National University of Computer and Emerging Sciences, Lahore Campus

	Course Name:	Internet of Things (IoT)	Course Code:	CN503
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	Section:	ALL	Page(s):	6
	Exam Type:	Mid Term		

Student : Name:_____ **Roll No.**_____

Instruction/Notes: Attempt questions on this paper. You may use rough sheet but it should not be attached to this paper as it will not be marked.

Question 1: Choose the best option for the following MCQs and provide your answer in the below table. Answers outside the table **will not** be considered. **[10 Marks]**

MCQ	Answer	MCQ	Answer
1.1	b	1.6	c
1.2	d	1.7	b
1.3	a/c	1.8	a
1.4	a	1.9	d
1.5	c	1.10	d

1.1 _____ allows us to control electronic components
a) RETful API
b) RESTful API
c) HTTP
d) MQTT

1.2. MQTT stands for _____
a) Message Queue Telemetry Things
b) Message Queuing Transport Telemetry
c) Message Queue Transport of Things
d) Message Queuing Telemetry Transport

1.3 Among the following set of protocols which protocol can be considered 'lightweight'?
a) MQTT
b) HTTP
c) CoAP
d) XMPP

1.4 Raspberry Pi uses which of the following types of instruction sets/architecture?
a) Reduced Instruction Set Computing (RISC)
b) Complex Instruction Set Computing (CISC)
c) Can be a combination of (a) and (b)
d) None of the above

1.5 IaaS stands for _____
a) Infrastructure as a Service
b) Infrastructure as a Software
c) Internet as a Service
d) Internet as a Software

1.6 Mobile Cloud applications move the _____ Power and _____ away from mobile phone and into cloud.
a) Computing and internet
b) Data storage and computing
c) Computing and data storage
d) Internet and computing

1.7 NFC stands for _____
a) Near Fast Communication
b) Near Field Communication
c) Near Field Customer
d) Near Field Connection

1.8 Which category finds an increase in applications targeting health and fitness?
a) Personal IoT
b) Group IoT
c) Community IoT
d) Industrial IoT

1.9 _____ are used to overcome the challenges of managing the resources of the IoT.
a) Clustering
b) Software agents
c) Synchronization techniques
d) Cluster, Software agent, and Synchronization techniques

1.10 Which of the following is NOT an example of Software Defined IoT Network protocol?
a) OpenFlow
b) OpFlex
c) RESTful API
d) CSMA/CD

For the following question, write/draw neat and clean answers. No credit will be given for an incomplete or in-cohesive answer. If you make any assumptions, state them clearly.

Question 2:

Depict the 3-layer and 5-layer architectural model prevalent in Internet of Things by creating suitable diagrams. Also briefly discuss the difference between the respective models. **[5 Marks]**

Question 3:

3.1 Complete the following table by listing examples of (IoT) protocols at the infrastructure and application layer. **[2 Marks]**

Application Protocol (list at least 5)		
Infrastructure Protocol (list at least 1 each)	**Routing**	
	Network	
	Link Layer	
	Physical/Device	

3.2 The following set of short questions relate to Bluetooth Low-Energy (BLE).

[3 Marks]

3.2.1 Describe the lowest layer of the BLE-stack and the purpose/operation of this layer.

Physical (PHY) Layer which transmits and receives bits.

3.2.2 What is the role of Logical Link Control in the BLE-Stack?

provides multiplexing for data channels, fragmentation and reassembly of larger packets.

3.2.3 Define and explain the difference between Generic Attribute Protocol (GATT) and Generic Access Profile (GAP).

The other upper layers are Generic Attribute protocol (GATT) which provides efficient data collection from sensors, and Generic Access Profile (GAP) that allows the application for configuration and operation in different modes such as advertising or scanning, and connection initiation and management

Scenario Overview

You have been given the task of designing and IoT-based solution for the sea-food/fishing supply chain industry. Fish from Karachi harbour are to be transported to distributed ware-housing across the country before being delivered to points-of-sale (retail shops and vendors) for consumer consumption. The general schematic is given in Figure 1.
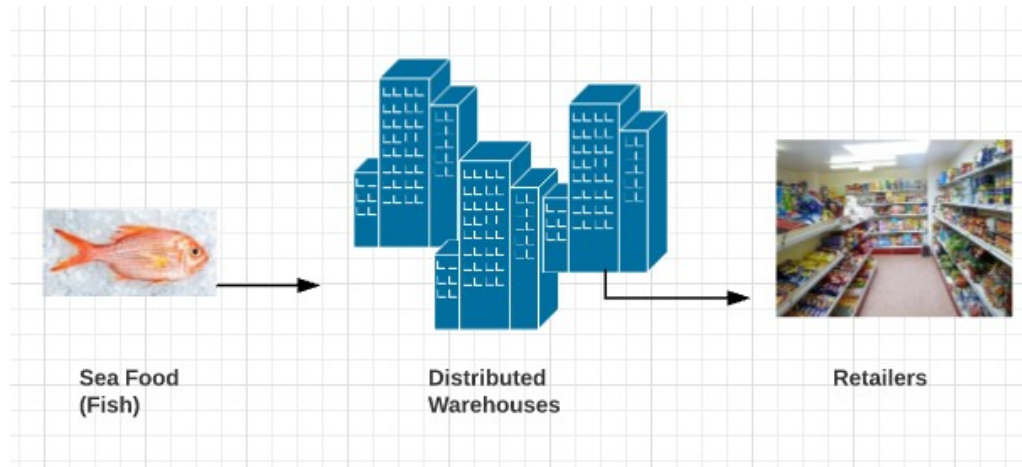

Figure. 1. Producer, logistics, storage and selling of sea-food supply chain

The port/harbour is the **producer**, distributed warehouses are responsible for **logistics and storage** and retailers **sell** it to consumers. You have been given the following set of requirements to generate an IoT solution.

1. All fish/sea-food produced needs to be **tracked** and **recorded** from producer all the way to consumer.

2. There should be **sufficient security in the solution** to avoid tempering of the original product and retailers selling stale/out-dated sea-food. The consumer should be able to validate the genuineness of the product.

3. Given the substantial amount of sea-food consumed, the IoT solution should be **resource-efficient and economical.**

4.1 At the producer, describe the technical solution(s) possible to cater to the above requirements. Note: we need to ensure that only genuine and fresh product is sold to the consumer and the consumer is also able to validate the product/track its history.   [1 Mark]

4.2 Draw a detailed architectural diagram depicting the <u>system workflow</u> as well as the <u>physical</u>, <u>data link</u>, <u>network</u>, <u>transport/security</u> and <u>application layer</u> protocols that are to be used for this end-to-end solution at each avenue. [6 Marks]

[Note: If a heterogeneous solution is used then highlight the necessary steps required to offer compatibility between protocols at each level].

<u>Architectural Diagram (Producer):</u>

<u>Technology Used</u>

Physical Layer:

Data Link Layer:

Network Layer:

Application Layer:

Other:

<u>Architectural Diagram (Warehouse):</u>

<u>Technology Used</u>

Physical Layer:

Data Link Layer:

Network Layer:

Application Layer:

Other:

Architectural Diagram (Retailer & Consumer):

Technology Used

Physical Layer:

Data Link Layer:

Network Layer:

Application Layer:

Other:

4.3 Assume that due to a security lapse at one of the warehouses, a significant amount of sea-food has been destroyed while at another warehouse a few containers of the product are missing. Since, security was a fundamental requirement of your solution, advise the steps an IoT network administrator/forensic analyst should follow in determining the causes of these unfortunate incidents. Also discuss the challenges that the investigator may face.
[3 Marks]

4.3.1 Steps of Investigation [Refer to your solution of 4.2]

4.3.2 <u>**Investigation Challenge(s) and Possible Solution(s)**</u>

<u>**Question 5:**</u> **Please read the given scenario and accordingly provide solutions to the follow-up questions.** **[10 Marks]**

<u>**Scenario Overview**</u>

Lahore development authority has to create an air pollution response center in collaboration with traffic police. This response center is supported by the Safe City Project, which collects information from IoT pollution monitoring devices/sensors, and provides it to the city authorities, traffic police as well as the citizens through their GPS-enabled mobile devices.

<u>**Requirement:**</u>

1. When congestion and air pollutants are high in certain areas traffic lights are **re-configured in real-time** to limit the flow of cars in these parts.

2. Citizens can also **view pollution values in city areas** and avoid traveling/change routes as applicable.

3. **Historical records** of air pollution values need to be **stored** and made available to authorities to enable any future prediction models.

You as an IoT engineer have been given the task of designing the above system from scratch.

5.1 Please recommend the communication technologies required to enable efficient communication among the different stake-holders, i.e. the city municipal authority, traffic police and user devices according to the given requirements. **[1 Mark]**

5.2 Draw a high level/abstract figure of the system described in the scenario. Label the communication links, system/devices, nodes, protocols, etc. based on your recommendations answered in 5.1. [4 Marks]

[Note: If a heterogeneous solution is used then highlight the necessary steps required to offer compatibility between protocols at each level].

5.3 Suppose that the system was initiated with 1150 IoT sensor nodes across the entire city. However, due to the success of the project, the city authority has decided to expand the scheme to include additional rural areas around the city. This requires an addition of further

650 pollution monitoring nodes. What <u>scalability</u> measures have you considered in expanding the already designed system. [3 Marks]

5.4 Can the IoT pollution sensors employ off-the-shelf Arduino or Raspberry Pi based solutions? If so what would be the optimal choice in terms of hardware specification, connectivity requirements and the Operating System to be used? Justify your answer. [2 Marks]