Performance Evaluation of VoIP Traffic on Wired and Wireless Networks

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ABSTRACT
Different types of traffic are transmitting over networks, and their performance evaluation depends not only on type of traffic itself, but on structure of networks and technologies used in them. The objective of this paper is the performance evaluation of VoIP traffic transmitted over wired and wireless networks. Tests were done using OMNeT++ simulator.

Keywords
Traffic, wireless network, WiFi, wired network, VoIP, OMNeT++, simulation, VoIPStream

1. INTRODUCTION
Today more and more companies have local networks. They are using different technologies when creating them. These networks can be based on different technologies both wired and wireless. If companies have branches, they can have corporate networks as well. Different types of traffic can be transmitted over those networks. They can use emails, send files, make VoIP calls or do videoconferences.

Performance evaluation of transmitted traffic depends on different facts, such as types of traffic, technologies used on network, protocols used for routing, etc.

Rapidly growing speed of internet is increasing the amount of transferred data. VoIP is one of the fastest growing internet applications [1]. Today it is used by many consumers and business users.

In this paper we are getting VoIP traffic performance evaluation in a network, which consists of four machines. Two models of network will be used. One is based on Ethernet (IEEE 802 standard) technologies and machines are connected to switch. Switch is connected to router which can get access to internet. The second one is based on WiFi (IEEE 802.11 standard) and is using WiFi router to machines communication.

To get performance evaluation of VoIP traffic, we will use OMNeT++ simulation framework [2]. VoIPStream application will be used, which allows sending an actual voice stream over the network.

2. VOIP
VoIP is an abbreviation for Voice over Internet Protocol. It is delivering voice communications and multimedia sessions over IP networks. More and more companies are starting to use VoIP service. And that has two main reasons:

1. Functionality
2. Cost

VoIP phones can work anywhere with internet connections. It can be used even without special hardware just by installing required software on a PC, laptop, tablet or a smartphone. It is possible to easily create multi-part conferences. VoIP has lower cost, as opposed to using regular internet connection. Additional VoIP devices can be added to existing networks and get access to internet.

Different open and proprietary protocols and standards can be used on VoIP. Such as:
- H.323
- Session Initiation Protocol (SIP)
- Real-time Transport Protocol (RTP)
- Media Gateway Control Protocol (MGCP)

Technical foundation of VoIP consist of RTP, RTCP (Real-time Control Protocol)– and H.323, SIP or other call signaling protocols.

3. VoIP TRAFFIC SIMULATION
3.1. Network simulation
Simulation tools are frequently used for investigation of new protocols, technologies and for optimizing the existing ones without using actual hardware.

Current network simulators are based on discrete-event simulation technique. Most popular are [4]:

- OMNeT++
- NS2
- OPNET Modeler

OMNeT++ and NS2 are both free and open source. OPNET Modeler is free for academic use, but is not open source.
All three simulators have lots of tools and libraries for simulation of different types of traffic.

In our research we choose OMNeT++, as it is open source, has all needed tools for VoIP traffic simulation and has easier structure than others.

3.2. VoIP simulation
OMNeT++ network simulator has VoIPStream package, which generates realistic VoIP packet streams. It is a part of INET framework [5].

VoIPStream uses PESQ-MOS (Perceptual Evaluation of Speech Quality - Mean Opinion Score) as simulated voice quality measurement [1]. MOS has 5 quality levels: from 1 to 5. The worst quality has value 1, the best one has value 5. MOS value and quality mapping is represented in Table 1.

MOS	Quality
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

Table 1: MOS quality mapping

Figure 1 shows how VoIPStream package is working. It takes input sound file, gives it to packet generator, which is splitting sound file and generating stream of VoIP packets. Size of packet depends on VoIP parameters, which will be discussed later. Packets are placed into packet trace, which is taking packets and sending them on scheduled time to Sink. Sink receiving packets, checks them for errors, and, if everything is correct generates output sound file.

Figure 1: VoIP simulation process on VoIPStream package

In OMNeT++ simulation environment parameters can be modified or accessed in omnet.ini files or in NED (stands for network description) files. Parameters can be of the following types [7]:

- double
- int
- bool
- string
- xml

VoIPStram uses more than 10 parameters [1]. Some of them are:

- coding rate
- header size
- results file name
- converted sound file name
- PESQ-MOS value

Coding rate can have one of the following values: 16000 bits/second, 24000 bits/second, 32000 bits/second and 40000 bits/second. Header size represents header size of VoIP packets in bits. Simulation logs are stored in a file, which is given a name according to the resulting file parameter. The next one is converted sound file name, which holds the name of output file. And the last one is the PESQ-MOS value, which is being calculated after comparison of original input sound file and generated one.

In the research, described in this paper, we simulated VoIP traffic on a network with 4 PCs. Two simulation scenarios were used. In first one we used wired network (Figure 2). All 4 PCs are connected to Ethernet switch. Switch is connected to router to get access to internet. 4 servers received traffic from PCs. On second scenario wireless connection was used. PCs were connected via Wi-Fi access point (Figure 3).

For simulation we used G.726 codec, which is a speech codec standard for voice transmission. Compressed bit rate value was set to 40000 bit/s and sampling rate was 8000 HZ. VoIP packet header size was set to 4 bytes.

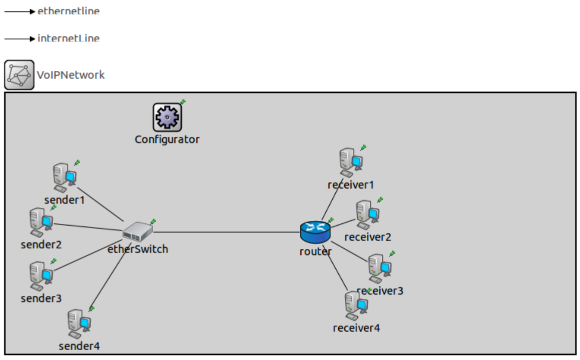

Figure 2: Network for wired simulation scenario

Simulation was done with OMNeT++ version 4.2 under Ubuntu 12.10 operating system. INET 2.0 framework was used, which contains VoIPStream package.

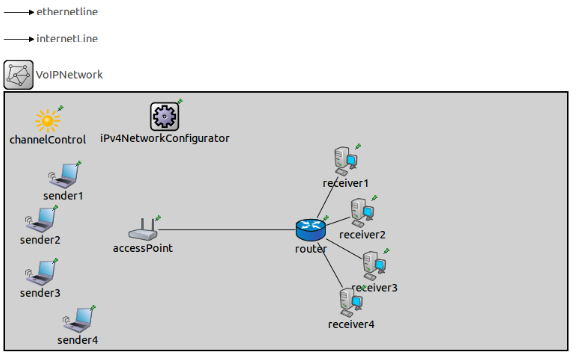

Figure 3: Network for wireless simulation scenario

To get results, we did 10 simulations with the same input for both wired and wireless networks. The same simulation parameters and the same audio file were used in both cases. As an audio file we used steuern.wav file, which is included on simulation package by default. All four machines started to generate traffic at the same time.

3.3. Simulation results

The results of simulation must be PESQ-MOS values. To get correct values, Perceptual evaluation of speech quality (PESQ) tool of International Telecommunication Union (ITU) was used [7].

After running simulations we took average value for each machine. PESQ-MOS Values for wired and wireless networks can be found respectively in Table 2 and Table 3.

Machine No.	PESQ-MOS value
1	3.915
2	3.898
3	4.102
4	3.979

Table 2: PESQ-MOS values for wired simulation

Machine No.	PESQ-MOS value
1	2.381
2	2.402
3	2.375
4	2.390

Table 3: PESQ-MOS values for wireless simulation

Graphical representations of PESQ-MOS values can be found in Figure 4 and Figure 5 for wired and wireless networks, respectively.

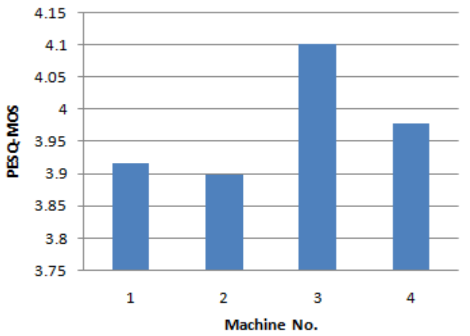

Figure 4: PESQ-MOS values for wired simulation

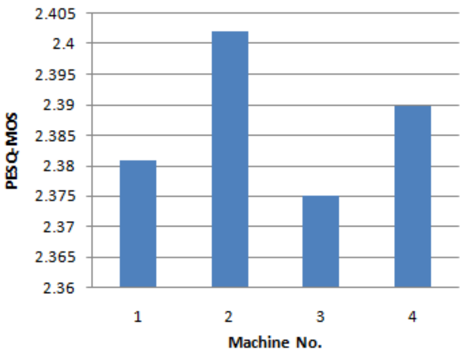

Figure 5: PESQ-MOS values for wireless simulation

Average value for wired network is about 3.97, which can be characterized as almost good quality (see Table 1). For wireless network, the result is about 2.4, which is a poor result. Maximum PESQ-MOS value for wired network was 4.102 and, for wireless, it was just 2.402, which is even less than the lowest value in wired network, which is 3.898. Putting together both charts we can get the chart in Figure 6. We can get clear representation on how values differ on those types of networks.

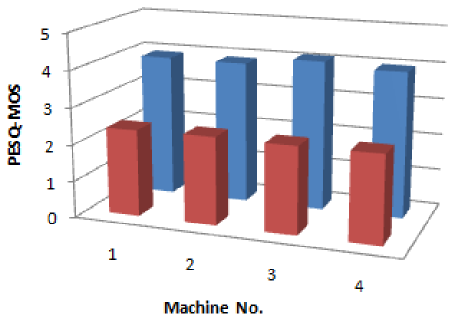

Figure 6: Comparison of PESQ-MOS values for wired (blue columns) and wireless (red columns) network simulations

4. CONCLUSION

The VoIP traffic is becoming more and more important in today's networks. It is very important to consider different types of traffic when designing networks. Simulation environments can play important role here. They are granting the ability to create different networks, modify them on the fly and simulate different kinds of traffic and network behavior. Analyzing results from simulations can give important information about expected stability and reliability of chosen architecture.

In this paper we simulated scenario of VoIP traffic generation from four machines on one network. We chose two different types as our environments: wired and wireless.

For wired network we got good quality of voice received from the end client. But for wireless networks the quality was poor.

As a result of this simulation we can notice, that for VoIP traffic wired networks are preferred. For each network, in order to have high stability, many aspects must be considered during design process, one of which is type of possibly generated traffic.

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