3G LTE
4G / LTE Advance

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Contributors

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Summary

- LTE introduction
- LTE architecture

3G LTE

- 3G - LTE (Third Generation - Long Term Evolution)
  - Project lead by the 3GPP - 3rd Generation Partnership Project - standardization group to design a new generation radiomobile system
    - Not fully a 4G system (3.9 G System) for the ITU (IMT Advanced recommendation)
    - « LTE Advanced » is a 4G standard
- Standardization
  - Standard initiated in 2004
  - Introduce in Release 8 (functionnalities frozen in december 08)
  - Small evolution of functionnalities in Release 09
  - LTE Advanced (4G system) in Release 10

Motivation for LTE (1)

- Need for PS optimised system
  - Evolve 3GPP systems towards packet only system
    - Only data services are supported (no circuit switched domain)
    - Connectivity to an IP network required
    - Consequently, Voice over LTE (VoLTE) is based on Voice over IP (VoIP) solution
- Need for high quality of services
  - Need for higher data rates
    - New air interface defined by 3GPP LTE
  - Always-on experience (significantly reduce control plane frequency)
  - Reduce latency and round trip delay
    - Transition from standby to active state < 100ms
    - Latency of the user plane <5ms in case of low network load
  - Must support several class of service

Motivation for LTE (2)

- Need for cheaper infrastructure
  - Simplify architecture, reduce number of network elements
  - Spectrum flexibility
- Services and compatibility requirements
  - Should facilitate introduction of new services
  - User mobility without service interruption
  - Strengthening of the network security
  - Interworking with non-LTE systems (3GPP and non-3GPP such as Wimax)
    - Mobility towards 2G and 3G networks

3G LTE

Standards characteristics

- For 20 Mhz of spectrum
  - Peak download rates of
    - 326.4 Mbit/s for 4x4 antennas
    - 172.8 Mbit/s for 2x2 antennas
  - Peak upload rates of 86.4 Mbit/s using a single antenna
- Quality of Service
  - Sub-5 ms latency for small IP packets
- Spectrum flexibility
  - Frequency bandwith ranging from 1,4 MHz up to 20Mhz
    - 1.4 MHz, 3 MHz, 5 MHz, 10MHz, 15 MHz and 20 MHz are standardized.
  - Can operate in several frequency : 900 MHz (current GSM bands) / 2,6 GHz...
- All IP network
  - Packet switching only
  - IPv6 support

4G = LTE advance

Motivations

- 3G LTE standard is a pre 4G standard (3.99G)
  - It does not meet the IMT Advanced requirements for 4G
    - IMT : International Mobile Telecommunications Advanced, defined by ITU-R
    - Peak data rates up to 1 Gbit/s

LTE Architecture

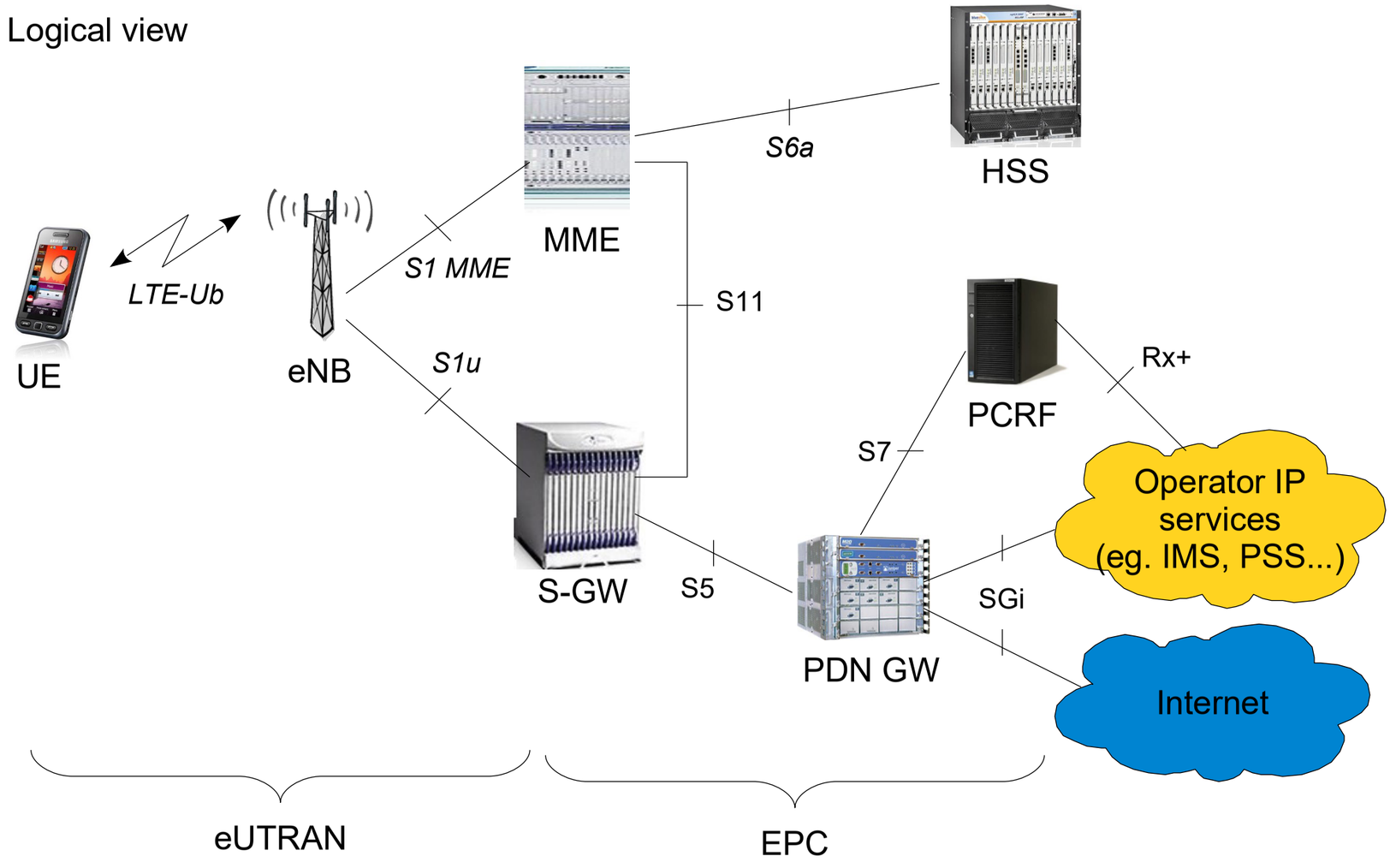
SAE – System Architecture Evolution
EPC – Evolved Packet Core

LTE Architecture

- LTE Architecture introduces majors changes in both access and core network
  - The eUTRAN – Evolved UTRAN - introduces a new architecture for the access network
    - New radio-transmission technology (SC-FDMA in upling / OFDMA in downlink)
    - New radio-equipments with a flat architecture
  - The EPC – Evolved Packet Core – introduced equipements to separe the User Plane and the Control Plane
    - The control plane is manage by the MME – Mobility Management Entity
    - The User plane is manage by the S-GW – Serving Gateway

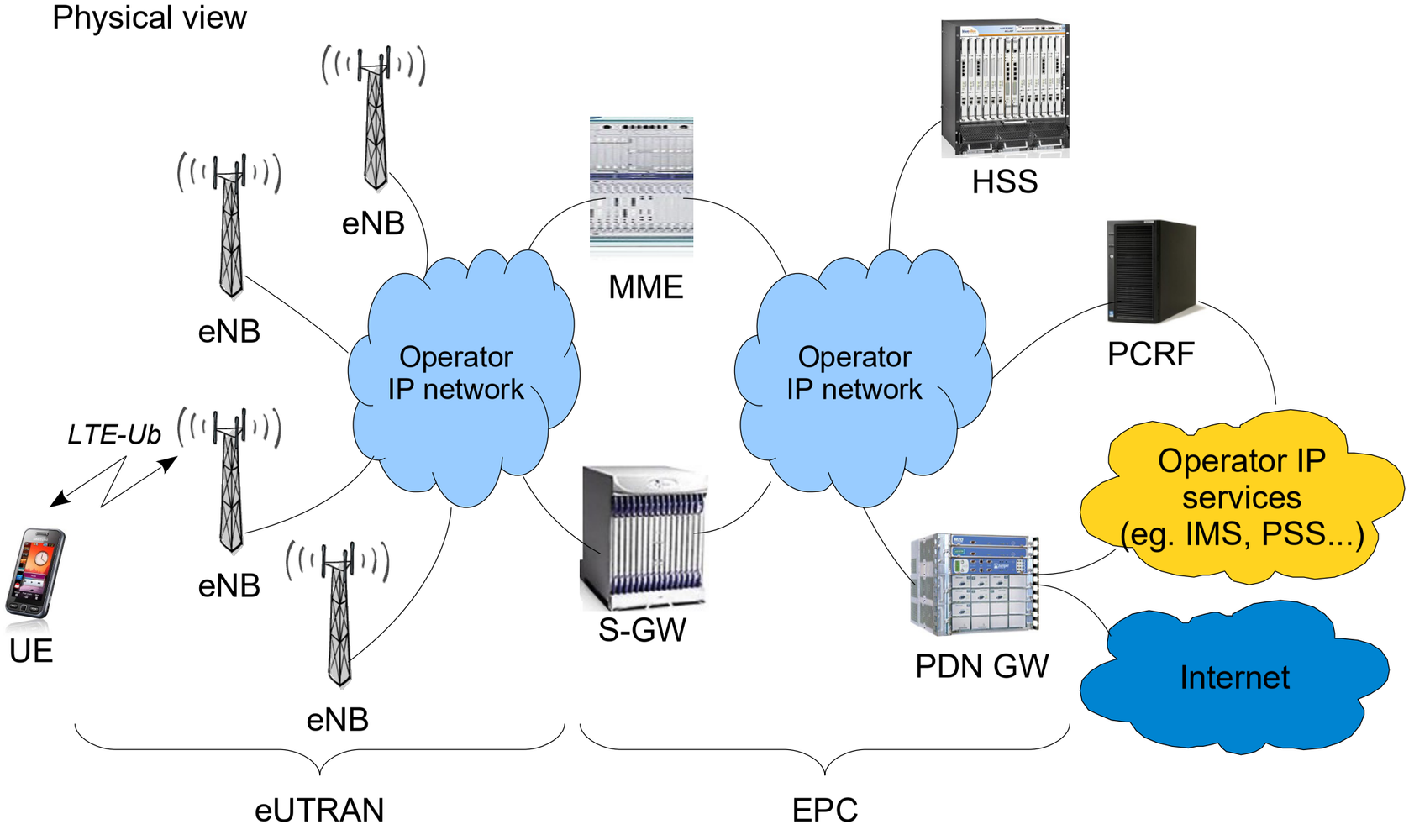
LTE architecture

Logical view



LTE architecture

Physical view



UE – User Equipment

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- ME + UICC
  - ME - Mobile Equipment
    - Equipment used by the subscriber to access the network

  - UICC – Universal Integrated Circuit Card (the smart card)
    - Contains the USIM – Universal Subscriber Identity Module (the application contained in the smart card, for 3G and 4G security procedures)

    - Can also contains :
      - SIM – Subscriber Indentity Module (the application for 2G security procedures)
      - ISIM – IP Multimedia Service Identity Module (the application for security procedures in the IMS domain – IP Multimedia Subsystem, required to provide voice services : VoLTE – Voice Over LTE)

eUTRAN / eNodeB

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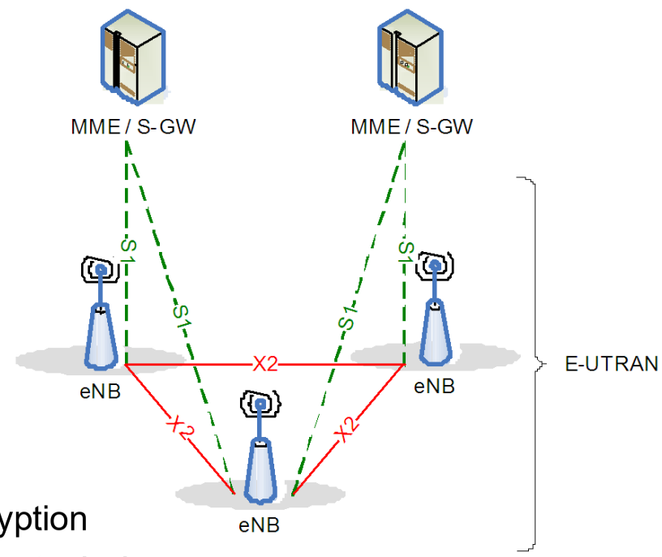
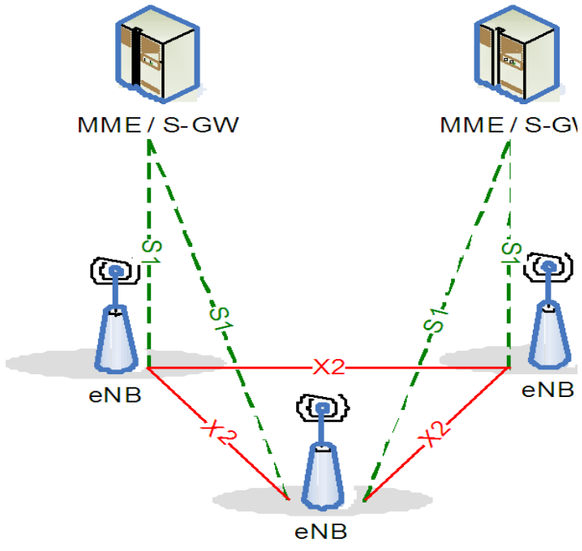
- Evolved UMTS Radio Access Network
  - Only equipment : eNB – evolved Node B
  - Manage interface with the UE
    - Physical Layer (PHY)
    - Medium Access Control (MAC)
    - Radio Link Control (RLC)
    - Packet Data Control Protocol (PDCP)
      - Header compression (for the user plane) and encryption
    - Radio Ressource Control (RRC) – only for the control plane
  - eNBs are interconnected
    - With each others by means of the X2 interface (optionnal)
    - With the EPC by means of the S1 interface
      - S1 MME for the eNB / MME link
      - S1 U for the eNB / SGW link



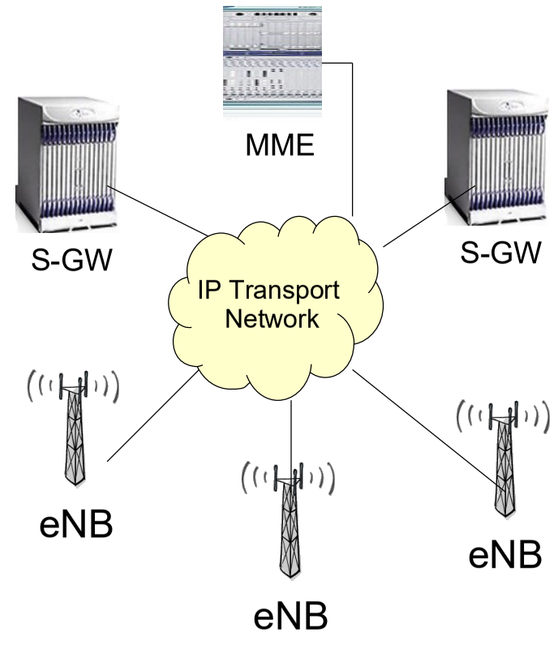
Logic Architecture view :

- Interfaces describes message format for user and control plane



Real Architecture view :

- Messages are transported over an IP network



Main functionnalities

- Radio ressource management
  - Radio Bearer Control
  - Radio Admission Control
  - Connection Mobility Control
  - Dynamic allocation of ressources to UEs in uplink and downlink (Schedulling)
    - Enforcement of negotiated QoS
  - Radio measurement and reporting
- Paging messages transmission
- Cell information broadcast
- Ciphering/deciphering of user and control plane
- Compression/decompression of DL/UL user plane packet headers

MME – Mobility Management Entity

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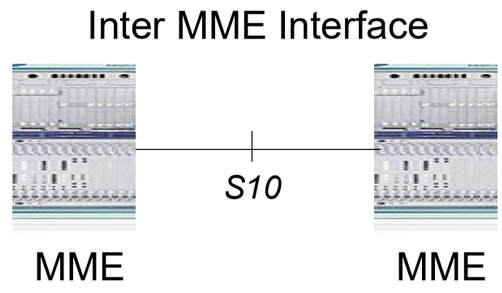
- Main functionnalities of the MME – Mobility Management Entity
  - NAS signalling & security
    - Authentication
    - Temporary identity allocation
  - AS control
    - Bearer management
    - Access control
  - PDN GW and Serving GW selection
  - Mobility
    - Tracking Area list management
    - Inter CN node signalling for mobility betwen 3GPP access networks
    - Idle mode UE reachability
    - Roaming
  - Handover
    - MME selection for inter-MME handover
    - SGSN selection for handover to 2G/3G 3GPP access networks



S-GW – Serving Gateway

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- Main functionnalities of the Serving Gateway
  - For transmission
    - User data packets routing and forwarding
    - In idle mode : Downlink Packet Buffering and network service request triggering
    - Transport level packet marking in the uplink and downlink
    - Accounting and charging
  - For mobility
    - Local Mobility Anchor for inter-eNB handover
    - Mobility anchor for inter-3GPP networks mobility

P-GW : Public Data Network Gateway

- Manage the access to the Public Data Network
- Main functionnalities of the PDN Gateway
  - Per-user based packet filtering (policy enforcement)
  - UE IP address allocation (PDP context activation procedure)
  - Transport level packet marking in the downlink
  - Service level charging
  - Mobility anchor for mobility between 3GPP and non 3GPP technologies (such as WIMAX)

Documentary Resources (Articles)

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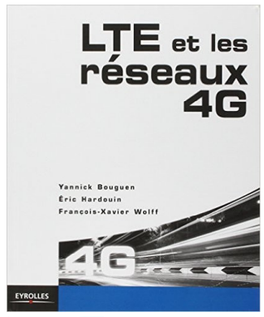

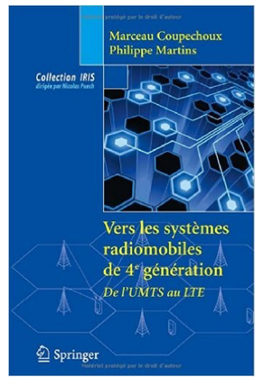

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