

COMPARATIVE EVALUATION OF COMPUTER NETWORK SIMULATORS

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Abstract

In this paper it is described a various simulators of computer networks. Simulators are mainly used for the education purposes. Also, we compared wide known tools with our simulator - WnetSim, which is developed in Business school Blace.

Keywords: Simulators, Computer networks, Network simulation, Education.

INTRODUCTION

Research in the field of computer networks with technology of Internet Protocol (IP) is based on analytical methods, simulation, experiments and measurements. While measurement and experimentation provide a means for testing of real world networks, simulation and analysis are limited to testing designed, abstract models.

Limiting methods of measurement and experimental methods is that they can be applied only to the existing system or partly new environments. On the other hand, although analytical methods are essential to the understanding of network behavior, there is a risk of application of simplified models that lose the essential features of network. Simulation is complementary to the analysis, because it allows the verification of the correctness of analysis and testing of complex models that would be difficult or impossible to solve analytically.

It is therefore advisable to use known and proven tools, and one of the best ways of solving the problem of simulation results verification is that simulators and associated scripts are freely available, so that other researchers can easily test effects of changes in initial assumptions about the network scenario.

CONSTRUCTION PRINCIPLES OF THE SIMULATION MODELS AND SCENARIOS SIMULATION

The key property that generally makes modeling and simulation of IP networks difficult is the heterogeneity [1], which is reflected in several aspects: network topology, choice of simulated applications, generates traffic, dynamic traffic routing, the differences in versions of the protocol and others. This means that there is no pre-defined set of simulation scenarios which is sufficient to verify the proposed solutions.

The problem is solved partly with the identification of invariant characteristics of IP traffic, the process of arriving calls, duration of sessions, as well as regular approximations of models and examining the behavior of the network in conditions of changing simulation set parameters in a wide range.

OPNET MODELER, SSFNET, J-SIM AND NETWORK SIMULATOR 3 (NS3)

OPNET Modeler [2] is a commercial simulator that supports a variety of LAN and WAN networks (ATM, IP, mobile networks, wireless LAN, etc.), and implemented more than 400 functions for modeling protocols, network elements and the dynamic behavior of the network.

OPNET modeler belongs to the class of events conducted in discrete time simulators, and the implementation of the simulator is based on object-oriented finite state machine combined with the analytical model.

It is available for Windows and Unix platforms. High quality graphical user interface and extensive documentation with examples of simulation studies are the main advantages of this simulator. Source programs aren't freely available – it is only available for the possibility of generating simulation scenarios with varying set of input parameters. **SSFNet** [3] is a simulator with the free distribution of source code and freely available programs. It is designed for modeling scalable global IP network and the Internet. SSFNet simulator is driven by discrete time events, which is implemented using the Java SSF (Scalable Simulation Framework) module. It is available for Unix and Windows platforms. For a description of abstract simulation models it uses standardized syntax of the DML (Domain Modeling Language) language, by which you can create simulation models with tens of thousands of hosts and IP routers.

J-Sim [4] implements an autonomous architecture based on components (Autonomous Component Architecture, ACA) in the Java programming language. The telecommunication network is modeled with hierarchically organized components, which have one or more end-points - ports. Exchange of information on the current-time simulation is performed by a set of predefined ports. J-Sim introduces the concept of centralized management independent instances of the simulation execution (background thread manager), which allows all active instances for global monitoring of simulation time.

Java is a programming language suitable for implementation of the ACA concept for object orientation, platform independence, performance of multiple instances and others. The distribution of the original J-Sim programs are free.

NS3 is also an open sourced discrete-event network simulator which targets primarily for research and educational use. NS3 is licensed under the GNU GPLv2 license, and is available for research and development.

NS3 is designed to replace the current popular NS2. However, NS3 is not an updated version of NS2 since that NS3 is a new simulator and it is not backward-compatible with NS2.

The basic idea of NS3 comes from several different network simulators including NS2, yans [yans], and GTNetS [GTNetS]. The major difference lying between NS3 and NS2 includes:

Different software core: The core of NS3 is written in C++ and with Python scripting interface (compared with OTcl in NS2). Several advanced C++ design patterns are also used.

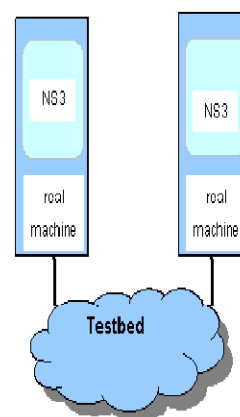


Fig. 1. Testbeds interconnect stacks NS3

WNETSIM

WnetSim is the computer network TCP/IP simulator, which was developed at the department of informatics in Business School Blace. Simulator has been used as a teaching tool for the course Computer Networks at the Department of Computer Science.

While working with the simulator, standard Windows window appear with the default look and features that are common with them, such as a decrease, increase or change the size and lowering the window at the service line and close the window. With these operations the user can adjust the screen to his needs, so that from the user depends on how the window will be displayed, or which window is active, and which will be located in the status line. The system enables editing of arbitrary topology of computer networks and monitoring processes in the network in real time.

Working in an educational environment can be divided into three parts:

- 1) Editing the desired computer network with components that are available;
- 2) Calculation of basic initial parameters of the desired process, such as setting names, IP addresses, configure the router ... ;
- 3) Following the process in the system as a visual representation of movement through the framework of network devices and transmission paths and text to screen.

Computer network of arbitrary topology can be edited using the toolbar components. Components, which can work in the system, are: PC, hub, switch, UTP router cable and serial connection.



Fig. 2. Components that allow editing of arbitrary topology of computer networks

Preferred component (PC, hub, switch, router) is chosen with the mouse from the drop-down list and draws by pressing the left mouse button in the editor. The components are connected with the corresponding service (UTP or Serial Link) by dragging with the mouse from one component to another.

Configure the components in the system can be done in two ways.

The first way is to use the standard Windows dialog box and Windows controls, such as when you configure the computer (Fig. 3). Characteristics of the PC can be set by right-clicking on the computer which opens the dialog, as shown below.

These include: computer name, IP address, subnet mask, default gateway address, physical address of the computer.

Another way is to configure using command line interface, for example, when configuring the router (Fig. 4).

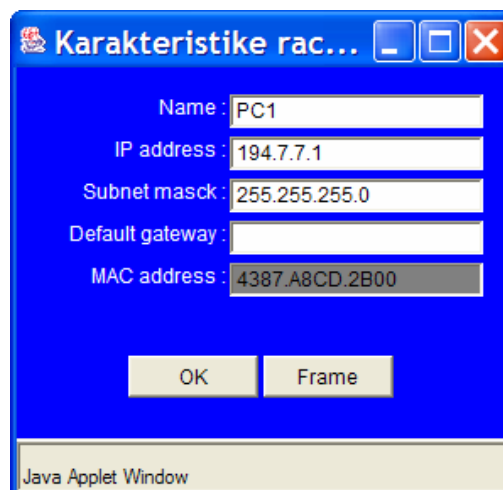


Fig. 3. Windows box for PC configuration

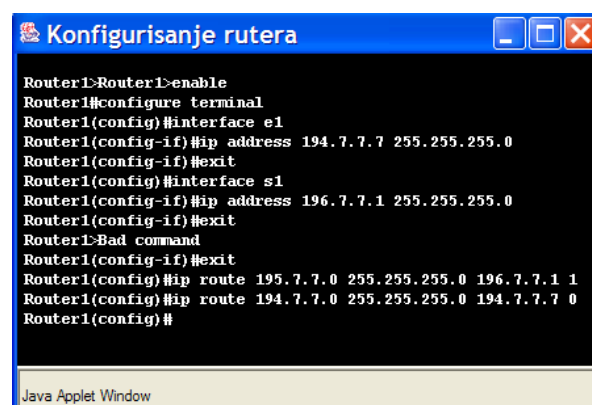


Fig. 4. Line-command interface for configuring routers

To route router packages and pass them through the appropriate interface to a network, it needs to have information on routes in its routing table. Routing table can be filled dynamically or statically.

The new route in the routing table is added by the command:

ip route network subnet_mask interface_address distance

Administrative distance is measured with the numerical value from 0 to 255. If the router is directly connected to the network, required distance is 0. If the network is further from the router, the metric distance has greater value.

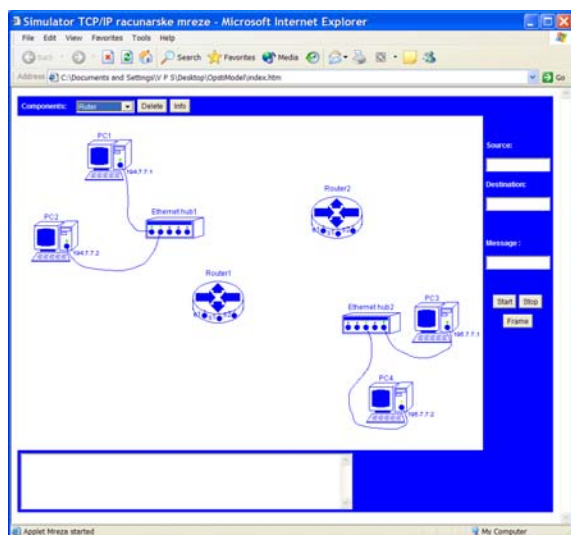


Fig. 5. Network Topology

COMPARISON OF THE SIMULATORS CHARACTERISTICS

Comparative analyses of the performance of these simulators are not published in large numbers, and the existing publications usually include a limited set of experiments with a simple simulation scenario.

Analysis comparing the results obtained with the simulator described Wnetsim-om similar results were obtained in several simulations of different scenarios, with approximately the same speed performance simulation. OPNET provides more opportunities than Wnetsim in the experimental environment, which makes it attractive tool for network operators. In [38] compared the scalability of the simulator NS2, JavaSim and SSFNet, in terms of speed performance required for simulation and computer memory resources. Simulation model involved multiplication by a few TCP connections that link the network bottleneck. The analysis results showed that NS2 is the

fastest, and most demanding in terms of memory resources. J-Sim is much slower than the other two simulators, but it requires much less memory resources than a Java implementation of the simulator SSFNet. The great advantage of freely available simulator for research in the field of IP network is able to add new or modify existing features (proposed new algorithm, modification of the protocol, etc.). Lack Wnetsim in relation to commercial simulators, such as OPNET Modeler, a worse user interface and visualization capabilities of more modest simulations. Nevertheless, Wnetsim simulation has good features and meets the criteria set simulation in educational environments.

CONCLUSION

In this paper it is described several computer network simulators. They have similar features and usability, so that they can be mutually compared. Also, it is introduced simulator which was developed at the Business School Blace - Wnetsim. It is shown that they have very good performance compared to other simulators, and its usability in the process of education is significant.

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