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Analysis a Performance Metrics of WSN

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Abstract:

Today Wireless Sensor Network (WSN) is a distributed network and it contain a large number of distributed, self-directed, and tiny, low powered devices called sensor nodes and also called motes. WSN is consists of base stations and numbers of nodes (wireless sensors).These networks are used to monitor physical or environmental conditions like sound, pressure, temperature and mutually pass data over the network to a main location. Now we are discussing WSN architecture that is used in various layer of OS model. It enhance the performance metric of WSN are increasing lifetime of system and Energy efficiency or reliability of network and also explain platform of WSN network. It helps in increasing the efficiency of the network and network throughput. In this paper, various applications and platform, characteristics, classifications are explained. CLD in WSN is also shown.

Keywords **—WSN, WSN Architecture, sensor nodes, motes, performs metrics and classification.**

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I. INTRODUCTION TO WSN

A Wireless sensor network can be described as a network of devices that can communicate the information gathered from a monitored field through wireless links. The data is delivered over multiple nodes, and with a gateway, the data is connected to other networks like wireless Ethernet. A Wireless Sensor Network (WSN) is a distributed network and it contain a large number of distributed, self-directed, and tiny, low powered devices called sensor nodes alias motes. WSN is consists of base stations and numbers of nodes (wireless sensors).These networks are used to monitor physical or environmental conditions like sound, pressure, temperature and mutually pass data over the network to a main location. At present, wireless network is the more popular services utilized in industrial and commercial applications, because of its technical advancement in processor, communication, and usage of low power embedded computing devices.

II. INTRODUCTION TO SENSOR NODES

Sensor nodes are used to monitor real conditions like temperature, pressure, humidity, sound, vibration, position etc. In real time applications the sensor nodes are performing various function like neighbour node discovery, smart sensing, data storage and processing, data aggregation, target tracking, control and monitoring, node localization, synchronization and efficient routing between nodes and base station Wireless sensor nodes are made up with sensing unit, a processing unit, communication unit and power unit. Every single node is able to perform data gathering, sensing, processing and communicating with other nodes. The sensing unit senses the environment, the processing unit computes the confined permutations of the sensed data, and the communication unit performs exchange of processed information among

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neighbouring sensor nodes. The basic building block of a sensor node is shown in Figure 1.1

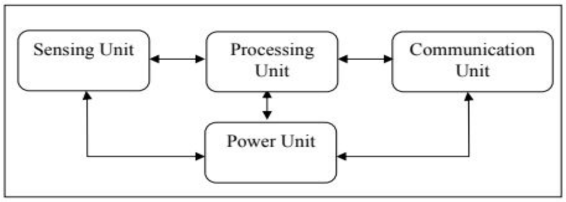

Figure 1.1 Basic Building Blocks of Sensor Node

A. SENSING UNIT

The sensing unit of sensor nodes combine various types of sensors like thermal sensors, magnetic sensors, vibration sensors, chemical sensors, bio sensors, and light sensors. The systematic guideline from the external environment by sensing unit of sensor node isdelivering into the processing unit. The analog signal developed by the sensors are digitized by using Analog to Digital converter (ADC) and sent to controller for further processing.

B. PROCESSING UNIT

The important unit of the sensor node is processing unit . The processor executes various tasks and controls the performance of other components. The appropriate services for the processing unit are pre-programmed and loaded into the processor of sensor nodes. The energy utilization rate of the processor varies depending upon the functionality of the nodes. The variation in the performance of the processor is describe by the calculating factors like processing speed, data rate, memory and peripherals supported by the processors . The calculation is performed in the processing unit and the collected result is transfer to the base station through the communication unit.

C. COMMUNICATION UNIT

In communication unit, a common transceiver act as a communication unit and it is used to transfer and receive the information among the nodes and base station and vice versa. There are four states in the communication unit: transmit, receive, idle and sleep. In general the functionality of the sensor node is shown in Figure 1.2.

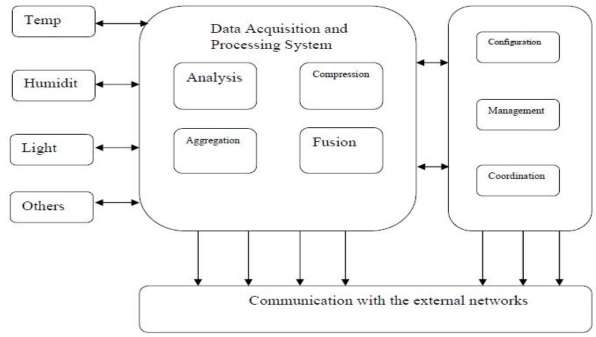

Figure 1.2 Functionality of A Sensor Node

III. CHARACTERISTICS OF THE SENSOR NODE USED TO EVALUATE THE PERFORMANCE OF WSN

The proposed system consists of advance, normal and super nodes using grid structure. Distance handling mechanism is associated with the system to reduce energy consumption. The structure of the proposed model is given as follows:

1. Fault tolerance: Each node in the network is prone to sudden failure. Fault tolerance is able to manage sensor network functionalities without any break due to sensor node failures.

2. Mobility of nodes: To increase the communication efficiency, the nodes can move in any place within the sensor field based on the type of applications.

3. Dynamic network topology: Connection between sensor nodes follows some standard topology. The WSN should have the ability to work in the dynamic topology.

4. Communication failures: If any node in the WSN fails to exchange data with other nodes, it should be informed without delay to the base station or gateway node.
5. Heterogeneity of nodes: The sensor node expand in the WSN may be of various types and need to work in a cooperative manner.

6. Scalability: The number of sensor nodes in a sensor network can be in the order of hundreds or even thousands. WSN designed for sensor networks is supposed to be highly scalable.

7. Independency: The WSN should have the potential to work without any central control point.

8. Programmability: The option for reprogramming or reconfiguring should be available for the WSN to become flexible for any dynamic changes in the network.

9. Utilization of sensors: The sensors should be utilized in a way that produces the maximum performance with less energy.

IV. APPLICATIONS OF SENSOR NETWORKS

Sensor networks have been used in high-end applications such as radiation and nuclear-threat detection systems, ‘‘over-the-horizon’’ weapon sensors for ships, biomedical applications, habitat sensing, and seismic monitoring. At present, interest has focusing on networked biological and chemical sensors for national security applications; moreover, expanding interest continues to direct consumer applications. Existing and potential applications of sensor networks include, among others, military sensing, physical security, air traffic control, traffic surveillance, video surveillance, industrial and manufacturing automation, process control, inventory management, distributed robotics, weather sensing, environment monitoring, national border monitoring, and building and structures monitoring . A short list of applications follows.

Military applications ➢ Monitoring inimical forces ➢ Monitoring friendly forces & equipment ➢ Military-theater or battlefield surveillance ➢ Targeting ➢ Battle damage assessment Nuclear, biological, and chemical attack detection and more	**Environmental applications** ➢ Microclimates ➢ Forest fire detection ➢ Flood detection ➢ Precision agriculture and more
Health applications ➢ Remote monitoring of physiological data ➢ Tracking and monitoring doctors and patients inside a hospital ➢ Drug administrate ➢ Elderly assistance and more	**Home applications** ➢ Home automation ➢ Instrumented environment ➢ Automated meter reading and more **Commercial applications** ➢ Environmental control in industrial and office buildings ➢ Inventory control ➢ Vehicle tracking and detection ➢ Traffic flow surveillance and more

V. WIRELESS SENSOR NETWORK ARCHITECHTURE

Wireless sensor networks obeys most usual architecture OSI model. Basically, there are five layers in sensor network. These are application layer, transport layer, network layer, data link layer and physical layer. There are three cross layers stages added to those above five layers of OSI model i.e. power management plane, connection management plane, task management plane. These layers are used to own the network connectivity and present the nodes to work separately to increase the global efficiency of the network.

1) Transport Layer : The purpose of this layer is to give congestion avoidance and reliability and there are a numbers of protocols developed to provide this function are either seek on downstream and upstream. This layer is specially needed when a method is organized to enter other network. The basic function of this layer is to receive data from upwards of layers and cut it up into smaller units then move these to the network layer and confirm the shipment of all pieces at the other end. It contains types of protocols like TCP, UDP, SCTP, DCCP, SPX.

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2) Network Layer : The major role of the network layer is forward. This layer has a numbers of challenges depending upon the demand but probably, the major challenges are in the few memory and buffers, power saving, sensor does not have a global ID and hold to be self-organized. This is dissimilar computer networks with IP address and central device for manage. The basic aim of the routing protocol is to define a dependable path and unnecessary paths according to a reliable scale called metric, which visible from protocol to protocol. There are different routing protocols accessible for this layer, they can be separate into; flat routing such as direct transmission and hierarchal routing e.g., filter or can be classified into time driven, event driven and query driven. In continuous time driven protocol, the data is sent periodically and time driven for applications that want a periodic monitoring. In event driven and query driven protocols, the sensor accept according to operation or user query.

3) Data link layer: The data link layer is responsible to preserve the error correction and error detection system. It is also responsible for the multiplexing of data frame detection, data streams, error control and medium access.

4) Physical layer: Physical layer can provide an interface to transfer a stream of bits over physical method. Responsible for producing carrier frequencies, frequency selection, signal detection, signals modulation and data encryption.

5) Application layer: Responsible for traffic management and provide software for varying applications that convert the data in a clear form or send queries to gain information. Sensor networks locate in different applications in various fields, for example; medical, military, environment, agriculture fields. It hold a variety of protocols such as NNTP, SIP, SSI, DNS, FTP, GOPHER, NFS, NTP, SMTP, SMPP, ANMP and TELNET.

VI. DESIGN ISSUES IN WSN

1.1 Energy Consumption: - It is one of the important issues in wireless sensor network. Sensor nodes are provided with battery that is used as their energy source. The sensor network can be located in unsafe condition so it becomes hard recharging or changing batteries. The energy consumption depends upon important operations of the sensor nodes which are sensing, data processing, communication. The large number of energy is consumed through communication. So, the efficient routing protocols ought to be applied at all layer to prevent energy consumption.

1.2 Localization: - Sensor localization is a basic and critical issue for network operations and management. The sensor nodes are located in ad-hoc manner so they do not have any information about their situation. The problem of deciding the physical location of the sensors after they have been located is called localization. This difficulty can be solved by beacon nodes, GPS, proximity derived from localization.

1.3 Coverage: - It maintained how well an area of interest is controlled as discovered by the sensor. These Sensor nodes apply coverage algorithm to sense data and send them to sink applied routing algorithm. For the good coverage, sensor nodes must be selected in such a way so that entire network should be covered. There efficient technique such as minimal and maximal detection path algorithms and coverage configuration protocol are advised.

1.4 Clocks: - Clock synchronization is a risky service in WSN. The purpose of time synchronization is to provide a general timescale for local clocks of nodes in sensor networks. Clocks should to be synchronized in some applications that are tracking and monitoring.

1.5 Computation: - The number of data move by every node is called computation. The major problem in computation is that it should minimize the use of resources. If the existence of base station

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is more critical then data processing can be completed at all nodes before sending data to base station. In case when we hold few resources at all node then whole computation must be done at sink.

1.6 Production Cost: - Large numbers of nodes are located in the sensor networks, so if the cost of a single node will be very high then we can suppose the overall cost of the network will also be very high. Sometime, the cost of every sensor node has to be kept low. So cost of each sensor node in the network is a exciting issue.

1.7 Hardware Design: - While developing any hardware of sensor network, it should be energy-efficient. Hardware such as power control, micro-controller, and communication unit must be design in such a method that it consumes less energy.

1.8 Quality of Service: - QOS means data must be delivered within time interval. There are some real time sensor applications that are form on time i.e. if data should not be carried on time to the receiver from the moment it is sensed; data will become useless. There is different quality of service issues in sensor networks such as network topology may change constantly and the accessible state details for routing is constitutionally indefinite.

VII. PERFORMANCE METRICS OF WSN

Metrics are measured to support the performance of wireless sensors in buildings. Wireless sensor networks present great opportunities for energy savings and development in holder relief in buildings by making data about conditions and equipment too easily usable. A hurdle to their maintenance is the uncertainty among users about the accuracy of the wireless links through building construction. There are three test to examined the performance metrics as a function of transmitter–receiver separation distance, transmitter power level, and obstruction type. It is certain that the opportunity of straightforward metrics on the range of wireless sensors in buildings will enable all over the place sensing in buildings for improved control and fault detection. Wireless sensor networks are various from the traditional communication networks, and different performance measures may also be required to check them. Among them are the following-

1. *System lifetime*- This term can be describe in several ways: (a) A Period of time until some node decrease all its energy; or (b) A Period of time until the QoS of applications cannot be assured; or (c) A Period of time until the network has been disjoined.

2. *Energy efficiency*- Energy efficiency means the number of packets that can be transmitted successfully using a unit of energy. Packet collision at the MAC layer, routing overhead, packet loss, and packet retransmission lower the energy efficiency.

3. *Reliability*- The event reliability is used to measure how reliable the sensed event can be reported to the sink. For applications that can tolerate packet loss, reliability can be describe as the ratio of successfully received packets over the total number of packets transmitted.

4. *Coverage*- Full coverage by a sensor network means the space that can be controlled by the sensor nodes. If a sensor node becomes improper due to energy reduction, there is a certain amount of that space that can no longer be control. The coverage is defined as the ratio of the monitored space to the entire space.

5. *Connectivity*- For multichip WSNs, it is possible that the network becomes disjointed because some nodes become improper. The connectivity metric can be used to evaluate how many network is connected and how many nodes have been hidden.

6. *QoS metrics*- Some applications in WSNs have real-time properties. These applications may have QoS requirements such as delay, loss ratio, and bandwidth.

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VIII. PLATFORMS OF WSN

Hardware

A major challenge in a WSN is to produce low cost and tiny sensor nodes. There are an increasing number of small companies generating WSN hardware. Many of the nodes are still in the research and development stage, especially their software. Sensor network acceptance is the use of very low power methods for radio communication and data acquisition. WSN communicates with a Local Area Network or Wide Area Network through a gateway. The Gateway is a bridge between the WSN and the other network. This implement data to be stored and processed by devices with more resources, for example, in a remotely located server. A wireless wide area network used primarily for low-power devices is known as a Low-Power Wide-Area Network (LPWAN).

Software

Energy is the limited resource of WSN nodes, and it regulate the lifetime of WSNs. WSNs may be expand in large numbers in various environments, including remote and hostile regions, where ad hoc communications are primary component. For this reason, algorithms and protocols need to address the following issues: Increased lifespan, Robustness and fault tolerance, Self-configuration. Lifetime maximization: Energy/Power Consumption of the sensing device should be minimized and sensor nodes should be energy efficient since their finite energy resource determines their lifetime. To conserve power, wireless sensor nodes normally power off both the radio transmitter and the radio receive when not in use.

Routing Protocols

Wireless sensor networks are composed of low-energy, small-size, and low-range unattended sensor nodes. It has been noticed that by regularly turning on and off the sensing and communication efficiency of sensor nodes, we can automatically reduce the active time and thus continue network lifetime. This duty cycling may result in high network latency, routing overhead, and neighbor discovery delays due to asynchronous sleep and wake-up scheduling. These limitations call for a countermeasure for duty-cycled wireless sensor networks which should minimize routing information, routing traffic load, and energy consumption.

Operating systems

Operating systems for wireless sensor network nodes are sometimes less complex than general-purpose operating systems. They resemble embedded systems, for two reasons. First, wireless sensor networks are commonly setup with a particular application in mind, rather than as a general platform. Second, a need for low costs and low power leads most wireless sensor nodes to have low-power microcontrollers establish that mechanisms such as virtual memory are either worthless or too costly to implement. It is possible to use embedded operating systems such as echoes or uC/OS for sensor networks. Such operating systems are often designed with real-time properties. Tiny OS is the first operating system exactly designed for wireless sensor networks. Lite OS is a newly developed OS for wireless sensor networks, which provides UNIX-like abstraction and support for the C programming language.

IX. INTRODUCTION TO MOTES

A sensor node, also known as motes. It is a node in a sensor network that is able to perform some processing, gathering sensory information and communicating with other connected nodes in the network. A mote is a node but a node is not always a mote

1. *Component*:- The main components of a sensor node are a microcontroller, transceiver, external memory, power source and one or more sensors.

2. *Controller:-* The controller performs tasks, processes data and controls the Performance of other components in the sensor node. The most common controller is a microcontroller, other alternatives that can be used as a controller are: a

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general purpose desktop microprocessor, digital signal processors, FPGAs and ASICs. A microcontroller is used in many embedded systems such as sensor nodes because of its low cost, flexibility to connect to other devices, ease of programming, and low power consumption. A general purpose microprocessor mostly has a higher power consumption than a microcontroller, it is not designed as a suitable choice for a sensor node. Digital Signal Processors may be chosen for broadband wireless communication applications, but in Wireless Sensor Networks the wireless communication is often modest: i.e., simpler, easier to process modulation and the signal processing tasks of actual sensing of data is less complicated.

3. *Transceiver:-* Sensor nodes generally make use of ISM band, which gives free radio, spectrum allocation and global oppotunity. The available choices of wireless transmission media are radio frequency (RF), optical communication (laser) and infrared. Lasers require less energy, but need line-of-sight for communication and are sensitive to atmospheric conditions. Infrared, like lasers, needs no antenna but it is limited in its broadcasting capacity. Radio frequency-based connection is more suitable for WSN applications. The functionality of both transmitter and receiver are united into a single device known as a transceiver. Transceivers generally have a lack of unique identifiers. The working states are transmit, receive, idle, and sleep. Current generation transceivers have built-in state machines that perform some operations automatically. Most transceivers operating in idle mode have a power consumption almost equal to the power consumed in receive mode.

4. *External memory*:- The most suitable kinds of memory are the on-chip memory of a microcontroller and Flash memory—off-chip RAM is rarely used. Flash memories are used due to their cost and storage capacity. Memory requirements are very much application dependent. The purpose of storage memory can divided into two category : user memory used for storing application related or personal data, and program memory used for programming the device. Program memory also consist of identification data of the device if present.

5. *Power source*:- A wireless sensor node is a suitable solution when it is difficult or impossible to run a mains supply to the sensor node. The wireless sensor node is suitable for placed in a hard-to-reach location, changing the battery regularly can be costly and difficult. An important condition in the development of a wireless sensor node is provide that there is always sufficient energy available to power the system. The sensor node expend power for sensing, communicating and data processing. More energy is nedded for data communication than any other process. Power is stored either in batteries or capacitors. Batteries, both rechargeable and non-rechargeable, are the main source of power supply for sensor nodes.

6. *Sensors:-* Sensors are used by wireless sensor nodes to take data from their environment. They are hardware devices that produce a measurable response to a change in a physical condition like temperature or pressure. Sensors measure physical data of the guideline to be monitored and have specific component such as accuracy, sensitivity etc. The continual analog signal formed by the sensors is digitized by an analog-to-digital converter and sent to controllers for more processing. Most sensor nodes are small in size, consume little energy, operate in high volumetric densities.

Sensors are classified into three division: passive, omnidirectional sensor, narrow-beam sensors; and active sensors. Passive sensors sense the data without actually manipulating the environment by active probing. They are self-powered, energy is needed only to amplify their analog signal. Active sensors actively probe the environment, for example, a sonar or radar sensor, and they require continuous energy from a power source. Narrow-beam sensors have a well-defined notion of direction of measurement, similar to a camera. Omnidirectional sensors have no notion of direction involved in their measurements.

X. CONCLUSION

In this paper, we have a survey on Performance metrics in wireless sensor networks. Firstly, we discussed about wireless sensor networks and wireless sensor networks architecture or classification, characteristics and applications. We have also defined four different stages of platform in WSN. Thus in the end we have reviewed various performance metrics in this paper. In this paper we are also discuss various types of modes used in WSN.

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