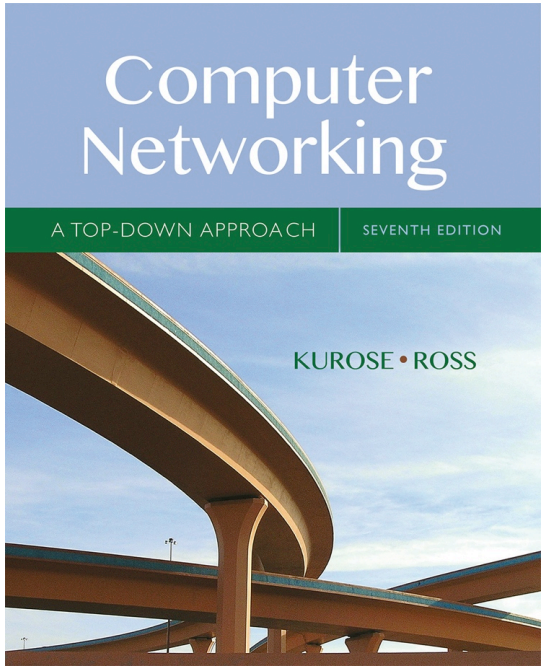
Information Technology Fundamentals

Mohammad Hossein Manshaei

manshaei@gmail.com

Networking: LTE Networks
Module 2: Part 4

Reference: Chapter 7 Wireless and Mobile Networks



Computer Networking: A Top Down Approach

7th edition
Jim Kurose, Keith Ross
Pearson/Addison Wesley
April 2016

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Thanks and enjoy! JFK/KWR

Chapter 7 outline

7.1 Introduction

Wireless

7.2 Wireless links, characteristics
- CDMA

7.3 IEEE 802.11 wireless LANs ("Wi-Fi")

7.4 Cellular Internet access
- architecture
- standards (e.g., 3G, LTE)

Mobility

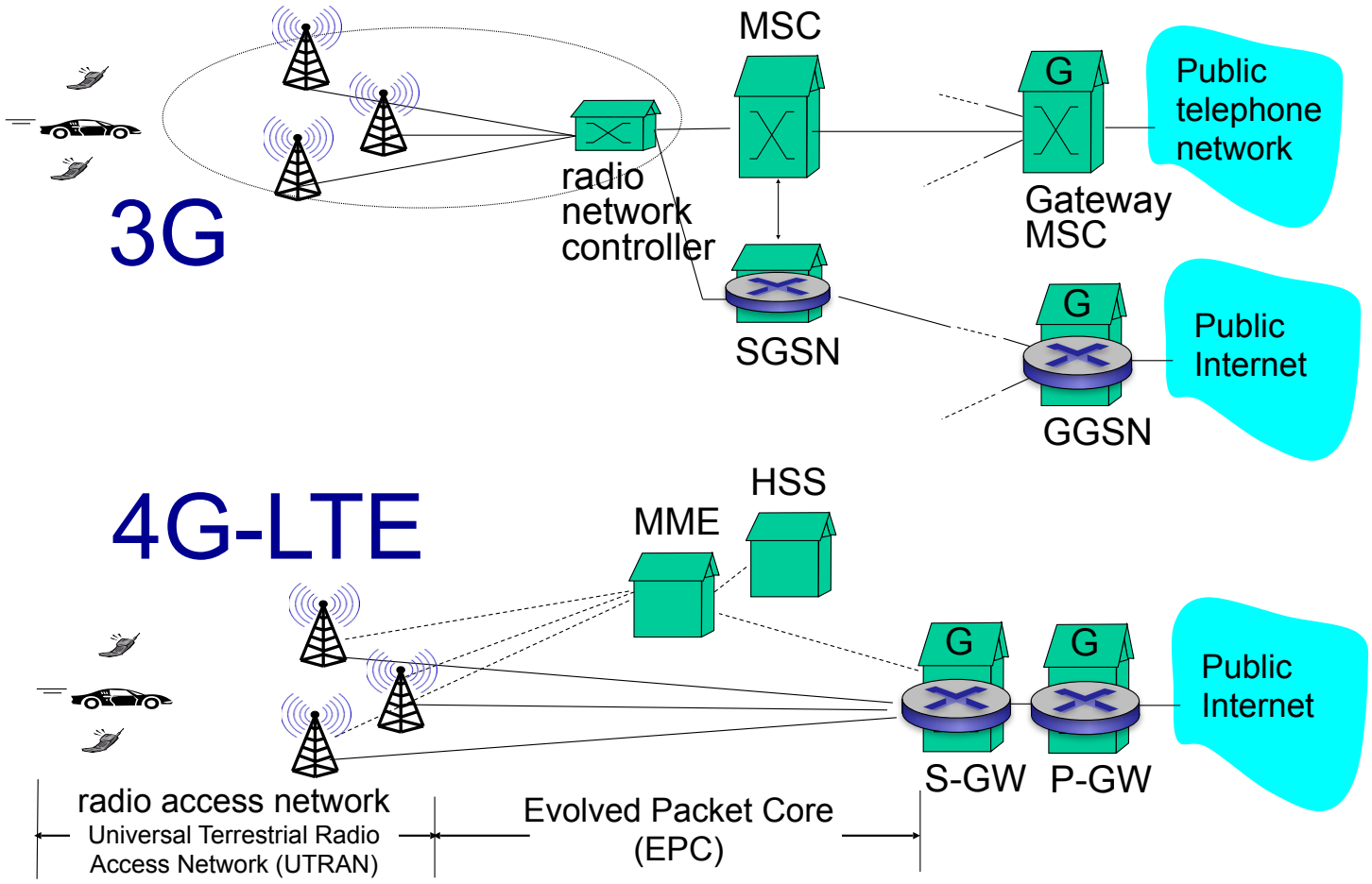
7.5 Principles: addressing and routing to mobile users

7.6 Mobile IP

7.7 Handling mobility in cellular networks

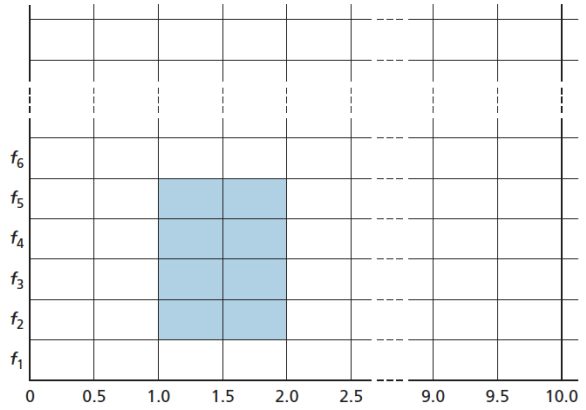
7.8 Mobility and higher-layer protocols

3G versus 4G LTE network architecture



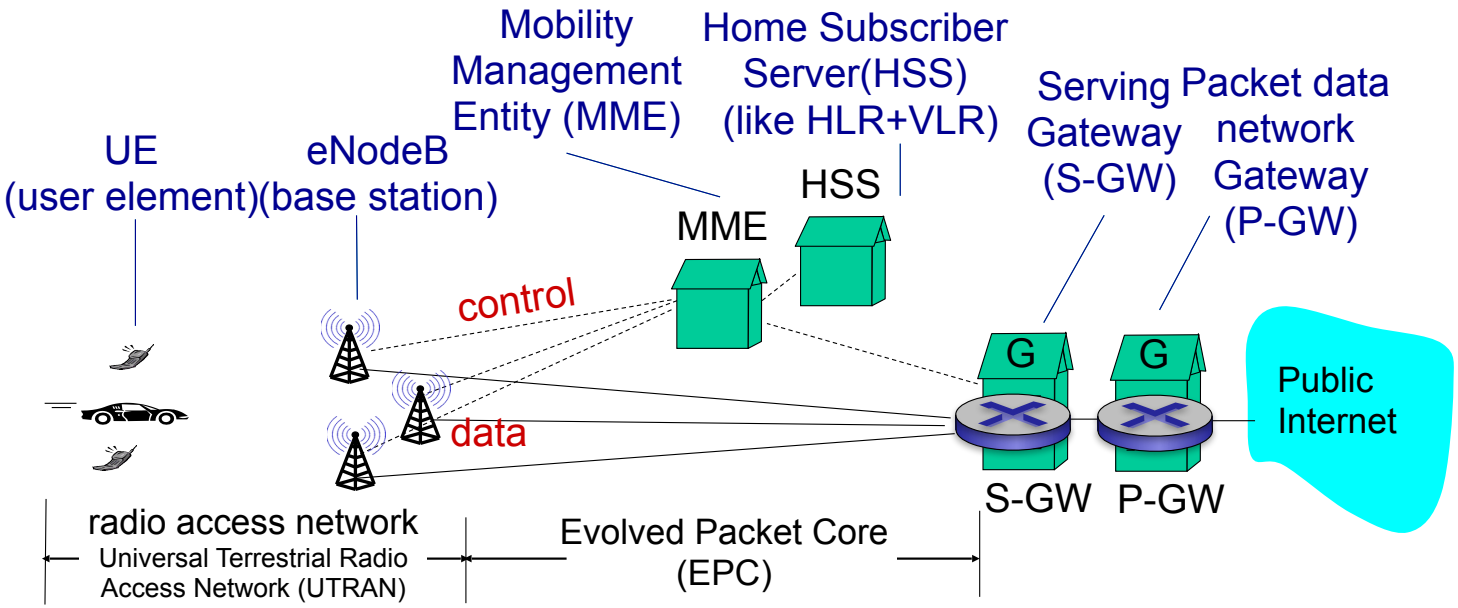
4G: LTE

- **All-IP core network**
- Need to provide QoS for VoIP:
  - **Evolved Packet Core:**
    - Manage network resources to provide high quality of service
    - Separation between the network control (Mobility) and user data planes
    - Allows multiple types of radio access networks (2G and 3G) to attach
  - **LTE Radio Access Network:**
    - OFDM
    - MIMO

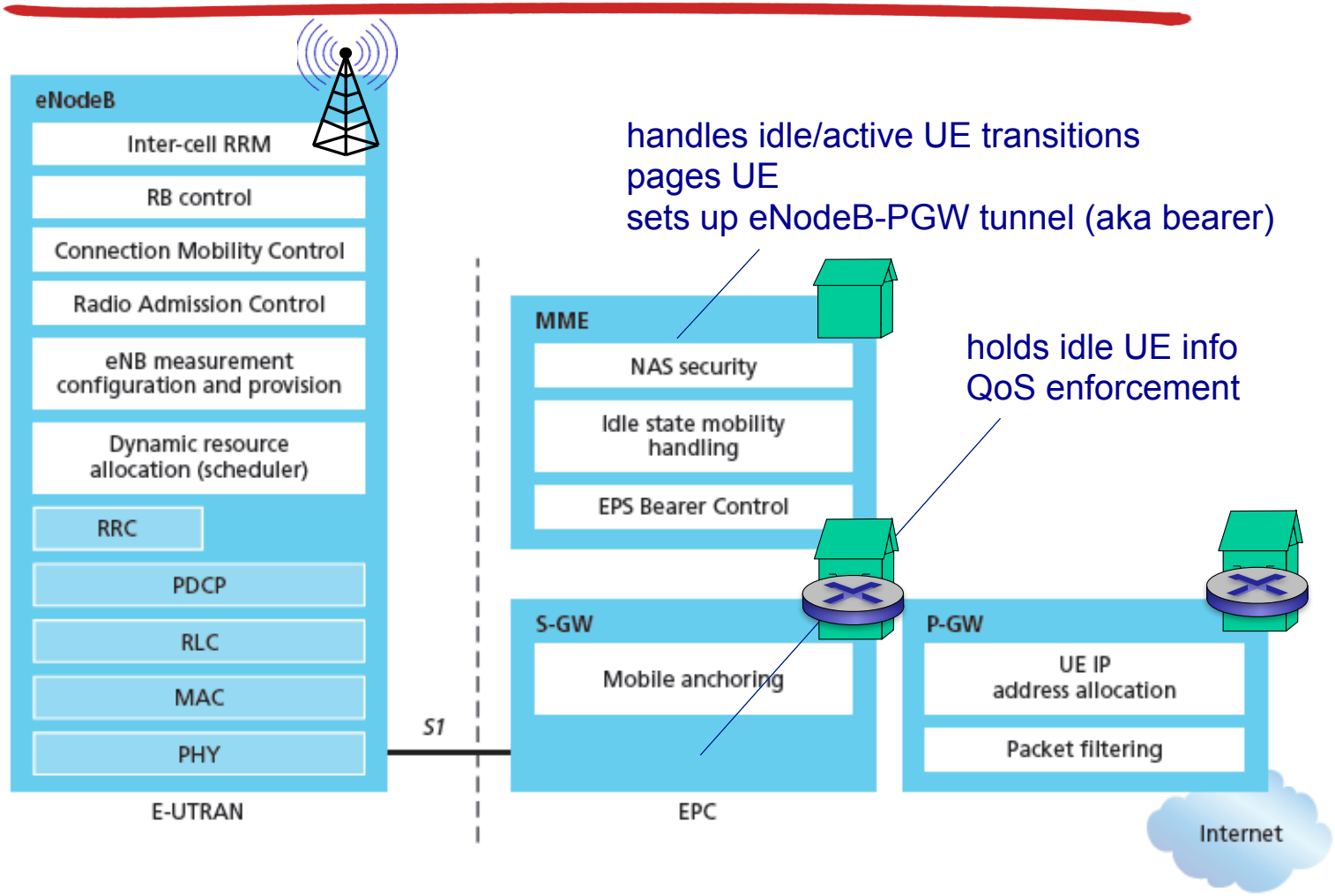


4G: differences from 3G

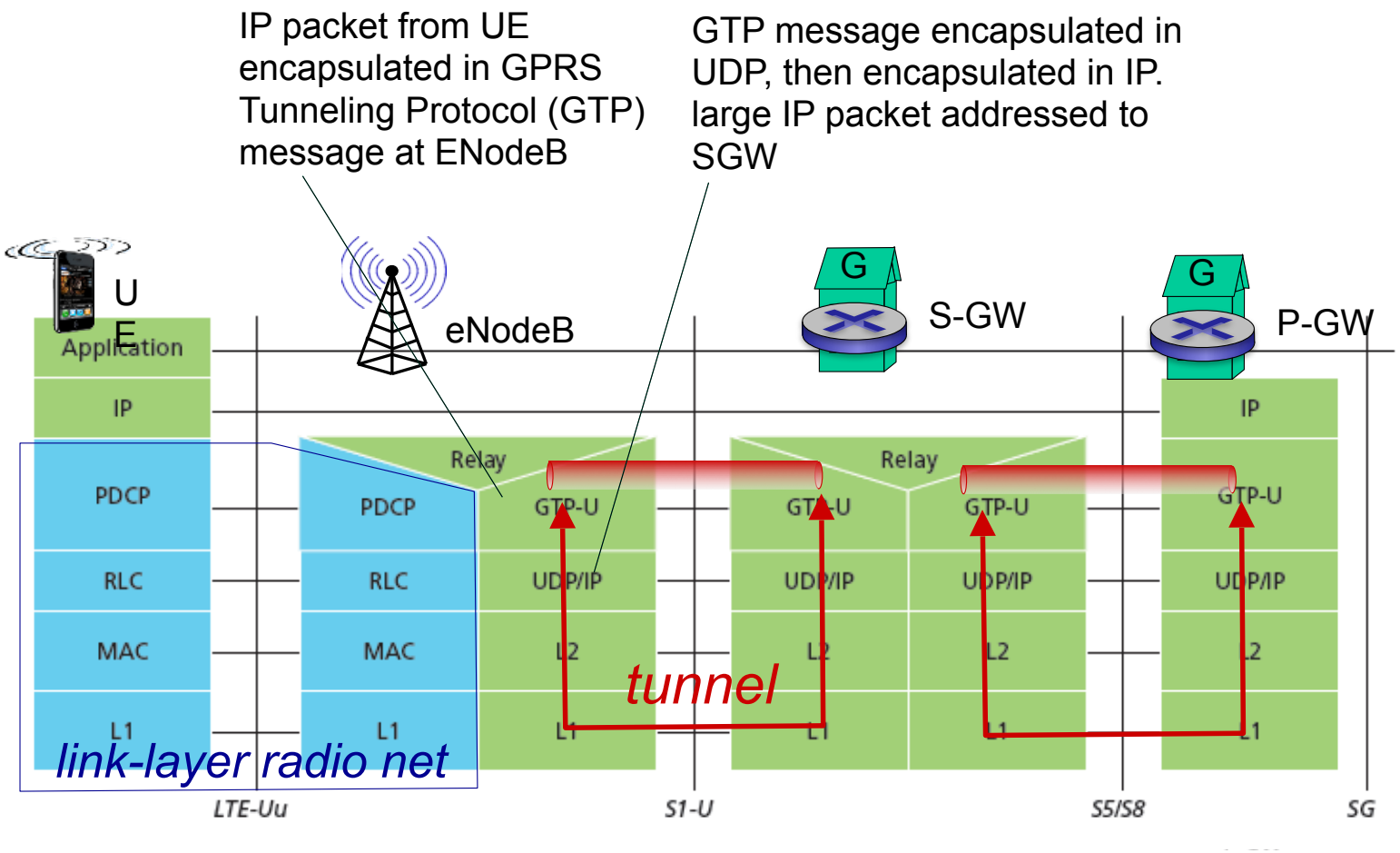
- all IP core: IP packets tunneled (through core IP network) from base station to gateway
- no separation between voice and data – all traffic carried over IP core to gateway



Functional split of major LTE components



Radio+Tunneling: UE – eNodeB – PGW



Quality of Service in LTE

- QoS from eNodeB to SGW: min and max guaranteed bit rate
- QoS in radio access network: one of 12 QCI values
- GBR: Guaranteed Bit Rate

QCI	RESOURCE TYPE	PRIORITY	PACKET DELAY BUDGET (MS)	PACKET ERROR LOSS RATE	EXAMPLE SERVICES
1	GBR	2	100	10^{-2}	Conversational voice
2	GBR	4	150	10^{-3}	Conversational video (live streaming)
3	GBR	5	300	10^{-6}	Non-conversational video (buffered streaming)
4	GBR	3	50	10^{-3}	Real-time gaming
5	Non-GBR	1	100	10^{-6}	IMS signaling
6	Non-GBR	7	100	10^{-3}	Voice, video (live streaming), interactive gaming
7	Non-GBR	6	300	10^{-6}	Video (buffered streaming)
8	Non-GBR	8	300	10^{-6}	TCP-based (for example, WWW, e-mail), chat, FTP, p2p file sharing, progressive video and others
9	Non-GBR	9	300	10^{-6}	

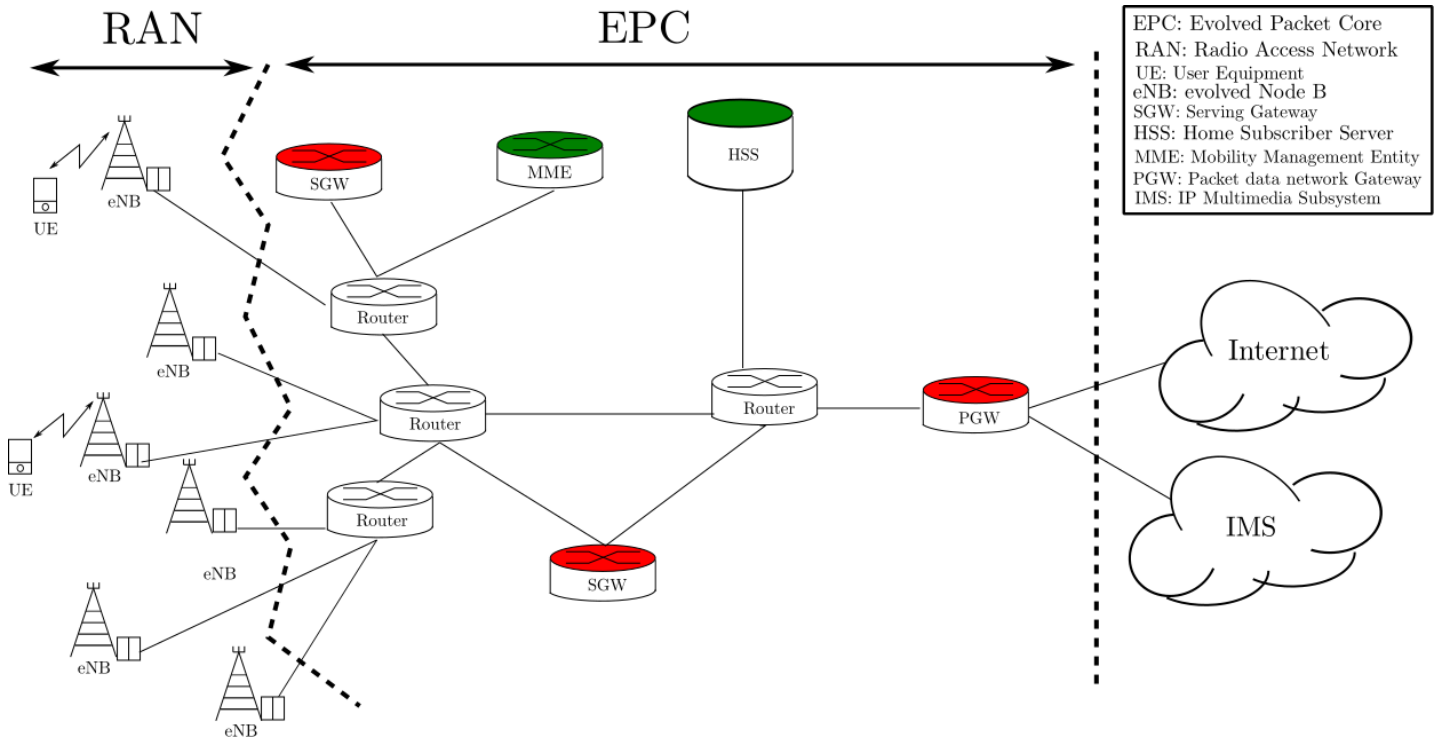
Long Term Evolution (LTE)

Please read the lecture notes available at lms.iut.ac.ir:
A Brief Introduction to Long Term Evolution (LTE) Architecture

Architecture

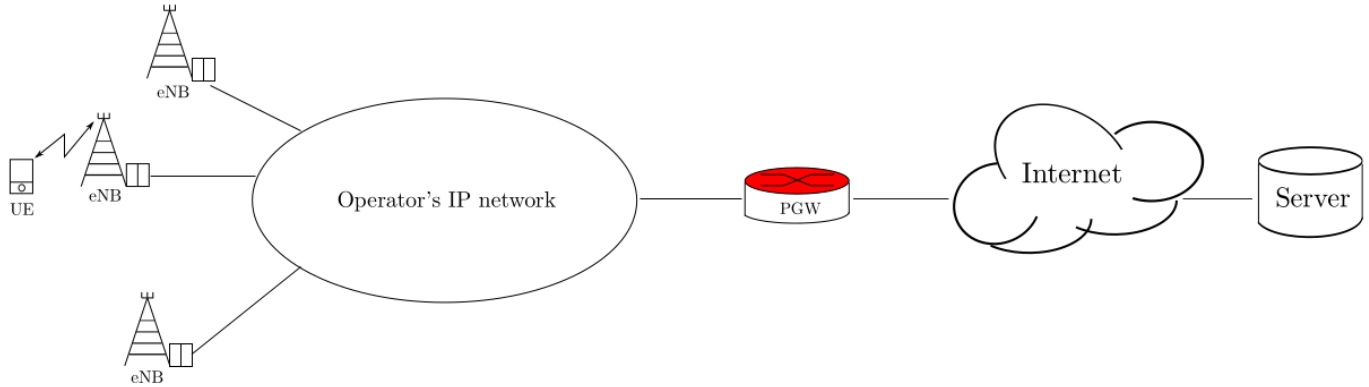
- All-IP: Only packet switching, based on IP
  - No circuit switched network even for voice!
- Reduced number of entities to lower latency
  - No “base station controller”

Architecture
Access and Core Networks



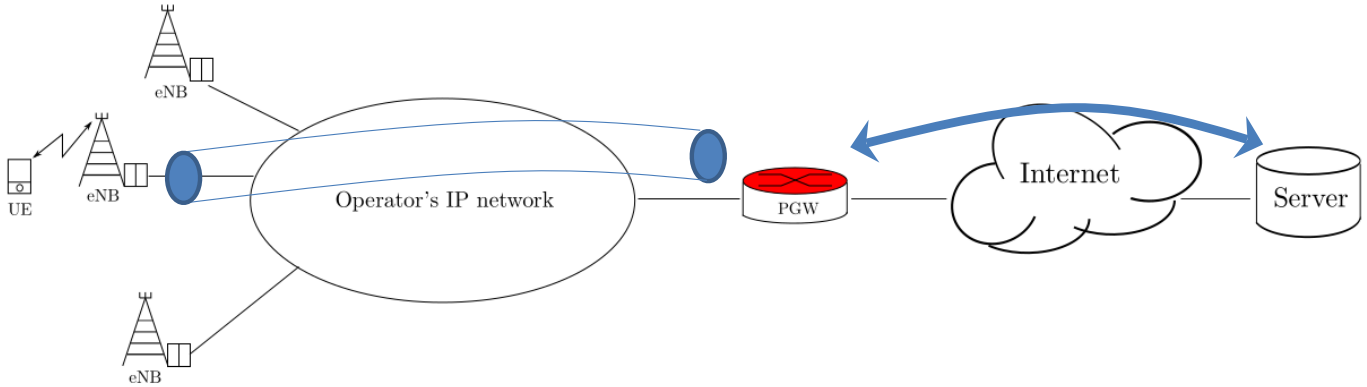
Where do the packets pass when UE wants to visit a server?

PGW



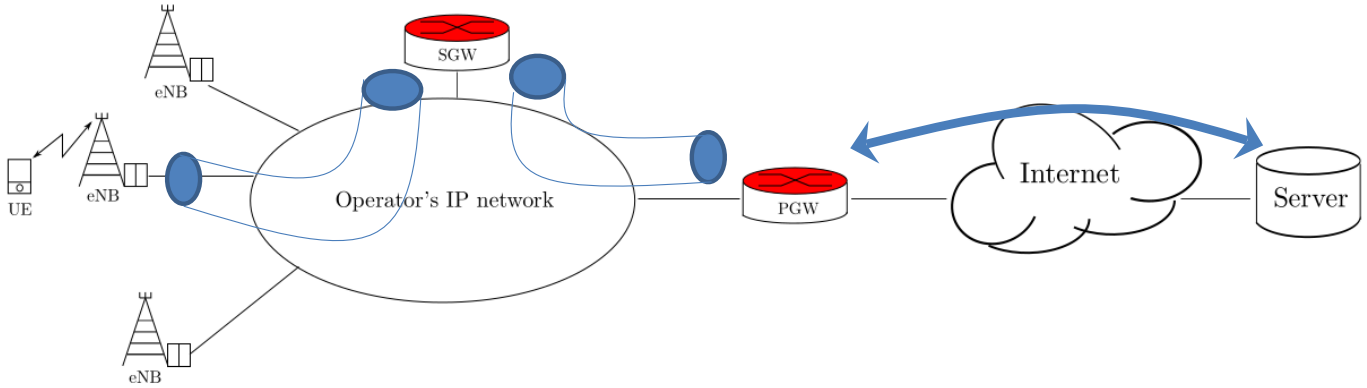
- The Internet cannot manage mobility
- The data packets must be routed to a "gateway": PGW, Packet data network Gateway

PGW



- PGWs establish **tunnels** to each UE connected to the EPC network.
- Incoming packets to the EPC, transmitted by a server in the outside world to a UE, are prioritized (tagged) and **encapsulated to an IP packet with the destination address which is different from the UE's IP address.**
- But, there are Millions of UEs!

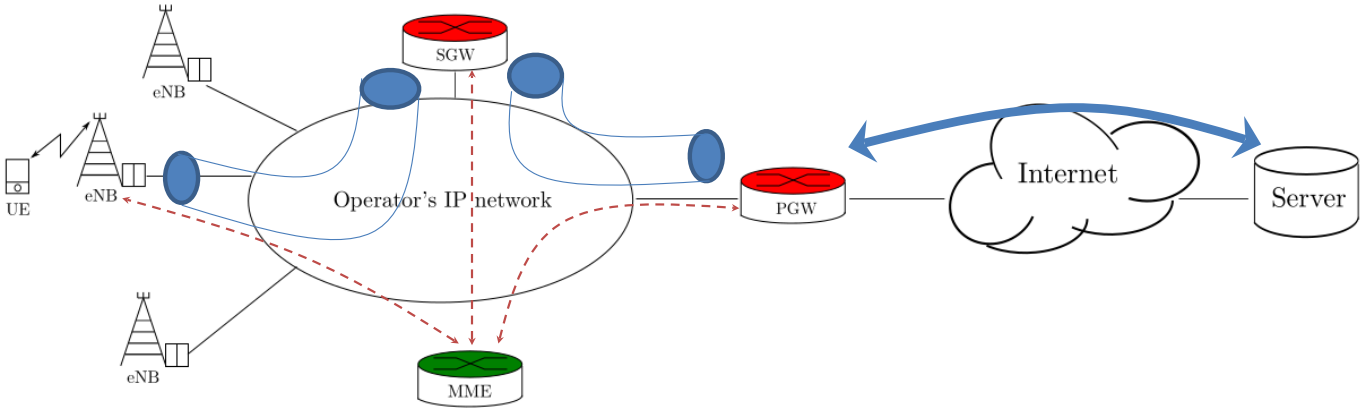
SGW: Regional Gateways



- Each Serving Gateway (SGW) handles packet-forwarding in a specific geographical area.
- The PGW sends packets to a SGW which UE resides in its geographical coverage.
- The SGW re-encapsulates packets to the eNB which has the radio connection with UE.

Who Controls the Tunnels?

MME

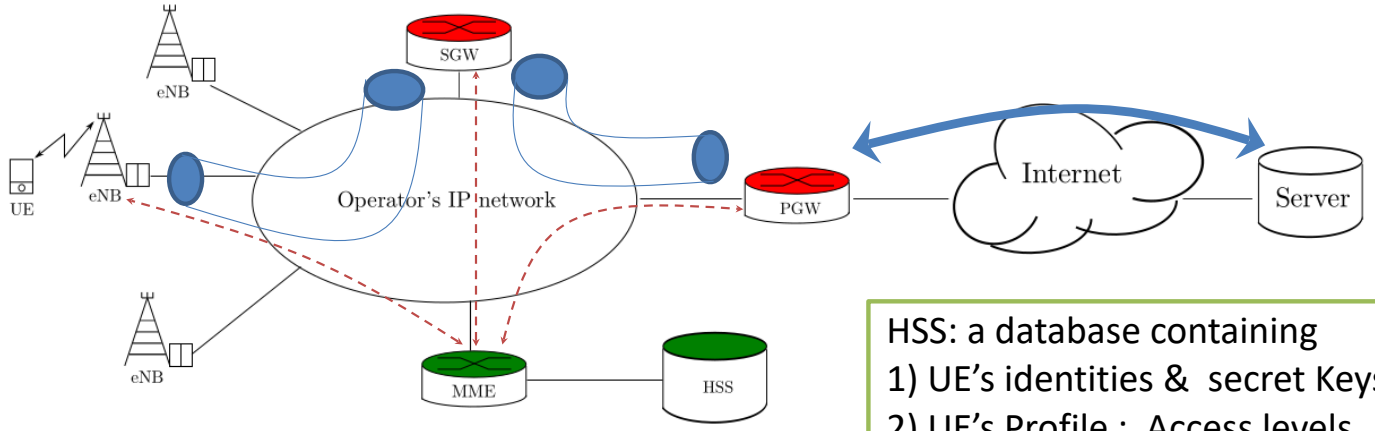


- Mobility Management Entity (MME) selects the SGW and PGW.
- MME exchanges controlling signals with eNBs, SGWs, and PGWs to establish the tunnels.

Access to network is not for FREE!

Even subscribers are under discrimination
on the basis of MONEY!

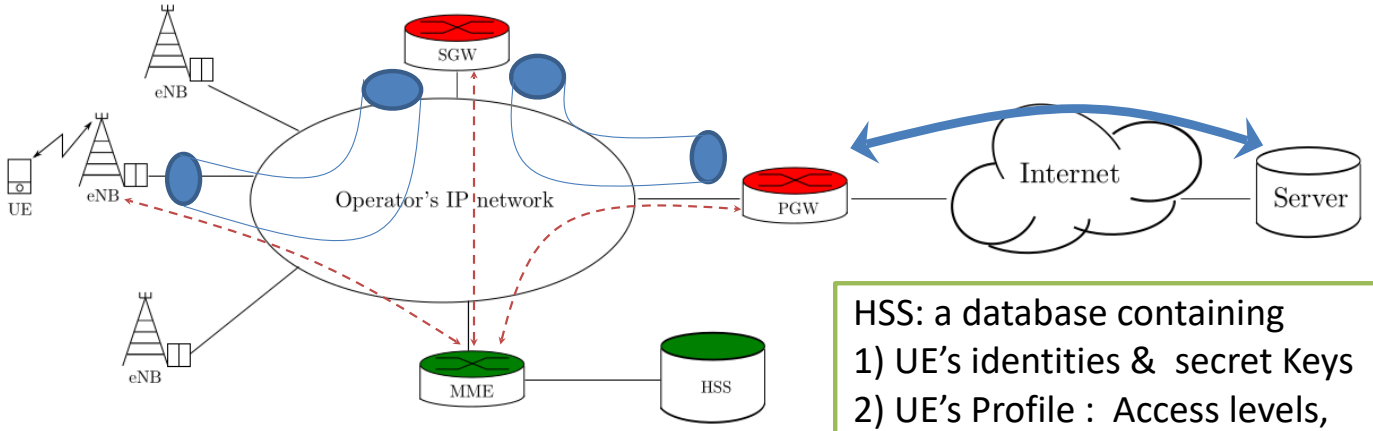
HSS



HSS: a database containing
1) UE's identities & secret Keys
2) UE's Profile : Access levels, QoS,
Imprecise location, …

- When UE tries to connect, it should pass through an authentication procedure with MME.
- The common secret key between UE and network is stored in the UE's UICC and EPC' Home Subscriber Server (HSS)

HSS



HSS: a database containing
1) UE's identities & secret Keys
2) UE's Profile : Access levels, statistical IP address, QoS, Imprecise location, …

- Authenticated UEs are treated (in terms of the level of QoS) based on their subscription profile stored in HSS*.

* The QoS based on the UE's profile in the HSS is preliminary. Final decision is made by the *Policy and Charging Rules Function* (PCRF) entity and enforced by the PGW.