# Performance Improvement of Wireless Network Based on Effective Data Transmission

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## Abstract

A major requirement of any computer network is scalability. This can be as a result of increase in the number of users, upgrading due to technological advancement, additional services, or the need for performance improvement. This will inevitably require changing infrastructure, deploying new applications, and dealing with security which definitely touches both hardware and software, in the sense that, the complexities of the hardware, software and firmware increase with the attendant growth of the network and maintainability. However, for the network to remain reliable and efficient, it is necessary that, implementation and administration of it requires a means of monitoring both the model of the network structures and processes occurring in them. The efficiency and throughput of the network depend on improving the effectiveness of data transmission carried out by the network protocols. This paper discusses the use of a protocol to meet the technological challenge towards improving the performance and throughput of a wireless network based on effective data transmission.

## 1. Introduction

A computer communication network is never appreciated a major asset until when there is performance degradation – a situation when the network starts crawling at peak period thereby creating problems for local hosts and also, when remote users find it a difficult task to connect to the network. In such cases frustration sets in especially when downtime becomes prolonged, let alone lost in revenue, profitability, bandwidth consumption and typing up of IT resources until these problems are resolved the huge cost on investment will not be justified.

However, contingency planning is very crucial in averting network breakdown or network traffic downtime as described above and one way achieving a good quality network carrying out a network modeling and simulation. Simulation has become a necessary tool in studying network. The use of simulation programs on TCP/IP protocol [4] with special attention on mode of data transmission will provide an improvement in bandwidth utilization even at peak periods.

Some of the software uses for modeling computer networks are OptiView™ Analyzer, ethereal, Netcracker Professional. They have been used for analyzing networks for unwanted applications, misconfigurations, in order to get network optimized and also, in finding solutions to some other network related problems.

Different researchers have looked into the network optimization issue and carried out work on improvement of bandwidth usage. Polly Huang and John Heidemann discovered TCP burstiness in light-weight simulations of data by counting packets with inter arrival times falling into certain critical intervals – round trip time (RTT) or retransmission timeout (RTO), they were able to create finite state automaton (FSA) with states and transitions indicating rounds of back-to-back packet transmissions. They demonstrated that an FSA approximation of TCP can produce lightweight simulation models of TCP suitable for background traffic, and that these models accurately reproduce multi-fractal scaling behavior in IP network traffic [1]. Increasing the effectiveness of data exchange within a network based on the protocol of TCP/IP [5] using simulation modeling were looked into and the result obtained showed that it is possible to maximize bandwidth efficiency by the mode of data transmission[2].

The key contribution of this paper is to develop a new approach of optimizing data transmission rate that leads to improvement in bandwidth utilization. After examining the factors that degrade network performance like mode of data transfer, topology, bandwidth, hardware and so on., we began to focus attention on the mode of data transmission. The way data are managed during transmission by the protocols handling the data transfer can really reduce the performance of a wireless and fixed local area network.

This paper is organized as follows Section 2 deals with Influence of data transfer modes on the efficiency of wireless data network; section 3 examined the analytical method of estimating the "bottleneck" on a wireless LAN; section 4 explains the results of simulation; and the paper is ended with a conclusion in section 5.

## 2. Influence of data transfer modes on efficiency wireless network

The rapid growth in the number of users and corporate networks, including the university networks has push the computer network beyond what it used to be - an experimental network. Meanwhile, it is necessary to use special simulation packages in analyzing and designing network connections because of the complexities of network infrastructure. This necessitates the need for the identification of the factors (topology, bandwidth, hardware, software and so on) that affect the mode of data transfer in a network which have been mentioned earlier in the introduction. The basic indexes of which are network performance and time delay in transmission of data.

## 3. Analytical method of estimating the "bottle neck" on a WLAN

Consider that the workload on the network are uniformly distributed among the nodes, as shown in Fig. 1 below, then with the aid of computer programs, the analysis of traffic passing through all the nodes in the network was done and statistical information were obtained and preliminary analysis of the workload on the communication channels was carried out.

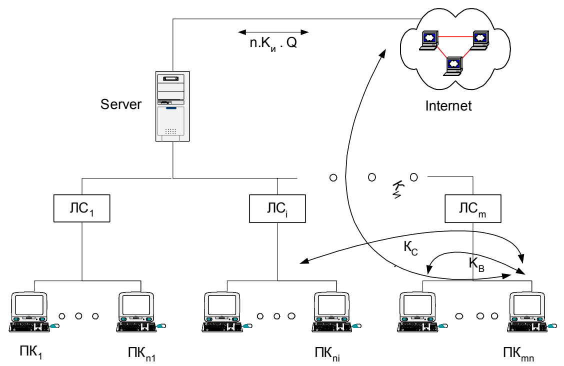


Fig. 1. Analytical scheme of corporate network

The bandwidth capacities of a communication channels is determined by the set of network equipment, desired workload – network structure (number of computers, topology of their connection), and also the necessary users and applications.

Firstly, the desired workload (bandwidth) can be determined analytically by taking into account the following assumptions:

- the average quantity of information transferred per unit time ($Q_1$) on one computer is the same for all the computers on the network
- the specific gravity of information transferred on the Internet is the volume of data transfer and is approximately identical for all computers as compared to internal network and determined by the coefficient ($K_H$);
- all the computers have the same speed of data transmission.
- specific gravity of information transferred on a network is characterized by the coefficient $K_B$ – the quantity of data transferred from a computer to computers on other subnets and $K_C$ – is the quantity of data transferred for computers on the same subnet.

Obviously, this gives the following equations:

$$K_C + K_B + K_C = 1$$

Work load on link Channel – coefficient of work load $(K_H)$:

$$K_H = \frac{Q_{LC}}{Q_n},$$

Where $Q_{LC}$ - Desired workload on link channel

$Q_n$ - Normal bandwidth on link channel

Work load of data transfer on the internal link

$$Q_N = Q_1 \bullet K_N \bullet n, \qquad n = \sum_{i=1}^{m} N_i$$

Where $n$ – number of computers on the LAN

$Q_1$ - average volume of data exchange for a node per unit time

$K_N$ - small quantity of information exchange on Internet

$N_i$ - number of computers on i=subnet (including those connected to the subnet of lower layer)

m – number of subnet on the LAN

Work load of data exchange on the bus of subnet LAN

$$Q_{LCi} = Q_1 \bullet N_i$$

Work load of data exchange on LAN tunnel

$$Q = Q_1\left[K_u \cdot n + \frac{1-K_N}{n-1}\sum_{I=1}^{m} N_i\left(n - N_i\right)\right]$$

The above equation can only be used to estimate the bandwidth of the first two levels of the network. Additional levels will render the equation more complex for the estimation of the desired bandwidth.

The extreme complexity of the topology of corporate intranet networks and the Internet make the development of analytic models very difficult and under such circumstances; simulation models are viable alternatives that can help in understanding the behavior of these networks during data transmission. However, the real corporate networks of major concerns and the universities as an example have greater number of levels, which substantially hampers the use of calculation/analysis methods and requires application of multilevel imitation design of network infrastructure. In realizing this, a specialized system on simulation NetCracker professional was deployed. Hence, for this, a research on workload of an external channel was carried out on the corporate intranet using the following parameters:

- size of the send files,
- number of connections,
- time domain between the transmissions of the files.

## 4. Graphical results of simulation

Fig. 2 shows the results obtained from simulation where it can be seen that increasing the send file size (at a fixed frequency of data flow), increases the workload on the channel and effective bandwidth utilization towards maximum level (ranging from 128 to 1024 Kbytes for different networks), so, this affects the throughput. Further increment will result in a drastic decline of the bandwidth and its performance as shown in Fig. 2 due to traffic congestion.

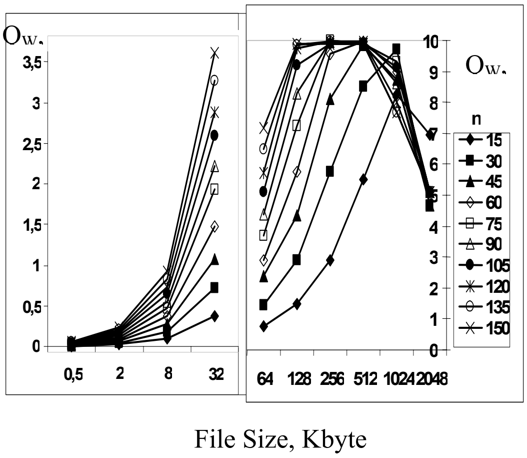


Fig. 2. Dependence graph of bandwidth capacity of external channel on a corporate network based on an average file size and different number of network connections

The dependence of bandwidth capacity on the average file size from different network nodes and its constancy to every dependent workload on a channel is shown in Fig. 3.

From the graph it is seen that a change of send file size from 128 – 512 Kbytes have no substantial influence on the bandwidth utilization of the external channel as shown Fig. 3 below (15 connections, $Q_{TN}$ = 0,61), and at the workload (30 - 150 connections, $Q_{TN}$ = 15).

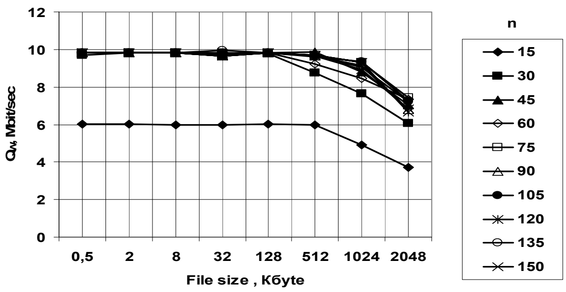


Fig. 3. Dependence of bandwidth capacity on an average file size of different network nodes and workload capacity

On further increase of workload to the channel the bandwidth capacity of channel begins to fall (in this case at an average send files size more than 512 Kbytes). Hence, if the send file size exceeds the maximum, substantial fall in the efficiency of data transmission results. However, for the purpose of experimental verification of the obtained results from simulation, the real model experiment was conducted, by sending different file sizes from the server to the workstation and vice versa.

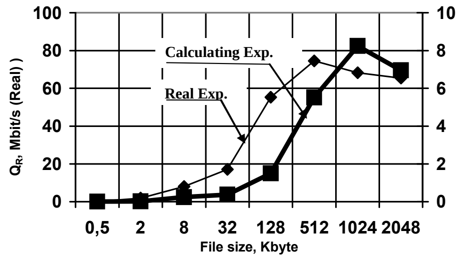


Fig 4. Research result of workload from main computing network system obtained by model and the Computer

During the processes of transmission, the time delay, transaction time and average bandwidth performance were recorded. The result of the modeling experiment was compared with the results obtained from calculations. Fig. 4 shows the graphs obtained by both methods. The Graph of $Q_R$ (L) obtained by calculations using 15 nodes and period of transmission of files, evenly distributed within the interval 1-19 seconds. The analysis of the graphs reveals rational maximal file size of 512Kb obtained from experimental method.

The results above reveal that the mode of data transmission influences the performance efficiency of the TCP/IP network as shown in the figures, (Fig. 4 and 5) below. So, summarizing the results of the researches, the three-dimensional dependences represented in Fig. 4 and 5, show, how the mode of data transmission depends strongly on the bandwidth capacity of a network. Matlab and Netcracker simulation programs were used to simulate the nodes of the network and the results showed that mode of data transfer affects the network performance.

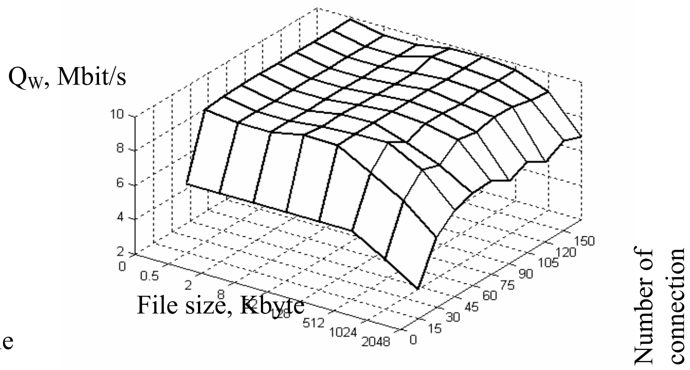


Fig. 4. Dependence of bandwidth capacity on an average file size of different network nodes and workload capacity in 3D

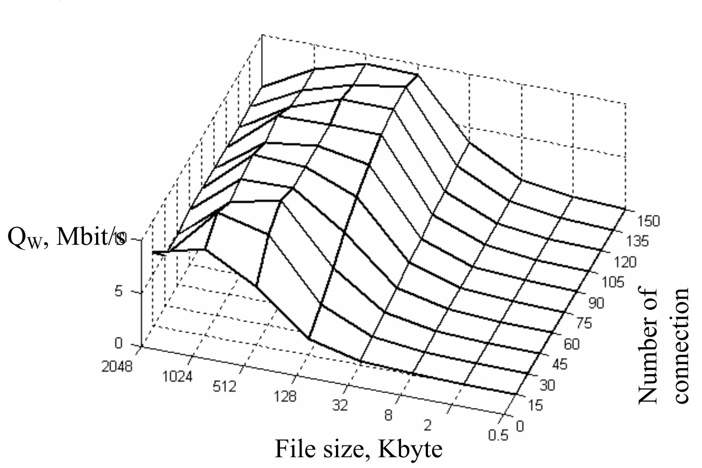


Fig. 5. Dependence of bandwidth capacity of a network on number of connections and send file size in 3D

Moreover, the result obtained gives us an insight to a new approach of increasing the efficiency of data transmission in a distributed computer network. Approach involves the sharing of the dependences gotten from both the analytical and experimental methods, and also complex developing simulation models, for deciding the most effective mode of data exchange during a given condition. In using the new approach, the following execution sequences are offered:

1. Preliminary determination of the different modes of data exchange in a network environment through developed models of physical and transport levels or the achieved dependences got from the research work [2].
2. Determine possible variants of network structure or network application.
3. Investigating the different throughputs using the simulation technique system of NetCracker.
4. Clarification where necessary a separate characteristic of the modes of data transfer in a network.
5. Making recommendations on the most rational organization of data transfer in a computer network.

## 5. Conclusion

In this paper, we presented a model for generating and realizing workload distributions for corporate intranet networks and the Internet using the Matlab/Simulink and NetCracker applications. This model captures data, from all the nodes of the network and spatial interactions between sources and the network with their connections. The analytical method has a limit due to network complication and simulation method gives the optimum results.

Sustainable development in IT needs this research work to improve network performance and its efficiency.

Based on the results of simulation with the use of the NetCracker Professional system the maximum value of workload for optimal performance should not exceed 512Kb otherwise a decline in the bandwidth utilization.

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