DEVELOPMENT OF SIMULATION PLATFORM USED FOR PERFORMANCE EVALUATION OF INFORMATION NETWORK AND IT'S APPLICATION

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ABSTRACT

Today, effective utilization of sophisticated networks greatly influences the activities of a business, making performance evaluations of computer network systems a necessity. We have developed a special computer network simulator capable of automatically generating a model based on data accumulated by a network analyzer to guide the user in selecting ideal parameters. The simulator was developed to provide user-friendly analysis for engineers involved in the actual network design. This paper gives an overview of the simulator and describes an example application of evaluating a network design that anticipates the future increase in traffic for a company introducing voice over frame relay (VoFR) into a wide area network (WAN).

1 INTRODUCTION

Information networks used in businesses are undergoing a sweeping transformation including the introduction of new technologies supporting high-speed communications and multimedia transmission through broadband networks. When constructing new and efficient networks or improving existing ones for new types of use, it is necessary to conduct performance evaluations prior to making such changes. Simulation techniques are effective for this application. By conducting various tests using a simulation model of a computer network, it is possible to elicit an optimal design plan, detect any danger accompanying an increase in the volume of data transfer, and verify the improved plan. Accordingly, the authors of this paper developed and improved a simulation tool called SeeNET for evaluating the performance of a network.

The most important point to consider in developing a special simulator is that engineers managing the network must be able to use the tool to construct simulation models and evaluate the system with only technical knowledge in the field and common sense. However, network technicians are of diverse standing, including those who are involved from the planning to the design stage of new networks and networks being reconstructed and those who manage operations and study improvements from an operational perspective. The required precision and scope of the system to be analyzed differs according to the objective and conditions of the evaluation and analysis. Hence, the simulator must be able to handle a wide range of conditions for model construction. By automatically generating models using data accumulated by a commercially available network analyzer, we devised a model constructing function that focuses on problematic configurations.

In order to support rapid analyses, we also considered a function that provides an initial feasible solution aimed at reducing trial and error in comparing alternate plans. If the allowable activity ratio of each network resource can be set in advance from experience, a near-ideal configuration can be devised in which the capacity of each component is maintained within the allowable range. By presenting this plan as an initial feasible plan, the number of alternate plans can be reduced.

2 MODELING TECHNIQUE FOR A NETWORK PERFORMANCE EVALUATING SIMULATOR

2.1 Network System Features and Modeling Technique

Here, we describe the features of an information network and a modeling technique that uses these features for modeling a network system. [1]

(1) Almost all the components of the network are with standardize processing specifications for the LAN/WAN, routers and the like. Movement can be clearly discerned since processes are in reality regulated based on protocols divided into seven layers. Rather than faithfully modeling the processes of the seven layers, operational events of the components are ascertained to eliminate the need for excessive details when modeling these events.

(2) A technique exists for collecting current operational data when the network is operating. A network model requires such data as performance data of elements, network configuration data for elements, amount of traffic over the network, and routing data. Recent LAN analyzers and routers with a function for monitoring transmission paths have facilitated the collection of current network configuration data and traffic data. By automatically creating models based on this data, it is possible to clarify the scope of the system and reduce time of modeling operations.

(3) Networks are growing in scale and complexity and cover vast regions. Although it is difficult to specify boundaries for modeling, bottlenecks and the like can often by analyzed by modeling only the configuration related to traffic flowing through nodes in the problematic network. The network analyzer is then used to collect data on the segment corresponding to the bottleneck and can specify boundaries for modeling by constructing a model covering the related configuration based on data from, to, and via that segment.

2.2 Modeling Capacity of the Special Simulator

Our special simulator uses the features of the information network system to detect the IP addresses of the source and destination in packet data collected by the network analyzer in order to estimate the existence of nodes and their locations. The simulator presents this data to the user as topology data. The user then provides specifications for each node. Here, Sniffer (Network Associates, Inc.) was used as the network analyzer.

3 INITIAL SOLUTION FOR SIMULATION ANALYSIS

Simulation analysis is an experiment for comparing established alternatives, rather than calculating optimal values. The method contains the following problems.

• Even after determining the bottleneck of the system, the component lacking most in capacity, we do not know how much to enhance its performance before the activity ratio decreases. Hence, there is potential for ending up with too much or too little capacity when improving performance.
• After improving the performance of the component determined to be the bottleneck, a different device may emerge as a new bottleneck.
• If the initial performance is too poor, packets may be detained and resent, requiring an enormous amount of time to execute the simulation.

Therefore, we incorporated a method for finding the optimal proposal quicker by presenting an initial proposal for analysis and then creating alternatives of that proposal and comparing. To generate an initial proposal, the activity ratio of each network resource is set to fall within a preset allowable range. A network provided with capacities of each resource that meets these restrictions is first presented as the initial proposal. [2]

(1) Setting preconditions
• An upper limit for the utilization is preset for each type of network resource (LAN, WAN, relay, etc.).
• Typical network devices and WAN services are recorded in a database with attributes, such as their speeds.

(2) Analytic process
• The load on each resource is add up from the amount of traffic set in the simulation model.
• The activity ratio is calculated from the added up load and the performance set for each resource (bps, pps).
• Resources whose calculated activity ratios exceed the upper limit are displayed in a warning list.

(3) Determining the required capacity and updating the model
• Performance values necessary for maintaining the activity ratio below the upper limit are calculated.
• A database is searched for superior type of instrument and superior WAN services capable of meeting these performance conditions, and the model is updated with alternative equipment.

4 EVALUATION EXAMPLE

4.1 Analytical Strategy

An actual performance evaluation was conducted using the function for model analysis in SeeNET on the WAN of a company we will call Company A. When Company A was constructing a new office, we introduced VoFR and converted the internal phone lines between headquarters and all branch offices to Internet Protocol. At the same time, we conducted an analysis for constructing an optimal network system that considers an estimated future increase in traffic volume.

The data used in VoFR, having a nature completely different from that of conventional data, is added to conventional traffic and transmitted over the network. We determined the increase in WAN bandwidth necessary to handle this data and a method of transmitting the packets. Since the problem was finding the necessary WAN bandwidth between the headquarters and each branch office, we generated a simple model of just the WAN between important nodes and studied the parameters in this model to form basic data.

Employing this basic data, we then created a model of the overall network and verified how much increase in traffic the network could handle.

4.2 An Analysis of Voice Over Frame Relay Requirements

Bandwidth allocation, fragmentation, prioritization, and tuning of a fluctuation absorbing buffer are necessary to introduce VoFR in a practical form. In this analysis, we found the following requirements using SeeNET.

- Bandwidth allocated for the voice system
- Packet size for minimizing transmission delay
- Buffer size required to absorb fluctuation

Although Company A has branches throughout Japan, we selected branches in three main regions, including the headquarters in Tokyo, the Osaka branch, which is the base in the Kansai Region, and the Kumamoto branch, which is the base of their software development. We analyzed voice and data exchanges between these three points. The ultimate objective was to maintain the transmission delay of voice packets within 100 ms, excluding the exchange time with PBX.

Table 1 System conditions

Line capacity: 128 kbps
Band allocated for voice: about 3 lines at 8-kbps compression
Prioritization: voice packet priority
Length of voice packet: evaluations at 20 and 40 bytes
Max. packet length for data system: evaluations at 250, 500, and 1000 bytes

Table 1 shows the system conditions, while Fig. 1 shows the topology model according to SeeNET. Table 2 and Fig. 2 give the results of the analysis.

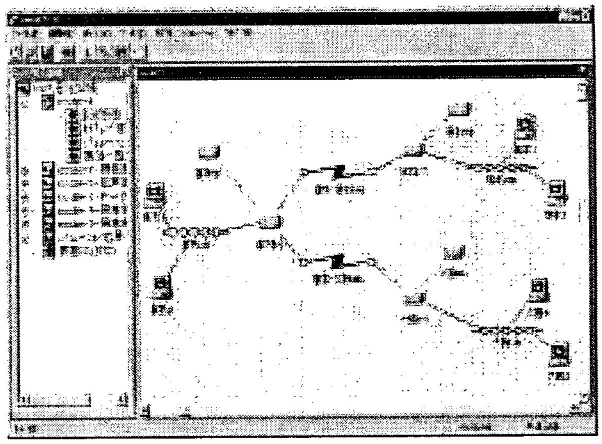

Fig. 1 Topology model by SeeNET

Table 2 A comparison of transmission delay time for voice packets

Delay time of packet transmission between Osaka and Kumamoto

	Voice 20 B average	Voice 20 B max	Voice 20 B min
No control/data 1000 B	111.112756	323.127706	8.75
Band control/prioritization/data 1000 B	94.094695	200.627706	8.75
Band control/prioritization/data500 B	52.120793	108.131678	8.75
Band control /prioritization /data 250 B	33.054479	51.011942	8.75
	Voice 40 B average	Voice 40 B max	Voice 40 B min
No control/data 1000 B	105.612341	289.893706	21.0848
Band control/prioritization/data 1000 B	88.012438	170.893706	21.0848
Band control/prioritization/data500 B	46.678701	70.976923	21.0848
Band control /prioritization /data 250 B	34.403176	56.951923	21.0848

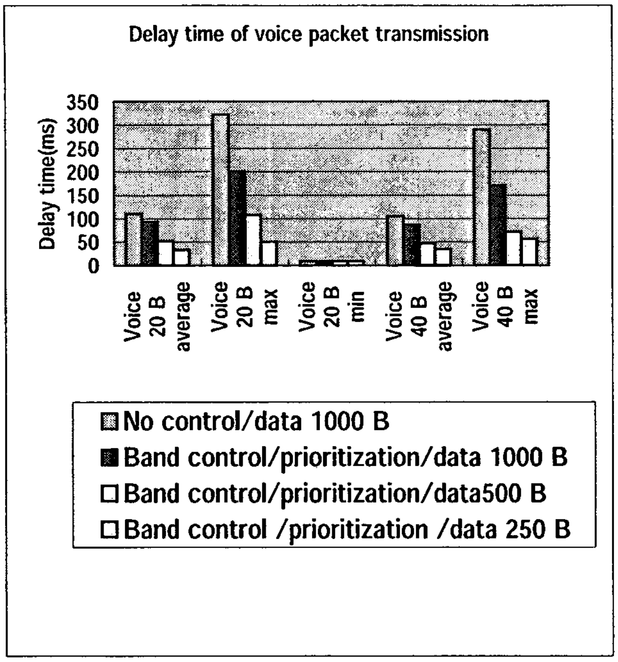

Fig. 2 Graph showing voice packet transmission delay times

The following can be derived from these results.

• When considering the longest routing path, between Osaka and Kumamoto, Fig. 2 indicates that the maximum transmission delay time can be maintained at 100 ms or less by conducting band control and prioritization and setting the packet length of the data system to 250 bytes. With this configuration, the voice packet length is the same at 20 bytes and 40 bytes.

• "Jitter" is the difference between the maximum and minimum delay times, which in this case is about 36–42 ms. If we were to employ a jitter n buffer capable of absorbing 40 ms, for example, the maximum time delay would be 91 ms for a voice packet length of 20 bytes and 97 ms for 40 bytes, thereby satisfying the condition of maintaining the delay within 100 ms. In this analysis, we settled on using a voice packet length of 20 bytes for a shorter maximum delay time.

4.3 Verifying the Overall Network

For the overall system, we included branch offices, hierarchies, and the like for each region with the modeling scope used for analyzing the requirements of VoFR to create a model closer to the actual system. However, since the system was only in the design stage, we could not use an automatic model generating function employing data collected from an actual LAN analyzer. In this model, branches in Hokkaido, Nagoya, Fukuoka, Kitakyushu, and an annex in Tokyo were added to the previous model. Fig. 3 shows the topology model created with SeeNET.

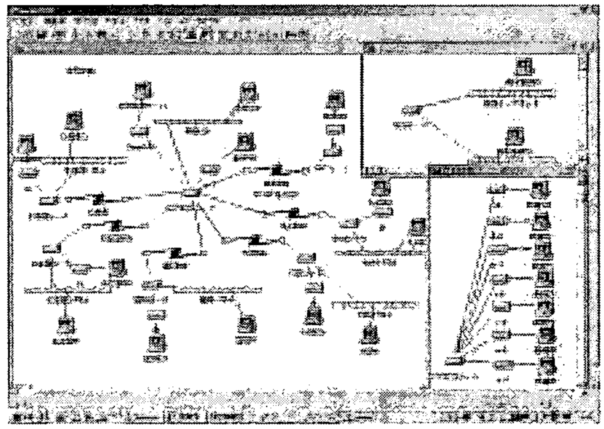

Fig. 3 Topology model created by SeeNET for the overall system

With the construction of a new office, we estimated a traffic load 1.5 times the current amount, considering such factors as data exchange between the new office and the annex and the introduction of new administrative applications Traffic settings were established after studying the frequency of interoffice telephone calls again.

In the analytic procedure, we set an initial equipment configuration and used the SeeNET function to find capacities of each WAN, router, and LAN needed for the estimated traffic volume to maintain the activity ratios of all WANs at 90%, all routers at 60%, and all LANs at 30%.

These findings showed that an increase from 128 to 256 Kbytes was necessary in the frame relay line speed between Kumamoto and the headquarters. By assuming a uniform annual increase in traffic of 1.5 times when setting the frame relay between Kumamoto and headquarters at 256 Kbytes, we used a simulation to find how many years the system could support the traffic.

Fig. 4 is a graph showing changes in the average response time and Fig.5 is a graph showing changes in the maximum response time for the main application. Using the response time of the main application as an index, conditions can be said to fall within the allowable values for two years Hence, the current system will need to be altered in another two years at its current state, but the system can sufficiently support current operations.

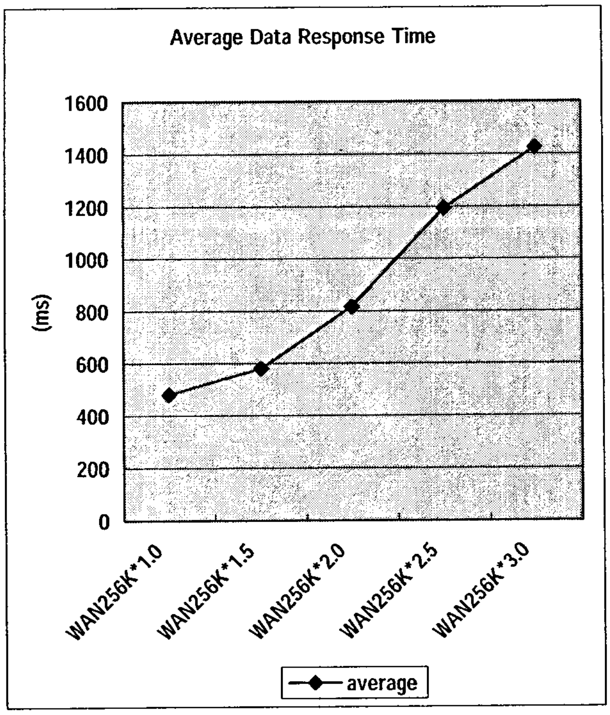

Fig.4 The average response time of the main application

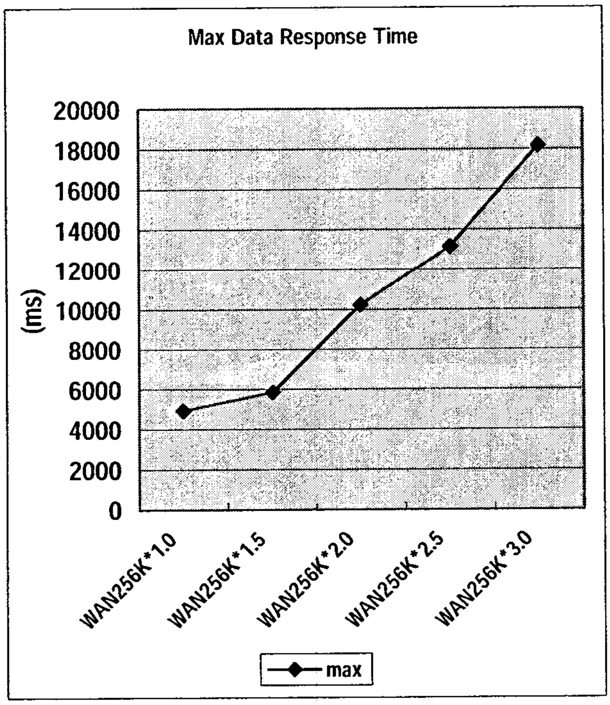

Fig.5 The muximum response time of the main application

5 CONCLUSION

In the present analysis, we developed a network performance evaluating simulator designed for use by system engineers conducting network design or administrators of network operations. We verified the effectiveness of the simulator to evaluate the performance of an actual reconstructed network.

We devised a function for automatically generating a model and a module for generating initial conditions in order to support use by engineers. In regard to the module for generating initial conditions, we found that analytical efficiency of a network could be gauged by presenting an initial proposal to be examined, without trying to determine the required performance of components through trial and error.

The automatic model generating function was effective for modeling existing systems by simply collecting their operating data, but cannot be used in the design stage since a network model must be created manually. We would like to consider functions for generating models from plans, and providing feedback from the model to plans by combining design support tools.

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