Internal Assessment Test 1 Scheme & Solution – May 2022

Sub:	Internet of Things					Sub Code:	18CS81	Branch:	ISE	
Date:	4/06/22	Duration:	90 mins	Max Marks:	50	Version/ Sem / Sec:	A/VIII/A,B,C			OBE

		MARKS	CO	RBT
1.	Explain Message Queuing Telemetry Transport	[10]	CO3	L2

At the end of the 1990s, engineers from IBM and Arcom (acquired in 2006 byEurotech) were looking for areliable, lightweight, and cost-effective protocol to monitor and control a large number of sensors and theirdata from a central server location, as typically used by the oil and gas industries.

Their research resulted in the development and implementation of the Message Queuing Telemetry Transport (MQTT) protocol that is now standardized by the Organization for the Advancement of Structured InformationStandards (OASIS).

Considering the harsh environments in the oil and gas industries, an extremely simple protocol with only afew options was designed, with considerations for constrained nodes, unreliable WAN backhaul communications, and bandwidth constraints with variable latencies. These were some of the rationales forthe selection of a client/server and publish/subscribe framework based on the TCP/IP architecture, as shown in Figure

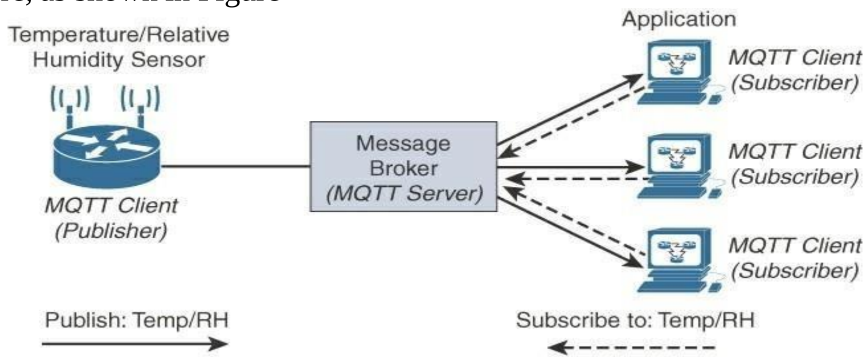


Figure 3.20 *MQTT Publish/Subscribe Framework*

An MQTT client can act as a publisher to send data (or resource information) to an MQTT server acting as an MQTT message broker. In the example illustrated in Figure 3.20, the MQTT client on the leftside is a temperature (Temp) and relative humidity (RH) sensor that publishes its Temp/RH data. The MQTT server (or message broker) accepts the network connection along with application messages, such as Temp/RH data, from the publishers. It also handles the subscription and unsubscription process and pushesthe application data to MQTT clients acting as subscribers.

The application on the right side of Figure 3.20 is an MQTT client that is a subscriber to the Temp/RHdata being generated by the publisher or sensor on the left. This model, where subscribers express a desireto receive information from publishers, is well known. A great example is the collaboration and social networking application Twitter.

With MQTT, clients can subscribe to all data (using a wildcard character) or specific data from theinformation tree of a publisher. In addition, the presence of a message broker in MQTT decouples the datatransmission between clients acting as publishers and subscribers. In fact, publishers and subscribers do noteven know (or need to know) about each other. A benefit of having this decoupling is that the MQTT message broker ensures that information can be buffered and cached in case of network failures. This also means thatpublishers and subscribers do not have to be online at the same time.

2.	Explain the working of LoRaWAN.	[10]	CO2	L2

Lora WAN:

LPWA technologies open new business opportunities to both services providers and enterprises considering IoT solutions. This section discusses an example of an unlicensed-band LPWA technology, known as LoRaWAN, and the next section, "NB-IoT and Other LTE Variations," reviews licensed-band alternatives from the 3rd Generation Partnership Project (3GPP).

Standardization and Alliances

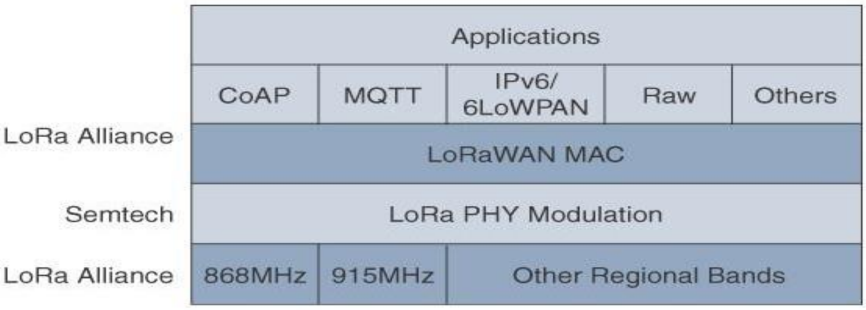


Figure 4-15 *LoRaWAN Layers*

Physical Layer

LoRaWAN 1.0.2 regional specifications describe the use of the main unlicensed sub-GHz frequency bands of 433 MHz, 779–787 MHz, 863–870 MHz, and 902–928 MHz, as well as regional profilesfor a subset of the 902–928 MHz bandwidth. For example, Australia utilizes 915–928 MHz frequency bands, while South Korea uses 920–923 MHz and Japan uses 920–928 MHz.

MAC Layer

This layer takes advantage of the LoRa physical layer and classifies LoRaWAN endpoints to optimize their battery life and ensure downstream communications to the LoRaWAN endpoints

LoRaWAN messages, either uplink or downlink, have a PHY payload composed of a 1-byte MAC header, a variable-byte MAC payload, and a MIC that is 4 bytes in length. The MAC payload size depends on the frequency band and the data rate, ranging from 59 to 230 bytes for the 863–870 MHz band and 19 to 250 bytes for the 902–928 MHz band. Figure 4-16 shows a high-level LoRaWAN MACframe format.

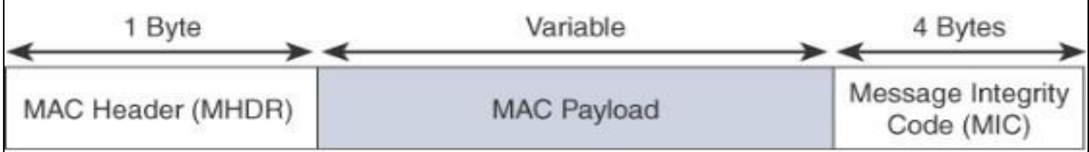


Figure 4-16 *High-Level LoRaWAN MAC Frame Format*

Topology

LoRaWAN topology is often described as a “star of stars” topology. As shown in Figure 4-17, the infrastructure consists of endpoints exchanging packets through gateways acting as bridges, with a central LoRaWAN network server. Gateways connect to the backend network using standard IP connections, and endpoints communicate directly with one or more gateways.

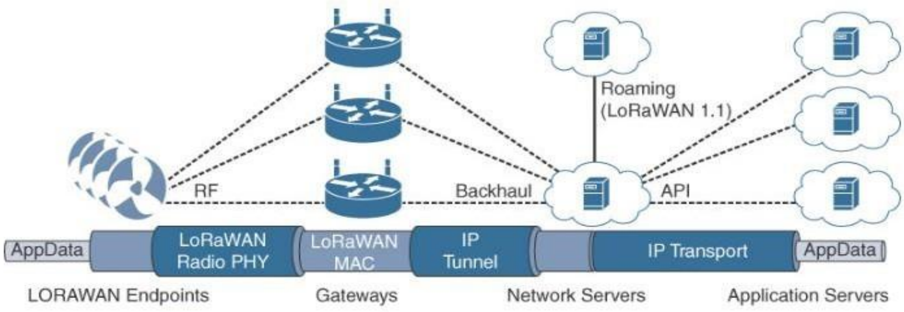


Figure 4-17 *LoRaWAN Architecture*

Security

Security in a LoRaWAN deployment applies to different components of the architecture, as detailed in Figure 4-18. LoRaWAN endpoints must implement two layers of security, protectingcommunications and data privacy across the network.

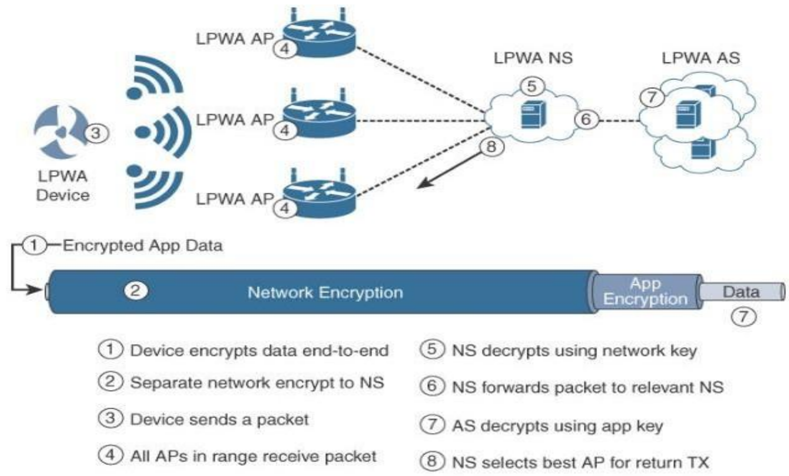


Figure 4-18 *LoRaWAN Security*

3. Explain about IEEE 1901.2a IoT Access Technology in detail. [10] CO2 L2

IEEE 1901.2a IoT Access Technology:

This is a standard for Narrowband Power Line Communication (NB-PLC). NB-PLC leverages a narrowband spectrum for low power, long range, and resistance to interference over the same wires that carry electric power. NB-PLC is often found in use cases such as the following:

Smart metering: NB-PLC can be used to automate the reading of utility meters, such as electric, gas, and water meters. This is true particularly in Europe, where PLC is the preferred technology for utilities deploying smart meter solutions.

■ Distribution automation: NB-PLC can be used for distribution automation, which involves monitoringand controlling all the devices in the power grid.

■ Public lighting: A common use for NB-PLC is with public lighting—the lights found in cities andalong streets, highways, and public areas such as parks.

■ Electric vehicle charging stations: NB-PLC can be used for electric vehicle charging stations, where thebatteries of electric vehicles can be recharged.

Microgrids: NB-PLC can be used for microgrids, local energy grids that can disconnect from thetraditional grid and operate independently.

■ Renewable energy: NB-PLC can be used in renewable energy applications, such as solar, wind power,hydroelectric, and geothermal heat.

All these use cases require a direct connection to the power grid. So it makes sense to transport IoT dataacross power grid connections that are already in place.

Standardization and Alliances:

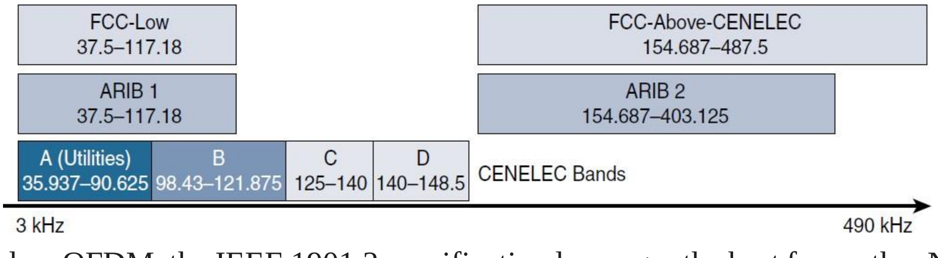
The first generations of NB-PLC implementations have generated a lot of interest from utilities in Europe but have often suffered from poor reliability, low throughput , lack of manageability, and poor interoperability.

The IEEE 1901.2a standard does have some alignment with the latest developments done in other IEEEworking groups. For example, using the 802.15.4e Information Element fields eases support for IEEE 802.15.9 key management. In addition, a dual-PHY approach is possible when combined with IEEE802.15.4g/e on endpoints.

Physical Layer

NB-PLC is defined for frequency bands from 3 to 500 kHz. Much as with wireless sub-GHz frequency bands, regional regulations and definitions apply to NB-PLC. The IEEE 1901.2 working group has integrated support for all world regions in order to develop a worldwide standard.

Figure shows the various frequency bands for NB-PLC. Notice that the most well known bands are regulated by CENELEC and the FCC, but the Japan Association of Radio Industries and Businesses (ARIB) band is also present. The two ARIB frequency bands are ARIB 1, 37.5–117.1875 kHz, and ARIB2, 154.6875–403.125 kHz.



Based on OFDM, the IEEE 1901.2 specification leverages the best from other NB-PLC OFDM technologies that were developed previously. Therefore, IEEE 1901.2a supports the largest set of coding and enables both robustness and throughput. The standard includes tone maps and modulations, such as robust modulation (ROBO), differential binary phase shift keying (DBPSK), differential quadrature phaseshift keying (DQPSK), differential 8-point phase shift keying (D8PSK) for all bands, and optionally 16 quadrature amplitude modulation (16QAM) for some bands.

One major difference between IEEE 802.15.4g/e and IEEE 1901.2a is the full integration of different types of modulation and tone maps by a single PHY layer in the IEEE 1901.2a specification

4	Illustrate the COAP Message format usage.	[10]	CO3	L3

CoAP

Constrained Application Protocol (CoAP) resulted from the IETF Constrained RESTful Environments (CoRE) working group's efforts to develop a generic framework for resource-oriented applications targeting constrained nodes and networks.

From a formatting perspective, a CoAP message is composed of a short fixed-length Header field (4 bytes),a variable-length but mandatory Token field (0–8 bytes), Options fields if necessary, and the Payload field.Figure 3.17 details the CoAP message format, which delivers low overhead while decreasing parsing complexity.

Figure 3.17 *CoAP Message Format*

As illustrated in Figure 3.18, CoAP communications across an IoT infrastructure can take various paths.

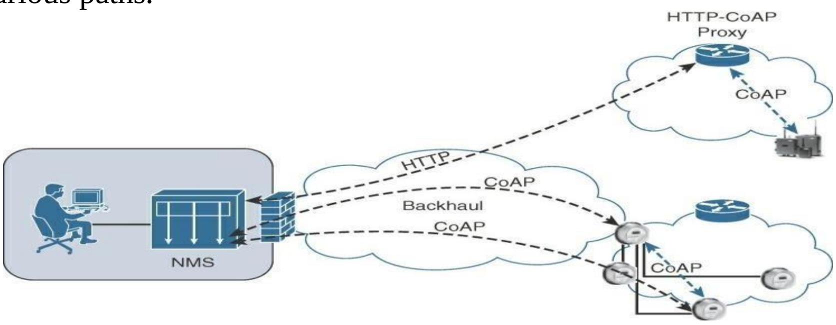


Figure 3.18 *CoAP Communications in IoT Infrastructures*

Connections can be between devices located on the same or different constrained networks or betweendevices and generic Internet or cloud servers, all operating over IP. Proxy mechanisms are also defined, andRFC 7252 details a basic HTTP mapping for CoAP. As both HTTP and CoAP are IP-based protocols, theproxy function can be located practically anywhere in the network, not necessarily at the border between constrained and non-constrained networks.

5 (a)	Explain the key advantages of the IP Suite for IoT	[05]	CO3	L2

The Key Advantages of Internet Protocol :

- Open and standards-based
- Versatile
- Ubiquitous
- Scalable
- Manageable and highly secure
- Stable and resilient
- Consumers' market adoption
- The innovation factor

(b)	Explain RPL in detail	[05]	CO3	L2

The IETF chartered the RoLL (Routing over Low-Power and Lossy Networks) working group to evaluate allLayer 3 IP routing protocols and determine the needs and requirements for developing a routing solution forIP smart objects. After study of various use cases and a survey of existing protocols, the consensus was thata new routing protocol should be developed for use by IP smart objects, given the characteristics and requirements of constrained networks.
This new distance-vector routing protocol was named the **IPv6 Routing Protocol for Low Power and Lossy Networks (RPL).**

RPLis based on the concept of a directed acyclic graph (DAG). A DAG is a directed graph where no cyclesexist. This means that from any vertex or point in the graph, it cannot follow an edge or a line back to thissame point. All of the edges are arranged in paths oriented toward and terminating at one or more root nodes.Figure 3.8 shows a basic DAG.

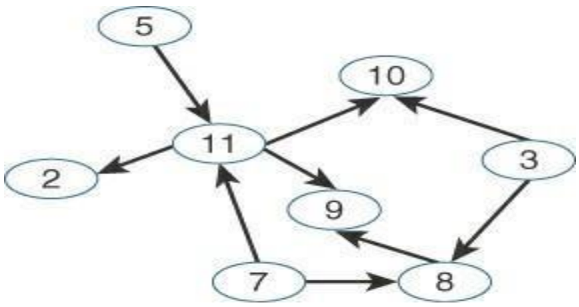


Figure 3.8 *Example of a Directed Acyclic Graph (DAG)*

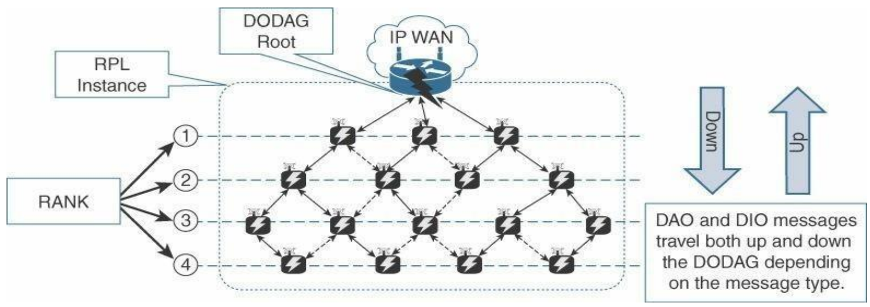


Figure 3.10 *RPL Overview*

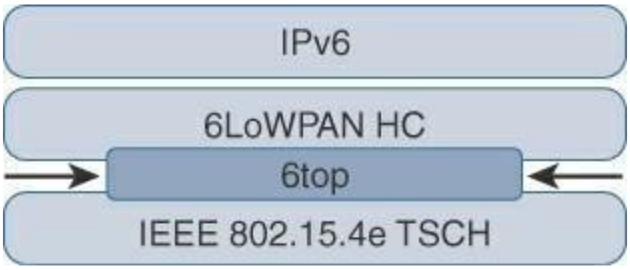
RPL messages, such as DIO and DAO, run on top of IPv6. These messages exchange and advertise downstream and upstream routing information between a border router and the nodes under it. As illustrated in Figure 3.10, DAO and DIO messages move both up and down the DODAG, depending on the exact message type.

6	Interpret 6Ti SCH.	[10]	CO3	L3

6TiSCH:

To standardize IPv6 over the TSCH mode of IEEE 802.15.4e (known as 6TiSCH), the IETF formed the 6TiSCH working group. This working group works on the architecture, information model, and minimal 6TiSCH configuration, leveraging and enhancing work done by the 6LoWPAN working group, RoLL workinggroup, and CoRE working group. The RoLL working group focuses on Layer 3 routing for constrained networks.

The IEEE 802.15.4e standard defines a time slot structure, but it does not mandate a scheduling algorithm forhow the time slots are utilized. This is left to higher-level

	protocols like 6TiSCH. Scheduling is critical because it can affect throughput, latency, and power consumption. Figure 3.7 shows where 6top resides inrelation to IEEE 802.15.4e, 6LoWPAN HC, and IPv6. HC  **Figure 5-7** *Location of 6TiSCH's 6top Sublayer*			