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A unified messaging system on the Internet

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Abstract

Messaging is an essential aspect of human communication and with the advance in technology and the merging technologies in telecommunications and computers, unified messaging has become very popular. Products that can unify email, voice mail and facsimile are reaching the market. These products will allow users to save time and money and provide them with an efficient way to manage different forms of information. This paper proposes a unified messaging system, UniMail, which is hosted on a PC platform. Access by client is primarily via the web browser with alternative access to voice messages, emails and fax messages by the telephone. A comparison between UniMail and existing unified messaging solutions is also made to provide an insight into the relative strengths of this new system. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Internet; Unified messaging system; Internet telephony; Email; Fax communication

1. Introduction

Broadly speaking, unified messaging can be defined as a system that allows users access to all of their messages, regardless of location, communication device or the type of connection used. Unified messaging is a simple, yet extremely powerful concept. An individual's communication environment is constantly changing. The amount of information and the respective sources are constantly increasing. Users should be able to listen to voice messages, view documents or faxes on screen, send faxes, create emails and manage information in the manner most appropriate to their communications universe, be it in the office, at home or on the road. Unified messaging enables users to see, hear, send, store or retrieve all of their messages with whatever tool is more conveniently available. These tools include the telephone, desktop, personal computer or laptop.

It is no surprise that unified messaging saves time and money. The fewer devices you need to access to send, retrieve and store messages, the more efficient you can be. The power of the Internet is limitless. With the Internet now at our fingertips, unified messaging takes another leap to improve communications. Imagine how much more effective your message becomes when it is heard rather than read.

Information technology research firm Ovum [1,2] released a report that finds *unified messaging*, the technology that allows access to email, voice mail, faxes, and other information from a single tool, will grow strongly and eventually replace separate email, voice mail and fax systems.

An Internet-based personal communications manager allows people to manage calls and messages from their PC. Any place where that they can set up and dial in can become their virtual office. Business communication is now empowered by the Internet with applications transforming the computer screen into a virtual communications centre. With the click of a mouse, users can listen to voice mail messages, place calls, manage speed dial lists and change telephone numbers and availability.

This paper proposes a unified messaging solution, the UniMail, which is built on an NT PC platform. UniMail is targeted at small and medium enterprises whereby their employees, even when they are on the move, can access their email, fax and phone messages via a web browser. Basic features such as listening to email, voice and Internet fax messages are also accessible via the telephone.

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2. System architecture

Fig. 1 shows the basic entities which constitute the

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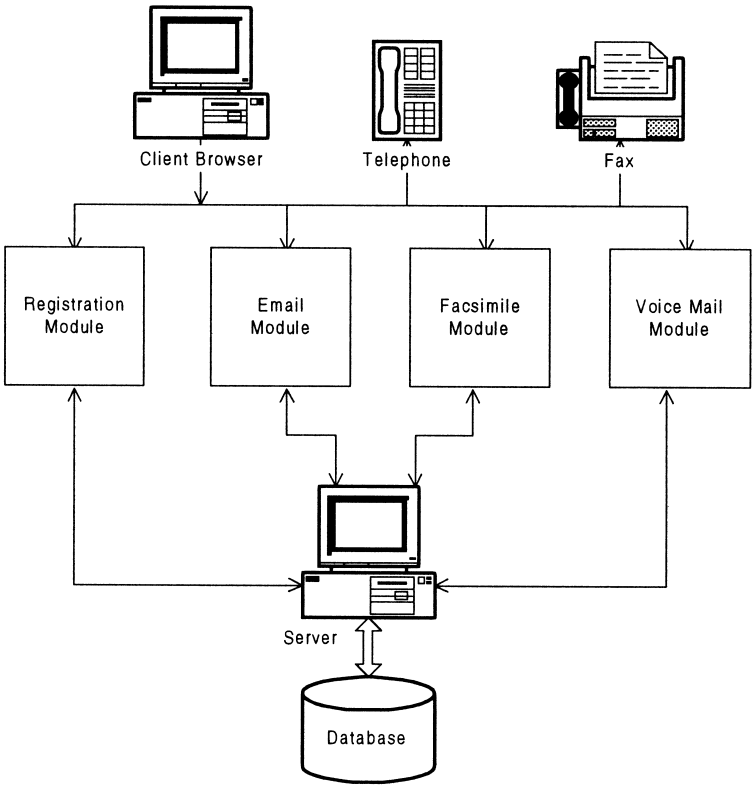

Fig. 1. Architecture for a typical unified messaging system.

architecture of a unified messaging system. The entities are discussed below.

2.1. Registration

The architecture provides for user registration for the unified messaging system. This is an important feature of the architecture because the information gathered from the user at the time of registration is required to implement the services provided by the system. Hence, it is imperative that error-free registration should be carried out and any potential problems identified and solved at this stage.

2.2. Electronic mail

The architecture must resolve the issues on how email can be sent, received and stored. Moreover, due to the features expected from a unified messaging system, the email aspect of the system must provide the user with more than normal text-based email.

2.3. Voice mail

Voice mail is typically provided by the phone system. The architecture therefore, analyses the manner in which the phone system and the Internet can be combined to provide a unified messaging solution.

2.4. Facsimile

Facsimile services are usually provided by the phone system. The architecture addresses the transmission and retrieval of fax messages. The user should be able to retrieve and send faxes from the fax machine as well as from the Internet using a browser.

2.5. Database

The message database architecture and design are extremely important. The database should allow fast and efficient retrieval of messages. It should also be able to store various types of data. Moreover, the design of the database should be extensible and robust.

3. System implementation

The UniMail is designed based on a client–server architecture. This follows from the fact that the Internet is used as a cheap mode of transmission and retrieval of messages. The UniMail system is hosted on a Windows NT [3] server that allows the full benefits of the architecture to be realized. Internet Information Server 4.0 [4] was used as the web and SMTP [5] server. Active Server Pages [6] and Active Data Objects [7] were utilized for providing the necessary programming logic for the entire application. SQL Server 6.5 [8] hosted the message database and Visual Basic 5.0

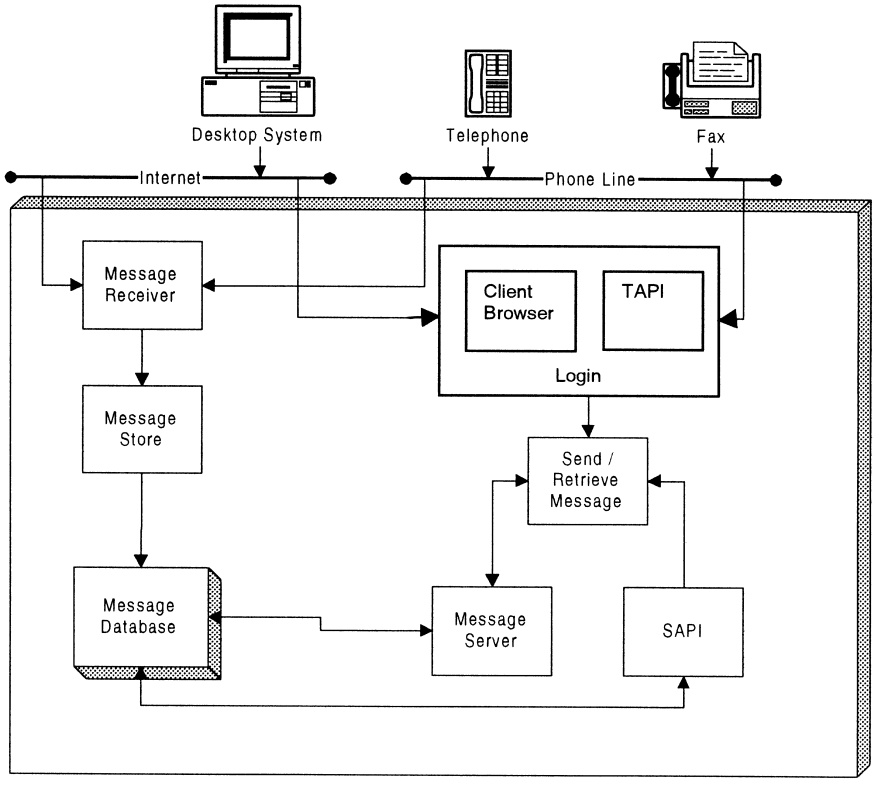

Fig. 2. Block diagram of UniMail implementation.

was used to develop the text-to-speech application and the fax server application. Perl [9,10] was used to provide file upload utility. The design of the web pages was done using Microsoft FrontPage 98.

The block diagram for the implementation of the architecture set out in Fig. 1 is shown in Fig. 2. The modules are as follows:

- Desktop client with browser;
- Message server;
- Message database;
- Login module;
- Message receiver module;
- Message store module;
- Send/retrieve message module;
- SAPI module.

A brief description of the various modules is given as follows:

3.1. Desktop client with browser

The user enters personal information like name and address This information is stored inside the message database. User is required to choose a unique login name and password, and supplied information such as email address, phone number and facsimile number. The email address needs to be a valid email address to prevent misuse of the system and to provide an effective means of communicating with the user regarding important information.

3.2. Message server

The message server doubles up as a web server to provide an interface to the client browser as well as being responsible for transferring the information entered by the user to the system database.

3.3. Message database

The database is the centre of all transactions that are associated with the UniMail system. It contains the user data as well as the message store. User data and information needed for routing of messages such as the various identification addresses of the user, namely, the email, phone and facsimile numbers are maintained. The message store contains the voice, fax and email messages. The database is designed based on the combined message approach whereby all messages (both old and new), irrespective of the user, are stored in a uniform database. This approach has the advantages of a straightforward database administration and concurrent accesses to the user's mailbox. The latter is achieved using connection pooling.

3.4. Login module

As shown in Fig. 2, this module allows the user to login to

the mailbox using either the Internet or the phone. The user is required to enter the username and password to access the mailbox. Access via Internet is through the UniMail login page while access via the phone is through the DTMF tones. Users enter information according to the voice prompts from the UniMail system.

The module determines whether the user is a registered user and verifies that the password supplied is valid. The result of this operation could be that the user is granted access to the mailbox or if the user enters an incorrect username/password combination, an error message results and the user will be prompted to re-login. The concept of state prevents the user from accessing any area of the mailbox without logging in successfully to the system.

The login module also handles the registration which is the first step in realizing a unified messaging solution. It is to be noted that the registration process is designed to be carried out over the Internet. This is because:

- validity checks on information provided by the user can be performed easily;
- users typically prefer a visual interface;
- the system is well established and the users have a gradual learning curve;
- more robustness and reliability can be provided in the system.

3.5. Message receiver module

This module comprises three sub-modules, one each for email, fax and voice messages.

3.5.1. Email

Delivering electronic mail over the Internet is relatively straightforward and widely established as all email messages are treated as Multipurpose Internet Mail Extensions (MIME) messages which can consist of several text or binary parts. Emails are sent via the SMTP server.

The email receiver receives email messages from the Internet and passes them to the Store Email module. At present, it is to be noted that only Internet mail is considered feasible. Email composed directly from the phone or the facsimile machine is not feasible due to lack of an interface that will allow the user to see the message entered.

3.5.2. Fax

Sending a fax involves using a fax machine to scan a document and then transmitting the scanned image via PSTN lines to another fax machine. A unified messaging system should allow users to send faxes on the Internet as well as via a fax machine.

The fax receiver module interfaces to a fax machine via a TAPI interface and through the web browser in the case of Internet faxing as shown in Fig. 2. Sending faxes from fax machines requires some means to capture the destination fax number [11]. In UniMail, the destination fax number is captured in two ways, namely, via the Dual Tone Multi-Frequency (DTMF) tones or via the web browser. The former requires the user to enter the destination number from the keypad of the fax machine in response to an interactive voice prompt. The latter makes use of the web browser to prompt user for destination fax number. It also has the added flexibility of allowing scanned images of the documents to be faxed to be uploaded.

3.5.3. Voice

Traditionally voice mail is delivered over PSTN systems. However, with the high costs of overseas phone calls, voice over IP is extremely attractive. UniMail therefore allows the receipt of voice mail from the phone as well as from the Internet by allowing users to compose voice message on their computers. This module receives the message and passes them to the Store Voice mail module. Note that for voice mails, there is no need to invoke the SAPI module in Fig. 2 as the module's primary function is to handle the text-to-speech conversion.

3.6. Message store module

The message store module handles the storage of email, fax and voice messages and stores them in the message database. It first separates the message into the different components and stores each message differently for retrieval. It also ensures that multiple copies of the same message, which has been sent to multiple recipients, are not being stored to optimise storage space.

Email message is stored inside the message database. Voice files are binary files and the voice messages are stored on the server's file system and the respective links are updated in the message database. Fax messages are stored in two ways, namely, as text files if the user enters the message using a web browser or as binary image files if the fax message is acquired using the fax machine.

3.7. Send/retrieve module

This module controls how the three types of messages are being retrieved from the system database. The different types of mail messages can be retrieved in two ways. They are retrieved over the Internet using a web browser or over the phone. If the user logs on from the Internet, then this module allows the delivery of email, fax files and audio files over the Internet. The voice message, in this case, is heard over the speakers of the client's native audio system. If the user logs on from the phone, the voice messages will be played out via the PSTN.

Accessing UniMail from the Internet allows users to view the textual aspect of the message directly within the browser. For the non-textual, binary part of the message, the user is able to download the files and view them using appropriate handler applications. The latter is not supported

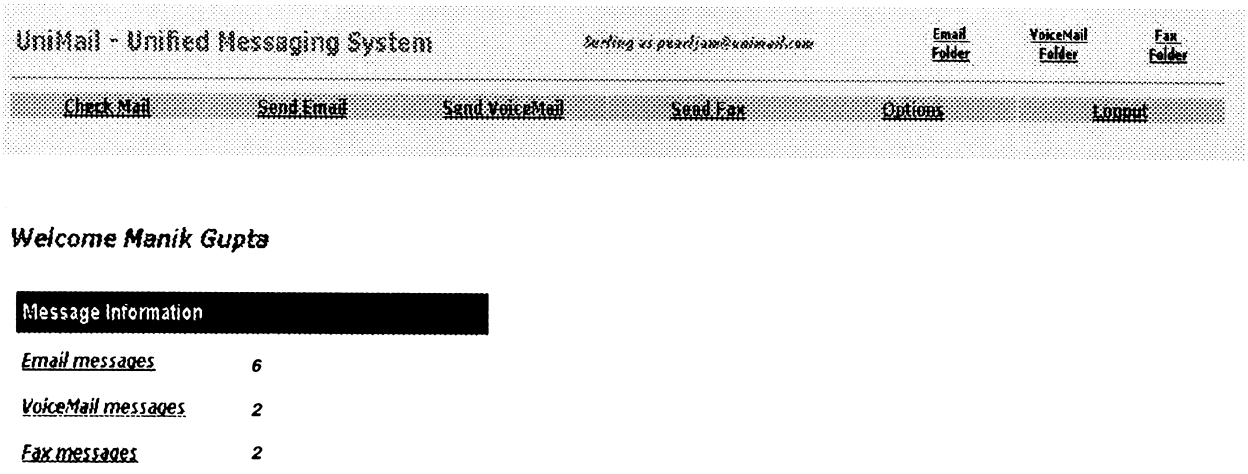

Fig. 3. Message summary page in UniMail.

when access is via the phone. The fax message in all cases is delivered to the recipient's fax machines.

3.8. SAPI module

The combined use of TAPI [12] and the text-to-speech engine in SAPI [13,14] allows voice, email messages and fax messages sent via the web browser to be read out to the user over the PSTN when the unified mailbox is accessed via the phone.

3.9. UniMail examples

Fig. 3 shows an example of a user's unified mailbox page. This page provides a summary of each of the different types of messages the user has. The user can click on any link to view that category of messages. Fig. 4 shows how a voice message can be retrieved in UniMail while Fig. 5 shows a fax retrieval. User can listen to the fax message by clicking on the Listen button for faxes sent via the Internet.

4. Evaluation

4.1. Systems comparison

To assess the performance of a unified messaging system, the following performance parameters are used.

4.1.1. Portability

This measures how portable is the system in terms of migrating to other platforms. It checks the amount of change that needs to be made to the system if it is deployed on a different platform.

4.1.2. Extensibility

Under this category, the ability of the system to support change in user preferences is investigated. The user should ideally be able to change his preferences without having to make significant changes to the system behaviour.

4.1.3. Effectiveness

This judges the reliability of the system in delivering the messages to the users.

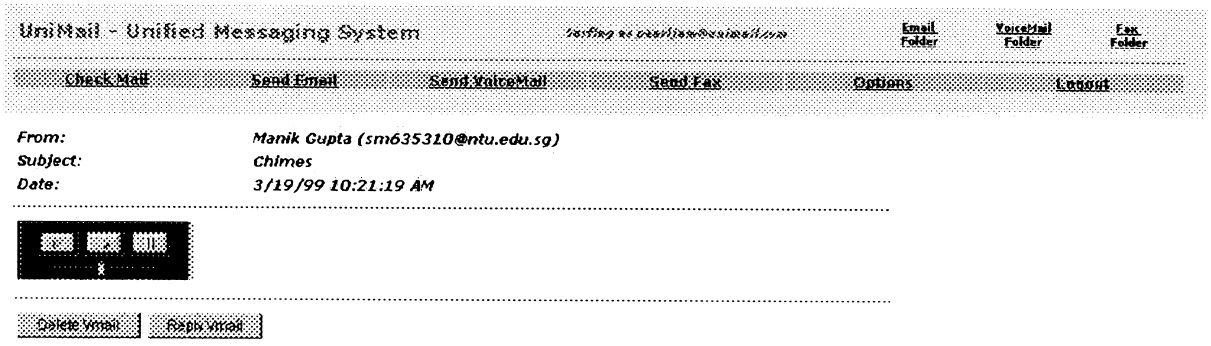

Fig. 4. Example on voice message retrieval.

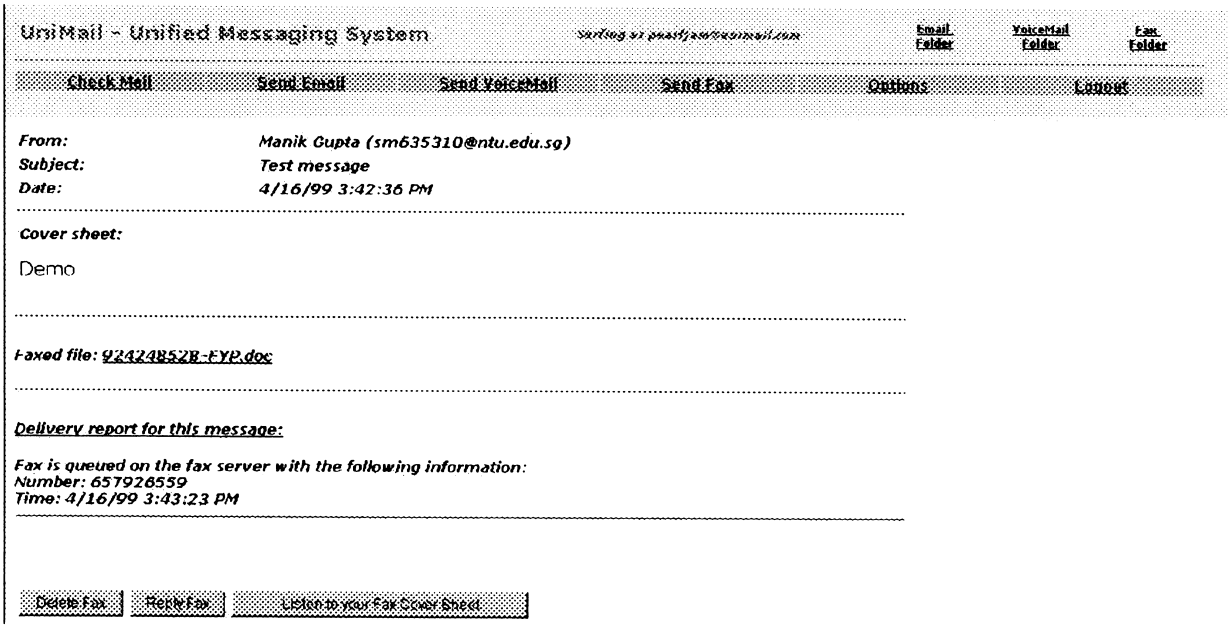

Fig. 5. Example on fax retrieval.

4.1.4. Integration

This parameter tests how well the system can be integrated with existing systems. Several issues here include the amount of proprietary technology used in developing the system.

4.1.5. Delivery

The speed with which the messages are delivered and the costs involved in their delivery are investigated under this category.

4.1.6. Management

This parameter refers to the relative ease of managing the system. Management issues can include routine database issues and complex migration issues.

4.1.7. Remote access

How well the system supports remote access of the mailbox is measured under this parameter.

UniMail is compared with JFAX [15], PrimeVoice [16] and Messagepoint [17].

JFAX. JFAX.COM is a popular unified messaging system resulting from a team up between Yahoo [18] and JFAX. By linking a unique phone number to your email, JFAX routes all voice mail and fax messages straight to email. In this manner, JFAX provides a unified mailbox for receiving all messages. Voice mail is played on the computer's speakers and faxes are displayed on the screen. It provides telephone access to email, voice messages and fax information such as originating fax number, time received and number of pages. Faxes can be sent from the computer to any fax machine at low rates.

Table 1
Comparisons among various unified messaging systems

Area	UniMail	JFAX	PrimeVoice	Messagepoint
Portability	Very portable	Not very portable	Not very portable	Portable
Extensibility	Good — because users do not have to change anything about their addresses	Difficult due to new number assigned	Good	Difficult due to new email address assigned
Effectiveness	Good	Good	Good	Good
Integration	Good — based on open standards	Not very good due to proprietary software	Reasonable	Good
Delivery	Fast and cheap	Fast	Fast	Fast and cheap
Management	Individual responsibility — administration module inherent in global transactions records	Individual responsibility	Administration module provided	Administration module provided
Remote access	Supported (web, telephone and fax machines)	Supported (web and telephone)	Supported (web and telephone)	Supported (web, telephone and handheld devices)

Table 2
Experiment results on the message retrieval latency of UniMail

No. of log-on clients	1	2	3	4
Retrieval latency (ms)	163	177	188	194
Direct file transfer time (ms)	155	165	173	177

PrimeVoice. PrimeVoice is a powerful, media rich messaging system on a single NT platform. This single platform architecture grants PrimeVoice users total access and control of the single store of mailboxes and messages through whichever medium best fits their immediate needs, namely, from any telephone, on desktop PCs over the corporate LAN and via world wide web Internet access.

Messagepoint. Messagepoint [17] allows the delivery and receipt of messages in various forms. Voice mail and faxes are received on a private number in a choice of cities. They can be retrieved over the phone, in the email as an attachment, with the Messagepoint 98 PC Client or over the Web and via another fax machine for faxes. As for email, every Messagepoint user gets a unique email address that can be diverted to any existing email address. Email retrieval can be done via the phone (read out with text-to-speech engine), with the Messagepoint 98 PC Client software, to any fax machine or over the Web. Messagepoint brings ultimate scalability, coverage, flexibility and user features to large corporations.

Table 1 discusses these aspects with regards to the UniMail system and compares it with JFAX, PrimeVoice and Messagepoint systems.

Compared to UniMail which is built upon an open framework with standard protocols, JFAX requires proprietary software to access the mailbox. The JFAX communicator software is required by the users to send and receive their messages. All messages are bounded to the number assigned and it does not support integration with existing legacy systems.

PrimeVoice uses certain proprietary protocols to link up to the various systems. Hence, the system is not portable unlike UniMail. Faxing is relatively expensive compared to UniMail as PimeVoice uses a fax server that communicates to a fax machine directly and not with another fax server. Hence for fax-to-fax operations, transcontinental fax charges will prevail for international faxing.

Messagepoint's total solution is appealing to large organizations that have numerous offices around the globe. These companies can save money by eliminating the costs of internal messaging by using the distributed characteristics of Messagepoint. However, smaller companies who need to constantly send messages to external entities do not see significant reduction in end user costs. A disadvantage of Messagepoint is that the user is required to change his email address to the format stipulated by Messagepoint. This means that the system is not fully integrable with existing messaging applications. UniMail does not have this constraint and addresses the needs of small and medium-sized corporations.

In summary, each of the systems has its relative merits and demerits. UniMail is designed to overcome some of the disadvantages of above systems through an open architecture based on Internet protocols and through a more user-friendly and seamless access to the unified messaging system.

4.2. Performance data

The UniMail server is housed on an NT dual-processor workstation running at 500 MHz. The web server is housed on a separate single-processor NT workstation (500 MHz) to offload the main server. The system allocates a maximum mailbox size of 20 MB per user. This allocation can be increased upon user request. Currently with a single server, a maximum number of 500 users are supported. Attachments to email are restricted to 5 MB in total size which is adequate to contain a 2-min long wavefile.

Common performance parameters such as access time to the mailbox, transmission delay and delivery time of mail messages are all dependent on the prevailing network infrastructure and traffic connections. Such performance data cannot be correlated directly with the performance of the UniMail. However, in order to obtain some insight into UniMail's performance, an experiment is conducted to measure the mail retrieval time. This parameter is chosen as it directly determines the waiting time for the user from the point he clicks on the message until the time when the message is retrieved from the UniMail server and is displayed on his PC.

The experimental set-up comprises four UniMail client PCs running Windows 98 operating system at 500 MHz and the UniMail and web servers, interconnected via a 100BaseT LAN. Intranet access is used in this experiment. The retrieval latency is measured by recording the time taken for the client to retrieve a 100-KB JPEG email attachment from the UniMail server. The experiment was conducted by varying the login clients from one to four. The experiment is repeated 100 times over different periods of the day so as to capture the system performance over varying network conditions. The time taken (averaged over 100) for each client to access the attachment is taken and averaged over the number of log-on clients. Table 2 shows the average retrieval time for the 100-KB attachment.

To provide some information on the overheads incurred by the UniMail server to process the clients' requests, the 100-KB file is directly transferred by the server to the client(s). The average time taken for the direct file transfer to the varying number of clients are recorded in Table 2.

Comparing the retrieval latency against the direct file transfer timing, it shows that for one client, the UniMail server overhead is about 8 ms. This overhead however does not increase very much as the number of clients is increased, as both sets of results increase in tandem. This

shows that the overhead of the UniMail server in processing requests from more clients is quite low compared to the time taken to affect the data transfer over the network to the clients. The experimental results also show that the retrieval time does not vary significantly with the number of log-on clients for the intranet environment where this experiment is conducted.

5. Conclusions

Unified messaging is a relatively new concept and thus the enabling technologies are only now becoming accessible to developers. UniMail is an open system so that it is extensible and scalable to allow IT professionals to integrate their existing applications within its architecture. Hence, UniMail was developed with the primary objectives of being able to have a uniform interface to other architectures and at the same time providing an intuitive unified messaging solutions to small and medium-sized corporations.

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