System for Communication Networks Modeling, Simulation and Analysis

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Abstract: - This project has developed an object-oriented software to perform the simulation of different components of Ethernet local and long distance area networks by using the "TCP/IP" protocol. It is also able to detect problems in projects and operation of communication networks through the separate or jointed analysis of these elements. The functions of the system are as follows: a) analysis of elements from different layers and protocols of the simulated network (reference to OSI model); b) analysis and efficiency measurement (quality of transmission, transfer rate, errors rate) of the information transmitted on the network; c) network performance evaluation and links capability analysis; d) analysis of errors detection and further correction capability as well as analysis of network failure tolerance. To start up the system parameters, data was statistically collect from real networks. The software works using mathematical models that represent elements of different layers (reference to OSI model) of the network to be simulated as well as the performance of the above mentioned jointed elements. The main target of the developed tool is to help engineers, computer analysts and technicians of the telecommunications areas to accomplish their task of projecting and evaluating the performance of local and long distance networks. The project itself is aimed to supply the Paraná state government as follows: a) costs cut in the network project preparation; b) ease to analyze the technical and economical feasibility at network start up, performing a better use of the economical resources; c) improvement in local and long distance networks performance in order to raise the state institutions productivity; d) larger communication network availability and performance, highering the user's satisfaction.

Key-Words: - local area networks; Ethernet; TCP/IP; long distance area networks; simulation; analysis; project and operation of communication networks; mathematical models; tool to help network projects and analysis.

1. Introduction

1.1 Objective

The objective of this work is to show the development and implementation of a local and long distance communication networks modeling and simulation system to aid in the activity of networks projects elaboration. The system will also perform the problem diagnosis in existing networks and indication of possible solutions.

The communication networks installed in Paraná state Government that uses the Ethernet and TCP-IP protocol was used as base for start up the parameters of the simulator.

1.2 Identification of the problem that originated the work

The proposal of the system came from the need of local networks existence in the organs of the Paraná state government and a long distance network to connect them, with high quality, availability and performance, implemented with technology and competitive price. Today there is a lack in the utilization of tools that help in analyses of technical and economic feasibility in network projects.

1.3 Possible use of the generated knowledge

The developed system will help in communication networks projects and in the diagnosis of problems in existing networks, enabling: a) reduction for the Paraná state government in the network projects elaboration costs; b) facility in the technical and economic feasibility analysis in the communication networks implementation, determining a better use of economic resorts; c) improvement in the local and long distance area networks performance to increase the productivity and satisfaction of the users.

2. Proposal of the work

2.1 Innovation in the approach

The system developed proposes specific characteristics of interest to the Paraná state government, using the domain of the networks in operation and the procedures and factors utilized for projects. They adapt analysis of the existing works and aggregate some functions found in commercial products but he joins topics not found in a unique software and employ specific approaches for the modeling and simulation.

2.2 Expected results

The theoretical point of view

The proposed tasks for the system simulator are: a) analysis of elements from different layers and protocols of the simulated network (reference to OSI model); b) analysis and efficiency measurement (quality of transmission, transfer rate, errors rate) of the information transmitted on the network; c) network performance evaluation and links capability analysis; d) analysis of errors detection and further correction capability as well as analysis of network failure tolerance.

The software works using mathematical models that represent elements of different layers (reference to OSI model) of the network to be simulated as well as the performance of the above mentioned jointed elements. We used the pre-existing communication networks in Paraná state government institutions as basis for properly meeting their needs.

The practical Point of view

About the practical point of view, the result expected is a tool capable to help engineers, analysts and technicians from the telecommunication and computer science area to project and evaluate the local and long distance Ethernet .networks performance.

As example in the economy provided by the system, it is possible with the utilization of the simulation, identify in the project phase if equipment is or not adapted to the best performance of a communication network. Today, the cost of a concentrator equipment' interface varies of U$S 40,00 to U$S 400,00 and for a medium network of 100 computers we have an estimated value of R$ 10.000,00 to R$ 20.000,00 by network. It is the investment that the system intends to protect.

3. Definition of the system to be simulated

3.1Ethernet Networks

The Ethernet (IEEE 802.3) system: Ethernet is a local area computers network technology that transmits computer information using speeds among 10 and 1000 millions of bits per second (Mbps). Nowadays, the more utilized version of the Ethernet technology is using Category 5 Unshielded Twisted Pair Cabling in 10 or 100 Mbps for workstations and 100 Mbps or 1 Gbps for servers on networks. The Ethernet technology can operate using Unshielded Twisted Pair, coaxial (older technology) or monomode or multimode optic fiber cable.

Ethernet advantages:

- popularity: the majority of the equipment and programs are developed for work with Ethernet (IEEE 802.3) standard;
- short cost compared to other technologies, for example, ATM (asynchronous Transfer Mode);
- the previous investments are maintained:
- change to faster speeds in the best time;
- Culture and previous knowledge are maintained.

Voice and video transportation:

- High rates of transmission: 100 Mbps [IEEE 802.3u, 1 Gbps [IEEE 802.3z and IEEE 802.3ab], 10 Gbps, 40 Gbps;
- Auto-negotiation and Full-Duplex communication;
- 802.1Q and 802.1p standards that supply Virtual LANs (VLANs) and priority of information for the packages in the network;

- RSVP and video compression, as the MPEG-2;

- Layer 3 switches witch high speed routing.

4. Measured Parameters

The parameters that will be constant, independent variables and dependent variables, in this work, with its domains, are:

I: Total time of networks analysis, in minutes: 120
II: Interval of time for the data average, determining a point of sample, in minutes: 5
III: Transmission speed, in Mbps (Mega bits per second): 10

A: number of stations in the network, in stations: 50 to 500
B: number of interfaces used at same ethernet bus: 1 to 48

a: medium utilization of the net, in percentage: 0 to 100
b: medium rate of frames, in frames by second: 0 to 20.000
c: medium size of frames, in bytes: 64 to 1.518
d: medium consumed band of network, measured in Mbps (Mega bits per second) : 0 to 10
e: maximum utilization of the bus, in the sampled time (A), in percentage: 0 to 100
f: medium broadcast rate, in second: 0 to 20.000
g: medium rate of remote collisions, in collisions per second: 0 to 20.000
h: medium rate of local collisions, in collisions per second: 0 to 20.000
i: number of delayed collisions, in collisions: 0 to 144.000.000
j: medium rate of collision as a percentage of the total sent frames, in percentage: 0 to 100
l: number of Jabbers, in frames: 0 to 144.000.000
m: number of wrong FCS (Frame Check Sequence"), in frames: 0 to 144.000.000
n: number of short frames, in frames: 0 to 144.000.000
o: number of frames with electric noise, in frames: 0 to 144.000.000
p: maximum rate of delayed collisions, in collisions per second: 0 to 20.000
q: maximum rate of remote collisions, in collisions per second: 0 to 20.000
r: maximum rate of local collisions, in collisions per second: 0 to 20.000
s: maximum rate of frames in the sample time (A), in frames per second: 0 to 20.000
t: maximum rate of broadcast in the sampled time (A), in frames per second: 0 to 20.000
u: maximum rate of jabbers about the time (A), in frames per second: 0 to 20.000
v: maximum rate of wrong FCS ("Frame Check Sequence") in the sampled time (A), in frames per second: 0
x: maximum rate of short frames in the sampled time (A), in frames per second: 0 to 20.000
z: maximum rate of frames with electric noise, in the sampled time (A), in frames per second: 0 to 20.000

5. Examples of results

With the collected points and with application of mathematical technicians, we find curves that represent the functions of the network, permitting the simulation.

As example of results, in valid sample of networks with size from 100 to 350 stations (microcomputers), we have:

The dependent variable (e) – maximum utilization of the bus, in percentage, can be writing in function of the independent variables (A), (B) and (c) - number of stations in the network, in stations; number of stations utilized at same ethernet bus and medium size of frames, in bytes, in the form: $(e) = \beta_0 + \beta_{1.}(A) + \beta_2.(B) + \beta_3.(c)$.

The dependent variable (e) – maximum utilization of the bus, in percentage, can be writing in function of the independent variables (A) and (c) - number of stations in the network, in stations; medium size of frames, in bytes, in the form: $(e) = \beta_0 + \beta_{1.}(A) + \beta_2.(c)$.

The dependent variable (e) – maximum utilization of the bus, in percentage, can be writing in function of the independent variable (c) - medium size of frames, in bytes, in the form: $(e) = \beta_0 + \beta_{1.}(c)$.

The dependent variable (q) – maximum rate of remote collisions, in collisions per second, can be writing in function of the independent variable (c) - medium size of frames, in bytes, in the form: $(q) = \beta_0 + \beta_{1.}(c)$

The dependent variable (a) – medium utilization of the network, in percentage, can be writing in function of the independent variable (B) - number of interfaces utilized at same ethernet bus, in the form: $(a)=\beta_0.e^{\beta 1. (B)}$.

The dependent variable (f) - medium rate of broadcast, in frames per second, can be writing in function of the independent variable (A) - number of stations in the net, in the form: $(f) = \beta_0.e^{\beta 1. (A)}$

6. Conclusion

The proposal of this work is measure and analyze parameters in local and long distance Ethernet networks installed in organs of Paraná state Government, that utilize the "TCP/IP" protocol, so that they can be simulated. The generation of simulation software will help engineers and computer analysts to project new communication networks and will permit a better application of the resorts of the state government, as well as the performance of the communications networks, increasing the user's productivity and satisfaction .

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