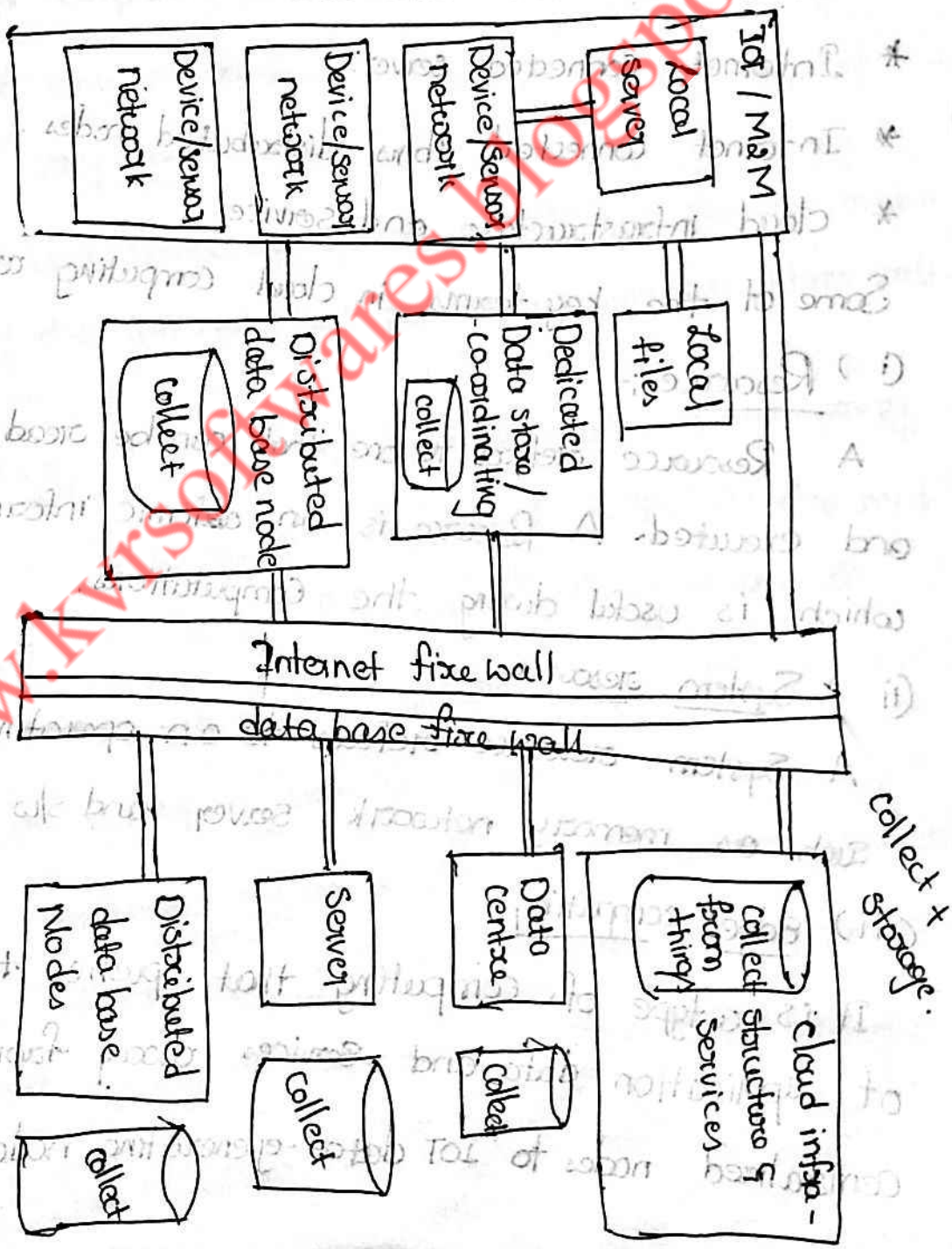
UNIT-VI

Data collection, storage and computing using a cloud platform

cloud computing is a greate evolution in information and communication technology. It uses XAAS (everything-as-a-Service) at the internet connected cloud for collection, storage and computing

The architecture of a cloud computing can be represented as.



The behind diagram shows different methods of data collection, storage and computing. It contains:

* Devices (eg) sensors network. data collection. at the device web browser.
* Local files.
* Dedicated Data stored at co-ordinating node.
* Local node in a distributed dbms.
* Internet connected data centre.
* Internet connected server.
* Internet connected dbms distributed nodes.
* cloud infrastructure and services.

Some of the key terms in cloud computing are:-

(i) Resource:-

A Resource refers to are that can be read, written and executed. A Resource is an aatomic information which is useful during the computations.

(ii) System resource:-

A System resource refers to an operating system such as memory network, server and s/w applications.

(iii) Edge computing

It is a type of computing that pushes the computing of application data and services away from the centralized nodes to IOT data-generating nodes.

(iv) Distributed computing :-

It refers to computing and usage of resources which are distributed at multiple computing environment over the internet.

(v) Grid computing :-

it refers the computing by using the pooled interconnected grid of computing resource and environments in the place of web servers.

(vi) cloud computing :-

A cloud computing refers a collection services available over the internet that provides computational functionalities.

(vii) XAAS :- it is a software architectural reference concept that enables the deployment & the development of application and offer services using web & SOA.

SOA (service-oriented architecture).

Cloud Computing paradigm :-

cloud computing means a collection of services available over the internet. It delivers the computational functionalities and deploys infrastructure of a cloud service provider. The infrastructure deploys on a utility (or)

grid computing (or) a web service environment that includes network, systems, grid of computers and data centers.

cloud platform services:-

it offers the following services.

→ it provides an infrastructure for large data storage of devices such as industrial plant machines, automobiles and device network.

→ It also provides computing capabilities.

→ It contains collaborative computing and data sharing.

Virtualization:-

It means user application (or) a service access by using abstract data base interface (or) file system. A virtualization can be classified into three types.

Network function Virtualization (NFV):-

It means a user application (or) a service access the resources appearing in one network.

Virtualization of server:-

In this, a user application not only access one server it can access multiple servers.

~~Virtualization~~.

Virtualized desktop:-

In this the user application can change and deploy multiple desktops access by the user through

their own computer platform.

Cloud Computing features:

- → Resource pooling
- → on-demand self-service
- → Easy maintenance
- → Large Network Access
- → Availability
- → Automatic system
- → Economical
- → security → measured service

⇒ Different types of cloud deployment models

public cloud:

This model can be used by educational institutions, industries and busines enterprises - This can be accessed by all the users.

private cloud:

This model can exclusively used by institutions and industries. It can be accessed only related employees with in the organization.

Community cloud:

This model foams a community with a group of people and the people belongs to that community only access the data.

The community provides seccuity comes consideration.

Hybrid cloud:

It specifies a set of two or more different clouds.

with different data stores and application. that combined b/w. the two sets to develop a standard technology.

Everything as a service & cloud service models :-

A cloud connects the devices, data, applications, services, persons and business. A cloud service can be considered as a distribution service.

A cloud computing can be consider by considering the below simple equation.

Cloud computing = Saas + ~~Paas~~ paas + Iaas + Daas.

Saas → Software as a Service. It is a service model where the applications or services develop the host at the cloud and ~~may~~ made available the host through the internet on demand by the service user.

The s/w control, ~~mention~~ maintanence, updation ~~are~~ the responsibilities of the cloud services.

paas :→ platform as a service. The platform is available to a developer of an application on a demand. paas is a Service model Where the applications and services develop and executes using the platform.

Iaas :- ⟶ infrastructure as a service. It is a service model where the applications use the infrastructure which is available through the internet on demand.

Daas :- ⟶ Data as a service. It is a service model

- Where the data store or a data wherehouse is available through the internet.

The data centre management power control, n/w and data application or the responsibilities of a data centre service provider.

Q21. List the features offered by Xively PaaS services?

Answer :

The various features offered by Xively PaaS services are as follows,

(i) It offers data collection in real time across the internet.

(ii) It allows data visualization for the data of connected sensors to IoT devices.

(iii) It provides graphical plots of the data collected.

(iv) It provides access to old data.

(v) It provides support for programming languages such as Java, Python and Ruby and for platform namely android.

(vi) It produces feeds representing real-world objects.

(vii) It produces alerts on the programmed triggers or alarms.

(viii) It can function on REST protocol.

(ix) It can operate on ARM mBed™, Arduino and hardware-platform based IoT devices.

(x) It provides services, business services platform that allows internet connectivity to the products and operations. Here, products include collaboration products, Rescue, Join.me and BoldChat.

Q22. Describe briefly about Xively as service to the users.

Answer : **Model Paper-I, Q7(b)**

Xively is a commercial PaaS for IoT/M2M and it is utilized as not only data aggregates but also as a data mining website. In addition to this, Xively is an IoT PaaS for both services as well as business services. It provides support for protocols like REST, web sockets and MQTT and establishes connection between devices and Xively cloud services. It provides Native System Development kits for Arduino, Android, Java, PHP, Ruby and Python languages.

An account with Xively need to be created by the user while deploying Xively APIs for carrying out data collection and other functionalities. The concepts of users feeds, data streams, data points and triggers form the basis for Xively. A feed refers to a location. While data streams refer to separate sensors having connected or associated with the location. Examples of feed and data streams includes house and temperature, ambiant lights, power consumption, respectively.

Push or Pull Methods

Xively offers two modes for capturing data. They are pull method and push method. The former one refers to automatic feed type where in data collection takes place from an http server whereas the later one refers to manual feed type, wherein data is written to xively by means of http client.

Data Formats and Structures

Multiple data formats and structures allow to carryout interaction, data collection and services with Xively.

Private and Public Data Access

A free account provides support to atmost ten sensor feeds modified so on in furture. The data stored can exist atmost for three months. An application can access the data existing at any location by means of interactive graphs embedded on the mobile. There is no restriction for an application to use data feeds of other users as inputs.

Data Streams, Data Points and Triggers

Xively platform allows data streams, data points and triggers.

- ❖ Data Stream : It refers to uninterrupted sensed dataflow on the internet.
- ❖ Data Points : It refers to set of data values.
- ❖ Trigger : It refers to an action on change of state.

Data Visualisation

Xively has the ability to capture data across the internet in real time. As a result, it provides alerts, graphing and access to historical data.

Xively allows data visualisation of both feeds as well as data streams apart from this, it also enables manual and automatic feeds.

Q23. List the features offered by Nimbits PaaS services.

Answer :

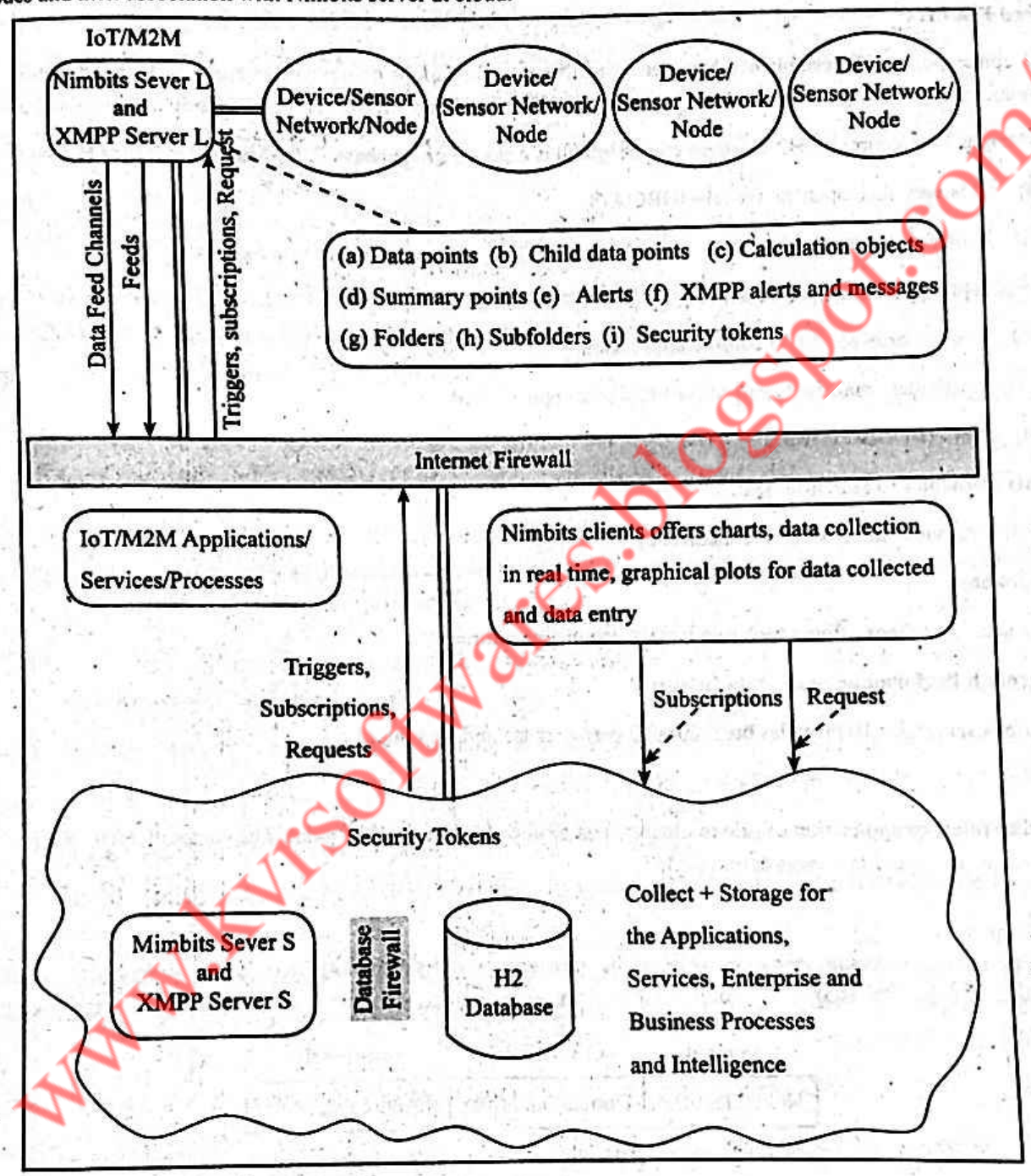
The various features offered by Nimbits PaaS services are as follows,

1. It provides solution to the complexity of edge computing involved in IoT by providing a platform that is built upon embedded systems locally and then runs the rules using rule engine and pushes the data that seems to be crucial on the cloud.
2. It offers Nimbits.io, an open source Java library that allows the process of developing JAVA, web and android solutions in a simple manner.
3. It provides support for programming languages such as Arduino, Push functions subjected to Arduino cloud, Latest Arduino library, HTML and JavaScript.
4. It offers a rule engine inorder to connect not only sensors but also persons and software to the cloud and with one another. Here, rules represent email alerts, XMPP messages, push notification, statistics and any calculation.
5. It offers a data logging service and access. It stores the old data points as well as data objects.
6. It can store any format which is later serialized to a string such as XML or JSON.
7. It is responsible for processing data of particular type and storing it.
8. It processes geo or time-stamped data.
9. It allows data visualization for the data of sensors attached to IoT devices.
10. It allows to create streams of data objects which are further stored in series of data points.
11. It allows to access and monitor the data from any location.
12. It provides support for ARM mBed-based, Arduino based and hardware-platform based IoT devices.
13. It allows to deploy software on Google App Engine and any server of J2EE on Raspberry Pi or on Amazon EC2.
14. The server of Nimbits serves as a backend platform.
15. It allows to filter the noise and changes that are sent to big central instance.
16. The Nimbits clients offer data collection in real time across the internet charts and graphical charts for the data collected and data entry.

Q24. With a neat diagram, discuss the deployment of devices at device network nodes and their association with Nimbits server at cloud for applications and services.

Answer : Model Paper-II, Q7(b)

The following figure illustrates deployment of devices, sensor nodes, data points of networks, Nimbits server at the device network nodes and their association with Nimbits server at cloud.



As shown in the figure, Nimbits Server L and XMPP Server L are deployed at every device node are instances of Nimbits Server S and XMPP Server S, respectively. Here, the former one is responsible for producing calculation objects for device nodes while the latter one is responsible for producing data feed channels for alerts and messages of XMPP.

Data Points

A data point refers to a value gathered from a sensor belonging to a set of sensors. The organization of data is performed by data points in several approaches. For example, points can include child points where child points refers to sub points.

Points can exists in folders, containing many sub folders, which in turn contain several sub-folders and so on. Here, trees can be used for representing folders and its leaves for representing sub-folders.

Data Channels

A data feed channel displaying the system events and messages can be developed by a user. In addition to this, it also displays data alerts subscribed by users so as to make them visible in the feed. The user can subscribe to other user's data point and can carryout configuration of subscriptions for transmitting messages to the feed. Here, low high and idle alerts can be noticed by the user in real time.

Advanced Features

A connection can be established between two different applications or services of Nimbits. If the invitation sent by an application is accepted by an invitee, then the points and data of invitee's will be visible in the tree to an application.

Nimbits 3.8.10 contains H2 database engine which is a Java SQL database. The various features of H2 are as follows,

(i) It is very fast, open source and JDBC API.

(ii) It offers in-memory databases.

(iii) It provides encrypted database.

(iv) It offers browser-based console application.

(v) It provides small foot print of Jar file size around 1.5 MB.

(vi) It offers ODBC driver.

(vii) It enables to search ful text.

(viii) It provides multi-version concurrency.

Security Tokens

The security tokens offered by Nimbits 3.9.6 are in a new form.

Break Through Performance and Data Integrity

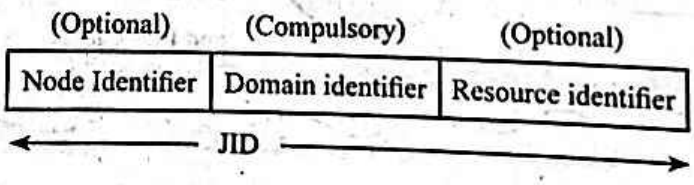
Nimbits server 3.9.10 provides breakthrough performance and data integrity.

Alerts

A filter refers to application of rule to obtain latest or new data for the data point. The custom IDs of data points can be used for sending alerts and messages across XMPP.

Jabbing

Jabbing is defined as the process of pushing the messages or alerts frequently and quickly. Every message and alert is associated with a Jabber ID (JID), which involves three parts namely node identifier, domain identifier and resource identifier.



Notational Form of JID

<JID>:=[<node> "@"]<domain>["/" <resource>]

Subscriptions

Several subscriptions for a point can be created by a user. It might subscribe to another user's point or a public point of another unknown user. Alerts are received by the user in case of point reaching an alarm state (preset value) or while receiving new data.

Summary Point

Summary point can be created by user to calculate minimum, average, maximum, standard deviation, variance and sums of other point on the basis of particular time interval.

Calculation

Calculation objects for a single point can be created by user. Multiple formulas for a point can be applied by a user and the objects can be organized in a tree.

Q25. What are the features of cloud PaaS and SaaS platforms?

Answer :

The various features of cloud PaaS and SaaS platforms are as follows,

1. **Spark**
   (i) It is a distributed cloud-based operating system for IoT.
   (ii) It is a web-based IDE consisting of a command-line interface. Besides this, it provides support for several different languages and libraries work with several IoT devices.
2. **Open IoT**
   (i) It is an open source middle-ware platform for IoT.
   (ii) It allows interaction with sensor clouds.
   (iii) It allows Cloud-based Sensing-as-a-Service (CSaaS).
   (iv) It is responsible for developing use cases for not only intelligent manufacturing, smart agriculture and urban crowd sensing but also for smart living and smart campuses.
3. **Device Hub**
   (i) It is an open source backbone for IoT.
   (ii) It is a cloud-based service to store information pertaining to IoT.
   (iii) It offers data visualizations.
   (iv) It enables web-page-based console for controlling IoT devices.
   (v) It allows developers to build applications like monitoring information about vehicles, tracking of information about weather.

6.2 SENSOR, PARTICIPATORY SENSING, ACTUATOR, RADIO FREQUENCY IDENTIFICATION AND WIRELESS, SENSOR NETWORK TECHNOLOGY, SENSORS TECHNOLOGY, SENSING THE WORLD

Q26. Explain about sensor technology and list some examples of sensors.

Answer :

Sensor Technology

Sensor technology plays a key role in designing the sensors and respective circuits, electronic readers and devices. A sensor is an electronic device that receives a signal and responds with an electrical signal. A sensor can sense different parameters like,

1. Physical parameters such as light, metal, energy, heat, smoke, pressure.
2. Acceleration, speed, orientation, angle etc.
3. A microphone can sense the change in the sound and also used to record the sound (like music or voice).

These parameters can be sensed and converted into electrical energy.

A sensor consists of electronic circuit connected to the input which is used to receive the output of the sensor that is in accordance with the change in the physical condition. A smart sensor is a sensor that consists of electronic circuit in it with some computing and communication capabilities. Analog sensor is used to compute the changes in the parameters on the basis of a reference or a condition and results the value of the sensed parameters after some appropriate calculations. In digital sensors, the changes in the parameters with respect to a reference or condition can be represented in the form of 0's and 1's.

Examples of Sensors

The different examples of sensors are as follows,

1. **Humidity Sensor**

Humidity sensor also known as hygrometer is used to sense and measure the water vapours or moisture in the air in terms of percentages. The relative humidity is the ratio of water vapours in the air to the highest possible content of water vapours in the air at a particular temperature. The humidity above 90% indicates that it is a rainy day.

2. **Light**

A photoconducter is used to sense the intensity of the light. The sensor displays a drop in resistance with the nearby light. On the other hand, the p-n junction potodiode or photo transistor is also used to measure the intensity of the light.

3. **Acceleration**

A Micro-Electro-Mechanical Sesnsort (MEMS) is used to measure the linear acceleration a_x, a_y, a_z across the three axes x, y, z with the help of capacitive change in the axes.

4. **Vibrations and Shocks**

A MEMS can also be used to sense and measure the vibrations and shocks by the variations that occurred due to the piezoelectric effect.

5. **Angular Acceleration and Change in Direction (Angle)**

A Gyroscope is used to sense and measure the change/variation in the angular velocity i.e., angular acceleration and change/variation in the direction (i.e., angle). An application is used to read the measurements with the help of a gyroscope or accelerometer and the system starts computing as programmed.

6. **LIDAR**

LIDAR (Laser Imaging, Detection and Ranging) sensors and Laser 3D imaging technology is used to turn on the remote sensing and imaging. It detects the distance by focusing the laser light on target. The sensor is used to sense the reflected laser light that enables the measurement of distance.

Q27. Explain the concept of sensing the real world.

Answer : **Model Paper-III, Q7(b)**

Sensing the Real World

For answer refer Unit-VI, Q26, Topic: Sensor Technology.

A sensor is used to sense a physical change when it exposes a measurable change in a characteristic circuit parameters on the change in the surrounding, physical state on a condition.

Analog Sensors

Analog sensor makes use of sensor with the respected electronic analog circuit. It is used to produce the analog outputs according to the physical environmental parameters like pressure, temperature, humidity, proximity or magnetic field. The resistance of the sensing component results a small change depending on the physical environmental variables, pressure or strain etc. If the pressure increases on a pressure sensor then the strain on the sensor will be increased. For example, a flex sensor of length 2.2 inch or 4.5 inch shows results the change in resistance across the sensor trip because of the change in path and deflection of the sensing resistor.

The analog output from a sensor circuit can be measured as given below,

(i) Initially, the sensor output is sent to signal conditioning-cum-amplifying circut (SC) as an input.

(ii) The output of SC will be sent to ADC as an input.

(iii) ADC produces the digital output in the form of 8 or 12 bits which can be read using the microcontrollers.

(iv) By using the microcontroller readings and computations, it produces the sensed parameter value and displays the physical condition of the sensor at surroundings.

Serial Port Interface

The main advantage of serial port interface with ADC is that the ADC 8 or 10 or 12 bit of output will be sent as an input to the interface and the interface provides the input to the serial port at microcontroller.

Analog to Digital Converter

It is an analog sensor circut that is connected to a signal conditioner amplifier and then to an Analog to Digital Converter (ADC).

Sampling ADC

Sampling is a process that an ADC is used to accept the input signals in particular periodic intervals and converting them into digits. Here, the interval will be provided according to the signal frequency and other requirements. There are many applications of ADC such as, the sampling ADC receives the signals from microphone for the recording sensor while recording a music, or voice.

Signal Conditioning Amplifier

Signal conditioning amplifier is used to amplify a signal at input and also to add or subtract the offset voltage in such a way that the minimum V_{in} (min) should be 0 V and the maximum V_{max} (max) should be V_{ref} at the outputs of SC.

Digital Sensors

A digital sensor is a sensor with the respected electronic circuit or component that produces the digital output of 0's and 1's (in binary form) or 1 and 0. The output can be read using ports in a microcontroller. This circuit helps in sensing the change in the physical state or condition or change in the set of physical states and conditions.

Sensing of an On-Off State

The digital output of on-off state detection requires a number of conditions. It requires a circuit or microcontroller to read the output. There are many applications that use sensing of an on-off state.

Examples

(i) Sensing the filling of water in a water tank and providing an emergency alert.

(ii) Sensing of petrol filling in the vehicle tank.

(iii) Sensing the traffic in a specific street.

Sensing a Set of On-off States

Most of the applications require detection with a number of conditions together. A specific circuit is used to produce a digital output for a set of on-off states. The specific electronic circuit or component produces the output in a set of 4 or 8 or 16 states which includes 1's and 0's to sense the set of changes in the physical state or condition.

Examples of Resistive, Capacitive, Diode and Transistor-based Sensors

The characteristic parameter like resistance, capacitor of an electronic circuit changes as per the physical state or condition. Now a days, the technology is developed in mobile phones i.e., they use finger print sensor, gesture via a sensor on touch screen. Mobile phones include resistive and capacitive sensors, photodiode current-based sensors and gyroscope, temperature, acceleration and pressure sensors which allows the functioning of various applications and games in a mobile.

A microcontroller is an associate computing device which consists of a sensor circuit that computes the touched position and links it to a user command when a resistive-based touch screen is used. Then, the mobile will respond as per the command.

Reading Temperature from Resistive Sensors

An electronic circuit consists of a resistor in the form of a wire or component. According to ohm's law, the resistance remains unchanged until the physical is changed. The resistor will run as a sensor when its values are changed measurably within the needed temperature range for sensing.

A table or an equation is used to compare the sensor resistance with the sensed and computed parameter values at a physical state or condition.

Reading from a Capacitive Sensor

A capacitance bridge is used by the sensing capacitor to enable the sensing which is as shown in the below figure,

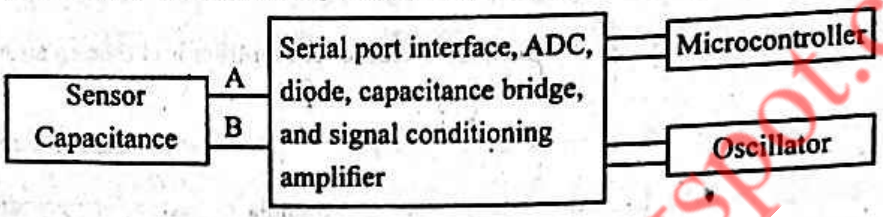


Figure: Microcontroller-based Electronic Circuit

The capacitance bridge consists of a sensing capacitor and 3 fixed capacitors. The above diagram depicts a microcontroller based electronic circuit in which the port is connected to four other sub circuits, serial port interface, capacitance bridge, diode, ADC, Signal conditioning amplifier. The microcontroller is an electronic device which reads the input at the ports and saves the input in the memory. Later the data is used to communicate over internet.

Q28. Explain the concept of participatory sensing.

Answer :

According to Deborah Estrin, Participatory Sensing is defined as a process that allows individuals and communities to adopt well sophisticated mobile phones and cloud services in order to perform systematic data collection and analytics so that it can be used in knowledge discovery.

In the process of participatory sensing, a participant could be sensors employed in mobile phones. Mobile phones include various sensors such as camera, temperature and humidity sensors, an accelerometer, compass, infrared sensors, NFC sensors, microphone, bar or QR code readers and GPs. Mobiles interact over the internet using sensed information associated with time, date and location stamps.

Various applications of participatory sensing are data collection regarding weather, pollution, environment, waste management. It also includes data about road faults, urban mobility, traffic congestion, health concerned to individuals as well as group of people and disaster management like flood, fire and so on.

The several challenges involved in participatory sensing are,

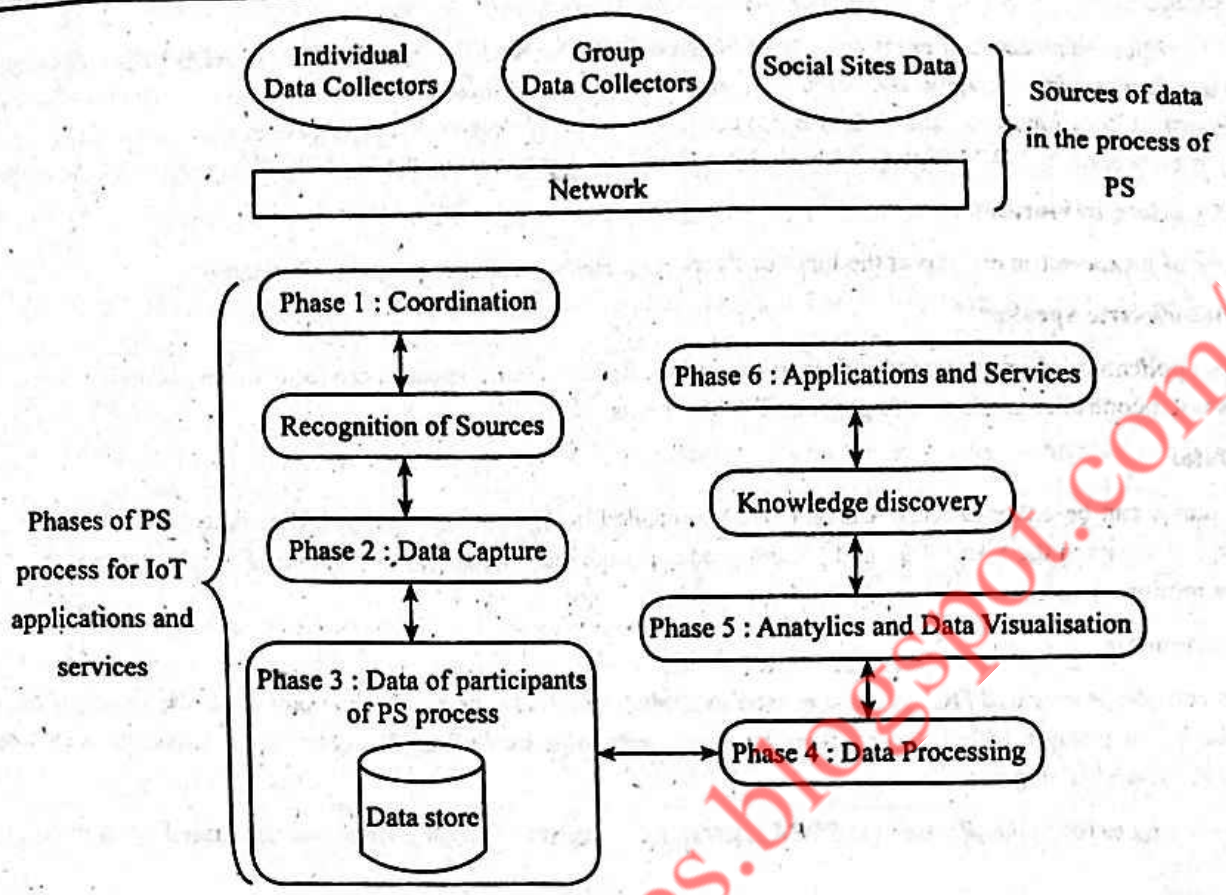
(i) Security

(ii) Privacy

(iii) Reputation

(iv) Poor incentives to participants.

The following figure illustrates various sources of data involved in the process of participatory sensing along with various phases involved in it.



Phase 1

This phase involves co-ordination where in participants organize soon after locating the data sources.

Phases 2 & Phase 3

In these phases, data capture, communication as well as storage on servers or cloud takes place.

Phase 4 & Phase 5

In these phases, data processing and analytics, visualisation and knolwedge discovery takes place.

Phase 6

This phase involves initiation of respective actions.

Q29. Define actuator. Discuss various examples of applications of actuators.

Answer :

Actuators

Actuator is a device which is used to achieve, actuation means producing physical changes such as linear and angular displacements. It is used to provide the actual motive force for the robot joints. It can also modulate the rate and power associated with changes in displacements. Actuators get their power from one of three sources such as electricity, compressed air, pressurised fluid.

Applications of Actuators

The various applications of actuators includes the following,

1. **Light Sources**

The best example of light sources is the traffic light as actuators are controlled using the inputs.

2. LED

LED refers to an actuator emitting light or infrared radiation are different colour LEDs, RGB LEDs, intensity variation of LED and display of text graphic and colours on large screens uses of these are actions that are controlled by the inputs. RGB LED consists of three inputs to control R, G and B components and as a result, it generates composite color. LED light emission intensity is controlled by PWM (PulseWidth Modulator) pulses. A microcontroller is adopted to generate PWM outputs.

3. Piezoelectric Vibrator

Use of piezoelectric crystals at the input of fluctuating electric voltages produce vibrations.

4. Piezoelectric Speaker

An application of programmed pulses at the input of piezoelectric speaker produces music, sounds, alarms as well as buzzar. A microcontroller is adopted to generate PWM outputs.

5. Motor

A motor can be either Directly Current (DC) controlled or Alternating Current (AC) controlled. The IO modules take control digital inputs in the form of 0's and 1's and produces high currents at output modules. The rotation motion is converted into linear motion by using a cam, provided it is rotated by a motor.

6. Servomotor

Servomotor is a geared DC motor. It is used in applications like robotics. Servomotor controls, positions or rotates the shaft of the motor through 180 (+90°) degrees. The angular position of shaft of the motor is controlled through 180 degrees, between –90° and +90° degrees.

According to the value 'P' stored in PWM register, PWM pulses of varying widths are generated by an internal circuit of microcontroller.

The shaft of a motor is positioned at mid-angular position if the widths of PWM pulse at output port is of 1.5 ms. Assume the following,

(i) The angular position is –90° if the pulse width is 1 ms.

(ii) The angular position is +90° if the pulse width is 2 ms.

The angular position will be changing by varying the pulse width between 1 ms and 2 ms by means of the value stored in PWM register.

7. Solenoid

A solenoid is an actuator containing several coils arranged in cylindrical fashion. It creates a magnetic field by the flow of electricity passing through it.

The magnetic field generated is in proportion to the number of turns as well as the electricity in the solenoid. The motion of solenoid is controlled using the input current, pulses and slight differences in current with respect to time by placing an iron shaft along the axis.

A solenoid can create not only a sharp forward push but also backward push and repeated to and from motion. In addition to this, it converts linear motion into rotator motion by means of a cam.

Q30. Explain the Radio Frequency Identification (RFID) technology and its principle.

Answer :

RFID

For answer refer Unit-II, Q17, Topic: RFID.

An UART or NFC protocol is used by an ID's reader circuit for recognizing the RFID tag located at a distance within 20 cm. In active NFC devices, an RF field generated activates or induces the currents in RFID and generates required power which is then used by RFID for transmitting the identification of tag contents.

In passive devices, incoming RF signals from a reader activates or induces the currents in the its antenna and generates enough power of transmitting the tag contents. While in active devices, a battery (power source) is in-built and therefore transmits the tag contents on its own.

A hotspot containing WiFi transceiver or wireless transceiver establishes connection with the internet for IoT services, applications and business processes. Its functionality is to receive signals coming from several RFID tags present in an organization and then transmit the data gathered at the web server from the internet. A mobile that is located near to the device can also act as a hotspot.

RFIDs altogether represents an IoT network which is connected to an IoT server of internet. Usually an IoT server contains RFID identity manager, device manager, data router, analyse, storage as well as database server and services.

Principle of RFID

A tag refers to an electronic circuit that makes use of RF signals for transmitting its corresponding ID. The ID is responsible for transmitting the tag contents to a reader. The reader which in turn transmits the tag contents associated with extra information to remote server on the internet. Here, the extra or additional information varies according to the application. For instance, in case of tracking application additional information could be location and time stamped data together with ID.

The processing of RFID data is simple and therefore the concept of RFID tag is more advantageous compared to bar code or QR-code. In addition to this, the tag can be made invisible to a person by using short range RF transceivers rather than laser or light in QR code. A short string of data is transmitted back to a RFID reader by the tag. Later, the reader receives the RF signals and interacts with remote server on he internet. Compared to passive devices, active devices can transmit the tag contents to the reader located at longer distances.

Q31. Discuss the components of RFID system of IoT applications and services.

Answer : Model Paper-IV, Q7(b)

The various components of RFID system are as follows,

1. RFID Tag

It refers to a tiny chip which is of three types namely passive, active and battery oriented. The chip serves as tag or label that is placed on an object.

2. Transceiver

It is built in on the chip and interacts with a reader at a distance ranging from 10 cm to 200 m based on the type of chip. The chip carries out UART communication with the reader by means of RF link or performs NFC communication with the reader located at a distance less than 20 cm. It uses a standard frequency ranging between 120 kHz to 150 kHz, 13.56 MHz, 433 MHz and higher frequencies in case of UHF and microwave frequencies.

3. RFID Reader

It uses the transceiver built in it for receiving the ID. The header received using UART protocol consists of three fields. The first field contains one start byte, the second field contains ten byte ID and the last field contains one end byte. Mobile or hotspot associated with Wi-Fi transceiver is responsible for sending and receiving signals coming from RFID tag.

4. Data Processing Subsystem

It contains computing device as well as middle-ware and enables connectivity to large networks like internet either directly or by means of gateway containing data adaptation sublayer. The subsystem represents a back end system reader circuit that transmits data to the internet directly or by means of computer or mobile. SparkFun SEN-08419 used in the process of prototype developments is an example of a reader.

5. Middle-ware

It refers to software units that are adopted at not only reader but also at read manager and data store for the transaction data store and APIs of IoT applications and services.

6. Applications and Services

These applications and services make use of data store residing at web server or cloud server.

The following figure illustrates various components involved in RFID system.

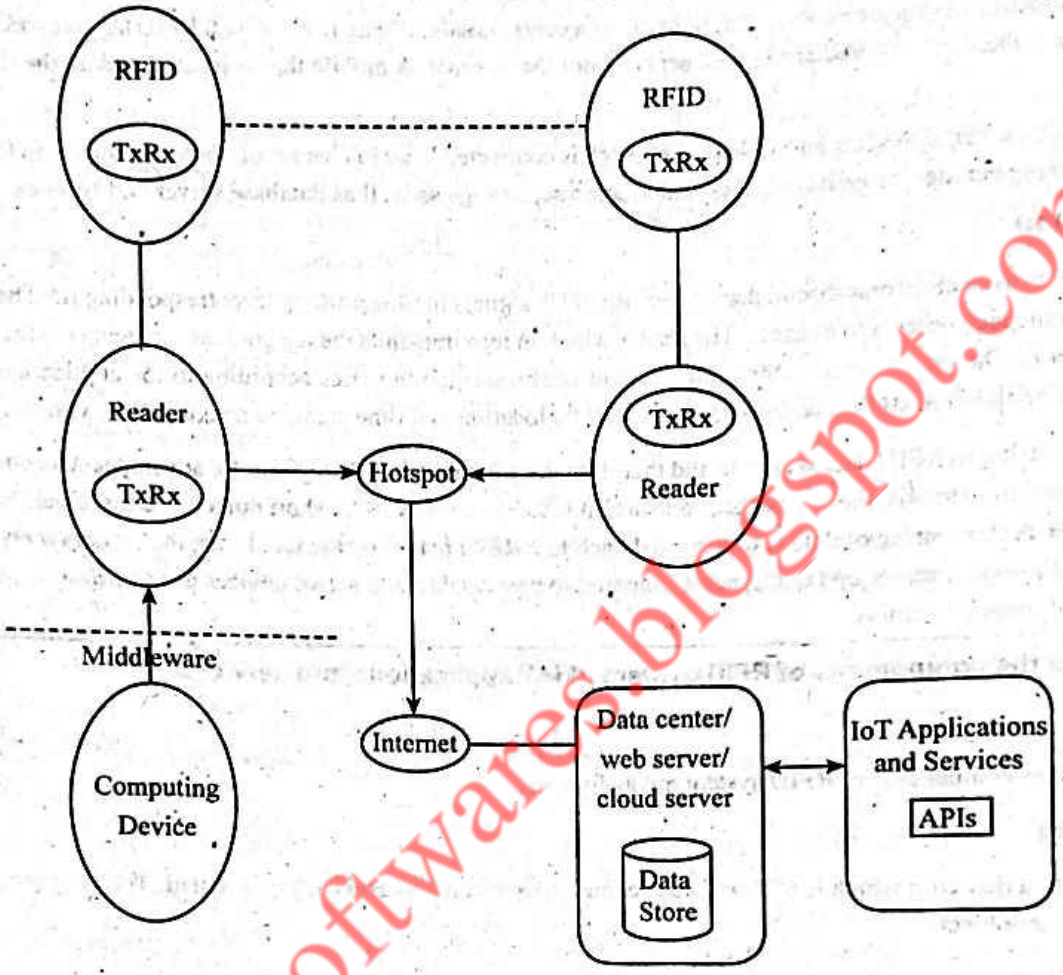


Figure: Various Components of RFID System

Q32. Explain briefly about wireless sensor networks.

Answer :

Wireless Sensor Networks

The mobile ad hoc network of smart sensors with communication, networking and computational features is referred to as wireless sensor networks. Smart sensor is the one which has computational and logical abilities. However, wireless sensors make use of radio frequency transceiver for communication purpose. This transceiver helps the node to send and receive the packets from the nodes closer to it. Thus, the smart wireless sensor node comprises of the following,

(i) A microcontroller with CPU, memory and ADC (Analog-to-Digital Converter)

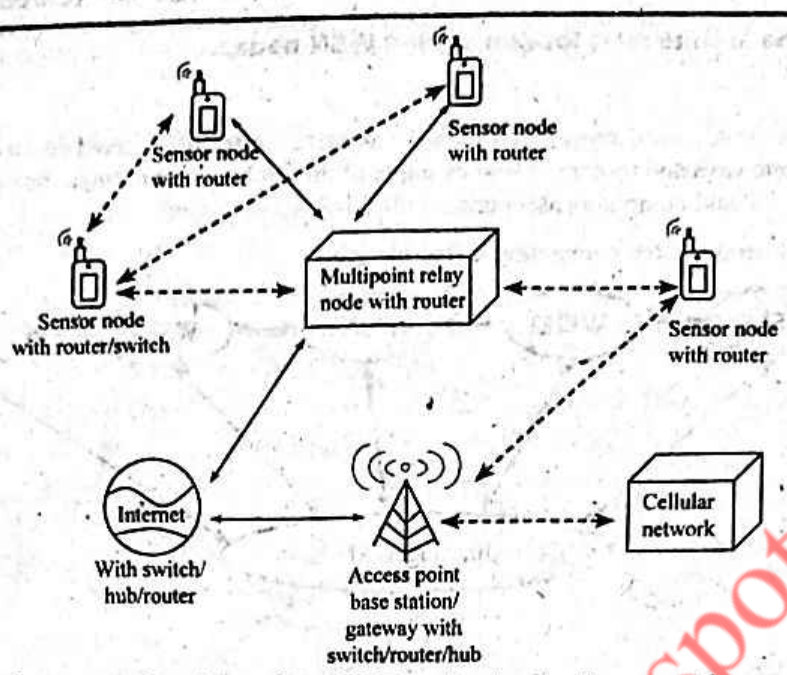
(ii) Sensor

(iii) Radio frequency transceiver

(iv) An energy-harvesting component so as to catch solar radiation and save the energy

(v) An energy source.

The figure below depicts the wireless sensor network.



Wireless sensor networks are used in wide variety of IoT applications such as smart homes and smart city.

The node of wireless sensor networks connected by wireless links have the ability to sense as well as communicate data residing at remote locations by means of internet. Here, remote locations include forests, industrial plant machines, lakes, gas pipelines, oil pipelines and so on.

Q33. Draw and explain the architecture of WSN.

Answer :

The following figure illustrates the architecture of wireless sensor node. It consists of three layers. They are,

(i) Application layer

(ii) Network layer

(iii) Physical and data link layer.

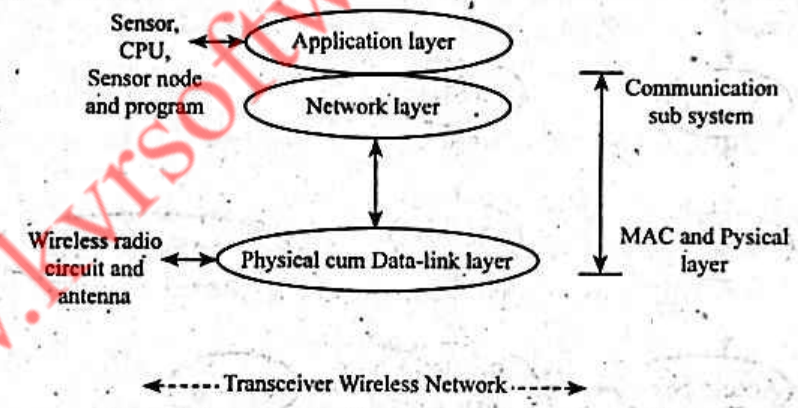


Figure: Three Layer Architecture of Wireless Sensor Node

The software units of application layer includes the following,

(a) Sensor management

(b) Sensor query and data dissemination

(c) Task assignment

(d) Data advertisement

(e) Application-specific protocols.

The combination of sensor, CPU, program and sensor node altogether represent application and network layers. A serial link between network layer and data-link layer establishes a connection between them and it also connects the layers to radio circuit and antenna. The wireless radio circuit is placed at physical cum data link layer and the protocols of MAC and physical layer are used by communication subsystem.

Q34. Draw and explain the architecture for connecting WSN nodes.

Answer :

There are two architectures for connecting WSN nodes. The first architecture is fixed connecting infrastructure of WSN nodes, relays, co-ordinators, gateways and routers. A best example of this architecture is smart-home network containing WSNs at refrigirator, air conditioner, TV and computers associated with Wi-Fi access points.

The following figure illustrates fixed connecting infrastructure.

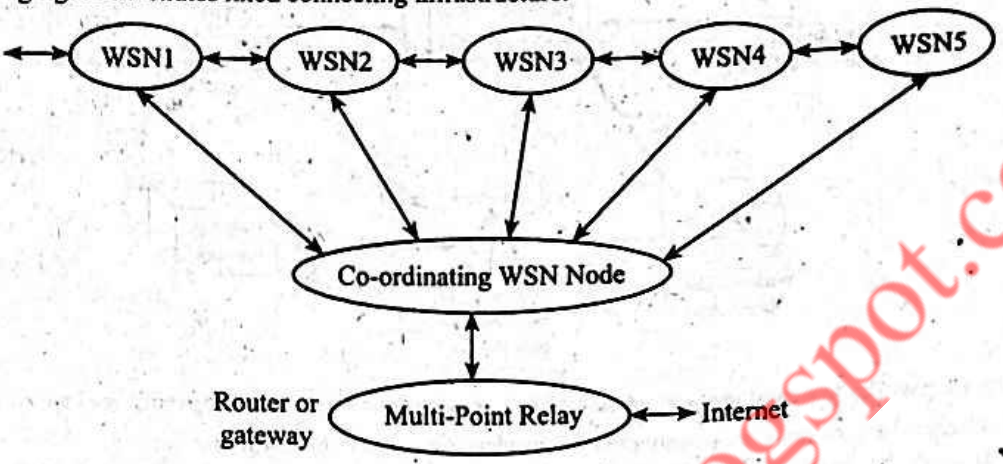


Figure: Fixed Connecting Infrastructure

The second architecture is Adhoc network of mobile WSNs, access points, gateways, routers and multpoint relays. A best example of this architecture is associating movable WSNs to birds or animals for performing habitat monitoring.

The following figure illustrates the architecture of mobile adhoc network of WSNs.

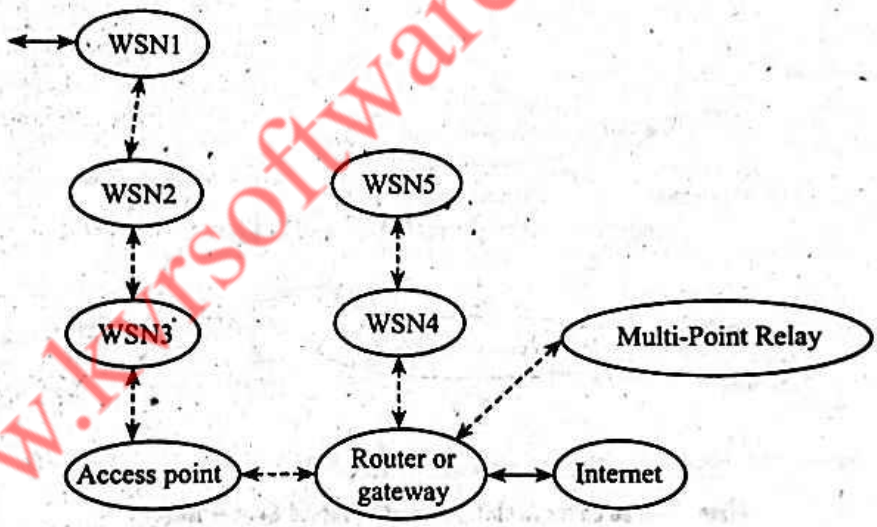


Figure: Mobile Adhoc Network of WSNs

(a) Access Point

It refers to a fixed point transceiver, which is responsible for providing access to nodes located within the range.

(b) Multipoint Relay

It is responsible for connecting to large networks like internet or mobile service provider network.

(c) Router

It is responsible for transmitting the packets along the path selected from several paths existing in the network.

(d) Co-ordinator

It is responsible for providing a connection or link between the networks.

Q35. Draw and explain the architectures for networking of the WSN nodes.

Answer :

There are two architectures for networking of the WSN nodes. They are,

(i) Layered architecture

(ii) Multiple clusters architecture.

(i) Layered Architecture

MINA stands for Multi Infrastructure Network Architecture. It refers to a layered architecture. The WSN nodes have the ability of sensing as well as forwarding this data to the base station. In addition to this, WSN nodes possesses coverage and mobility range so as to interact with the access points that are remotely connected.

Base stations have the abilities such as data collection, data processing and connectivity with huge networks like Internet.

The following figure illustrates layered architecture for network of WSN nodes.

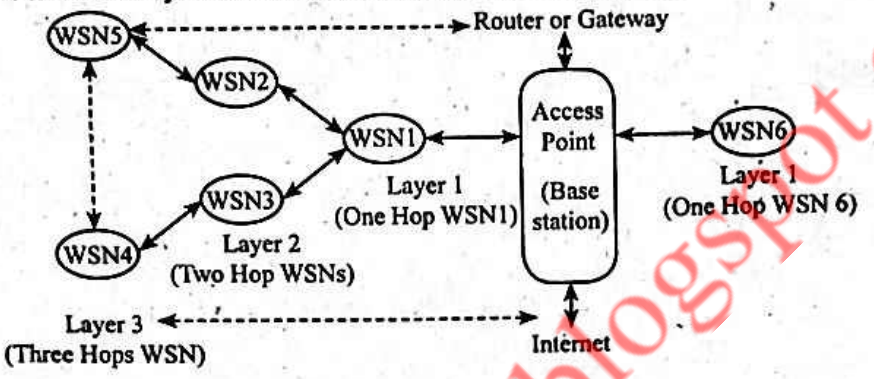


Figure: Layered Architecture for Network of WSN Nodes

As shown in the figure, every node is connected to the nearest neighbour. The WSN nodes can interact with access point 2 via two or more hops if there is large distance between them. There are three layers around the base station WSN1 and WSN6 in first layer directly connected to the access point. So hop count is one for first layer. WSNs is second layer i.e., WSN2 and WSN3 are connected to WSN1 in first layer and then connected to the access point. So, hop count is two for second layer. WSNs in third layer i.e., WSN5 and WSN4 are connected to WSN2 and WSN3, respectively in second layer which are inturn connected to WSN1 in first layer and then connected to the access point. So hop count is three for third layer. Access points have connectivity to the large networks like Internet.

(ii) Multiple Clusters Architecture

Multiple clusters architecture consists of multiple clusters associated with a cluster head gateway where each cluster is connected or associated to a gateway node.

In this architecture, cluster head and its associated clusters form a tree like topology. The process of grouping the nodes into clusters and the selection of clusters head is autonomous in both distributed WSNs as well as WSN clusters.

The following figure illustrates multiple clusters architecture containing two clusters associated with a cluster head gateway.

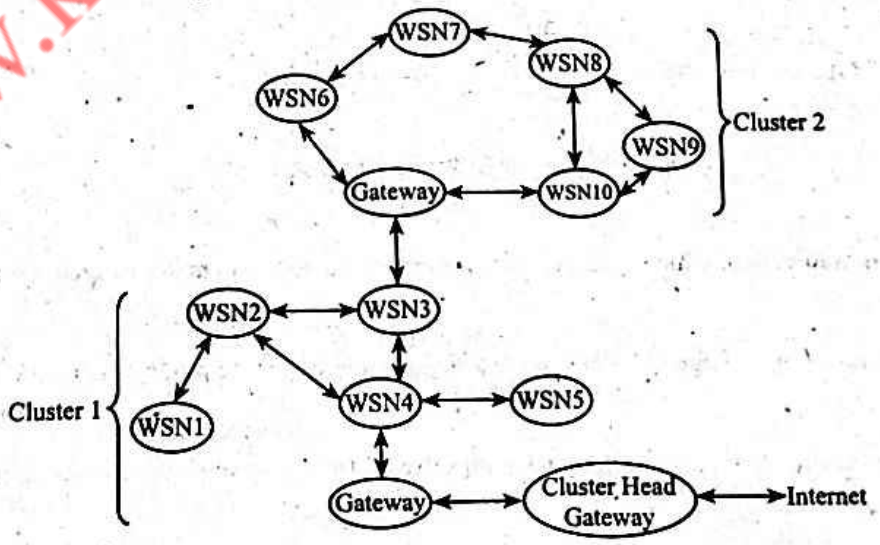


Figure: Multiple Cluster Architecture

As shown in the figure, the cluster head gateway is connected to large networks like internet and it enables connectivity to WSNs present in various clusters.

Cluster 1 and cluster 2 represents mobile Ad-hoc network of WSNs such as WSN1 to WSN5 and WSN6 to WSN10 respectively. The WSNs located in a cluster possesses either layered or mesh architecture. Two clusters are interconnected in the wireless range through a gateway in the existence of one cluster-head gateway. Every node is connected to nearest neighbour. The node is connected to a gateway by means of one or more hops when it is connected to the WSN of some other cluster. The communication among nodes of one cluster to nodes of nearly cluster occurs via gateway node.

Multiple clusters architecture allows compaction and aggregation of data. A gateway interconnecting two clusters is responsible for interacting compacted or aggregated data between them. The aggregated and compacted data received at cluster-head gateway is, inturn aggregated and compacted before sending it to the web server or cloud server.