Analysis of Data Communication Aspects of Computer-Based Teaching

Dr. Anatoliy Gordonov
Department of Computer Science, College of Staten Island/City University of New York
2800 Victory Blvd., 1N-215, SI, NY 10314
Tel: (718) 982 2850
E-mail: Gordonov@postbox.csi.cuny.edu

ABSTRACT

The paper represents the results of an ongoing research aimed at investigating the data communications consequences of using network-based electronic classroom systems. We formulated practical recommendations that allow the instructor to optimize the network performance inside a classroom and minimize the influence on the network outside the classroom. These recommendations can be used by any instructor and do not require administrative network privileges.

INTRODUCTION: THE PROBLEM STATEMENT

The Electronic Learning Environments currently available can considerably improve teaching effectiveness. Networked multimedia computers enhance instruction by facilitating the distribution of text, graphics, sound and video images, providing communication links, and allowing continuous monitoring of student work. Benefits of employing networks in the classrooms include student access to sharable resources, enhancing communication between a student and an instructor, between students inside a working group, between working groups, etc. Transmission of information (especially video information) interferes with the local area network users outside of the classroom. It may considerably slow down all network activities, may affect other classrooms, research laboratories, faculty, and administrative offices.

In this paper we are going to consider one of the popular solutions for the [1]electronic classroom – "NetOp® School"[1]. We are going to focus on the analysis of data communication issues related to the employing of NetOp School and will try to give some recommendations that allow the instructor to optimize the network performance inside a classroom and minimize the influence on the network outside the classroom.

NetOp School supports the following operations:
* *Demo*
* *Monitoring*
* *Chat*
* *File Transfer*
* *Remote Control*
* Run Program

Table 1 shows the correlation between the operations mentioned above and various activities of the instructor.

Table 1

#	Instructor's Activities.	NetOp Operations
1	Lecture	Demo
2	Individual Tutorial	Individual Demo, Individual Monitoring Remote Control, Individual Chat
3	Group Tutorial	Group Demo, Group Monitoring Group Chat (Conference), Run Program
4	Class Monitoring	Monitoring
5	Teaching By Example	Demo, File Transfer, Remote Control Run Program, Student's Demo

As we can see, all the instructor's activities fall into the category of synchronous teaching which means that all communicating parties must participate in any action in real-time.

Typically a NetOp classroom is a part of the Local Area Network (Figure 1). Any instructor's action generates additional network traffic. In other words, any action has some influence on the network load and, vise versa, the network load may affect the performance of the NetOp operations.

Depending on LAN features (such as topology, access method, protocols used, hardware and software characteristics), NetOP settings, and the instructor's activities NetOp operations may considerably degrade overall network performance and, as a result, prevent using NetOp.

OPTIMIZING NETWORK PERFORMANCE

There are several levels of optimization that may help avoid communications problems.
* Level 1: Automatic optimization imbedded in the NetOp software. This mode utilizes commonly used and default settings and may require minimum user involvement.
* Level 2: Allows the users to set some parameters manually in order to optimize network performance based on some specific features of the network, computers, and software.
* Level 3: Requires making changes in the network architecture, choosing another media and access method, and/or using a different type of network hardware.

In this paper we are going to consider the first two levels. These levels can be handled by an instructor and do not require network administrative privileges. Nevertheless, in many cases this optimization may enhance both NetOp and overall network performance.

Figure1. Possible Network Configuration
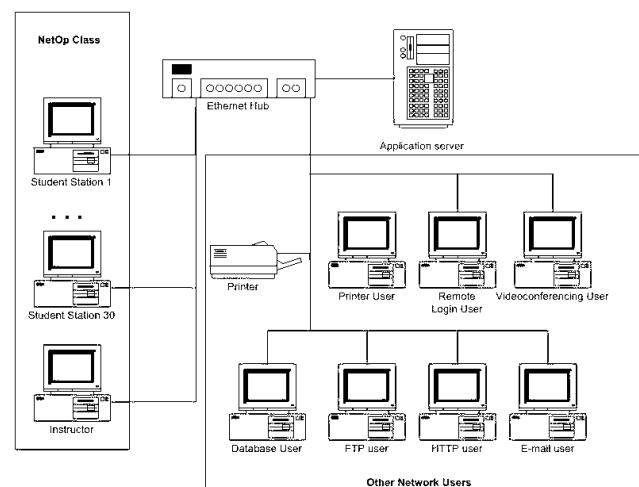
Level 1 Optimization

As it was mentioned above, Level 1 represents automatic optimization and is implemented by the NetOp School software. However, some parameters should be appropriately set to enable this mode. Generally, there are two groups of parameters that can be set by the instructor:

- Teacher station parameters – These parameters define the behavior of both the teacher station and the classroom as a whole. There are several of them that may influence network load:
  - o If TCP (UDP)/IP profile is used for communication (which is the most common case), the maximum allowed packet size may affect the overall network performance. By default, the max packet size is 2600 bytes. Normally, the instructor should only change this setting if the default packet size is not supported by the TCP/IP setup. If the network settings allow only smaller packets, many IP packets will be fragmented which, in turn, will increase network load. In this case, the instructor may try to lower the packet size. If the instructor does not have enough information for setting the maximum packet size explicitly, the automatic option should be set allowing the NetOp software and communication system to handle the situation.
  - o In the Monitor mode the teacher station will be connected to a student computer for a certain amount of time. The default value for the time interval is 15 seconds, which is acceptable for most students' activities. Nevertheless, the instructor should be aware that the traffic generated by monitoring also depends on the students' activities. Students watching full-screen high-quality video clips may create much higher traffic during monitoring as compared to those who work with word processors. In this case, the "waves" of different network loads will be generated. Increasing the time interval in this situation will not only increase monitoring time for the whole class but also prolong the interval with higher network traffic.

Note: NetOP features the Attention mode that allows the instructor to make the students stop working on their computers while listening to the teacher. This is done by locking the screen, keyboard, and mouse on the selected students' computers. On each student computer this mode is indicated by displaying text or bitmap on the student's screen. Either text or bitmap must be saved on each computer, which is done automatically by the NetOp software. Changing from text to bitmap or defining more advanced bitmap does not contribute to the network traffic each time the Attention mode is turned on.

- Student Options

The instructor may change student station settings remotely. Some of these settings may affect the network traffic. Level 1 optimization does not require any changes of the default values. Nevertheless, it is worth checking that the default parameters have been selected and automatic optimization may be provided by NetOp.

The default settings are:
  - o Compression – *Automatic*
  - o Desktop. Optimize screen transfer – *Always*
  - o Desktop. Optimization parameters – *Full Optimization.*

Level 2 Optimization

At this level the instructor may change some default settings in order to minimize the influence on the network performance. As we have considered above, we are going to analyze two groups of parameters: for the teacher station and for student stations.

NetOp supports communication using TCP (UDP)/IP or Internet, IPX, NetBIOS. For each setup there is a communication profile that includes all the necessary information and makes it easy to quickly switch between communication setups.

Let us consider pre-defined profiles:
- TCP (UDP)/IP. NetOp School supports any 100% WinSock 1.1 compatible TCP/IP implementation.
  - o As it was mentioned earlier, in case of necessity the default value of the *maximum packet size* can be changed. The allowed range is 512-5120 bytes. Changing the *maximum packet size* requires knowledge of the TCP/IP settings in the network. Either unreasonable

lowing or increasing the NetOp packet size setting may lead to extra traffic in the network.
  - o When the TCP (UDP)/IP is used, NetOp School provides automatic browsing operations that allow the teacher computer to search for students and vise versa. By default, NetOp assumes that all the PCs are located on the same subnet (IP address of all 1s is used for local broadcast). It limits the number of IP addresses to be used during browsing. If students' PCs belong to different subnets, their IP addresses should be explicitly included in *IP Broadcast List.* At the same time, *Disable Local Subnet Broadcast* option should be chosen. It will prevent local broadcast.
  - o If NetOp School is used through the Internet, the default packet size should be set to 1024 bytes. The *Optimize for the Internet communication* option should be chosen.

- When NetOp School is used in Novell Netware environment, the IPX communication profile must be used. Because the structure of Novell networks may include several sub-networks, three alternatives may be used:
  - o Local network only
  - o User defined list of networks
  - o *Build list of known networks* (will be done automatically by NetOp software)

Being able to choose one of the settings, the instructor cannot change the physical network structure. NetOp allows the user to change the packet size between 512 and 5000 bytes, but this action is beyond the boundaries of the instructor's responsibility. As a result, nothing can be done on level 2 of optimization that may enhance IPX network performance.

- NetBIOS is a popular protocol for various LANs. The settings that the instructor can change will not affect network performance and will not be considered here (similarly to IPX, NetOp allows the user to change the packet size by configuring NETOP.INI file, but we do not recommend the instructor to do it without the network administrator).
- Student Options – As it was mentioned earlier, several student options that may affect network traffic can be set remotely from the teacher station.
  - o Both the keyboard and mouse on a student computer may be controlled either by a student locally or by the instructor remotely. Remote control will introduce extra traffic and should be used only when it is necessary. The following options are available for the keyboard:
  Remote Keyboard – All keystrokes will be sent to a student computer.
  Local Keyboard – Special keystrokes will not be sent to a student computer
    No Keyboard Control
  - o The following options can be set for the mouse:
  Remote Mouse – All the mouse events will be transmitted.
  Local Mouse – Only clicks and drags will be sent.
    No Mouse Control
    Display Student Mouse Movement – Controls transmission of all mouse events from a student station to the instructor
  - o *Compression Level* – Normally, *Automatic* compression should be used. If the classroom activities include intensive transmission (ex: life video), the *High* compression level should be chosen. Being able to transmit data faster, this level also requires better processors to avoid bottleneck while processing compressed images. This level should be used when communication channels are not fast enough (ex: WAN). If the communication channel is fast and there are no high LAN activities unrelated to the NetOp class, the use of *Low* compression is preferable because it will decrease processing time and increase overall performance.
  - o *Optimize screen transfer* – These settings allow the teacher to change some of the student desktop settings that are not necessary for the current session but, when being used, will increase network traffic. Among these settings are: wallpaper, screen saver, animation, etc. All changes will be automatically restored after the end of the session.

- On the student side, by setting communication options the instructor can change the way packets should be sent from the teacher's station to the student's station. The student's computer may accept either broadcast packets sent to a group of students or packets individually addressed to this computer. Individual addressing should be used only on the Internet or when broadcast is not possible. The unjustified use of the individual addressing will lead to increasing the number of transmitted packets and will dramatically low the network performance.

CONCLUSION

The paper represents the results of an ongoing research aimed at investigating the data communications consequences of using network-based electronic classroom systems. We formulated practical recommendations that allow the instructor to optimize the network performance inside a classroom and minimize the influence on the network outside the classroom. These recommendations can be used by any instructor and do not require administrative network privileges. As it was mentioned in the paper, we emphasized three levels of optimization that may be employed to enhance the overall network performance. Two levels – Level 1 that requires minimum instructor involvement and Level 2 that requires changing and setting some of parameters by the instructor – were considered in this paper. Level 3 – that will include network modeling for various topologies and access methods – will constitute the next stage of this research.

ENDNOTES

1   NetOp® is the registered trademark of Danware Data A/S (Denmark).

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