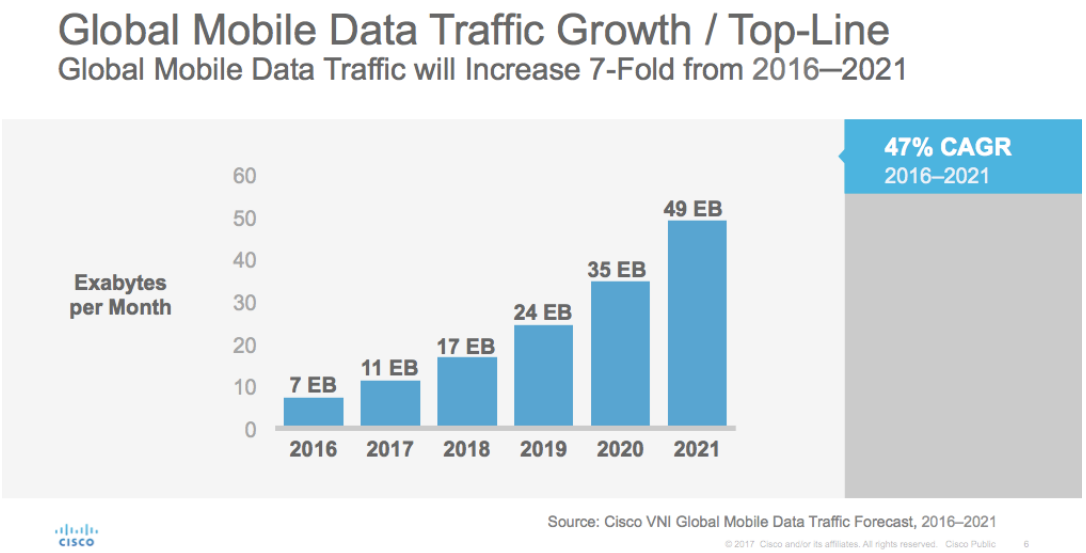
Lecture 1
Introduction &
Review of the cellular networks

Trends of Mobile Traffic (1)

- LTE-A: peak downlink 1 Gbps, peak uplink 500Mbps
- 5G is designed to deliver peak data rates up to 20 Gbps based on IMT-2020 requirements
  - What's IMT-2020? International Mobile Telecommunications-2020 (IMT-2020 Standard) proposed by ITU (International Telecommnuication Union) in 2015



Observation: We need new technologies to support the upcoming mobile traffics

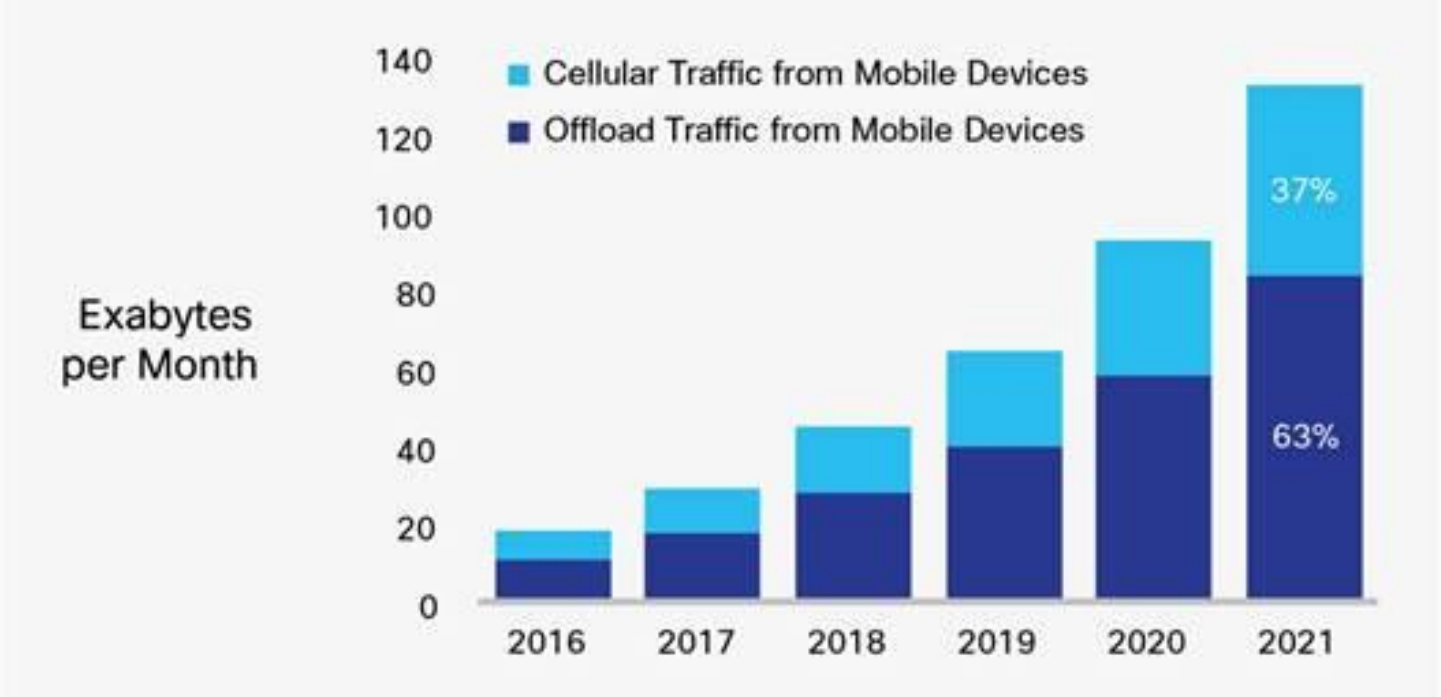
Note: 1 exabyte (EB)=1000^6 bytes=10^{18} bytes

https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=1819296

Trends of Mobile Traffic (2)

- Why WiFi is getting important?
  - Cost issue
  - Coverage issue
  - ….

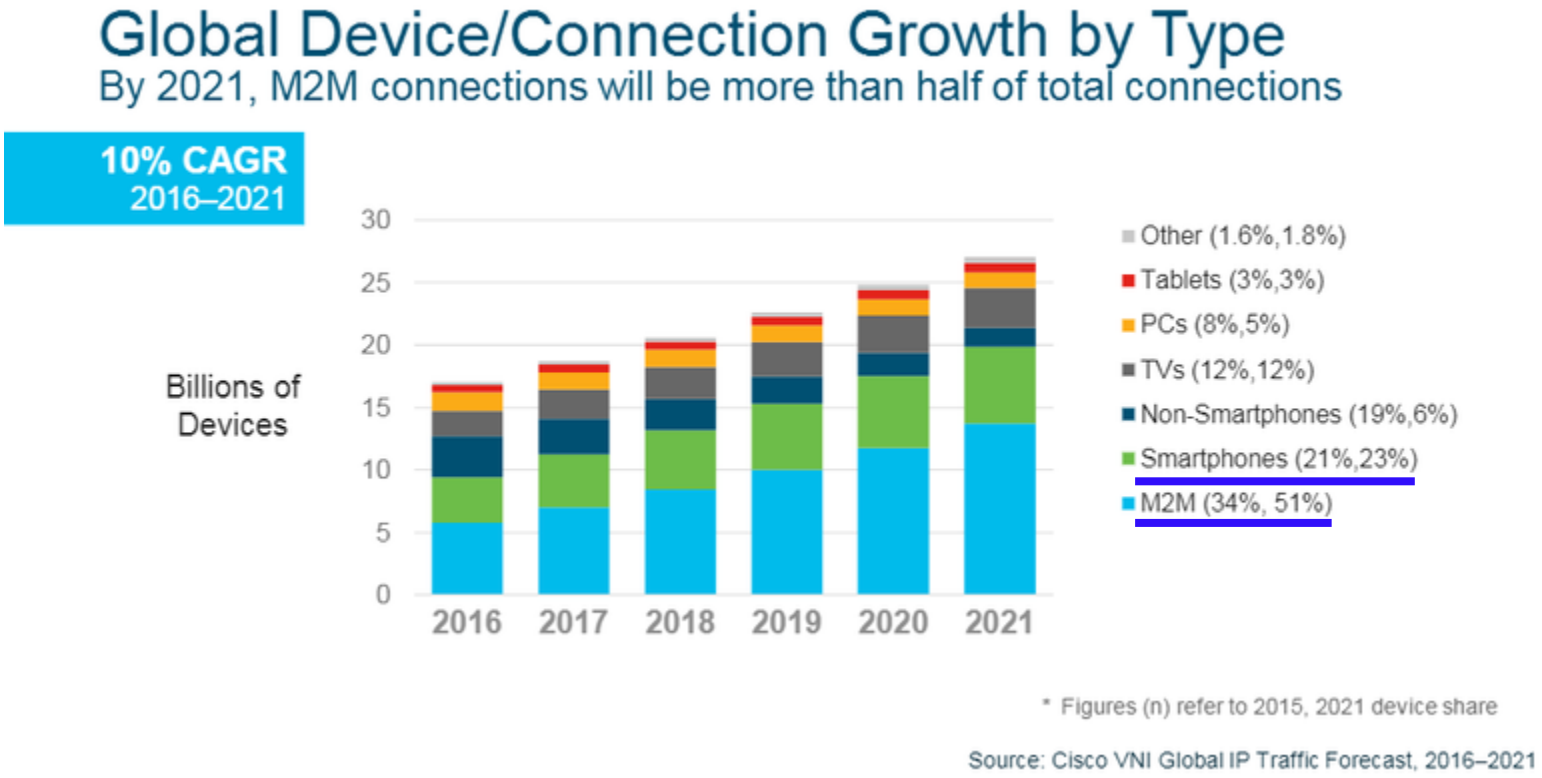
Heterogeneous network



Source: https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=1819296

Device Analysis

- Cisco, Ericsson, TI, and others predict there will be more than 20 billions connected devices by 2020
- Bringing connectivity to those objects is challenge



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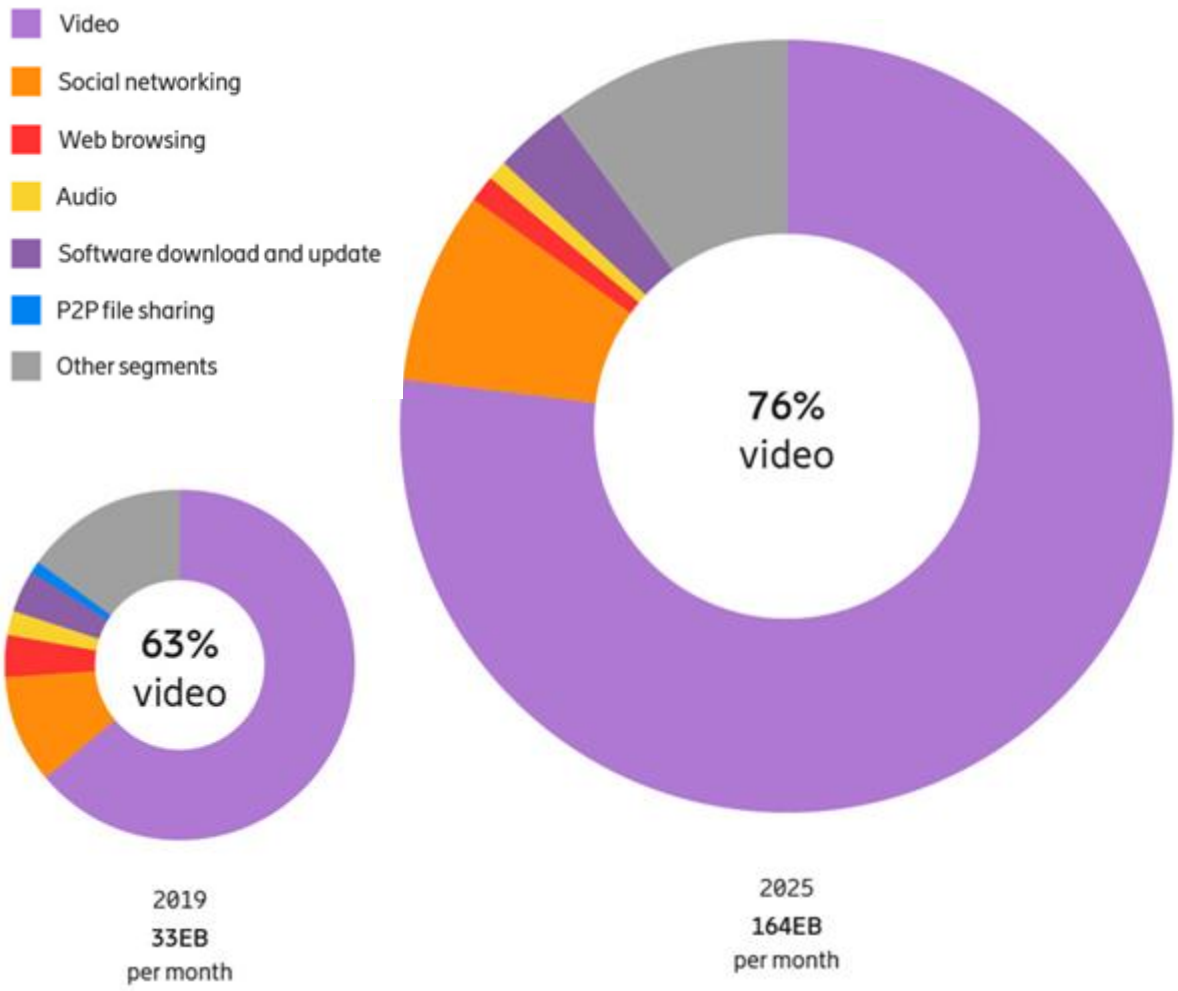
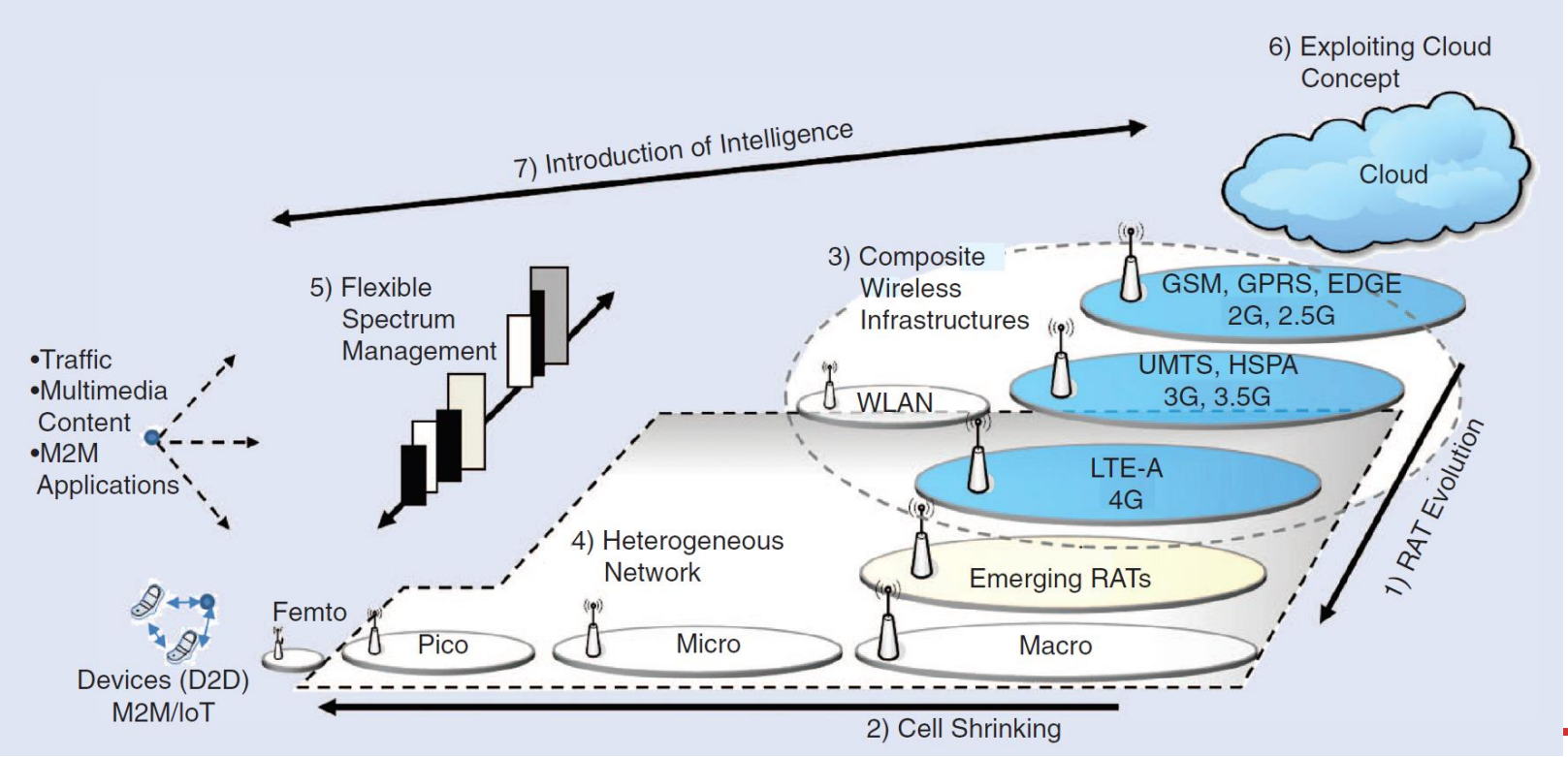
Application Traffic Growth



Source: https://www.ericsson.com/en/mobility-report/reports/june-2020/mobile-traffic-by-application-category

New Technology Development Trends (1)

- Small cell
- Multi-RAN (heterogeneous network)
- Unlicensed band utilization [LTE-U: LTE-LAA (License Assisted Access)]



New Technology Development Trends (2)

- Cloud/edge computing
- SDN & NFV
- Network slicing
- Service-oriented cloud
- Internet QoS
- Resource management
- Massive MIMO
- CoMP (Coordinated Multi-Point Transmission)
- Beamforming technology

Syllabus

Item	Topic	Note (week)
1	Introduction of this course Review of the cellular networks	1
2	Introduction to Quality of Service (QoS) Traffic Management-Inserve Traffic Management-DiffServ	2
3	Traffic Management-MPLS Traffic Management-Traffic Engineering	2
4	IGMP & Multicasting	1
5	WiFi 5 (ac) and WiFi 6 (ax) WiFi 7 (be)	1
6	LTE/5G/WiFi offloading (LAA, LWA)	1
7	5G/B5G/6G system architecture and services (SDN/NFV/NS/MEC/IoT etc)	1.5~2
8	Cloud Radio Access Network (C-RAN) Architecture Open Radio Access Network (O-RAN) Architecture	1
9	Deterministic networks (DetNet) & Traffic Steering Concept (Case Study) & Time sensitive networks (TSN)	1

Textbooks

- Z. Wang, Internet QoS-Architecture and Mechanisms for Quality of Service, 1st Ed., Morgan Kaufmann Series in Networking
- Dave Kosiur, IP Multicasting: The Development Guide to Interactive Corporate Networks, John Wiley & Sons Inc.
- Cloud Radio Access Networks: Principles, Technologies, and Applications, Tony Q. S. Quek, Mugen Peng, Osvaldo Simeone, and Wei Yu, Cambridge University Press
- Research papers/technical reports

Grading Policy

- Midterm: 30%
- Final: 35%
- Project: 35% (1~2人)

GSM Architecture (1)-2G

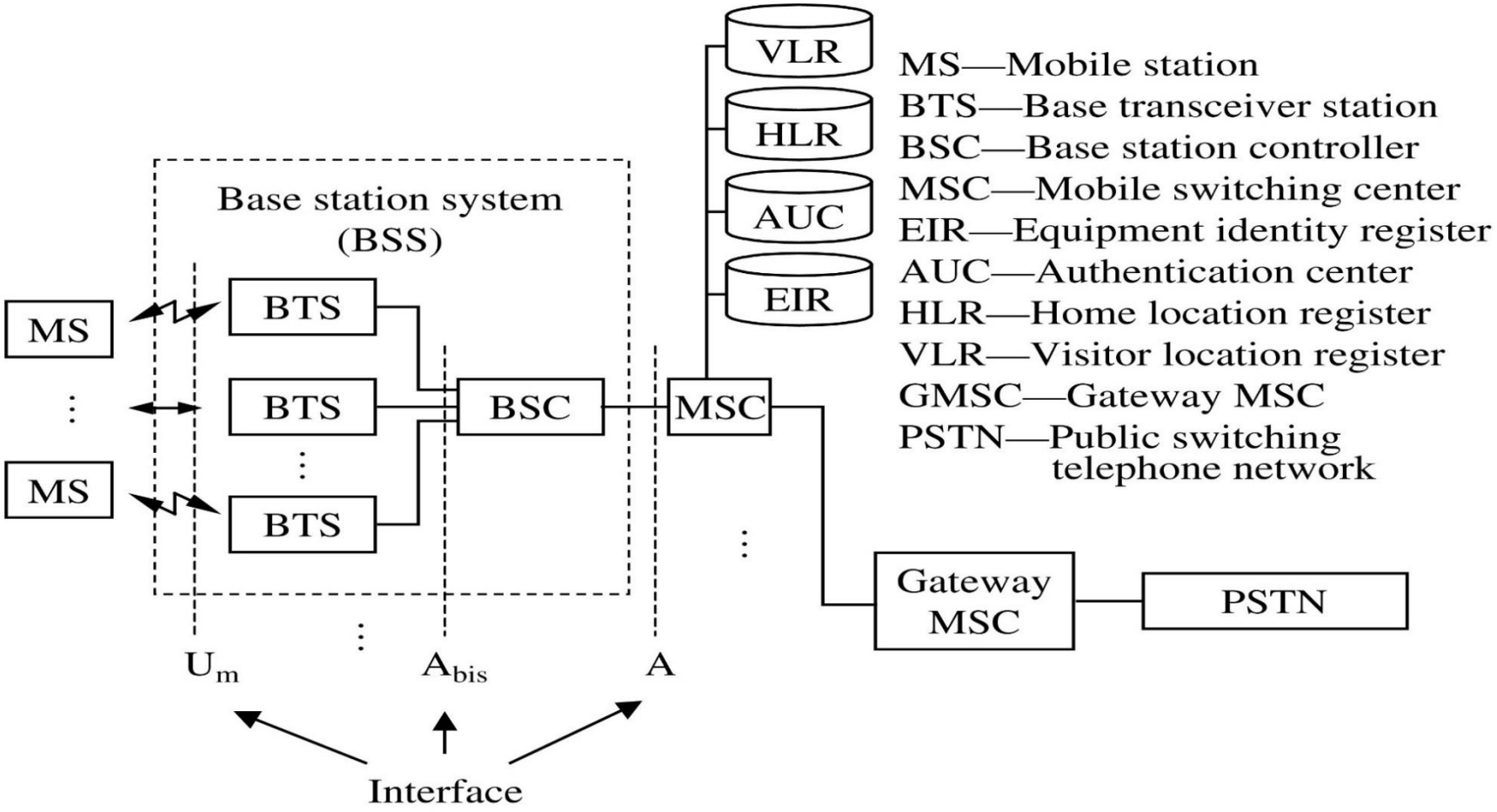
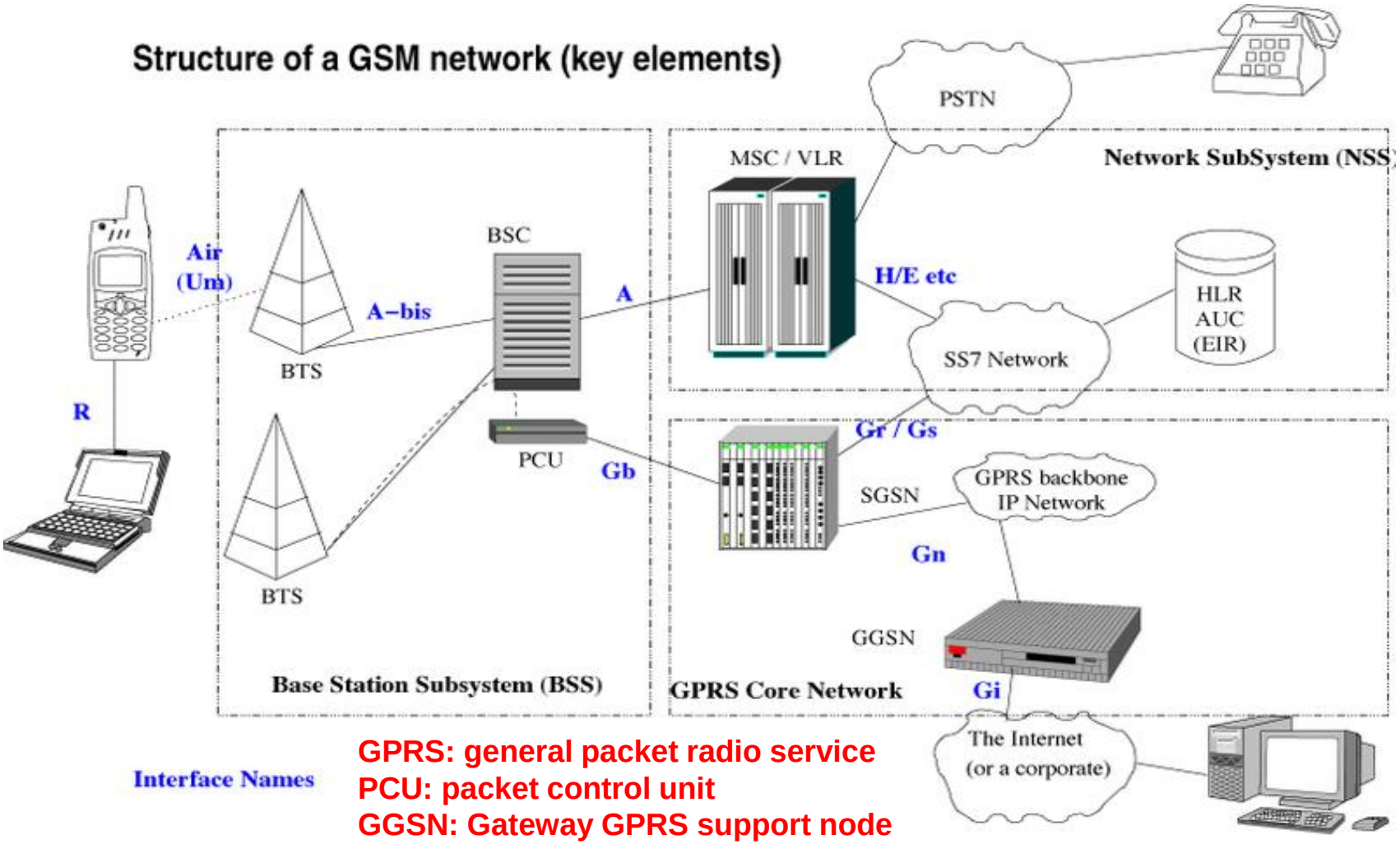


Figure 10.8 GSM infrastructure.

GSM Architecture (2)-2G



Interface Names

GPRS: general packet radio service
PCU: packet control unit
GGSN: Gateway GPRS support node
SGSN: serving GPRS support node
GTP: GPRS tunneling protocol

GSM Architecture (3)-2G

- Mobile switching center (MSC)
  - Switching functions
  - Network interfacing
  - Common channel signaling
  - Gateway functionality
  - HLR and VLR maintenance
- Base station controller (BSC)
  - Handoff between managed BTSs
  - Signal power level management
  - Frequency management among BTSs
- Authentication center (AUC)
  - Deal with authentication and encryption
  - Deal with frauds and spoofing
- Equipment identity register (EIR)
  - Database containing information about the identity of mobile equipment

UMTS Architecture (1)-3G

- Universal Mobile Telecommunications System
- Network reference architecture

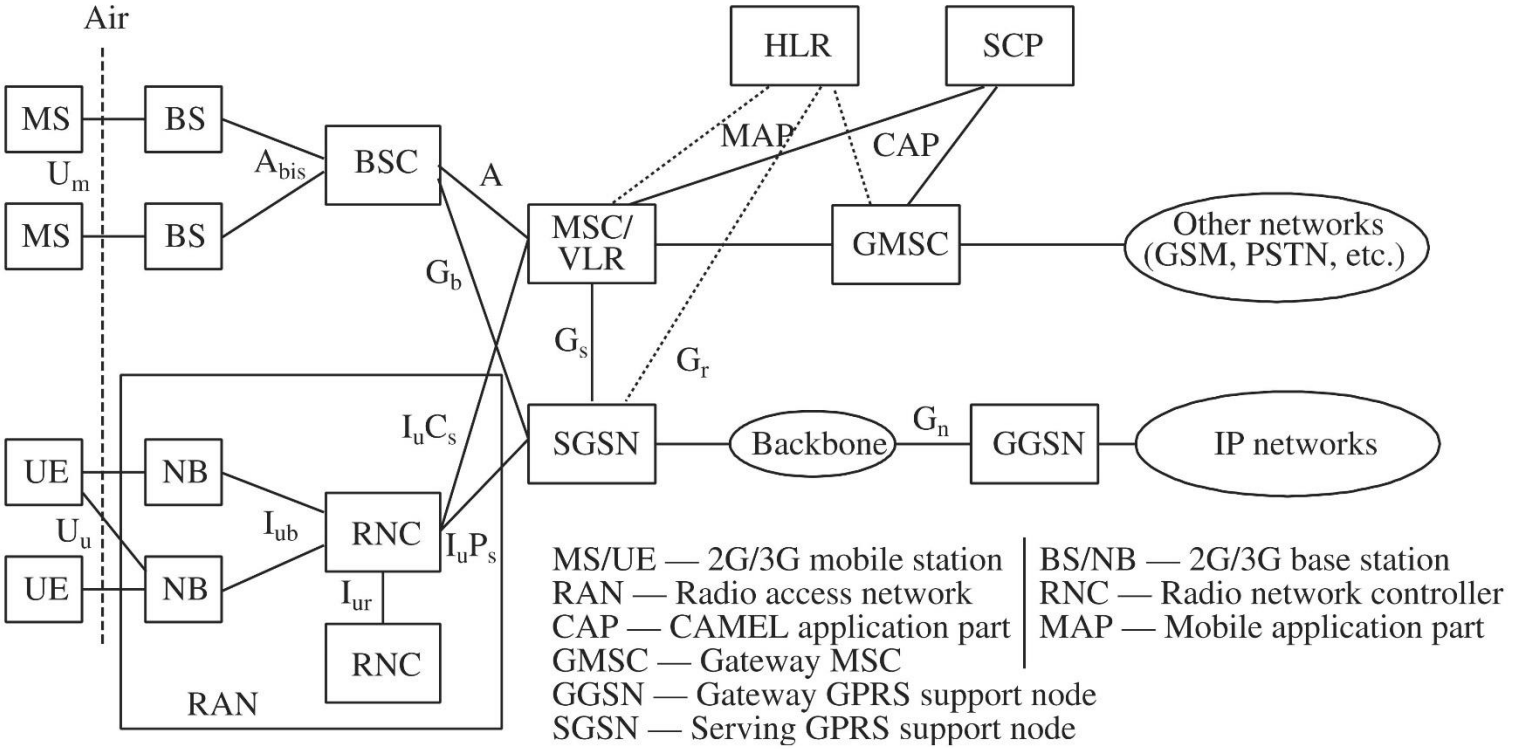
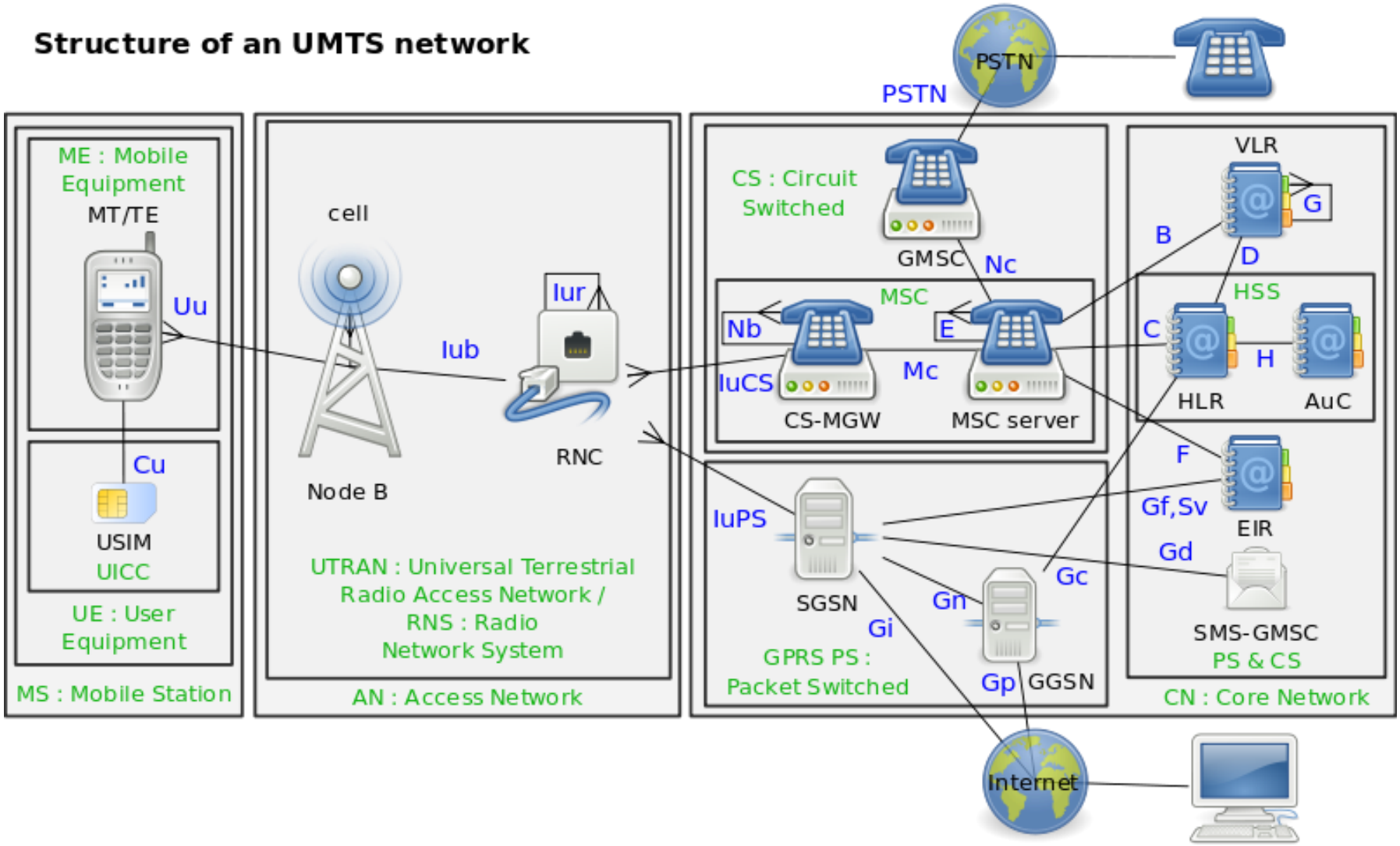


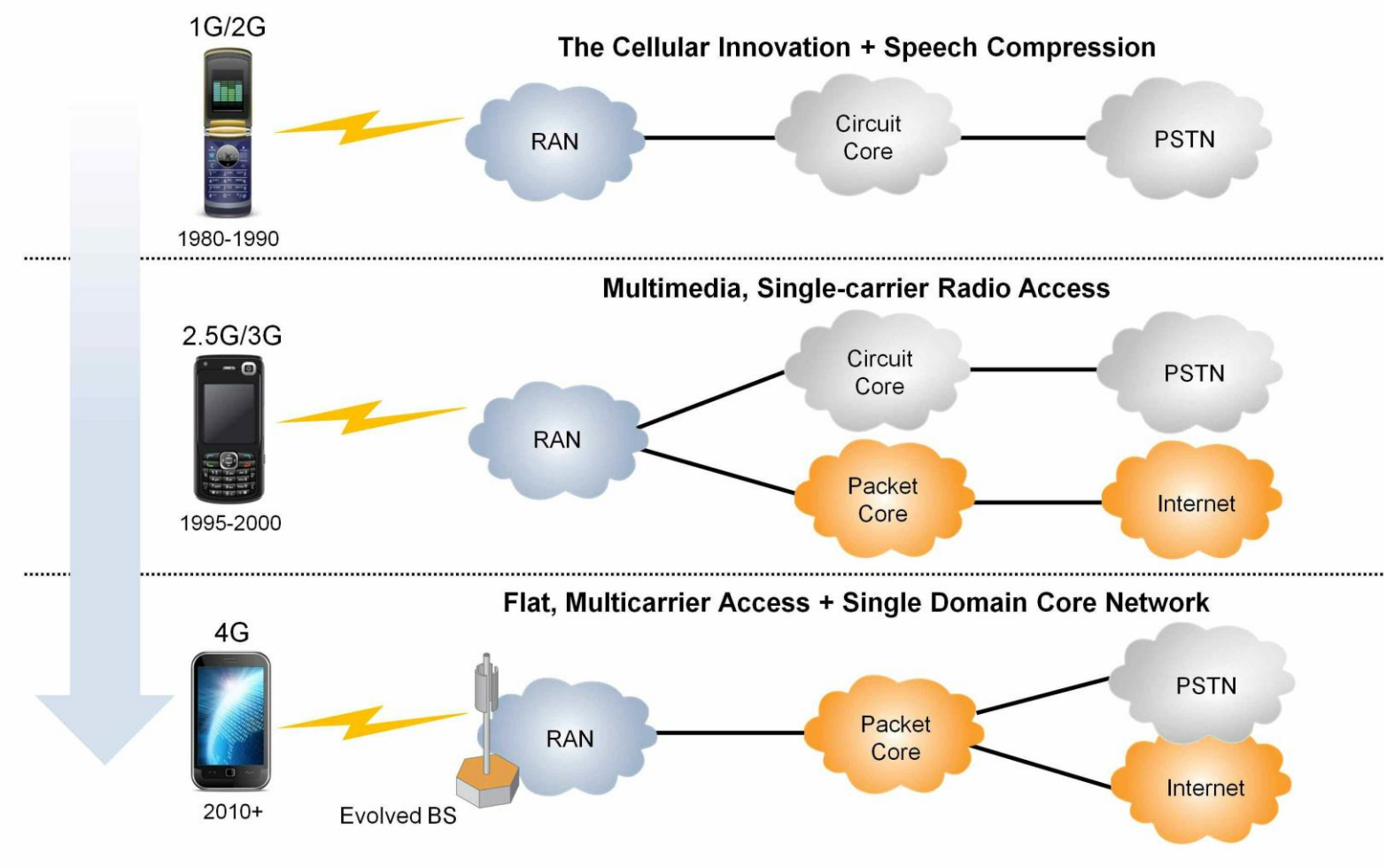
Figure 10.37 UMTS network architecture.

UMTS Architecture (2)-3G



From UMTS to LTE

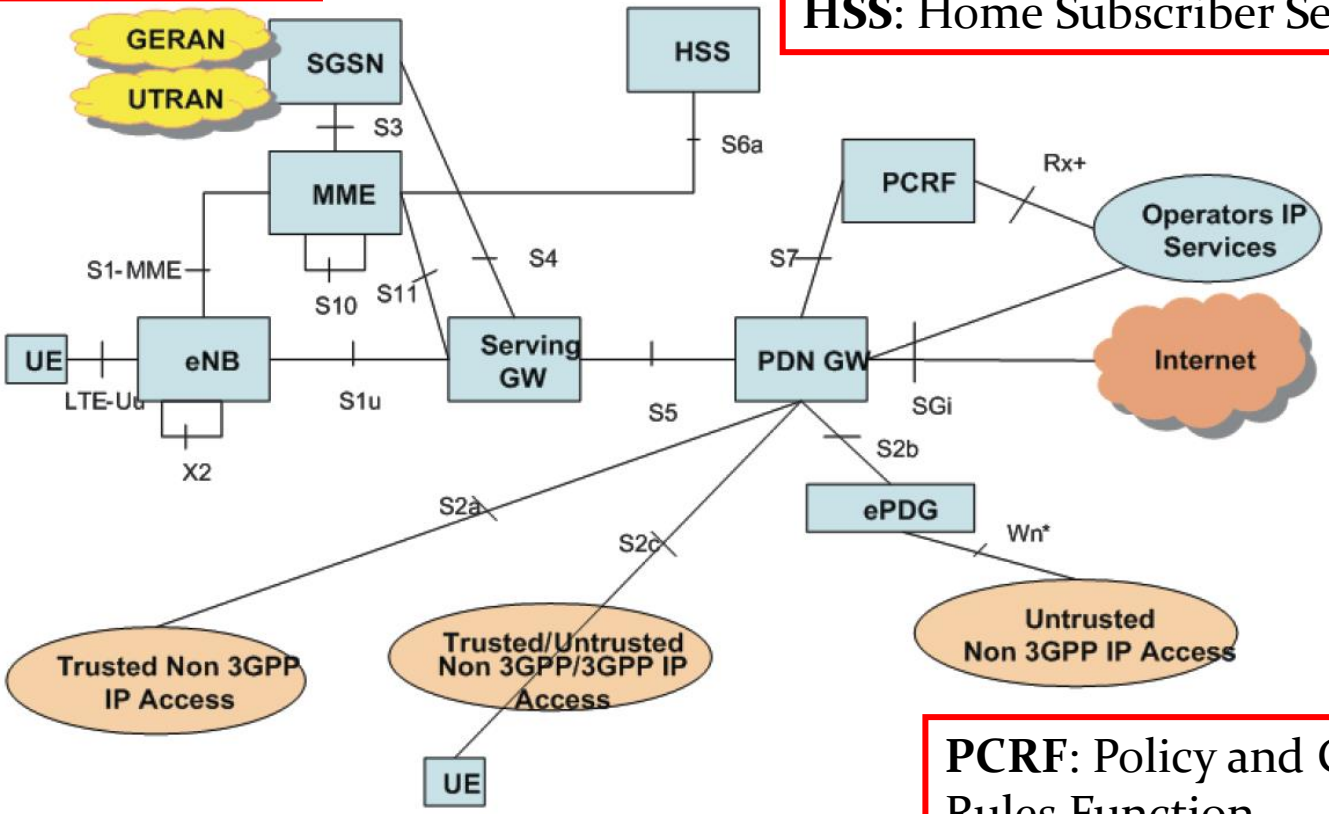
- From circuit core to packet core (IP convergence)



LTE Network Architecture (1)-4G

ePDG: Evolved Packet Data Gateway

GERAN: GSM/Enhanced Data Rates for GSM Evolution (EDGE)
HSS: Home Subscriber Server (HLR)



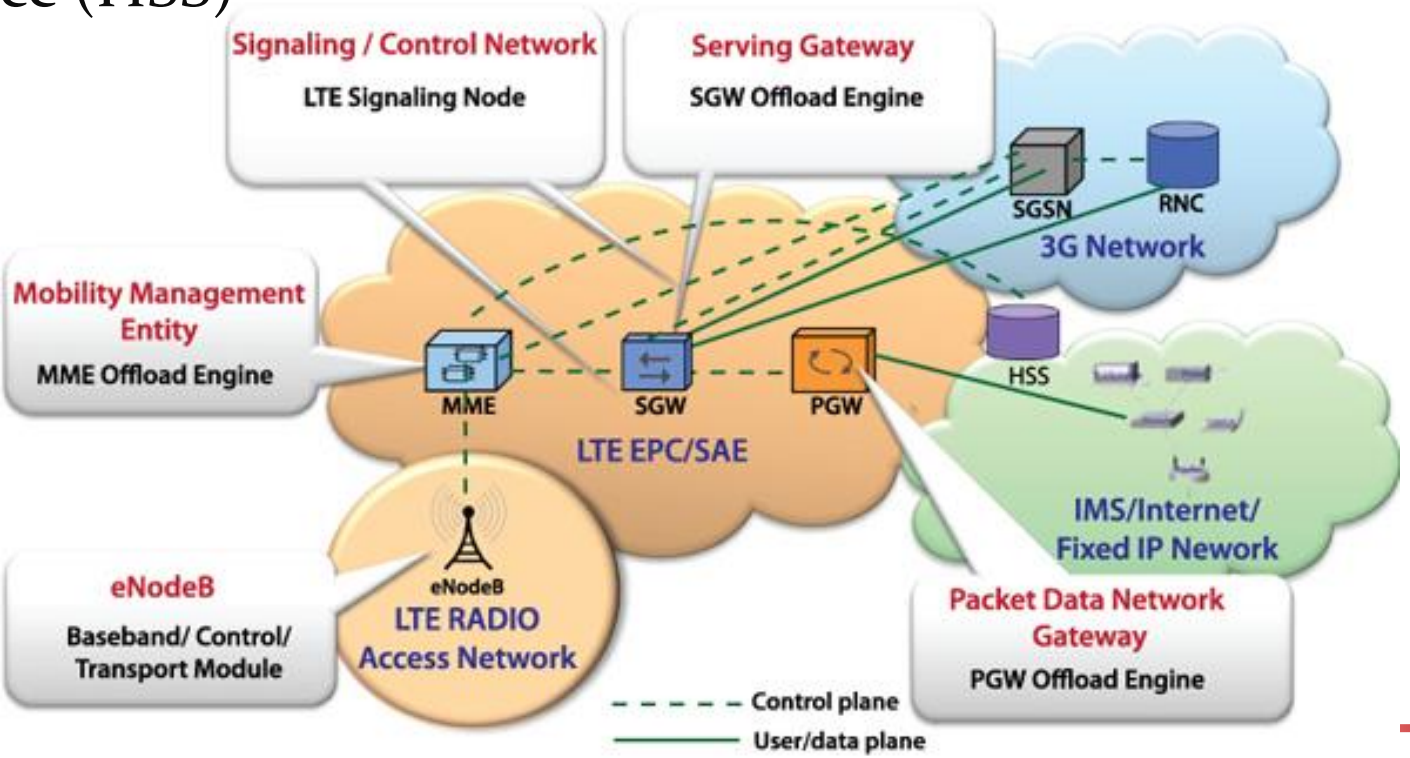
(Untrusted non-3GPP access requires ePDG in the data path)

Figure 1: High level architecture for 3GPP LTE (Details of all LTE interfaces are given in Appendix A)

PCRF: Policy and Charging Rules Function

LTE Network Architecture (2)-4G

- LTE radio access network (RAN): user equipment (UE) + E-UTRAN Node B (eNB)
- LTE EPC: mobility management entity (MME) + serving gateway (SGW) + PDN gateway (PGW) + home subscriber service (HSS)



5G System Architecture

- System architecture?
- Technologies?
- Common services?
  - eMBB (enhanced mobile broadband)
  - Massive machine-type communications (mMTCs)
  - Ultra-reliable low-latency communications (URLLCs)