

INVESTIGATION OF ONLINE GRADUATE COURSES
AT WORCESTER POLYTECHNIC INSTITUTE

An Interactive Qualifying Project Report:

submitted to the Faculty

of the

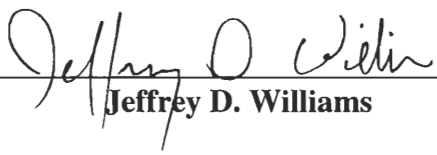
WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

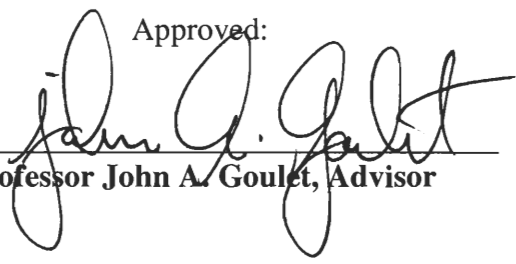
Degree of Bachelor of Science

by


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Approved:

Professor John A. Goulet, Advisor

Foreword

The documentation for this project is concise to say the least. During our exploration into this project, it was determined that there truly does not exist much in the way of useful reference material when it comes to the social aspects of synchronous online learning solutions. Most solutions utilize an asynchronous method to deliver course material therefore the material available was not significantly relevant to our proposed solution.

Furthermore, documentation into the technologies we utilize to overcome the barriers encountered did not in themselves provide any pertinent documentation that gave suggestions, potential solutions, or even technical advice as to the implementation of contained technologies. Our primary source of background information was through typical methods of research: information mining on the Internet and the utilization of various on-campus resources through faculty and staff.

We would like to express our gratitude to the following faculty and staff for their assistance, cooperation and guidance: Jon Bartelson, Sean O'Connor, Pamela Shelley, Professor Diane M. Strong, and especially Chris Cox who allowed us virtually unlimited access to the space and device that brought us to our proposed solution.

We cannot leave out our personal friends whom have been a continual source of physical and intellectual resources, and guidance throughout the project. Their professional experience and input has been the greatest knowledge asset available. Thank you Dean Chambers for enlightening us on certain assumptions regarding synchronous delivery of online material we were operating under. Also, Benjamin Higgins of Dovetail Internet Technologies, LLC who provided access to various software packages, development documentation, network and hosting resources for our edification.

Lastly our project advisor Professor John Goulet, who is one of the most dynamic mentors one could encounter within the academic or non-academic realm. Thank you for taking on this pair of Jeffs.

Introduction

It makes sense that in this day-and-age of technology there should exist a realistic virtual learning environment. Distance learning over the Internet has been prevalent for the past decade – typically offered in areas that are remote or do not have the resources available to physically “host” classes such as areas of Canada, Australia, and upstate New York to name a few.

Worcester Polytechnic Institute has been offering “online” classes for a few years now for several of their courses and programs. The primary method of delivery for these classes is asynchronous. The students download course content, and receive communications and announcements through a static delivery system – a course management tool via a web page. Synchronous tools, “real-time”, such as online chat environments and shared whitespace are available should the students and/or professors decide to utilize them.

Professor Goulet informed us that he instructed a Masters’ of Mathematics for Educators Program but never had the number of participants the class could handle or the amount he desired. The primary cause of this, he believed, was due to distance. Few people are willing to make the commute necessary to attend regularly scheduled classes. Consider driving from Cape Cod, the Berkshires or Mid-New Hampshire to attend a class after work on a regular basis. If there were some way to make the school closer to the participants, then this issue would no longer pose a barrier to enrollment.

At the onset of this project, we were posed with this scenario from Professor Goulet to determine if with current technologies, this was actually possible. He was familiar with the resources available on campus for distance learning but they did not provide for the level of interaction that he felt was required to effectively present course content.

Professor Goulet had witnessed individuals conversing through the Internet utilizing simple devices, a web camera and microphone in real-time and was interested in determining if similar technology could be implemented to increase class enrollment.

Voice over Internet Protocol (VoIP) has been a technology that has been available for several years now. Why wouldn't it be possible to provide a class through a similar mechanism such as a web camera and microphone? This is where the project begins.

Our goal was clear: to determine if there were current online technologies available that would allow for effective synchronous presentation of course material. If such technologies were readily available and could be implemented easily, doing so could help increase the number of participants by increasing the accessibility of Professor Goulet's Masters' of Mathematics for Educators Program. Synchronous online presentation would maintain the social/interactive process of learning. Any solution found could not sacrifice the quality of education one would receive by physically attending the same class with the professor while the lecture was taking place. The one stipulation given to us from Professor Goulet was that the synchronous online course environment could be provided at no or minimal additional expense to the distant student.

Technical Aspects

Before any duplication of effort is undertaken, let it be known that in implementing and testing the components as prescribed hereafter yielded less than a 100% operational solution. The only aspect missing from the IP Multicast conference was the ability to pass audio and video through the server. Data functions such as application sharing, file transfer, and chat worked fine, but one or two details are missing from the configuration of the server that would have allowed us to provide a solution beyond the scope of this project. Those more familiar or who are administrators of the various Microsoft components suggested will probably find this process easier to use and may be able to find out what is missing to make it completely operational.

The solution we provide met the constraints defined as part of the project. The project constraints were:

- No additional cost to the student:

Expenses for attending a synchronous on-line class should only be limited to the fees they pay for the class and any required reading materials. This criteria is met as the client-end software components are either in place, or are available for no cost to the student:

- Microsoft Windows 95/98/ME/NT/2000/XP Operating System.
- Microsoft Internet Explorer 4.01 (or better) or Netscape Navigator x.xx (or better)
- NetMeeting 3.01 (or better) – installed with the operating system or is available for free download at: <http://www.microsoft.com/windows/netmeeting/download>
- Only a *suggested* headset/microphone combination will be the only cost. The user may already have speakers and a microphone, but the combination is suggested as will help prevent possible issues with sending and receiving audio. The unit runs about \$10-15 in most electronics stores, as nothing fancy is required.

- No additional needed resources for the school:

Due to the current hiring freeze at WPI, it is unlikely that any proposed solution that required additional personnel would be approved. Thus it was our goal to ensure that the proposed solution be implemented and managed by current personnel who are familiar with the recommended technologies. This will also help minimize costs to the school for training as well.

- WPI currently has a Windows 2000 Server infrastructure, thus this solution would only add to an existing technology.
- WPI also utilizes Exchange 2000 Server that be augmented.
- The only possible needed component is Exchange 2000 Conferencing Server, if the school does not already possess copies or cannot negotiate this as a component of their Campus License Agreement.

- No cumbersome technology in the classroom:

Any suggested solution cannot significantly detract from a professor's teaching of a class. This means that it has to be intuitive and quick in its setup and operation, as well as in the handling of any minor issues that may occur (basically configuration or connectivity problems).

More complex problems would be similar to an inoperable screen projector or lighting not working or a network outage, events that are beyond the scope of this project.

The suggested solution is no more complex than web surfing. The interface is quite intuitive and the whole solution is a web-based application whose parameters are basically configured once (during setup of the server) and able to be used many times.

The programs and software that comprise the solution are in bold. Main components or functions of those programs are italicized and explained in further detail.

Microsoft Windows 2000 Server (or Advanced Server)

- *Active Directory* allows organizations to centrally manage and share information on network resources as well as users while acting as the central authority for network security. In addition to providing comprehensive directory services to a Windows environment, Active Directory is designed to be a consolidation point for isolating, migrating, centrally managing, and reducing the number of directories that companies require. (<http://www.microsoft.com/windows2000/technologies/directory/ad/default.asp>). This is the Active Directory homepage and contains useful information about the planning and management of the windows AD.
- *Multicast Address Dynamic Client Allocation Protocol (MADCAP) Service* is a Class D DHCP server that is responsible for leasing dynamic addresses for use with IP multicast conferences. Similar to a standard DHCP server, MADCAP allows for management of various zones, resources and lease times. NOTE: The MADCAP server will not interfere with any other DHCP service on the network. Also one server cannot be simultaneously used as a DHCP and a MADCAP server. For instructions on how to install and configure a MADCAP server, refer the help file included in the DHCP program.
- *Certificate Sever* is used to manage and serve digital certificates to ensure identity and security for resources. This is mainly used for secure conferences. There has not been a considerable amount of literature found as to how this is useful in the suggested configuration.
- *Internet Information Service (IIS)* is the server responsible for serving the webpages for a conferencing site. Resources are scheduled, meetings are listed, and users are automatically logged into meetings through active server pages managed through IIS.
- *Site Server Internet Locator Service (ILS)* allows computers to find one another on the Internet. This can be useful for point-to-point conferences and its directory services are a required component of an IP Multicast conference.

Microsoft Exchange 2000 Server

- *Exchange Messaging and Collaboration Services* through various protocols forms the connector between an Exchange post office and Conferencing site. Conferencing Server cannot be installed without NNTP enabled and this option installed.

Microsoft Exchange 2000 Conferencing Server

- *Exchange Conferencing Management Service* is responsible for managing various conferencing resources and sites as well as the virtual resource mailboxes for the same.
- *Exchange Data Conferencing Service*
- *Exchange Video Conferencing Service*
- *Support for Third Party Providers* lets any third party resources such as cameras, video walls, etc be identified and managed by the Conferencing Server, provided an Exchange 2000 snap-in (similar to a driver) exists for such hardware.
- *Exchange T.120 Multipoint Control Unit (MCU)* is the service responsible for sending and receiving data between multiple conference participants using the T.120 protocol. Such data is relegated to binary files and application data.
- *Exchange H.323 Video Conferencing Bridge* allows more than two H.323 (the standard protocol for voice and video over the Internet) clients to hear and see transmitted audio and video. H.323 is a “static point-to-point” protocol meaning that it only works between two established points. The bridge is responsible for making this a “broadcast protocol” meaning that more than one person can receive the audio/video stream.

Component Configuration

This section lists the various configurations of the components for the suggested solution. Keep in mind that this was done in a test, bare network with no active connection to the Internet. Thus there may be some components that may need or not need to be installed based on your organizational requirements.

The following is the key used to denote specific components:

Symbol Meaning

- Denotes that the component has little or no effect on the solution.
- + Denotes a component that is suggested for installation or would be of some use.
- * Denotes a mandatory or highly important component.
- (on) Denotes a parent component, thus subordinate components are installed.
- (off) Denotes that the parent component is not installed.
- () Any other notes in parenthesis indicate a special instruction or configuration.

Windows 2000 Server Components

These can be set at time of OS installation or through the Control Panel → Add/Remove Programs → Add/Remove Windows Components upon completion of OS installation.

Accessories and Utilities (On – although most not important)

- Accessibility Wizard
- Accessories
 - Calculator
 - Character Map
 - Desktop Wallpaper
 - Document Templates
 - Mouse Pointers
 - Object Packager
 - Paint
 - WordPad

–Communications

Chat

HyperTerminal

Phone Dialer

–Games

Freecell

Minesweeper

Pinball

Solitaire

–Multimedia

CD Player

Media Player

Sample Sounds

Sound Recorder

Utopia Sound Scheme

Volume Control

***Certificate Services (On)**

Certificate Services CA

Certificate Services Web Enrollment Support

Indexing Service (On)

Internet Information Service (On)

*Common Files

+Documentation

+File Transfer Protocol (FTP) Server

+Front Page 2000 Server Extensions

+Internet Information Services Snap-In

+Internet Services Manager (HTML)

*NNTP Service

- *SMTP Service
- +Visual InterDev RAD Remote Deployment Support
- *World Wide Web Server

Management and Monitoring Tools (On)

- Connection Manager Components
- Network Monitor Tools
- Simple Network Management Protocol

Message Queuing Services (On)

Networking Services (On)

- +COM Internet Services Proxy
- *Domain Name System (DNS)
- *Dynamic Host Configuration Protocol (DHCP)
- +Internet Authentication Service
- +QoS Admission Control Service
- Simple TCP/IP Services
- *Site Server ILS Services
- Windows Internet Name Service (WINS)

Other Network File and Print Services (On)

- File Services for Macintosh
- Print Services for Macintosh
- Print Services for Unix

Remote Installation Services (Off)

Remote Storage (Off)

Script Debugger (On)

Terminal Services (Off)

- Client Creator Files
- Enable Terminal Services

Terminal Services Licensing (Off)

Windows Media Services (Off)

- Windows Media Services
- Windows Media Services Admin

Exchange 2000 Enterprise Server Components

Microsoft Exchange 2000 (Custom)

- Microsoft Exchange Messaging and Collaboration Services (Install)
 - Microsoft Exchange MSMail Connector (Off)
 - Microsoft Exchange Connector for Lotus cc:Mail (Off)
 - Microsoft Exchange Connector for Lotus Notes (Off)
 - Microsoft Exchange Connector for Novell GroupWise (Off)
 - Microsoft Exchange Key Management Service (Off)
- Microsoft Exchange System Management Tools (Install)
 - Microsoft Exchange 5.5 Administrator (Off)
- Microsoft Exchange Chat Service (Install)
- Microsoft Exchange Instant Messaging Service (Install)

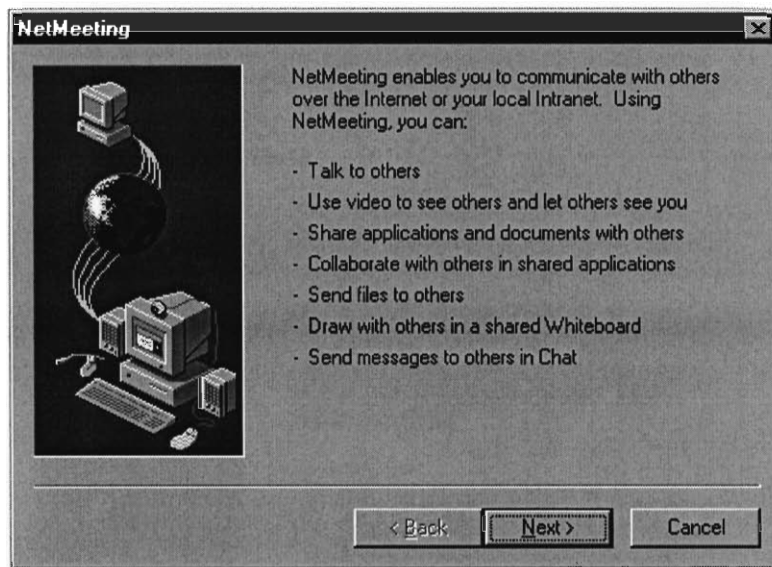
Exchange 2000 Conferencing Server Components

- Conference Management Service (Install component on hard disk)
- T.120 MCU/H.323 Conference Bridge (Install component on hard disk)
- Conference Access Web Pages (Install component on hard disk)
- Conferencing Manager (Install component on hard disk)

Netmeeting Initial Setup

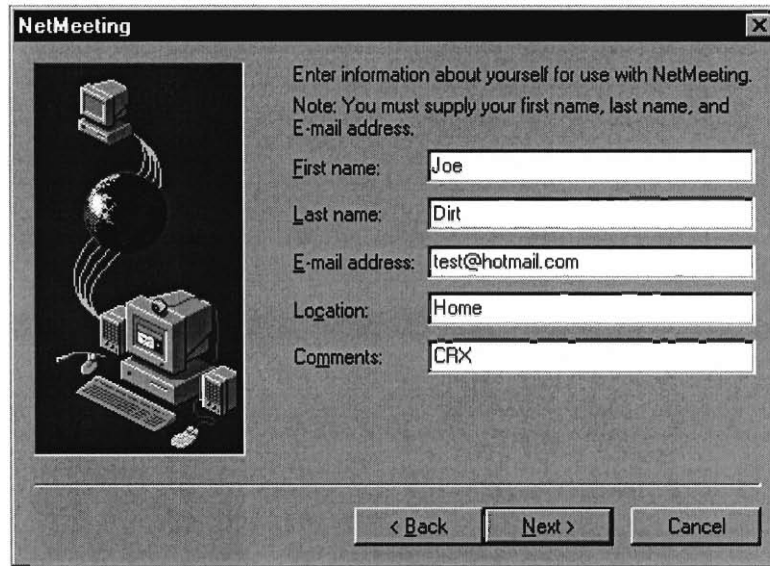
This procedure is intended to navigate you through the first-time setup wizard for the NetMeeting program. This will be triggered either by manually running NetMeeting or automatically through attending an online conference. This procedure assumes that you have a working soundcard installed in your computer, and that you have speakers and a microphone connected to that soundcard. Once that is so, you may continue with the following steps:

1. Introduction Screen. The following introduction screen will appear:



Simply click Next.

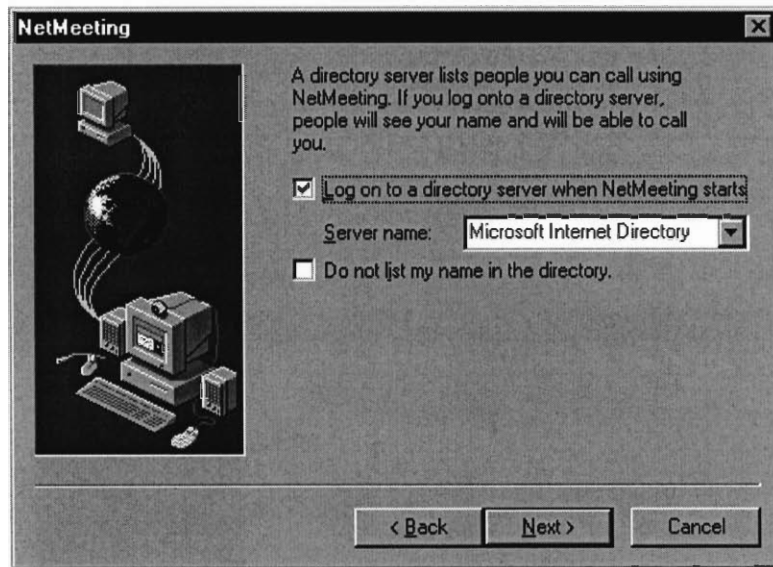
2. Information Screen. Enter your information on the following screen:



The image shows a screenshot of the NetMeeting 'Information' dialog box. The window title is 'NetMeeting'. On the left is a graphic of a globe with computer icons. The main text reads: 'Enter information about yourself for use with NetMeeting. Note: You must supply your first name, last name, and E-mail address.' Below this are five input fields: 'First name:' with 'Joe', 'Last name:' with 'Dirt', 'E-mail address:' with 'test@hotmail.com', 'Location:' with 'Home', and 'Comments:' with 'CRX'. At the bottom are three buttons: '< Back', 'Next >', and 'Cancel'.

Then click Next

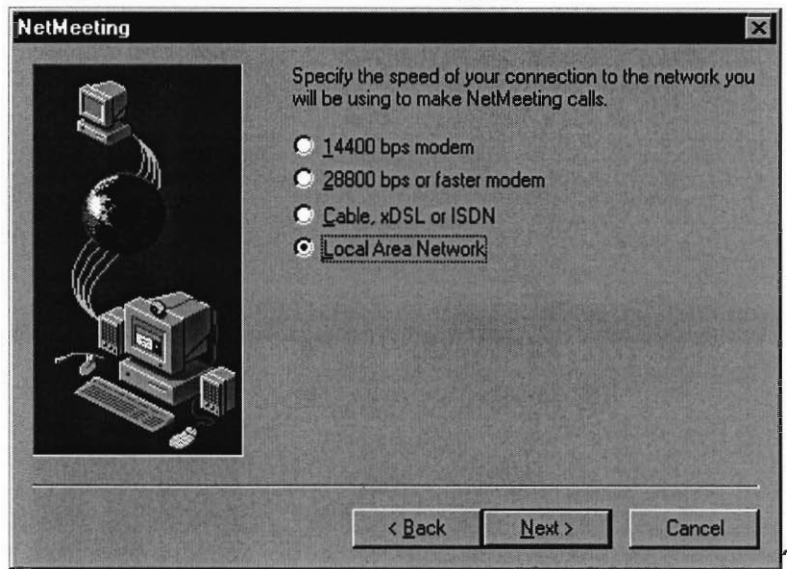
3. Directory Server Screen. You can either choose to login to a directory server automatically (top box checked) or not (unchecked). A directory server is a way for computers to see one another on the Internet. Chances are you will know the IP address or domain name of the machine that is hosting the meeting, so the Microsoft Internet Directory option is not always preferred. Most likely your organization is running a directory server, so your administrator will give you the IP address or domain name of the server. Enter the information below in the server name box.



You may choose to list your computer in the directory or not. If you are attending web-based conferences or are simply using NetMeeting for one on one communications, you will most likely not need to enable this option.

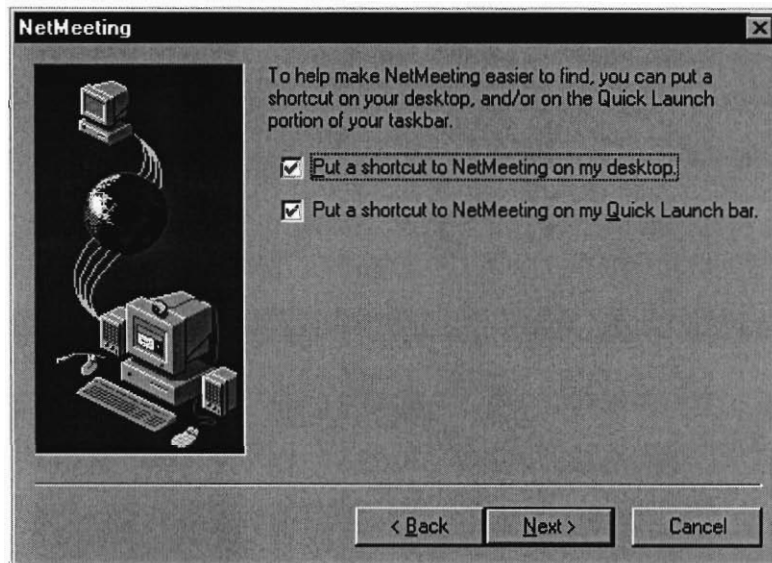
Click Next.

4. Network Configuration Screen. Select the speed of the connection that is used to make calls and participate in meetings. This will allow NetMeeting to select audio and video options that best suit the selected connection speed.



Click Next.

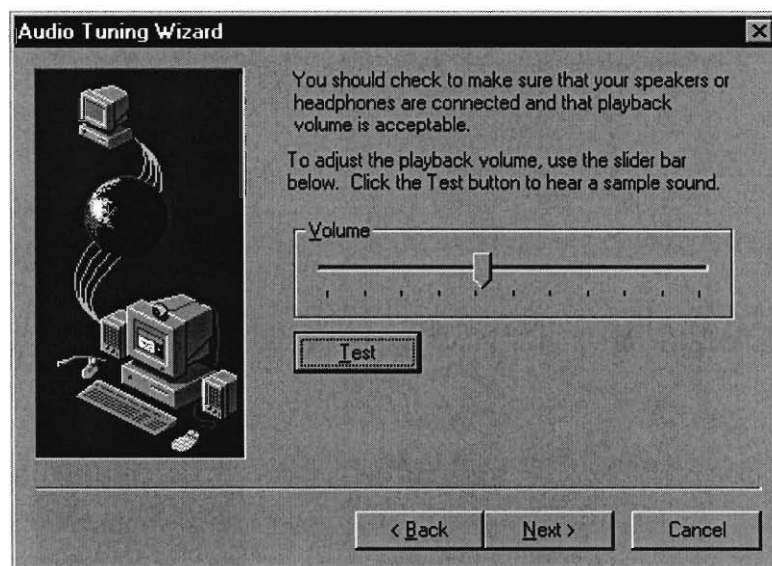
5. Shortcut Screen. The next options will simply make NetMeeting easier to run manually by either placing an icon on your desktop and/or in the Quick Launch bar next to the start button.



Once you select you options, click Next two times. The next screen merely tells you that it is about to configure your audio settings. You may be prompted to select the wave device for

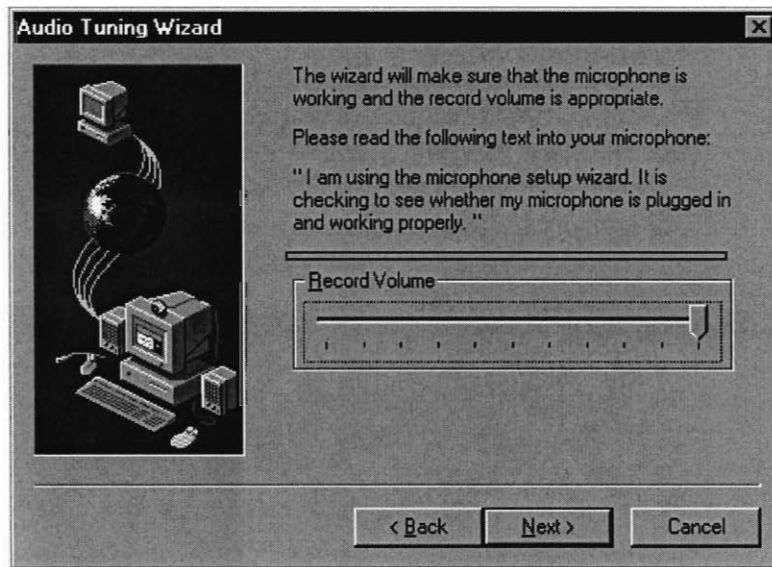
audio. This usually happens when there is more than one sound capable card in your PC, such as a modem. Simply choose the one that represents the soundcard that your microphones and speakers are connected to.

6. Speaker Level Screen. Click on the Test button to start an audio test. This will be how loud received audio will play. NOTE: If you do not have a headphone/microphone combination, you may want to keep the volume low. This will prevent “echo” or the retransmission of received audio over the microphone.



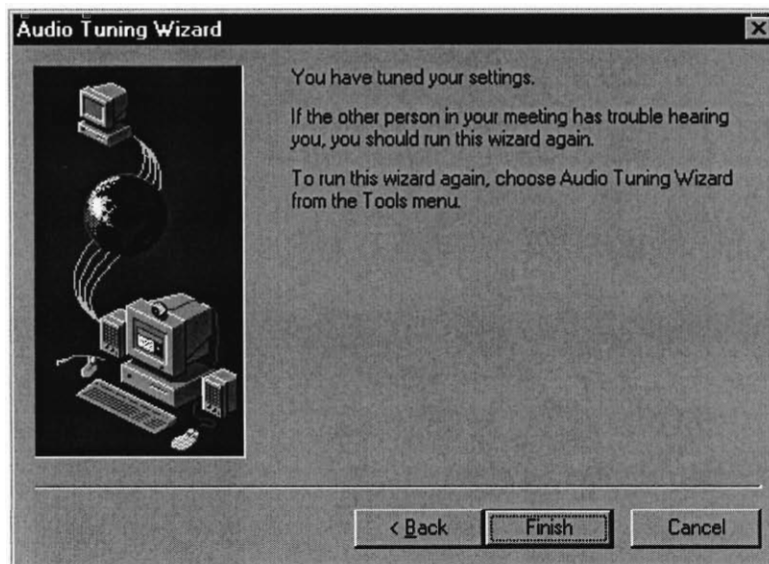
Click Next.

7. Microphone Level Screen. The following screen will test the microphone recording level. NOTE: If you do not have a headphone/ microphone combination, you will have to keep the microphone away from the speakers. This will help prevent the loud “shrieking” or feedback noise often heard when a microphone is placed too close to speakers.



Once the audio level is adjusted to your liking, click Next.

8. Final Screen. The next screen contains information on where to change the audio settings if ever needed.



At this point, you have completed the initial setup for NetMeeting and are ready to host or join meetings or participate in IP Multicasts. Refer to the following procedure to learn the basics of hosting and connecting to meetings.

Basic NetMeeting Operation

This procedure is intended to show how to host and call meetings using NetMeeting. Both placing and receiving calls occur from the NetMeeting Main Window:



Part 1 below is used to create (host) meetings.

Part 2 is used to call (join) a created meeting.

Part 3 is used when a meeting is created and users have called.

Part 1 – To Host a Meeting:

Click Call → Host Meeting. The following window will appear:

Host a Meeting ? X

Hosting a meeting starts a meeting on your computer and lets you define some properties for the meeting. The meeting will remain active until you hang up.

Meeting Settings

Meeting Name:

Meeting Password:

Require security for this meeting (data only)

Only you can accept incoming calls

Only you can place otgoing calls

Meeting Tools

Only you can start these meeting tools:

Sharing Chat

Whiteboard File Transfer

Here are the components and their functions:

Component

Function

Meeting Name

Arbitrary name of the meeting that joining users will need to enter when calling.

Meeting Password

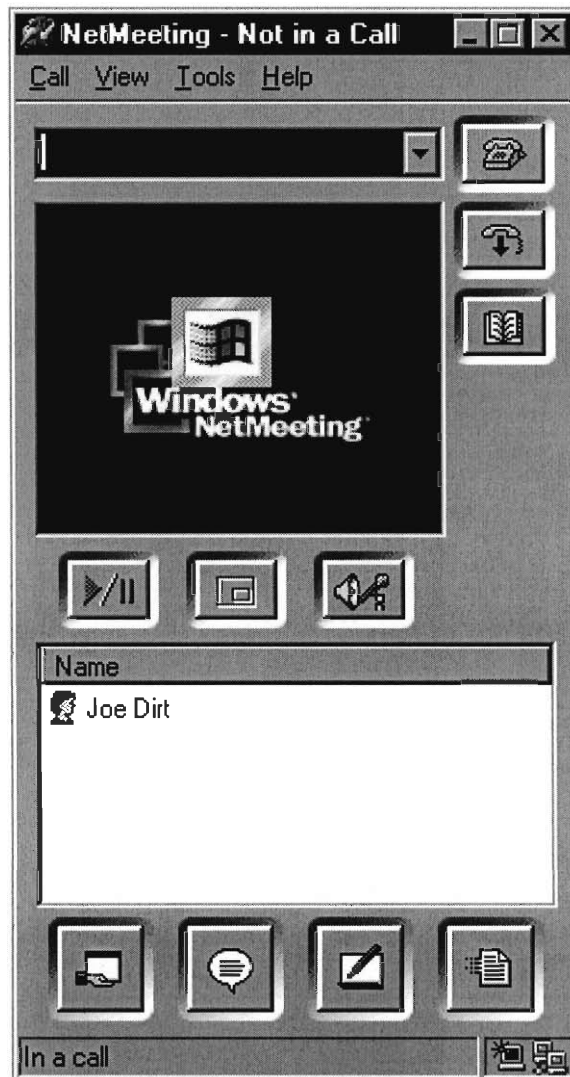
Arbitrary password to ensure only those who know it will be able to join the meeting.

Require security

If this is enabled, only data sharing and chat will be enabled. This is due to the fact that audio and video streams are not encrypted. (Suggested - unchecked)

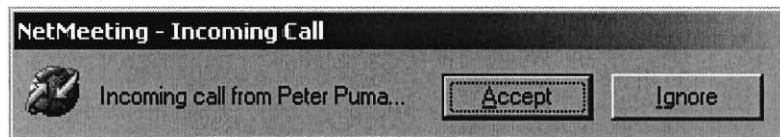
- Accept incoming calls Selecting this means that you are the only one who can answer calls to those looking to join the meeting. (Suggested – checked)
- Place outgoing calls Selecting this means that participants will not be able to invite other people. (Suggested – checked)
- Meeting Tools Dictates who can open shared applications. If disabled, applications may accidentally be opened and seen by all. (Suggested – all checked)

Once the options are selected, click OK. The following screen will appear:



Notice that there is a name listed under the Name section and the bottom left now indicates that this PC is ready to receive calls.

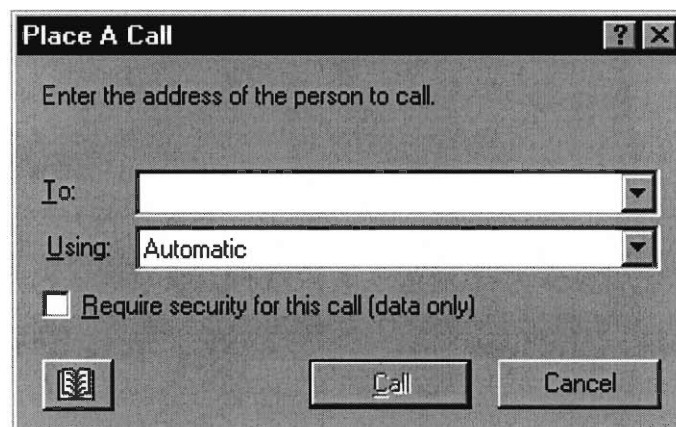
When people are ready to join, they will follow step 2 below in order to call your PC. When they have entered in the correct meeting name and passwords the following screen will appear:



If you would like this user to join the meeting, click Accept, if not, click Ignore.


Part 2 – To Join a Meeting:

Click Call → New Call. The following window will appear:



Enter the IP address or domain name of the PC given to you by the administrator, then click Call. You have the option of trying to find the PC using a directory server (by using the phonebook on the bottom left of the window). It is not suggested that this be tried as it may take considerably longer and may not succeed if you and the PC hosting the meeting are on different servers or if you do not know the name of the server the host PC is logged into.

Once the information is correct, and a call is placed, if there is a password that has been setup by the host, you will need to enter it here.

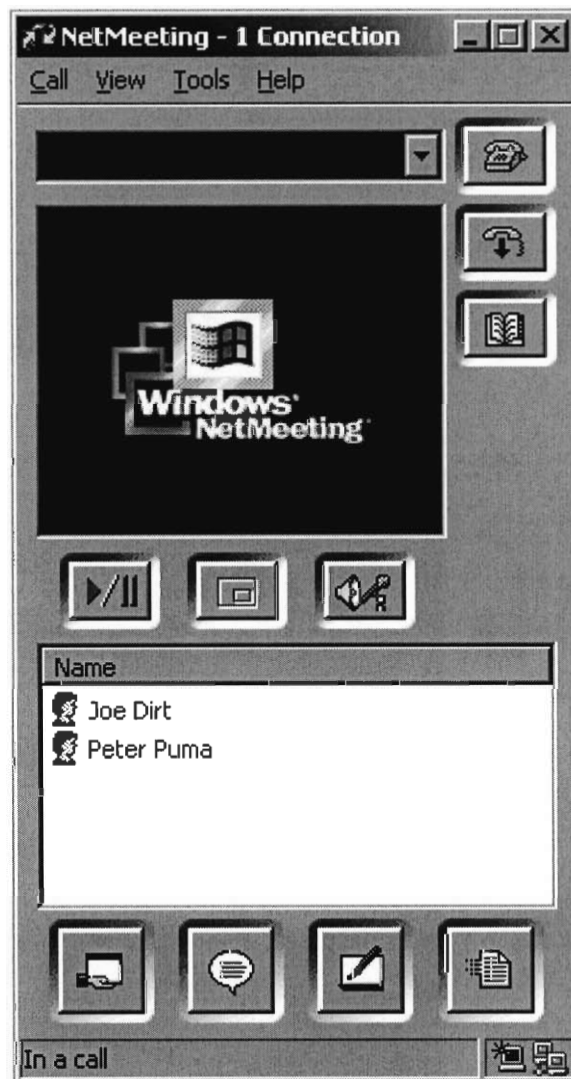


The image shows a standard Windows-style dialog box titled "Enter Password". The title bar includes a question mark icon and a close button (X). The main text inside the dialog reads "You must supply a password to join this meeting". Below this text are two input fields. The first field is labeled "Meeting:" and contains the text "Test321". The second field is labeled "Password:" and contains seven asterisks "xxxxxxx". At the bottom of the dialog are two buttons: "OK" and "Cancel".

Click OK when the password is entered.

Part 3 – Meeting Time:

Once the meeting has been created and users start to call, the NetMeeting window will look something like the following (the names will most likely be different):

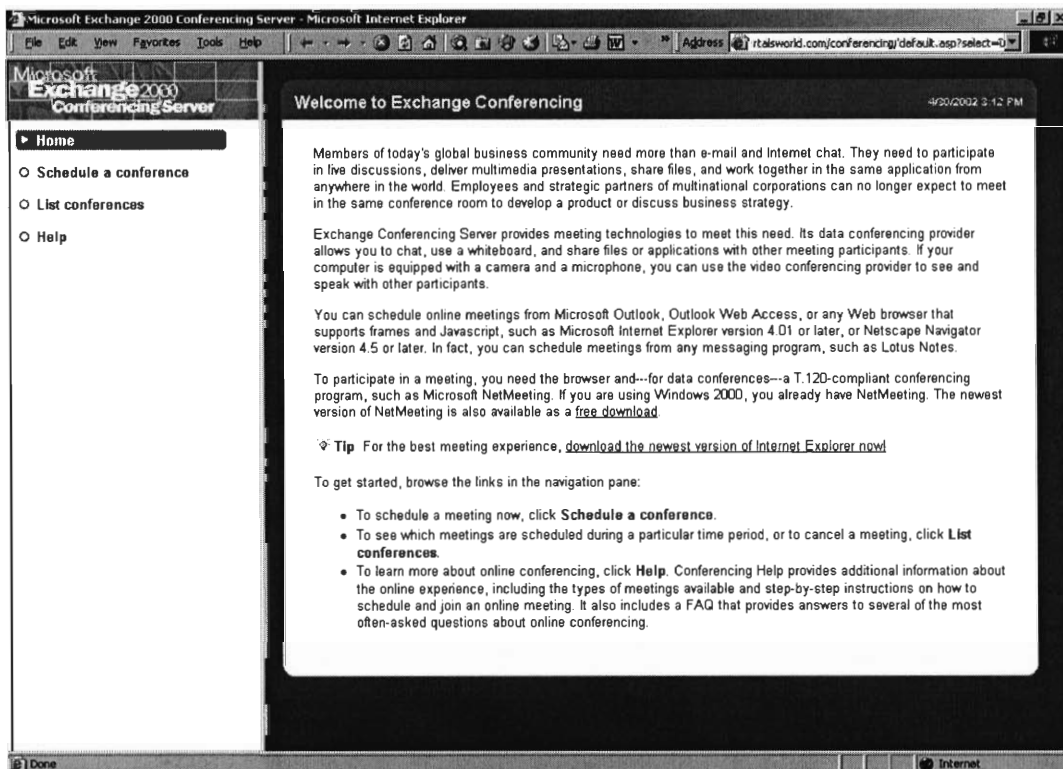


At this time, refer to the NetMeeting Help Topics for further information regarding data, audio, video, chat, and application sharing options available for use.

Microsoft Exchange 2000 Conferencing Server Interface

The following demonstrates the Conferencing interface. The interface is responsible for scheduling, listing, and attending conferences and contains the ActiveX scripts for NetMeeting.

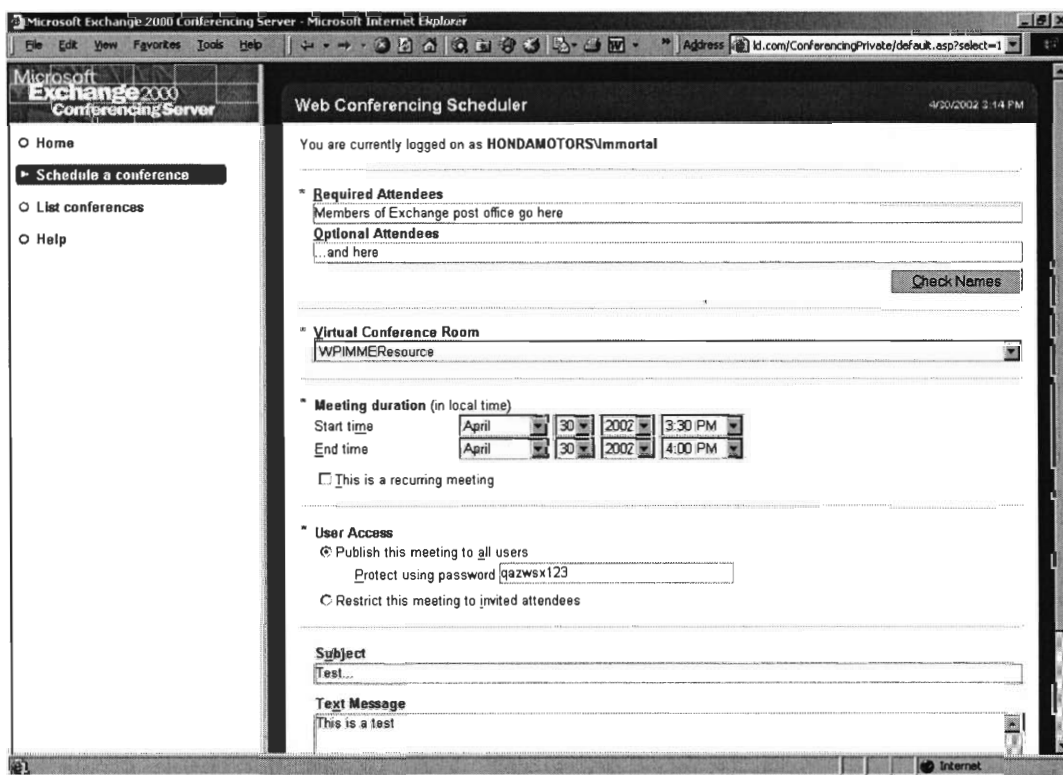
1. Opening Screen. This is the main screen (for Conferencing Server SP2) that is displayed when a user enters in the URL of the conferencing server in the format: `http://<FQDN>/conferencing` where <FQDN> stands for the Fully Qualified Domain Name of the server (IP addresses are allowed as well). For example the server `http://odyssey.hondamotors.immortalsworld.com/conferencing` was used as a test server. The `/conferencing` prompts IIS to load the conferencing pages that are installed as part of the Conferencing Server setup.



This document will cover the following:

- Scheduling a conference (2)
- Listing conferences (3)
- Joining conferences (4-6)

2. Scheduling Screen. The user requires a valid account name in the domain of which the conferencing server resides. When they click on the “Schedule a conference” link from the main page, and then click on the “Log On” link.



Once the user has logged in, the domain and username will appear as “You are currently logged on as” <DOMAINNAME>\<username>. The login process is necessary before a user can schedule a conference.

The following lists the options that can be set from this screen:

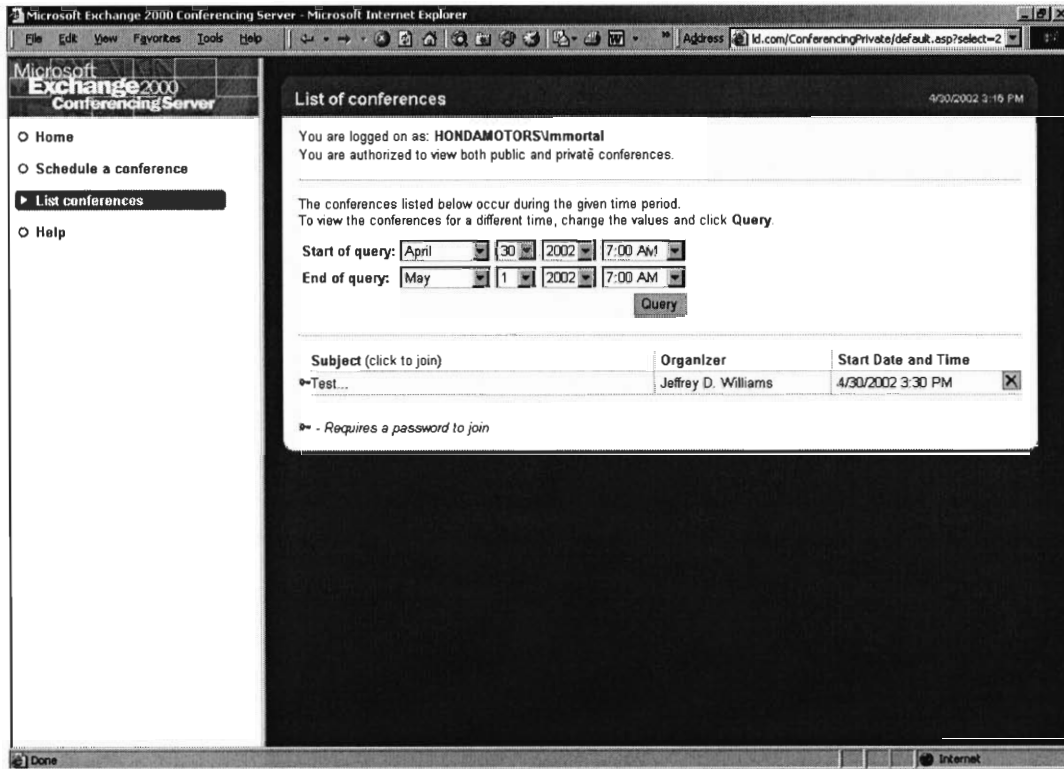
<u>Option</u>	<u>Function</u>
Required Attendees	Sends e-mail to each of the specified users informing them that they are required attendees. If they accept, their Outlook calendar (if enabled) is automatically filled for that time and a confirmation message is sent to the conference organizer.
Optional Attendees	Same as above, but the users will not be informed that they are required attendees.
Virtual Conference Room	The name of the resource to be utilized - either hardware such as video conferencing equipment or software below.
Meeting Duration	Simply set the start and end time of the conference.
User Access	Allows some degree of security by prompting users for a password before they can join the conference.
Subject	Title, what the meeting is about or involves.
Text Message	More in depth information (optional) about the conference.

NOTE: Specifying required and optional attendees is not mandatory and is only used for Outlook scheduling.

Once the organizer is satisfied with their options, simply click the Send button. If there are any problems, such as double booking a resource for the same time, the user will need to change their options. Upon successful scheduling, the user will be informed that the resources for the conference have been successfully booked.

At this time a screen will appear which allows the scheduler to either join the conference or view a listing of scheduled conferences.

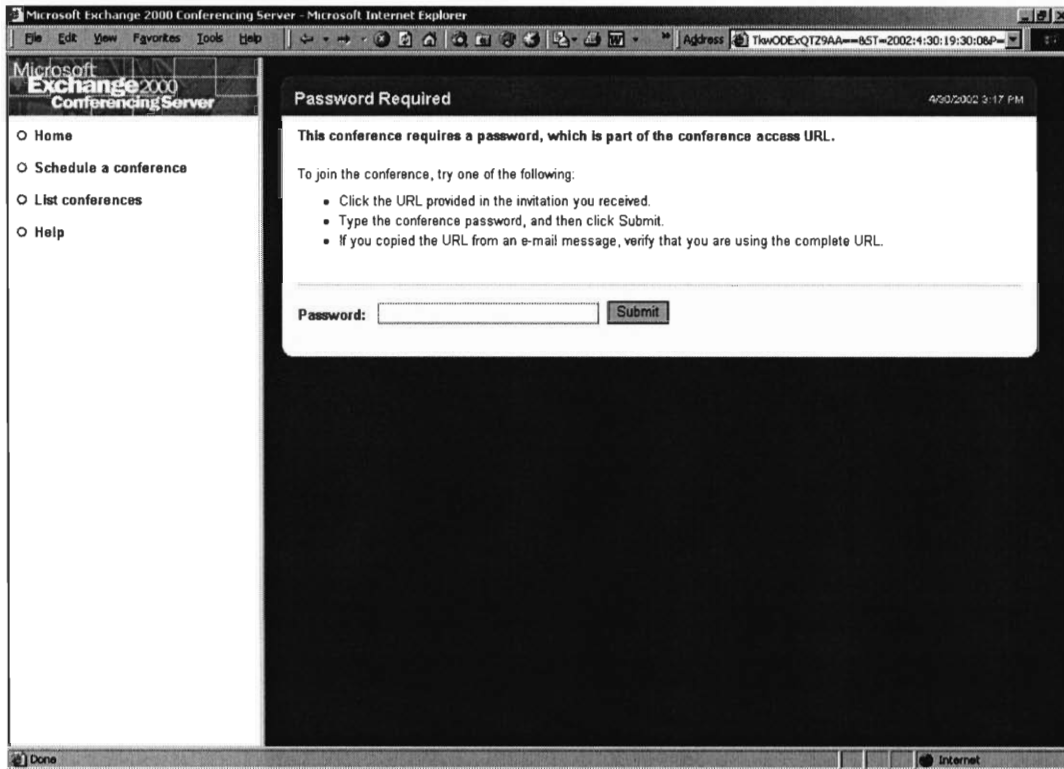
3. Conference List Screen. This screen allows users to see scheduled conferences for a given time (query able) and the organizers.



Clicking a link in the Subject section will take a user to that conference. Clicking on the Organizer for a conference will automatically address e-mail to the conference organizer (using a MAPI compliant e-mail program such as Outlook (all versions), Lotus cc:Mail 8 and above, etc).

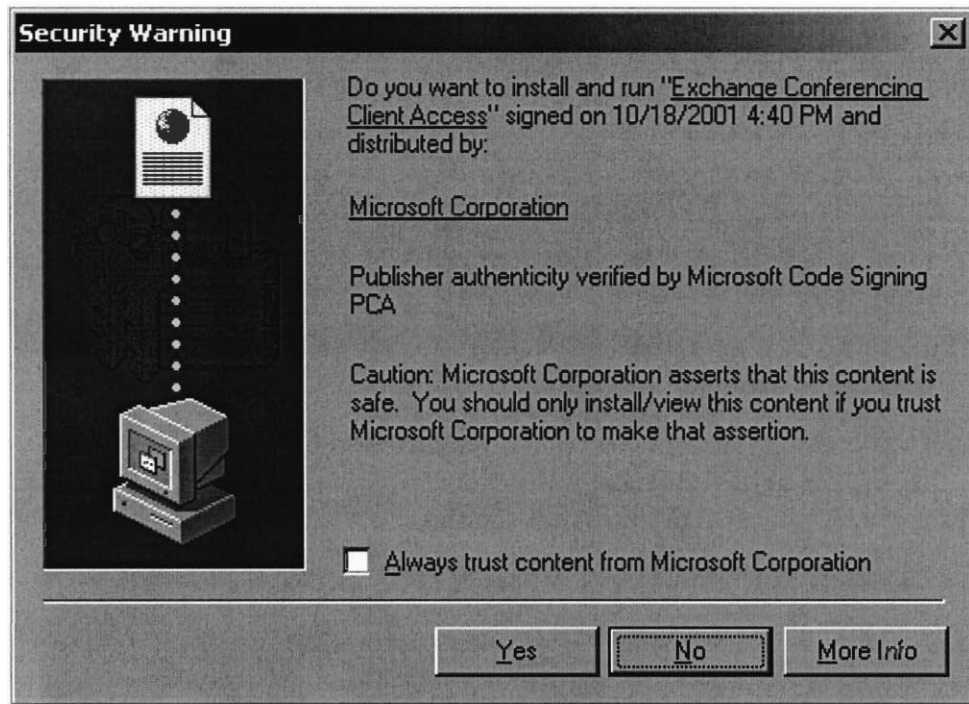
The "X" at the far right appears only for the conference organizer. This allows them to clear or cancel a conference.

4. Password Screen. If a user clicks on a link for a conference that has a password, they will be prompted to enter it in the following screen:



If the password is incorrect, a pop-up window will appear informing them of their incorrect entry and to try again. If the password is correct, the conference will be joined. NOTE: intrusion lockout is not one of the features of the service. Thus a user could try a number of passwords until they find the correct one. It is suggested that passwords contain a combination of alpha, numeric, and symbol characters.

5. ActiveX Install Screen. The following screen will appear if the *NMClient Class*, an ActiveX Control is not installed on the user's computer or account:

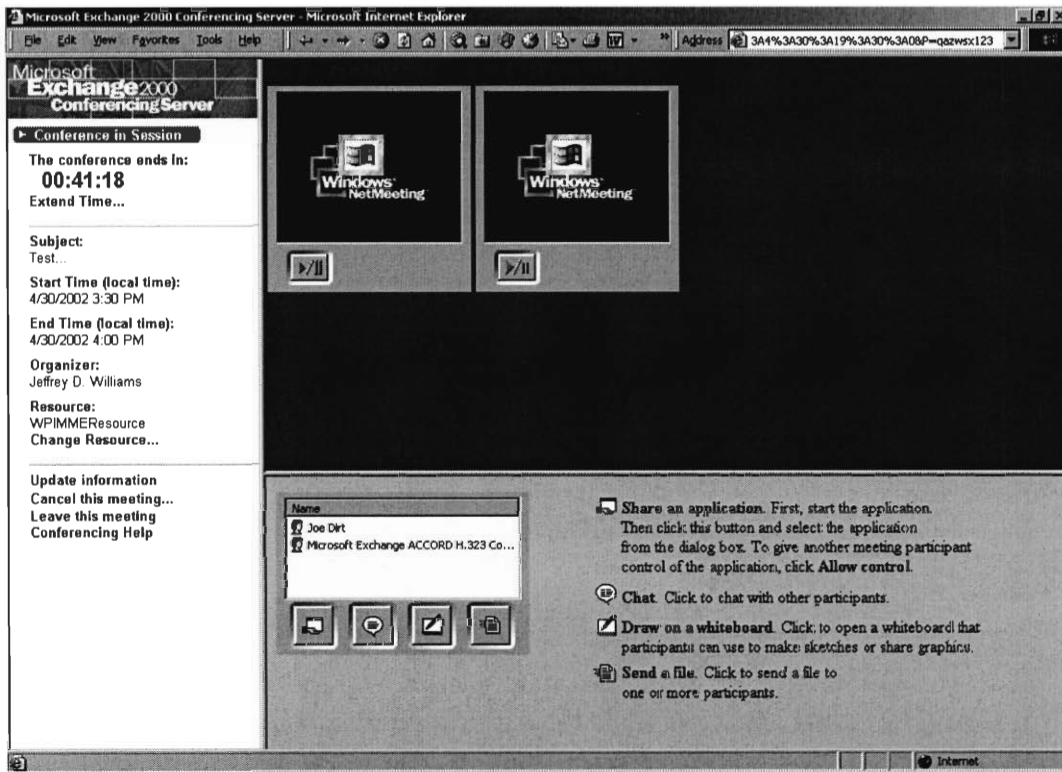


If the user accepts this certificate, downloading of the control will commence and the user will then successfully join the meeting. If user does not accept the certificate the following message will appear:

An audio video connection to the Exchange Conferencing Server could not be automatically established. Verify that your browser security settings permit the download of ActiveX controls.

The user will not be able to join the meeting until the control has been downloaded and installed.

6. Conferencing Screen. This is how an active conference appears:



Notice the similarities between this interface and the NetMeeting interface. The downloaded ActiveX control runs NetMeeting in a web interface. Operation of this interface is the same what was shown in previous section. Users can transfer files, share applications, etc in this interface as they can just using NetMeeting.

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– Microsoft Developer's Network Library. (2002)

http://www.microsoft.com/uk/servers/downloads/Active_Directory_Integration.doc
– Design Considerations for Windows 2000 Active Directory with Exchange 2000 Server in Mind

Technical Information and White Pages (recommended background reading)

http://www.microsoft.com/exchange/evaluation/overview/ECS_Datasheet.doc
– Microsoft Exchange 2000 Conferencing Server Datasheet. (2001)

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<http://www.microsoft.com/exchange/techinfo/productdoc/2000/conceptspplanning.chm>
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Other Reading

<http://www.lotus.com/products/learnspace.nsf/frame?openform&/products/learnspace.nsf/allpublic/CB3A67F9F86A93898525679900531DC7>

– Primer on the T.120 Series Standard

<http://www.itu.int/rec/recommendation.asp?type=folders&lang=e&parent=T-REC-H.323>

– International Telecommunications Union information regarding the H.323 protocol

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