A Characteristic Analysis on Heterogeneous Communication Networks

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Abstract

This paper presents a guideline of network design. Most large scale computer networks are constituted of heterogeneous connecting subnetworks. The computer network must be changed according to traffic characteristic.

The traffic model is made by measuring the network traffic in our institution configuration. The network model consists of Ethernet and FDDI. Ethernet is the most popular in local area networks. FDDI is used in the parts which transmit a large quantity of data.

The lost rate and the average wait time are measured by simulation which use the traffic model on the network model. A guideline of network design is proposed based on the simulation result.

This paper describes the traffic model, the network model, some simulation experiments, and proposes a guideline of network design.

1 Introduction

The packet switching computer network is often constituted of heterogeneous networks. The structure consists of low velocity networks and fast velocity networks. The advantage of connecting networks are described as following.

- Using the effect of large groups, A lot of transmission circuits of the low velocity network are multiplexed the fast velocity network.
- Any client share data or application in a server on the fast network like NFS.

- It is possible to build network with router or bridge.

In many case, the previous research works to evaluate network efficiency has assumed that packets originated at random, and the interval of arrival time is complied with the exponential distribution. A packet size is assumed to be fixed length or at random a minimum length(64 Byte) to a maximum(1518Byte)[1]. There are analysis considering arrival distribution according to applications[2]. However, these analysis treat single communication applications. There traffic characteristic are different from real networks.

In this paper, the models used for network characteristics analysis are made by measuring the real network. The methods are described as following. First, in a traffic models, the interval time of originating packet and packet length are made from measuring real traffic. Second, a network model consists of transmission velocity and communication protocols. The simulation using the traffic models on the network model gives packet lost rate and average wait time at clients, a server and bridges. From a result of simulation, this paper estimates the traffic capacity of the network system connecting heterogeneous communication subnetworks, and goals of this paper is to propose a guideline of network design with high QoS [1].

2 Network Structure

This paper uses a heterogeneous network which connect Ethernet for low velocity and FDDI for high velocity. The physical layer of each networks are 10Base-T and Optical fiber of 100Mbps. Ethernet and FDDI are connected by bridges. Ethernet can connects many clients, and FDDI connects some bridges and a server.

The QoS of a network is expressed frame loss rate(FLR) and frame mean wait time(FWT). Characteristics of FLR and FWT are determined by frame arrival interval time, service time and maximum buffer length.

A frame arrival interval time is determined by originating time or arrival interval time via communication line.

A service time are the sum of data transmission time and time for bus request procedure. A data transmission time is the period in which it spend frame transmission. The bus acquiring time is different between CSMA/CD and Token Ring.

The maximum buffer length extremely affects FLR. The mean wait time can be computed by the product of the average service time and the queue length. Hence, if a maximum buffer length is infinity, FLR will become zero. If frame interval time become as same as service time, FWT will increase to an unlimited extent. Also, if the maximum buffer length is limited to some value, FLR will increase and FWT will be settled to fixed value. From this characteristic, the relation between FLR and FWT can be investigated by experiments where the maximum buffer length is varied.

[1] Quality of Service

3 Traffic Models

3.1 Measuring the Network Traffic

The network Traffic is measured in our institution configuration. The period of measurement is three weeks. All traffics within one network segment are measured.

3.2 Traffic models

In a computer network, the traffic is much affected by human activities, networking protocols and applications, and is extremely complicated. Hence the traffic model can be classified as "a burst traffic" or "an average traffic".

In this paper, the traffic model is made based on probability distribution function, of which candidates are normal distribution, exponential distribution and log-normal distribution. The parameter of each probability distribution functions are estimated by measuring traffic. Normal distribution and log-normal distribution are estimated by an average and a standard deviation of sample data. Exponential distribution is estimated by generation rate which is derived from average[3, 4, 5].

Model approximation is done by χ^2 test. The model becomes optimal when the χ^2 value goes to minimum.

The model of generation interval time versus a number of frame is modeled by the log-normal distribution. Also, The model of frame length versus a number of frame used originating table, because the model doesn't fit all distributions.

4 Network Mode1

The network model consists of Ethernet and FDDI. The model, which is based on the MAC layer, consists of network characteristic which are transmission velocity, communication protocols, number of byte per one frame, and so on. Clients, a server, and bridges have buffers to store data temporarily. If data from FDDI are larger than MTU of Ethernet, IP fragmentation will be performed on the bridge[6, 7].

5 Experimental Simulation

There are eight simulations for analysis of network characteristics[8, 9]. The first simulation is to compare a method of using the log-normal distribution with a method using the exponential distribution on the previous research. The second simulation is about characteristic of Ethernet side on a bridge(bridge downside). Then the traffic is average. The third simulation is as same as the second except that the traffic is burst. The fourth simulation is about characteristic of FDDI side on a bridge(bridge upside). Then there is a single bridge on the FDDI. The fifth simulation is as same as the fourth except that there are many bridge on the FDDI. Sixth, seventh and eighth simulation are done by specific configuration.

As a result of simulation, the mean wait time of the exponential distribution was longer than the log-normal distribution. Because the originating system which used exponential distribution occurs much short term call than the log-normal distribution.

In bridge downside, when a traffic is average, if five or more client's calls occur, a QoS will become bad. When a traffic is burst, if two or more client's calls occur, a QoS will become bad.

In bridge upper-side, the configuration which one bridge is connected to multiple Ethernets gives much better QoS than those of Ethernet distributing multiple bridges on FDDI.

6 A Proposal for a Guideline of Network Design

As a result of simulation, in a network transmitting average traffic, it needs to design that client are limited to four on one Ethernet.

It is possible to have a few bridges on FDDI and many Ethernets on one bridge.

7 Conclusion

Computer network which contains heterogeneous connecting sub-networks needs to be designed with both client and server traffic consideration, because the bridge has only bandwidth as same as the client, although the frame length of a server is longer than its clients and the response to client multiplies all traffic.

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