Research Article Impact Factor: 0.621 ISSN: 2319-507X
Sushil Sawdekar, IJPRET, 2014; Volume 2 (9): 913-919 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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WIRELESS SENSOR NETWORKS AND SIMULATION

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Accepted Date: 27/02/2014 ; Published Date: 01/05/2014

Abstract: Wireless sensor networks have been identified as one of the most important technologies for the 21st century and have become a growing area of research and development. The designing of WSN become more complex due to characteristics of deploying nodes, security, authentication and its operation scenario. This paper provides the important features and overview of wireless sensor network. And since running real experiments is costly and time consuming, the simulation is very important for the study of wireless sensor network. This paper also compares various sensor network simulators to help researchers to choose the best simulator available for a particular application environment.

Keywords: WSN, Infrastructure, Simulator

PAPER-QR CODE

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Access Online On:

www.ijpret.com

How to Cite This Article:

Sushil Sawdekar, IJPRET, 2014; Volume 2 (9): 913-919

INTRODUCTION

A WSN is a network of nodes that sense and may manipulate the environment thus modifying the interaction between persons or computers and the surrounding environment. A complete wireless sensor network usually consists of one or more base stations (or gateway), a number of sensor nodes, and the end user. Running real experiments on a testbed is costly and difficulty. Besides, repeatability is largely compromised since many factors affect the experimental results at the same time. It is hard to separate a single aspect. Moreover, running real experiments are always time consuming. Therefore, WSNs simulation is important for WSNs development. Protocols, schemes, even new ideas can be evaluated in a very large scale. WSNs simulators allow users to isolate different factors by tuning configurable parameters. Consequently, simulation is essential to study WSNs, being the common way to test new applications and protocols in the field.

2. CHARACTERISTICS OF WIRELESS SENSOR NETWORKS (WSN)

The important characteristics of wireless sensor network are given below as: [1]

- Ability to resist coarse environmental conditions
- Communication failures
- Heterogeneity of nodes
- Low-complexity, low cost and size of nodes
- Mobility of nodes
- Power consumption constrains for nodes using batteries
- Scalability with respect to the number of nodes in the network
- Self-organization and self-healing

3. CLASSIFICATION OF SENSOR OF WSN

Wireless networks are broadly classified into two classes as infrastructured and infrastructure less network. Infrastructured network consists of wireless node with a network backbone. And Infrastructure less network consist with dynamic topology, independent, low-power, distributed, task–oriented wireless node as shown in the following figure.

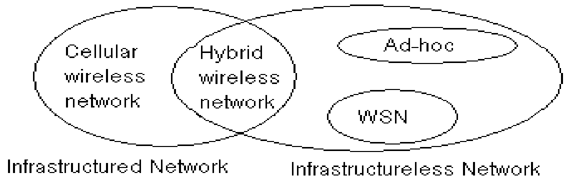

Fig1: Classification of Wireless Sensor Network

- The **cellular wireless network** falls under the class of infrastructure network.
- **Ad-hoc** & **wireless sensor network (WSN)** are the part of infrastructure less network.
- The common part of these network forms **hybrid wireless network (HWN)** which adopt the characteristics of both network i.e. architecture of HWN is based on cellular wireless network and communication is performed by using infrastructure less network.

In WSN, the nodes sense the activity of its region and supply to the next upper node which collects different information from different nodes. Then the final information is supplied to the central node to remove the redundant information and further processing. [2, 3, 4, 5, 6]

4. DESIGN CONSEQUENCES AND ROUTING / COMPUTING CHALLENGES IN WSN

The main task of WSNs is to carry out data communication, extend the lifetime of network and prevent connectivity failure by using appropriate energy management techniques. The challenging thing in WSNs is routing due to following features which distinguish these networks from other wireless networks such as mobile ad hoc networks or cellular networks. [1]

- As compared to other networks, all applications of sensor networks require the flow of sensed data from multiple sources to a particular BS but this does not prevent the flow of data to be in other forms.
- As compared to other conventional wireless networks, nodes in WSNs are generally stationary after deployment while in conventional wireless networks, nodes are free to move, however resulting in unpredictable and frequent topological changes. But some applications may permit some sensor nodes to move and change their location.
- Because of large number of nodes in these networks and the priority of overhead of ID maintenance, a global addressing scheme cannot be established for the formulation of sensor nodes, thus conventional IP based protocols cannot be employed.
- There is a high probability that the data in WSNs has some redundancy, as the data collected by many sensors in WSNs is based on common physical processes.

- A careful resource management is important as the sensor nodes are tightly constrained in terms of energy, processing and storage capacities.
- The recognization of position of sensor nodes is very important as the data collection is normally based on the location.

The factors affecting the routing process in WSNs are as follows:

- Coverage
- Node deployment
- Transmission media
- Connectivity
- Data aggregation
- Quality of service
- Energy consumption without losing accuracy
- Fault tolerance

5. SIMULATION OF WSNs

Simulation is very important for the study of WSN. Simulation is the process of designing a model of a real system and conducting experiments to understand the behaviour of the system and/or evaluate various strategies for the operation of the system. The simulation result may not be accurate to predict the real behavior of wireless sensor network. Simulation is necessary to test the application and protocols.

The capabilities that a WSN simulator should have are: [7]

5.1 Reusability and availability

Simulation is used to test novel techniques in realistic and controlled scenarios. Researchers are usually interested in comparing the performance of a new technique against existing proposals.

5.2 Performance and scalability

Performance and scalability is a major concern when facing WSN simulation. The former is usually bounded to the programming language effectiveness. The latter is constrained to the processor, memory and logs storage size requirements.

5.3 Support for rich-semantics scripting languages to define experiments and process results

The vast amount of variables involved in the definition of a WSN experiment requires the use of specific input scripting languages, with high-level semantics. Additionally, it is likely that large quantities of output data will also be generated through many replicas of the experiments. Therefore, it is desirable to have a suitable output scripting language, which helps to obtain the results from the experiments quickly and precisely.

5.4 Graphical, debug and trace support.

Graphical support for simulations is interesting in three aspects as - (a) a debugging aid. The practical way to quickly detect a bad behavior is to "watch" and follow the execution of a simulation. The key features that a graphical interface should support are: Capability of inspection of modules, variables and event queues at real time, together with "step-by-step" and "run-until" execution possibilities. These features make graphical interfaces a very powerful debugging tool. (b) a visual modeling and composition tool. This feature usually facilitates and speeds the design of small experiments or the composition of basic modules. (c) Finally, it allows quick visualization of results without a post-processing application.

6. WSN SIMULATION SOFTWARES

There are many simulators used in wireless sensor networks. The key features and limitations of each of these simulators are listed below [8].

NS-2

Programming language used: C++

Merits: Easy to add new protocols; A large number of protocols are available publically; Availability of visualization tool.

Demerits: Supports only two wireless MAC protocols, 802.11, and a single-hop TDMA protocol; need to familiar with writing scripting languages.

NS-3

Programming language used: C++

Merits: NS-3 is not a extension of NS-2, it is a new simulator; NS-3 is open-source.

Demerits: Python buildings do not work on Cygwin; only IPV4 is supported.

TOSSIM

Programming language used: nesC

Merits: High degree of accuracy or running the application source code unchanged; Availability of visualization tool.

Demerits: Compilation steps lose the fine grained timing and interrupt properties of the code.

J-sim

Programming language used: java

Merits: Provides support for energy modeling with the exception of radio energy consumption; Supports mobile wireless networks and sensor networks; Component oriented architecture.

Demerits: Low efficiency of simulation; Only MAC protocol provided for wireless networks is 802.11.; unnecessary run-time overhead

OMNeT

Programming language used: C++

Merits: Powerful graphical User Interface (making tracing and bugging easier); Simulate power Consumption problem.

Demerits: Number of protocol is not large enough; Compatibility problem (not portable)

Castalia

Programming language used: C++

Merits: Physical process modeling, sensing device bias and noise, node clock drift, and several MAC and routing protocols implemented; highly tunable MAC protocol and a flexible parametric physical process model.

Demerits: Not a sensor specific platform; Not useful if one would like to test code compiled for a specific sensor node platform.

QualNet

Programming language used: C++

Merits: Easy-to-use and clear User Interface. Sophisticated animation capabilities; Supp-ort for multiprocessor systems and distri-buted computing.

Demerits: Difficult installation on Linux; Slow Java-based UI; Very expensive.

CONCLUSION

This paper guides the users and researchers in understanding the basics of wireless sensor networks with its characteristics, classification and design consequences and routing, computing challenges in WSN. The properties of good simulators and types of WSN simulators with its strengths and weaknesses are provided which may helps the users to select the most appropriate simulator for their testing.

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