



## **WEEK-1**

# **INTRODUCTION TO MOBILE COMPUTING**

(Appreciation of the GSM Backbone Infrastructure supporting Mobile App Development)

Dr Eric Opoku Osei

### **Outline:**

- 1. Overview of Mobile computing**
- 2. GSM networking Architecture for mobile App streaming**
- 3. GSM Evolution (1G, 2G, 3G, 4G, 5G)**
- 4. Connection between Internet architecture AND GSM architecture**

# Goals & Objective

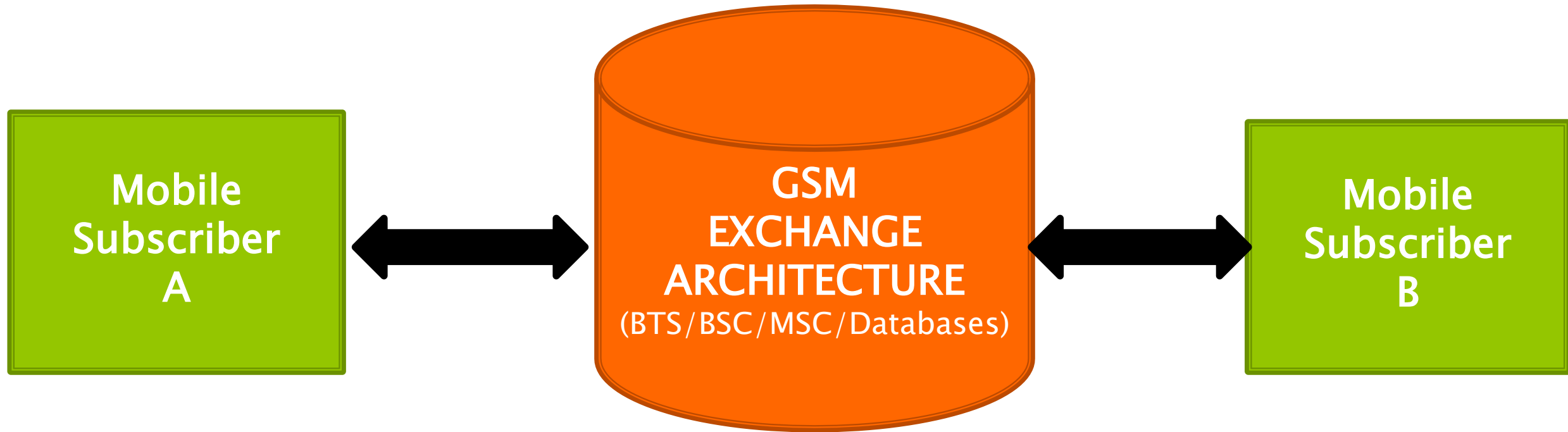
## Learning Goal:

At the end of this teaching session, the learner will be able to describe the principle of operations of the GSM architecture supporting data-driven Apps.

## Teaching Objectives:

1. Identify sub-systems of the GSM network Architecture
2. Explain functions of each sub-system in mobile computing
3. Describe principle of operations of the Architecture
4. Understand the interconnection of the GSM and Internet architectures

# GSM Black Box Network Architecture



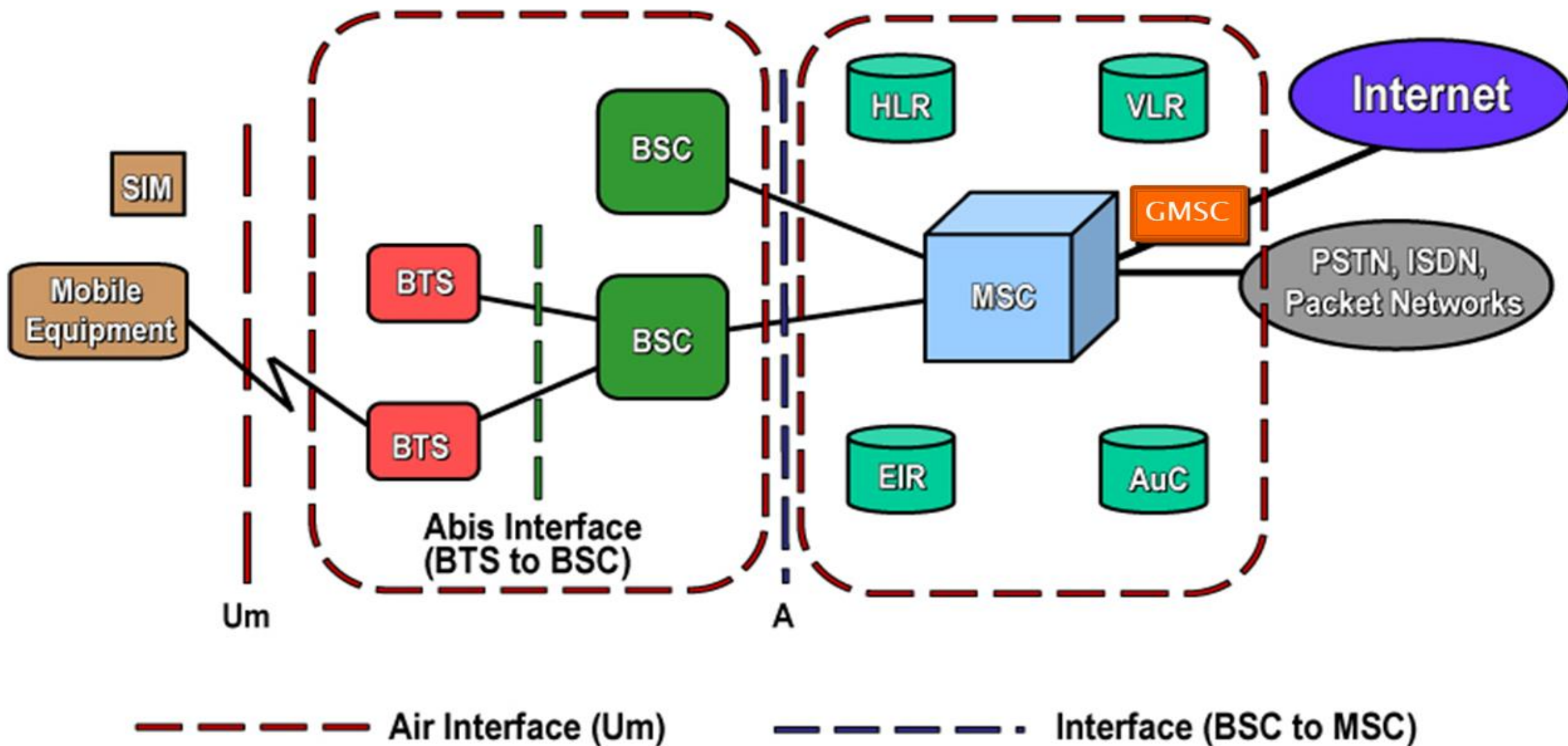
# Principle of Operations

## Call interconnection mapping:

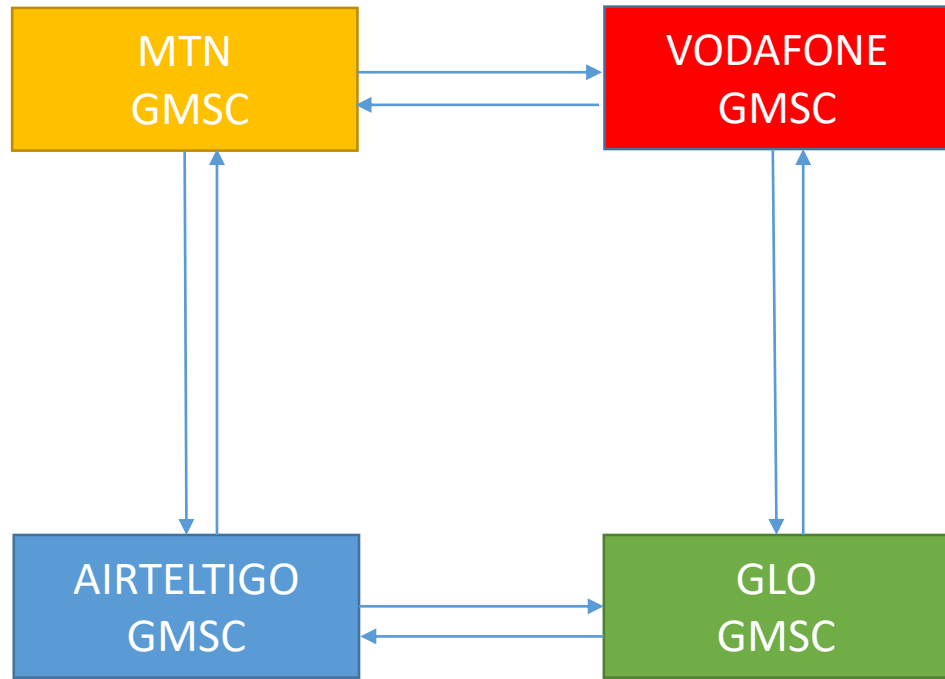
1. MTN-MTN (on-net)
2. MTN-TIGO (off-net)
3. MTN-PSTN/LandLine (off-net)
4. MTN-International (off-net)
5. MTN-Roaming (off-net)
6. Porting of numbers
7. VOIP Call (internet-based)
8. SIMBox Call (Fraud/backdoor)



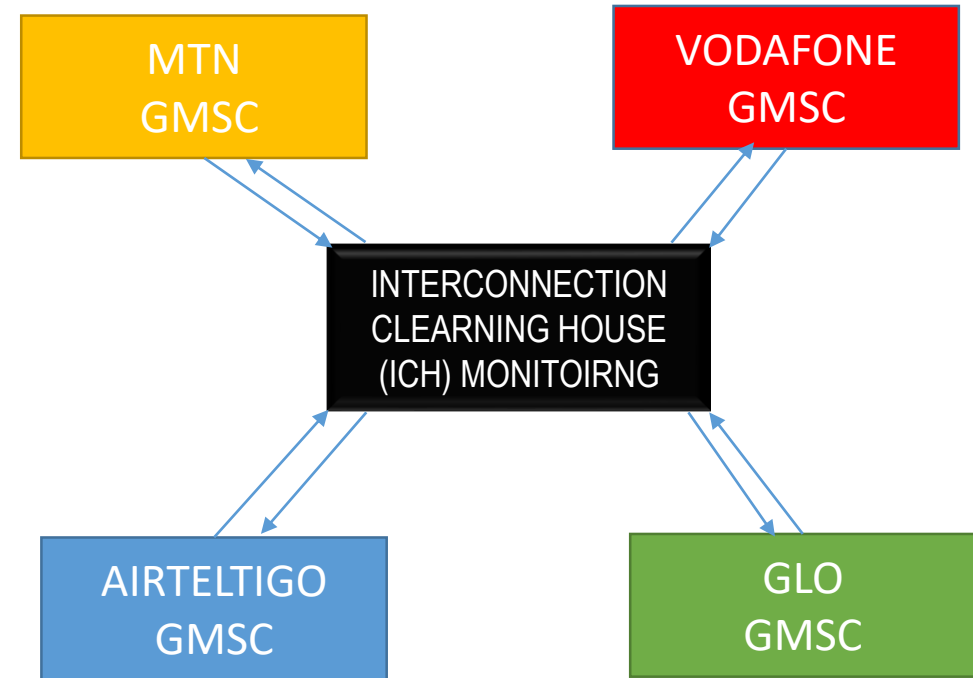
# Block Diagram of the GSM Architecture



# GSM Service Providers Inter-connection



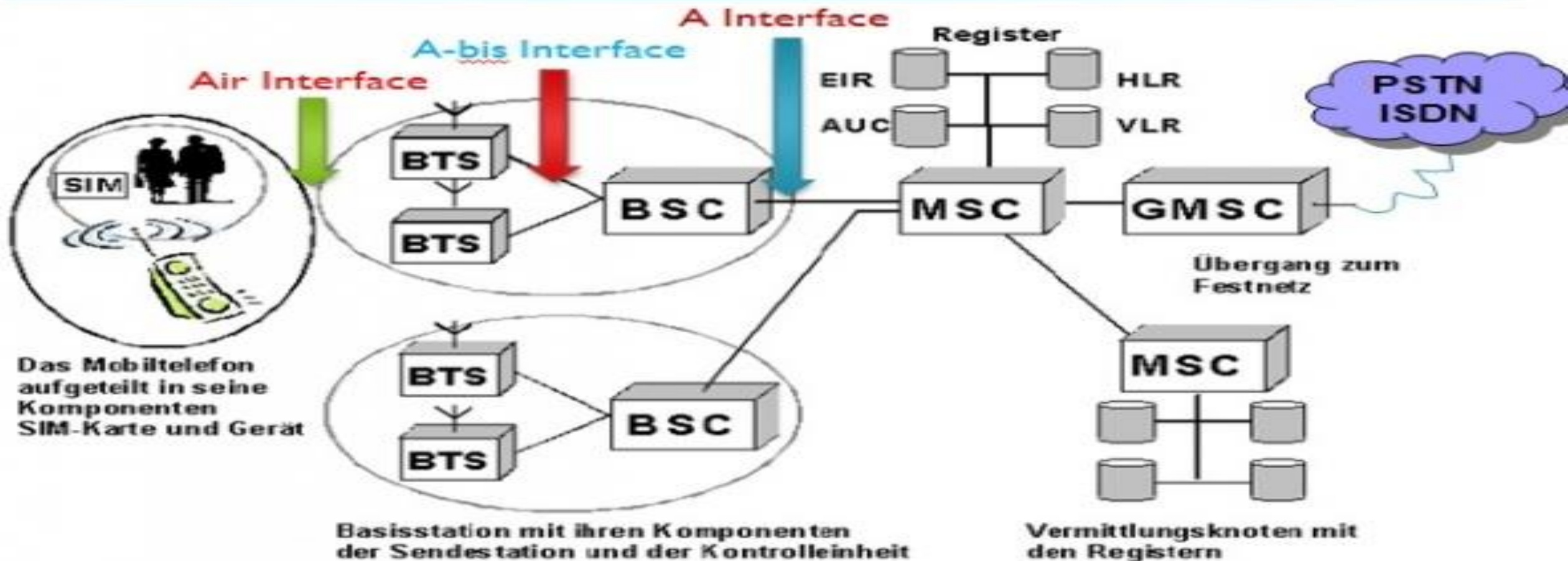
Previous:  
Direct Interconnection  
between the Telco's



Present:  
Indirect Interconnection of  
the Telco's


# Further Explanation

## GSM Architecture





# BTS OUTDOOR SITE

A man in a dark t-shirt and blue jeans stands on two concrete steps, looking through a tall metal fence at an outdoor BTS site. The fence is made of vertical metal bars. Behind the fence, there are white BTS cabinets, red structural beams, and coiled cables. In the background, there are buildings and a fence topped with barbed wire under a cloudy sky.

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Sector Antenna

Transmission Unit

To BSC

BTS

Mobile equipment  
(ME)

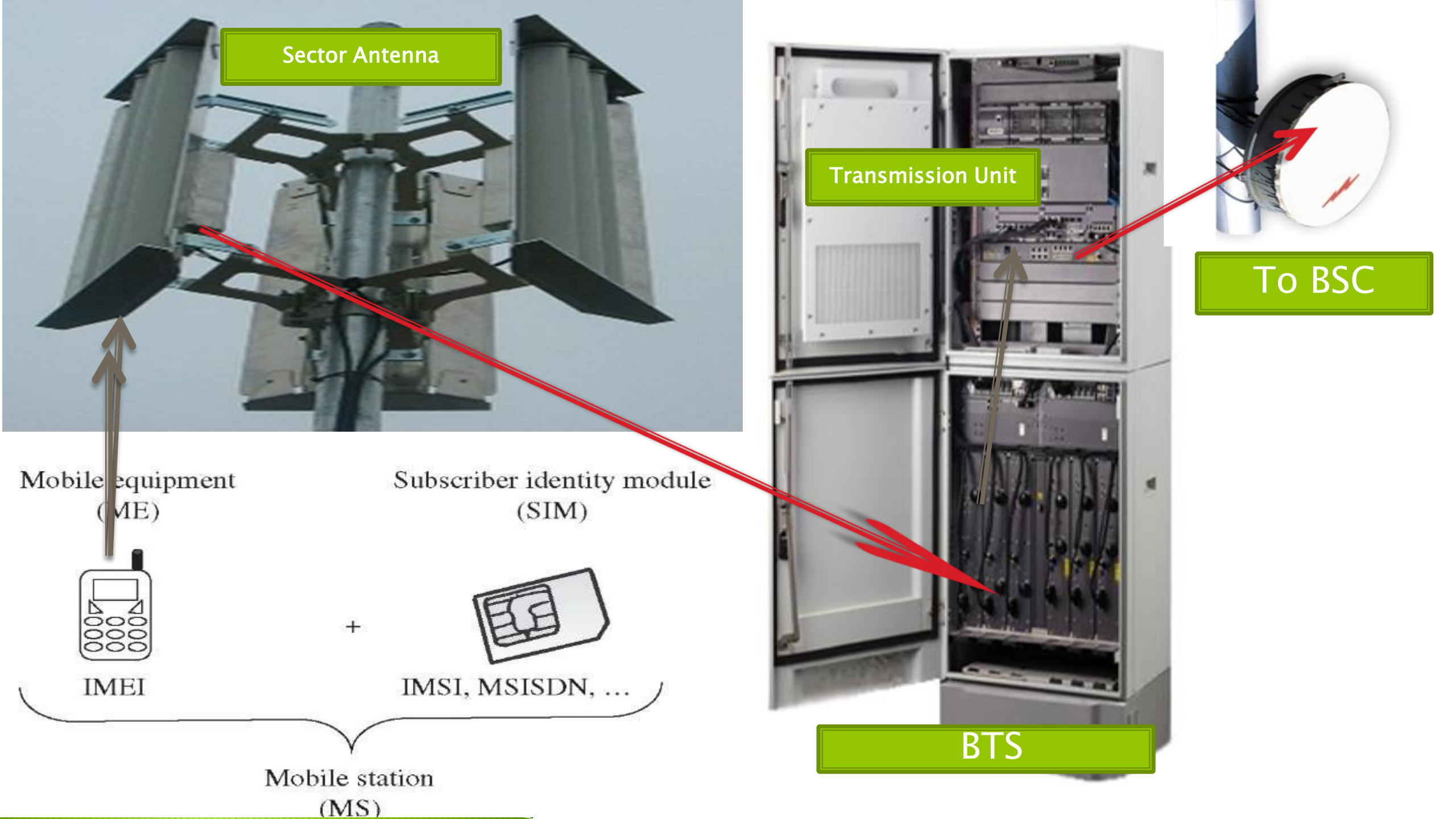
Subscriber identity module  
(SIM)



IMEI

IMSI, MSISDN, ...

Mobile station  
(MS)



# Base Station Controller (BSC)





# MSC–Mobile Switching Center



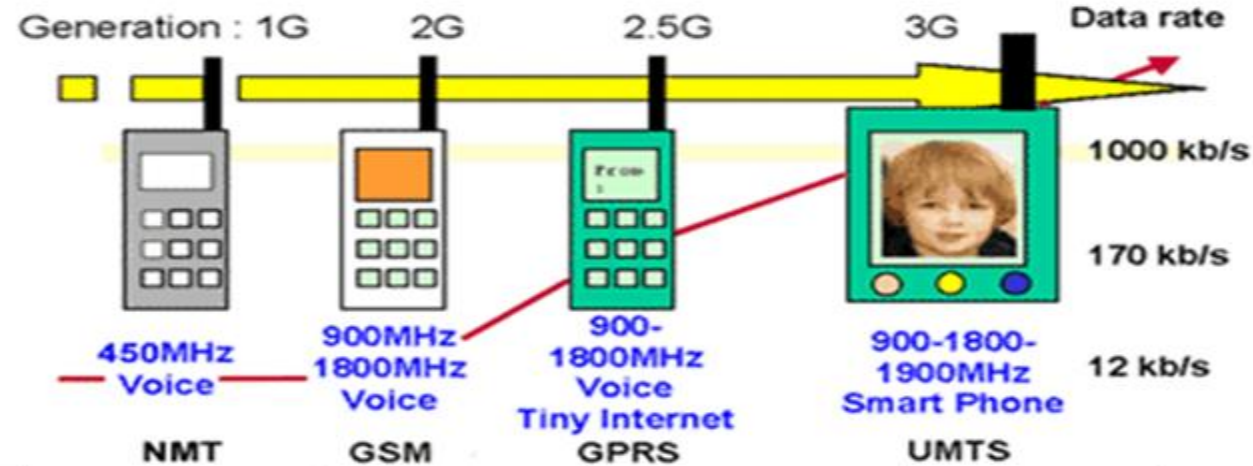
# GSM Key Terminologies for Reflections

1. Home Location Register (HLR)
2. Visitor Location Register (VLR)
3. Equipment Identity Register (EIR)
4. Authentication Center (AuC)
5. SMS Serving Center (SMS SC)
6. Mobile Switching (*Exchange*) Center (MSC)
7. Gateway MSC (GMSC)
8. Subscriber Identification Module (SIM)
9. BTS, BSC, MSC, Air Interface A-bis, A
10. Interconnection Clearing House (ICH) policy implementation in Ghana
11. PSTN: Public Switched Telephone Network (e.g. Landline, Fiber optic cable networks )

**Question: Explain the functions/operations of the following during data streaming)**



# GSM GENERATIONS: Key Factor to consider in Mobile-App Development ( What network is available for target users?)



Generation	1G	2G	2.5G	3G	3.5G	4G	5G
Start	1970-1980	1990-2000	2001-2004	2004-2005	2006-2010	2011-Now	Soon (2020)
Data Bandwidth	2 Kbps	64 Kbps	144 Kbps	2 Mbps	More than 2 Mbps	1 Gbps	more than 1 Gbps
Technology	Analog Cellular	Digital Cellular	GPRS, EDGE, CDMA	CDMA 2000 (1xRT, EVDO) UMTS, EDGE	EDGE, Wi-Fi	WiMax LTE Wi-Fi	www
Service	Voice	Digital Voice, SMS, Higher Capacity Packet Size Data	SMS, MMS	Integrated High Quality Audio, Video & Data	Integrated High Quality Audio, Video & Data	Dynamic Information access, Wearable Devices	Dynamic Information access, Wearable Devices with AI Capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	Packet	All Packet	All Packet	All Packet
Core Network	PSTN	PSTN	PSTN	Packet N/W	Internet	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal & Vertical	Horizontal & Vertical



# GSM Data Speed: Key Factor to consider in Mobile-App Development

(What type file formats and number of User interface pages are adequate to run effective Mobile-App in a low bandwidth internet area?)

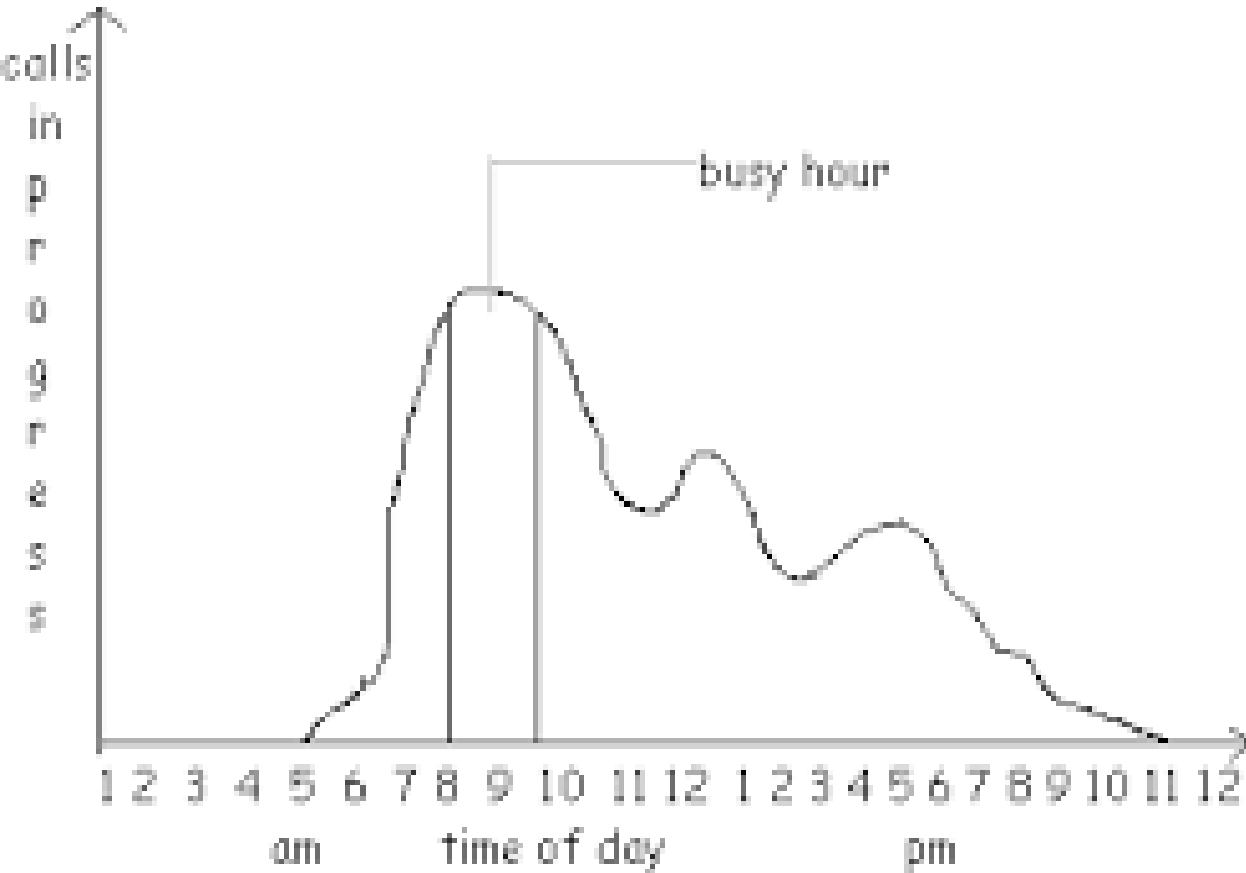
Network Service 5G available now	4G✓	3.75G✓	3.5G✓	3G✗	2.5G✗	2G✗
Symbol of Phone	LTE [4G]	H+ [HSDPA]	H [HSDPA]	3G [3G]	E [Edge]	G [GPRS]
Data Download Speed	150Mbps	21Mbps	7.2Mbps	2Mbps	0.4Mbps	0.1Mbps

1. **GPRS:** General Packet Radio Service is a packet oriented mobile data standard on the 2G
2. **EDGE:** Enhanced Data rates for GSM Evolution is a digital mobile phone technology that allows improved data transmission rates as a backward-compatible extension of GSM. EDGE is considered a pre-3G radio technology and is part of ITU's 3G definition.
3. **3G/UMTS:** Universal Mobile Telecommunications System is a 3<sup>rd</sup> generation mobile cellular system for networks based on the GSM standard.
4. **4G/LTE:** Long-Term Evolution is a standard for wireless broadband communication for mobile devices and data terminals, based on the GSM/EDGE and UMTS/HSPA technologies.
5. **HSDPA (H & H+):** High-Speed Downlink Packet Access, is a new protocol for mobile telephone data transmission. It is known as a 3.5G (HSDPA + is an upgraded version of HSDPA)

# GSM Data Traffic: Key Factor to consider in Mobile-App Development

(Erlang Theory or the Busy Hour Calling Model)

The tele-traffic intensity or simply the traffic is defined as the average no. of calls in progress. The unit of traffic is erlang (named after the Danish pioneer in teletraffic A.K.Erlang).



- ▶ The maximum number of calls occurs between 8:00 and 10:00 am for this particular exchange. This hour which corresponds to the peak traffic of the exchange is called the busy hour.

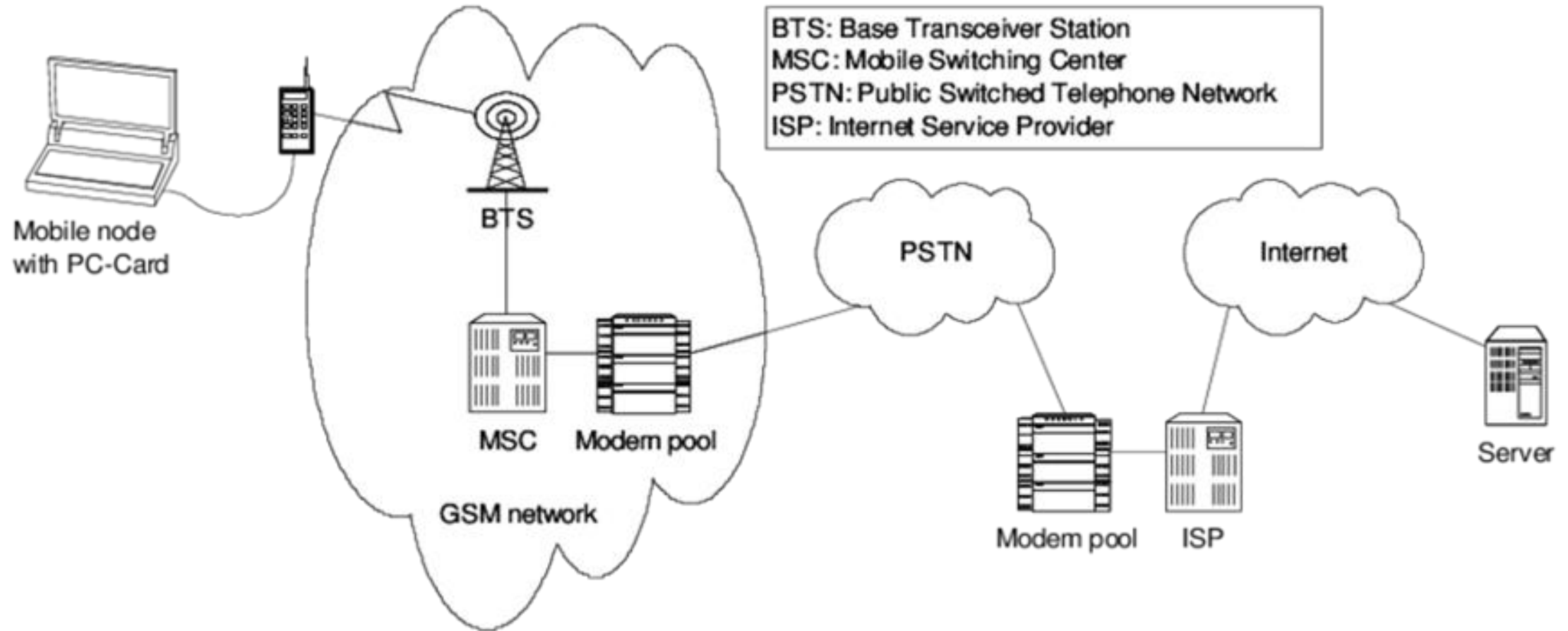
Telecommunications traffic Exchanges in which offices and business establishments predominate usually have a busy hour between 10:00 and 11:00 am.

Residential exchanges have a busy hour normally between 4:00 and 5:00 pm.  
The limit of traffic:

# Internet Architecture

(How Mobile Apps Fetch and stream data from internet servers)

NB: The GSM and Internet are two different Architectures integrated for users



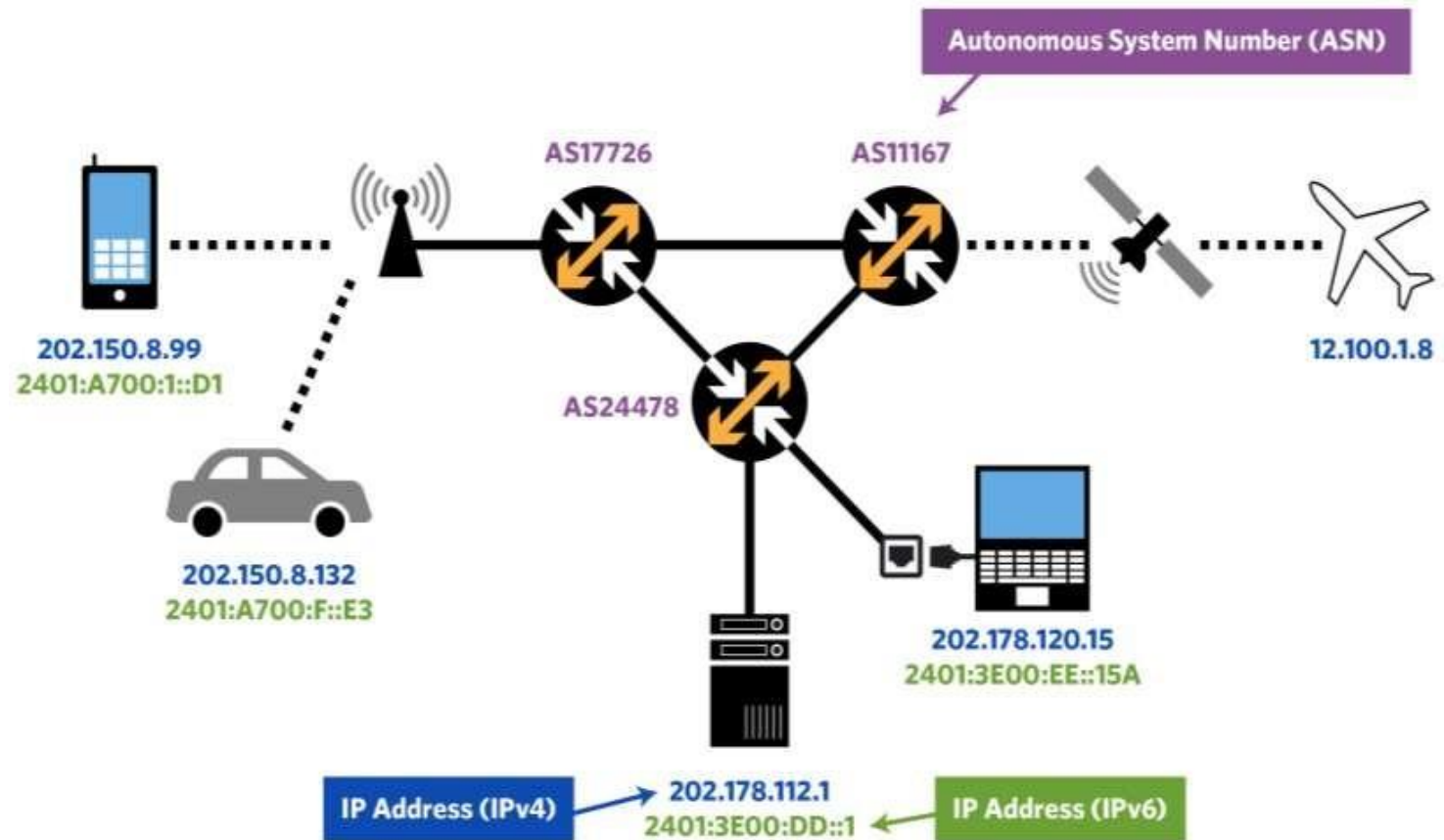
An **AUTONOMOUS SYSTEM** is a collection of connected Internet Protocol routing prefixes under the control of one or more network operators on behalf of a single administrative entity or domain that presents a common, clearly defined routing policy to the Internet.

1. The AS handles all IP routing to direct users request to the servers to fetch data.
2. The function is closely related to the MSC in GSM architecture that handles all routing to servers.



All Internet Service Providers (ISP) systems connect to the ASN for routing management.

*E.g. The ASN manages all IPV4 and IPV6 and direct a user request from Japan to fetch data from KNUST server about admission requirement.*



**THANK YOU**