



# Developing Web-Based Computer Lab Through Terminal Services

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## ABSTRACT

*This paper considers IT solution for Web-based teaching. It discusses the issues in developing a computer lab on the Web through Microsoft Terminal Services. We will show how to configure the Terminal Services server and client. We will discuss the hardware, software, and course materials necessary to set up the computer lab server at the instructor's office. By using these tools, a fully functioning Web-based computer lab for the Database Management class is developed for information system majors.*

## 1. INTRODUCTION

In the past, college faculty had to physically meet students in the classroom and lab. This traditional teaching and learning model has many difficulties for a campus with remote teaching sites. The campus where the author is teaching has three teaching sites about a hundred miles away. It is difficult for both instructors and students to have the traditional classroom. As computer technology becomes more and more available to students and instructors, some of the lectures and lab activities can be taught over the Internet. On our campuses, many courses are taught on-line now. However, the class evaluation is quite different between the courses with no lab activities and the lab-based courses. Generally, in the classes with no lab activities, such as English, History, and Education, class evaluation is similar between on-line classes and face-to-face classes. On the other hand, the lab-based courses received many complaints due to difficulties in implementing the lab activities. Some of difficulties encountered by the students are:

- Many students do not have enough computer equipments at home to install the software packages.
- It is much more expensive to purchase individual copies of software than to purchase lab licenses. In our computer science curriculum, almost all of the classes require some lab activities. Many students cannot afford to purchase all the software for these classes. These students have to drive long distance to use the software installed in the university lab.
- Students configure their home computer differently, which causes the problem that some of the lab activities cannot be completed.
- When technical problems occur, it is difficult to get technical support due to lack of detailed information about students' home computers and shortage of technicians in the IT department. It is a nightmare for a small IT department to handle so many different brands of computers at many remote locations.

Due to these difficulties, many of our computer science courses are not on-line at this time. As computer technology advances, some of these new technologies can be useful in developing a Web-based computer lab. One of these technologies is the Terminal Services technology. Starting from July 1998, Microsoft developed a multiple-user version of Windows NT called Terminal Services Edition of NT. Later, Terminal Services was included in Windows 2000 and Windows XP as a basic system administration tool. The Terminal Services technology has the following advantages when creating a Web-based computer lab.

- It allows the students to use low-end home computers to access the lab-activity related power-hungry software at a remote location.

- Students do not have to upgrade their home computers for each of the lab-based courses.
- It will prevent students from wrongly configuring the software and the operating system on their home computers.
- The entire course related software and teaching materials are installed in a central location so that maintenance work is much easier.
- It also allows the instructor to create teaching materials from a remote location without physically sitting in front of the server computer.

All of the above advantages indicate that the Terminal Services technology can make a Web-based computer lab possible. It is not only convenient for the students and instructors, but also convenient for the IT department that is providing technical support for distance education. On the other hand, Terminal Services is not perfect for everything, the following are the problems we have encountered when developing the Web-based lab.

- It requires that each student can access the Internet. The 56K dial-up connection is a bit slower for the graphical based software.
- It does not support non-Windows software. If students' home computers have operating systems such as Macintosh, Terminal Services will not work for them.
- The Terminal Services technology uses the TCP/IP based Remote Display Protocol, which means that if your campus network is created based on the technology such as IPX/SPX or NetBEUI, Terminal Services will not work for your campus.

Now that we have discussed the needs for a Web-based computer lab and the pros and cons of the Terminal Services technology, let us look at the details on implementing the Web-based computer lab with Terminal Services.

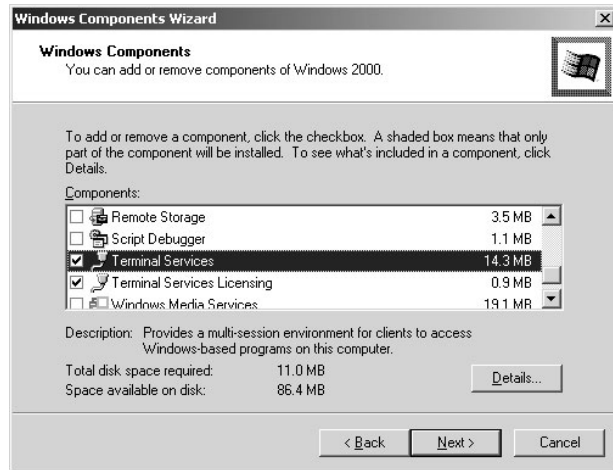
## 2. DEVELOPING A WEB-BASED COMPUTER LAB

Developing a Web-based computer lab consists of two parts, server development and client development. Most of the developing work is done on the server side. On the client side, the required configuration is limited. We will start with the development of the Web-based computer lab on the server side first.

**Server Development:** We recommend that you install Windows 2000 Server on a computer with 10 GB hard drive (depending on how many applications you will install on this computer), Pentium III CPU with 500mhz or better, 128 MB or larger RAM, and a 10/100Mbps network adapter. If you have a powerful office computer, the easiest way is to convert the existing office computer to a Web-based computer lab server to minimize the cost. To the author's knowledge, based on the education price, the cost of Windows 2000 Server is less than \$100. The following steps will lead you through the configuration of the Terminal Services server in the Application Server mode.

1. Installing Support for Terminal Services: Open the Add/Remove Programs applet in the Control Panel; select Add/Remove Windows Components to open Windows Components Wizard; check the box next

Figure 1. Windows Components Wizard



to Terminal Services; follow the wizard and select Application Service Mode and options related to it to complete the configuration. After the Terminal Services server is configured, you can install the application for your class such as SQL Server 2000 or Oracle Developer 6/6i for the database related courses.

2. Creating Terminal Services Set-up Disk for Students: If a student who has Windows XP installed on his/her home computer, you need to create a Setup disk for the student to use Terminal Services. To do so, open Administrative Tools on the Programs menu. Select Terminal Services Client Creator. Choose Terminal Services for 32-bit x86 Windows; then click OK. You need two floppy disks to hold the Setup file.

**Client Development:** If the operating system installed on students' home computers is not Windows XP, they need to run the Setup file created earlier. If their home computers have Windows XP installed, the client side configuration is really easy. To connect to the Terminal Services server, the student just needs to click the Start button; then All Programs, Accessories, Communications, and Remote Desktop Connection as shown in the following Figure.

Figure 2. Remote Desktop Connection in Windows XP

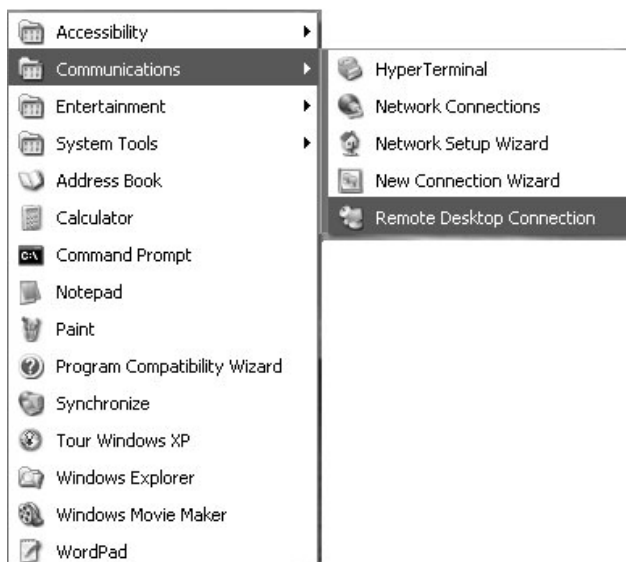
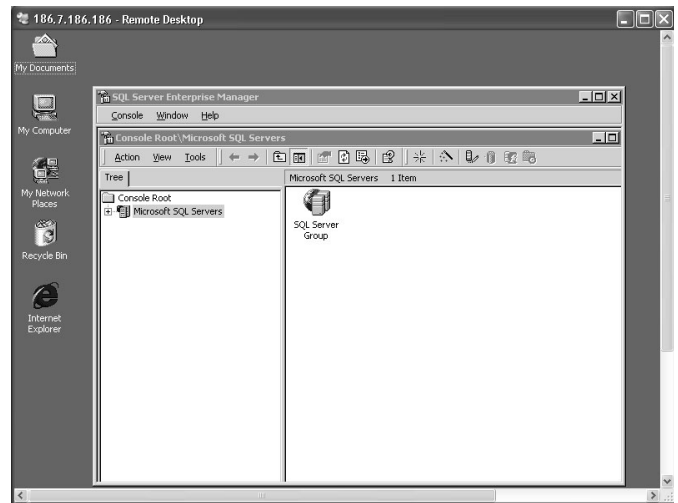


Figure 3. SQL Server 2000 Enterprise Manager Shown on Terminal Services Window



Enter the name or IP address of the computer on which the Terminal Services server is installed. If the configurations on both the client and server are correct, the student should see the remote Login window taking over the full screen. Enter the username and password to log on to the remote computer where the application software is installed. Once the student successfully logs on to the Terminal Services server, (s)he can open the application software to begin the lab activity. The screen that appears on the student's home computer is just like the one in the university computer lab. The following Figure shows that the SQL Server 2000 Enterprise Manager window is opened on a student's home computer through Terminal Services.

For the business use of the application software through Terminal Services, you need to consider the Terminal Services licensing. There are two types of licenses available, Terminal Services Client Access Licenses and Terminal Services Internet Connector Licenses. The cost for the Terminal Services licensing is relatively cheaper than installing an individual copy on each computer. For the academic use of the application software, contact the software vendor for a lab license.

### 3. CONCLUSION

The Terminal Services technology provides a convenient tool for teaching and learning. It allows us to develop a Web-based computer lab for teaching database related courses. A Web-based lab is convenient for computer science instructors and students who are conducting their teaching and learning through distance education. Terminal Services is a popular vehicle for carrying out lab-based courses on line. There are books available to help faculty members develop Web-based computer labs. The book *Mastering Windows 2000 Server* by Mark Minasi (1999) gives a clear and step-by-step instruction on building Terminal Services for Windows 2000 or the earlier versions of the Windows operating system. For those who have Windows XP, the book *Microsoft Windows XP Inside Out* by Ed Bott and Carl Siechert (2001) will help you to create a Windows XP based Terminal Services.

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