 LTE Attach Procedure Call Flow

The LTE attach procedure call flow is a subject that may seem hard to understand. So let’s break it down. How does the LTE attach procedure call flow work?

Well first, the UE needs to register with the network to receive services that require registration. This registration is known as the network attachment. IP connectivity for UE is enabled after establishing a default EPS bearer during the network attachment procedure. Attach procedure may trigger one or multiple Dedicated Bearer Establishment procedures to establish dedicated EPS bearer for that UE.

During the LTE Initial Attach procedure, the Mobile Equipment Identity is obtained from the UE. The MME operator may check the Mobile Equipment Identity with EIR. In roaming situations, the MME should pass the ME Identity to the HSS, and, if a PGW outside of the VPLMN (Visited PLMN), should pass the ME Identity to the PGW.
Here's the LTE Attach Procedure Call Flow, broken down into steps, derived by 3GPP.

**Step 1.** The UE initiates the attach procedure by transmitting an attach request to the eNodeB.

**Step 2.** The eNodeB derives the MME from the RRC parameters carrying the old GUMMEI and the indicated Selected Network.

**Step 3.** If the UE identifies 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/SGSN address, and send an Identification Request to the old MME/SGSN to request the IMSI.

**Step 4.** If the UE is unknown in both the old MME/SGSN and new MME, the new MME sends an Identity Request to the UE to request the IMSI. The UE responds with Identity Response (IMSI).

**Step 5a.** If no UE context for the UE exists anywhere in the network, if the Attach Request (sent in step 1) was not integrity protected, or if the check of...
the integrity failed, then authentication and NAS security setup to activate integrity protection and NAS ciphering are mandatory.

**Step 5b.** The ME Identity shall be retrieved from the UE.

**Step 6.** If 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.

**Step 7.** If there are active bearer contexts in the new MME for this particular UE (i.e. the UE re-attaches to the same MME without having properly detached before), the new MME deletes these bearer contexts by sending Delete Session Request (LBI) messages to the GWs involved.

**Step 8.** If the MME has changed since the last detach, or if there is no valid subscription context for the UE in the MME, the MME sends an Update Location Request message to the HSS.

**Step 9.** The HSS sends Cancel Location (IMSI, Cancellation Type) to the old MME.

**Step 10.** If there are active bearer contexts in the old MME/SGSN for this particular UE, the old MME/SGSN deletes these bearer contexts by sending Delete Session Request (LBI) messages to the GWs involved.

**Step 11.** The HSS acknowledges the Update Location message by sending an Update Location Ack message to the new MME.

**Step 12.** For an Emergency Attach situation, the MME applies the parameters from MME Emergency Configuration Data for the emergency bearer establishment performed in this step and any potentially stored IMSI related subscription data are ignored by the MME.

**Step 13.** The Serving GW creates a new entry in its EPS Bearer table and sends a Create Session Request message to the PDN GW indicated by the PDN GW address received in the previous step.

**Step 14.** If dynamic PCC is deployed and the Handover Indication is not present, the PDN GW performs an IP-CAN Session Establishment procedure.

**Step 15.** The PGW creates a new entry in its EPS bearer context table and generates a Charging Id.

**Step 16.** If the MS Info Change Reporting Action (Start) or the CSG Information Reporting Action (Start) are received for this bearer context, then the SGW stores this for the bearer context and the SGW reports to that PGW whenever a UE’s location and/or User CSG information change occurs that meets the PGW request.

**Step 17.** If an APN Restriction is received, then the MME shall store this value for the Bearer Context and the MME shall check this received value with the stored value for the Maximum APN Restriction to ensure there are no conflicts between values.
Step 18. The eNodeB sends the RRC Connection Reconfiguration message including the EPS Radio Bearer Identity to the UE, and the Attach Accept message will be sent along to the UE.

Step 19. The UE sends the RRC Connection Reconfiguration Complete message to the eNodeB.

Step 20. The eNodeB sends the Initial Context Response message to the new MME.

Step 21. The UE sends a Direct Transfer message to the eNodeB, which includes the Attach Complete message.

Step 22. The eNodeB forwards the Attach Complete message to the new MME in an Uplink NAS Transport message.

Step 23. Upon reception of both, the Initial Context Response message in step 20 and the Attach Complete message in step 22, the new MME sends a Modify Bearer Request message to the Serving GW.

Step 23a. If the Handover Indication is included in step 23, the Serving GW sends a Modify Bearer Request (Handover Indication) message to the PDN GW to prompt the PDN GW to tunnel packets from non-3GPP IP access to 3GPP access system and immediately start routing packets to the Serving GW for the default and any dedicated EPS bearers established.

Step 23b. The PDN GW acknowledges by sending Modify Bearer Response to the Serving GW.

Step 24. The Serving GW acknowledges by sending Update Bearer Response (EPS Bearer Identity) message to the new MME.

Step 25. After the MME receives Modify Bearer Response (EPS Bearer Identity) message, if Request Type does not indicate handover and an EPS bearer was established and the subscription data indicates that the user is allowed to perform handover to non-3GPP accesses, and if the MME selected a PDN GW that is different from the PDN GW identity which was indicated by the HSS in the PDN subscription context, the MME shall send a Notify Request including the APN and PDN GW identity to the HSS for mobility with non-3GPP accesses. The message shall include information that identifies the PLMN in which the PDN GW is located.

Step 26. The HSS stores the APN and PDN GW identity pair and sends a Notify Response to the MME.[1]
With Long Term Evolution (LTE) comes a myriad of new and exciting attributes. One of these is the LTE call flow itself. In fact, call flow and signaling is unique for LTE, and is driven by 3GPP standards. Call flow is how signaling and sessions are created across an LTE network.

So how does LTE call flow work exactly?

According to Wired n Wireless, the LTE call flow travels through many steps during its end-to-end signaling between from user equipment (UE) to the evolved node B (eNB), mobility management entity (MME), home subscribe server (HSS), serving gateway (SGW) and PDN gateway (PGW).

LTE Call Flow Diagram – Wired n Wireless

It begins with S1 Setup, where the eNB is initially attached to the network. The eNB supports the LTE air interface and includes the following functions:

- Functions for Radio Resource Management: Radio Bearer Control, Radio Admission Control, Connection
- Mobility Control, Dynamic allocation of resources to UEs in both uplink and downlink (scheduling)
- Selection of an MME at UE attachment when no routing to an MME can be determined from the information provided by the UE
- Routing of User Plane data towards Serving Gateway
- Scheduling and transmission of paging messages (originated from the MME)
- Scheduling and transmission of broadcast information (originated from the MME or O&M)
- Measurement and measurement reporting configuration for mobility and scheduling

As long the eNB is functioning properly, the S1 setup will stay intact. Once UE comes up a radio resource control (RRC) connection is established for communication with the network. After RRC is established, network attached storage (NAS) signaling begins.

UE then sends an attach request along with a PDN connectivity request to the network. Attach is for attaching to the network. Once MME receives the attach request, it queries the HSS for authentication details. HSS then sends the authentication vectors to MME in an authentication info answer. The next step in call flow for LTE has to do with authentication and security. The network requests UE for authentication vectors. When the UE provides the same one, MME compares it with what HSS has sent. If they match, the UE is authenticated. MME manages mobility, UE identities and security parameters. It includes the following functions:

- Non Access Stratum (NAS) signaling and security
- Idle mode UE reachability (including control and execution of paging retransmission)
- Tracking Area list management (for UE in idle and active mode)
- PDN GW and Serving GW selection; MME selection for handovers with MME change
- Roaming (terminating S6a towards home HSS)
- Authentication Bearer management functions including dedicated bearer establishment
Next security takes over and all NAS messages are encrypted using the security algorithms that were exchanged. After the LTE call flow moves through the security step, the network creates the EPS bearers. Then the radio bearers are created and RRC connections are modified accordingly. Once these radio bearers are created the eNB down link addresses are sent to SGW in GTP messages. The Serving Gateway is the node that terminates the interface towards EUTRAN. For each UE associated with the EPS, at a given point of time, there is one single Serving Gateway. Functions include:

- Packet routing and forwarding
- The local mobility anchor point for inter eNB handover
- E-UTRAN idle mode downlink packet buffering and initiation of network triggered service request procedure
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- Accounting on user and QoS Class Identifier (QCI) granularity for inter-operator charging
- UL and DL charging per UE, PDN, and QCI
- End marker handling
- Packet Filtering with TFT

It seems technical, but LTE call flow is a technical process!
Packet Call Initiation

**UE**
- **RRC**: RRC Connection Request (cause = mo-Data)
- **RRC**: RRC Connection Setup
- **RRC**: RRC Connection Setup Complete (NAS: Service Request)
- **S1-AP**: Initial UE Message (NAS: Service Request)

**eNodeB**

**MME**

**S-GW**

**PDN-GW**

**HSS**

**Security Procedure**
- **S1-AP**: E-RAB Setup Request (NAS: Activate Dedicated EPS Bearer Context Request)
- **RRC**: RRC Connection Reconfiguration (NAS: Activate Dedicated EPS Bearer Context Request)
- **RRC**: RRC Connection Reconfiguration Complete
- **S1-AP**: E-RAB Setup Response
- **RRC**: UL Information Transfer (NAS: Activate Dedicated EPS Bearer Context Accept)
- **S1-AP**: UL NAS Transport (NAS: Activate Dedicated EPS Bearer Context Accept)

**PS RRC Connection Release**
PS RRC Connection Release

UE  eNodeB  MME  S-GW  PDN-GW  HSS

... after data transfer completed ...

S1-AP: DL NAS Transport (NAS: Deactivate EPS Bearer Context Request [cause = regular deactivation])
RRC: DL Information Transfer (NAS: Deactivate EPS Bearer Context Request [cause = regular deactivation])
RRC: UL Information Transfer (NAS: Deactivate EPS Bearer Context Response)
S1-AP: UL NAS Transport (NAS: Deactivate EPS Bearer Context Response)
S1-AP: UE Context Release Command [cause = unspecified]
S1-AP: UE Context Release Complete
RRC: RRC Connection Release [cause = other]
UE Registration Signalling

- **eNodeB**: Security Procedure
- **MME**: UE Capability Transfer
  - S1-AP: E-RAB Setup Request (NAS: Attach Accept, NAS: Activate Default EPS Bearer Context Request)
  - RRC: RRC Connection Reconfiguration (NAS: Attach Accept, NAS: Activate Default EPS Bearer Context Request)
  - RRC: RRC Connection Reconfiguration Complete
  - S1-AP: E-RAB Setup Response
  - RRC: UL Information Transfer (NAS: Attach Complete, NAS: Activate Default EPS Bearer Context Accept)
  - S1-AP: UL NAS Transport (NAS: Attach Complete, NAS: Activate Default EPS Bearer Context Accept)
- **S-GW**: RRC Connection Release
Security Procedure Signalling

UE → eNodeB → MME → S-GW → PDN-GW → HSS

- S1-AP: DL NAS Transport (NAS: Authentication Request)
- RRC: DL Information Transfer (NAS: Authentication Request)
- RRC: UL Information Transfer (NAS: Authentication Response)
- S1-AP: UL NAS Transport (NAS: Authentication Response)
- S1-AP: DL NAS Transport (NAS: Security Mode Command)
- RRC: DL Information Transfer (NAS: Security Mode Command)
- RRC: UL Information Transfer (NAS: Security Mode Complete)
- S1-AP: UL NAS Transport (NAS: Security Mode Complete)
- RRC: Security Mode Command
- RRC: Security Mode Complete
UE Capability Transfer Signalling

S1-AP: Initial Context Setup Request
S1-AP: Initial Context Setup Response
RRC: UE Capability Enquiry
RRC: UE Capability Information
S1-AP: UE Capability Info Indication