DAY 2

HSPA Systems Architecture and Protocols

LTE Basic Reference Model

☐ **UE: User Equipment**

☐ **S-GW: Serving Gateway**

☐ **P-GW: PDN Gateway**

☐ **MME : Mobility Management Entity**

☐ **eNB: evolved Node B**

☐ **HSS: Home Subscriber Server**

LTE Basic Reference Model

- **PCRF: Policy Control and Charging Rule Function**
- **IMS: IP Multimedia Subsystem**
- **EPC: Evolved packet Core**
- **SAE: System Architecture Evolution**
- **LTE: Long-Term Evolution**
- **EPS: Evolved Packet System**

User Equipment (UE)

 Access device for user.

 Provides measurements that indicate channel conditions to the network

eNodeB (1/3)

- Hosts PHYsical (PHY), Medium Access Control (MAC), Radio Link Control (RLC), and Packet Data Convergence Protocol (PDCP) layers.

- Controls user-plane header-compression and encryption.

- Provides Radio Resource Control (RRC) functionality for the control plane.

eNodeB (2/3)

☐ Functions include :

- ◦ radio resource management,

- ◦ admission control,

- ◦ scheduling, enforcement of negotiated uplink QoS,

- ◦ cell information broadcast,

- ◦ ciphering/deciphering of user and control plane data, and

- ◦ compression and decompression of downlink and uplink user-plane packet headers.

eNodeB (3/3)

- Cell control and MME pool support
- Mobility control
- Control and User Plane security
- Shared Channel handling
- Packet Segmentation/Concatenation
- HARQ
- Scheduling
- Multiplexing and Mapping.
- Physical layer functionality Measurements and reporting Automated operation and maintenance

Serving Gateway (S-GW)

- Routes and forwards user data packets.

- Acts as the mobility anchor for the user plane during inter-eNB handovers and as the anchor for mobility between LTE and other 3GPP technologies.

- Terminates the downlink data path for idle state UEs and triggers paging when DL data arrives for the UE.

- Manages and stores UE contexts, e.g.
  - parameters of the IP bearer service and network internal routing inform

PDN Gateway (P-GW)

- Provides connectivity between the UE and external packet data networks (PDNs) by being the point of exit and entry for UE traffic (A UE may have simultaneous connectivity with more than one P-GW for accessing multiple PDNs).

- Performs policy enforcement, packet filtering for each user, charging support, lawful Interception, and packet screening.

- Acts as the anchor for mobility between 3GPP and non- 3GPP technologies such as WiMAX and 3GPP2 (CDMA 1X and EvDO).

MME (Mobility Management Entity) 1/2

- The key control node for the LTE network.
- Responsible for idle mode UE tracking and paging procedure including retransmissions.
- Controls bearer activation/deactivation process.
- Chooses the Serving Gateway (S-GW) for a UE at initial attachment and at the time of intra-LTE handover.
- Authenticates the user by interacting with the Home Subscriber Server (HSS).

MME (Mobility Management Entity) (2/2)

□ The termination point for the Non-Access Stratum (NAS) signaling.

□ NAS signaling is responsible for generation and allocation of temporary identities to UEs and checks the authorization of the UE to camp on the system.

□ The termination point for ciphering and integrity protection for NAS signaling.

□ Handles security key management.

□ Controls plane function for mobility between LTE and other access networks.

Policy and Charging Role Function

☐ The Policy and Charging Rules Function (PCRF):

- A policy decision point for policy and charging control of service data flows and IP bearer resources.

- Selects and provides the applicable policy and charging control decision to the PCEF (i.e. P-GW).

- The policy and charging control element.

Policy and Charging Role Function

☐ A single logical PCRF entity may be deployed by means of multiple and separately addressable PCRFs in the PLMN.

☐ In this case, the PCRF discovery and selection is enabled by Diameter Routing Agency (DRA).

☐ More detail in TS 23.203 [73].

Home Subscriber Server

☐ The HSS is already introduced by UMTS release 5.

☐ With LTE/SAE the HSS will get additionally data per subscriber for SAE mobility and service handling.

☐ Some changes in the database as well as in the HSS protocol (DIAMETER) will be necessary to enable HSS for LTE/SAE.

☐ The HSS can be accessed by the MME via S6a interface.

☐ The HSS is the permanent and central subscriber database;

  ◦ stores mobility and service data for every subscriber, and

  ◦ contains the Authentication Center (AuC) functionality.

LTE-U Interface

☐ Air interface of EUTRAN

☐ Based on OFDMA in downlink and SC-FDMA in uplink

☐ FDD and TDD duplex methods

☐ Scalable bandwidth 1.4MHz to 20 MHz

☐ Data rates up to 100 Mbps in DL

☐ MIMO (Multiple Input Multiple Output)

X2 Interface

- Inter eNB interface
- Handover coordination without involving the EPC
- X2AP: special signalling protocol
- During HO, Source eNB can use the X2 interface to forward downlink packets still buffered or arriving from the serving gateway to the target eNB.
- Avoids loss of a huge amount of packets during inter-eNB handover.

S1-MME Interface

☐ Controls interface between eNB and MME

☐ MME and UE exchange non-access stratum signaling via eNB through this interface.

☐ E.g.: if a UE performs a tracking area update the TRACKING AREA UPDATE REQUEST message will be sent from UE to eNB and the eNB will forward the message via S1-MME to the MME.

☐ S1AP: S1 Application Protocol

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S1-U Interface

☐ User plane interface between eNB and serving gateway.

☐ Pure user data interface (U=User plane).

☐ S1flex-U supported: a single eNB can connect to several Serving GWs.

☐ Which Serving GW a user's SAE bearer signaled from the MME of this user.

S10 Interface

- Interface between different MMEs
- Used during inter-MME tracking area updates
- The new MME can contact the old MME the user had been registered before to retrieve data about identity (IMSI),
- security information (security context, authentication vectors) and
- SAE bearers (PDN gateways to contact, QoS, etc.)
- S10 is a pure signaling interface, no user data runs on it.

S6a Interface

☐ Interface between the MME and the HSS

☐ The MME uses it to retrieve subscription information from HSS (handover/tracking area restrictions, external PDN allowed, QoS, etc.) during attaches and updates

☐ The HSS can during these procedures also store the user's current MME address in its database.

S11 Interface

- Interface between MME and a Serving GW

- A single MME can handle multiple Serving GW each one with its own S11 interface

- Used to coordinate the establishment of SAE bearers within the EPC

- SAE bearer setup can be started by the MME (default SAE bearer) or by the PDN Gateway.

S5/S8 Interface

☐ Interface between Serving GW and PDN GW

☐ S5: If Serving GW and PDN GW belong to the same network (non-roaming case)

☐ S8:If this is not the case (roaming case)

☐ S8 = S5 + inter-operator security functions

☐ Transfers user packet data between PDN GW and Serving GW

☐ Signaling on S5/S8 is used to setup the associated bearer resources

☐ S5/S8 can be implemented either by reuse of the GTP protocol from 2G/3G or by using Mobile IPv6 with some IETF enhancements.

S7 (alias Gx) Interface

☐ Interface between PDN GW and PCRF (Policy and Charging Rule Function)

☐ Allows the PCRF to request the setup of a SAE bearer with appropriate QoS

☐ Allows the PDN GW to ask for the QoS of an SAE bearer to setup

☐ Allows to indicate EPC status changes to the PCRF to apply a new policy rule.

SGi Interface

- Used by the PDN GW to send and receive data to and from the external data network
- Either IPv4 or IPv6 based
- Downlink data from the external PDN assigned to the right SAE bearer of the right user by analysis of the incoming packet's IP addresses, port numbers, etc.
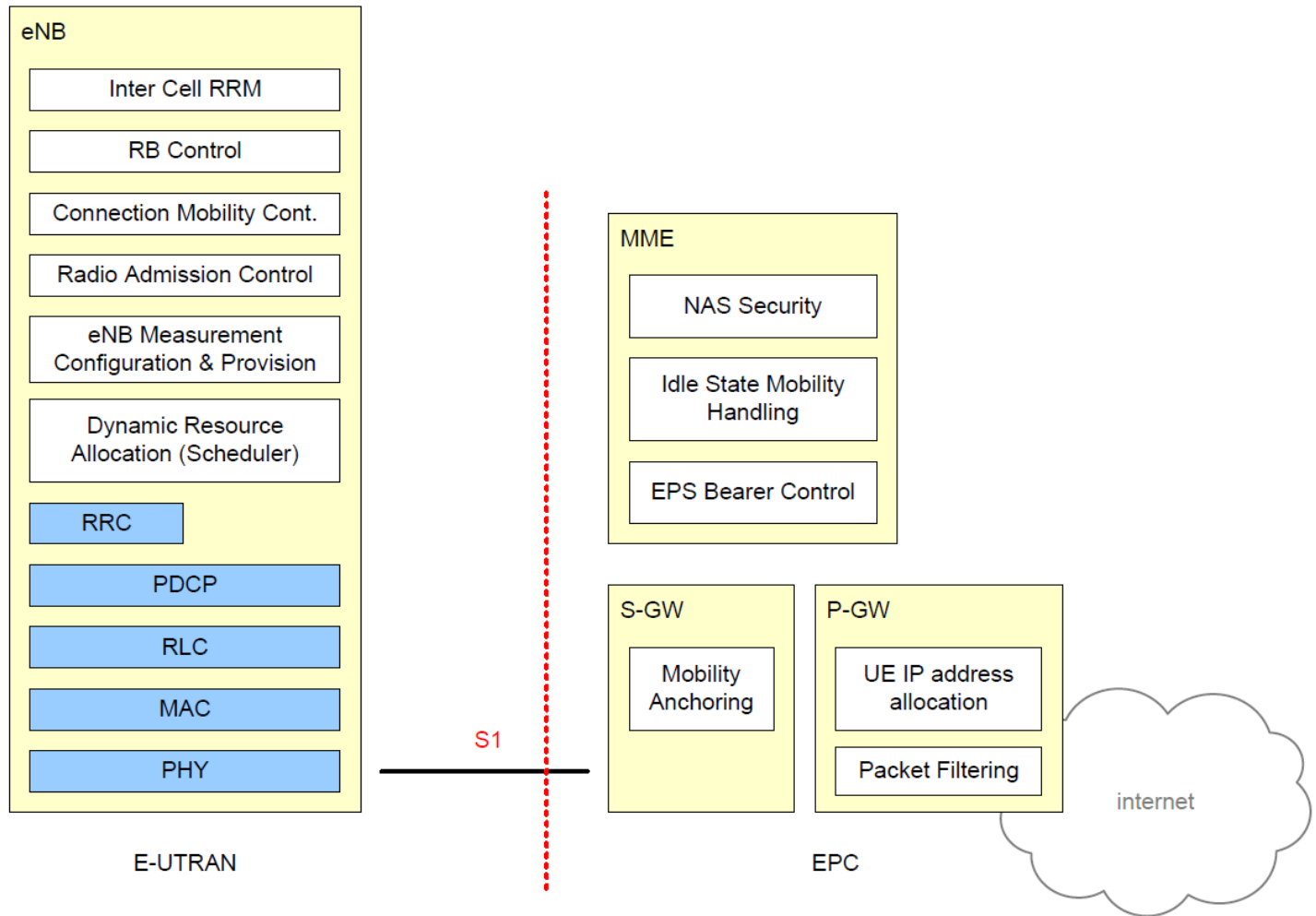- Corresponds to the Gi interface in 2G/3G networks

Rx Interface

☐ Interface between PCRF(Policy & Charging Rules Function) and the external PDN network/operators IMS

☐ Standardized in 3GPP TS 23.203.

Functional Split between eUTRAN and EPC

Network Evolution

- RNC functions migrated to eNB and MME
- eNB Control Plane aggregation => MME
- eNB User Plane aggregation => SGW
- User Plane ciphering => eNB
- NAS Signaling ciphering => MME