COMP4336/9336 Mobile data networking
W1 Quiz on PHY Fundamentals I

Q1.

A telephone line is known to have a loss of 20 dB. The input signal power is measured at 1 Watt, and the output signal noise level is measured at 1 mW. What is the signal to noise ratio in dB?

a) 1
b) 10
c) 100
d) -10
e) -100

A1.

1 Watt = 30dBm
Received signal = 30 – 20 = 10dBm
Noise = 1mW = 0dBm
SNR = signal power(dBm) – noise(dBm) = 10-0 = 10

Q2.

What is the maximum data rate that can be supported on a 10 MHz noise-less channel if the channel uses eight-level digital signals?

a) 80 Mbps
b) 160 Mbps
c) 60 Mbps
d) 60 kbps
e) 160 kbps

A2.

Nyquist formula is about noise-free channel capacity.

Max. data rate = $2 \text{x} 10 \text{x} 10^6 \text{x} \log_2(8)$ = 60 Mbps

Q3.

What signal to noise ratio (in dB) is required to achieve 10 Mbps through a 5 MHz channel?

a) 3
b) 4.77
c) 5
d) 9
e) 10

A3.

Shannon's formula is about noisy channel.
10 Mbps = 5 MHz × $\log_2$ (1+S/N)
2 = $\log_2$ (1+S/N)
4 = 1+S/N
S/N = 3
In dB: S/N = 10$\log_{10}$ (3) = 4.77 dB

Q4.

What is the average Doppler frequency shift at 36 km/hr using 3 GHz band (average Doppler shift for a band is computed at the centre frequency of the band; for 3 GHz band, the centre frequency can be assumed as 3 GHz)?

a) 100 Hz
b) 100 sec
c) 10 Hz
d) 10 sec
e) None of these

A4.

Doppler Shift = fv/c = $(3\times10^9)\ (36\times10^3/3600)/(3\times10^8)$ = 100 Hz

Q5.

What is the Doppler spread at 36 km/hr for 3 GHz band?

a) 100 Hz
b) 150 Hz
c) 200 Hz
d) 300 Hz
e) 400 Hz

A5.

Doppler spread = 2 x Doppler shift = 2 x 100 Hz = 200 Hz

Q6.

What is the channel coherence time for a wireless link between a car travelling at 36 km/hr and a stationary base station for a 3 GHz band?

a) 5 Hz
b) 5 ms
c) 10 Hz
d) 10 ms
e) 100 ms

A6.

Coherence Time = 1/Doppler Spread = 1/200Hz = 5 ms

Q7.

To transmit 2-bit symbols, a transmitter uses the following 5-bit codewords (5-bit codewords are eventually transmitted instead of 2-bit symbols):

Data Codeword

00 --> 00000

01 --> 00111

10 --> 11001

11 --> 11110

What is the minimum Hamming distance between any two codewords?

a) 1
b) 2
c) 3
d) 4
e) 5

A7.

HD(1-2): 3
HD(1-3): 3
HD(1-4): 4
HD(2-3): 4
HD(2-4): 3
HD(3-4): 3

Q8.

If a mobile error coding system uses a minimum Hamming distance of 3, which of the following statements is correct?

a) **All single bit errors can be detected**
b) All double bit errors can be corrected
c) All triple bit errors can be detected
d) All triple bit errors can be corrected
e) Bit errors can be detected, but they CANNOT be corrected

A8.

Any single bit error will still be closer to the original codeword compared to any other codewords, so it can be corrected.

Q9.

Frequency hopping requires less bandwidth because it never uses the same channel for too long.

a) False
b) True

A9.

It requires large bandwidth because it needs to transmit different parts of the signal in different frequencies.

Q10.

To achieve high security, a secret service agent is using a direct-sequence spread spectrum with a spreading factor of 1000 for all its transmissions. To transmit a message comprising of 10,000 bits, the transmitter will have to transmit

a) 100 thousand bits
b) 1 million bits
c) 10 million bits
d) 100 million bits
e) 1 billion bits

A10.

10,000 x 1,000 = 10,000,000

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W2 Quiz: PHY Fundamentals II

Q1. What is the received signal power (approx.) observed by a user equipment (UE) at 4m and at a distance of 500 m from a 14 m high base station? The transmitter and receiver antenna gains are 10 dBi and 5 dBi, respectively. Base station transmission frequency is 2GHz and transmission power is 30 dBm.

a) 30 dBm
b) -30 dBm
c) 30 W
d) 30 mW
e) 30 dBW

A1.

$D_{break} = 4(14*4*2*10^9/3*10^8) = 1493.33$m; thus at 500m, the UE is NOT at far field and hence we CANNOT use the 2-ray model. One option would be to use the Free-space model, but that could be grossly incorrect for the practical scenario explained in the question (not clearly a free-space scenario). Also, none of the options of the multiple choice are for the free-space model. This question is therefore abandoned and all students who attempted this question was given the full mark.

Q2. With a subcarrier spacing of 10 kHz, how many subcarriers will be used in an OFDM system with 8 MHz channel bandwidth?

a) 8
b) 80
c) 800
d) 8000
e) None of these

A2.

Number of Subcarriers = $(8\times10^6)/(10\times10^3) = 800$

Q3. Let us consider an OFDM system that uses the same carrier spacing irrespective of the channel bandwidth used. It employs 1024 subcarriers for 10 MHz channel. How many subcarriers will be used if the channel was 1.25 MHz wide?

a) 1000
b) 1024
c) 1280
d) 128
e) 900

A3.

Inter carrier spacing = 10MHz/1024 = 9.7656 kHz
Now, for a 1.25 MHz channel: $1.25 \times 10^3/9.7656$ = 128 subcarriers.

Q4. You have bought a 2.4 GHz WiFi router with two dipole antennas claiming effective antenna gain of 6 dB. Your laptop has a single dipole with 0 dB gain and it claims a receiver sensitivity of -64 dBm. What is the maximum distance from the router your laptop can receive data if the router always use a transmit power of 20 dB?

a) 10m
b) 20m
c) 115m
d) 215m
e) 315m

A4.

We can tolerate a maximum pathloss of 90 dB (20+6+64 = 90). 2.4 GHz will lose 90 dB at 315 m. Beyond 315 m from the router, the laptop will receive signal strength below its sensitivity level and hence will not be able to decode information.

Q5. You have bought a 2.4 GHz WiFi router with antenna gain of 6 dB and default transmission power of 100 mW. Your laptop has a 0 dB antenna gain and claims a receiver sensitivity of -60 dBm. Can you connect your laptop to the router from a distance of 150 m?

a) YES
b) NO

A5.

There is 83.56 dB path loss at 150 m. Therefore, the laptop will receive a signal strength of 20+6-83.56 = -57.56 dBm, which is higher than its receiver sensitivity. Therefore the laptop **can** connect to the router.

Q6. An omni-directional antenna radiates power in ALL directions equally.

a) True
b) False

A6.

Only the **isotropic** antenna radiates power in all directions EQUALLY.

Q7. A lamp post would cause scattering for a 300 GHz transmission.

a) True
b) False

A7.

A 300 GHz signal has a wavelength of only 1mm. Lamp posts are usually much wider objects having diameters on the order of centimeters, hence are unlikely to serve as effective scatters for such high-frequency signals.

Q8. In the presence of multipath, symbols get wider at the receiver.

a) True
b) False

A8.

With multipaths, reflections from different paths keep coming to the receiver for some time, effectively widening the symbol interval.

Q9. Symbols must be wider than the delay spread to avoid inter-symbol interference.
a) True
b) False

A9. If symbols are shorter than delay spread then signals with significant power from previous symbol will interfere with signals from the next symbol.

Q10. MIMO is only useful with the presence of multipath and scattering.
a) True
b) False

A10. Even for LoS-only scenarios, the separation of multiple antennas in MIMO leads to uncorrelated LoS paths, thus providing spatial diversity benefits.

End of Quiz-2

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W3 Quiz: WiFi Basics

Q1. Which of the following protocol mechanism helps achieve collision avoidance in WLAN?

a) Carrier Sensing
b) RTS/CTS
c) MIMO
d) Virtual Carrier Sensing
e) DCF

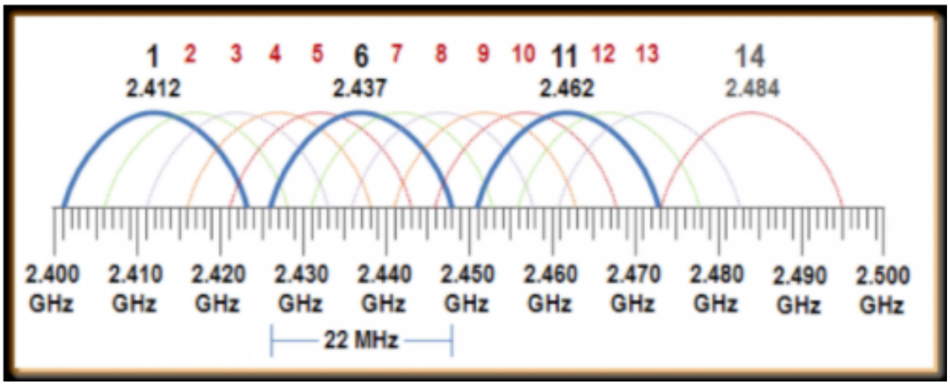
Q2. What is the slot-time for 5 GHz WLANs?

a) 9ms
b) 9µs
c) 12ms
d) 12µs
e) 12ns

Q3. Although a total of fourteen 22-MHz channels are defined for 2.4 GHz DSSS WLANs, the 14th channel is not always available. The first 13 channels follow the 5 MHz channel spacing for the centre frequency (starting from 2412) with 11 MHz assigned on both sides of the centre frequency. If we consider the first 13 channels, a maximum of three non-overlapping channels exist. (1, 6, 11) is an example of a set of three non-overlapping channels. Can you identify another set of three non-overlapping channels among the first 13 channels?

a) (2,7,12)
b) (1,5,12)
c) (1,11,13)
d) (3,8,11)
e) (5,10,13)

A3. There are several sets of 3 non-overlapping channels. (2,7,12), (1,7,12), etc.



Q4. How many successive unsuccessful transmission attempts are required for the Congestion Window (CW) variable to reach its maximum value in an 802.11n WLAN operating in the 5 GHz band?

a) 3
b) 4
c) 5
d) 6
e) 7

A4

For 5 GHz 802.11n, CWmin=15 and CWmax=1023. After n^{th} unsuccessful attempt, CW = (2n x CWmin + 2n -1, CWmax) For n=6, 2n x CWmin + 2n -1 = 1023. Therefore, after 6 successive unsuccessful transmission attempts, CW will reach its maximum value.

Q5. Consider an 802.11a WLAN. A station estimates the transmission times of RTS, CTS, and ACK as 16 µs, 16 µs, and 25 µs, respectively. After receiving the RTS, the AP generates a CTS. What would be the value of the Duration field in the CTS header if the station wanted to send a 250 µs long data frame?

a) 339µs
b) 355µs
c) 400µs
d) 323ms
e) 323µs

A5.

802.11a has SIFS = 16 µs.
Duration field in CTS = CTS_time + ACK_time + data_time + 2xSIFS = 16+25+250+2x16 = 323 µs

Q6. An WiFi frame has the following contents in its first three address fields, ADR1 to ADR3: Destination Address, BSSID, and Source Address. Which of the following is a likely transmission event for this frame?

a) Server to mobile client
b) Client to mobile server
c) Mobile to Mobile direct communication without any access point (adhoc WiFi)
d) Mobile from one Distribution System to a mobile in another Distribution System connected via two WiFi access points (wireless bridge)
e) None of these

Q7. Which of the following bits are used for power saving in WiFi?

a) Power management and Retry bits
b) Power management and Order bits
c) Power management and ToDS bits
d) Power management and FromDS bits
e) Power management and More Data bits

Q8. Dynamic Frequency Selection (DFS) is required for 5GHz WiFi irrespective of the choice of channel.

a) True
b) False

A8

A set of channels are always available, no DFS required (not shared by RADAR).

Q9. It is always wise to combine two channels into a wider channel of larger bandwidth.

a) True
b) False

A9.

Wider channel means more chances of interference from adjacent WLAN. This is particularly problematic in dense deployment (typical urban living) and for 2.4GHz WiFi (40MHz channel would occupy a large fraction of the 2.4GHz band and finding non-overlapping channel would be problematic)

Q10. What would be the channel width if two 5GHz channels are combined into a single one?

a) 44MHz
b) 40MHz
c) 44GHz
d) 40GHz
e) None of these

A10

5GHz WiFi uses 20 MHz-wide channels. So 20+20=40MHz.

End of Quiz-3

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W4 Quiz: 802.11a/b/g/n/ac/ax

Q1.

A WLAN standard is employing a spread spectrum coding, which produces chips at a rate of 1 chip per two cycles (two Hz). It uses 8 chips to code a symbol. To achieve a data rate of 11 Mbps for a 22 MHz channel, what level/order of QAM is needed to modulate the signal?

a) 16-QAM
b) 32-QAM
c) 64-QAM
d) 128-QAM
e) 256-QAM

A1.

Chip rate = ½ x 22 = 11 Mcps
With 8 chips per symbol, the symbol rate = 11/8 = 1.375 Msps
Lets assume that the standard has *b* bits per symbol
Data rate = 11 Mbps = (symbol rate) x (bits per symbol) = 1.375 Msps x *b*
b = 11/1.375 = 8 bits per symbol
QAM level for 8 bits per symbol = 2^8 = 256 [note that $\log_2(256)=8$]

Q2.

The original OFDM for 802.11a-1999 has a 3200ns data pulse, but the effective symbol interval is extended by another 800 ns guard interval (GI) to cater for multi-path delay spread. If a low-spread environment reduces the GI by half, what will be the increase in symbol rate?

a) About 5%
b) About 12%
c) About 50%
d) About 100%
e) None of these

A2.

Symbol rate with 800 ns GI = 1/(3200+800) = 0.25 Msps
Symbol rate with 400 ns GI = 1/(3200+400) = 0.28 Msps

Increase in symbol rate = 0.28 – 0.25 = 0.03 Msps or about 12% (0.03/0.25 = 0.12)

Q3. 802.11a-1999 supports 8 data rates, ranging from 6 Mbps to 54 Mbps. What data rate could be achieved if 256 QAM was used with a coding rate of 5/6?

A3.

54 Mbps is achieved with 64-QAM (6 bits/symbol) and ¾ coding rate.
Increasing QAM level to 256 (8 bits/symbol) would increase data rate by a factor of 8/6
Improving coding from ¾ to 5/6 would increase data rate by a factor of (5/6)/(3/4)=10/9
Data rate achieved with 256-QAM and 5/6 coding rate = 54 x 8/6 x 10/9 = 80 Mbps

a) 80 Mbps
b) 100 Mbps
c) 125 Mbps
d) 150 Mbps
e) 175 Mbps

Q4. What could be the maximum achievable data rate for 802.11n if it were allowed to use a 128-QAM?

a) 650 Mbps
b) 700 Mbps
c) 750 Mbps
d) 1Gbps
e) 1.2Gbps

A4.

Minimum guard interval: 400ns (data interval=3200ns) à 3.6µs symbol interval
Maximum modulation: 128 QAM
Maximum coding: 5/6
Maximum # of MIMO streams: 4 (4x4 MIMO)
Maximum # of data carriers: 108 (for 40MHz bonded channels)
Coded bits per symbol = $\log_2 128$ ✗ #-of-data-subcarriers = 7x108
Data bits per symbol = coding rate x 648 = 5/6 x 7x108 = 630
Symbol rate = 1/symbol-interval = 1/3.6Msps
Data rate (single MIMO stream) = symbol rate x data bits per symbol = 1/3.6 x 630 Mbps = 175 Mbps
Data rate with 4 streams = 4 x 175 = 700 Mbps

Q5. Which of the following WiFi would allow multiple mobile clients to communicate with the access point simultaneously?

a) 802.11a
b) 802.11n
c) 802.11ac
d) 802.11ax

e) None of these

A5.
802.11ax uses OFDMA, which allows the AP to allocate different subsets of subcarriers from the same WiFi channel to allocate to different clients. Thus, it allows to share the same channel with different clients simultaneously.

One could perhaps also argue that MU-MIMO also allows sharing the same physical (frequency) channel among multiple clients using spatial multiplexing, i.e., by creating multiple spatial streams out of the same physical channel and then share different streams with different users.

Q6. With 8 antennas, it is possible for an 802.11ac access point to deliver 8 times the throughput of a single-antenna access point irrespective of the number of antennas fitted to individual mobile clients associated with this access point.

a) TRUE
b) FALSE

Q7. Which WiFi has the lowest symbol rate?

a) 802.11a
b) 802.11b
c) 802.11n
d) 802.11ac
e) 802.11ax

A7. 802.11ax has a very large data pulse length of 12.8 microsec, which makes its symbol duration the longest and hence the symbol rate, which is inverse of symbol duration, the lowest.

Q8. 802.11ax achieves higher data rates compared to its predecessor, 802.11ac, by further shortening the guard interval.

a) TRUE
b) FALSE

Q9. 802.11ax uses wider subcarriers compared to 802.11ac.

a) TRUE
b) FALSE

Q10. Which of the following WiFi flavours has more than two options for selecting its guard interval?

a) 802.11a

b) 802.11n
c) 802.11ac
d) 802.11ax
e) None of these

End of Quiz-4

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W5 Quiz: 802.11af/ah/ad/ay

Q1.
To cover all directions (360 degrees), an 802.11ad PCP/AP employs two 10-sector antennas. Each antenna sector covers 18 degrees. During a Beacon Time (BT), how many beacons the AP should transmit?

a) 2
b) 10
c) 18
d) 20
e) 38

A1.
Beacons must be transmitted in omni-direction, so all STAs receive it. 360-degree coverage is achieved by a total of 20 sectors (each sector covers 18 degrees). The AP therefore will send 20 beacons, one per sector.

Q2. IEEE 802.11af would be suitable for rural areas because it uses TV signals, which can travel long distance.

A. TRUE
B. FALSE

Q3.
In Example 4 (Slide 70, Week-5 lecture notes), the outcome of the SLS is the beam pair (3,1). For what range of RSS values recorded at the responder for the frame transmitted by the first antenna sector in A would lead to (1,1) as the SLS outcome?

A. RSS greater than -50dBm
B. RSS smaller than -50dBm
C. RSS greater than -64dBm
D. RSS smaller than -64dBm

A3.
For the SLS outcome to be (1,1), A.1 has to produce the strongest signal at B. For RSS > -50 dBm, A.1's signal would be the strongest among all other sectors (note that A.3 is currently the strongest with an RSS of -50 dBm).

Q4. 802.11ay achieves higher speed compared to 802.11ad at the expense of shorter communication range.

A. TRUE

B. FALSE

Q5. If two 802.11ad devices have 64 antenna sectors each, searching the best sector pair using omnidirectional approach can reduce the total number of training frame transmissions, compared to the exhaustive search, by

a) 4096 transmissions
b) 64 transmissions
c) 3968 transmissions
d) 4032 transmissions

A5. Exhaustive search would transmit 64x64 = 4096 training frames. Using omnidirectional approach would transmit only 64+64=128 frames. Savings: 4096-128 = 3968

Q6.
PHY-A uses a guard interval (GI) of 400 ns to combat inter-symbol interreference. PHY-B is derived by down clocking PHY-A by a factor of 5. What is the length of GI used by PHY-B?

2millisecond
2nanosecond
2microsecond
80nanosecond
0.2microsecond

A6. GI of PHY-B = 5 x 400 ns = 2 μs.

Q7.
What is the maximum number of non-overlapping channels possible in an 82.11ah network deployed in the U.S.A?

a) 13
b) 15
c) 20
d) 26
e) 30

A7.
1 MHz is the narrowest channel bandwidth allowed in 802.11ah. In USA, 902-928 MHz has been allocated for 802.11ah, which provides a total bandwidth of 26 MHz. Therefore, a maximum of 26 channels (1 MHz channels) are possible in 802.11ah in USA.

Q8. In IEEE 802.11ad, BRP precedes SLS.

a) TRUE
b) FALSE

Q9. By executing the beam refinement protocol (BRP), a pair of devices can widen the beam that was selected by the sector level sweep (SLS).

a) TRUE
b) FALSE

Q10. During Beacon Time (BT), all non-AP stations have their antennas configured as omni-directional (or quasi-omnidirectional).

a) TRUE
b) FALSE

End of Quiz-5

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W7 Quiz: Bluetooth

Q1. Protocol A has four times the data rate of Protocol B but consumes three times as much power. Which protocol has less energy consumption per MB (mega byte)?

a) Protocol A
b) Protocol B
c) Both protocols have the same energy consumption

A1.

Energy = power x time. Transmission time for each MB depends on the data rate; the higher the data rate, the quicker the completion of the transmission job. Protocol A reduces time by 4x and increases power by only 3x; so it becomes the winner.

Q2. If 2-slot packets were allowed in Bluetooth, we could not guarantee

a) that the master starts in even numbered slots only
b) that the slave starts in even numbered slots only
c) interference-free communication
d) error-free communication

Q3. In Bluetooth, only masters are allowed to transmit 5-slot packets.

a) True
b) False

Q4. In Bluetooth, the 3b member address is used to identify the

a) Parked devices
b) Active devices
c) Both active and parked devices
d) Piconet
e) Scatternet

Q5. Bluetooth employs Frequency Hopping to

a) Detect communication errors
b) Correct communication errors
c) Avoid interference with other networks operating in the 2.4GHz band
d) Avoid interference with all types of WiFi networks

e) Recover from packet loss

Q6. With Gaussian FSK,

a) Frequencies do not change
b) Frequencies switch rather smoothly
c) A large number of frequencies are used, which have a Gaussian distribution
d) Both amplitude and frequency are used for modulation
e) Both phase and amplitude are used for modulation

Q7. Bluetooth LE uses

a) Less number of channels than Bluetooth 5
b) Less number of channels than Bluetooth Classic
c) Less number of channels than WiFi
d) 3 data channels and 37 advertising channels
e) A different spectrum than Bluetooth 5

Q8. What would be the total number of non-payload bits in a Bluetooth packet if the header was encoded with 2/3 rate FEC?

a) 84
b) 86
c) 89
d) 95
e) 99

A8. Header is 18 bits without FEC coding. With 2/3 rate FEC, total number of bits in the encoded header = 18 x (3/2) = 27 bits. Total non-payload bits = 27 (header) + 72 (access code) = 99 bits

Q9. Which Bluetooth LE channels will have less likelihood of interference with wireless LAN?

a) 1,2,35
b) 32,33,34
c) 33,34,35
d) 36,37,38
e) 37,38,39

Q10. Bluetooth 5 achieves longer range by

a) **using error detection and correction, which reduces the effective data rate**
b) using higher transmission powers
c) using a more sensitive receiver circuit that can decode symbols at a much lower received power
d) using a wider channel bandwidth
e) using a narrower channel bandwidth

End of Quiz-5

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W8 Quiz: Cellular Networks

Q1.
In a cellular deployment, assume that the distance between co-channel cells is required to be at least 6 km. What is the minimum cell radius allowed for the cluster size of 12?

a) 3km
b) 2km
c) 1km
d) 500m
e) 200m

A1.

D=R x sqrt{3N} = 6R
For D>=6, R >=1km

Q2. A particular cellular system has the following characteristics: cluster size =9, uniform cell size, user density=100 users/sq km, allocated frequency spectrum = 900-945 MHz, bit rate required per user = 10 kbps uplink and 10 kbps downlink, and the modulation code rate = 2 bps/Hz. What is the cell radius, approximately, assuming circular cells and FDMA/FDD?

a) 1km
b) 2km
c) 0.5km
d) 712m
e) 792m

A2.

Using FDMA/FDD:

1. How much bandwidth is available per cell using FDD?
45MHz/9 = 5 MHz/cell
FDD ⇒ 2.5 MHz/uplink or downlink
2. How many users per cell can be supported using FDMA?
10 kbps/user = 5 kHz ⇒ 2500/5=500 users per cell
3. What is the cell area?
100 users/sq km ⇒ 5 Sq km/cell
4. What is the cell radius assuming circular cells?
$\pi r^2 = 5 \Rightarrow r = \text{sqrt}(5/\pi)$ km = **1.26 km**

Q3. A particular cellular system has the following characteristics: cluster size =9, uniform cell size, user density=100 users/sq km, allocated frequency spectrum = 900-945 MHz, bit rate required per user = 10 kbps uplink and 10 kbps downlink, and the modulation code rate = 2 bps/Hz. If the available spectrum is divided in to 100 channels and TDMA is employed within each channel, how many time slots are needed in a TDMA frame to fully utilize the channel bandwidth?

a) 5
b) 10
c) 15
d) 20
e) 100

A.

Available bandwidth for uplink/downlink: 2.5MHz
Bandwidth per channel = 2.5 MHz/100 = 25kHz
Total data rate per channel = 25x2 = 50Kbps (note 2bps/Hz)
Each user would use only 10Kbps, hence 50/10=5 users can be accommodated per channel.
To support 5 users per channel, the TDMA frame should be divided into **5 time slots**, each for one user.

Q4. Which of the following cannot be a valid cluster size in cellular networks?

a) 25
b) 26
c) 27
d) 28
e) 37

A4. 25 (i=5;j=0); 27 (i=3;j=3); 28 (i=4;j=2); 37 (i=4;j=3); **26 not possible.**

Q5. What would be the minimum distance between two co-channel cells if cell radius is 1 km and the reuse factor is 1/3?

a) 1km
b) 2km
c) 3km
d) 4km
e) 9km

A5.

D = R x sqrt(3N) = 1 x sqrt(3x3) = 3km

Q6. NxSxK notation defines the frequency distribution among sectors

a) True
b) False

Q7. In fractional frequency re-use, more frequencies are available at the cell border than in the centre.

a) True
b) False

Q8. The two dimensions of LTE resource allocation (resource block) includes

a) frequency and data rate
b) frequency and time
c) time and data rate
d) frequency and cell size
e) frequency and transmission power

Q9. In LTE, up link and down link slots are

a) 1 ms each
b) 1 micro second each
c) 500 micro second each
d) 500 ms each
e) 100 ms each

A9. 1ms slot is divided into uplink and downlink, each 0.5ms or 500 microsecond.

Q10. In LTE, the longer the Cyclic Prefix is, the smaller the number of symbols that can be transmitted within the 0.5ms UL/DL slot.

A. True
B. False

A10. Cyclic Prefix takes up some time from the finite slot time, leaving less room for actual symbol transmission.

End of W8 Quiz

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W9 Quiz: Mobile IP

Q1. In Mobile IP, the mobile device needs to update the DNS with its care-of-address as soon as it moves to a new subnet.

a) True
b) False

A1.

The mobile needs to update the Home Agent with his CoA. DNS always store the *home address*.

Q2. Mobile IP is a mobility solution that requires changes to be implemented in all internet routers.

a) True
b) False

A2. Only local routers need to install home agents and optionally foreign agents. Routers in the internet do not need to install anything (they do not need to know anything about Mobile IP).

Q3. Home agent acts as a location server.

a) True
b) False

Q4. Foreign agent is not required if all mobiles use co-located care-of-addresses.

a) True
b) False

Q5. Which of the following protocols must be used for successful operation of Mobile IP?

a) DHCP
b) ICMP
c) Both DHCP and ICMP
d) None of these

A5. ICMP is required only if foreign agents are used. DHCP is required only if co-located CoA is used.

Q6 In Mobile IP, an IP-in-IP tunnel is created between the home agent and the remote (i.e., the corresponding host/server in the Internet) host.

a) True
b) False

A6. A tunnel is created between the HA and the FA or the mobile.

Q7. In an IP-in-IP tunnel, the IPv4 header carries two destination addresses.

a) True
b) False

A7. IPv4 headers cannot carry **two** destination addresses (IPv6 can).

Q8. In NEMO (Network Mobility), how many IP headers an onboard user device, which implements Mobile IP with co-located care-of-address, would have to process when it receives an IP packet from the onboard router?

a) None
b) 1
c) 2
d) 3
e) 4

A8. There is an IP-in-IP tunnel between the onboard user and the on-board router, so there will be two IP headers.

Q9. What would a major advantage of Proxy Mobile IP against the original Mobile IP?

a) Client (or user) devices do not need to install any software and do not need to know anything about Mobile IP at all

b) The amount of configuration required in user devices is minimised.

c) No changes are required in wireless access points

d) No changes are required in local routers

A9. Proxy MIP requires changes in AP and routers but requires no changes in user devices. MIP remains completely transparent to the users.

Q10. Proxy Mobile IP (for IPv6) can be used

Only in WiFi networks
Only in cellular networks
In both WiFi and cellular networks
For neither WiFi nor cellular networks

A10. Both WiFi and 3GPP supports it (3GPP is for cellular networks).

End of W9 Quiz

COMP4336/9336 Mobile data networking
W10 Quiz: SWIPT and RF Sensing

Q1. A mobile fitted with 2.4GHz RF energy harvesting circuit CAN simultaneously communicate and charge while being 5m away from a 2.4GHz WiFi access point operating with a transmission power of 100mW (assume free-space path loss with unit antenna gains, i.e., all antennas have 0dB gains).

True
False

A1. There is 54dB path loss at 5m. Tx power = 100mW = 20dBm. So RSS=20-54=-34dBm, which is OK for communication, but not good for energy harvesting.

Q2. The same antenna cannot be used for both communication and energy harvesting at the same time.

True
False

A2. Power splitting will allow using the same antenna for both tasks.

Q3. Power splitting enables sharing the same antenna for both communication and energy harvesting, but it reduces the capacity of both communication and energy harvesting compared to a dual-antenna system because

a) The antenna is not available for both communication and energy harvesting at the same time
b) The antenna power is reduced for both energy harvesting and communication
c) There is additional noise in the system
d) None of these

A3. Reduced antenna power reduces harvesting capacity and also the signal-to-noise ratio, which reduces communication capacity (Shannon's theorem).

Q4. In power splitting, antenna power can be split disproportionately between the energy harvester and the receiver. For example, only 30% of the received power from the antenna could be allocated to the energy harvester, while 70% would be used for communication to sustain a high signal-to-noise ratio and high data rate. Now assume that a mobile is fitted with a 2.4GHz RF energy harvesting circuit with a harvesting sensitivity of only -10dBm, while its receiver has a sensitivity of -60dBm. The mobile wants to simultaneously communicate and charge while being 1m away from a 2.4GHz WiFi access point operating with a transmission power of 100mW. If the mobile wants to allocate the minimum power to the energy harvester, what would be the power split (approximately) between the energy harvester (EH) and the receiver (assume free-space path loss with 9dBi antennas, i.e., all antennas have 9dB gains)?

a) EH=20%; receiver=80%
b) EH=16%; receiver=84%
c) EH=12%; receiver=88%
d) EH=10%; receiver=90%
e) EH=5%; receiver=95%

A4. Tx power = 100mW = 20dBm. At 1m, free space path loss is 22dB after considering a total of 9+9=18dB antenna gains. Therefore, the receiver antenna power = -2dBm = ~630μW.

The harvester sensitivity = -10dBm = 100μW meaning that it needs to be allocated at least 100μW, which is approximately **16%** (15.87% to be more accurate) of 630μW.

End of W10 Quiz