IOT Sessional-1 Solution Marks: 60

Question No. 1 [CLO 01]

Marks: 25 Give short answers to the following questions in the space provided:

1. Give a precise and a complete definition of the Internet of Things.

A system of
> Interrelated computing devices,
> Mechanical and digital machines,
> Objects,
> Animals or People,

provided with unique identifiers and
the ability to transfer data over a network,
without requiring human-to-human or human-to-computer interaction

2. What are Apple HomeKit and Apple HealthKit?

Apple HomeKit and Apple HealthKit are IOT developer tools released by Apple as part of its latest Operating System upgrade.

3. The IOT has evolved from the convergence of three primary technologies; wireless technologies, MEMS, and the Internet. What are these technologies and what role they have in the IOT?

What are these technologies:

Wireless: 6LoWPAN, ZigBee, Wi-Fi, Bluetooth, Cellular etc.
MEMS: A technology that combines computers with tiny mechanical devices such as sensors, valves, gears, mirrors, and actuators embedded in semiconductor chips
Internet: The global computer network for data communication

What role they have in IOT:

Wireless required as access network for the IOT devices in a majority of the IOT applications
MEMS would enable low cost, low power and small sized Smart Objects
Internet would enable global availability and access to real-time IOT data

4. Name some use cases of the Smart City application of the IOT.

> Traffic management
> Water distribution
> Waste management
> Urban security and
> Environmental monitoring

5. What is the primary difference between a typical Power Grid and a Smart Grid?

A typical Power Grid is an Electrical System of Generation, Transmission and Distribution of Electricity.

A Smart Grid is a Power Grid which is equipped with communication abilities to enable bi-directional communication of useful data and information between the customers and the electricity company. It comprises of smart meters, smart appliances, renewable energy resources, and energy efficient operation.

Give short answers to the following questions in the space provided:

1. **Give a precise and generic definition of a Network Protocol.**

A Network Protocol defines the format and the order of messages exchanged between two or more communicating entities, as well as the actions taken on the transmission and/or receipt of a message or other event.

2. **Does FDM or TDM suit packet-switched networks? Or is there a different approach? Justify your answer.**

FDM and TDM both do not suit packet-switched networks, these are suited to circuit-switched networks where low-bandwidth dedicated channels are required for voice communication. Data in packet-switched networks is intermittent and sporadic and dedicated channel allocation is not suitable.

Statistical Multiplexing is implemented in packet-switched networks where each user gets its share of bandwidth based on its data traffic. If only one user is active, he gets full bandwidth, if more users are active, their packets share bandwidth. Packets from different users are intermixed on the shared channel without any TDM or FDM allocations.

3. **Name and define the basic network performance parameters. What are the factors on which each of these performance parameters depend?**

Delay: It is the end-to-end latency in transferring data from one end system to another end system in network. It comprises of transmission delay, propagation delay, queuing delay and processing delay. These depend on file size, channel bandwidths, length and speed of links, router buffer space, network traffic etc.

Loss: The number of packets lost in the network that is packets that were sent by the sender but did not reach the receiver. This happens due to buffer overflow at the routers or checksum fail due to bit errors.

Throughput: Data rate or rate at which bits are transferred between the sender and the receiver.

4. **What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?**

Application Layer:
Transport Layer: to provide transport service (reliable or timely) to applications (processes)
Network Layer: data communication between end systems or hosts and routing of packets through routers
Data Link Layer: data communication across a link
Physical Layer: actual communication of bits in the form of electrical signals based on the link

5. **What is data encapsulation? How does it operate in the Internet? Explain with the help of a Figure.**

Data encapsulation is the process of adding protocol headers by various layers protocols at the sending side to form a packet and removal of those headers by peer layers protocols at the receiver side. Each header has defined fields for implementing the functionality of the protocol (or service of the layer).

In the Internet, a file to be communicated is divided into chunks of data (based on link MTU), first of all Application Layer protocol (http, ftp, smtp etc.) attaches its header to it to form a Message, then Transport Layer protocol (TCP/UDP) appends its header to it form a TCP/UDP Segment, then Network Layer protocol (IP) attaches its header to it to form IP Datagram, then Link Layer protocol (PPP/Ethernet/Wi-Fi) attaches its header and trailer to it to form Link Layer Frame. At the receiver side, protocols at each layer, remove headers to extract their data units and act upon them as defined in the protocol.
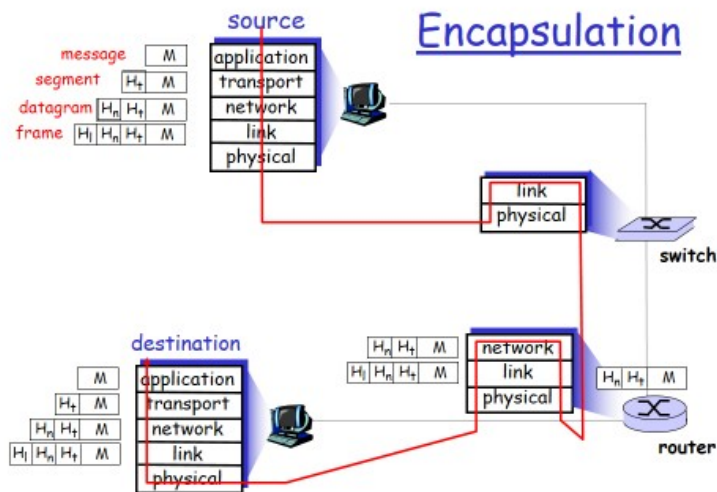
Question No. 3
Marks: 10

1. **A file of 640,000 bits is to be sent from Host A to Host B over a circuit-switched network. Suppose that the two links in the network use TDM with 24 slots and have a bit rate of 1.536 Mbps. Also suppose that it takes 500 msec to establish an end-to-end circuit before Host A can begin to transmit the file. How long does it take for the file to reach from Host A to Host B if the length of each link is 100 m and the speed of each link is 3×10^8 m/s?**

End-to-end delay = Circuit-establishment time + Transmission delay + Propagation delay = 0.5 + 10 + 0.0000006667 = <u>10.500000667 s</u>

Transmission delay is computed as follows:
Each circuit has a transmission rate of (1.536 Mbps)/24 = 64 kbps, so it takes (640,000 bits)/(64 kbps) = 10 seconds to transmit the file.

Propagation delay is computed as follows:
Two links means total distance = 2d = 2 * 100 = 200 m and link speed = 3×10^8 m/s
Total Propagation delay for file = 640,000 * $200/3 \times 10^8$ = 0.42 s
But propagation delay of all bits except last bit overlaps with transmission delay of 10 s therefore propagation delay of only the last bit is added to the total delay which is $200/3 \times 10^8$ = 0.67 μs

2. **A file of 640,000 bits is to be sent from Host A to Host B over a packet-switched network. There is a single router connecting Host A and Host B. The transmission**

rate of link-1 is 10 kbps and link-2 is 1 kbps. The length of each link is 100 m and the speed of each link is 3×10^8 m/s. The router processing delay is 10 μsec and queuing delay is negligible. The packet size is 1000 bits. How long does it take for the file to reach from Host A to Host B?

1 packet End-to-end delay = dtrans1+dprop1+dproc+dtrans2+dprop2
dtrans1 = L/R = 1,000/10,000 = 0.1 s
dprop1 = L * d/s = 1,000 * $100/3\times10^8$ = 0.000333 s which overlaps with dtrans1 so dprop1 = 0.000000333 s
dtrans2 = L/R = 1,000/1,000 = 1 s
dprop2 = L * d/s = 1,000 * $100/3\times10^8$ = 0.000333 s which overlaps with dtrans2 so dprop2 = 0.000000333 s

1 packet End-to-end delay = 0.1+0.000000333+0.00001+1+0.000000333 = 1.100010666 s
File (640 packets) End-to-end delay = 640 * 1.100010666 = <u>704.00682624 s</u>