

Question 3

a) Answer the following questions in the GSM system.

- What kind of random access method is used when a Mobile Station wants to access to GSM system?

GSM uses the slotted ALOHA protocol:

- Explain what kind of power control is used in the GSM system.

Closed-loop power control.

b) Explain how the capacity of a single CDMA cell can be calculated and supply an example considering a SIR between 3dB and 9dB, a data transmission rate of 9600bps, and the carrier bandwidth used in IS-95 (the channel bandwidth is 1.25MHz).

The receiver processes the received signal with a processing gain of N, Assume

- M simultaneous users on the reverse channel
- Ideal power control
- The system is interference limited
- The background noise is dominated by the interference noise from other users
- Received power from all terminals has the same value P

Then, the received power from the target user after processing at the receiver is NP, The received interference from M-1 terminals is (M-1)P, The received signal-to-noise ratio (Sr) will be:

$$S_r = \frac{NP}{(M-1)P} = \frac{N}{M-1}$$

For a given modulation and coding specification of the system, the acceptable error rate will be supported by a minimum Sr. Then, we could calculate the capacity by the solved equation by:

$$M = \frac{W}{RS_r} + 1 \approx \frac{W}{RS_r}$$

$$10 \log x = 3 \rightarrow \log x = \frac{3}{10}$$

$$10 \log y = 9 \rightarrow \log y = \frac{9}{10}$$

$$x \approx 2$$

$$y \approx 8$$

$$M = \frac{1.25 \times 10^6}{9600} \times \frac{1}{8} \approx 16$$

$$M = \frac{1.25 \times 10^6}{9600} \times \frac{1}{2} \approx 65$$

So the users capacity of this is from 16 users to 65 users.

c) What code is used to encode the reverse channel in IS-95 system? If the input bits is: 101010, please select the right code for mapping.

1. Walsh codes can be used to encode n-ary bit sequences as in IS 95 reverse link.

Example Input :

- $B_0 = 1$
- $B_1 = 0$
- $B_2 = 1$
- $B_3 = 0$
- $B_4 = 1$
- $B_5 = 0$

the Walsh code selected is $W = 1 + 2 \times 0 + 4 \times 1 + 8 \times 0 + 16 \times 1 + 32 \times 0 = 21$.

d) The GPRS network is built on the GSM network to provide data services. Sketch the GPRS network architecture and describe briefly the function of each node.

GPRS reuses the GSM architecture, the new entities are called GPRS support nodes (GSN):

- Serving GPRS Support Node (SGSN):
 - It controls access to MSs that may be attached to a group of BSCs (routing area - RA or service area of the SGSN)
 - It is a router, responsible for the delivery of packets to the MS in its service area and from the MS to the Internet
 - It also performs the logical link management, authentication, and charging functions
- Gateway GPRS Support Node (GGSN):
 - It acts as a logical interface to the Internet
 - It maintains routing information related to an MS to be able to route packets to the SGSN servicing the MS
 - It analyses the PDN (Public Data Network) address of the MS and converts it to the corresponding IMSI