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Design and Architectural Issues in Wireless Sensor Networks

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Abstract-There are large varieties of applications of wireless sensor networks. The two major applications of the wireless sensor network are tracking based and second is monitoring based. There are sensors which communicate with each other to form a network. In the wireless sensor network there are number of issues which affects the performance and efficiency of the wireless sensor network. This paper covers almost all issues and simulation tools.

Keywords-Wireless sensor network, Tools, Security, Energy Consumption, Routing protocols

I. INTRODUCTION

With the help of recent researches in micro-electro-mechanical technology, wireless communication and digital electronics low cost, low power multipurpose sensors nodes of small size have been developed. Wireless sensor node's major steps in their work are sensing, processing of data, and communicating with other nodes. Wireless sensor network consists of electronics devices which form the network in which information sensed or gathered is transmitted to the sink node. Each device in the sensors network is capable of sensing, processing and transmitting of the sensed data. Data is transmitted on the network to sink in two way first, it can be directly sent to sink node, and secondly it can be transmitted by gateway. Types of sensor networks-There are five types of the wireless sensor networks i.e. Terrestrial Wireless sensor network, Underground Wireless sensor network, Underwater Wireless sensor network, Multimedia Wireless sensor network, Mobile Wireless sensor network [30].For the efficiency and reliability of the wireless sensor we have to consider different issues based on the design, architecture and applications.

II. DESIGN ISSUES

The wireless sensor network is smaller in size and having limited memory, computation and battery power. Related to design of wireless sensor network different factors are discussed as:

A. ENERGY CONSUMPTION

As energy consumption determines the lifetime of the Wireless sensor network. Hence it becomes the major issue in Wireless sensor network. Most of sensor nodes use battery power as their energy source. The sensor network can be deployed in hazards conditions so it becomes difficult to change their batteries or provider the energy so there is requirement of developing the networks which efficiently use the battery as energy [3].The energy consumption depends upon major operations of the sensor nodes which are [2]

- Sensing.
- Communication
- Data processing.

The large amount of energy is consumed during the communication. The various routing protocols are discussed in [4] Therefore the efficient protocols should be used at each layer in order to control energy consumption. Batteries with high power as rechargeable batteries like solar panel can be used in some wireless sensor networks.

B. LOCALIZATION

As in the wireless network the sensor nodes are deployed in ad-hoc manner so they do not have knowledge about their position. The problem of determining the position of nodes is called localization. The problem can be solved by:

- GPS
- Beacon nodes.
- Proximity based localization.

Other techniques such as Moore's algorithm [6], Radio interfermetric positioning system [7], and mobile assisted localization [8] can be used.

C. TOPOLOGY CONTROL

There are large number of nodes deployed in the over Wireless sensor network. Main purpose of topology control so that the entire environment should be covered with the nodes. [9], [2] there are three phases in which topology control involves are:

1) Pre-deployment and development phase: Sensor nodes can be either thrown or placed one by one in the field .These sensors can be deployed by

- Dropping from a plane.
- Placing in factory.
- Delivering in rocket or missile.
- Placing one by one human or robot.
- Throwing by a catapult

2) Post deployment phase: Due to position, reach abilities, available energy, malfunction and task detail changes, there is change in the topology.

3) Redeployment of additional nodes phase: Due to change in malfunctioning or task dynamics additional nodes can be redeployed. Redeployed poses need to re-arrange the network.

D. COVERAGE, CONNECTIVITY, CLOCKS AND COMPUTATION

1) Coverage: It tells how well an area of interest in monitored as traced by the sensor. These sensor nodes sense the data using coverage algorithm and send them to base station using routing algorithm. For the good coverage, coverage nodes should be selected in such a way so that whole network should be covered. Therefore efficient technique such as Coverage Configuration Protocol [11], Minimal and maximal exposure path algorithms [12] are suggested.

2) Connectivity: Connectivity is maintained in distributed fashion due to energy constraints and power consumption. Connectivity tells how by using radio transmission the sensed data by the sensor node is delivered to sink node. The various techniques are discussed in [14], [15].

3) Clocks: Clocks should be synchronized in some applications such as monitoring and tracking. Clock synchronization also helps in the saving energy.

4) Computation: Amount of data proceeds by each node is computation. The major problem in computation is that it should minimize the use of resources. By exploit the structure of data that need to be transmitted computation can be made effective. If the lifetime of sink is more critical then data preprocessing can be completed on each node before sending data to sink node. Otherwise when we have very few resources at each node then entire computation should be done at sink [13].

E. DATA GATHERING

It is a major issue in Wireless sensor network as it determines the lifetime of network. Data gathering is task of collecting the data from different sensors by removing the redundant data. The information collected must be delivered to sink node without loss of information. Sensors node forward their own packet and also forward packets produced by others sensors, hence tends to consume more energy and form the energy holes near the sinks [29]. There are number of security threads in data gathering which are reduced by compression technique [17] and aggregation technique.

F. QUERY PROCESSING

Query processing involves the answering the query from sink by gathering the information from other sensor nodes. The storage node stores the data from other nodes and answers the query from sink in this way it is a two tier architecture and storage node act as intermediate node.

G. SCHEDULING

It is also a important factor as it determines that for which time period the sensor node will in which node either sleep, active or on standby mode. Scheduling also plays important role for coverage and connectively. By using proper scheduling we can reduce the energy consumption [18].

H. RELIABILITY

Fault tolerance - A node may fail due to various reasons. The failure of one node should not affect the overall performance of the Wireless sensor network. Information delivery application information deliveries dependent have issues [4]:

1) Packet reliability: applications that are less sensitive require successful transmission of all packets.

2) Event reliability: applications require only successful event detection and not successful transmission of all packets.

3) Destination related reliability: applications have to send message to node that lies is specific area of network.

I. SCALABILITY

There are number of nodes in wireless sensor network. Depending on the requirements of the application number of nodes can be increased or decreased. Wireless sensor network should be such that it should be able to accept new node and co-ordinate them with existing nodes.

J. PRODUCTION COST

When the cost of traditional sensors is less than cost of network then Wireless sensor network is not justified [9].

K. HARDWARE CONSTRAINTS

Wireless sensor network consists of sensors, processing unit, transceiver and power unit. Hardware should be in such way that it should be capable of operating with high volumetric densities.

L. SECURITY

It should achieve all security goals which are confidentiality, Availability, Integrity, Authentication, Authorization, Non-repudiation and Freshness [1].

1) Physical Layer: It is transmission medium can be suffered from denial of service, node capture etc.

2) Data link layer: It suffers from dos and jamming attacks. In this layer perform error detection and correction.

3) Network layer: This layer is affected by routing related attacks such as dropping entire packet, global broadcast.

4) Application layer: Data collection and management is done at this layer .This layer ensures that when sink collects from sensor node no malicious node is allowed to interfere.

III. ARCHIETECURAL ISSUES [2]

There are 5 layers .The problems or issues related to each layer are discussed as

A. PHYSICAL LAYER

Physical layer adds the modulation, transmission and relay techniques. The issues related to this are:

- Signal fading due to noisy environment
- Shadowing and path loss effect

Baseband, pass band or UNB are low power modulation techniques.

B. DATA LINK LAYER

Main purpose of this layer is to provide the reliable point to point or point to multipoint connection in Wireless sensor network. The major problem in this are:

- Requirement of protocol for mobile sensor networks
- Determination of lower bounds on energy required for sensor network self organization.

C. NETWORK LAYER

It deals with the routing of data in the network data aggregation should be used properly .The routing protocols must be adjust according to availability of memory, energy.

D. TRANSPORT LAYER

This layer provides end to end reliability and handles congestion. Overheads can be minimized by using hop by hop transmission as it consumes less energy and bandwidth. There should be proper method for detection of packet loss.

E. APPLICATION LAYER

This provides access to information either by query or by node advertisement services. Issues in multimedia application services-

- large amount of data transfer require more power
- some require more memory

IV. SIMULATION TOOLS

There are number of various tools which are used for simulation of the wireless sensor network which are as following:

A. NS-2

NS-2 [21] is non-specific network simulators which supports a wide range of protocols in all layers.NS-2 is discrete event simulator which is developed in C++. Otcl [22] is used as configuration and script interface in NS-2. It provides the most complete support of communication protocol models, among non-commercial packages. WSN and ad-hoc specific protocols such as directed diffusion [23] or SMAC [24]

B. OMNET++ [25]

OMNET++ is easy simple modular discrete event simulator and implemented in C++. Powerful GUI library for animation and tracing and debugging Support is provided by this tool. The major drawback of OMNET++ is the lack of available protocols in its library. Mobility framework released for OMNET++ [26] and it can be used as a starting point for WSN modeling. Additionally, several new proposals for localization and MAC protocols for WSN have been developed with OMNET++, under the Consensus project, and the software is publicly available [27].

C. GloMoSim [28]

Simulation environment for wireless networks built with Parsec [17] which is a simulation language derived from C .Semantics for creating simulation entities and message communication on a variety of parallel architectures are added by Parsec. Taking advantage of parallelization, it has been shown to scale to 10,000 nodes [18] several proposals for WSN protocols have been tested with it. Recently, a development kit for WSN has been released, sQualnet [19].

D. SSFNet [20]

Scalable Simulation Framework (SSF) is set of Java network models. Portability between compliant simulators is assured by specification of a common API for simulation. Multiple Java and C++ implementations of SSF are available. DartmouthSSF (DaSSF), for instance, is a C++ implementation of SSF oriented to (parallel) simulation of very large scale communication networks.

E. Ptolemy II [29]

Different models of simulation paradigms are supported by PtolemyII. Modeling, simulation and design of concurrent, real-time, embedded systems are addressed by this. By sub classing base classes of the framework or by combining existing Ptolemy models, models can be developed.

V. APPLICATIONS [30]

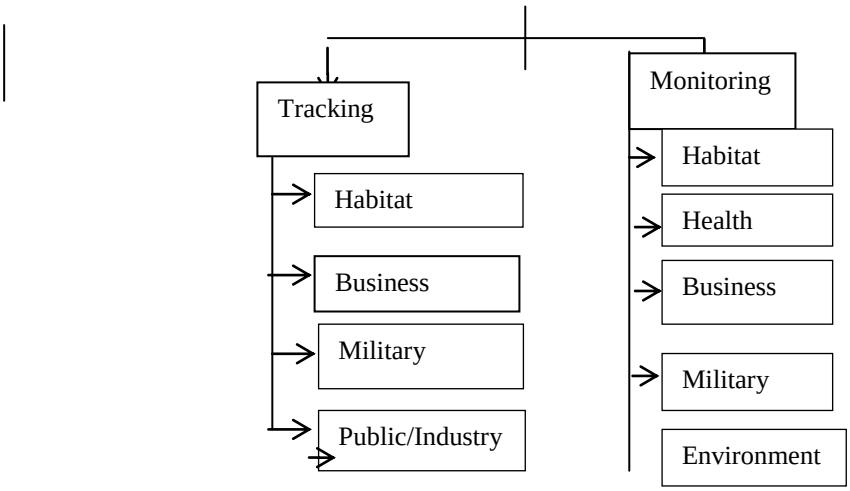

Fig. 1 Applications of wireless Sensor network

VI. CONCLUSIONS

Wireless sensor network has many applications. Life time and overall performance of the network is affected by issue power consumption so it becomes major issue in the wireless sensor network. Efficient data gathering techniques and routing protocol can be used in order to minimize the energy consumption. Overview of issues, simulation tools are presented in this paper.

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