Closed books. Duration: 45 min Part 1

Name:

Quotations for each question:
- correct answer: 1 valor
- incorrect answer: - 0.15 valores

Minimum classification in Part 1: 0 valores

Each question has multiple alternative answers but only one is TRUE. Please select the alternative that is TRUE. The answer to a question will be considered INCORRECT if a FALSE alternative is selected or if multiple alternatives are selected.

1. [1 val] The efficiency of a wireless channel (**bit/s/Hz**), as given by

$$\log2(1+SNR) ,$$

a) increases when the distance (d) between the transmitter and the receiver decreases and is independent of the channel bandwidth (B).

b) increases when d decreases and B decreases.

c) is independent of d.

d) None of the above is correct.

2. [1 val] Current technologies use Adaptive Modulation-Coding (AMC) techniques. Let us assume AMC is employed with the purpose of enabling the highest possible bitrate at a low Bit Error Ratio. If the transmitter is using a modulation QPSK and a coding rate R=3/4, and the SNIR at the receiver increases, then the transmitter will switch to the transmission mode characterized by

a) Modulation=BPSK, R=3/4.

b) Modulation=QPSK, R=1/2.

c) Modulation=16-QAM, R=1/2.

3. [1 val] If node A is hidden to node C, that means that

a) A is out of range of both C and C's receiver.

b) A is in the range of C's receiver but out of the range of C.

c) A is in the range of C but out of the range of C's receiver.

d) None of the above.

4. [1 val] In Mobile IPv6, when the Mobile Node is visiting a Foreign Network and there is no route optimized towards the Correspondent Node, the destination address of the IP packets generated by the Mobile Node for the Correspondent Node is the IP address of the

a) Access router in the Foreign Network.

b) Home Agent.

c) Correspondent Node.

d) Mobile Node.

5. Let us assume a wireless LAN 802.11 and two stations S1 and S2 that are associated to an AP. Let us also assume a notation where *S1!DATA; S2?DATA* represents that S1 sends (!) DATA and then (;) S2 receives (?) DATA. When S1 has to send a data frame DATA to S2, the following sequence of events is observed

a) S1!DATA; S2?DATA; S2!ACK; S1?ACK.

b) S1!DATA; S2?DATA; S2!ACK; AP?ACK; AP!ACK; S1?ACK.

c) S1!DATA; AP?DATA; AP!DATA; S2?DATA; S2!ACK; AP?ACK; AP!ACK; S1?ACK.

d) S1!DATA; AP?DATA; AP!ACK; S1?ACK; AP!DATA; S2?DATA; S2!ACK; AP?ACK.

6. [1 val] In a wireless mesh network using Expected Transmission Count (ETX) metric to estimate the cost of paths, if the success probability of transmitting the DATA frame in a link is 0.2 and the success probability of transmitting the corresponding ACK is 0.5, then the cost of the path from A to C, in the figure, becomes

a) 4.

b) 10.

c) 20.

d) Other value.

7. [1 val] In 802.11ac if an aggregate bandwidth of 80 MHz (4*20 MHz) is used it means that during data transmission the transmitter Station may use

a) 40 MHz.

b) 80 MHz.

c) 40 MHz or 80 MHz.

d) 20 MHz, 40 MHz or 80 MHz.

8. [1 val] In a cell of radius D let us assume that a terminal located at a distance D/2 from the base station receives C bit/s. Assuming the Shannon law and the Friis propagation model, we may say that the majority of locations inside the cell will enable the terminal to receive a bitrate R characterized by

a) R < C.

b) R = C.

c) R > C.

d) R = 10 C.

9. [1 val] Let us assume a GSM cell supporting C channels and each channel containing T circuits (time slots). Let us also assume that there is a density of U users/m^2, each user offering a given traffic load to the cell (given in Erlang or call attempts/hour). The quality of service provided to the users served by the cell is characterized by the call blocking probability. In this situation, when the maximum power transmitted by the Base Station / Mobile Terminal decreases, the quality of service provided to the users currently served by the cell

a) Increases.

b) Decreases.

c) Is not affected.

10. [1 val] In an OFDMA system using a *Max Throughput Scheduler* the Node B will schedule the mobile phone having

a) The lowest long-run throughput.

b) The highest ratio between instantaneous capacity and the long-run throughput.

c) the maximum SNIR.

d) None of the above.

11. [1 val] The Packet Data Convergence Protocol (PDCP), used in UMTS and LTE networks, runs below IP and has functions related to header compression, ciphering, integrity protection, in-sequence delivery, and buffering/forwarding of packets during handover. In the User (Data) plane of LTE, the PDCP is implemented between the User Equipment (UE) and

a) Mobility Management Entity (MME)

b) Enhanced Node B (e-NodeB).

c) Serving Gateway (Serving GW).

d) Packet Data Network Gateway (PDN GW).

12. [1 val] In an UMTS WCDMA network, the interference caused by a terminal

a) increases when the bitrate generated by the terminal increases.

b) decreases when the bitrate generated by the terminal increases.

c) is independent of the bitrate generated by the terminal.

Closed books. Duration: 45 min Part 1

Name:

Quotations for each question:
- correct answer: 1 valor
- incorrect answer: - 0.15 valores

Minimum classification in Part 1: 0 valores

Each question has multiple alternative answers but only one is TRUE. Please select the alternative that is TRUE. The answer to a question will be considered INCORRECT if a FALSE alternative is selected or if multiple alternatives are selected.

1. [1 val] In a narrowband channel where there is no Line-of-Sight component, the power received by a terminal may be modelled by an exponential probability density function. The average power received by a terminal in this situation is obtained by considering the effect(s) of:

a) Path loss.

b) Path loss and noise.

c) Path loss and shadowing.

d) Path loss, shadowing and noise.

2. [1 val] When the Signal-to-Noise-Ratio (SNR) observed by a receiver varies, the transmitter may adapt by controlling the transmitted power, the modulation, or the code used. Conventional Wi-Fi systems adapt to SNR variation by controlling:

a) Power and modulation.

b) Power and code.

c) Modulation and code.

d) Power, modulation and code.

3. [1 val] In the protocol Carrier Sense Multiple Access/Collision Avoidance (CSMA/CA), the mechanism Request-To-Send (RTS) / Clear-To-Send (CTS) is employed to:

a) Avoid the hidden node problem.

b) Avoid the exposed node problem.

c) Avoid the capture node problem.

d) None of the above.

4. [1 val] Tunnels are used in wireless networks to manage mobility. In MIPv6, when the Mobile Node is visiting a foreign network and it transmits a packet

a) There is a tunnel between the Mobile Node and the Home Agent and the destination address of the inner header is the IP address of Home Agent.

b) There is a tunnel between the Mobile Node and the Home Agent and the destination address of the inner header is the IP address of Correspondent Node.

c) There is a tunnel between the Mobile Node and the Correspondent Node and the destination address of the inner header is the IP address of Home Agent.

d) There is a tunnel between the Mobile Node and the Correspondent Node and the destination address of the inner header is the IP address of Correspondent Node.

5. [1 val] Frame aggregation is used in the latest versions of IEEE 802.11. Aggregation - MAC Service Data Unit (A-MSDU) aggregates multiple MSDUs in a single frame using the following frame format:

[PHY-header | MAC-header | MSDU1 | … | MSDUn | FCS]

In this case, when MSDU1 is received in error the transmitter retransmits

a) [PHY-header | MAC-header | MSDU1 | … | MSDUn | FCS].

b) [PHY-header | MSDU1 | … | MSDUn | FCS].

c) [PHY-header | MAC-header | MSDU1 | FCS].

d) [PHY-header | MSDU1 | FCS].

6. The adoption of Multi Point Relay (MPR) nodes in an OLSR enabled ad-hoc network

a) Increases the number of nodes generating link state messages and increases the length of these messages.

b) Increases the number of nodes generating link state messages but decreases the length of these messages.

c) Decreases the number of nodes generating link state messages and decreases the length of these messages.

d) Decreases the number of nodes generating link state messages but increases the length of these messages.

Closed books. Duration: 45 min Part 1

Name:

7. [1 val] When the Routing Protocol for Low-Power and Lossy Networks (RPL) operates in the non-storing mode, characterized by sensor nodes having no forwarding tables, the transmission of a packet from node X to node Y, both belonging to the same DODAG, is made as follows:

a) Packet is forwarded to first parent node common to X and Y; then packet is forwarded to Y.

b) Packet is forwarded to first parent node common to X and Y; first parent node adds source routing header to packet and forwards it to Y.

c) Packet is forwarded to root node; then packet is forwarded to Y.

d) Packet is forwarded to root node; root node adds source routing header to packet and forwards it to Y.

8. [1 val] When planning a cellular network, if a small reuse factor K is used, the network is characterized by

a) Low number of calls/m^2 ; Low SNR.

b) Low number of calls/m^2 ; High SNR.

c) High number of calls/m2 ; Low SNR.

d) High number of calls/m2 ; High SNR.

9. [1 val] In GSM a set of channels are used at the radio interface, including the Fast Associated Control Channel (FACCH). The FACCH is used by the

a) Mobile terminal to request the establishment of a new call.

b) Network to announce a new call for the mobile terminal.

c) Mobile terminal to send information after the call is established.

d) Network to request the mobile terminal to associate to another Base Station.

10. [1 val] In WCDMA UMTS the power control mechanism known as Closed Loop Control aims at

a) Determining the Signal to Interference Ratio (SIR) objective for a call which demands a given Frame Error Ratio.

b) Maintaining the SIR during a call.

c) Determining the transmit power at the establishment of a call.

d) None of the above.

11. [1 val] The 5G generation of mobile communications will serve multiple use cases including *Ultra-Reliable and Low latency Communications* (URLLC), *enhanced Mobile Broadband* (eMBB), and *massive Machine Type Communications* (mMTC). The symbol length, which is the time required to transmit a symbol, will a controllable system parameter. Assuming t(mMTC) represents the time required to transmit a symbol of mMTC traffic, the following is expected:

a) t(URLLC) > t(eMBB) > t(mMTC).

b) t(URLLC) < t(eMBB) < t(mMTC).

c) t(URLLC) > t(mMTC) > t(eMBB).

d) t(URLLC) < t(mMTC) < t(eMBB).

12. [1val] The admission of a new call in GSM, UMTS and LTE is made by considering the following radio resources:

a) GSM: interference; UMTS: time*frequency slot; LTE: time slot.

b) GSM: time*frequency slot; UMTS: time slot; LTE: interference.

c) GSM: time slot; UMTS: interference; LTE: time*frequency slot.

d) GSM: time slot; UMTS: interference; LTE: interference.

Closed books. Duration: 40 min Part 1

Name:

Quotations for each question:
- correct answer: - 1 valor
- incorrect answer: - 0.15 valores

Minimum classification in Part 1: 0 valores.

Each question has multiple alternative answers but only one is TRUE. Please select the alternative that is TRUE. The answer to a question will be considered INCORRECT if a FALSE alternative is selected or if multiple alternatives are selected.

1. [1 val] The efficiency of a wireless channel (bit/s/Hz), as given by the Shannon law $C/B = \log_2(1+SNR)$

a) decreases when the distance between the transmitter and the receiver (d) increases and is independent of the channel bandwidth (B).

b) decreases when d increases and B increases.

c) is independent of d.

d) None of the above is correct.

2. [1 val] Current radio technologies use Adaptive Modulation-Coding (AMC) techniques. Let us assume AMC is employed with the purpose of enabling the highest possible bitrate at low Bit Error Ratio. If the transmitter is using a modulation QPSK and a coding rate R=3/4, and the SNIR at the receiver increases, then the transmitter will switch to the transmission mode characterized by

a) Modulation=BPSK, R=3/4.

b) Modulation=QPSK, R=1/2.

c) Modulation=16-QAM, R=1/2.

3. [1 val] If node C is hidden to node A, that means that

a) C is out of range of both A and A's receiver.

b) C is in the range of A's receiver but out of the range of A.

c) C is in the range of A but out of the range of A's receiver.

d) None of the above.

4. [1 val] In Mobile IPv6, when the Mobile Node (MN) is visiting a foreign network and communicating with a Correspondent Node (CN) using an optimized route, the packets exchanged between the CN and the MN

a) Are sent in a tunnel IP-in-IP between the CN and the MN.

b) Are forwarded normally between the CN and MN's home network, and in a tunnel between the HA and the MN.

c) Contain a Routing header in the CN → MN direction and a Destination header in the opposite direction.

d) Contain a Destination header in the CN → MN direction and a Routing header in the opposite direction.

5. [1 val] A station WLAN 802.11 operating in infrastructure mode

a) Transmits using a default power and adapts its transmission bitrate based on received ACKs.

b) Transmits using a default power and adapts its transmission bitrate based on received beacons.

c) Transmits using the power indicated in received beacons and adapts its transmission bitrate based on received ACKs.

d) Transmits using a power and a transmission bitrate indicated in received beacons.

6. [1 val] Let us assume the AODV routing protocol. A node **A** tries to find a route to node **B**, not directly connected to A. When the process of finding the route is concluded with success, a node C **not** in the path selected between A and B will get

a) A route to node A.

b) A route to node B.

c) Routes to nodes A and B.

d) No routes.

7. [1 val] In the GSM system, the power of the signal transmitted by the Mobile Station (MS) towards a Base Transmission Station (BTS)

a) Is determined by the MS and kept constant during a call.

b) Is determined by the BTS and kept constant during a call.

c) Is determined by the MS and may vary during a call.

d) Is determined by the BTS and may vary during a call.

Name:

8. [1 val] In the UMTS WCDMA system, dedicated channels using variable bitrates in the downlink direction are implemented

a) Using spreading codes with different lengths.

b) Using variable transmission powers.

c) Using intermittent transmissions at the maximum bitrate.

d) Using constant (non-intermittent) transmissions at the maximum bitrate.

9. [1 val] Consider the following notation used to describe the path followed by traffic when a mobile node moves between access points:

GW.pAP.MN; GW.(pAP+nAP).MN; GW.nAP.MN

In this notation the traffic flows through the path Gateway, previous Access Point, Mobile Node: **GW.pAP.MN**. Then (;), in a next phase, the traffic flows through the path Gateway, which duplicates the traffic and sends it both (multicast) through the previous Access Point and new Access Point, and this traffic reaches the Mobile Node via one or both the access points: **GW.(pAP+nAP).MN.** Then (;) the traffic flows through the path Gateway, new Access Point, Mobile Node: **GW.nAP.MN.**

Please select the alternative which corresponds to the solution adopted by UMTS and LTE (assume downlink direction)

a) GW.pAP.MN; GW.nAP.MN

b) GW.pAP.MN; GW.(pAP+nAP).MN; GW.nAP.MN

c) GW.pAP.MN; GW.pAP.nAP.MN; GW.nAP.MN

10. The admission of a new call in GSM, UMTS and LTE is made by considering the following radio resources:

a) GSM: interference; UMTS: time*frequency slot; LTE: time slot

b) GSM: time*frequency slot; UMTS: time slot; LTE: interference

c) GSM: time slot; UMTS: interference; LTE: time*frequency slot

d) GSM: time slot; UMTS: interference; LTE: interference

Closed books. Duration: 40 min Part 1

Name:

Quotations for each question:
- Correct answer: 1 valor
- Incorrect answer: - 0.15 valores

Minimum classification in Part 1: 0 valores.

Each question has multiple answers but only of them is TRUE. Please select the alternative that is TRUE. The answer to a question will be considered INCORRECT if a FALSE alternative is selected or multiple alternatives are selected.

1. [1 val] Let us assume that in a wireless link the receiver is moving towards the transmitter by a short distance so that the path loss and the shadowing loss can be considered constant, and the multipath fading modelled by Rayleigh. In this case, the majority of symbols received by the mobile receiver will be received with a power which is

a) Smaller than the mean received power.
b) Higher than the mean received power.
c) Constant and equal to the mean received power.

2. [1 val] Let us assume an OFDM system operating in a wireless channel with a delay spread T_m= 10 μs. In order to eliminate ISI, 100 narrowband channels were defined, each having a bandwidth of 10 kHz. Assuming BPSK modulations, the bitrate provided by this system is:

a) 1 Mbit/s.
b) 2 Mbit/s.
c) 4 Mbit/s.
d) 10 Mbit/s.

3. [**1 val**] Two options for implementing full-duplex have been studied: Frequency Division Duplex (FDD) and Time Division Duplex (TDD). When comparing those techniques with respect to **(a) the simplicity of power control** and **(b) the ability of handling asymmetric traffic** we may say that the preferable solutions are

a) TDD for (a) and TDD for (b).
b) TDD for (a) and FDD for (b).
c) FDD for (a) and TDD for (b).
d) FDD for (a) and FDD for (b).

4. [**1 val**] Let us assume two Mobile IPv6 nodes – MN1 and MN2 – that are visiting the same Foreign Network and using optimised routes. When MN1 sends a packet to MN2 the destination address of the packet is the

a) IP address of the Home Agent of MN1.
b) IP address of the Home Agent of MN2.
c) Home address of MN2.
d) Care of Address of MN2.

5. [1 val] Let us assume a wireless LAN 802.11 and two stations S1 and S2 that are associated to the same AP. Let us also assume a notation where **S1!DATA; S2?DATA** represents that S1 sends (!) DATA and then (;) S2 receives (?) DATA. When S1 needs to send a data frame DATA to S2, the following sequence of events is observed

a) S1!DATA; S2?DATA; S2!ACK; S1?ACK.
b) S1!DATA; S2?DATA; S2!ACK; AP?ACK; AP!ACK; S1?ACK.
c) S1!DATA; AP?DATA; AP!DATA; S2?DATA; S2!ACK; AP?ACK; AP!ACK; S1?ACK.
d) S1!DATA; AP?DATA; AP!ACK; S1?ACK; AP!DATA; S2?DATA; S2!ACK; AP?ACK.

6. [**1 val**] Let us assume 2 wireless mesh networks: WMN1 and WMN2. WMN1 is characterized by highly mobile routers and low traffic loads. WMN2 is characterized by very low mobile routers and high traffic loads. Let us also assume we may use AODV or OLSR in these networks. In these conditions:

a) AODV is the preferable solution both for WMN1 and WMN2.
b) OLSR is the preferable solution both for WMN1 and WMN2.
c) AODV is preferable for WMN1 and OLSR is preferable for WMN2.
d) OLSR is preferable for WMN1 and AODV is preferable for WMN2.

7. [**1 val**] In GSM a set of channels are used at the radio interface, including the Fast Associated Control Channel (FACCH). The FACCH is used by the

a) Mobile terminal to request the establishment of a new call.
b) Network to announce a new call for the mobile terminal.
c) Mobile terminal to send information after the call is established.
d) Network to request the mobile terminal to associate to another Base Station.

Closed books. Duration: 40 min Part 1

Name:

8. [1 val] In Wideband Code Division Multiple Access (WCDMA) systems such as UMTS

a) The larger is the code length the higher is the bitrate; variable bitrates in downlink dedicated channel are obtained by using different code lengths.

b) The larger is the code length the higher is the bitrate; variable bitrates in downlink dedicated channel are obtained by using discontinuous transmission.

c) The smaller is the code length the higher is the bitrate; variable bitrates in downlink dedicated channel are obtained by using different code lengths.

d) The smaller is the code length the higher is the bitrate; variable bitrates in downlink dedicated channel are obtained by using discontinuous transmission.

9. [1 val] Communications systems such as LTE use Orthogonal Frequency Division Multiplexing Access (OFDMA). Let us assume that SxT resource blocks are available for downlink, where S is the number of channels, each channel having a bandwidth of B Hz, and T is the number of timeslots per frame. The OFDMA system delivers continuously F frame/s but each frame has an efficiency of 2/3, that is, the T timeslots are delivered in 2/3 of the frame duration, while the other 1/3 is used by the system to transmit control information. Assuming that terminal U is assigned the radio resource block (i,j) in every frame and that it receives a power Pr then, according to Shannon law, the maximum theoretical bitrate received by this terminal is

a) $2.\{B.\log_2[1+(Pr/N_0B)]\}$ / (3FT) bit/s.

b) $2.\{B.\log_2[1+(Pr/N_0B)]\}$ / (3T) bit/s.

c) $(2/3).\{B.\log_2[1+(Pr/N_0B)]\}.FT$ bit/s.

d) Other value.

10. **[1 val]** In UMTS the Soft handover occurs when a mobile terminal moves between two cells defined by different Nodes B but under the control of the same Radio Network Controller (RNC). In this situation, during the handover,

a) Only one NodeB is used at time and the RNC orders the terminal to move to the new NodeB.

b) Only one NodeB is used at time and the previous NodeB orders the terminal to move to the new NodeB.

c) The previous NodeB and the new NodeB are used simultaneously and the RNC selects the best frames.

d) The mobile terminal measures the Signal to Noise plus Interference Ratios and selects the best NodeB.

Closed books. Duration: 40 min Part 1

Name:

Quotations for each question:
- correct answer: - 1 valor
- incorrect answer: - 0.15 valores

Minimum classification in Part 1: 0 valores.

Each question has multiple alternative answers but only one is TRUE. Please select the alternative that is TRUE. The answer to a question will be considered INCORRECT if a FALSE alternative is selected or if multiple alternatives are selected.

1. **[1 val]** Consider a wireless link characterized by a bandwidth of B Hz, a transmitted power P_t , and the simplified path loss model with γ=3. The capacity of this link, in bit/s,
   a) Increases with the increase of distance (between transmitter receiver).
   b) Decreases with the increase of distance.
   c) Is independent of the distance.

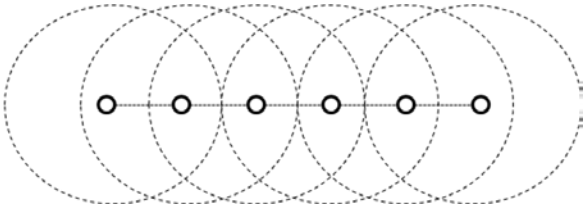
2. **[1 val]** Let us assume that the receiver is moving by a short distance, so that the path and the shadowing losses can be considered constant, and the multipath fading modelled by Rayleigh; that is, the power received (or channel gain) may be modelled by an exponential distribution. In this case, the majority of symbols received by the mobile receiver will be received with a power which is
   a) Smaller than the mean received power.
   b) Higher than the mean received power.
   c) Constant and equal to the mean received power.

3. **[1 val]** Let us assume that a wireless link is being monitored and that the Signal to Noise plus Interference ratio (SNIR) decreases. In order to maintain the Bit Error Ratio (BER), the adaptive transmission system should
   a) select a modulation with a higher number of constellation points (M) and maintain the coding rate (k/n).
   d) select a modulation with a smaller number of constellation points (M) and decrease the coding rate (k/n).

errada

   e) select a modulation with a higher number of constellation points (M) and increase the coding rate (k/n).
   f) maintain the modulation and increase the coding rate (k/n).

4. **[1 val]** Let us assume a chain of 6 nodes (5 wireless links), in which a node may exchange frames with its neighbours using the CSMA/CA protocol (DATA+ACK, but no RTS+CTS). Consider also that the decode distance is equal to the interference distance and that this distance is 1,5 times the distance between the nodes, as represented in the figure.



In this case, the number of links that can **simultaneously** support the DATA+ACK frame exchange with 100% of success is

a) 1.

b) 2.

c) 3.

d) 4

5. **[1 val]** Tunnels are used in wireless networks to manage mobility. In MIPv6, when the Mobile Node is visiting a foreign network and it transmits a packet

a) There is a tunnel between the Mobile Node and the Home Agent and the destination address of the inner header is the IP address of Home Agent.

b) There is a tunnel between the Mobile Node and the Home Agent and the destination address of the inner header is the IP address of Correspondent Node.

c) There is a tunnel between the Mobile Node and the Correspondent Node and the destination address of the inner header is the IP address of Home Agent.

d) There is a tunnel between the Mobile Node and the Correspondent Node and the destination address of the inner header is the IP address of Correspondent Node.

Name:

6. [**1 val**] In a wireless mesh network using Expected Transmission Count (ETX) as the metric used to estimate the cost of paths, if the success probability of transmitting the Data frame in a link is 0.2 and the success probability of transmitting the corresponding ACK is 0.5, then the cost of the path from A to C, in the figure, becomes

a) 4.
b) 10.
c) 20.
d) Other value.

7. [**1 val**] Let us assume a GSM cell supporting C channels and each channel containing T circuits (time slots). Let us also assume that there is a density of U users/m^2, each user offering a given traffic load to the cell (given in Erlang or call attempts/hour). The quality of service provided to the users served by the cell is characterized by the call blocking probability. In this situation, when the maximum power transmitted by the Base Station / Mobile Terminal decreases, the quality of service provided to the users currently served by the cell

a) Increases.
b) Decreases.
c) Is not affected.

8. [**1 val**] In the UMTS system, the control of power and interference is very important. In particular, UMTS cells are said to breathe, that is to have coverage areas that may vary along the time, depending on a set of factors. Let us assume a scenario LOW-BITRATE where a set of users in a cell transmit data at low bitrates, and scenario HIGH-BITRATE where the same set of users transmit data at high bitrates. In these scenarios

a) The radius of the cell is higher for scenario LOW-BITRATE than for scenario HIGH-BITRATE.
b) The radius of the cell is higher for scenario HIGH-BITRATE than for scenario LOW-BITRATE.
c) The radius of the cell is independent of the bitrates generated by users.

9. [**1 val**] Communications systems such as WiMaX or LTE use Orthogonal Frequency Division Multiplexing Access (OFDMA) where **SxT** is the number of radio resources (e.g symbols) available for downlink, **S** is the number of sub-channels, each sub-channel having a bandwidth of **B** Hz, and **T** is the number of timeslots per frame. The OFDMA system delivers continuously **F** frame/s. Consider also that a terminal **U** receives from the base station the mean power P_r. The capacity of a sub-channel is given by the Shannon law $C=B*\log_2[1+(P_r/(N_0B))$ bit/s. If terminal **U** is assigned for downlink the radio resources **(i,j)** and **(i,j+1)** in every frame, that is, 2 time slots in sub-channel **i**, per frame, then the bitrate obtained by this user is

a) 2C/(FT) bit/s.

b) 2C/T bit/s.

c) 2CFT bit/s.

d) Other value.

10. [**1 val**] Consider the following notation used to describe mobility management techniques

[Downlink] GW.pAP.MN; GW.pAP.nAP.MN

In this notation, for the Downlink direction ([Downlink]), the traffic flows through the path Gateway, previous Access Point, Mobile Node (GW.pAP.MN). Then (;), the traffic flows through the path Gateway, previous Access Point, new Access Point, Mobile Node (GW.pAP.nAP.MN). Please select the case that represents better the mobility management solution adopted by the 3GPP LTE technology.

a) Case 1

a. [Downlink] GW.pAP.MN; GW.nAP.MN
b. [Uplink] MN.pAP.GW; MN.nAP.GW

b) Case 2

a. [Downlink] GW.pAP.MN; GW.pAP.nAP.MN; GW.nAP.MN
b. [Uplink] MN.pAP.GW; MN.nAP.GW

c) Case 3

a. [Downlink] GW.pAP.MN; GW.pAP.nAP.MN; GW.nAP.MN
b. [Uplink] MN.pAP.GW; MN.nAP.pAP.GW; MN.nAP.GW

Closed books. Duration: 40 min Part 1

Name:

Quotations for each question:
- correct answer: - 1 valor
- incorrect answer: - 0.15 valores

Minimum classification in Part 1: 0 valores.

Each question has multiple alternative answers but only of them is TRUE. Please select the alternative that is TRUE. The answer to a question will be considered INCORRECT if a FALSE alternative is selected or if multiple alternatives are selected.

1. [**1 val**] In a wireless transmission media and for a given transmission baudrate, the inter-symbol interference at the receiver
   a) Decreases with the increase of the channel bandwidth.
   b) Increases with the increase of channel bandwidth.
   c) Is independent of the channel bandwidth.

2. [**1 val**] Modern radio technologies use Adaptive Modulation-Coding (AMC) techniques. Let us assume that AMC is employed with the purpose of maintaining the Bit Error Ratio at the receiver low and stable. If the transmitter is using a modulation QPSK, a coding rate R of ½ (percentage of useful information), and the SNIR at the receiver decreases then the transmitter will switch to a transmission mode characterized by
   a) Modulation=BPSK, R=1/2.
   b) Modulation=16-QAM, R=1/2.
   c) Modulation=QPSK, R=3/4.

3. [**1 val**] Let us assume a cell consisting of a Base Station and a set of terminals transmitting at a bitrate R bit/s to the Base Station using a Code Division Multiple Access (CDMA) technique. If the terminals change the transmission bitrate to 2R bit/s then
   a) Interference decreases and cell radius increases.
   b) Interference decreases and cell radius decreases.
   c) Interference increases and cell radius increases.
   d) Interference increases and cell radius decreases.

4. [**1 val**] If node C is hidden to node A, it means that

a) C is out of range of both A and A's receiver.

b) C is in the range of A but out of the range of A's receiver.

c) C is in the range of A's receiver but out of the range of A.

d) None of the above.

5. [**1 val**] In Mobile IPv6, when the Mobile Node (MN) is visiting a foreign network and communicating with a Correspondent Node (CN) using a non-optimized route, the packets exchanged between the CN and the MN

a) Are sent in a tunnel IP-in-IP between the CN and the MN.

b) Are forwarded normally between the CN and MN's home network, and in a tunnel between the HA and the MN.

c) Contain a Routing header in the CN→MN direction and a Destination header in the opposite direction.

d) Contain a Destination header in the CN→MN direction and a Routing header in the opposite direction.

6. [**1 val**] A station WLAN 802.11 operating in infrastructure mode

a) Transmits using the power indicated in received beacons and adapts its transmission bitrate based on received ACKs.

b) Transmits using a power and a transmission bitrate indicated in received beacons.

c) Transmits using a default power and adapts its transmission bitrate based on received ACKs.

d) Transmits using a default power and adapts its transmission bitrate based on received beacons.

7. [**1 val**] Let us assume the AODV routing protocol. A node A tries to find a route to node B, not directly connected to A. When the process of finding a route is concluded with success, a node C in the path selected between A and B will get

a) Routes to nodes A and B.

b) Route to node A.

c) Route to node B.

d) No routes.

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8. **[1 val]** In GSM the identifier that enables the mobile network to forward a call to a given mobile terminal is the

a) IMSI.

b) MSISDN.

c) MSRN.

d) TMSI.

9. **[1 val]** Let us assume a GSM cell supporting C channels and each channel containing T circuits (time slots). Let us also assume that there is a density of U users/m^2, each user offering a given traffic load to the cell (given in Erlang or call attempts/hour). The quality of service provided to the users served by the cell is characterized by the call blocking probability. In this situation, when the maximum power transmitted by the Base Station / Mobile Terminal increases, the quality of service provided to the users currently served by the cell

a) Decreases.

b) Increases.

c) Is not affected.

10. **[1 val]** In the mobility solution ProxyMIPv6

a) There is a tunnel between the Mobile Node and Mobile Agent (LMA).

b) There is a tunnel between the Access Router (MAG) and the Mobile Agent.

c) There is a tunnel between the Mobile Node and the Correspondent Node.

d) There are no tunnels