Introduction to Internet of Things (IO4041)

Sessional-II Exam

Total Time (Hrs): **1**
Total Marks: **38**
Total Questions: **3**

Date: April 6th 2024

Course Instructor(s)

Dr. Ammar Haider

Student Name	Roll No	Section	Student Signature
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Instructions:

1. Attempt all questions on the answer booklet.
2. If you think some information is missing then make an assumption and state it clearly.

CLO 1: basic ecosystem and architecture of IoT systems

Q1: Multiple Choice Questions — Write the chosen option on answer sheet. [7 marks]

1. What kind of routing is used in Zwave mesh?
   A. source routing
   B. reactive routing
   C. on-demand routing
   D. ad hoc routing

2. In classic Bluetooth piconets, a master can manage up to ____ slave(s).
   A. 1
   B. 2
   C. 5
   D. 7

3. Low power and Lossy Networks (LLNs) are characterized by all of the following, except:
   A. Limited energy in routers
   B. Limited processing power in routers
   C. Non IP communication
   D. Limited bandwidth of links

4. In LOADng routing protocol, Route Replies (RREPs) are sent via broadcasting/flooding.
   A. True
   B. False

5. A router will always drop IPv6 packets that have a _____ address in its destination field.
   A. unique local
   B. link local
   C. global
   D. none of the above options is correct.

6. Anti-theft tags in garment stores contain:
   A. NFC tag
   B. active RFID tag
   C. passive RFID tag
   D. Bluetooth transmitter

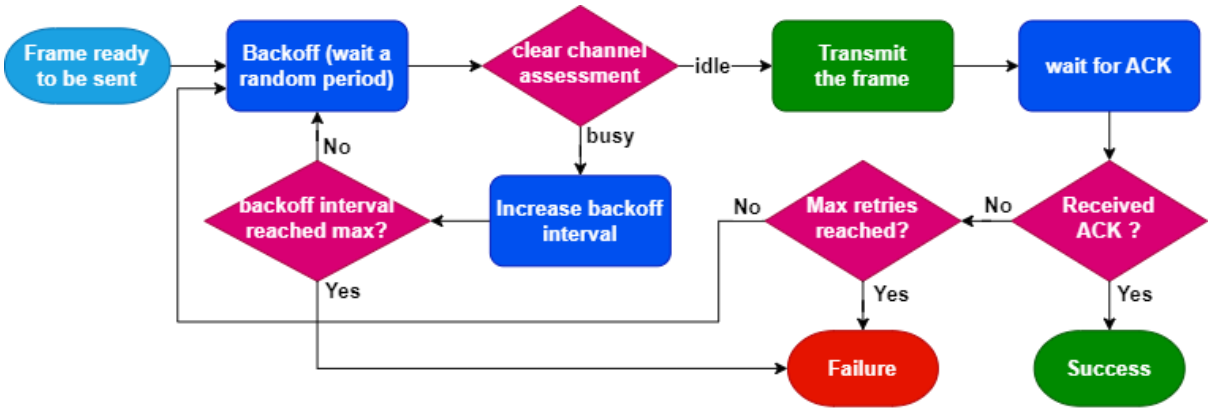
7. 6LoWPAN adaptation layer does NOT include the following functionality
   A. Header compression
   B. Error detection
   C. Packet fragmentation
   D. Mesh networking

CLO 2: the key enabling technologies for developing IoT applications.

Q2: Short answer questions **[6 + 4 + 6 marks]**

A. Given the following flowchart of CSMA/CA in IEEE802.15.4, explain the advantage or reasoning for including the following steps.

i. clear channel assessment
ii. check for max retries
iii. check for max backoff interval



i.

making sure our frame does not collide with an already in-progress transmission.

ii.

We are not receiving an ACK, it means either

- the receiving device has gone offline, OR
- all frame transmissions end up in a collision, due to high interference.

Either way, there is a max limit before the sender gives up, instead of staying stuck in an infinite loop.

iii.

if interference is extreme, the device never finds the medium free. That is why this check is there to ensure a frame does not stay in wait state forever.

B. If a ZigBee network and Bluetooth network operate in the same area, they will interfere with each other since both technologies operate on the same 2.4GHz band. Discuss how Bluetooth manages this interference challenge?

BT uses continuous frequency hopping, a piconet switches to another of the 79 available channels. Interference is not avoidable completely, but because of hopping, any interference will only last for one hop period which is 1/1600s.

C. For each of the given-below IoT applications, recommend one connectivity technology from the following: Zibgbee, LoRaWAN, Bluetooth, 6LoWPAN, none of the above.
Give a brief but good justification for your choice, otherwise no credit will be awarded.

i. A home automation system inclides sensors and actuators (like cameras and door locks) that should be accessible and controllable even when you are away from home.

ii. Pet animals like to wander away on streets and sometimes go missing. A company sells neck-collar-trackers for pets – these allow the owners to see the location of their lost pets anywhere within the city.

iii. High-definition cameras are installed on major road intersections. City traffic control department wants to monitor traffic congestion via live video feeds.

i.

6LoWPAN looks best, since each device will get an IPv6 address that is globally reachable.

Zigbee is also fine since it is designed for home automation use cases, although remote access will be achieved using additional functionality of zigbee controller (hub) which acts as a gateway to IP world.

ii.

Among the given technologies, LoRaWAN is best suited since it is designed for small data transmissions over long distances (hundreds of square km).

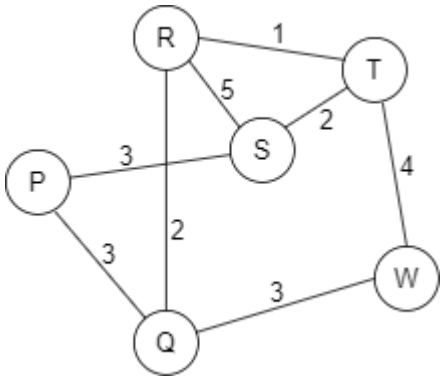
iii.

None of the technologies (zigbee, Bluetooth, lorawan, 6lowpan) is capable of delivering large amounts of data like HD video.

CLO 3: wireless connectivity standards and underlying protocols for IoT applications.

Q3: Practical Problems **[6 + 5 + 4 marks]**

A. For the given graph, construct a DODAG rooted at node **S**. Rank of a node is its distance from root.
It is optional to show the intermediate steps of DODAG formation, but the final state should be indicated in a table format below.



Note: For rank calculation, distance does NOT mean hop count, it means total cost of all links towards root. Final DODAG below

Node	Rank	Parent
P	3	S
Q	5	R
R	3	T
S	0	--
T	2	S
W	6	T

If raw hop count is used for rank (incorrect), the DODAG becomes:

Node	Rank	Parent
P	1	S
Q	2	P or R
R	1	S
S	0	--
T	1	S
W	2	T

B. Consider a LoRaWAN network containing two class B clients, x and y.

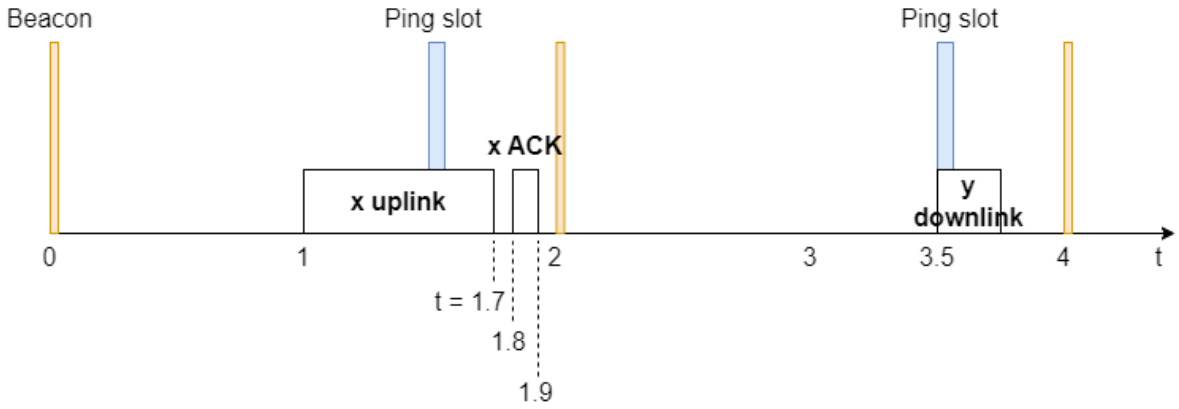
Assume that at t=1s, device x has some data ready to transmit to server. Transmitting this data will consume 700ms. In response, server will send an ACK message that will take 100ms to transmit. Finally, at t=3s, server has a control message ready for device y. This message will take 200ms on the clock.

These are the operational parameters of the network: Rx1delay = 0.1s, Rx2delay = 0.5s Beacon period = 2 seconds. Only one ping slot opens at 1.5 seconds from the start of beacon period. First beacon is transmitted at t=0.

Show on a time scale, when will clients send their uplink packets, and when will the server send its downlink packets. Make sure to consider uplink and downlink latencies if any.

For device x uplink, no latency. Downlink ACK will be sent Rx1delay after uplink message completes.

For device y downlink, there will be some latency, server will wait until the next ping slot before it can transmit.



C. The IPv6 network layer is provided a payload of 350 bytes by the upper (transport) layer. IPv6 packet is prepared with a base header and an unfragmentable 30-byte extension header, and another 20-byte fragmentable extension header. MTU of the is discovered to be 300 bytes, hence fragmentation is essential. Within each fragment, another 8-byte fragment header would be included.

   Show the structure of all the fragments that will be created in order to send this data. For each fragment, clearly label the size of each header and payload block.

Fist fragment can carry 300 – (40+30+8) = 222 bytes at most, but to keep content size a multiple of 8, it will carry only 216. Out of these, 20 are taken up by fragmentable extension header, and remaining 196 bytes are of payload.

IPv6 header 40	Ext header unfrag 30	FH 8	Ext header frag 20	Payload 196

Left over data of transport layer is 350 – 196 = 154 which is within the limit of 216, so all of it goes in 2nd fragment.

IPv6 header 40	Ext header unfrag 30	FH 8	Payload 154