A Survey Of Network Modelıng And Sımulatıon Tools: Devs Comparıson

Bülent Çobanoğlu
Sakarya University Electronics and Computer Science Department
54187 Sakarya, TURKEY
bcobanoglu@sakarya.edu.tr

Ahmet Zengin
Sakarya University Electronics and Computer Science Department
54187 Sakarya, TURKEY
azengin@sakarya.edu.tr

Sinan Tüncel
Sakarya University Electronics and Computer Science Department
54187 Sakarya, TURKEY
stuncel@sakarya.edu.tr

Hüseyin Ekiz
Sakarya University Electronics and Computer Science Department
54187 Sakarya, TURKEY
ekiz@sakarya.edu.tr

Abstract: Speed, hardware, cost, diversity of user demands and interoperability requirements of today's network systems cause several difficulties in network research. In design phase, due to time and cost advantage of modeling and simulation science it is widely used by researchers working on network systems. In order to expedite and simplify the design process, to design and develop network simulation tools is an active research area. Today, many modeling and simulation tools are available in computer networks research and education. In this study, to assist researchers working on computer networks in the selection of modeling and simulation tools, several best-known simulators are selected and compared. Especially to examine the advantages and disadvantages of network simulators used for training purposes, an OSPF protocol implementation was devised to discuss strengths and weaknesses of simulators. At the same time, executing a general purpose DEVS based OSPF model in DEVS-Suite simulator; the advantages of the method are summarized.

1. Introduction

The primary aim of computer networks is providing connection among users to access resources. Currently, computer networks has become a very complex structure including variety of applications such as operating systems, communication protocols, link technologies, traffic flow, routing algorithms and protocols.

Network design process is a difficult task in case of meeting user requirements, cost and capacity. To simplify the design process, researchers and manufacturers maintain different network modeling and simulation (M & S) tools have already developed and still under development. These network modeling and simulation tools (M & S) can be used for practical purposes and they can be also used for educational and research purposes.

Modeling and simulation (M & S) methodologies play an important role in computer network research and design. Real networks can be investigated by modeling the new networking technologies that efficient development and testing, various network conditions and scenarios under the communication protocol development and evaluation [7] [8] [12]. To investigate interactions with other protocols and to make comparisons with other approaches, to study the behavior and properties of the protocols are very important.

There are a wide range of network modeling and simulation tools used today. In general, these tools can be divided into four classes: analytics, simulation, network topology discovery and production tools. Analytical tools help the design of a network model calculation (eg, reliability, usability, etc.). Analytical model, among

other methods have the advantage of simplicity and often simplified assumptions. If network discovery tools available to a system, real network components and their graphic or textual (text) can be obtained. Simulation tools are used to simulate the dynamic behavior a network components such as packet switch, link errors, TCP protocol, etc [1, 12].

Today, number of network simulators and simulation tools are found to design and analysis of networks (see Figure 1).

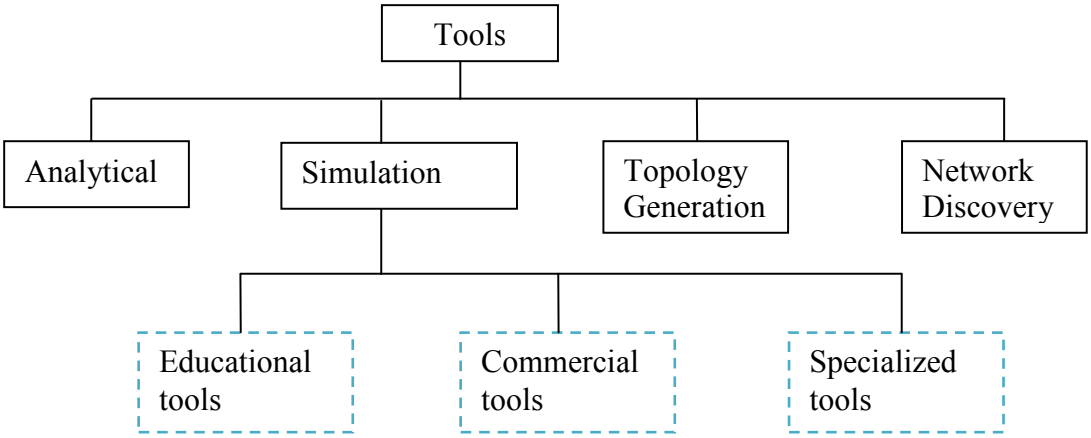

Figure 1. Classification of the network design and simulation tools.

2. Network Sımulatıon Tools

Network simulators were developed to help researchers in network design and development processes. The large number of network simulators for training purposes and commercial purposes are available. Their features and capabilities will be examined in this. In this study we compared OPNET, ns-22 and OMNET with special-purpose simulator DEVS Suite.

Most known simulators for training are ns-2, pdns, Netsim, GTNetS, WIPSIM, OMNET++ and commercial simulators are OPNET, QualNet, COMNET, REAL, SSFNet and Ted, special-purpose simulators are Glomosim, QUIPS-II, the ATM-TN, and Devs Suite.

In this study, commonly used network simulation software and tools are given in Table 1 and a survey research conducted among the results obtained [1, 3, 9, 20].

2.1 Educational tools

2.1.1 OMNET++

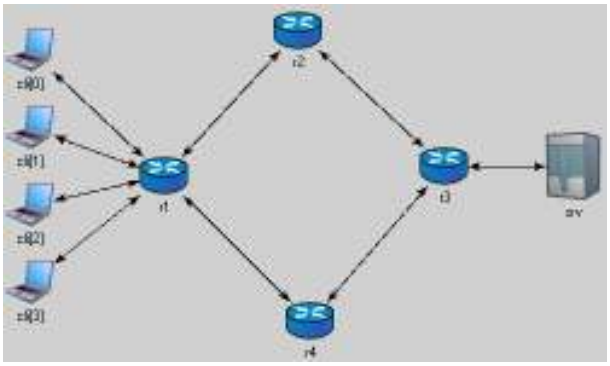

Figure 2. OMNET screenshot of the simple network consisting of router nodes and duplex links

OMNET + + (Objective Modular Network Testbed in C + +), object-oriented (object-oriented) and this software is a modular discrete event network simulator itemized below can be used in the simulation of the process.

- Communication modeling of traffic
- Modeling of communication protocols
- Multi-processor and other distributed hardware systems, modeling
- Hardware structure review
- Evaluation of performance analysis of complex systems
- Discrete event approach is suitable for modeling of other systems.

OMNeT + + software models a network as composed of interconnected modules. The top-level module is network module. The depth last module is connected to the user so that models of complex systems can be realized easily. Modules can be divided into two categories: simple and compound. A simple module is to describe the behavior of a model associated with C + + file. This file is written by the user using OMNET + + simulation class library. Compounds from a combination of the modules consists of the simple modules and are not directly associated with a C + + file. Modules communicate among themselves and with the help of the messages of the simulation time, a module receives a message from the module itself or another is progressing. The structure of modules and interfaces and the simulation parameters can be organized using Network Definition Language (Network Description Languages - NED) and are created as a startup file (. Ini) which is easily adjustable. [22], [6]

2.1.2 The network simulator ns-2

The network simulator ns-2 is developed based on REAL network simulator project. It is designed for research for local and wide-area network simulations and network education. Ns-2 is an object-oriented, open source, discrete event network simulator, which is written in C++ and uses OTcl as a command and configuration interface. It is based on a seven-layer network synthesis and designed as packet-based, which means that all packet interactions are in focus during simulation. It implements network transmission protocols such as TCP and UPD, traffic source behavior such as FTP, Telnet, Web, CBR and VBR, router queue management mechanism such as DropTail, RED and CBQ, routing algorithms such as Dijkstra , and other algorithms. Network simulator 2 provides an important support for modeling and simulation of TCP, routing, and multicast protocols over wired and wireless networks and is primarily useful for simulating local and wide area networks. Although ns-2 is fairly easy to use once you get to know the simulator, it is quite difficult for a first-time user, because there are few user-friendly manuals and it is difficult to install. Various extensions of parallel and distributed variations are developed to achieve execution scalability (e.g., pdns).
Many researches including design, test and comparison of new network algorithms, protocols, and technologies are done with ns-2. Some deficiencies of ns-2 include limited support for visualization and complex simulator design. Since ns-2 is dependent on different technologies, it can be very difficult to make changes to the existing models. Furthermore, from the modeling methodology vantage point, ns-2 can be considered a domain-specific simulator which is intimately tied to the computer network concepts.

2.2 Commercial tools

2.2.1 OPNET (OPtimised Network Engineering Tool)

OPNET, which was developed in 1987 is the first commercial network simulation tool. Network can be established very easily, with a graphical interface, user-friendly, widely used in industry, a powerful discrete event network simulator.

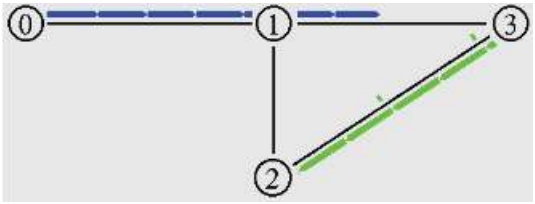

Figure. 3. NAM screenshot of the simple network consisting of router nodes and duplex links

OPNET software of the system behavior and the analysis of discrete event simulation can be performed. OPNET simulation program has three levels: network, node and process. These levels can be developed using the visual

editor. The programs also edit the parameters of the simulation and data analysis tools to create the graph contains.

Network structure, node and process models are included in a project file is created in the scenarios. Simulation tool will be collected with the help of the design is complete, statistics are determined and work. Even with the program analysis tool obtained data can be displayed in the desired chart type. Of data from more than one scenario is also possible to compare the same show on the graph [1,10,11,13].

Node model and process model, with the help of an editor for creating user-defined nodes and protocols can be created. Profile descriptions and application definitions can be changed with the help of the editors.

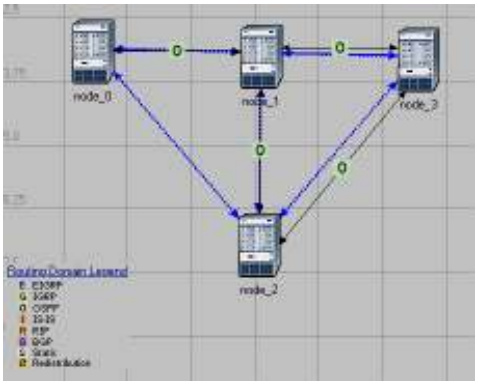

Figure 4. OPNET screenshot of the simple network consisting of router nodes and duplex links

2.3 Specialized tools

2.3.1 DEVS Suite:

To use modeling and simulation as problem solving technique, there is need for a modeling formalism. As a formal system definition, formalism renders possible to create virtual worlds in our limited computation frameworks and tools. Limitations of the computation environments demand new high performance modeling formalisms and approaches. Large scale network systems exhibit very high level complex, dynamic and parallel characteristics. Therefore, complex and distributed behaviors of the large scale systems make modeling effort of the networks difficult. However, discrete event modeling formalisms bringing abstraction and simplification mechanisms to modeling and simulation discipline facilitates modeling and simulation study systems such as computer networks demonstrating complex, dynamic, distributed and unpredicted behavior. The dynamics of network systems can be described using discrete event modeling. This is because the dynamics of network systems can be characterized in terms of components that can process and generate events. Among discrete event modeling approaches, the Discrete Event Systems Specification (DEVS) is well suited for formally describing concurrent processing and the event-driven nature of arbitrary configuration of nodes and links forming network systems. This modeling approach supports hierarchical modular model construction, distributed execution, and therefore characterizing complex, large-scale systems with atomic and coupled models. Atomic models represent the structure and behavior of individual components via inputs (X), outputs (Y), states (S), and functions. Parallel DEVS, which extends the classical DEVS, is capable of processing multiple input events and concurrent occurrences of internal and external transition functions. Parallel DEVS atomic model supports local control on the handling of simultaneous internal and external events.

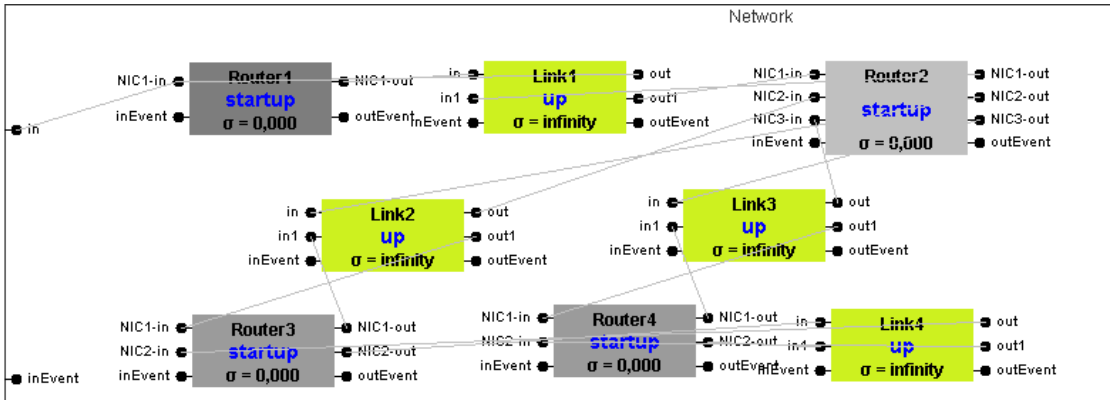

Figure 5. DEVS Suite OSPF Simulator screenshot of the simple network consisting of router nodes and duplex links

DEVS formalism can be executed using simulation engines such as DEVS-Suite and DEVSJAVA. DEVS-Suite and DEVSJAVA are object oriented realization of Parallel DEVS and its associated simulators. They support describing complex structures and behaviors of network systems using object-oriented modeling techniques and advanced features of the Java programming language. The formal foundation of DEVS, its efficient execution, and the availability of sequential, parallel, or distributed simulation engines using alternative computational environments such as CORBA, HLA, and Web-services are important considerations. Furthermore, the DEVS models are extended with other kinds of models such as fuzzy logic.

3. Comparison Of The Simulation Tools

As shown in Table 1, network simulators characteristics and their capabilities can be examined under the following aspects:
Purpose: commercial, educational and private purposes to indicate the intended use.
License: simulator open source (free) if you indicate whether a commercial product.
Ease of Use: Graphical interface to support the flexibility of existing models and interfaces to enhance the new models can be added
User Interface: Graphical user interface (GUI) to have
Parallel Operation: Parallel simulator can run in a distributed environment
Scalability: The maximum number of nodes that can be used in the simulation (Medium: thousands Good: Ten thousand, Very Good: hundreds of thousands)
Programming language: programming language that specifies the simulator is written
Documentation: Network simulator, presented in conjunction with / accessible documentation indicates
Rate: indicates the operating speed of the simulation.
Platform: simulator operating environment (operating system) indicates.
Level Simulation (Abstraction): Simulation indicates the lowest level of abstraction. This level of package, the message transfer or may nodal.

Properties	**OPNET**	**QualNet**	**NS-2**	**SSFNet**	**OMNET**	**DEVS Suite**
Purpose	Commercial	Commercial	Educational , Resource	Commercial, Resource	Resource	Specialized
License	Commercial	Commercial	Free	Free	Free	Free
Ease of Use	Very Good	Very Good	Bad	Good	Good	Good
Flexibility	Good	Good	Medium	Good	Very Good	Very Good
User Interface	Good GUI	Good GUI	Poor GUI	Good GUI	Good GUI	Good GUI

Parallelism	Yes	Yes	No	Yes	Yes	Yes
Scalability	Medium	Very Good	Medium	Very Good	Good	Good
Programming Language	C++	C++	C++ and OTcl	Java, C++	C++	Java
Documentation	Very Good	Good	Good	Good	Good	Good
Speed	Bad	Medium	Medium	Good	Good	Good
Platform	X window	Linux, Unix, Windows	Unix	Linux, Unix, Windows	Windows	Windows, Linux
Simulation Level (Abstraction)	Packet Level	Packet Level	Packet Level	IP Packet	Packet level	Packet Level

Table 1. **Simulators comparison**

4. Conclusions

To choose between the existing hundreds network simulators is very difficult. In this study, modeling and simulation tools that used for studying on the network are examined, especially in network simulators used for training purposes as the advantages and disadvantages are analyzed. DEVS is also taken into consideration which is providing useful features for network community. In addition, this study can help to most researchers in the selection of appropriate network modeling and simulation tool.

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