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15CS81

Eighth Semester B.E. Degree Examination, Dec.2019/Jan.2020

Internet of Things Technology

Time: 3 hrs.

Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. What is IOT? Explain evolutionary phases of the internet. (06 Marks)
 b. Explain Access Network sublayer with a neat diagram. (06 Marks)
 c. What are the elements of one M2M IOT architecture? Explain. (04 Marks)

OR

- 2 a. Explain the functionality of IOT network management sub layer. (05 Marks)
 b. Describe IOT World Forum (IOTWF) Standardized architecture. (07 Marks)
 c. Compare and contrast IT and OT. (04 Marks)

Module-2

- 3 a. With a neat diagram, explain how actuators and sensors interact with physical world. Classify actuators based on energy type. (08 Marks)
 b. List out the limitations of the smart objects in WSNs and explain the data aggregation in WSN with a neat diagram. (08 Marks)

OR

- 4 a. What is Zigbee? Explain 802.15.4 physical layer, MAC layer, and security. (08 Marks)
 b. Explain LoRaWAN standard and alliance MAC layer and security. (08 Marks)

Module-3

- 5 a. With a neat diagram, explain 6LOWPAN protocol header comparison and fragmentation. (08 Marks)
 b. List and explain the key advantages of internet protocol. (04 Marks)
 c. Explain RPL encryption and authentication on constraint nodes. (04 Marks)

OR

- 6 a. Explain tunneling legacy SCADA over IP networks and SCADA protocol translation with a neat diagram. (08 Marks)
 b. Describe MQTT framework and message format in detail. (08 Marks)

Module-4

- 7 a. Explain the elements of Hadoop with a neat diagram. (07 Marks)
 b. Explain neural network in machine learning with a detailed example. (05 Marks)
 c. Describe the components of FNF. (04 Marks)

OR

- 8 a. Explain Formal Risk Analysis Structures. (08 Marks)
 b. Explain the Purdue model for control hierarchy and OT network characteristics. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
 2. Any revealing of identification, appeal to evaluator and/or equations written eg. #2+8 = 50, will be treated as malpractice.

15CS81

Module-5

- 9 a. Explain the following with respect to Arduino programming.
- i) Structure
 - ii) Functions
 - iii) Variables
 - iv) Flow control statements
 - v) Data type
 - vi) Constants.
- b. Explain Raspberry Pi learning board.
- (08 Marks)
(08 Marks)

OR

- 10 a. Write a python program on Raspberry Pi to blink an LED. (06 Marks)
- b. Explain Smart city security architecture. (06 Marks)
- c. Write a short note on :
- i) IOT challenges
 - ii) Backhaul Technologies.
- (04 Marks)

Time: 3hrs

Internet of Things Technology.

Subcode: 15CS81

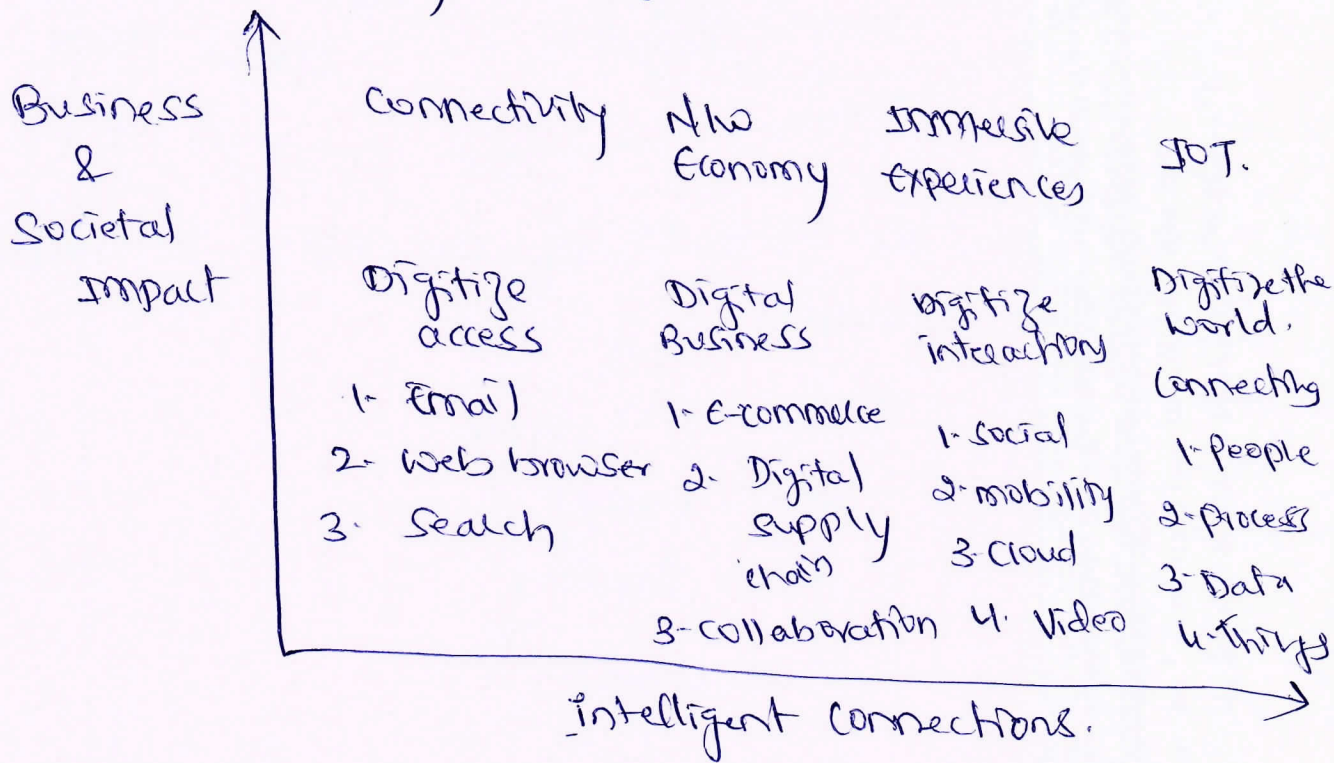
Max. marks:

Module 01.

80.

1.a. What is IOT? Explain evolutionary phase of the internet? 06 marks.

From self-driving drones delivering your grocery order to sensors in your clothing monitoring your health, the world you know is set to undergo a major technological shift forward. This shift is known collectively as the IOT.

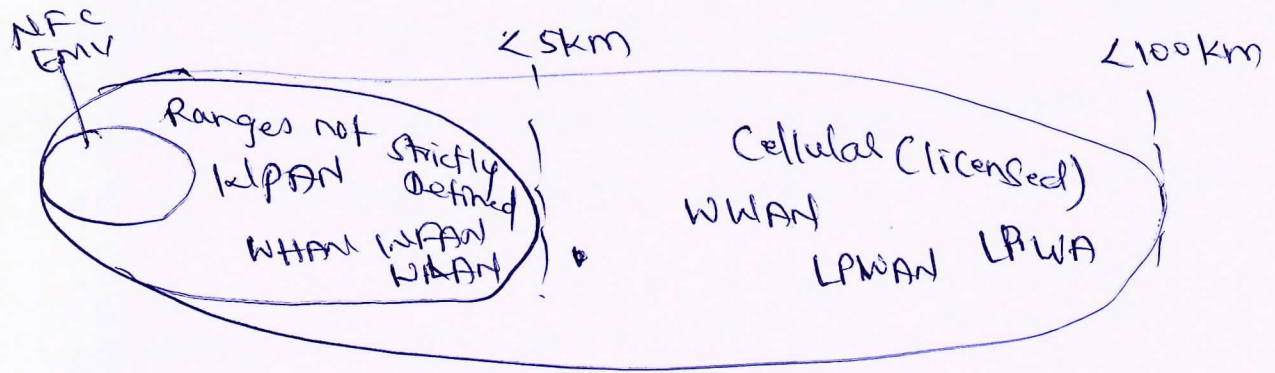


1.b. Explain Access Network Sublayer with a neat diagram? 20m

There is a direct relationship between the IOT network technology you choose & the type of connectivity topology this technology allows. Each technology was designed with a certain number of use cases in mind.

As IoT continues to grow exponentially, you will encounter a wide variety of applications & special use cases.

One key parameter determining the choice of access technology is the range between the smart object & the information collector.



Q What are the elements of OneM2M IoT architecture? Explain? (4 marks)

1. Applications layer.

Smart Energy,
Asset Tracking.

Fleet Mgmt.

2. Services layer.

OneM2M includes a common services horizontal framework supporting Restful API's

3. Network layer.

Applications talk to the API to communicate to sensors.

2.a. Explain the functionality of IOT n/w management sublayer? or mark.

IP, TCP & UDP bring connectivity to IOT n/w, upper-layer protocols need to take care of data transmission between the smart objects & other systems

multiple protocols have been leveraged or created to solve IOT data communication problems.

Some networks rely on a push model, whereas others rely on a pull model & multiple hybrid approaches are also possible.

2.b. Describe IOT world forum (IOTWF) standardized architecture? or mark.

In 2014, the IOTWF architectural committee published a seven-layer IOT architectural reference model.

While various IOT reference models exist, the one put forth by the IOT world forum offers a clean, simplified perspective on IOT & includes edge computing, data storage & access.

It provides a succinct way of visualizing IOT from a technical perspective.

Each of the seven layers is broken down into specific functions & security encompasses the entire model.

Details the IOT Reference model published by the IOTvF

Levels.

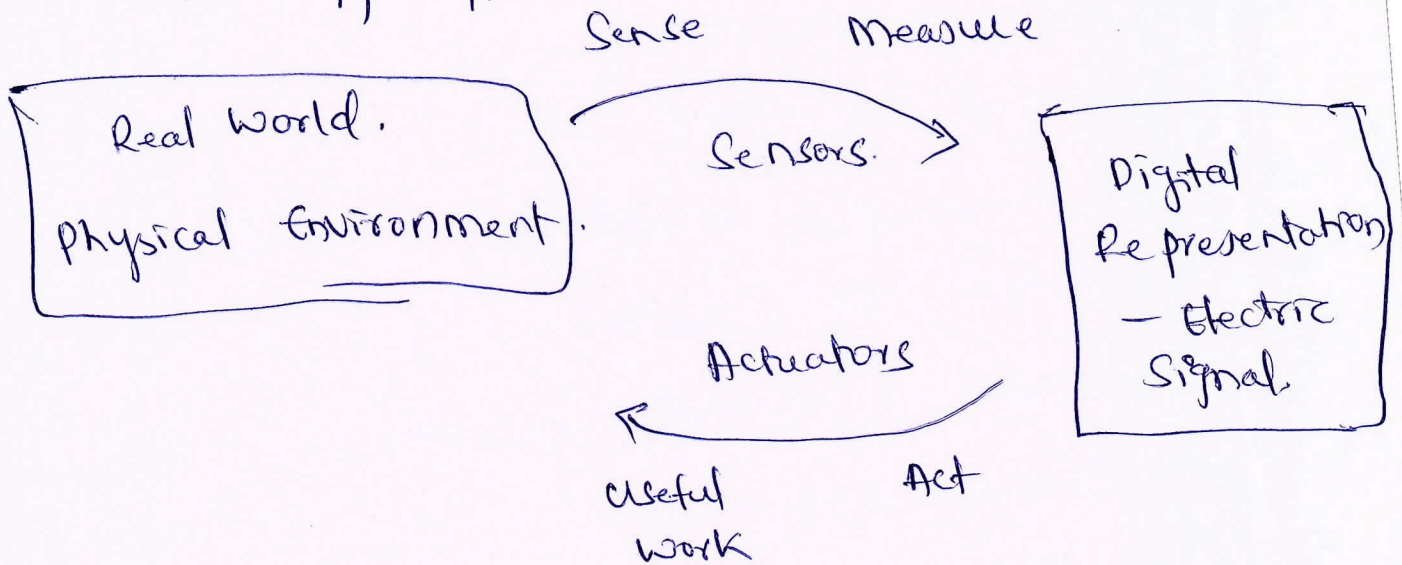
7. Collaboration & Processes.
6. Application
5. Data Abstraction.
4. Data accumulation
3. Edge Computing.
2. Connectivity.
1. Physical Devices & Controllers.

2.c. Compare & contrast IT and OT. 04 marks.

Criteria	Industrial OT Network	Enterprise IT Network
1. Operational focus	Keep the business operating 24x7	manage the computers, data & employee communication system a secure way.
2. priorities	<ol style="list-style-type: none">1. Availability.2. Integrity.3. Security	<ol style="list-style-type: none">1. Security.2. Integrity.3. Availability.
3. Types of data.	monitoring, control, & supervisory data.	Voice, video, transactions & bulk data.
4. Security	Controlled Physical access to devices	Devices & users authenticated to the network.

Module 02.

3a. With a neat diagram, explain how actuators & sensors interact with physical world. classify actuators based on energy type. 08 marks.



How sensors & actuators interact with the physical world.

Much like sensors, actuators also vary greatly in function, size, design and so on.

Some common ways that they can be classified include the following.

1. Type of motion.
2. power.
3. Binary or continuous.
4. Area of application.
5. Type of energy.

Table 3.2 shows actuators classified by energy type & some examples for each type.

Type.

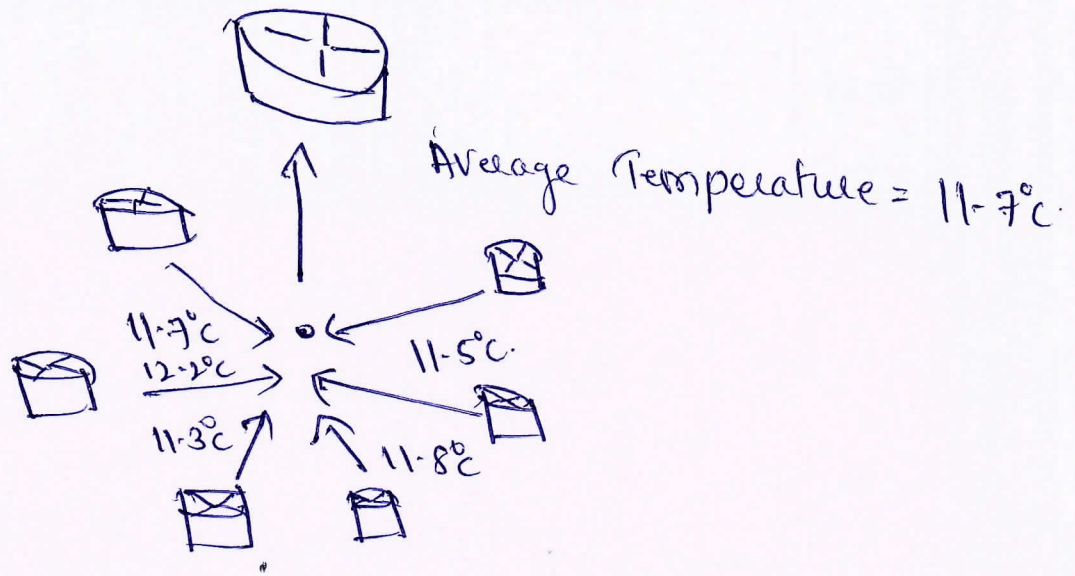
1. Mechanical actuators.
2. Electrical actuators
3. Electromechanical actuators
4. Electromagnetic actuators.
5. Hydraulic & pneumatic actuators.
6. Smart material actuators.
7. micro & nano actuators.

3.b. List out the limitations of the smart objects in WSNs & explain the data aggregation in WSN with a neat diagram. 08 marks.

Limitations of the Smart objects in WSNs

1. Limited Processing power.
2. Limited memory.
3. Costly Communications.
4. Limited transmission speeds.
5. Limited power.

fig. Shows an example of such a data aggregation function in a WSN where temperature readings from a logical grouping of temperature sensors are aggregated as an



Data Aggregation in Wireless Sensor Networks

These data aggregation techniques are helpful in reducing the amount of overall traffic in WSNs with very large numbers of deployed smart objects.

wirelessly connected smart objects generally have one of the following two common patterns.

1. event-driven.
2. periodic.

4.a. What is Zigbee? Explain 802.15.4 physical layer, MAC layer & security? 08 marks.

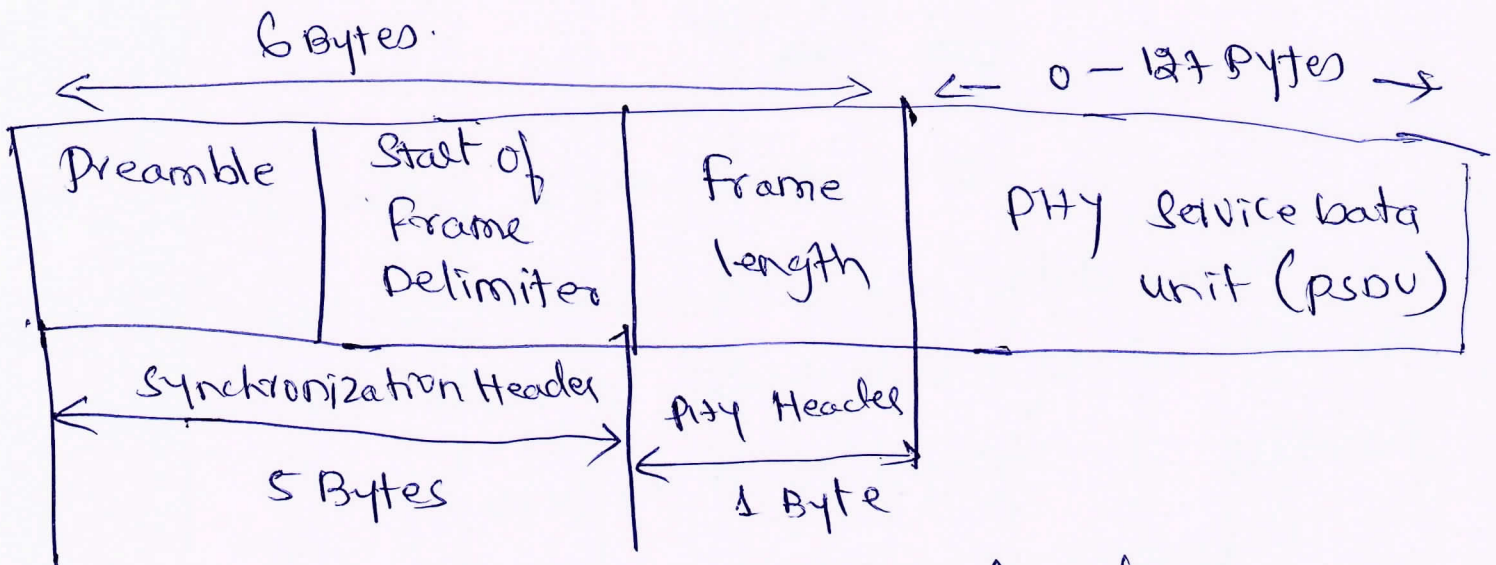
Zigbee promoted through the ZigBee alliance. Zigbee defines upper-layer components as well as application profiles.

Physical layer.

The 802.15.4 standard supports an extensive number of PHY options that range from 2.4 GHz to sub-GHz frequencies in ISM bands.

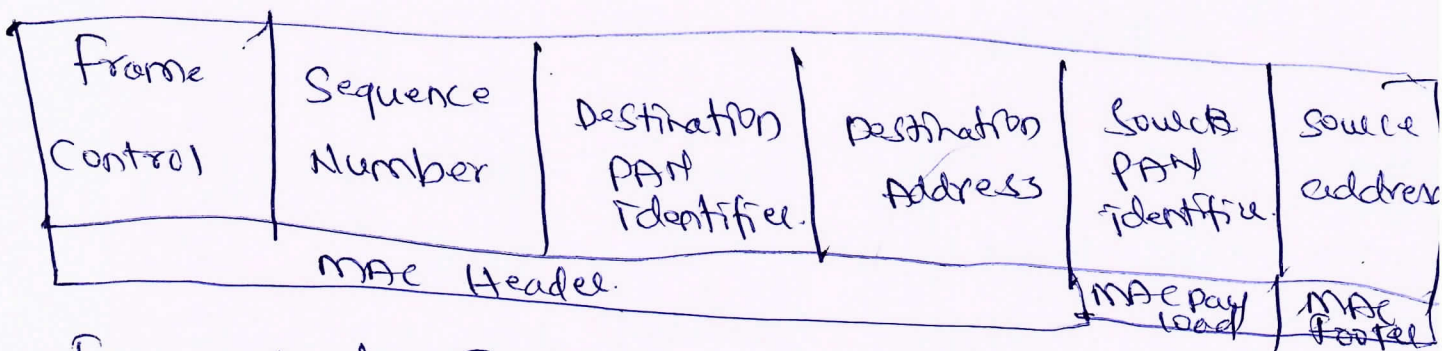
The original physical layer transmission options were as follows.

1. 2.4 GHz, 16 channels, with a data rate of 250 kbps
2. 915 MHz, 10 channels, with a data rate of 40 kbps.
3. 868 MHz, 1 channel, with a data rate of 20 kbps.



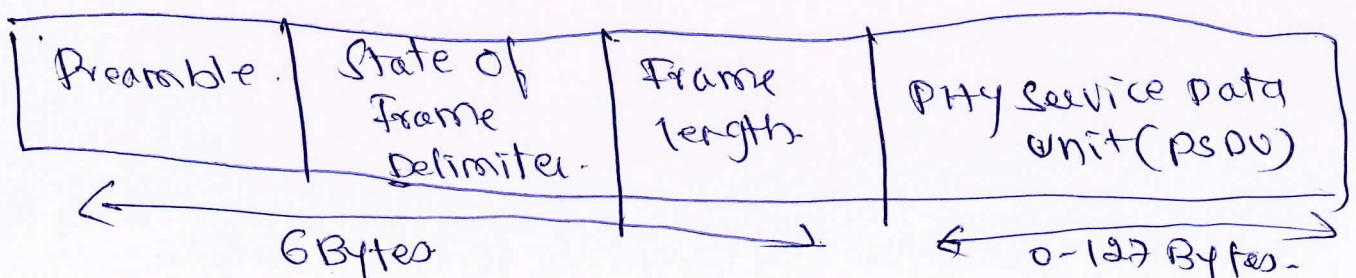
IEEE 802.15.4 PHY format.

MAC Layer.



From payload Frame check Sequence.

PHY Frame.



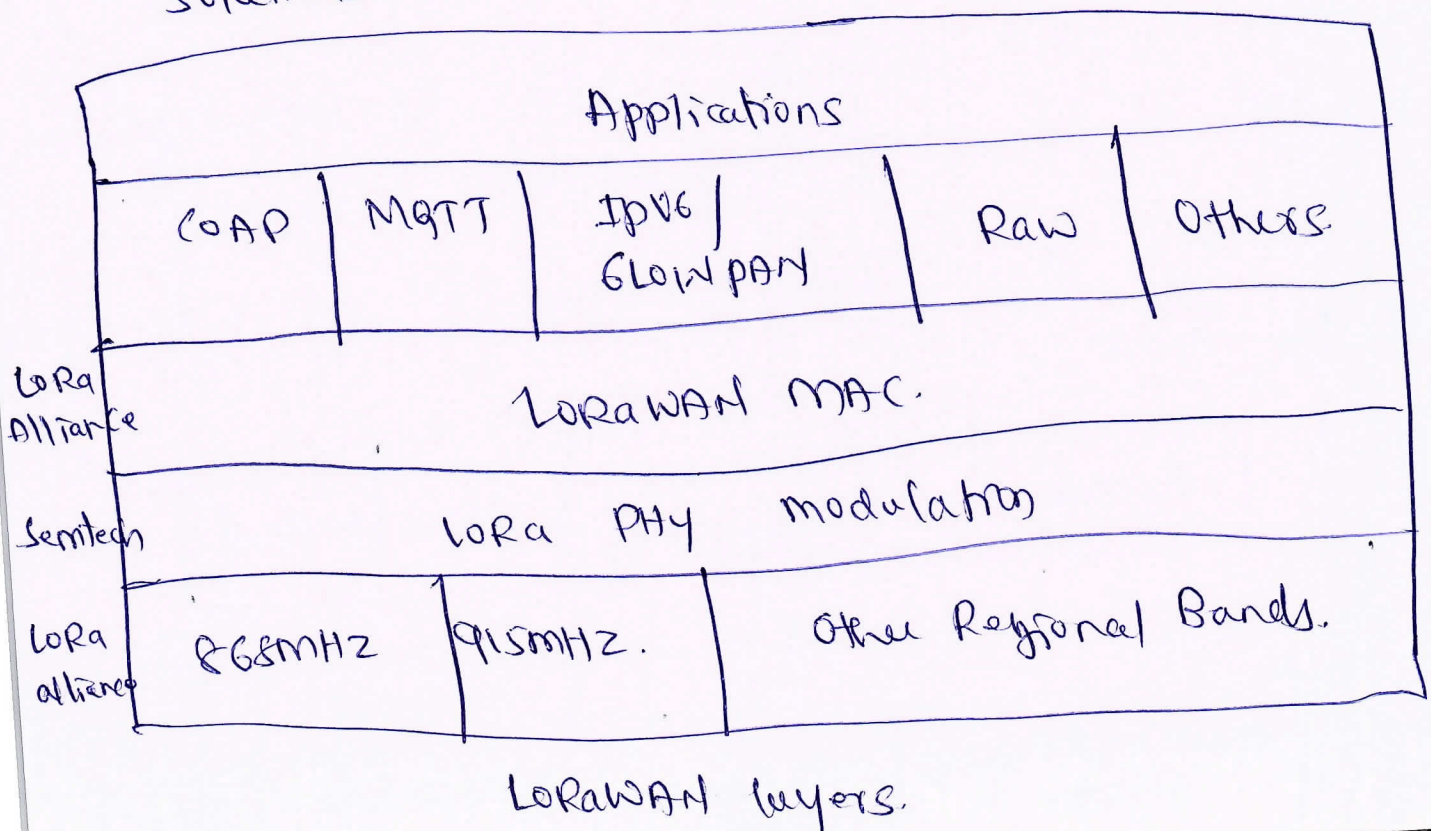
Security.

The IEEE 802.15.4 Specification uses Advanced Encryption Standard (AES) with a 128-bit key length as the base encryption algorithm for securing its data.

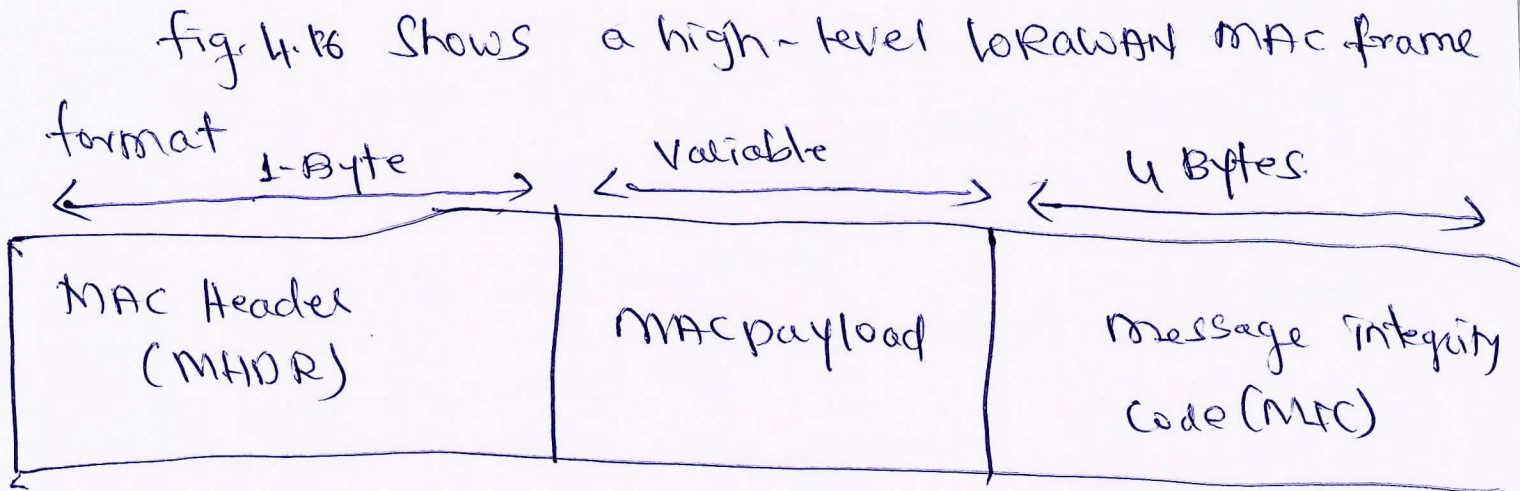
4b. Explain LoRaWAN standard and Alliance MAC layer & security? 8 marks.

In recent years, a new set of wireless technologies known as low-power wide Area (LPWA) has received a lot of attention from the industry & press particularly well adapted for long-range & battery-powered endpoints,

LPWA technologies open new business opportunities to both services providers & enterprises considering IoT solutions.



LoRaWAN messages, either uplink or downlink, have a PHY payload composed of a 1-byte MAC header, a variable-byte MAC payload & a MIC that is 4 bytes in length.



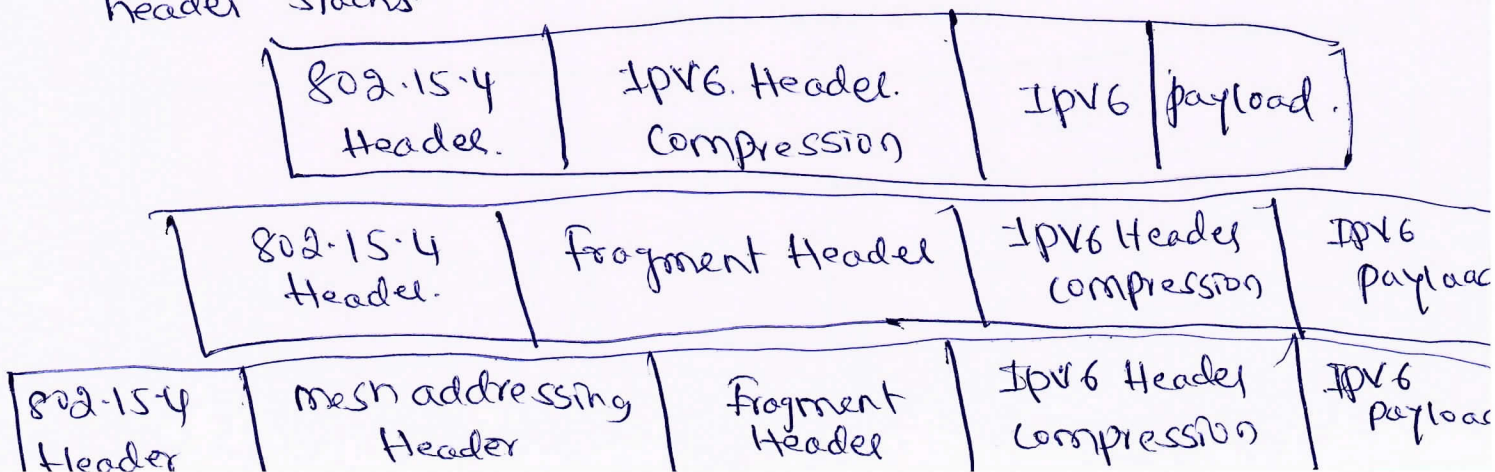
High-level LoRaWAN MAC frame format.

Security :- Security in a LoRaWAN deployment applies to different components of the architecture.

Module-03.

Sa. with a neat diagram, explain 6LoWPAN protocol header comparison & fragmentation. 08 marks.

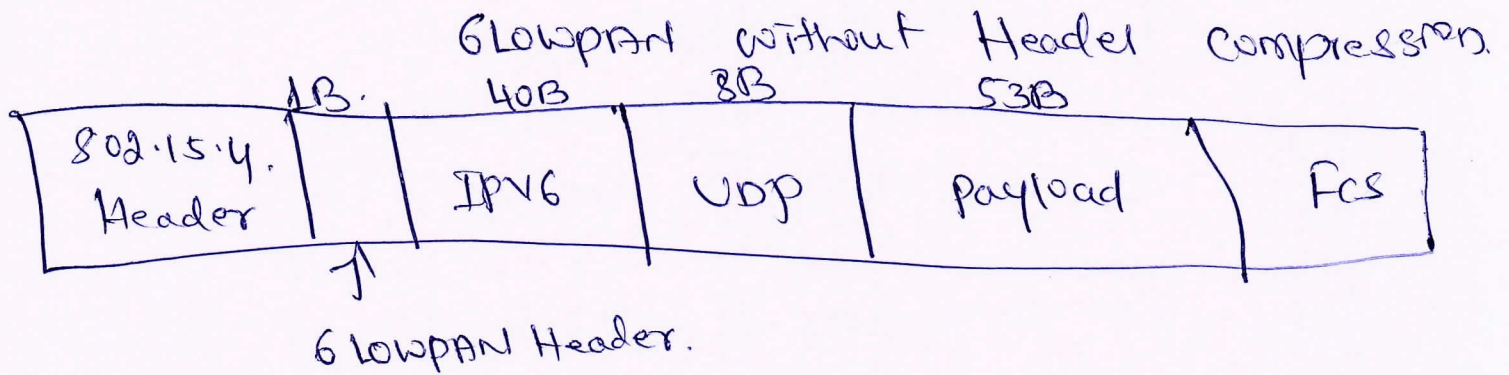
Fig. shows some examples of typical 6LoWPAN header stacks



Header Compression

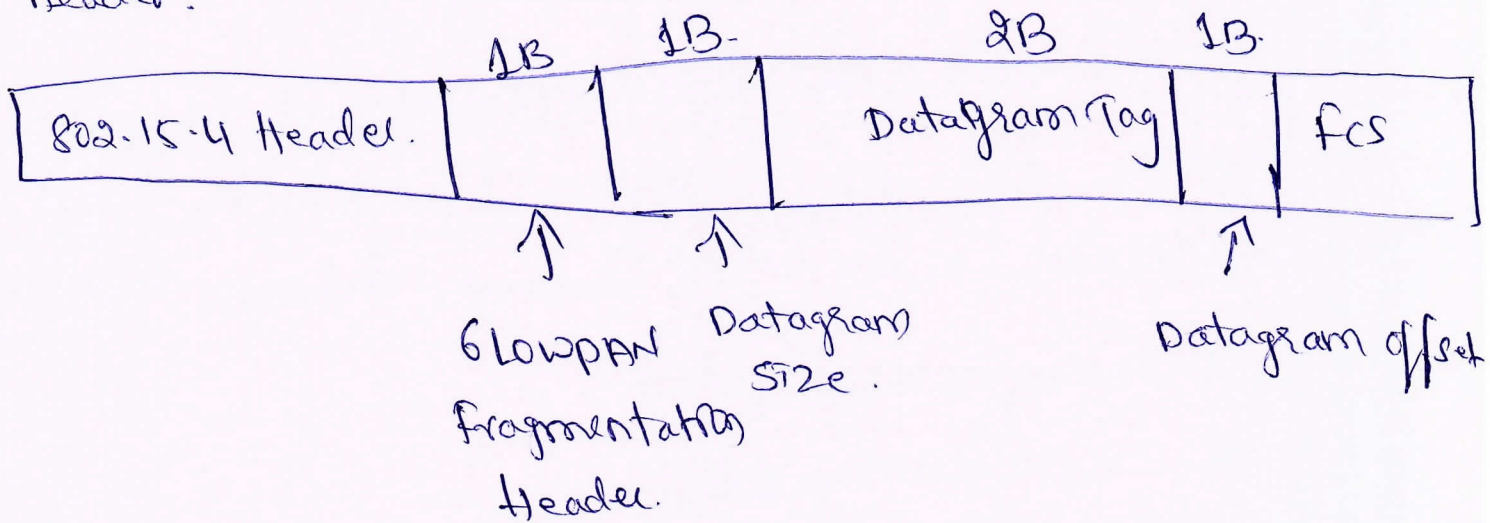
IPv6 Header Compression for 6LoWPAN was defined initially in RFC 4944 & subsequently updated by RFC 6282.

Fig. 5-4 highlights an example that shows the amount of reduction that is possible with 6LoWPAN header compression.



Fragmentation

Fig. provides an overview of a 6LoWPAN fragmentation header.



6LoWPAN fragmentation header.

5.b. List & explain the key advantages of Internet Protocol. 04 marks.

1. Open & Standard based.
2. Versatile.
3. Ubiquitous.
4. Scalable.
5. Manageable & highly secure.
6. Stable & resilient.
7. Consumers market adoption
8. The innovation factor.

5c. Explain RPL encryption & authentication on constraint nodes. 04 marks.

The RPL Specification was published as RFC 6550 by the Roll working group.

To cope with the constraints of computing & memory that are common characteristics of constrained nodes, the protocol defines two modes:

- 1. Storing mode.
- 2. Non-Storing mode.

RPL is based on the concept of a directed acyclic graph (DAG).

A DAG is a directed graph where no cycles exist.

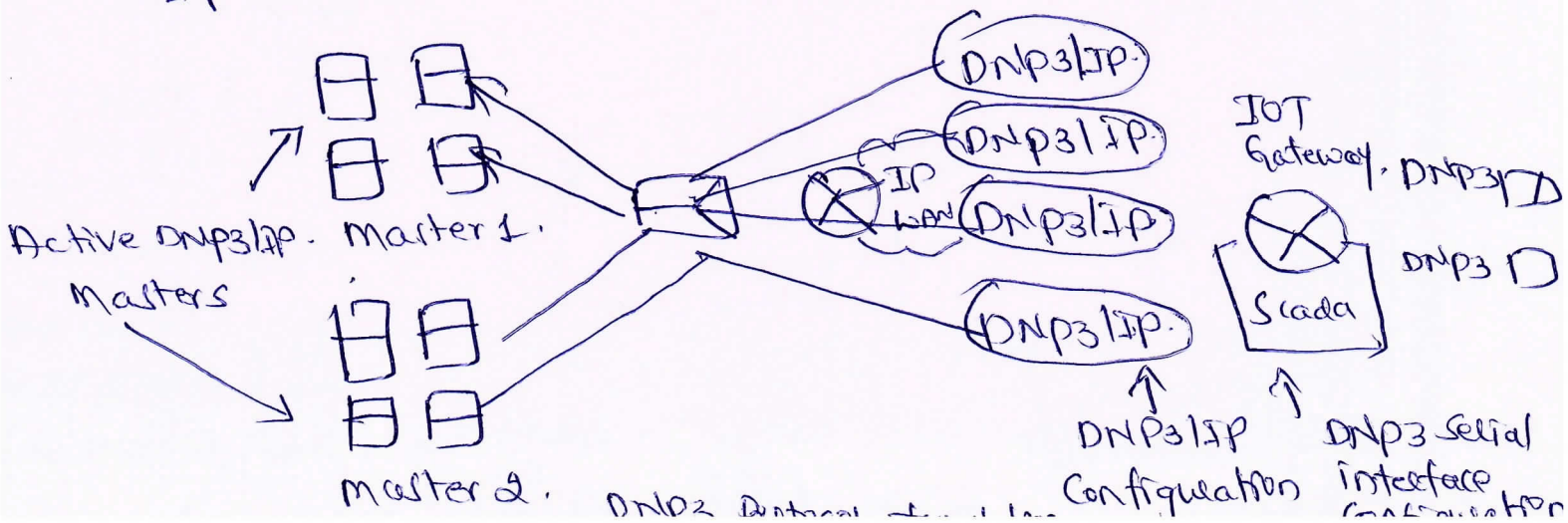
6a. Explain tunneling legacy SCADA over IP networks and SCADA protocol translation with a neat diagram? osmark

SCADA protocol translation

An alternative to a raw socket connection for transporting legacy serial data across an IP network is protocol translation. With protocol translation, the legacy serial protocol is translated to a corresponding IP version.

For example, Fig. shows two serially connected DNP3 RTUs & two master applications supporting DNP3 over IP that control & pull data from the RTUs.

The IOT gateway in this figure performs a protocol translation function that enables communication between the RTUs and servers, despite the fact that a serial connection is present on one side & an IP connection is used on the other.



b. Describe MQTT framework & message format in detail. 8marks

At the end of the 1990's engineers from IBM & Arcorn were looking for a reliable, lightweight, and Cost-Effective Protocol to monitor & control a large number of sensors & their data from a central Server location, as typically used by the oil & gas industries.

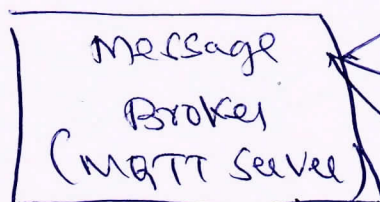
Their research resulted in the development & implementation of Message Queuing Telemetry Transport (MQTT) Protocol that is now standardized by the organization for the advancement of structured information standards (OASIS)

Considering the harsh environments in the oil & gas industries, an extremely simple protocol with only a few options was designed, with considerations for constrained nodes.

Temperature /
Relative Humidity
Sensor.



MQTT Client
(Publisher)
publish: Temp/RH



Application



MQTT Client
(Subscribe)



MQTT Client
(Subscribe)

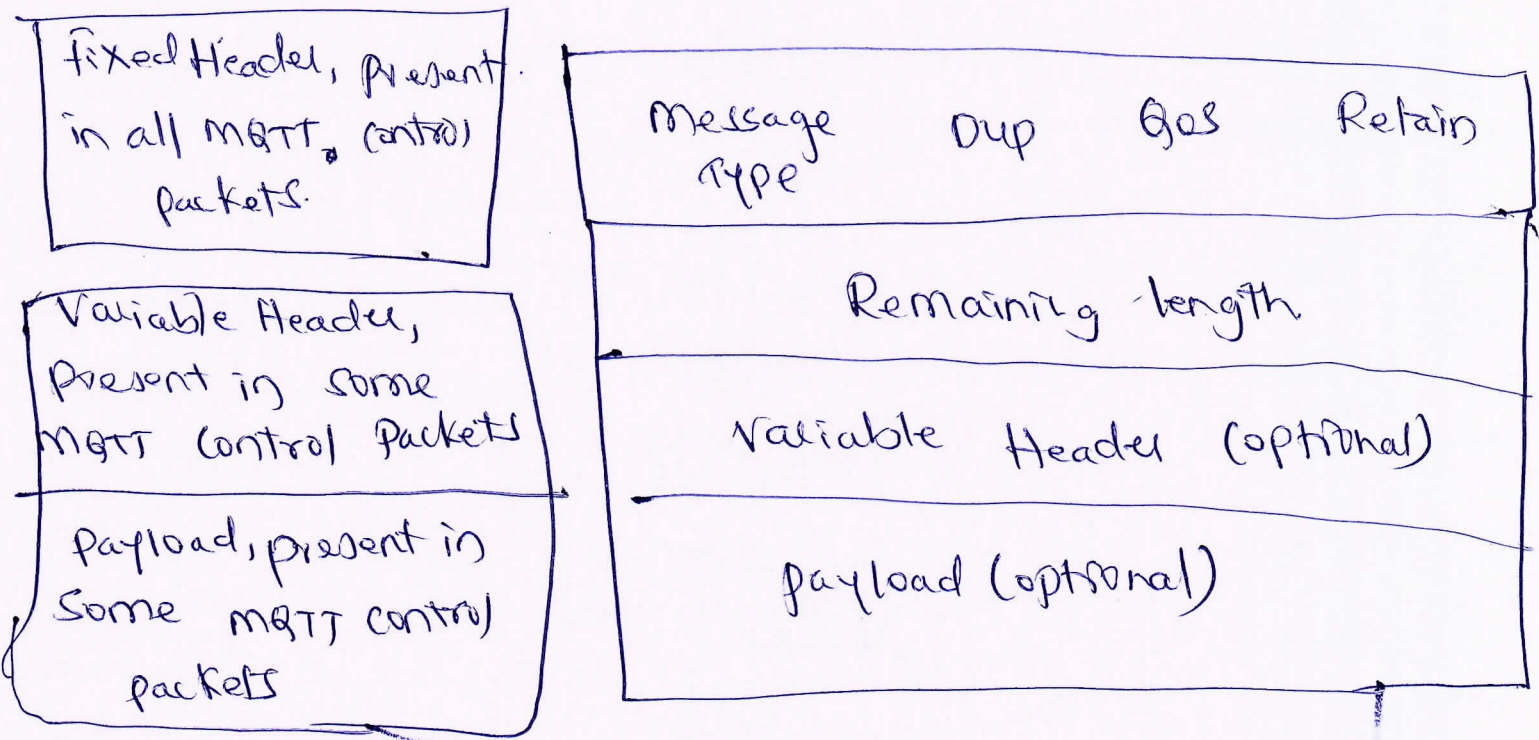


MQTT Client

Subscribe to Temp/RH (Subscribe)

publish / Subscribe framework.

MQTT IS a lightweight protocol because each control packet consists of a 2-byte fixed header with optional variable header fields & optional payload, you should note that a control packet can contain a payload up to 256 MB.



MQTT Message format.

Module 04

7a Explain the elements of Hadoop with a neat diagram? 07marks

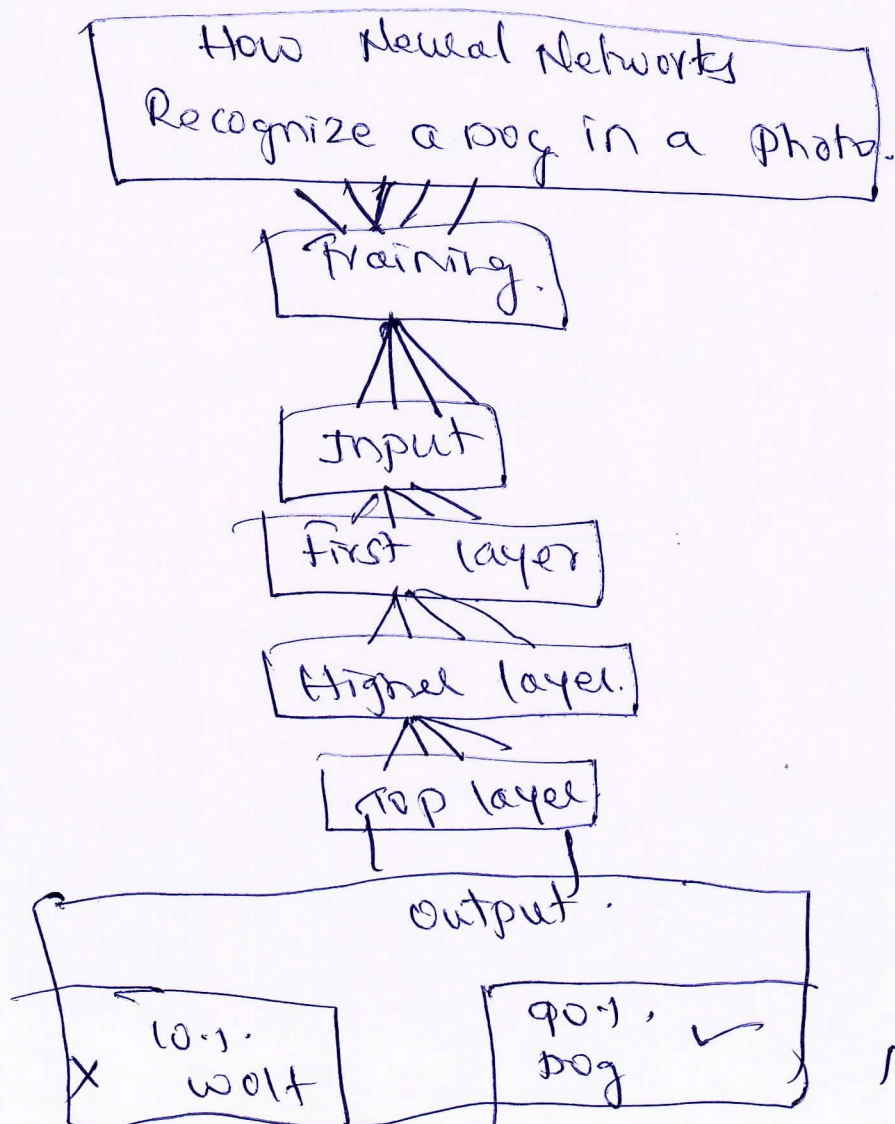
Hadoop is the most recent entrant into the data management market, but is arguably the most popular choice as a data repository & processing engine.

Hadoop was originally developed as a result of projects at Google & Yahoo. and the original intent for Hadoop was to index millions of web sites & quickly return search results for open source search engines.

The projects had two key elements.

1. Hadoop Distributed File System (HDFS).
2. MapReduce.

7.6 Explain neural network in machine learning with a detailed example. osman.



Neural Network Example.

In a sense, neural networks rely on the idea that information is divided into key components, & each component is assigned a weight.

Q.c Describe the components of ANF? or mark

Big data analytics can consist of many different sho pieces that together collect, store, manipulate & analyze all different data types.

It helps to better understand the landscape by defining what big data is and what it is not.

Generally, the industry looks to the "three Vs" to categorize big data.

- 1- Velocity.
- 2- Variety.
- 3- Volume.

Q.a Explain Formal Risk Analysis Structures? or mark

Two such risk assessment frameworks are

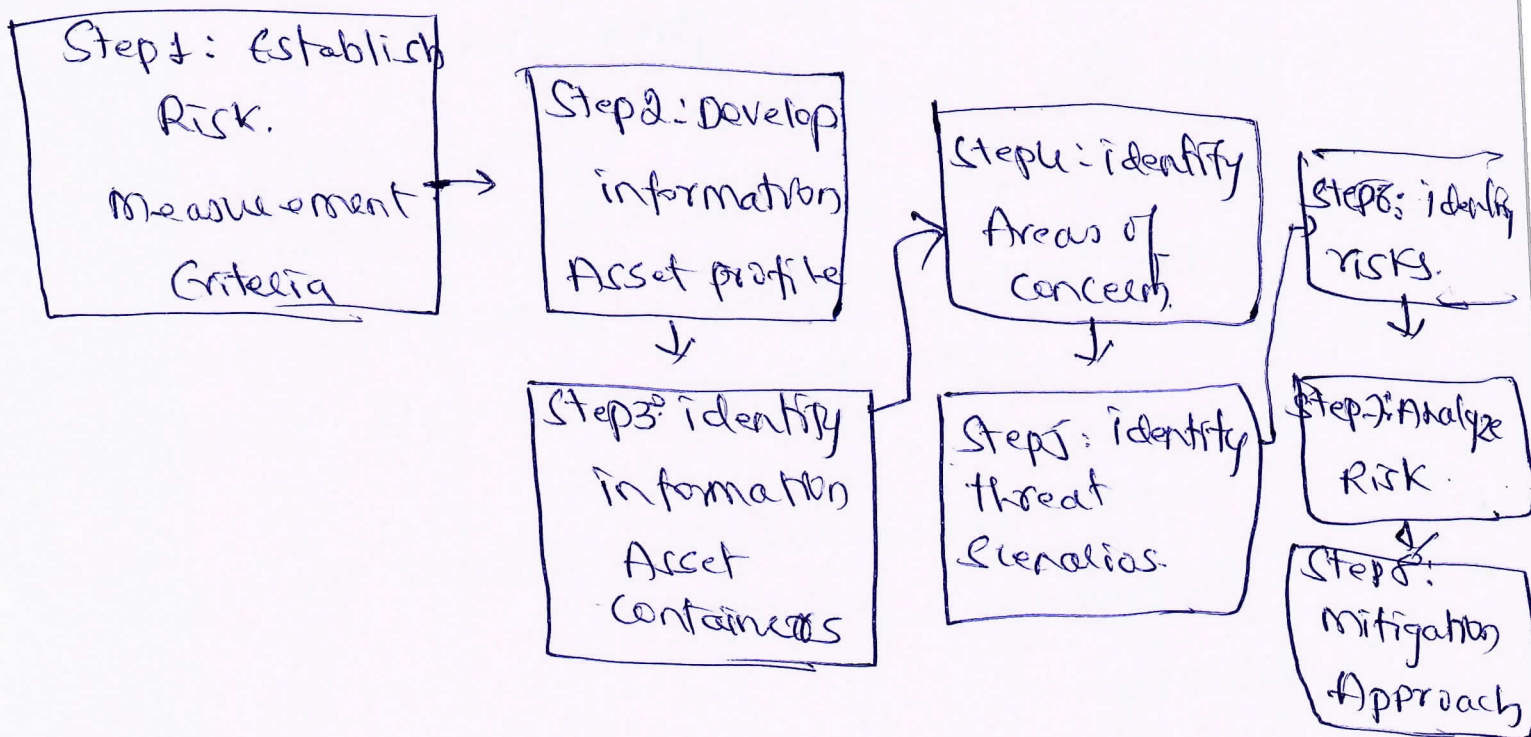
1. OCTAVE (Operationally Critical Threat, Asset & Vulnerability Evaluation).
2. FAIR (Factor Analysis of Information Risk)

↳ OCTAVE

OCTAVE has undergone multiple iterations.

The version this section focuses on is OCTAVE Allegro.

Fig. illustrates the OCTAVE Allegro steps & Phases



Establish Drivers

Profile Assets

Identify threats

Identify & mitigate Risk.

Fair (Factor Analysis of information Risk) is a technical standard for risk definition from the open group.

while information Security is the focus, much as it is for OCTAVE,

Fair has clear applications within operational technology.

8.b. Explain the Purdue model for control hierarchy & OT network characteristics? 08 marks.

Regardless of where a security threat arises, it must be consistently & unequivocally treated. IT information is typically used to make business decisions, such as those in process optimization, whereas OT information is instead characteristically leveraged to make physical decisions, such as closing a valve, increasing pressure & so on.

Thus the Operational domain must also address physical safety & environmental factors as part of its security strategy.

OT Network characteristics impacting security.

While IT & OT networks are beginning to converge, they still maintain many divergent characteristics in terms of how they operate & the traffic they handle.

These differences influence how they are treated in the context of a security strategy.

For example, compare the nature of how traffic flows across IT & OT networks.

1. IT networks.
2. OT networks.

By comparison in an OT environment there are typically two types of operational traffic.

Module 05

Q. a Explain the following with respect to the Arduino programming? 08 marks.

- i) Structure
- ii) Functions
- iii) Variables
- iv) Flow control / Statements
- v) Data type
- vi) Constants.

Fundamentals of Arduino programming.

Two required functions/methods/routines

void setup()

{ // runs once

}

void loop()

{ // repeats

}

Declaring a variable assignment

int val = 5;

↑ ↓ ↑

type Variable name value

If-else Condition

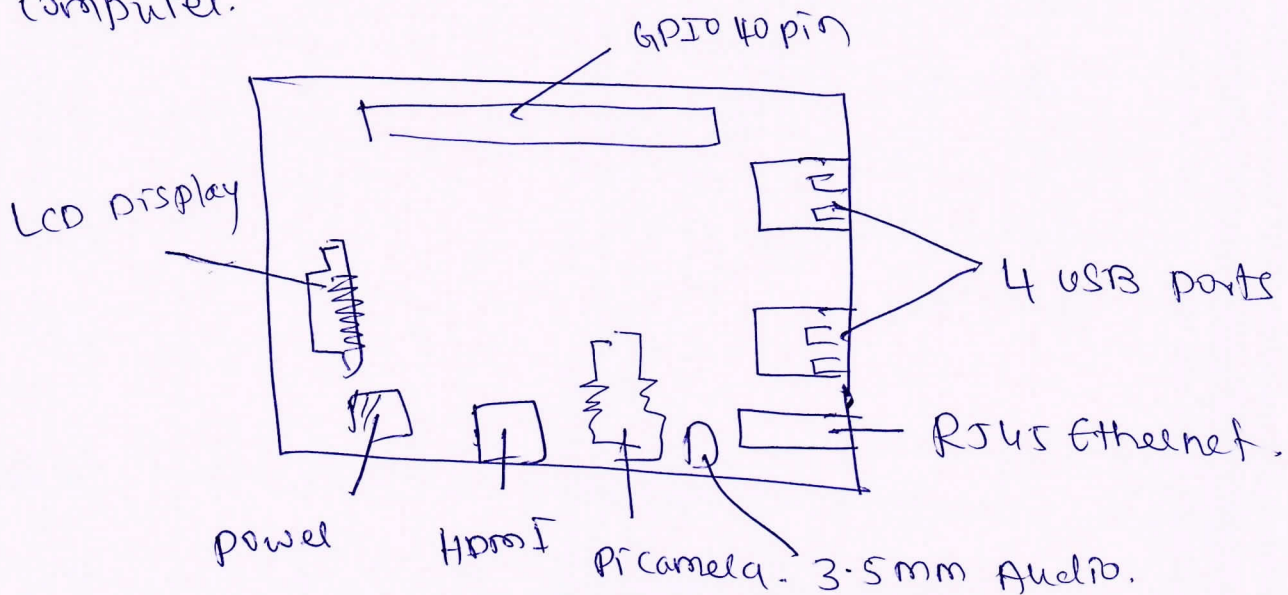
if ("answer is true")

{ "perform some action";

}
else { "perform some other action";

b. Explain Raspberry Pi learning board? 08 marks.

Raspberry Pi → A low cost, credit-card sized computer.



`raspi-config` :- Change your Pi Configuration Settings

`startx` :- Start the GUI

`ifconfig` :- Get the details of your Ethernet or wireless network adapter.

`pi-update` :- updates your Raspberry Pi firmware

`ssh` :- connect your pi to other components

`sudo` :- Run commands as Super user.

`shutdown` :- This will shutdown your pi

`nano` :- This is your text editor for changing or adding files, save, edit, create.

10.a write a python program on Raspberry pi to blink an LED? 06 marks.

```
void main()
{
  Light enum { Red, orange, Green};
```

```
loop: light = RED;
```

```
    delay(20000)
```

```
    light = orange.
```

```
    delay(2000);
```

```
    light = GREEN
```

```
    delay(20000)
```

```
    goto loop;
```

y.

b. Explain Smart City security architecture? Or make,

A Smart City IoT infrastructure is a four-layer architecture.

1. Street layer.

The street layer is composed of devices & sensors that collect data & take action based on instructions from the overall solution, as well as the networking components needed to aggregate & collect data.

2. City layer.

This layer aggregates all data collected by sensors & the end-to-end network into a single transport network.

3. Data Center layer:

Data collected from the sensors is sent to a data center, where it can be processed & correlated.

4. Service layer.

ultimately, the true value of ICT connectivity comes from the services that the measured data can provide to different users operating within a city.

c. write a short note on. Outmarks.

i) IOT Challenges.

1. Safety.

2. mobility.

3. Environment.

4. Privacy.

5. Big data & data analytics

6. Interoperability.

ii) Backhaul Technologies.

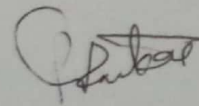
IOT devices & sensors often have constrained resources, however as compute capabilities increase.

Some new classes of IOT endpoints have enough compute capabilities to perform at least low-level analytics & filtering to make basic decisions.

PREPARED BY



(Sandeep P.)



HOD.



Dean, Academics.