INTRODUCTION TO 2ND GENERATION CELLULAR COMMUNICATION SYSTEMS

ECE 525E – WIRELESS & MOBILE COMMUNICATION

Monday, 24 February 2025

GLOBAL SYSTEM FOR MOBILE COMMUNICATION

1. **GSM is a digital cellular system developed by as a committee of the European Telecommunications Standard Institute (ETSI) in the 1980s**
2. **The committee was called Groupe Special Mobile (GSM).**
3. **The goal of the GSM development process was to offer compatibility of cellular services among European countries.**
4. **Later, the standard was adopted by the International Telecommunication Union and is now the most commonly used standard in the world.**
5. **GSM combines both Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) Technologies.**

GLOBAL SYSTEM FOR MOBILE COMMUNICATION

1. The frequency carrier is divided into eight time slots where the speech coding rate is 13 Kbps.

2. A GSM base station, every pair of radio transceiver-receiver supports eight voice channels, whereas the 1st generation systems, e.g. AMPS supported one channel in every pair.

3. The GSM Mobile equipment control their RF output power to counter interference at low levels, i.e the phone increases the RF transmitter power when it is far from the base station.

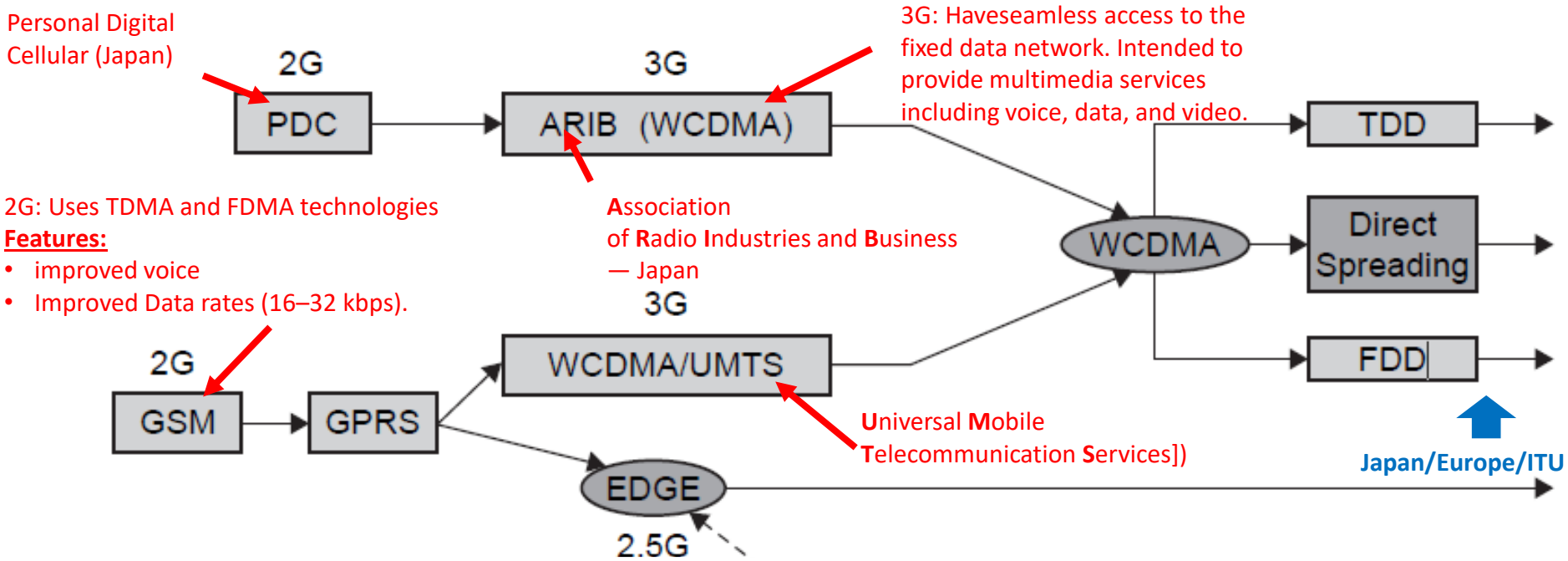
4. The GSM air interface later evolved into Enhanced Data Rate for GSM Evolution (EDGE) with variable data rate and link adaptation.

5. As a result, EDGE is generally referred to as generation 2.5.

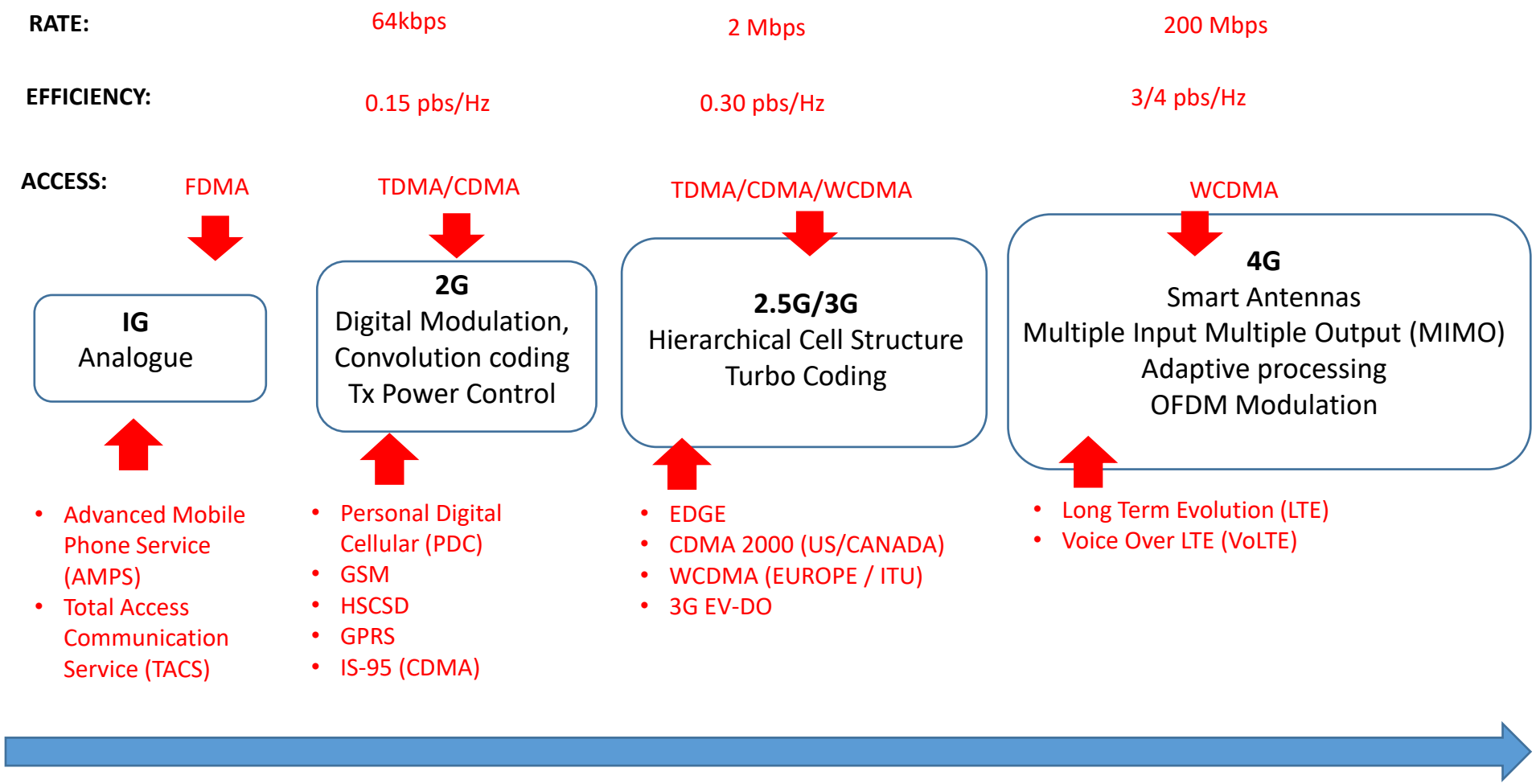
GENERATIONS OF MOBILE COMMUNICATION SYSTEMS

- 1st Generation: Analogue systems, e.g. AMPS
- 2nd Generation: Global System for Mobile Communication (GSM) designed for voice and low rate data services.
- 2.5 Generation: Designed to provide enhanced data rates when compared with 2nd generation systems.
- 3rd Generation: Higher system capacity with high speed data/internet access (> 2Mbps)

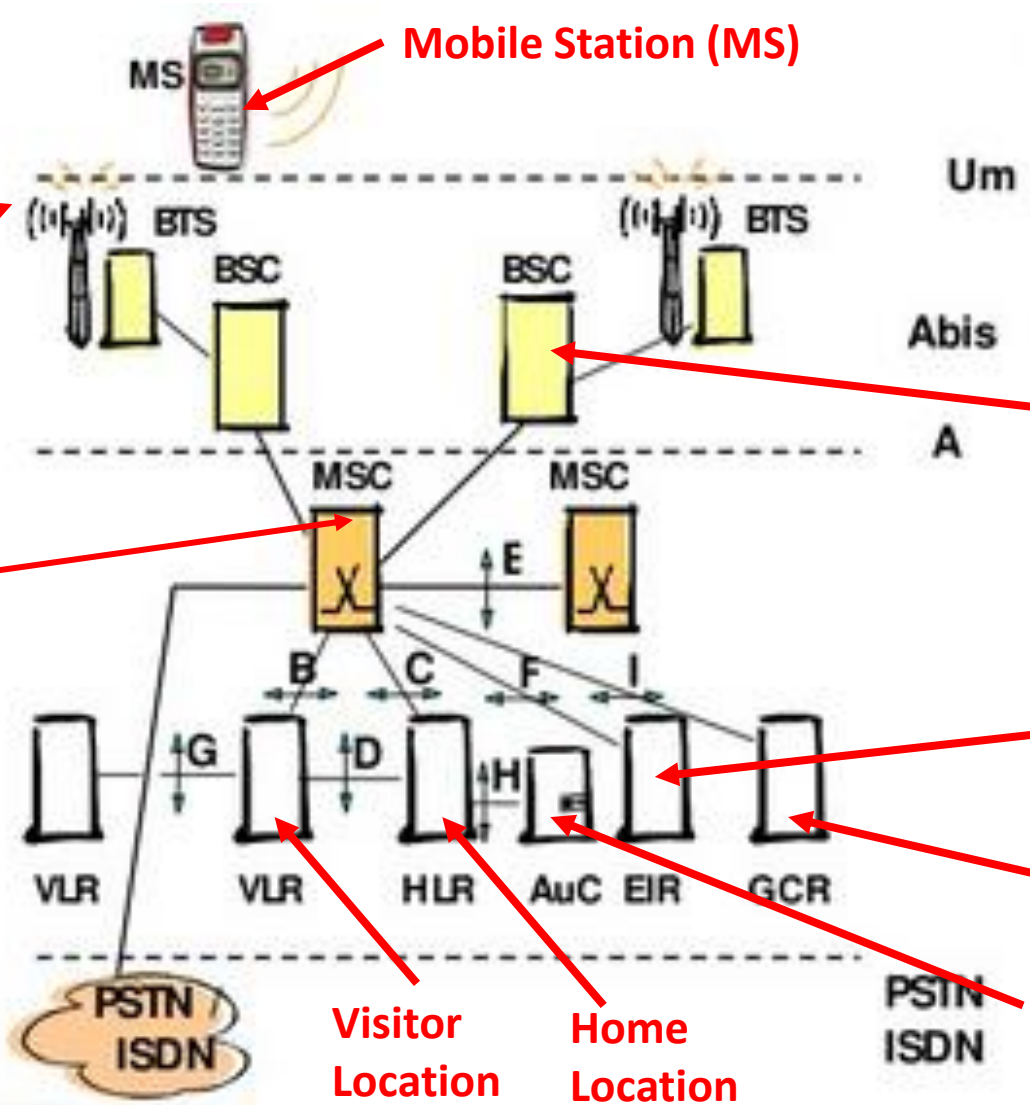
EVOLUTION OF WIRELESS PUBLIC TELEPHONE NETWORKS



EVOLUTION OF CELLULAR SYSTEMS



GSM NETWORK ARCHITECTURE



Mobile Station (MS)

Base Transceiver Station (BTS)

Base Station Controller (BSC)

Mobile Switching Centre (MSC)

Equipment Identity Register (EIR)

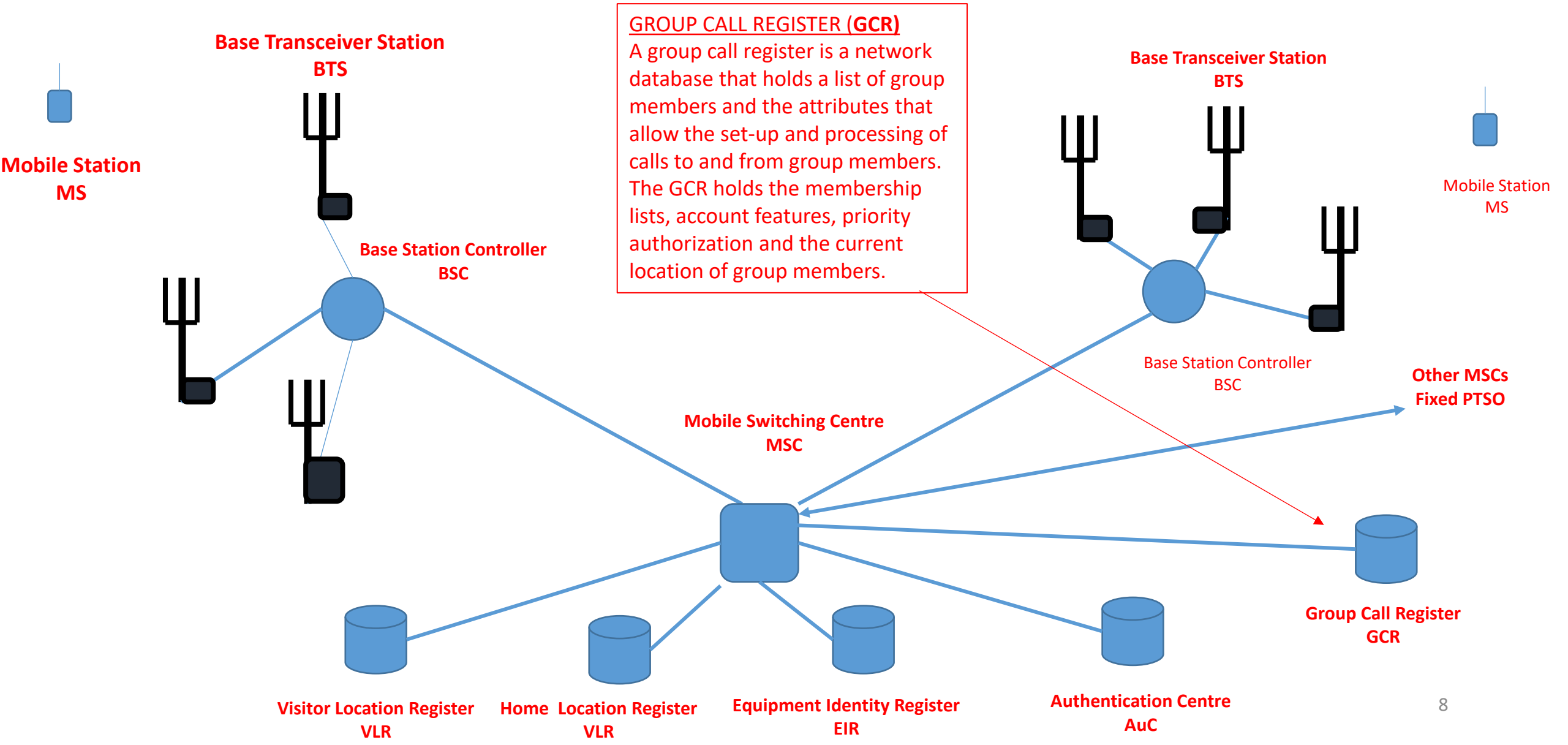
Visitor Location Register

Home Location Register

Authentication Centre (AuC)

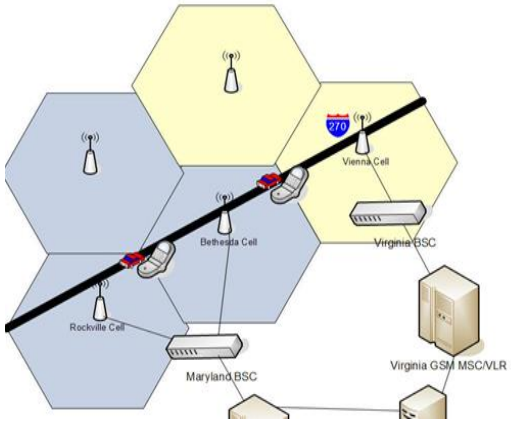
Group Call Register

GSM ARCHITECTURE (2)



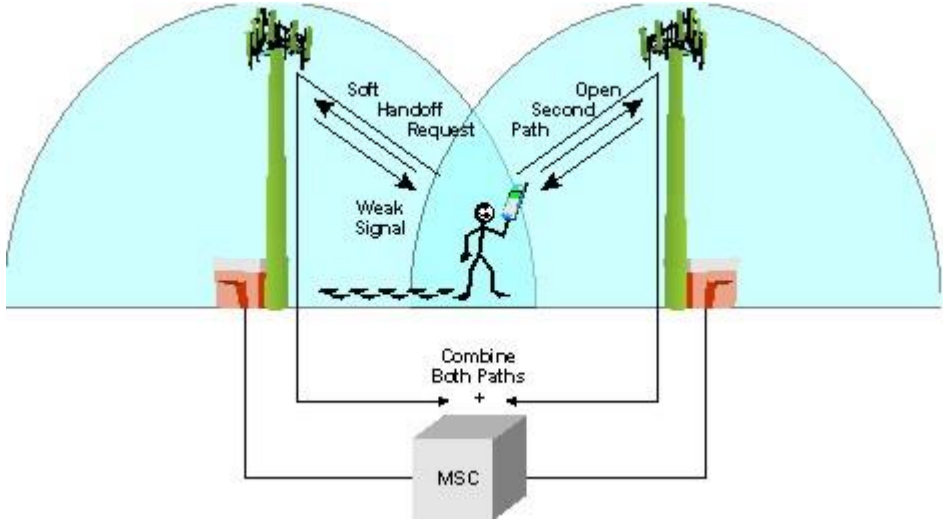
MOBILE STATION HAND-OFF STRATEGIES

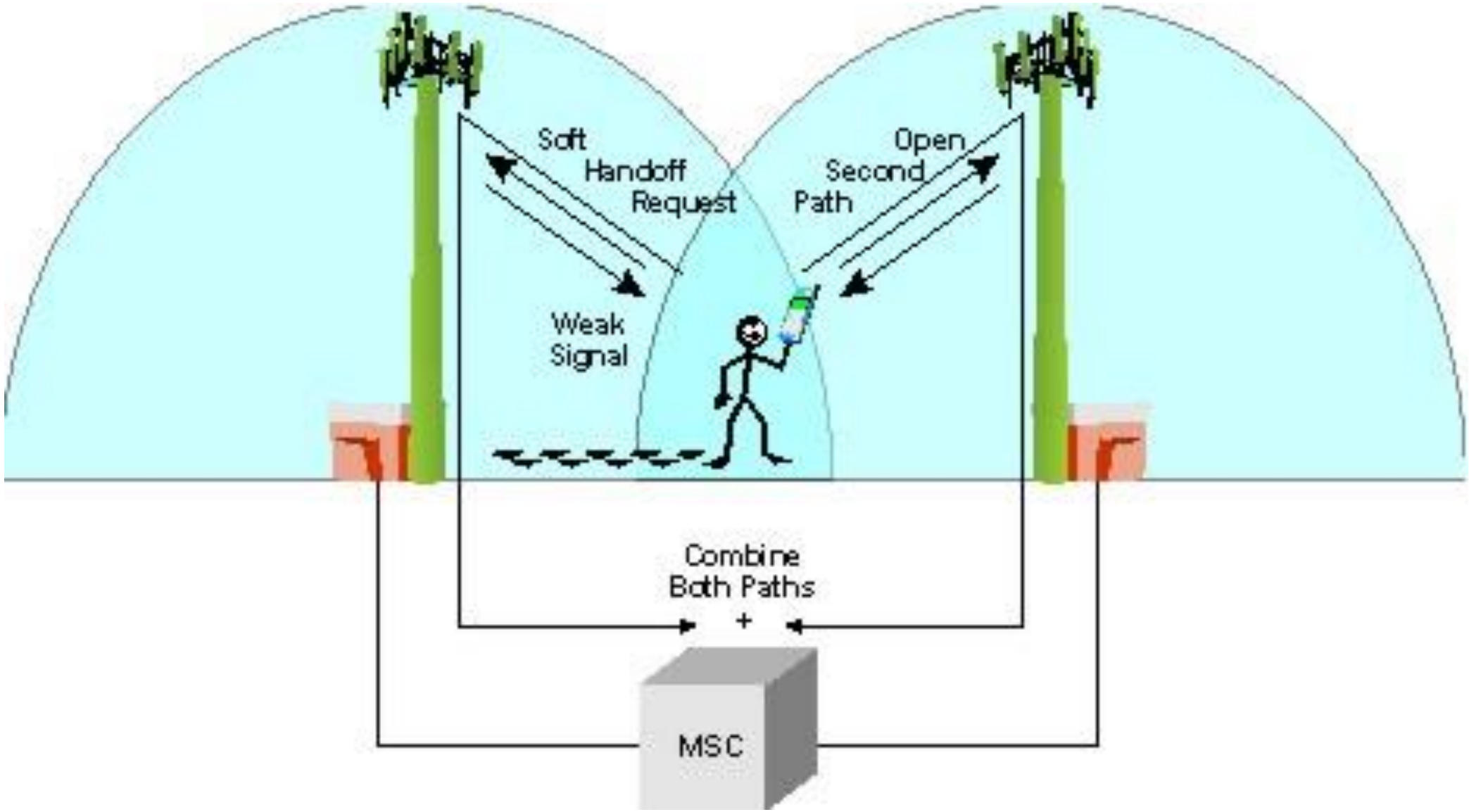
1. **Mobile-controlled handoff:** the MS continuously monitors the signals of the surrounding BSs and initiates the handoff process when some handoff criteria are met. Used in DECT and PACS.
2. **Network-controlled handoff:** the surrounding BSs measure the signal from the MS, and the network initiates the handoff process when some handoff criteria are met. Used in AMPS.
3. **Mobile-assisted handoff:** the Network (MSC) asks the MS to measure the signal from the surrounding BSs. The Network(MSC) makes the handoff decision based on reports from the MS. Used in GSM and CDMA.



PROBLEMS WITH HAND-OFFS

1. Hand-offs are expensive to execute and should therefore be minimized.
2. If the handoff criteria is very strict, then at the boundaries between cells, the calls may be handed over several times.
3. On the other hand, if the criteria is very conservative, then the call may be lost before handover.
4. Variations in the propagation environment due to such problems as multipath propagation my temporarily make a signal of a far away BS appear stronger.
5. The problem becomes even more acute as more and more small sizes are introduced especially in urban areas.




Soft
Handoff
Request
Open
Second
Path
Weak
Signal
Combine
Both Paths
+
MSC

MEASUREMENTS USED TO DETERMINE THE QUALITY OF THE HANDOVER

1. **Word Error indicator (WEI):** Metric that indicates whether the current burst was demodulated properly in the MS.
2. **Received Signal Strength Indication (RSSI):** Measure of received signal strength. The RSSI metric has a large useful dynamic range, typically between 80 to 100 dBm.
3. **Quality Indicator (QI):** Estimate of the "eye opening" of a radio signal which relates to the **signal to noise (S/N) ratio**, including the effects of dispersion.

Compare with the other two, QI has a narrow range (from 5 dB -25 dB).

REASONS FOR HAND-OFF FAILURES

1. No channel is available on target BS.
2. Handoff is denied by the network for reasons such as lack of resources-for example, no free channels on target cell;
3. The MS has exceeded some limit on the number of handoffs that may be attempted in some period of time.
4. It takes the network too long to set up the handoff after it has been initiated.
5. The target link fails during the execution of handoff.

ECE 525E - ASSIGNMENT I

1. Why is the hexagon the most preferred model for a cell in cellular communications?
2. What are the three measurements that can be performed to decide on handoff?
3. What is distance-dependent fading? Which theoretical model describes distance-dependent fading
4. Describe the **three** handoff detection strategies. What are the advantages and disadvantages of the three handoff detection strategies? For example, in terms of load balancing, Which handoff detection strategy is better?
5. Can you implement Mobile Controlled Hand-off (MCHO) or Mobile Assisted Hand-off (MAHO) on FDMA-based Systems (i.e no TDMA or CDMA)?