COMP4336/9336 Mobile data networking
Quiz: IoT and LoRa

1. Which of the following statements is true for LoRa Class A devices?

    a) They can receive data from the gateway only when they upload some data.
    b) The gateway can communicate with these devices at any time.
    c) They are likely to be connected to the grid for continuous power supply.
    d) They typically consume more power than Class B devices.
    e) The gateways are not expected to acknowledge the data transmitted by the device.

    A. A) is the correct statement. All other statements are incorrect.

2. In LoRa networks, why are end devices restricted from transmitting continuously?

A) To comply with regulatory requirements that limit on-air time for devices operating in unlicensed spectrum.
B) To improve the reliability of application servers by reducing network traffic.
C) To conserve energy in gateways by reducing their data processing load.
D) To minimize the time end devices spend in idle mode, maximizing energy efficiency.

A. Correct Answer: A

LoRa devices have duty cycle restrictions primarily to meet regulatory standards, which prevent continuous transmission on unlicensed frequencies. These limits reduce interference, allowing more devices to coexist on the same spectrum and improving overall network efficiency.

3. In LoRa, the maximum symbol duration can be approximately
    a) 50 ms
    b) 40 ms
    c) 35 ms
    d) 60 ms
    e) 32 ms

    A. The correct answer is e) 32 ms.

The maximum SF=12. The minimum channel bandwidth B = 125 kHz

The maximum symbol duration possible = $2^{SF}/B = 2^{12}/125$ ms = 32.768 ms

4. What would be the maximum data rate possible in LoRa (approximately)?

    a) 21 kbps
    b) 54 kbps
    c) 15 kbps
    d) 37 kbps
    e) 11 kbps

    A. The correct answer is a).

Maximum channel bandwidth B = 500 kHz
Minimum SF=7
Maximum coding rate (CR) = 4/5 [Assuming error correction is used]
Maximum data rate possible = SF x B/2SF x CR = 7 x (500x103)/27 x 4/5 = 21.875 kbps

5. A LoRa device using a 500 kHz channel is configured with a coding rate (CR) of 4/5. If the data rate achieved is approximately 21.875 kbps, what is the spreading factor (SF) used in this configuration?

a) 7
b) 8
c) 9
d) 10
e) 11
f) 12

A. The correct answer is SF=7

Let R denote the data rate.
We have $SF/2^{SF} = R/(BxCR)$
Or, $SF/2^{SF} = (21875x5)/(500000x4) = \sim 0.05$

Now try different values of SF to see which one gives ~0.05.

SF=7 yields 7/128 = 0.0546
SF = 8 yields 8/256 = 0.0313
SF = 9 yields 9/512 = 0.0176

We can see that the value of $SF/2^{SF}$ decreasing with increasing SF.

The closest is SF=7.

6. A LoRa network server

a) Has a direct wireless link with a LoRa device.
b) Is responsible for MAC.
c) Is a Layer-1 device.
d) Is connected to a maximum of one LoRa gateway.

A. The correct answer is b).

7. Which of the following statements is correct?

a) In LoRa upchirps, frequency increases exponentially
b) In LoRa upchirps, frequency increases linearly.
c) In LoRa downchirps, frequency increases linearly.
d) In LoRa upchirps, frequency decreases linearly.
e) LoRa chirps always start from the lowest frequency of the channel.

A. The correct answer is b)

8. If SF is downgraded from 12 to 7,

a) Symbol duration is decreased by a factor of 2
b) Symbol duration is decreased by a factor of 32.
c) Symbol duration is decreased by a factor of 4.
d) Symbol duration is decreased by a factor of 8.
e) Symbol duration is decreased by a factor of 16.

A.8 The correct answer is b)

$T_S(SF=12) = 2^{12}/B$, $T_S(SF=7) = 2^7/B$
Decrease factor for $T_S = T_S(SF=12)/T_S(SF=7) = 2^{12}/2^7 = 2^5 = 32$

9. If SF is upgraded from 7 to 11,

a) Symbol duration is increased by a factor of 16.
b) Symbol duration is increased by a factor of 2.
c) Symbol duration is increased by a factor of 4.
d) Symbol duration is increased by a factor of 8.

A.9. The correct answer is a)

Increase factor for $T_S = T_S(SF=11)/T_S(SF=7) = 2^{11}/2^7 = 2^4 = 16$

10. If there are three gateways within the range of a LoRa device,

a) Only the gateway closest to the device would process the packets transmitted by the device
b) **All three gateways would process the packet received from the device**
c) All three gateways would transmit the ACK packets to this device
d) Only the gateway farthest from the device would transmit an ACK packet for this device
e) The gateways would coordinate to decide which gateway should act as the real gateway at any given time

A.10 LoRa gatways are only L1 (layer 1) devices. They all forward the PHY signal to the server and the server decides which gateway to transmit the ACK.

End of LoRa Quiz