

SOFTWARE NETWORK SIMULATORS FOR IPTV QUALITY OF SERVICES

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ABSTRACT

Quality of Services (QoS) is important for data management in congested networks, especially that one which transfers television streams over internet protocol and can compete with other services available in this network. Network simulators help us to better understand the whole process of QoS. We can better realize purpose of the QoS parameters in simulations, therefore important is to use the proper network simulator. We decide to make short overview of available network simulators used in IPTV QoS research. Article summarize the available computer network simulators, their advantages and disadvantages, mainly their possibility to handle the characteristic network properties like the QoS certainly is.

Keywords: network simulator, Opnet, NS3, QualNet, Matlab, QoS, IPTV

1. INTRODUCTION

This article describes and analyzes a couple of available software for the network simulations. It is an important part of our study of network Quality of Services problem while the several video streams are competing at one transport channel, where we need to simulate our protocol modifications. We were searching for our research work in network protocols the right network simulator from the available ones.

2. NETWORK SIMULATORS

Many different parameter variations and different possible network scenarios can be used to define which network simulator is the best. Someone can prefer faster speed other can uses a number of library components for simulations or choice can be done considering the programming language at the simulation base level.

2.1. NS3 Simulator

NS3 is a discrete-event network simulator in which the simulation core and models are implemented in C++. NS3 is built as a library which may be statically or dynamically linked to a C++ main program that defines the simulation topology and starts the simulator. NS3 also exports nearly all of its API to Python, allowing Python programs to import an “NS3” module in much the same way as the NS3 library is linked by executables in C++ [1]. Currently version 3.17 is available to download and ns-3.18 is scheduled for August 14, 2013. Using the Gnuplot Class we can making n-dimensional plots as we need (Fig. 1)

In 2009, NS3 releases were downloaded around 14,000 times. In 2011, NS3 releases were downloaded 86,014 times. As of ns-3.13 release, 93 people are listed as authors.

NS3 is targeted primarily for research and educational use. NS3 is free software, licensed under the GNU GPLv2 license, and is publicly available for research, development, and use. NS3 is usefull for QoS in IPTV

simulations [7] and also great choose is for wireless network simulations [11].

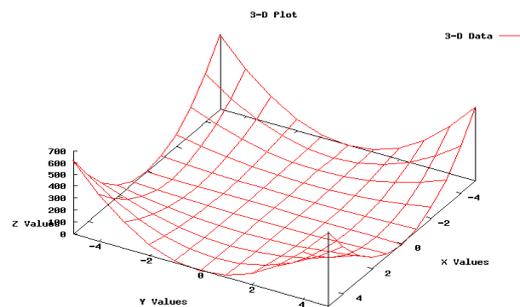


Fig. 1 An example of 3-dimensional plot for NS3 simulator

2.1.1. Advantages compared to NS2:

- NS3 performs better than NS2 in terms of memory management,
- the aggregation system prevents unneeded parameters from being stored, and packets don't contain unused reserved header space,
- NS3 employs a package known as PyViz, which is a python based real-time visualization package,
- a simulation script can be written as a C++ program, which is not possible in NS2. With modern hardware capabilities, compilation time was not an issue like for NS2, NS3 can be developed with C++ entirely,
- automatic de-allocation of objects is supported using reference counting (track number of pointers to an object); this is useful when dealing with Packet objects,
- the buffer corresponds exactly to the stream of bits that would be sent over a real network,
- information is added to the packet by using subclasses; Header, which adds information to the beginning of the buffer, Trailer, which adds to the end,

- unlike NS2, there is generally easy way to determine if a specific header is attached [10]

2.1.2. Important notes about NS3:

- NS3 is not backward compatible with NS2; it's built from the scratch to replace NS2,
- NS3 is written in C++, Python Programming Language can be optionally used as an interface,
- NS3 is trying to solve problems present in NS2,
- there is very limited number of contributed codes made with NS3 compared to NS2,
- in NS2, bi-language system make debugging complex (C++/Tcl), but for NS3 only knowledge of C++ is enough (single-language architecture is more robust in the long term),
- NS3 has an emulation mode, which allows for the integration with real networks [10]

2.2. Opnet

Riverbed OPNET Modeler® Suite comprises a suite of protocols and technologies, and features a sophisticated development environment. By modeling all network types and technologies (including VoIP, TCP, OSPFv3, MPLS, IPv6, and more), OPNET Modeler lets you analyze realistic simulated networks to compare the impact of different technology designs on end-to-end behavior. OPNET Modeler Suite lets you test and demonstrate technology designs in realistic scenarios before production; increase network R&D productivity and accelerate time to market; develop proprietary wireless protocols and technologies; and, evaluate enhancements to standards-based protocols [2].

Compared to competitive solutions, OPNET Modeler boasts the fastest discrete event-simulation engine on the market. Also it save time with access to the largest, most comprehensive library of open source, discrete event simulation models for the IT industry. Open interface allows you to integrate external object files, libraries, and other simulators [2].

Last years expand research in QoS for IPTV using Opnet Modeler, where simulations help us to understand simulation globally from parameter settings such as services, applications, profiles, model systems, infrastructure and user behavior over measuring the QoS value such as MOS, jitter, delay, throughput and comparing these results with standard values or tolerance of the ITU-T and Thipon to determining ideal queue method in the optimizing QoS [8].

Over 25,000 university professors and students use OPNET products in Electrical Engineering, Computer Science, and related disciplines. OPNET supports 4 simulation technologies: Discrete Event Simulation (DES), Flow Analysis, ACE QuickPredict, Hybrid Simulation (within the DES environment) [13].

2.2.1. Opnet Modeler Editors

The Project Editor is used to construct and edit the topology of a network model. The Node Editor provides operations to support creation and editing of node models. The Process Editor (Fig. 2) is used to specify the behavior

of process models Process models use a finite state machine (FSM) paradigm to express behavior that depends on the current state and a new stimulation. The operations performed by a process model are described in statements based on the C or C++ languages These statements can be associated with states, transitions, or special blocks within the process model.

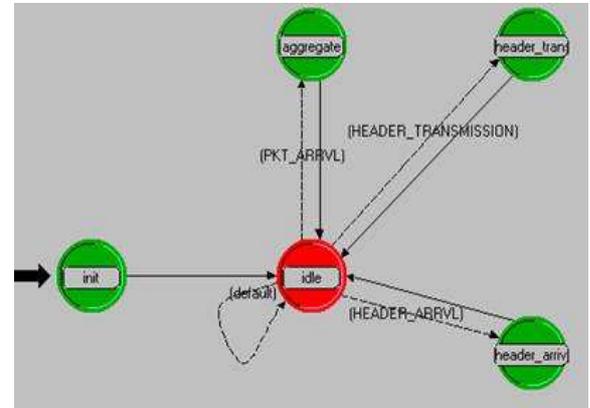


Fig. 2 Opnet Process Editor

2.2.2. Opnet IT Guru Academic Edition

IT Guru Academic Edition software was created for introductory level networking courses, and designed and tested to be used with popular classroom lab manuals [12].

Convenient features are:

- based on IT Guru commercial version 9.1,
- downloadable from our website at no charge,
- greatly simplified licensing relative to the commercial version of IT Guru,
- built-in Application Characterization Environment (ACE™) and Wireless capability,
- specially designed and tested to be used with popular textbooks and lab manuals,
- 6-month renewable license

IT Guru Academic edition limitations:

- limited import and export capabilities,
- limited wireless functionality,
- other product modules are not supported,
- the maximum number of simulation events is limited by 50 million,
- the maximum number of intermediate nodes is limited by 20 [13].

2.3. Qualnet

The QualNet® communications simulation platform (QualNet) is a planning, testing and training tool that "mimics" the behavior of a real communications network. Simulation is a cost-effective method for developing, deploying and managing network-centric systems throughout their entire lifecycle. Users can evaluate the basic behavior of a network, and test combinations of network features that are likely to work. QualNet provides

a comprehensive environment for designing protocols, creating and animating network scenarios, and analyzing their performance.

QualNet enables users to: design new protocol models, optimize new and existing models, design large wired and wireless networks using pre-configured or user-designed models and analyze the performance of networks and perform what-if analysis to optimize them. It is available for Microsoft Windows operating systems and also for Linux systems, 32 and 64-bit versions of the systems. Simulator desktop is corresponding to Opnet desktop [3] (Fig. 3).

For QualNet you can use standard "classes" of elements include: terrain (the physical terrain over which the communications takes place) and weather (descriptions of different weather behavior and its impact on communications) [4].

Experimental results has been done with QualNet network simulator at University of Haute Alsace. Adaptive scheduling mechanism for IPTV has better performance than the traditional scheduling techniques for rtPS traffic [9].

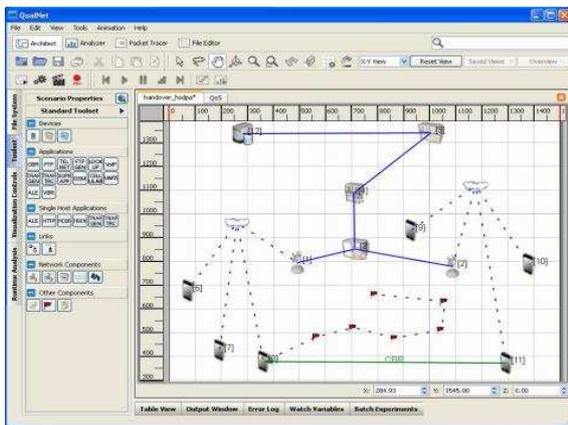


Fig. 3 Desktop of the QualNet simulator

2.3.1. Scenario-based Communications Simulation

In QualNet, a specific network topology is referred to as a scenario. A scenario allows the user to specify all the network components and conditions under which the network will operate. This includes: terrain details, channel propagation effects including path loss, fading, and shadowing, wired and wireless subnets, network devices such as switches, hubs and routers, the entire protocol stack of a variety of standard or user-configured network components, and applications running on the network. Most of these are optional; you can start with a basic network scenario and specify as much detail as necessary to improve the accuracy of your network model [3].

2.3.2. The main key features of Qualnet are:

- **speed:** real-time speed is supported to enable software-in-the-loop, network emulation, and human-in-the-loop modelling. Faster speed enables model developers and network designers to run multiple "what-if" analyses by varying

model, network, and traffic parameters in a short time.

- **scalability:** QualNet can run on cluster, multi-core, and multi-processor systems to model large networks with high fidelity.
- **model fidelity:** highly detailed standards-based implementation of protocol models are used, including advanced models for the wireless environment to enable more accurate modelling of real-world networks.
- **portability:** QualNet and its library of models run on a vast array of platforms, including Windows and Linux operating systems, distributed and cluster parallel architectures, and both 32- and 64-bit computing platforms. Users can now develop a protocol model or design a network in QualNet on their desktop or laptop Windows computer and then transfer it to a powerful multi-processor Linux server to run capacity, performance, and scalability analyses.
- **extensibility:** QualNet can connect to other hardware and software applications, such as OTB, real networks, and third party visualization software, to greatly enhance the value of the network model.

2.4. Matlab

MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java™.

You can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing. There is also available Matlab version for Android so you can use it with your smart phone or any device operating with this OS [5].

2.4.1. The main key features of Matlab are:

1. high-level language for visualization and application development,
2. interactive environment for iterative exploration and problem solving,
3. mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration, and solving ordinary differential equations,
4. built-in graphics for visualizing data and tools for creating custom plots,
5. development tools for improving code quality and maintainability,
6. tools for building applications with custom graphical interfaces,

7. functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET, and Microsoft® Excel® [6]

3. CONCLUSIONS

We had briefly summarized the available computer network simulators, their advantages and disadvantages, mainly their possibility to handle the characteristic network properties like the QoS certainly is.

Every simulator is unique. There are simulators for

education purpose that are totally free (NS3, Opnet IT Guru Academic Edition) or licensed simulators with great libraries (Matlab). You can choose simulator working on both systems, Windows and Linux (QualNet). Complete summing-up of described simulators is in Table 1.

There are many of simulation software available today and it's upon the user requirement which one he decide use for simulations finally. Based upon our experiences with NS-3 and Opnet simulations untill now, we had decided we will continue using the Opnet simulator with its main advantage which are network devices library and the graphic results representation.

Table 1 Summing-up of described network simulators

Simulator	Programming language	Operating system	Simulation speed	Handle with QoS	Free download	Notes
Matlab	C++, Java, .Net	Windows	fast	Yes	-	Android compatible
NS-3	C++, Python	Linux	fast	Yes	Yes	ideal for lab education
Opnet Modeler	C, C++	Windows	fastest	Yes	-	open interface
Opnet IT Guru AE	C, C++	Windows	fastest	Yes	Yes	ideal for lab education, limited capabilities
Qualnet	C, Java	Linux, Windows	real-time	Yes	-	running on multicore and multi processor systems

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REFERENCES

- [1] A Discrete-Event Network Simulator, <http://www.nsnam.org/docs/release/3.17/manual/singlehtml/index.html#document-events>.
- [2] Network Simulation (OPNET Modeler Suite), <http://www.riverbed.com/products-solutions/products/network-planning-simulation/Network-Simulation.html#Overview>.
- [3] Scalable Network Technologies – QualNet, <http://web.scalable-networks.com/content/qualnet>.
- [4] Libraries of "Element" Models, <http://web.scalable-networks.com/content/libraries-element-models>.
- [5] Matlab – The Language of Technical Computing, <http://www.mathworks.com/products/matlab/>.
- [6] Matlab – Key features, <http://www.mathworks.com/products/matlab/description1.html>.
- [7] TRISNAWAN, P. H. – BUDIARTO, R.: Priority-based QoS mechanism for multiple multicast IPTV streams, AINTEC '09 Asian Internet Engineering Conference, pp. 19-24, ACM, New York, ISBN: 978-1-60558-614-4, 2009.
- [8] MOBIU, A. – WIDYAWAN, – HARTANTO, R: Analysis Quality of Service from Internet Protocol Television (IP TV) Service, International Journal of Informatics and Communication Technology (IJ-ICT), Vol. 1, No. 2, pp. 100~108, ISSN: 2252-8776, 2012.
- [9] BRAHMIA, M. el. A. – ABOUAISSA, A. – LORENZ, P.: Adaptive scheduling mechanism for IPTV over WiMAX IEEE 802.16j networks, International Journal of Communication Systems, Wiley Online Library, 2012.
- [10] NS2 versus NS3, <http://wrc-ejust.org/crn/images/Tutorials/ns2vsns3.pdf>.
- [11] PIAMRAT, K. – FONTAINE, P.: CLAP: Coordinated Lightweight Aps Architecture for Wireless IPTV Service in Home Networks. Technicolor, Cesson-Sévigné, ACM 978-4503-8/11/10. 2011.
- [12] IT Guru Academic Edition, http://www.opnet.com/university_program/itguru_academic_edition/.
- [13] DUNAYTSEV, R.: Network Simulators: Opnet Overview and Examples, Tampere University of Technology, 2010.

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BIOGRAPHIES

Rastislav Kokoška was born on 5.11.1978 in Prešov. In 2003, he graduated (M.Sc.) from Technical University in Košice, Slovakia. He worked at Samsung Electronics Slovakia in Galanta as an engineer for testing circuit boards PBA. He is studying at doctoral studies in the external form at the Department of Electronics and Multimedia Communications, Faculty of Electrical Engineering and Computer Science at the Technical University in Košice. His scientific research focuses on modelling quality transmission of video data stream Internet TV on an unstable network.

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