LTE:

A feature based approach

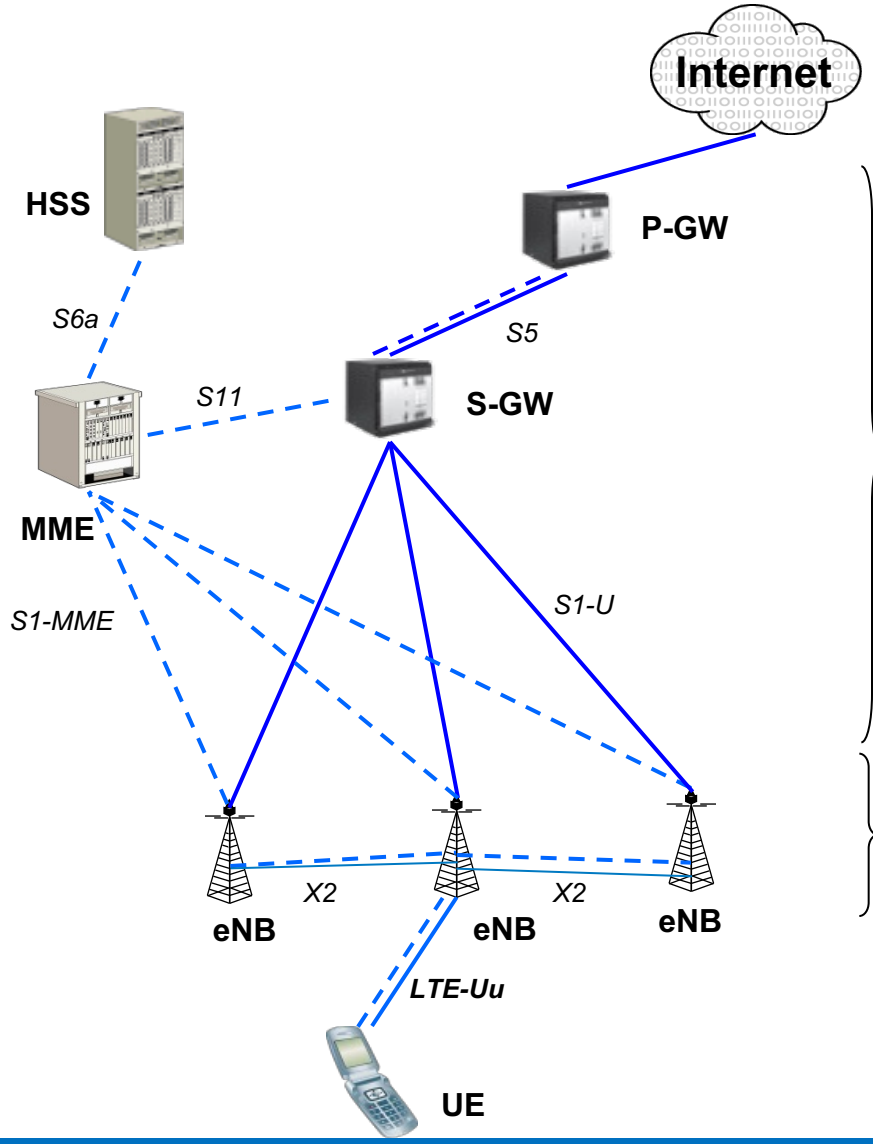
LTE Core Features

LTE Attach

Overview

- Process of a mobile obtaining an IP address
  - Identity
  - Attach Call flow
  - Access Stratum and Non Access Stratum
  - Mobility Management and Session Management
  - Protocol Stacks
    - Annex: GTP Primer
    - Annex: S1-MME (S1AP) Primer

LTE Network Architecture



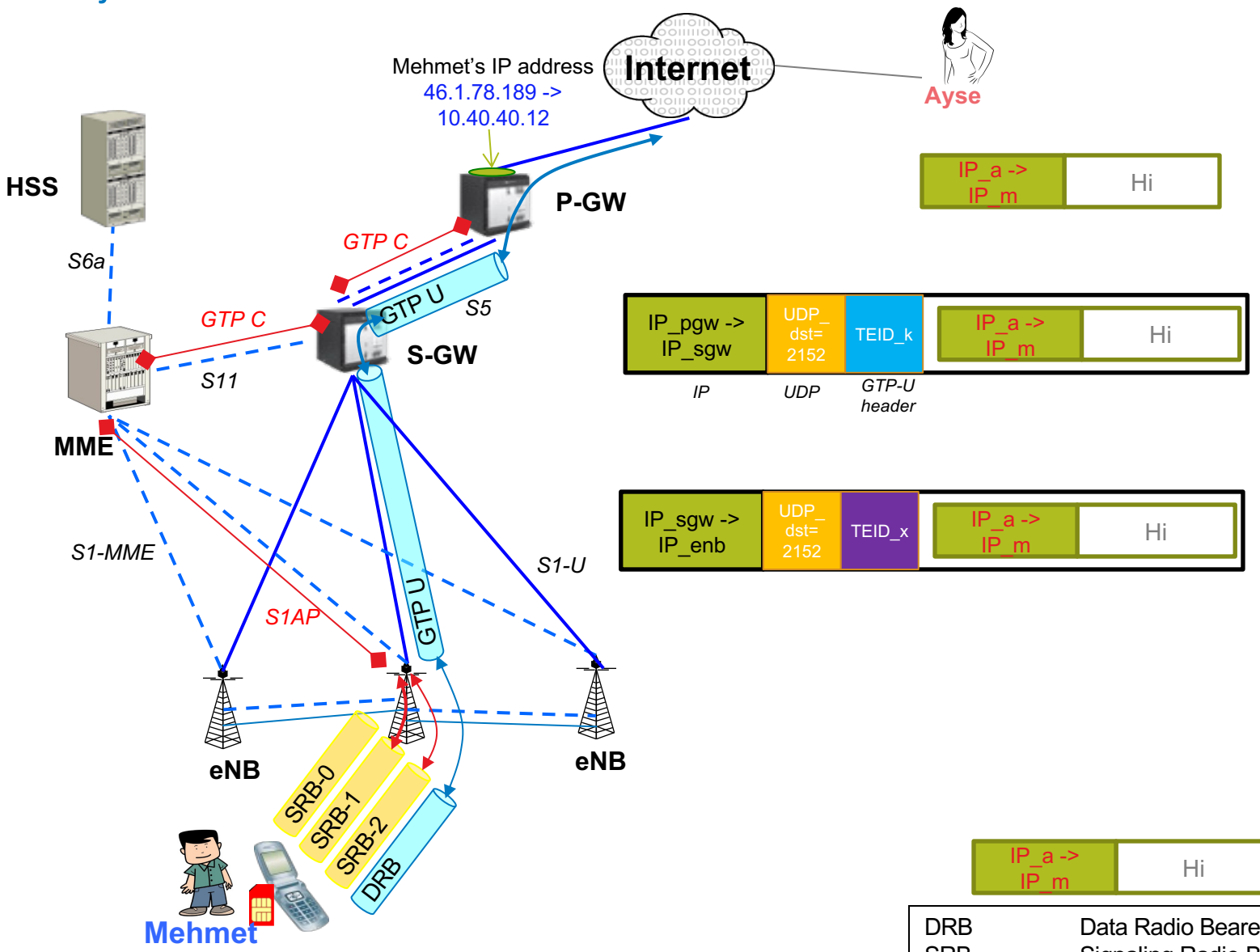
Evolved Packet Core (EPC)

Evolved Universal Terrestrial Radio Access Network (E-UTRAN)

Evolved Packet System (EPS)

eNB	Enhanced Node Base Station
MME	Mobility Management Entity
S-GW	Serving Gateway
P-GW	Packet data network Gateway
HSS	Home Subscriber System
UE	User Equipment

Objective of UE Attach Procedure



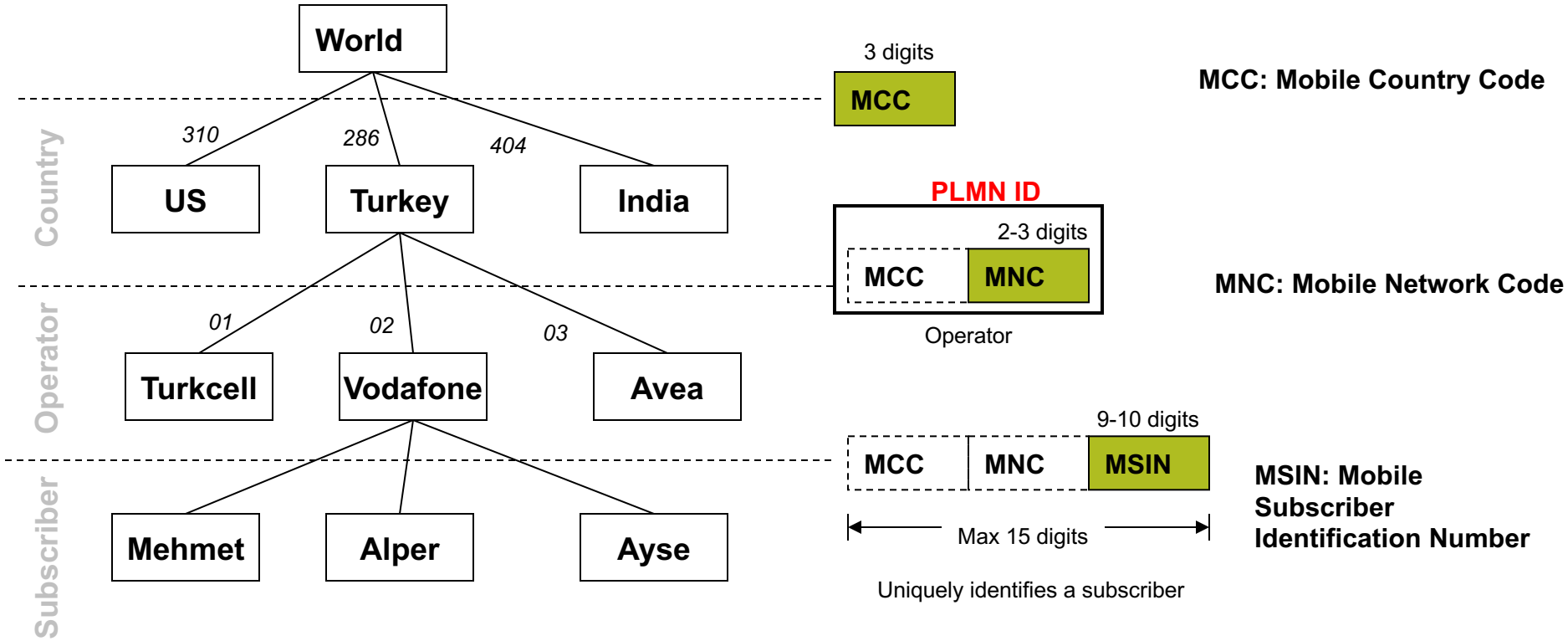
Network plumbing end of the Attach Procedure

DRB	Data Radio Bearer
SRB	Signaling Radio Bearer
GTP	GPRS Tunneling Protocol
S1AP	S1 Application Protocol
TEID	Tunnel Endpoint Identifier

User Identifier in the Network

- Who are you not:
  - Your Phone Number
    - Mobile Station Integrated Services Digital Network Number (MSISDN)
  - Your Mobile Identity
    - International Mobile Equipment Identity (IMEI)
- Who are you:
  - International Mobile Subscriber Identifier (IMSI)
    - Embedded in SIM card
    - Stored in subscription data of HSS (Home Subscriber System)

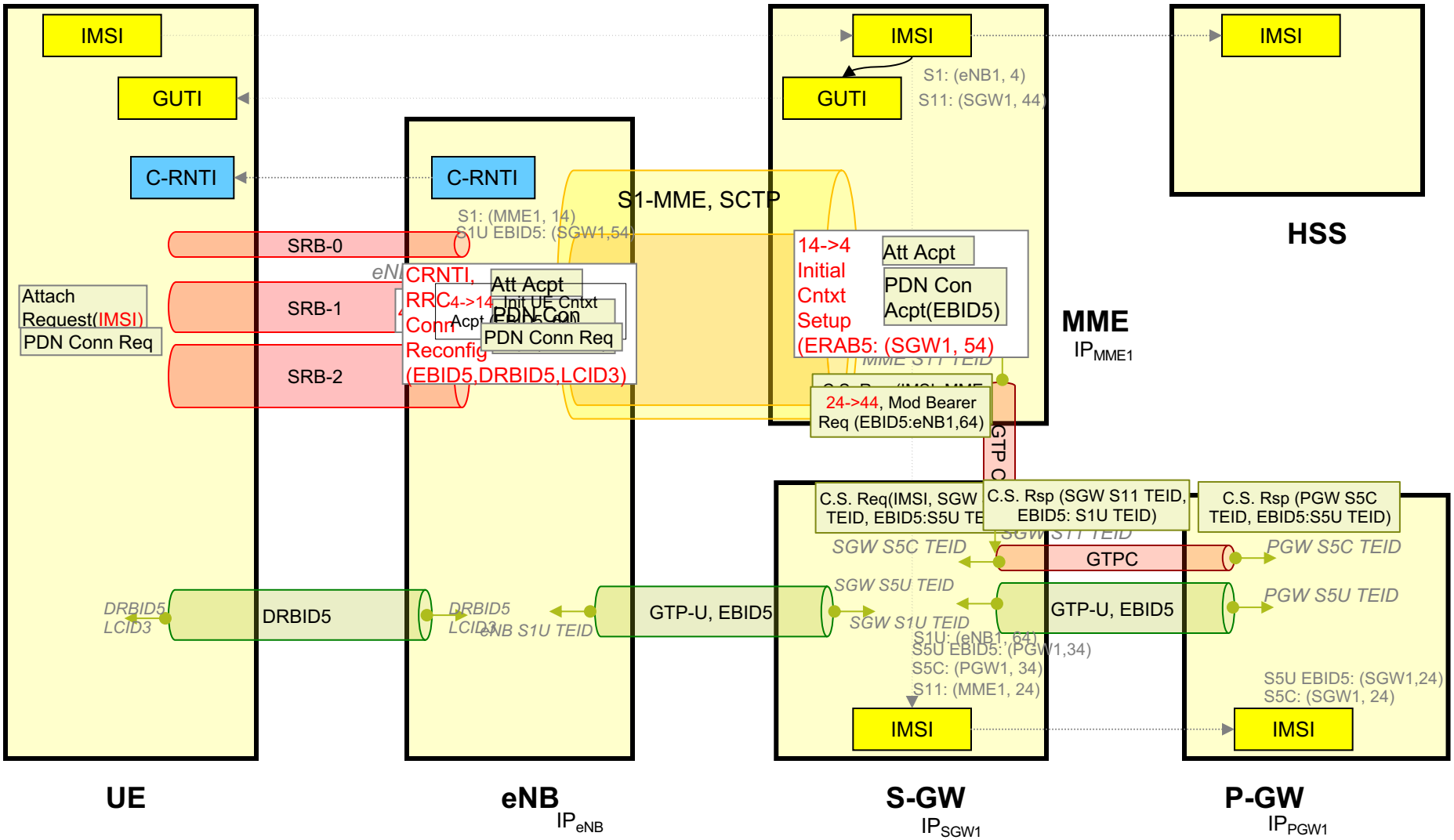
(International Mobile Subscriber Identifier) IMSI - Structure



Source for MCC and MNC codes:
http://en.wikipedia.org/wiki/Mobile_Network_Code
http://en.wikipedia.org/wiki/Mobile_Country_Code

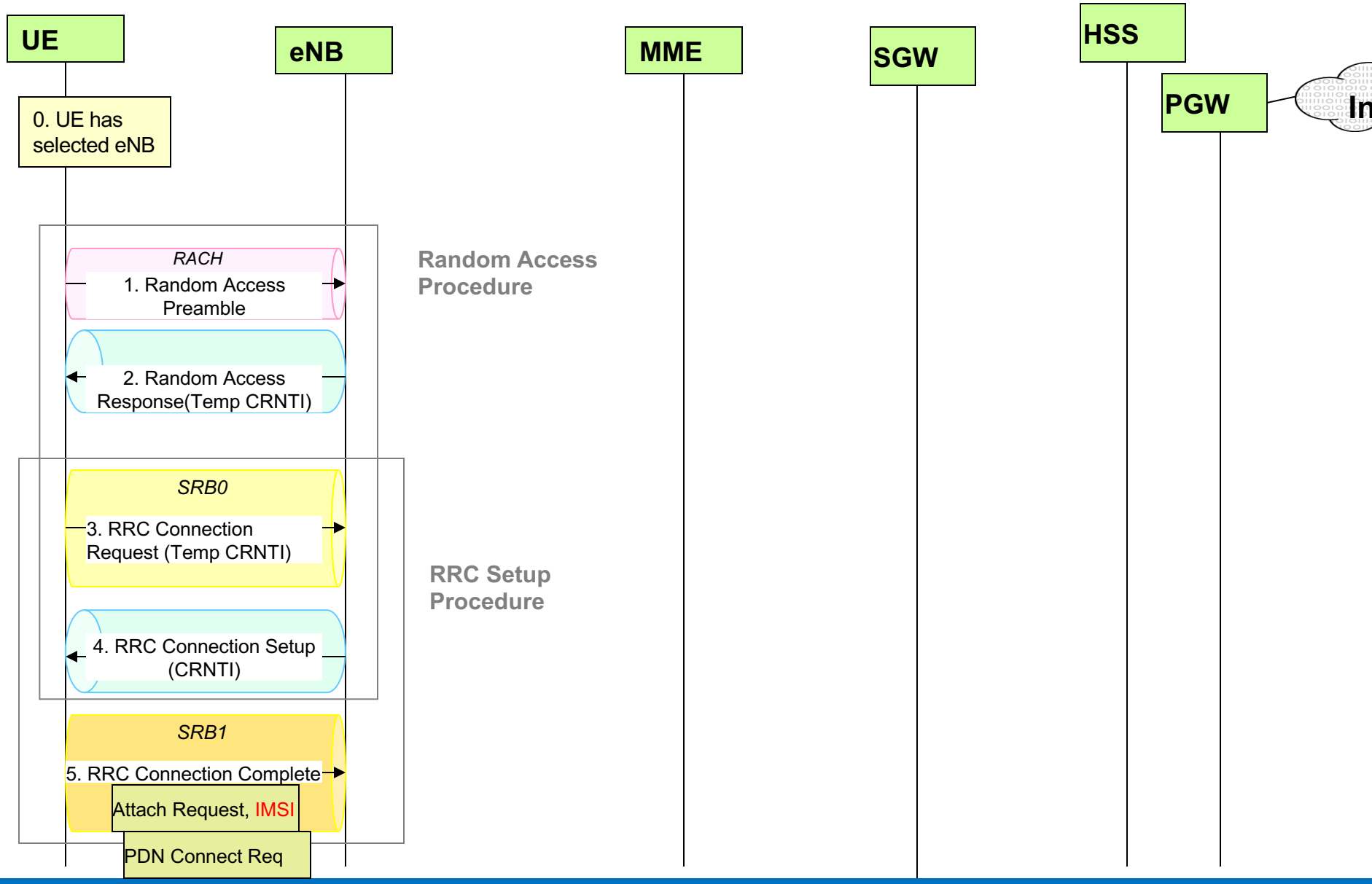
PLMN Public Land Mobile Network (Operator)

Identities and Plumbing for LTE

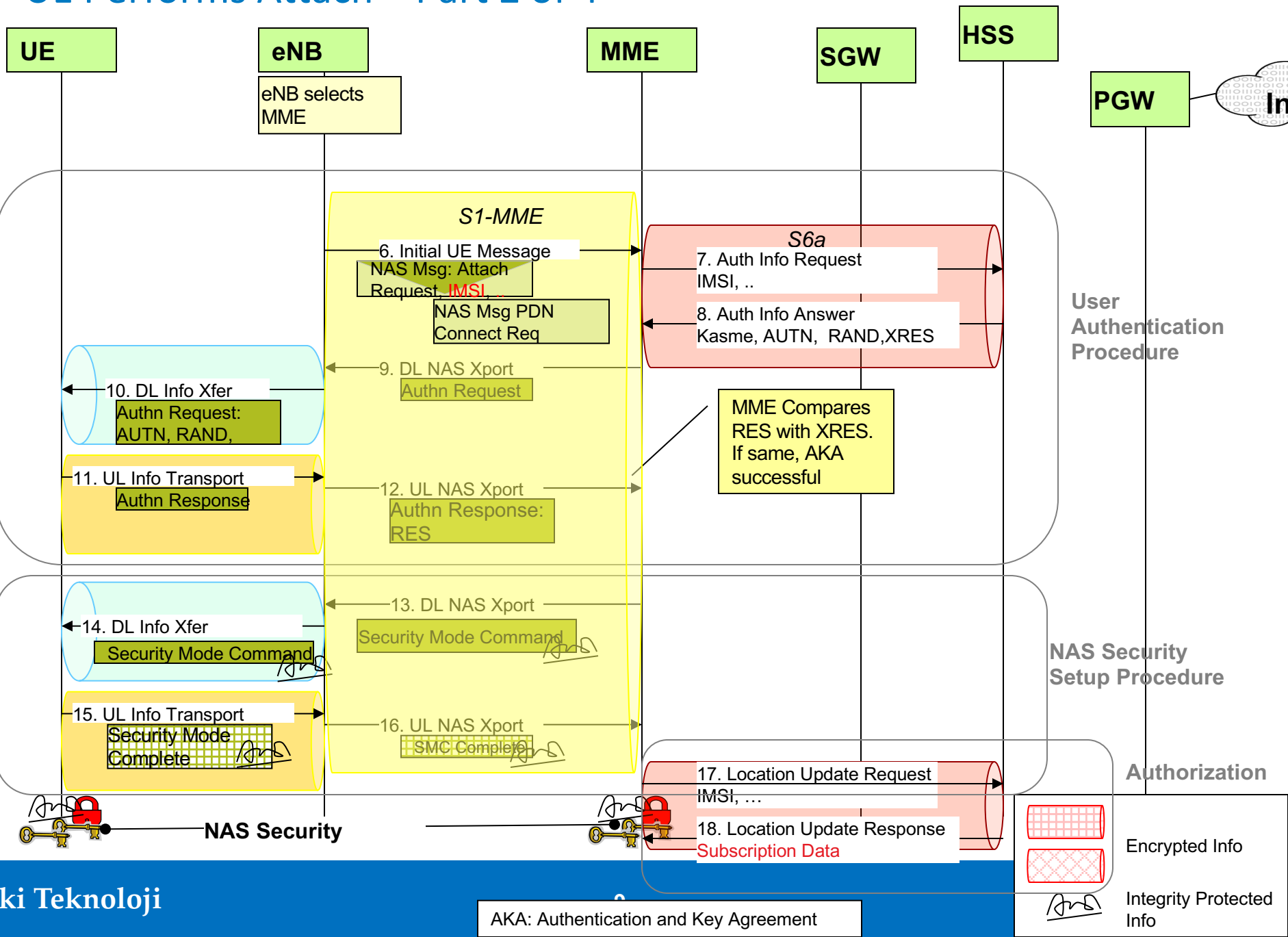


SRB	Signalling Radio Bearer
DRB	Data Radio Beaer
TEID	Tunnel Endpoint Identifier
GTP	GPRS Tunneling Protocol
C-RNTI	Cell- Radio Network Temporary Identity
GUTI	Globally Unique Temporary Identity

UE Performs attach – Part 1 of 4

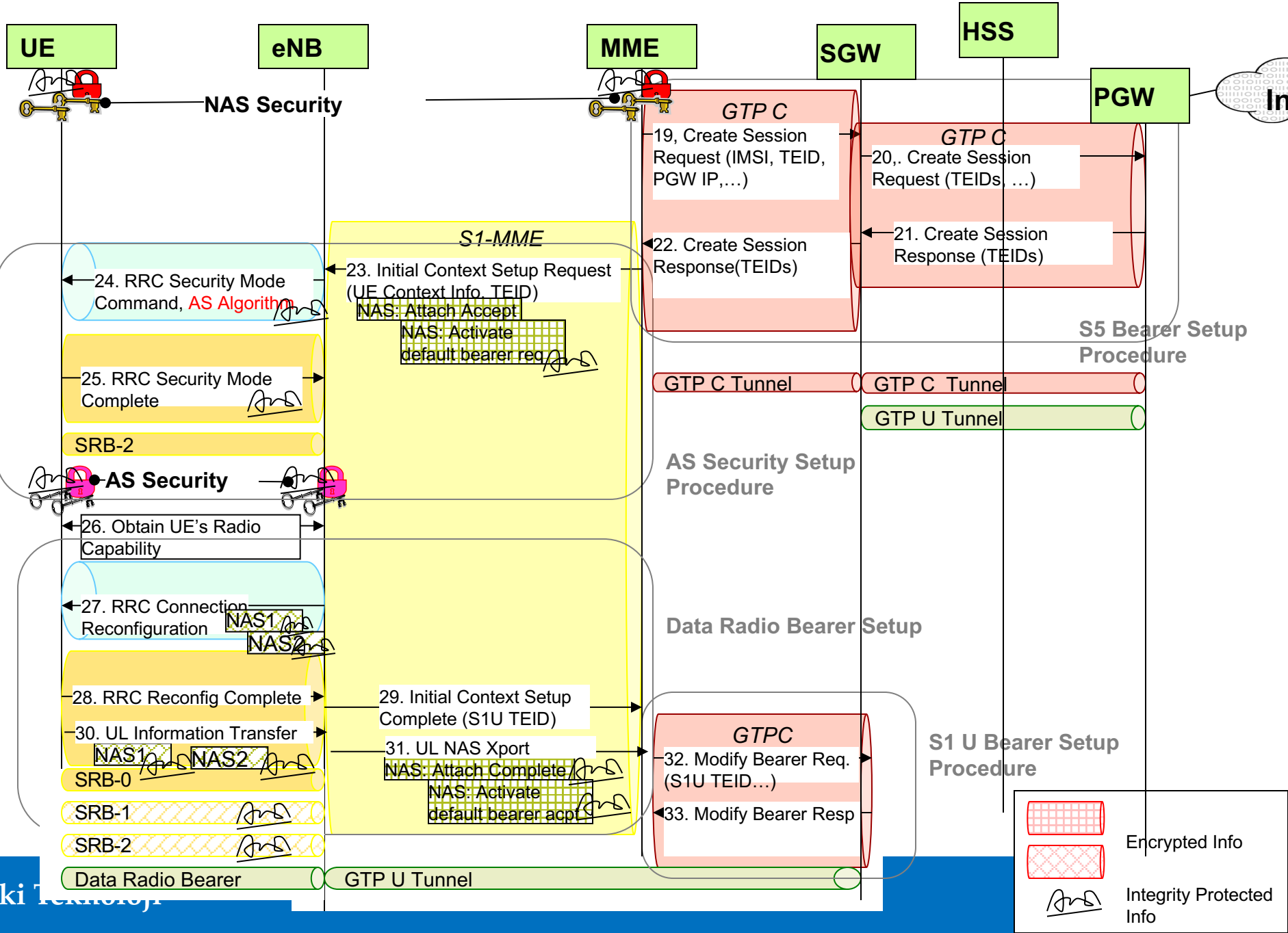


UE Performs Attach – Part 2 of 4

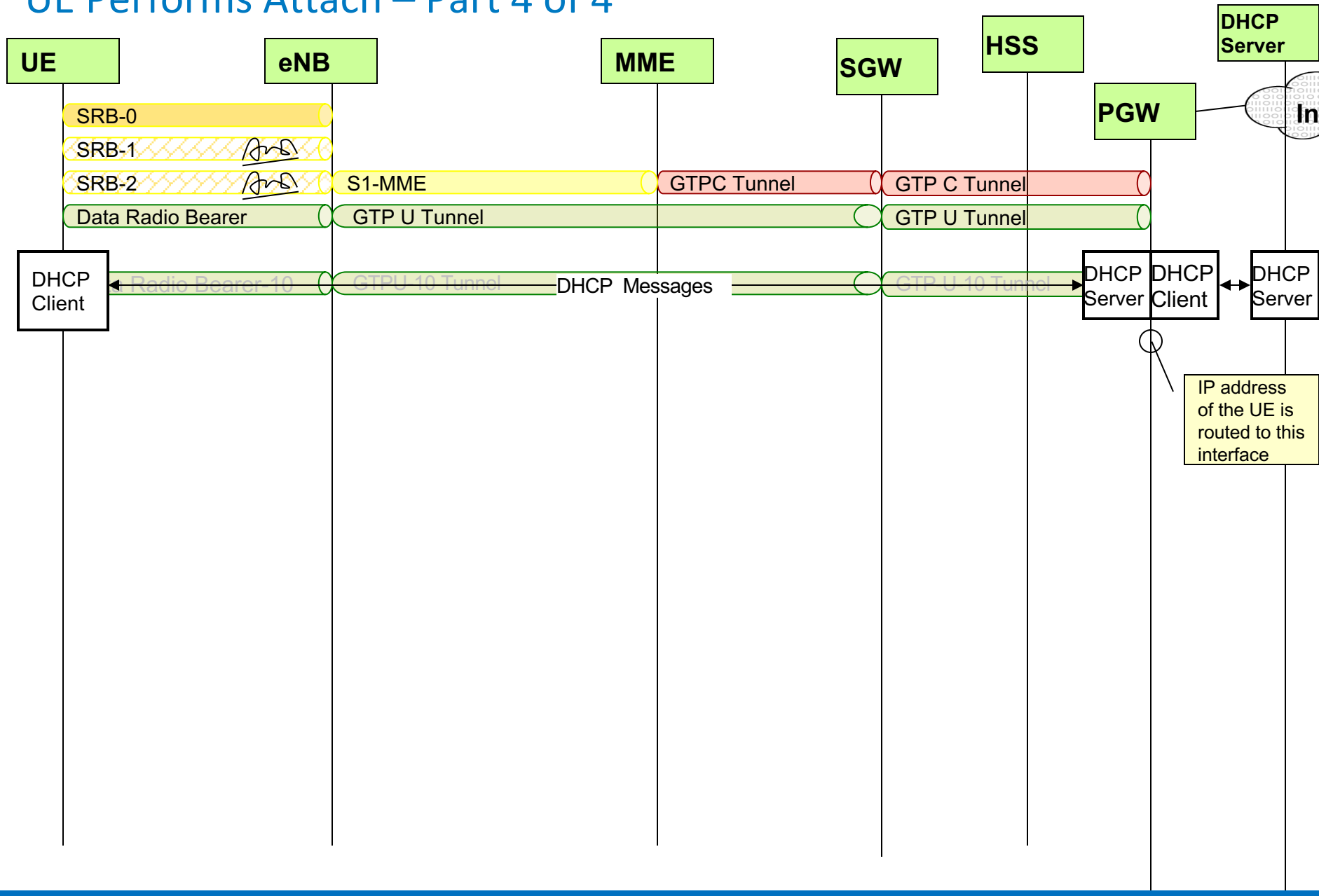


AKA: Authentication and Key Agreement

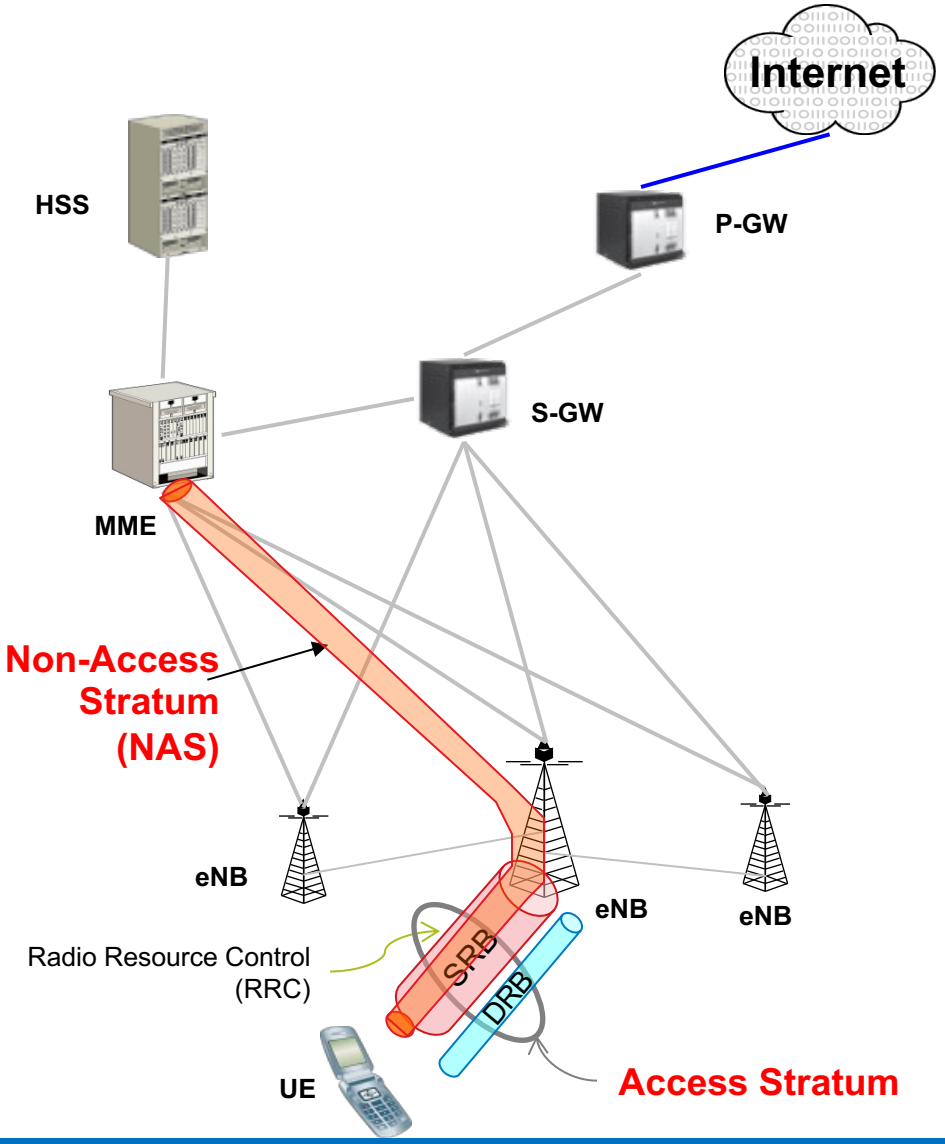
UE Performs Attach – Part 3 of 4



UE Performs Attach – Part 4 of 4



Architecture Concept 1: Access Stratum and Non-Access Stratum



Architecture Concept 2: Mobility Management (MM)

- What is Mobility Management in LTE?
  - It is concerned about the UE's registration state at the NAS layer.
  - There is an MM state-machine that runs in both the MME and UE. They key states are:
    - EMM-DEREGISTERED
    - EMM-REGISTERED
  - Examples of EMM Procedures
    - Attach
    - Authentication
    - Security Mode Command
    - GUTI reallocation
    - Tracking Area Update
    - Paging
    - Service Request
    - …
  - For each UE there is a MM context. The MM context consists of UE's security related parameters (keys, counters)

For details, please refer to section 5.1.3 in TS 24.301

Architecture Concept 2: Session Management (SM)

- What is Session Management in LTE?
  - It is related to UE's connectivity (EPS bearers) at the NAS layer.
- There is an ESM state-machine that runs in both the MME and UE for each EPS bearer. They key states are:
    - Bearer Context In-active
    - Bearer Context Active

- Examples of ESM procedures are:
  - PDN Connectivity Request/ Activate Default EPS bearer
  - PDN Disconnect Request/ Deactivate Default EPS bearer
  - Activate dedicated EPS bearer
  - Modify default/dedicated EPS bearer
  - …

- For each UE there is a ESM context that includes context for all active bearers and includes parameters applicable to the bearers (Bearer ID, QoS parameters,…).

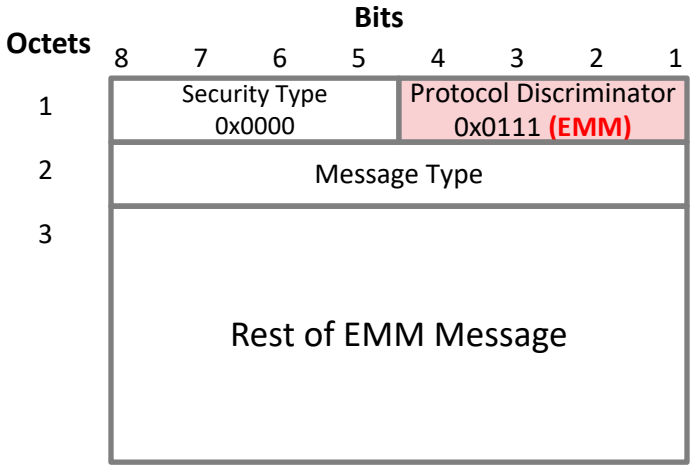
For details, please refer to section 6.1.3 in TS 24.301

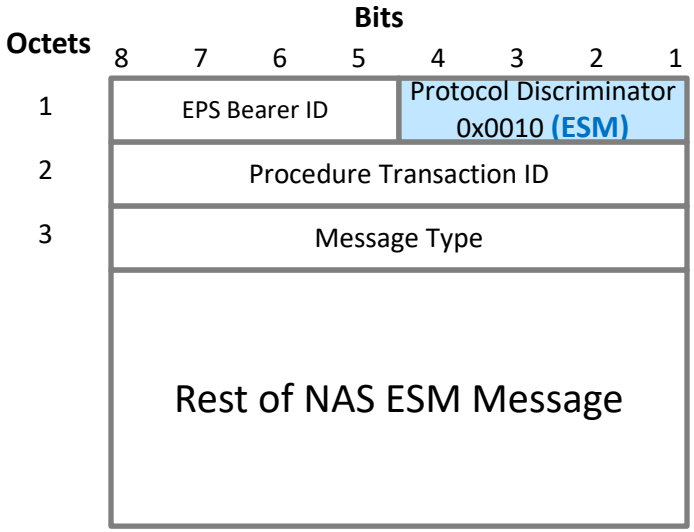
Architecture Concept 2: Mobility Management (MM) and Session Management (SM) Relation

- There are separate NAS messages for EMM and ESM.
- EMM Context and ESM context are stored separately in the MME.
- LTE has the concept of “Always ON” IP connectivity.
  - The moment the UE attaches, a default bearer is setup for the UE to have connectivity. For UE to be in EMM-REGISTERED state, the UE MUST have at least one bearer context.
  - If the last default bearer is removed, UE is moved to detached state. If the last default bearer is removed, the UE automatically enters EMM-DEREGISTERED state.
- ESM procedures can be performed only if an EMM context has been established between the UE and the MME.
- Hence, there is coupling between EMM and ESM state in LTE.

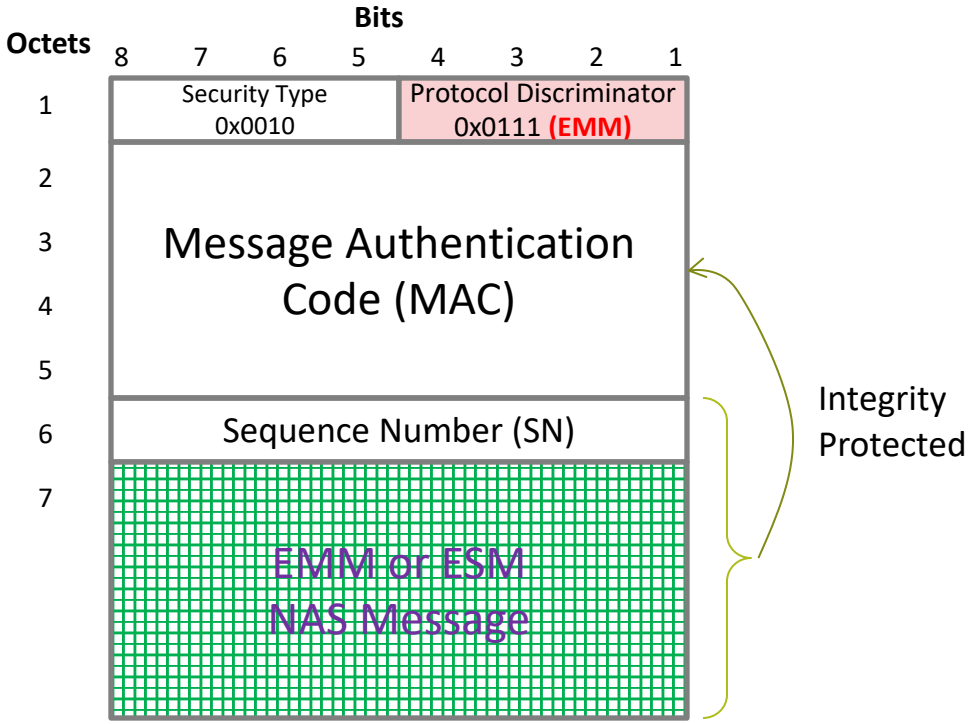
NAS EMM and ESM Message Formats

Non-secured NAS Messages

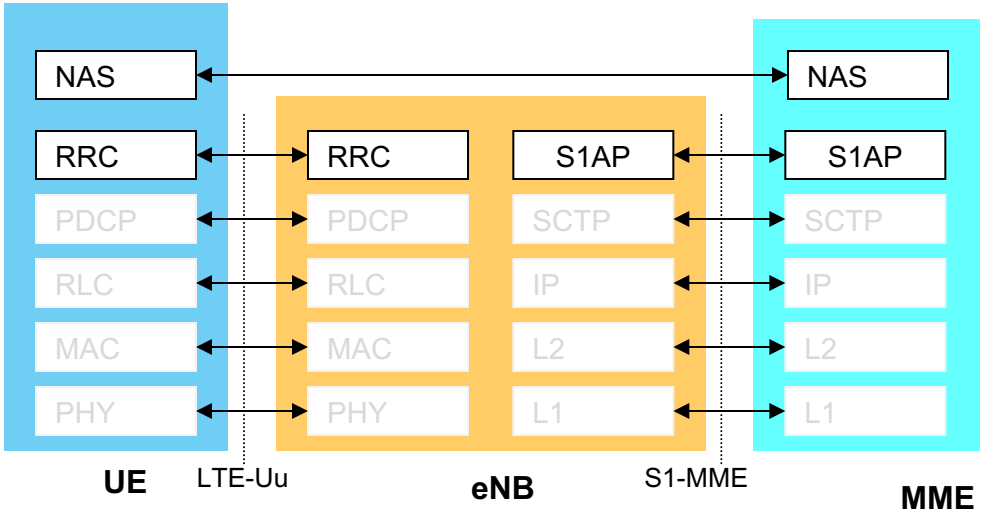




Secured NAS Messages



Protocol Stacks: Control Plane between UE, eNB and MME



Non-Access Stratum (NAS): The key control interface between MME and UE

Radio Resource Control (RRC): The main control interface between eNB and UE

Packet Data Convergence Protocol (PDCP): Duplicate detection, ROHC

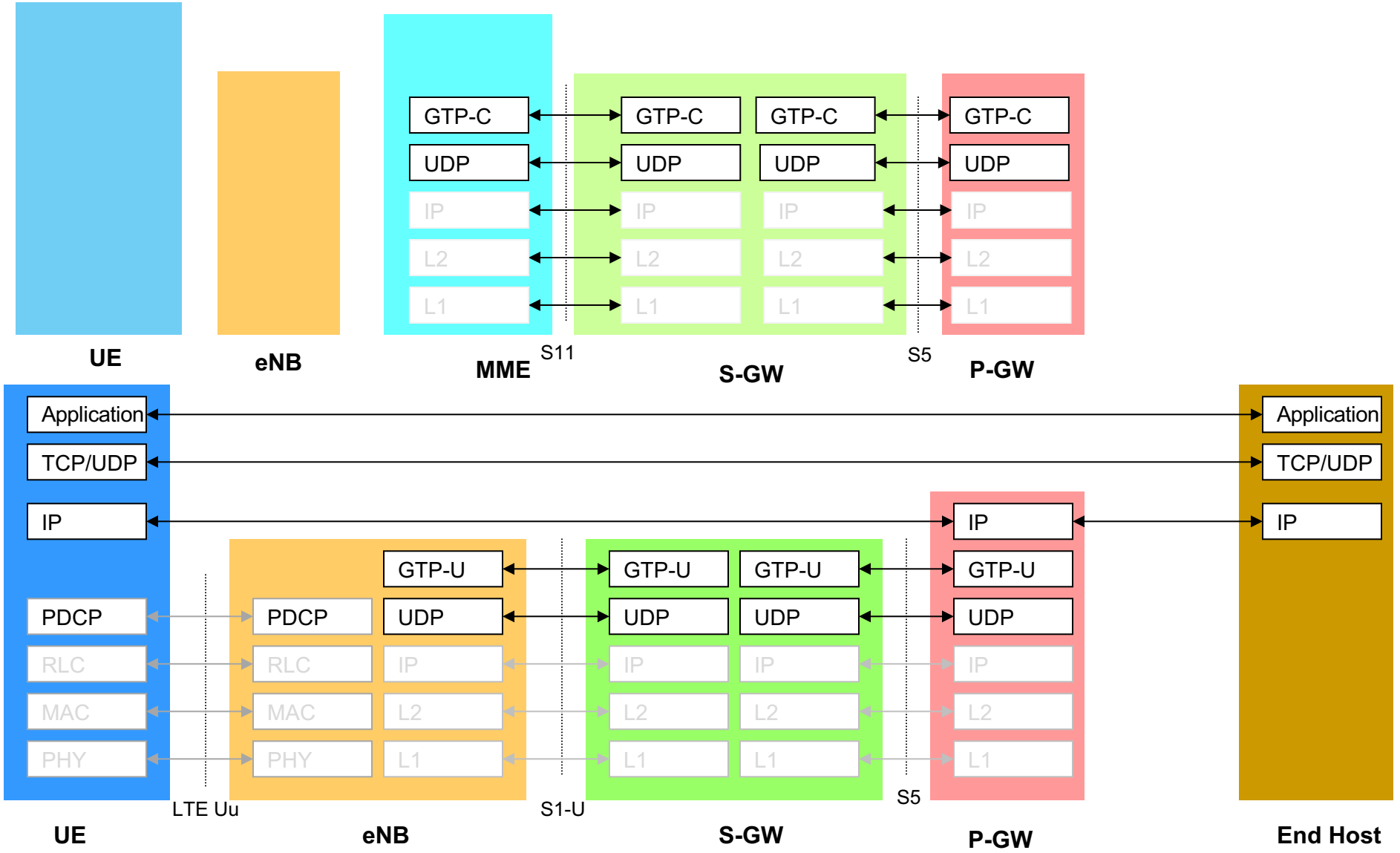
Radio Link Control (RLC): Segmentation/re-assembly, ARQ, acknowledge mode (AM)/ un-acknowledged mode (UAM)

Medium Access Control (MAC): Access the channel, scheduling

Physical Layer (PHY): Radio layer, eg. modulation, MIMO

S1-AP	S1 Application protocol

The GTP-C and GTP-U Protocols



GTP-C GPRS Tunneling Protocol Control

References

- LTE Attach Procedure
  - TS 23.401, Section 5.3.2.1
- Random Access Procedure
  - TS 36.300, Section 10.1.5.2
- NAS
  - EMM State: TS 24.301, Section 5.1.3
  - ESM State: TS 24.301, Section 6.1.3

Next Video

- Protocol Details
  - GTP Primer
  - S1-MME (S1AP) Primer

- LTE Radio Primer
  - How are data and signaling messages transmitted between the mobile and eNB?