

Integration of Wireless Sensor Networks with Cloud:

- These days Wireless Sensor Networks (WSN) are integrated with cloud computing to facilitate the end users in many ways.
- It helps the end users to run several applications of various wireless sensor networks through virtualization. This integration can provide sensor-as a-service and known as sensor cloud.
- Cloud computing helps to virtualize the physical sensors and this virtualization provides end users an opportunity to execute multiple applications without having any care of numbers and types of WSN.

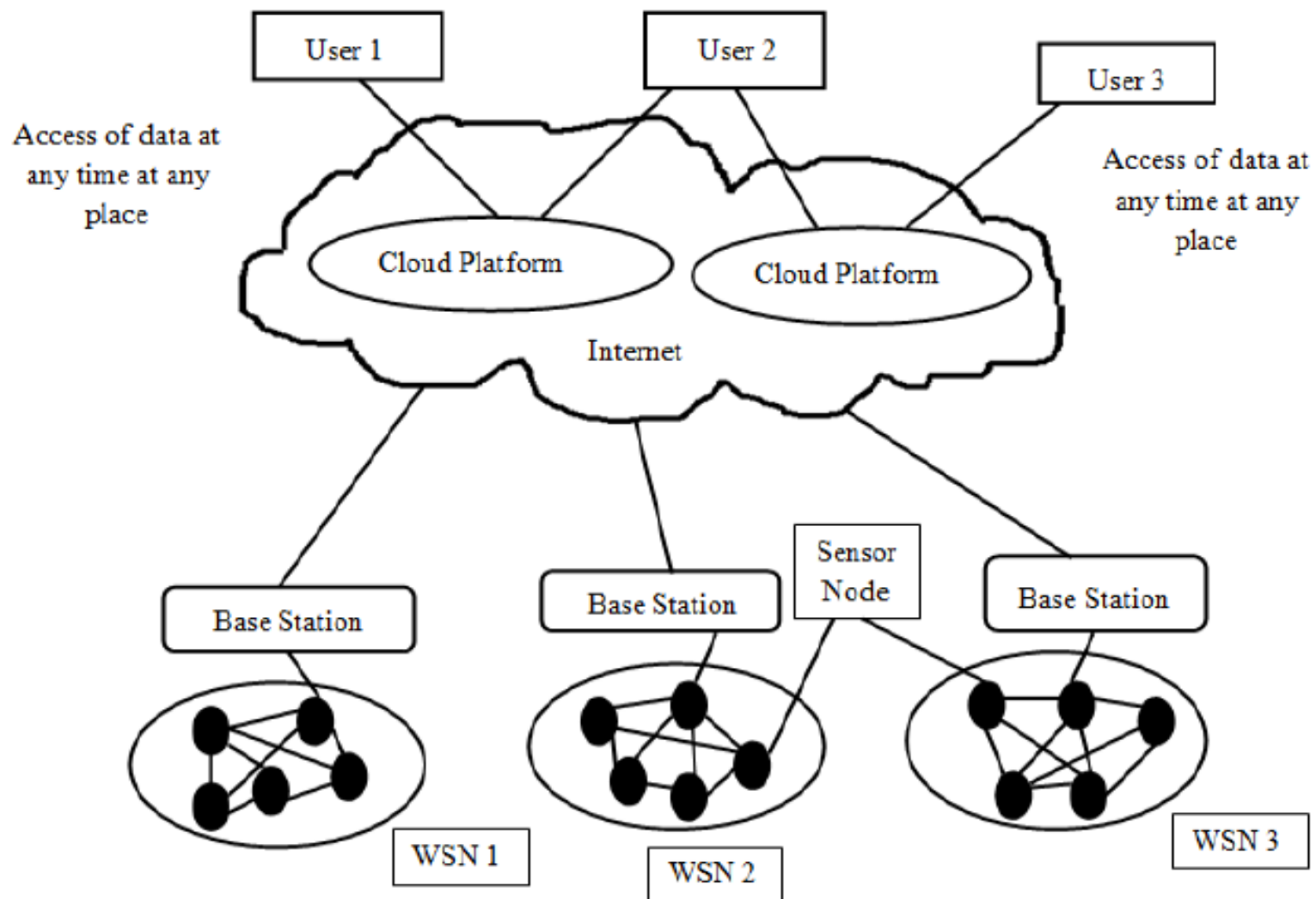


Fig 1: Integrating WSN with cloud [16]

- WSN is having several applications and being integrated with other technologies , although it is having some challenges such as energy efficiency, security, fault tolerance, scalability etc.
- An application of WSN does not use all physical sensors always. Sensor cloud is a paradigm which collects the data from physical sensors and sends it into a cloud computing infrastructure.
- This processed data is provided to the users anytime and anywhere when requested by him. This paradigm provides intelligent operation and communication of WSN by integrating it with cloud to serve the people better. Sensor cloud can be of three types: Independent SC, collaborative SC and mutual SC.
- The architecture of sensor cloud model is slightly different with the architecture of traditional WSN. In this new model, many small sensor nodes are available which collect the data.
- This data is sent to the base station or gateway and then the collected information is transmitted to the cloud. This information is stored on the cloud computing platform. Multiple users or clients can access the data from the cloud using internet.

Advantages of sensor cloud

- ☐ Increased data storage
- ☐ Increased processing power
- ☐ Dynamic provisioning of services
- ☐ Quick response time
- ☐ Flexibility
- ☐ Scalability
- ☐ Multi-tenancy
- ☐ Agility of services
- ☐ Resource optimization
- ☐ Collaboration
- ☐ Automation
- ☐ Virtualization

Issues and challenges with sensor cloud

- ☐ Storage issue
- ☐ Power issue
- ☐ Bandwidth limitation
- ☐ Massive scaling
- ☐ Real time multimedia content processing
- ☐ Authorization issues
- ☐ Security and privacy support issues
- ☐ Efficient information dissemination
- ☐ Pricing issues
- ☐ Network access management
- ☐ Resource and hardware compatibility issues
- ☐ Resource scheduling
- Resource usage policy
- ☐ Interface standardization issues
- ☐ Quality of Service

ARCHITECTURE OF SENSOR CLOUD

- The sensor cloud architecture is shown in fig 2.
- The integrating system includes many components such as

Identity Access Management Unit (IAMU),

Request Subscriber (RS),

Sub/Pub Broker

Data Processing Unit (DPU).

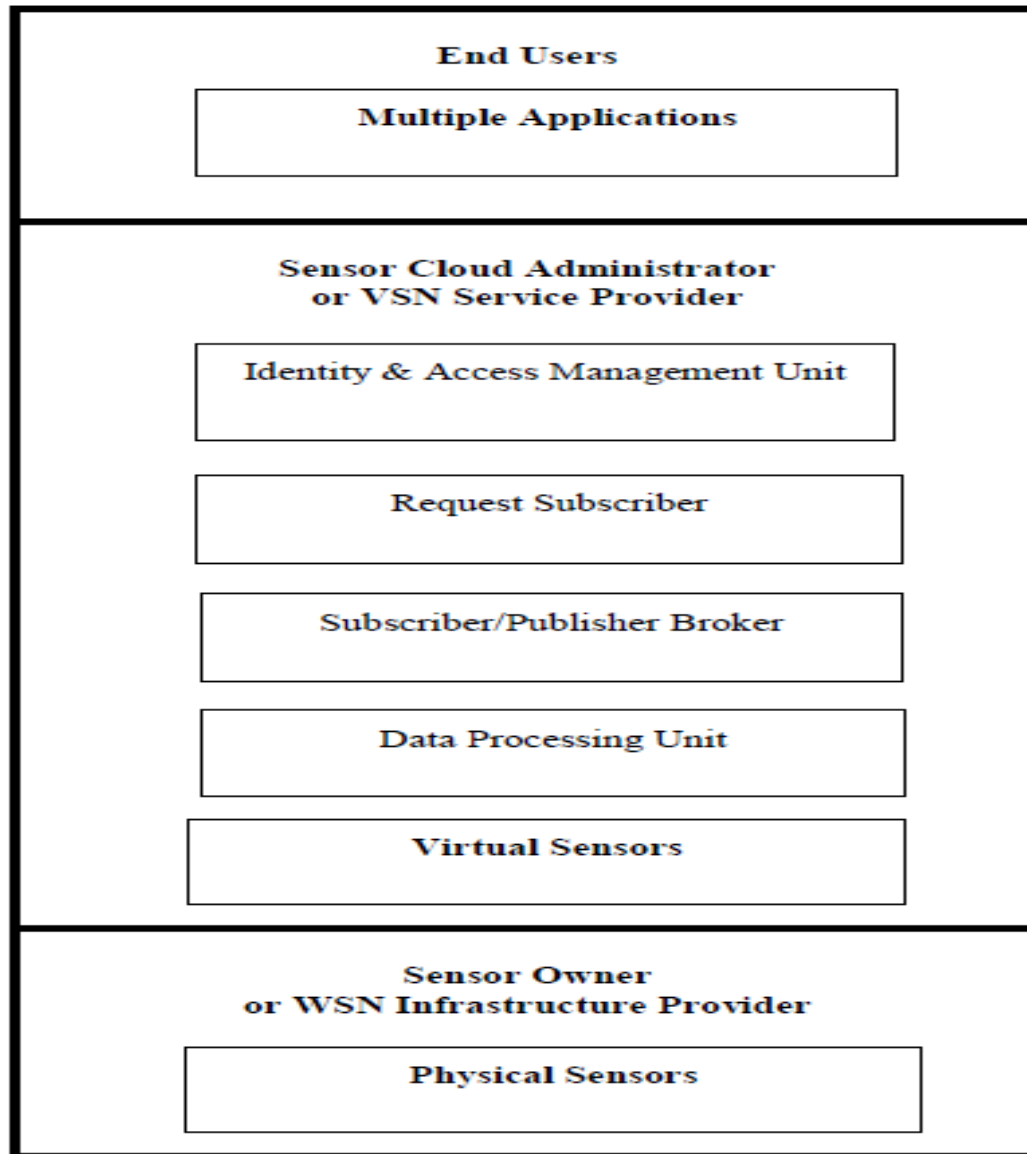


Fig 2: Architecture of Sensor Cloud

- *A. Identity Access Management Unit (IAMU):*

Basic goals of Identity Access Management Unit (IAMU) are to create authentication for consumer, to define service type and to provide the policy for access control of cloud resources. With help of IAMU consumer gets connected with provider.

- *B. Request Subscriber (RS)*

RS explains the request of users. This unit verifies the request of clients. This unit works for retrieval of data on the user's request. RS passes the request to Sub/ Pub Broker. It also implements monitoring & metering.

- *C. Subscriber/ Publisher (Sub/Pub) Broker*

Publisher submits the new data in the resource system. Data is stored in the index of the Sub/Pub Broker. When any Subscriber requests the data then RS creates the new subscription. If this subscription is matched with publisher data, then Sub/Pub Broker access the data. This system reduces resource consumption as well as complexity of the system.

- *D. Data Processing Unit (DPU)*

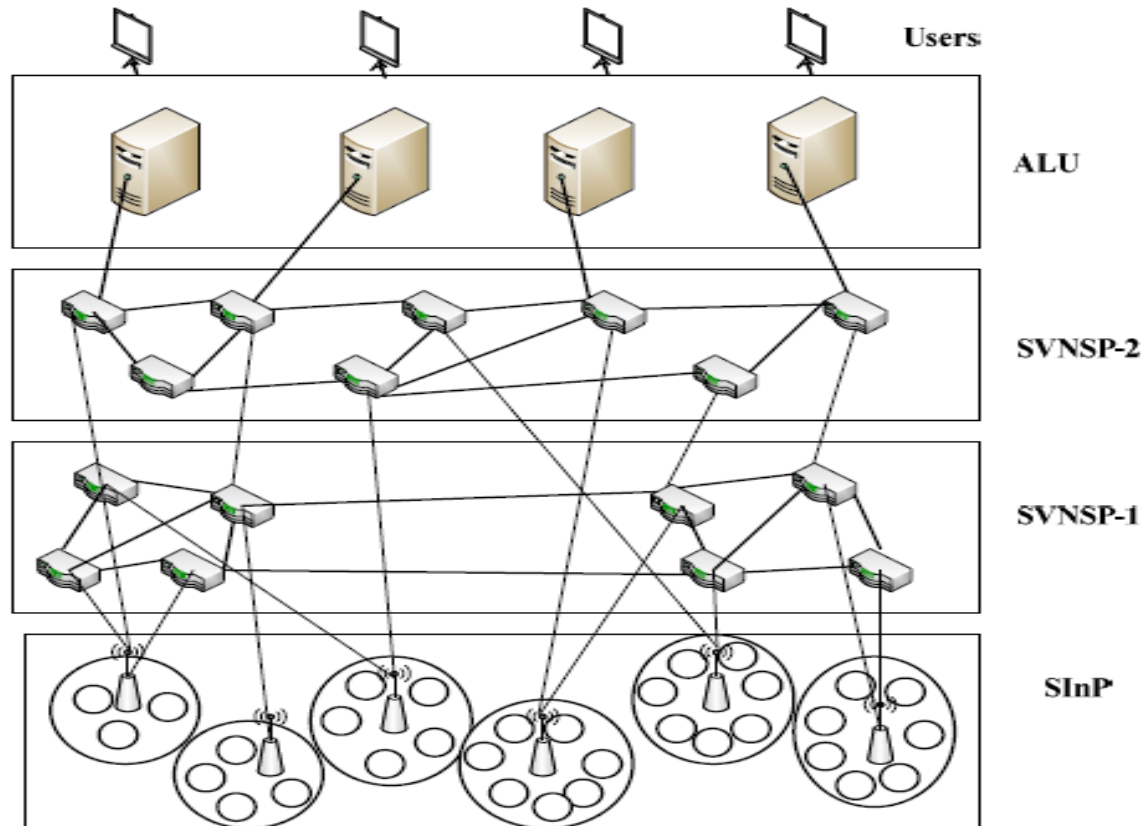
This unit is useful for processing and disseminating the outcome which is created by queries. DPU is used as database. It has collection of several tables. In these tables individual sensor readings are stored. Every sensor reading is linked with each other in the table. This unit is helpful for storing the data and also for retrieving the data from cloud.

Process between User and WSN

- ☐ User creates the account at IAMU & sends the request to it.
- ☐ IAMU defines type of service and creates request message.
- ☐ Request message is sent to the RS.
- ☐ RS creates the subscription & sends it to Sub/Pub Broker.
- ☐ Data is collected from WSNs to virtual nodes.
- ☐ Virtual nodes relate it with each application.
- ☐ DPU stores the data from virtual node.
- ☐ DPU send the index data to the Sub/Pub Broker.
- ☐ Sub/Pub Broker matches both index data with DPU and required by RS.
- ☐ If data is matched, then Sub/Pub Broker sends request to retrieve the data from DPU.
- ☐ DPU provides the requested data to the Sub/Pub Broker.
- ☐ Sub/Pub Broker forwards the data via RS and IAMU to the client.

VIRTUALIZATION IN SENSOR CLOUD

Virtualization concept facilitates to execute many applications concurrently at same sensor node. Sensor network virtualization model is shown in fig 3.



ALU: Application Level User
SVNSP: Sensor Virtualization Network Service Provider
SInP: Sensor Infrastructure Provider

Fig 3: Model of sensor network virtualization [15]

- This model consists of two types of providers. First provider is called Sensor Infrastructure Provider (SInP) that manages all the sensor nodes in WSN.
- Other provider is known as Sensor Virtualization Network Service Provider (SVNSP) which creates virtualization of sensor networks using multiple SInP. This virtualization of sensor networks is called Virtual Sensor Network (VSN). Application Level User (ALU) can connect to various SVNSP for different applications .
- Virtualization helps in maximum utilization of physical sensors through multiple applications running at a time. This technology provides new opportunities in various fields of applications such as battlefield surveillance, healthcare, vehicle telemetric, structural monitoring and agriculture monitoring etc.

- Virtualization in WSN can be divided in two categories as discussed below:
- Node level virtualization
- Network level virtualization

Node Level Virtualization

- This type of virtualization is implemented to execute multiple tasks on a physical sensor node at the same time. This is shown in fig 4.

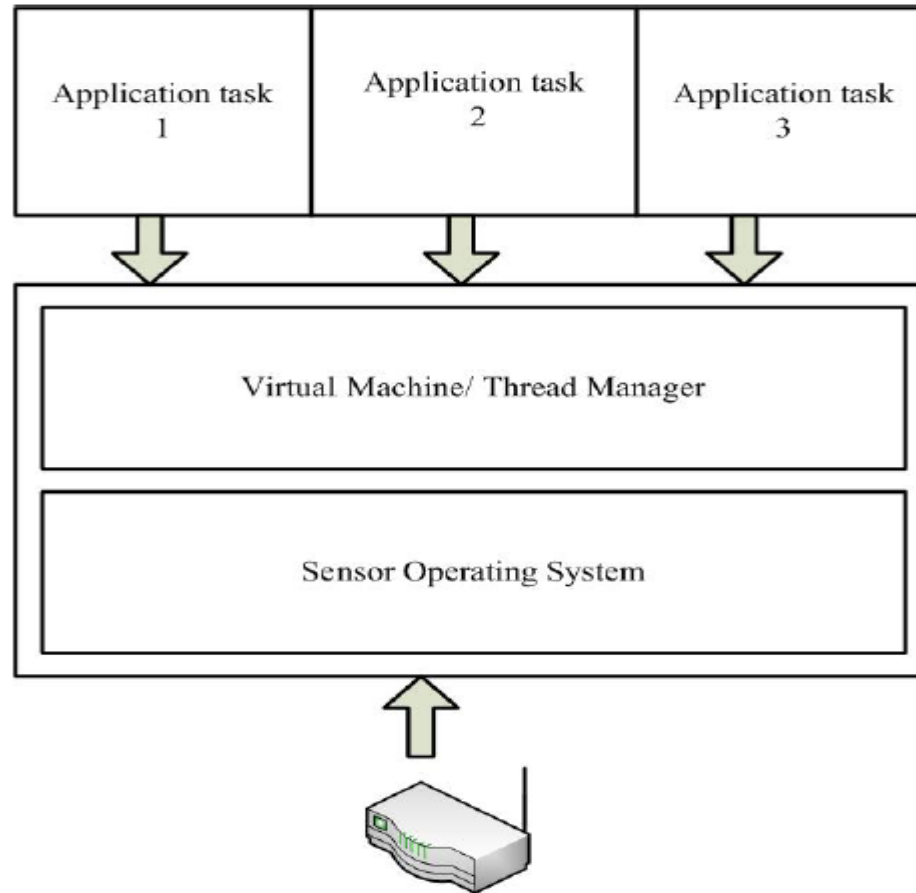


Fig 4: Model of node level virtualization

B. Network Level Virtualization

Here we create subsets of the WSN nodes with respect to various applications. Fig 5 shows network level virtualization in which logical groups of sensor nodes are created. These groups are related to the particular applications.

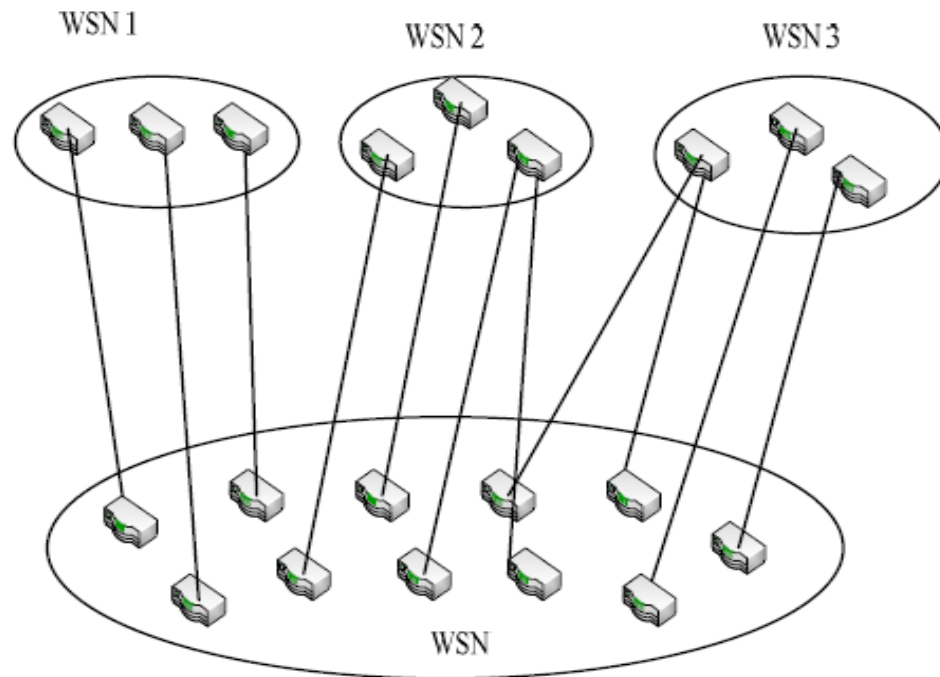


Fig 5: Model of network level virtualization

VI. APPLICATIONS OF SENSOR CLOUD

- There are several applications of sensor cloud in today's era.
- *Rock sliding & animal crossing monitoring* is one of the popular applications of sensor cloud to protect animals from rock slides in mountain area.
- When this application is deployed, an emergency signaling is used to make the animals aware of rock sliding.
- Fig 6 shows a mountain area where animals cross the road and on the mountains, there may be rock slides. In this case, there is a single physical WSN.
- Two VSNs are using this single WSN for two different applications: *monitoring rock slides* and *monitoring animal crossing*.

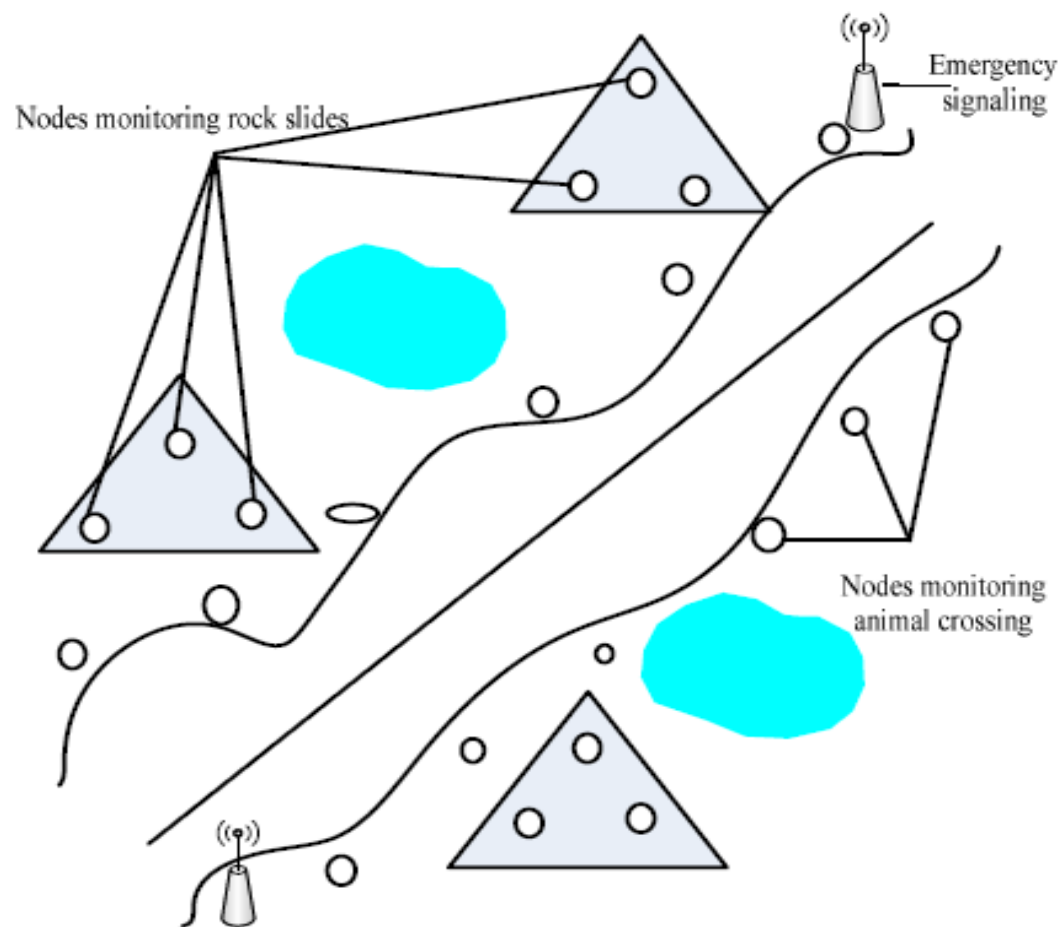


Fig 6: Rock sliding & animal crossing monitoring

Contd.

- ☐ Battlefield monitoring
- ☐ Environmental monitoring
- ☐ Disaster detection
- ☐ Smart home monitoring
- ☐ Healthcare monitoring
- ☐ Wildlife monitoring
- ☐ Weather monitoring
- ☐ Transport and vehicle telematics
- ☐ Agriculture monitoring
- ☐ Industrial monitoring
- ☐ Structural monitoring
- ☐ Target tracking applications

ISSUES AND CHALLENGES

- *Authorization Issue*- It is a most common issue in sensor network .If anyone can authorize sensor network without any permission of administrator then generate the authorization issue in Sensor-Cloud.
- *Energy Issue*- WSN and sensor-cloud are require to lot of energy and power consumption for proper working of sensor nodes and large amount of sensor data that is avoid the large data transmission.
- *Security Issue*- For authorization transaction and smooth working of network or infrastructure however maintain and manage integrity in daily routine. Therefore, if a sensor-cloud network system sensor data are send
- *Storage Issue*- Storing the sensor data at back end side is important issues in sensor cloud. Data storage issue is one of the common issues in wireless sensor network and sensor cloud.

SUBSTANCES INVOLVED IN SENSOR CLOUD

- *Owner*- Sensor cloud owner is a person who manages or maintained its own physical sensor .which is established as per the owner requirement.
- *Administrator*- Sensor cloud services are organized by the sensor administrator. It also regulates virtual sensor and the user interface.
- *End user*- It can be defined as the person who utilized the sensor cloud data for one or more application.
- *Earth observation*- In this application sensor grid analyzes, visualizes the GPS data and also collects the data from various GPS location.

ADVANTAGES OF SENSOR CLOUD

- *Analysis*-It is combination of large amount collected sensor data and sensor networks over the cloud computing prototype. It maintain cloud computing infrastructure being fascinating for various kind of analysis.
- *Scalability*-If the need of increase resources so, organization add some extra services from cloud merchant without any expenditure. That is called scalability of sensor cloud.
- *Visualization*-Sensor cloud infrastructure provides a imagination platform to be used for gathered and reacquire sensor data from different sources.
- *Collaboration*-Sensor cloud allow to share sensor data by several category of retailers therefore, the union of many physical sensor networks.

- *Increase data storage and processing*-It allocate facility to store data and excessive processing and also provide an application manage large amount of data.
- *Dynamic processing of services*-In this benefit Sensor cloud access their data from anywhere, everywhere and any time they want to access data from sensor data.
- *Flexibility*-It provides extensibility to its user then the prior computing procedure. It allows to stored and share sensor data under flexibility usage environment.
- *Quick response time*-It is concatenation of (WSN) wireless sensor network and cloud computing supply a rapid to the user. Therefore it is called real time application.
- *Automation*-Automation play an important role in sensor cloud computing. It also increases the transmission time to significant changes.

- *Multitenancy-*

It is an ability which distributes services to multiple users and share sensor cloud resources. It also provided openness of sensor data to access anywhere and everywhere.

Conclusion

- This module describes a survey on integration of WSN with cloud. People can use the sensors of multiple WSN for various applications with help of virtualization and cloud.
- Virtualization facilitates in creating virtual sensor networks from various physical sensors which helps the cloud to provide sensor-as a-service to its end users. In this way, this integration helps to optimize the usefulness of the sensor networks as well as the cloud.