

Significant Effect of Vital Rule of Simulators in Wireless Sensor Networks

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Abstract

It is the requirement of the time, to simulate/emulate for analyzing the system. Therefore we must need some tools for this specific task. This paper is for encompassing the available tools for analyzing and evaluation purpose. Papers having all these exclusive information with detail are not available. We show ATEMU, Avrora, EmStar, J-Sim, NS-2, OMNeT++ and TOSSIM. We try to analyze the tools thoroughly. We define and discuss about the operation, functionality, advantages, disadvantages and constraints. These are the main stream superb simulation tools based on state of the art techniques. We explore on the basis of popularity, accessibility (open source), complexity, accuracy, scalability, extensibility and availability of various problems in homogenous and heterogenous WSN and other networks on different platforms and with or without using different scripting languages.

Keywords: ATEMU, Avrora, EmStar, J-Sim, NS-2, OMNeT++ and TOSSIM, wireless sensor network, simulation, simulator

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1. Introduction

WSN become essential part of our life in different aspects. It has various and widespread effects in different aspects of our life as well. Therefore correct and exact realization of Figure 1.

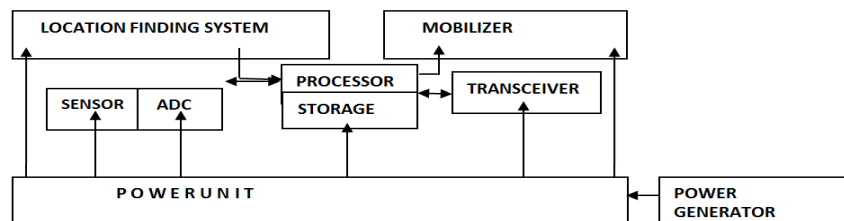


Figure 1. Therefore Correct and Exact Realization

Technique is the need of the time. Exclusively by research community and mess generally. Implementation of new ideas, and correct realization of previously embedded features is required the exclusive simulator. To deal with testbed is more cumbersome. For the beginners it is too much difficult. Therefore new coming tools got their places within no time. The tools, which we are going to discuss, are easier to operate and realize too. And low price is another quality of these simulators. In the older ones, it was so hard to isolate any aspect. Simulation gives the solution of all these problems and issues. In WSN it is very hard to setup the situation in laboratory in real.

2. Simulation Techniques

Trace-Driven Simulation, Discrete-Event Simulation and Monte Carlo Simulation are the techniques, details are as under.

2.1. Trace- Driven simulation

It provides simulation on real time. Real time simulation is the very good feature for the research community. It provides the research to correct and implement any thing on time to make the system very favorable. Accurate detail information is given by this simulator, which gives the opportunity to researchers to take the appropriate action [4].

2.2. Discrete-Event simulations

This provides the good robust system for debugging. Debugger breakpoints are given. The researcher can easily go through the code step by step and debug the chunk. This will not disturb the operation of the program. Scheduling to time is advance is easy is this simulation. Input, output and trace routines are the good features of this simulation. Another feature of this is the dynamic memory management facility.

2.3. Monte Carlo Simulation

It is very useful in risk accounting, quantitative analysis and decision making purposes. It is very widely used simulation. It is for engineering, insurance, finance, research and development and many others also. Researchers assumes that decision making feature of this simulator is tremendous. It have a very special feature of encountering probability distribution, in which it encounters following special types Normal, Lognormal, Uniform, Triangular, PERT and Discrete are encountered.

3. Simulation Tools

This section is for mentioning and illustrating contemporary simulation tools for the simulation facility of WSN related issues and problems. We arrange these in alphabetically order. ATEMU, Avrora, EmStar, J-Sim, NS-2, OMNeT++ and NS-2 are most exclusive tools.

3.1. ATEMU

ATEMU is very exclusive for emulations for all WSNs. It is an emulator of the AVR processor based on C language. For simulation or emulation purpose it have very exclusive library for hardware devices like transceivers and timers. It is helpful to run TinyOS on MICA2. ATEMU can simulate each sensor separately at the same time. It is equally good for Solaris and Linux operating system. ATEMU is the GUI based system, which provides the facility to the users to use it for different purpose (Figure 2).

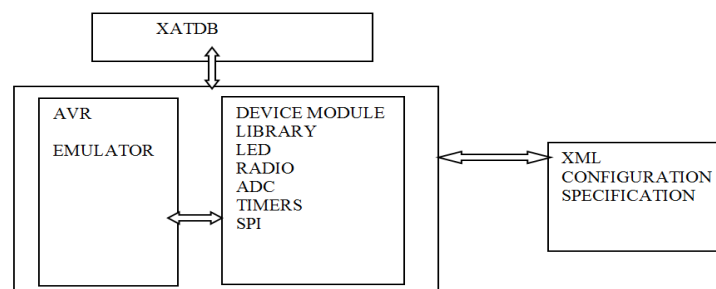


Figure 2. Basic Components Architecture of ATEMU

It is open source and provides the online documents. It is equally good for homogeneous and heterogeneous networks at the same time. It has the facility of testing OS and applications too. It is also very useful for simulating wireless sensor networks. Scalability is poor of this simulator. The simulation speed is slow. ATEMU is 30 times slower than TOSSIM. It has few solutions for clustering issues. It can emulate different application run on MICA [7].

3.2. Avrora

UCLA research group presented this simulator in 2004 in Los Angeles. Avrora is a simulator based on Java language. It has the analysis tools for AVR micro-controllers. Avrora is

the exclusive simulator, which provides different tools facility to simulate. This is very useful for simulating all aspects in WSNs. It is much better than TOSSIM and ATEMU simulators. It provides the option to simulate different programming codes unlike others; this makes it demanding in the research community. Energy consumption can also be supported and the issues can be simulated related to this. Although it has very positive aspects of this simulator, but have some limitations as well at the same time. No GUI facility for the user in this simulator, therefore the user has to take the decision on the basis of text message. It runs codes instruction by instruction. Only this simulator can have the capability to simulate thousands of nodes at the same time. Very good scalability and accuracy provided by this simulator. It can support different platforms to simulate, like Mica2 and MicaZ [8].

3.3. EmStar

EmStar is the C language based emulator. It is built for Linux based devices. Therefore it is called micro servers. GUI based, provides the user friendly environment. It is developed in UCLA Los Angeles by the research group. As in all other simulators we have advantages and the limitations at the same time. Therefore in EmStar we have some constraints as well. It's a real time simulator. Scalability is not good of this simulator; therefore we cannot simulate a large number of nodes. EmStar provides good simulation on hardware sensor of WSN. Microkernel is the Linux extension is included in the EmStar library. EmStar can run on Linux. Simulation mode, emulation mode, real mode and hybrid mode facilities are available through this simulate for the user, makes it more demanding. EmStar is robust enough to rectify the problems generated in sensors. Provides the online documents for making widely used. Same code is used for every platform, reducing the possible bugs [2].

3.4. J-Sim

J-Sim is a component based simulation facility. It is on Java language based program. It provides the GUI facility for the users for animation, tracing and debugging, therefore user can take the decision on the basis of images and rather on text. J-Sim supports mathematical modeling; this facility makes this simulator more versatile. Online documents and open source facility is available in J-Sim. Real time processing is possible by using this simulator. It can simulate radio channel and power consumption related problems. It support protocols, and all problems related to WSN. Implementation of schemes related to localization, routing and data diffusion can easily be carried out by J-Sim. Execution time is slow takes time to execute the instructions. Scalability is much better also able to save energy. Biomedicine and physiology are the main areas as far as usage of this simulator is concerned generally, while it is also good in other areas to simulate. J-Sim models are interchangeable and reusable gives flexibility to the user. It is the real time simulation facility [3].

3.5. NS-2

NS-2 (Network Simulator Version 2) is developed in 1989. It is discrete event simulator based on C++ language. Defense Advanced Research Projects Agency and National Science Foundation supported NS-2. Although number of contributing researchers, but there are low support for WSN specific protocols. One extension NS2-MIUN is also available for WSN related issues with focus on intrusion detection. Another simulator name SensorSim and NRL, which are built on the NS-2 simulator. It is the non-specific simulator. It provides open source and online documents, which allows the user to modify the code very easily. NS-2 provides the simulation facility to channel models and power models also. This brings the convenience to the concerned people. It uses OTcl as scripting language. NS-2 supports ad hoc and WSN and specific protocols like directed diffusion. Scalability of NS-2 is not much good. As the number of nodes increases, file management become difficult. NS-2 is complex and difficult and it is very time consuming. To write tool command language is considered difficult in generally. It does not support GUI [1].

3.6. OMNeT++

The architecture of OMNeT++ is rather generic. OMNeT++ is equally well for both wired and wireless networks areas. Therefore it is very popular due to have equally good for both regimes. It is an object-oriented discrete network simulation framework built in C++. It can be run on Windows, Linux and UNIX like system, proving the portability of the system as well. It is

assumed that, this is much simple simulator at the same time because it uses the C++ language coding. It provides powerful GUI facility for the user. On the basis of this GUI user may use give different options? Non availability of Protocols in the library is the disadvantage of this simulator. On the other side we found that many positive steps in this simulator. Power consumption issues can be model in this simulator. We found the compatibility issues, among all other available simulators. This is the open research for making sure of the unified model of having compatibility facility for the user. Proposal for localization and MAC protocol for WSN have been developed with OMNET++. Channel issues can be simulated in this OMNeT++. There are two framework associated with this simulator, Mobility Framework and MiXiM [5].

3.7. TOSSIM

TOSSIM (TinyOS mote simulator) is a discrete event simulator. TinyOS group in 2003 developed TOSSIM emulator in UC Berkeley. This is the Python based simulating platform. User can run this simulator on Linux, Cygwin and Windows operating systems. Open source and online documents provision is available within this simulator. Three types of network connectivity is available within this simulator are, simple, static and space connectivity. Debugging option is so strong in this simulator. GUI based simulator, gives the facility to the user to visualize, because results came in the form of images rather text form. Low level protocol schemes up to top level applications can be simulated by this simulator. Energy consumption could not be simulated. Every node run the same code, this assumes the negative point for this simulator by the research community. The scalability of TOSSIM is good enough; it can simulate thousands of nodes at a time. Most of the simulators /emulators do not offer to simulate the issues related to power consumption. TOSSIM address the energy consumption related problems in the well manner. Another version of TOSSIM is Power TOSSIM, for the resolution of the problems related to energy consumption. This simulator, simulate in a well manner to motes. Therefore TOSSIM is excellently well for WSN. Heterogenous applications can be easily simulated. This simulator can easily and exclusively simulate and analyze the nodes, and all aspects of nodes. It's a real time simulator, which have the capability to simulate on time. Very precise and accurate simulator [6].

4. Summary

Before this no paper was available for having comprehensive material and knowledge about this specific topic. We not only gave the detail, but we also analyze and compare different tools each other. On the basis of this user can easily choose the tools according to their need. This is very helpful for the research community. In the initial part we define, what it is simulator and why it is need for WSN? In the following sections define, Analyze, compare and pros and cons to each simulator, which is also depicting in the table. General as well as specific simulators are discussed here. Beside of this we try to mention the unorthodox simulators, which could also be used for simulation. This makes this paper superb in this particular field. Comparison of different simulators is shown in the Table 1.

Table 1. Comparison in Main Stream Simulation Tools

Name	Simulator/Emulator	Discrete-Event/Trace Driven	GUI	General/ Specific Simulator	Scalability
NS-2	Simulator	Discrete-Event	No	General	Not more than 100
TOSSIM	Emulator	Discrete-Event	Yes	Specific	1000 nodes
EmStar	Emulator	Trace-Driven	Yes	Specific	Cannot support large no
OMNeT++	Simulator	Discrete-Event	Yes	General	Can support MAC Protocols
J-Sim	Simulator	Discrete-Event	Yes	General	Can support large nos
ATEMU	Emulator	Discrete-Event	Yes	Specific	Can emulate different SNs
Avrora	Simulator	Discrete-Event	Yes	Specific	1000 of nodes

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