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A New Approach in Development of Data Flow Control and Investigation System for Computer Networks

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ABSTRACT

This paper describes a new approach in development of data flow control and investigation system for computer networks. This approach was developed and applied in the Moscow Radiotechnical Institute for control and investigations of Institute computer network. It allowed us to solve our network current problems successfully. Description of our approach is represented below along with the most interesting results of our work.

INTRODUCTION

Seven years ago we started the development of a new control system for an experimental electron accelerator in our institute. It was planned at the beginning to apply six computers PDP 11/70 and six computers PDP 11/23. These computers were interconnected by lines DL KI/SI (These lines were developed and manufactured in the USSR. The throughput is about 500 kbit/sec). The operating systems are RSX11M/S.

The main our problem was a choice of network software. In that time we knew the DECNET and the so called ALISA, and had two class of software simultaneously on each computer. One week we used DECNET and next week ALISA. The DECNET is a more powerful network package, but the main problem for us was a limited size of available operating memory. First of all it is valid for PDP 11/23. The compromise was as follows: ALISA as a first step, and DECNET for our perspective, when we will get a more powerful computers.

OUR PROBLEMS

It was planned to control the accelerator from a dedicated console. Console consists of four graphical stations. Each graphical station is a ordinary network node (from viewpoint of network service). In addition one computer was planned for a database management. And the first task for us was to investigate application efficiency of network graphical stations and network database. At that time first users of our network appeared. This period is characterized as a period of development and debugging of software for accelerator automation. Terminals and computers were placed in different rooms. And often the main problem for users was to find a free terminal. If free terminal was connected to another computer he used either virtual (remote) terminal service or virtual disk. Also network services were used for transfer of files, and copying of disks and magnetic tapes. In addition another problem for us was the development and enhancement of our network. Many colleagues from other experimental systems asked us to connect their computers to our network for use of graphical stations, plotters, densitometer. Figure 1 illustrates a structure of our computer network (1988). And the vital problem for us was the creation tools for network investigations to solve correctly all our problems.

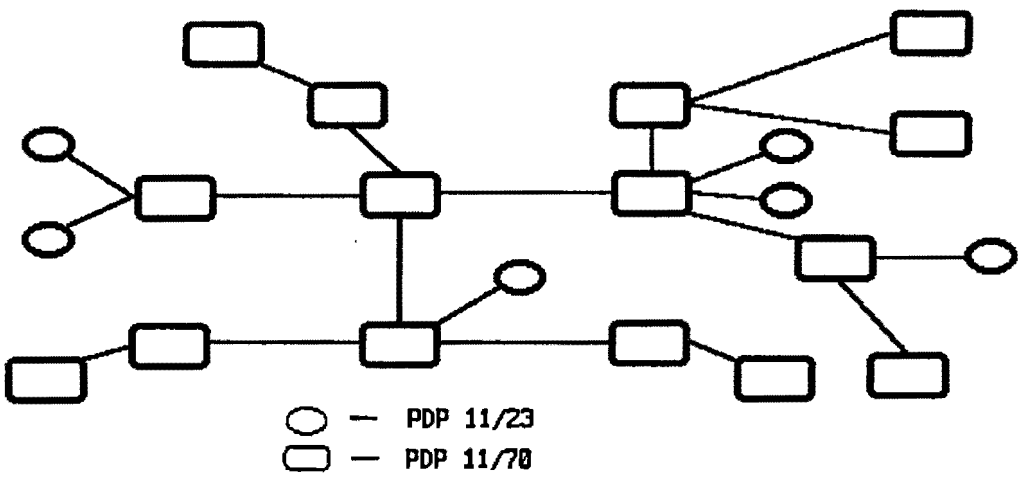

Figure 1. Network structure (1988).

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PROBLEM of INVESTIGATION

First of all the problem of network study for us was the problem of network traffic research. A conventional approach for the message flow description is based on data flow representation in terms of a distribution function of time intervals between the two adjacent messages . The advantage of the approach lies in the use of the queueing techniques. However , the utilization of the approach in real networks traffic representation seems to meet with difficulties. Thus another approach was used in message flow description for communication networks . A pair of counters is associated with a network node . One of them is incriminated in the case of a message reception in the node whilst the second is incriminated in the case of a message delivery . Both receiving and transmitting parts are equipped with counters which have to measure the lengths of messages . Within preset time intervals (e.g. every second) the counters are sampled . The differences between current and preceding readings feature numbers of transmitted and received messages (i.e. the speed) .

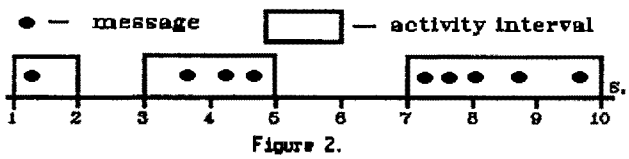

Figure 2.

The set of adjacent unit intervals with zero number of transmitted (received) messages is considered as inactivity interval . On the contrary , the set of adjacent unit intervals with number of transmitted (received) messages more null is called the activity interval. Figure 2 illustrates our new definitions. Spaces between activity intervals are the intervals of inactivity.

Respectively , the communication network flows are described by distribution functions of activity intervals , inactivity intervals , message reception (transmission) rates and lengths of messages .

The structure of network software for one networks node is shown on Figure 3. System receive information about messages from standard QIO requests. Standard QIO request issued from user task are directed by operational system to device driver. The ALISA device drivers were edited to contain counters and a program was developed to sample information from this counters every second and to modify distribution functions. In addition a program was developed for demonstration of all current traffic information on user terminal. The size of the program to sample information is about 5 kbyte. The influence of this changes on network throughput are less than one percent.

RESULTS of INVESTIGATIONS

If we take into account network software and hardware delays, the network rate between two adjacent nodes is about 15 kbyte/sec for messages of 512 byte length. It's enough for normal work in the regimes of virtual terminal or virtual disk. In this case user don't see distinction from situation when terminals or disks are connected directly to computer. Below most interesting results of investigation will be represented.

A. Virtual terminal service

We investigated about 30 users. Users did not knew about our researches Figure 4 illustrates the histograms of inactivity and activity intervals and transmissions rates histogram obtained from one user. The user activity was a development and debugging of programs (edition process). Investigations showed that such histograms are similar for all users who have a little experience with computer keyboard and editor. The average inactivity intervals for this category of users are between 8 - 12

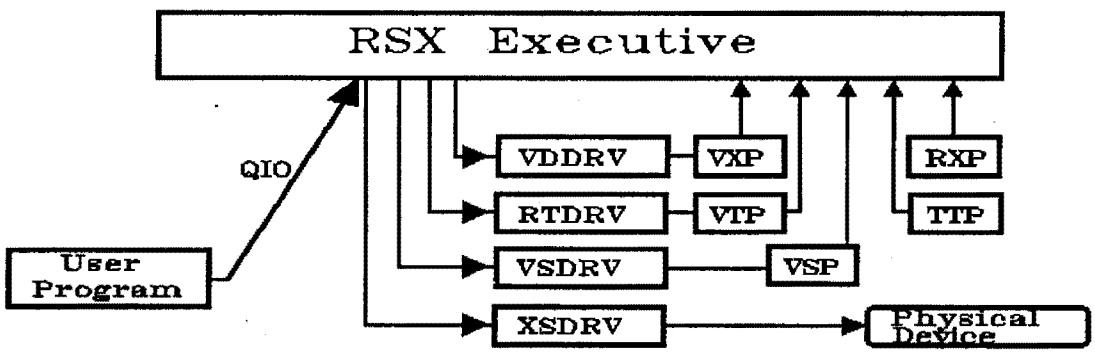

Figure 3. RSX ALISA Structure.
VXP <=> RXP - Virtual System Device Processes
VTP <=> TTP - Virtual Terminal Processes
VSP - Network Communications Process

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seconds. For unskilled users this intervals are about 20 - 30 seconds. Figure 5 shows the same histograms obtained from two users. They used the same line simultaneously.

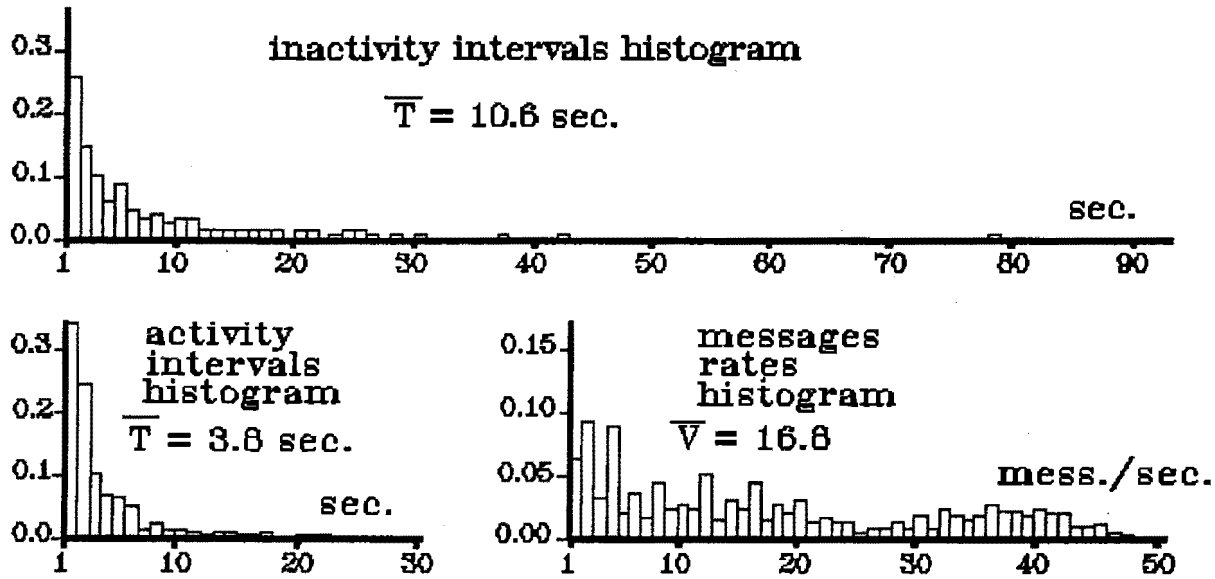

Figure 4. Virtual terminal service (one user).

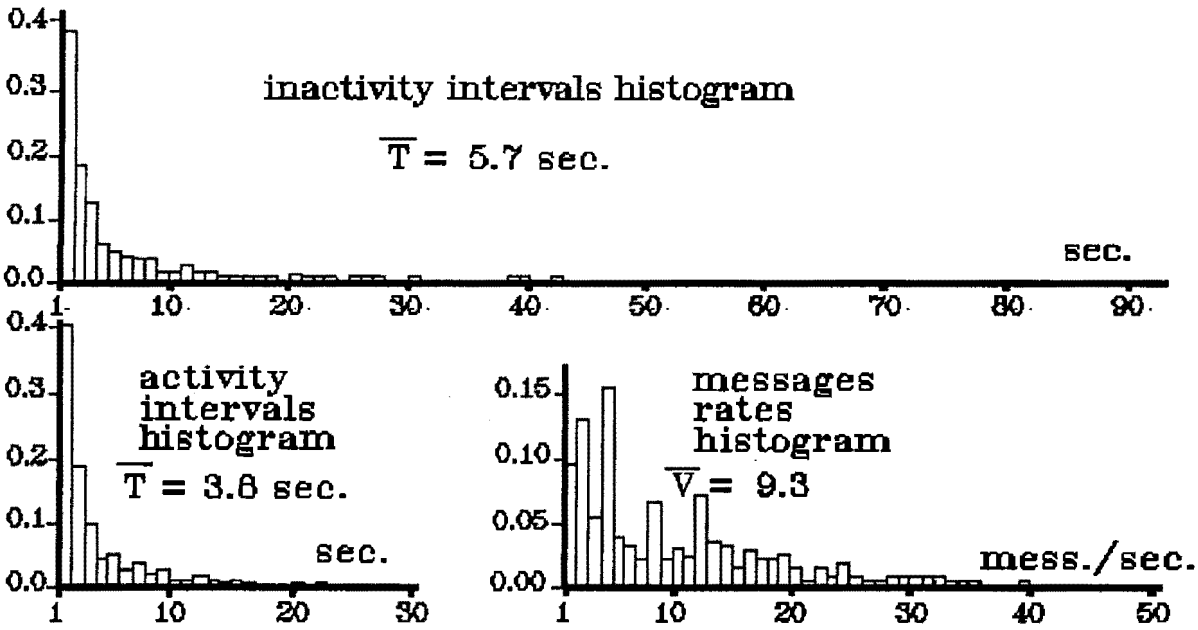

Figure 5. Virtual terminal service (two users).

As we see the average value of inactivity time interval reduced practically by a factor of 2 but the average value of activity interval essentially doesn't changed. This result can be easy explained from Figure 4. The proportion between average values of inactivity and activity intervals are about 3/1 - 4/1. Figure 4.1 illustrates distribution function for lengths of messages in the

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virtual terminal service. It' s difficult to represent this result as a histogram. We have investigated many cases and we can say that these digits are approximately the same in all cases.

Lengths	<50	<100	<150	<200	<250	<300	<350	<400
Share	0.89	0.088	0.004	0.001	0.003	0.01	0.0	0.0

Figure 4.1.Distribution Function for Lengths of Messages.

C. Virtual graphical station

We investigated many cases of experimental data processing on graphical station. The processing is a visualization of two dimensional matrix (256 X 256, 64 X 64 and others), graphics drawing, search and generation of cross sections and so on. It's interesting that the obtained results are analogous to the results for virtual terminal investigations. In all probability to explain this results we need take into account the characteristics of men's mental processes.

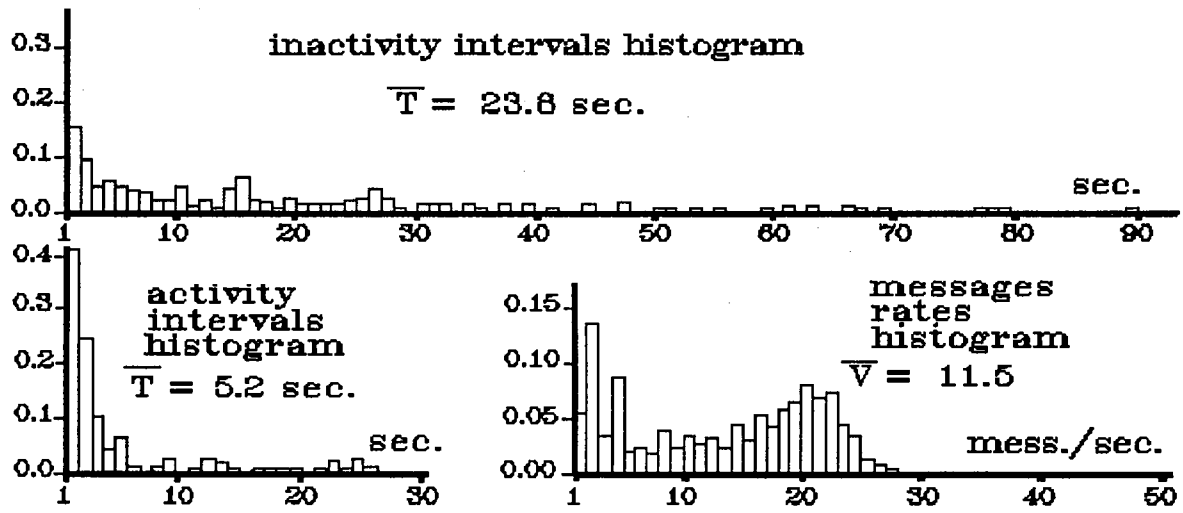

Figure 7. Virtual disk service (one user).

B. Virtual disk service

Figure 7 shows the set of histograms obtained when one user used virtual disk service for programs development and debugging. The average time of inactivity intervals is about twice that for virtual terminal case. The situation for two users is similar to the situation with virtual terminal service. Figure 6 shows the transmission rate histogram for case of copying one disk to another through the network. We can't account for this result but we think it will be of interest for other colleagues.

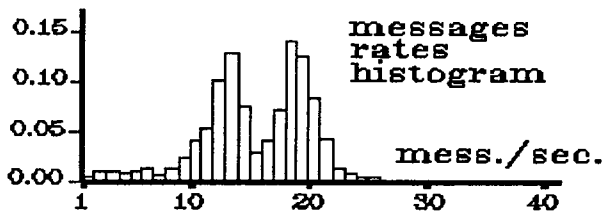

Figure 6. Disk Copy through Network.

CONCLUSIONS

It was very useful for us to have the system for investigations our computer network. We obtained working tool for normal work. We have acquired possibility to make accurate decisions and pleasure to understand it. Any time we need to connect next computer to network we haven't problems. We decide problem on the common sense level but not the level of complex theory. Of course such approach is true only for a little computer networks (a few dozens nodes). Our investigations have shown that for a little networks the flows in lines are far from Puasson type. Our approach can be useful for networks with insufficiently fast lines, when the problem of overloading are vital, but for users with fast communications lines the problem of network investigations don't exist. Meanwhile we hope that our results will be of interest for network experts from academic viewpoint and will be helpful for psychology.