
UE Security Capabilities:
  Encryption Algorithms
  Integrity Protection Algorithms
Security Context:
  Next Hop Chaining Count
  Next Hop Parameter

```

S1AP Handover Request [Handover Resource Allocation]

The Handover Request message creates the UE context in the target eNodeB, including information about the bearers, and the security context. For each EPS Bearer, the Bearers to Setup includes Serving GW address and uplink TEID for user plane, and EPS Bearer QoS. Since the direct forwarding flag indicates unavailability of direct forwarding and the target MME knows that there is no indirect data forwarding connectivity between source and target, the Bearers to Setup shall include "Data forwarding not possible" indication for each EPS bearer. Handover Restriction List is sent if available in the Target MME. S1AP Cause indicates the RAN Cause as received from source MME.

This message also carries the "Source to Target Transparent Container" that was received from the source eNodeB.

S1AP Handover Resource Allocation [Handover Request Acknowledge] (Target eNodeB -> Target MME)

```

MME-UE-S1AP-ID
ENB-UE-S1AP-ID
E-RAB Admitted List:
  Element 0:
    E-RAB Id
    Transport Layer Address
    GTP-TEID
Target to Source Transparent Container:
  RRC Container:
    Handover Command:
      RRC Message:
        RRC Connection Reconfiguration:
          RRC Connection Identifier
          RRC Mobility Control Info:
            Target Phys Cell Id
            T304
            New UE Identity
          RRC Config Common:
            Preamble Info (number of RA preambles)
            RRC Power Ramping Parameters
            RRC Supervision Info:
              RA Response window size
              MAC contention resolution timer
              MAX HARQ Msg3 TX
          RRC PRACH Configuration:
            Root Sequence Index
            PRACH Config Index
            High Speed Flag
            Zero Correlation Zone Config
            PRACH Frequency Offset
          RRC PUSCH Config:
            N_SB
            Hopping Model
            Enable 64 QAM
          RRC UL Reference Signals PUSCH:
            Group Hopping Parameters
            Group Sequence Hopping Parameters
            Cyclic Shift
            P_MAX

```



```

UL Cyclic Prefix Length
RACH Config Dedicated:
  RA Preamble Index
  RA PRACH Mask Index
RRC Config Dedicated:
  RRC Physical Config Dedicated:
  RRC PUCCH Config Dedicated:
    Ack Nack Repetition
  RRC CQI Report Config:
    CQI Report Mode Aperiodic
    Nominal PDSCH RS EPRE Offset
    CQI Report Periodic:
      CQI PUCCH Resource Index
      CQI PMI Config Index
      Format Indicator Periodic:
        Wideband CQI Element
      RI Config Index
      Simultaneous Ack Nack and CQI Flag
  RRC SRS UL Config Dedicated
  RRC Scheduling Request Config:
    SR Config Index
    DSR Trans Max
  RRC Security Config HO:
    RRC Security Algorithm Config:
      RRC Ciphering Algorithm
      RRC Integrity Protection Algorithm
  Key Change Indicator
  Next Hop Chaining Count
  
```

S1AP Handover Request Acknowledge [Handover Resource Allocation, RRC Connection Recon

The target eNodeB responds with Handover Request Acknowledge. The message contains EPS Bearer Setup list includes a list of addresses and TEIDs allocated at the target eNodeB for downlink traffic on S1 U reference point (one TEID per bearer) and addresses and TEIDs for receiving forwarded data if necessary.

The message carries a "Transparent Target to Source Container" that needs to be delivered to the source eNodeB. The container carries an RRC Connection Reconfiguration message prepared by the target that needs to be delivered to the UT via the source eNodeB (Note that at this point, the target can only communicate with the UT via the source eNodeB).

The RRC Connection Reconfiguration message carries system information, RACH preamble assignment, PUCCH resource assignment and security configuration.

Since the MME has been relocated, the target MME sends a Forward Relocation Response message to the source MME. Since indirect forwarding is being used, this message includes Serving GW Address and TEIDs for indirect forwarding (source or target). Serving GW change indication indicates a new Serving GW has been selected.

Forward Relocation Response

S1AP Handover Command [RRC Connection Reconfiguration] (Source MME -> Source eNodeB)

```

MME-UE-S1AP-ID
ENB-UE-S1AP-ID
Handover Type (Intra LTE)
E-RAB Subject to Data Forwarding List:
  Element 0:
    E-RAB Id
    DL Transport Layer Address
    DL GTP-TEID
Target to Source Transparent Container:
  RRC Container:
  
```

Source eNodeB

Source MME

Target MME

Target eNodeB

```

Handover Command:
RRC Message:
  RRC Connection Reconfiguration:
    RRC Connection Identifier
    RRC Mobility Control Info:
      Target Phys Cell Id
      T304
      New UE Identity
    RRC Config Common:
      Preamble Info (number of RA preambles)
      RRC Power Ramping Parameters
      RRC Supervision Info:
        RA Response window size
        MAC contention resolution timer
        MAX HARQ Msg3 TX
      RRC PRACH Configuration:
        Root Sequence Index
        PRACH Config Index
        High Speed Flag
        Zero Correlation Zone Config
        PRACH Frequency Offset
      RRC PUSCH Config:
        N_SB
        Hopping Model
        Enable 64 QAM
      RRC UL Reference Signals PUSCH:
        Group Hopping Parameters
        Group Sequence Hopping Parameters
        Cyclic Shift
      P_MAX
      UL Cyclic Prefix Length
      RACH Config Dedicated:
        RA Preamble Index
        RA PRACH Mask Index
    RRC Config Dedicated:
      RRC Physical Config Dedicated:
        RRC PUCCH Config Dedicated:
          Ack Nack Repetition
        RRC CQI Report Config:
          CQI Report Mode Aperiodic
          Nominal PDSCH RS EPRE Offset
          CQI Report Periodic:
            CQI PUCCH Resource Index
            CQI PMI Config Index
            Format Indicator Periodic:
              Wideband CQI Element
            RI Config Index
            Simultaneous Ack Nack and CQI Flag
        RRC SRS UL Config Dedicated
      RRC Scheduling Request Config:
        SR Config Index
        DSR Trans Max
    RRC Security Config HO:
      RRC Security Algorithm Config:
        RRC Ciphering Algorithm
        RRC Integrity Protection Algorithm
      Key Change Indicator
      Next Hop Chaining Count

```

S1AP Handover Command [Handover Preparation, RRC Connection Reconfiguration]

The source MME sends a Handover Command message to the source eNodeB. The Bearers subject to forwarding includes list of addresses and TEIDs allocated for forwarding. The transparent container with the RRC Connection Reconfiguration is embedded in the message delivered to the source eNodeB.

S1AP eNB Status Transfer (Source eNodeB -> Source MME)

```

MME-UE-S1AP-ID
ENB-UE-S1AP-ID
eNB Status Transfer Container:

```



```

Bearer Subject to Status Transfer List:
  Element 0: Bearers Subject to Status Transfer Item:
    E-RAB Id
    UL Count Value:
      PDCP SN
      HFN
    DL Count Value:
      PDCP SN
      HFN
  
```

S1AP eNB Status Transfer

Forward Access Context Notification  
 Forward Access Context Acknowledge

The source eNodeB sends the eNodeB Status Transfer message to the target eNodeB via the MME(s) to convey the downlink and uplink PDCP sequence numbers and HFN status of the E-RABs for which PDCP status preservation applies.

S1AP MME Status Transfer (Target MME -> Target eNodeB)

```

MME-UE-S1AP-ID
ENB-UE-S1AP-ID
eNB Status Transfer Container:
  Bearers Subject to Status Transfer List:
    Element 0: Bearers Subject to Status Transfer Item:
      E-RAB Id
      UL Count Value:
        PDCP SN
        HFN
      DL Count Value:
        PDCP SN
        HFN
  
```

S1AP MME Status Transfer

UT performs the random access procedure with the target eNodeB

The target MME passes the Status Transfer message to the target eNodeB. After the UE has successfully synchronized to the target cell, it sends a Handover Confirm message to the target eNodeB. Downlink packets forwarded from the source eNodeB can be sent to the UE. Also, uplink packets can be sent from the UE, which are forwarded to the target Serving GW and on to the PDN GW.

S1AP Handover Notification (Target eNodeB -> Target MME)

```

MME-UE-S1AP-ID
ENB-UE-S1AP-ID
E-UTRAN-CGI:
  PLMN Id
  MCC (Mobile Country Code)
  MNC (Mobile Network Code)
  Cell Id
TAI:
  PLMN Id
  MCC (Mobile Country Code)
  MNC (Mobile Network Code)
  TAC (Tracking Area Code)
  
```

S1AP Handover Notification

Forward Relocation Complete Notification  
 Forward Relocation Complete Acknowledge

The target eNodeB sends a Handover Notify (TAI+ECGI) message to the target MME. This signals the completion of the handover. Since the MME has been relocated, the target MME sends a Forward Relocation Complete Notification message to the source MME. The source MME in response sends a Forward Relocation Complete Acknowledge message to the target MME. A timer in source MME is started to supervise when resources in Source



eNodeB shall be released.

S1AP UE Context Release Command (Source MME -> Source eNodeB)

UE-S1AP Ids:  
 MME-UE-S1AP-ID  
 ENB-UE-S1AP-ID  
 Cause:  
 Radio Network (Successful Handover)

S1AP UE Context Release Command

The source MME asks the source eNodeB to release the UE context

S1AP UE Context Release Complete : Source eNodeB -> Source MME

MME-UE-S1AP-ID  
 ENB-UE-S1AP-ID

S1AP UE Context Release Complete

The source eNodeB releases the context and replies back.

EXPLORE MORE

LTE <http://www.eventhelix.com/lte/>

IMS <http://www.eventhelix.com/ims/>

S1 Handover Detailed Flow <https://www.eventhelix.com/lte/handover/s1/>

X2 Handover Detailed Flow <https://www.eventhelix.com/lte/handover/x2/lte-x2-handover-sequence-diagram.htm>