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WEB/EMULATOR SERVER AND WEB BROWSER TERMINAL EMULATOR FOR PERSISTENT CONNECTION TO A LEGACY HOST SYSTEM OPERATION

TECHNICAL FIELD OF THE INVENTION

This invention relates in general to the field of electronic systems, and more particularly to a web/emulator server and a web browser terminal emulator for persistent connection to a legacy host system and a method of operation.

BACKGROUND OF THE INVENTION

Many organizations operate computer network environments that include legacy host systems which store data and provide applications important to the operation of the organization. Such legacy host systems can include IBM mainframes (MVS, VM and VSE environments), IBM AS/400 systems and UNIX host systems.

It is desirable for such organizations to provide connection to the legacy host systems through terminal sessions on distributed client systems such as personal computers and computer workstations. This connection to the legacy host system provides access for users of the client systems to the data and applications on the legacy host system. These terminal sessions can include 3270, 5250, NVT and VT220 type terminal sessions.

One conventional method for providing terminal sessions is to execute a terminal emulator application on the client systems that connects directly to a host legacy system using a TCP/IP socket connection. Another

conventional method is to provide connection through a web browser application by translating standard legacy data flows into HTML pages. However, such conventional web browser methods suffer from an inability to handle real-time host updates to user screens as well as other significant problems. For example, forms-based HTML/TN3270 packages are unable to overcome a range of problems associated with common HTML implementations such as real-time host updates to user screens or finding a user's browser platform address on the network.

SUMMARY OF THE INVENTION

In accordance with the present invention, a web/emulator server and a web browser terminal emulator for persistent connection to a legacy host system and a method of operation are provided that substantially eliminate or reduce disadvantages and problems associated with previously developed methods.

According to one aspect of the present invention, a computer network environment allowing connection of a client system to a legacy host system using a web/emulator server is provided. The computer network environment includes a legacy host system having TCP/IP connectivity. The legacy host system is operable to support a terminal session for access to the legacy host system. The computer network environment also includes a server system executing a client thread under a web/emulator server. The client thread is operable to communicate with the legacy host system across a persistent TCP/IP socket connection. The computer network environment further includes a client system executing an applet process under a web browser. The applet process is operable to communicate with the client thread across another persistent TCP/IP socket connection and is operable to provide a terminal session to a user

of the client system. This terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system.

According to another aspect of the present invention, a web/emulator server for providing a persistent connection between a client system and a legacy host system is provided. The web/emulator server includes a client thread operable to communicate with a legacy host system across a persistent TCP/IP socket connection. The web/emulator server also includes applet code operable to create an applet process executing under a web browser on a client system. When executed, the applet process is operable to communicate with the client thread across another persistent TCP/IP socket connection and to provide a terminal session to a user of the client system. The web/server emulator is operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system.

According to a further aspect of the present invention, a method is provided for connecting a client system to a legacy host system using a web/emulator server. A uniform resource locator associated with a legacy host system is selected from a web browser executing on a client system. The uniform resource locator is received by a web/emulator server executing on a server system. Executable code for an applet process is then downloaded to the client system, and the applet process is executed under the web browser on the client system. The applet process is connected to a client thread executing under the web/emulator server via a persistent TCP/IP socket connection. The client thread is connected to a legacy host system associated with the uniform resource locator via another persistent TCP/IP socket connection. The client thread and the legacy host

system communicate across the first persistent TCP/IP socket connection, and the client thread and the applet process communicate across the second persistent TCP/IP socket connection. A terminal session is provided by the applet process to a user of the client system which allows real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system.

A technical advantage of the present invention is the ability to allow users to access legacy host system data, such as IBM mainframe data, from client systems, such as desk top personal computers and computer workstations, using a web browser where the access is provided through a persistent TCP/IP socket connection to the legacy host system. This ensures a persistent bidirectional connection to the legacy host system such that real-time host updates, security, encryption, help-desk support, and other real-time features can be supported. One embodiment of the present invention uses SUN MICROSYSTEMS' JAVA technology and includes JAVA-capable web browsers and embedded JAVA applet processes to provide terminal session connectivity to the distributed client systems.

Another technical advantage of the present invention is the provision of connectivity to a legacy host system through web browsers without the need for specialized emulation software to be manually loaded on each client computer system and without the need for user programming.

A further technical advantage of the present invention is allowing the expansion of access to existing data and applications on legacy host systems from existing client systems using existing network capabilities. The present invention provides a network environment that allows the use of a web browser

environment, having web browser tools, such as JAVA tools, and web-serving, to incorporate Internet-type technologies, through the Internet or an intranet, with existing network architectures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram of a computer network environment that allows connection of a client system to a legacy host system using a web/emulator server according to the teachings of the present invention;

FIGURE 2 is a flow chart of a method for connecting a client system to a legacy host system using a web/emulator server according to the teachings of the present invention; and

FIGURE 3 is a block diagram of load-balancing across multiple web/emulator servers according to the teachings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGURE 1 is a block diagram of a computer network environment, indicated generally at 10. Network environment 10 includes a legacy/SNA environment 12, a TCP/IP environment 14 and a public Internet/intranet environment 16.

Legacy/SNA environment 12 includes one or more legacy host systems such as an IBM host system 18 and a UNIX host system 19. IBM host system 18 can comprise an IBM mainframe (MVS, VM and VSE environment) or an IBM AS/400 system. UNIX host system 19 can comprise a computer workstation or server running a UNIX-type environment.

A gateway system 20 can be coupled to IBM host system 18 via a connection 22. Connection 22 can comprise an SNA or channel attachment to IBM host system 18. Gateway system 20 provides an interface between

legacy/SNA environment 12 and TCP/IP environment 14. Gateway system 20 can be integral with IBM host system 18 or can be a separate, add-on system extending the functionality of IBM host system 18. For example, gateway system 20 can comprise an OC SERVER II™ gateway product available from OPENCONNECT SYSTEMS. UNIX host systems 19 and some IBM host systems 18 have built in TCP/IP connectivity such that the use of a gateway system 20 is unnecessary.

TCP/IP environment 14 includes a server system 24. Server system 24 executes one or more web/emulator servers 26. Web/emulation server 26 provides an interface between TCP/IP environment 14 and public Internet/intranet environment 16 and is operable to execute one or more client threads 28. Web/emulator server 26 is operable to connect to gateway system 20, to IBM host system 18 and to UNIX host system 19 via a persistent TCP/IP socket connection 30. Server system 24 includes a data storage device 32 that stores applet code 34. Applet code 34 comprises executable code for an applet process. Web/emulation server 26 can comprise an OC://WEBCONNECT™ server available from OPENCONNECT SYSTEMS, and applet code 34 can comprise a JAVA applet for use within SUN MICROSYSTEM's JAVA environment.

Public Internet/intranet environment 16 includes one or more client systems 36. Client system 36 can comprise a desk top computer such as a personal computer or computer workstation. Client system 36 is operable to execute a web browser 38. Web browser 38 is operable to establish a virtual machine 40 for executing an applet process 42. Applet process 42 comprises an instance of applet code 34 downloaded to client system 36 by web/emulator server 26. Applet process 42 is connected to client thread 28 via a persistent TCP/IP socket connection 44. Web browser 38 can comprise a

commercially available web browser application such as NETSCAPE NAVIGATOR that is JAVA-capable and applet process 42 can comprise a JAVA applet.

In operation, web/emulator server 26, client thread 28 and applet process 42 form a web browser terminal emulator providing a persistent bidirectional connection between client system 36 and a legacy host system such as IBM host system 18 or UNIX host system 19. Applet process 42 communicates with client thread 28 across persistent TCP/IP socket connection 44. Client thread 28 communicates with an appropriate legacy host system, either IBM host system 18 or UNIX host system 19, across a persistent TCP/IP socket connection 30. Client thread 28 and applet process 42 allow a user of client system 36 to use web browser 38 to invoke a terminal session for accessing data and applications on a legacy host system. Each web/emulation server 26 is operable to manage a plurality of client threads 28 associated with a plurality of applet processes 42. In one embodiment of the present invention, each web/emulation server 26 is operable to manage a thousand such connections.

Client thread 28 executes under web/emulator server 26 and is operable to communicate with a legacy host system across a persistent TCP/IP socket connection 30. Client thread 28 is operable to interface between TCP/IP environment 14 and public Internet/intranet environment 16. Applet process 42 executes under web browser 38 and is operable to communicate with client thread 28 across persistent TCP/IP socket connection 44. In one embodiment of the present invention, client thread 28 and applet process 42 using a web/emulator data flow. Applet process 42 is further operable to provide a terminal session to a user of the client system 36. The terminal session can comprise a 3270, 5250, NVT or VT220 type terminal session. This terminal session provided by

applet process 42 and client thread 28 is supported by a persistent TCP/IP socket connection which allows real-time bidirectional communication with the legacy host system.

In one embodiment of the present invention, the applet process uses three threads to implement the terminal session. The applet process uses a READ thread, a WRITE thread and an EMULATION thread. The READ thread provides a buffer interface to persistent TCP/IP socket connection 44 and reads information from the socket. The WRITE thread provides a buffer interface to persistent TCP/IP socket connection 44 and writes to the socket. The EMULATION thread provides the user interface representing the terminal session on the legacy host system. In this embodiment, the applet process and the client thread communicate using a web/emulator data flow based upon the communication protocol that is set forth in APPENDIX A.

According to the present invention, a user of client system 36 can access data and applications on the legacy host system using web browser 38 where the access is provided through a persistent bidirectional connection to the legacy host system. Persistent TCP/IP socket connections 30 and 44 provide this persistent bidirectional connection to IBM host system 18 or UNIX host system 19 such that real-time host updates, security, encryption, help-desk support, and other real-time features are supported. One embodiment of the present invention uses SUN MICROSYSTEMS' JAVA technology and includes JAVA-capable web browsers 38 and embedded JAVA applet processes 42 to provide terminal session connectivity to client systems 36.

The present invention provides connectivity to legacy host systems such as IBM host system 18 and UNIX host system 19 through web browser 38 without the need

for specialized emulation software to be manually loaded on each client system 36 and without the need for user programming. Web/emulator server 26 downloads applet code 34 to client system 36 when the uniform resource locator (URL) of the legacy host system is selected by the user. This is accomplished automatically without requiring service personnel to load software on client system 36.

The present invention also allows the expansion of access to existing data and applications on legacy host systems from existing client systems 36 using existing network capabilities. The present invention provides a network environment 10 that allows the use of a public Internet/intranet environment 16 having web browser tools, such as JAVA tools, and web-serving to incorporate Internet-type technologies, through the Internet or an intranet, with existing network architectures. Thus, an organization can implement web browser 38 based access to legacy host systems, such as IBM host systems 18 and UNIX host systems 19, without scrapping or significantly restructuring existing network resources.

FIGURE 2 is a flow chart of a method for connecting a client system to a legacy host system using a web/emulator server according to the teachings of the present invention.

In step 50, a uniform resource locator (URL) associated with a legacy host system is selected from a web browser executing on a client system. The web browser can comprise a JAVA-capable NETSCAPE NAVIGATOR web browser as mentioned above. The selected uniform resource locator is received by a web/emulator server in step 52. In step 54, the web/emulator server downloads executable code for an applet process to the client system for connecting to the legacy host system. In step 56, the client system executes the applet process under

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the web browser. The applet process can comprise a JAVA applet for execution within a JAVA virtual machine within the NETSCAPE NAVIGATOR web browser.

In step 57, the applet process connects to a client thread executed by the web/emulator server, and the client thread connects to the legacy host system across persistent TCP/IP socket connections. In step 58, the client thread then communicates with the legacy host system across the persistent TCP/IP socket connection. This communication allows the client thread to establish and maintain a terminal connection to the legacy host system. In step 60, the client thread communicates with the applet process across a persistent TCP/IP socket connection. This communication can be accomplished using a web/emulator data flow such as that based upon the communication protocol set forth in APPENDIX A.

In step 62, the applet process provides a terminal session to a user of the client system. According to the present invention, this terminal session allows real-time bidirectional communication with the legacy host system across a persistent TCP/IP socket connection to the legacy host system. This terminal session, as mentioned above, can comprise a 3270, 5250, NVT or VT220 type terminal session.

The terminal session can be terminated by the user of the client system as desired. The applet process and client thread are terminated, in step 64, when the terminal session is terminated. In one embodiment, after termination, the applet process is removed from execution memory and is no longer present on the client system. In another embodiment, the executable code for the applet can be stored on a data storage device associated with the client system. In this embodiment, the web/emulation server can check the client system to determine whether new executable code for the applet needs to be downloaded

based upon the version present, if any, on the data storage device of the client system.

The present invention provides an interface to legacy data flows, such as telnet (TN) data flows, across persistent TCP/IP socket connections to give users persistent bidirectional access to legacy host system data in terminal sessions, such as 3270, 5250, NVT and VT220 type terminal sessions. According to the present invention, terminal emulation is partially provided by applet executable code downloaded from the web/emulation server. The user can select the uniform resource locator (URL) of the legacy host system via a web browser package, such as NETSCAPE's NETSCAPE NAVIGATOR, and transparently receive the applet code which is executed and invokes an appropriate terminal session.

The present invention provides users of the client system access to real-time legacy host system data and applications using a web browser. The web/emulator server system converts standard legacy data flows into web/emulator data flows and vice versa permitting multi-session, multi-protocol access to legacy data and applications. The applet process converts the web/emulator data flows into a terminal session for display to the user. As mentioned above, the web browser can comprise a JAVA-capable web browser, the applet process can be a JAVA applet, and the web/emulator data flow can be based upon the protocol set forth in Appendix A. This embodiment of the present invention can blend web browsers enhanced by SUN MICROSYSTEMS' JAVA with legacy host systems having TCP/IP connectivity to allow users on any client system platform to connect to and access legacy host systems via 3270, 5250, NVT and VT220 type terminal emulation.

FIGURE 3 is a block diagram of load-balancing across multiple web/emulator servers according to the teachings

of the present invention. An HTTP server 70 is coupled to a client system 72. HTTP server 70 receives request information, REQUEST, from client system 72 in the form of a uniform resource locator (URL) and provides redirection information, REDIRECT, to client system 72. Client system 72 is then coupled to one of a plurality of web/emulation servers 74 according to the redirection information. In this manner HTTP server 70 can redirect access by a plurality of client systems 72 to manage the load on web/emulation servers 74 to ensure a balance across all available web/emulation servers 74.

This load-balancing can remain transparent to a user of client system 72. The user enters the uniform resource locator associated with the legacy host system. That information is transmitted to HTTP server 70 as a request. HTTP server 70 interprets the request, identifies the selected legacy host system, and selects a web/emulation server 74 to manage the connection. This selection of a web/emulation server 74 can be based upon information of the current loading of each web/emulation server 74. HTTP server 70 transparently provides redirect information to client system 72 which identifies the uniform resource locator of the selected web/emulation server 74. Client system 72 then initiates the above described terminal session through the selected web/emulation server 74 and the selected web/emulation server 74 connects to the legacy host system as described above.

The present invention provides web browser connectivity with relatively low initial and recurring cost. The need for individual emulation software products based upon each particular client system is removed. This eliminates many technical support, help desk and software distribution problems, including version level control and configuration management

issues. Extensive user training is no longer necessary because web browsers generally offer intuitive common user interfaces and are known by many users. Implementation time is improved by taking advantage of an existing widely-installed web browser base. Specifically, the platform independence provided by the JAVA architecture allows the web browser terminal emulator of the present invention to avoid problems with operation differences between computer environments. In addition, numerous users can be supported concurrently by each web/emulation server. For example, the OC://WEBCONNECT™ product from OPENCONNECT SYSTEMS can support a thousand users per instance.

The present invention provides connectivity from any client system, such as a personal computer or computer workstation, to a legacy host system, such as a mainframe or mid-range system, without costly redesign or rebuilding of legacy applications. The benefits of a distributed client/server type data exchange can be realized without requiring systems redesign. This approach means that the many advantages of Internet-type access and functionality can be blended into an organization's network architecture simply and efficiently, thus protecting existing information technology infrastructures and investments.

Although the present invention has been described in detail, it should be understood that various changes, substitutions and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

APPENDIX A

The following provides one implementation of a communication protocol for web/emulation data flow between a client thread and an applet process. (For all values with a length, length = 0 indicates the field is not present. All fields are byte values.)

Client (applet process) to Server (client thread)

Connect Session

/ S / *emutype* / *hostlen* / *hostname* .../ *lunamelen* / *luname* ... / *portnolen* / *portno* ... / *sessionlen* *sessionname*...

emutype: Emulation type to create 01 = 3270, 02 = 5250, 04 @ VT220 *hostlen, hostname:* length and content of gateway hostname to connect with *lunamelen, luname:* length and content of luname name for session

portnolen, portno: length and content of port number (as ASCII text) for gateway *sessionlen,* *sessionname:* length and content of session name

Field Update

/ F / *reason* / *reasonparm* / *curposhigh* / *curposlow* / *fieldcounthigh* / *fieldcountlow* / *bufposhigh* / *bufposlo lengthy* / *lengthlow* / *fieldchars*

reason: Reason for field update. 0 1 = Unsolicited, 02 = reply to Query Field Update from server.

reasonparm: If reason = 01, AID value from client. If *reason = 02, reasonparm from* Query Field Update command from server.

curposhigh, curposlow: Cursor Position at time of update

fieldcounthigh, fieldcountlow: count of fields

bufposhigh, bufposlow: Buffer position of field

lengthy, lengthlow: Length of field data (16 bits)

fieldchars: field data in ASCII

row, column, length,fieldchars ... are repeatedfieldcount times.

NVT Keystroke

/ N / *asciikey*

asciikey: value of keystroke as an ASCII character

Run Script

/ R / *scriptnamelen* / *scriptname*...

scriptnamelen, scriptname: length and name of TCL script to execute

Query Help Desk

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/ H /
Process Emulation Keystroke
/ K / *keyvaluehigh I keyvaluelow*
keyvaluehigh I keyvaluelow: Emulation key value to process

Server (client thread) to Client (applet process)
Erase Display
/ E /
Set Display Size
/ S / *rows / columns*
rows: Number of rows for display
columns: Number of columns for display
Set Cursor Position
/ C / *bufposhigh, bufposlow*
bufposhigh, bufposlow: Position for cursor
Display Text
/ D / *bufposhigh I bufposlow I lengthhigh I lengthlow I text...*
bufposhigh, bufposlow: Position for text (Ignored when in NVT mode) *lengthhigh, lengthlow:* Len-th of text (16 bits)
text: ASCII text for display
OIA Text
/ 0 / *column / length / oiatext ...*
Field List
/ F / *fieldcounthigh, fieldcountlow / bufposhigh / bufposlow / fieldattr / xattr / lengthhigh / lengthlow fieldcounthigh, fieldcountlow:* Number of fields (O = unformatted screen) *bufposhigh, bufposlow:* Position for start of field *fieldattr:* Field attribute byte

3270 bits	definition use
0	Modified Data Tag (I @ field modified)
0	Reserved (0)
2 - 3	00 = Display/non-detectable, 01 = Display/detectable, 10=lntensitied Display/detectable, 11 =Nondisplay/non-detectable
4	0= Alphanumeric, 1 = Numeric
5	0 = Unprotected, 1 = Protected

xattr: Field extended attribute byte 3270 Definition

3270 Definition bits	se
7	field mark
6	unused
5	transparent/opaque
4-3	highlighting (00=default, 01 =blinking, 10=reverse, 11=underline)

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2-0 color(00 1=blue, 010= red, 011=pink, 100=green, 101=turquoise,110=yellow, 111=white)

lengthhigh, lengthlow: length of field (16 bits, may wrap off initial row)

bufposhigh, btifposlow, fieldattr, lengthhigh, lengthlow are repeatedfieldcounthigh, fieldcountlow times.

Character Override Attribute List

/A / *attrcounthigh / attrcountlow / bufposhigh / bufposlow / lengthhigh / lengthlow / attrbytel*

attrcounthigh, attrcountlow: Count of attributes

bufposhigh, biifposlow: Position of attribute

lengthhigh, lengthlow: length of field (16 bits, may wrap off initial row)

attrbytel: Attribute byte 1

3270 bits	Definition use
0 - 2	color bits (1 = Blue, 2 = Red, 3 = Pink, 4 = Green, 5 = Turquoise, 6 = Yellow, 7 =White)
3 - 4	Extended highlighting (mutually exclusive) (01= Blinking, 10 = Reverse, 11 = Underline)
7	Field mark (1= Start of field position)

bufposhigh, bufposlou,, lengthhigh, lengthlow, attrbytel are repeated *attrcounthigh, attrcountlow times.*

Query Field Update

/ Q / *reasonparm*

reasonparm: Reason value returned in Field Update message from client

Set NVT Mode

/ N / *nvtmode*

nvtmode: 00 = Emulation mode, 0 1 = NVT mode

Keyboard Lock State

/ K / *mode*

mode: 00 = KB Free, 01 = KB Locked

Sound Alarm

/ B / *length / filenametext ...*

length - Length of filename

filenametext: Name of audio file for alarm

Error Message

/ M / *length / messagetext...*

length, messagetext: Length and content of error message

Protocol Version

/ V / *verhigh / verlow*

verhigh, verlow: Protocol version number

Help Desk Reply

/ H /

length / versionstr: Server version
sessionIDhigh / sessionIDlow: server session ID for this client connection
emulationtype: 01 = 3270, 02 = 5250
(if emulation type is 3270)
displaytype: 00 = 3278, 01 = 3279, 02 = 3179, 03 = 3472
status: 00 = Unowned, 01 = SSCP, 02 =LULU
defauItPartition.- default model size 2 - *5*
alternatepartition: alternate model size 2 - 5
currentpartition: current model size 2 - *5*
(if emulation type is 5250)
displaytype: 00 = 3477, 01 = 3179, 02 = 5151, 03 = 3196
screensize: screen size, 2 or 5
ocserver: 01= connected to OC server, 00 = other type of server
ptsoverride: 01 = passthru screen override, 00 = no override
monochrome: 00= color, 01 = monochrome
protocoltype: 0 1 = RUI, 02 =TN
(if protocol type is RUI)
length /requstedLUname: configured LU name
length/grantedLUname: LU name returned by server
length/ruiversion: Version of RUI support in use
sessIDhigh I sessIDlow: RUI session ID
(if protocol type is T-N)
length, termTypeString: terminal type string negoiated with TN server *is*
TN3270EI: 00 = not 3270E, 01 = using 3270E
length, devicename: device name in use
length, puLuName: PU/LU name for session (OCS gateways only)
transporttype. 00= None (valid if protocol is RUI), 01 = Network (if transport type is Network)
length, configuredHostName: host name in session configuration
length, configuredport: port in session configuration
length, connectedHostName: host name (ip address) in actual use
length, connectedport: port in actual use

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WHAT IS CLAIMED IS:

1. A web/emulator server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent TCP/IP socket connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent TCP/IP socket connection and to provide a terminal session to a user of the client system;

the web/server emulator operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system.

2. The web/emulator server of Claim 1, wherein the client thread and the applet process are operable to communicate using a web/emulator data flow.

3. The web/emulator server of Claim 2, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the web/emulator data flow used by the applet process.

4. The web/emulator server of Claim 3, wherein the applet code comprises executable code for a JAVA applet to be executed under a JAVA-capable web browser.

5. The web/emulator server of Claim 4, wherein the web/emulator server is implemented by an OC://WEBCONNECT server.

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6. The web/emulator server of Claim 1, wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

7. The web/emulator server of Claim 1, wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

8. The web/emulator server of Claim 1, wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

9. The web/emulator server of Claim 1, wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

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10. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a web/emulator server on a server system, the client thread operable to communicate with a legacy host system across a first persistent TCP/IP socket connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent TCP/IP socket connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system.

11. The web browser terminal emulator of Claim 10, wherein the client thread and the applet process are operable to communicate using a web/emulator data flow.

12. The web browser terminal emulator of Claim 11, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the web/emulator data flow used by the applet process.

13. The web browser terminal emulator of Claim 12, wherein the applet process comprises a JAVA applet executing under a NETSCAPE NAVIGATOR web browser.

14. The web browser terminal emulator of Claim 13, wherein the web/emulator server comprises an OC://WEBCONNECT server.

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15. A computer network environment allowing connection of a client system to a legacy host system using a web/emulator server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a web/emulator server, the client thread operable to communicate with the legacy host system across a first persistent TCP/IP socket connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent TCP/IP socket connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system.

16. The computer network environment of Claim 15, wherein the client thread and the applet process are operable to communicate using a web/emulator data flow.

17. The computer network environment of Claim 16, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the web/emulator data flow used by the applet process.

18. The computer network environment of Claim 15, wherein the legacy host system comprises a mainframe computer system.

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19. The computer network environment of Claim 15, wherein the legacy host system comprises a mid-range computer system.

20. The computer network environment of Claim 15, wherein the legacy host system comprises a computer workstation executing a UNIX environment.

21. The computer network environment of Claim 17, wherein the applet process comprises a JAVA applet executing under a NETSCAPE NAVIGATOR web browser.

22. The computer network environment of Claim 21, wherein the web/emulator server comprises an OC://WEBCONNECT server.

23. The computer network environment of Claim 15, wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

24. The computer network environment of Claim 15, wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

25. The computer network environment of Claim 15, wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

26. The computer network environment of Claim 15, wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

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27. A method for connecting a client system to a legacy host system using a web/emulator server, comprising:

selecting a uniform resource locator associated with a legacy host system from a web browser executing on a client system;

receiving the uniform resource locator by a web/emulator server executing on a server system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the web/emulator server via a first persistent TCP/IP socket connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent TCP/IP socket connection;

communicating between the client thread and the legacy host system across the first persistent TCP/IP socket connection;

communicating between the client thread and the applet process across the second persistent TCP/IP socket connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system.

28. The method of Claim 27, wherein communicating between the client thread and the legacy host system is accomplished using a legacy data flow.

This Sheet Has Been Replaced

29. The method of Claim 28, wherein communicating between the client thread and the applet process is accomplished using a web/emulator data flow.

30. The method of Claim 29, wherein executing the applet process comprises executing a JAVA applet under a NETSCAPE NAVIGATOR web browser.

31. The method of Claim 27, wherein providing a terminal session comprises providing a 3270 type terminal session.

32. The method of Claim 27, wherein providing a terminal session comprises providing a 5250 type terminal session.

33. The method of Claim 27, wherein providing a terminal session comprises providing an NVT type terminal session.

34. The method of Claim 27, wherein providing a terminal session comprises providing a VT220 type terminal session.

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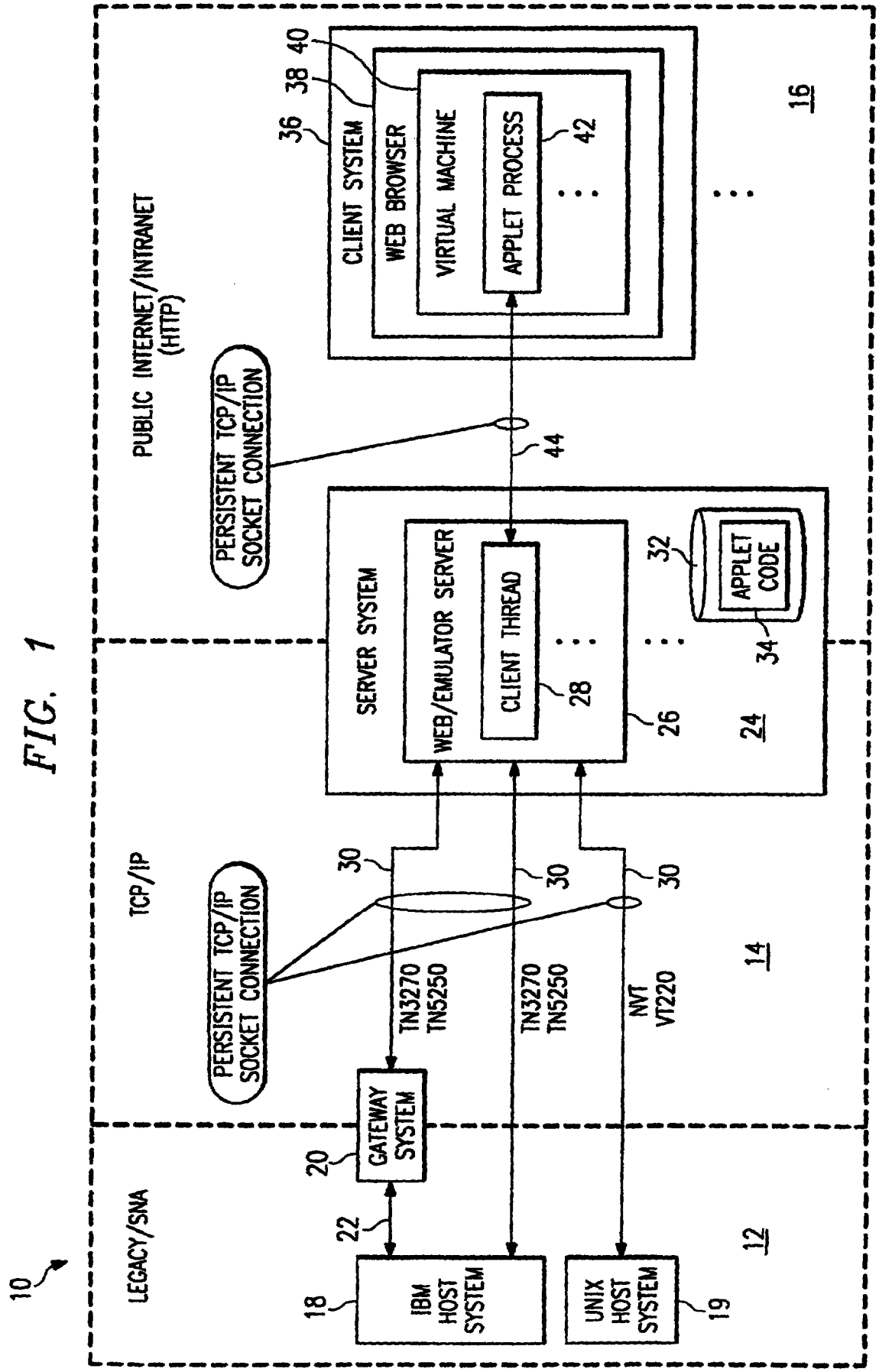
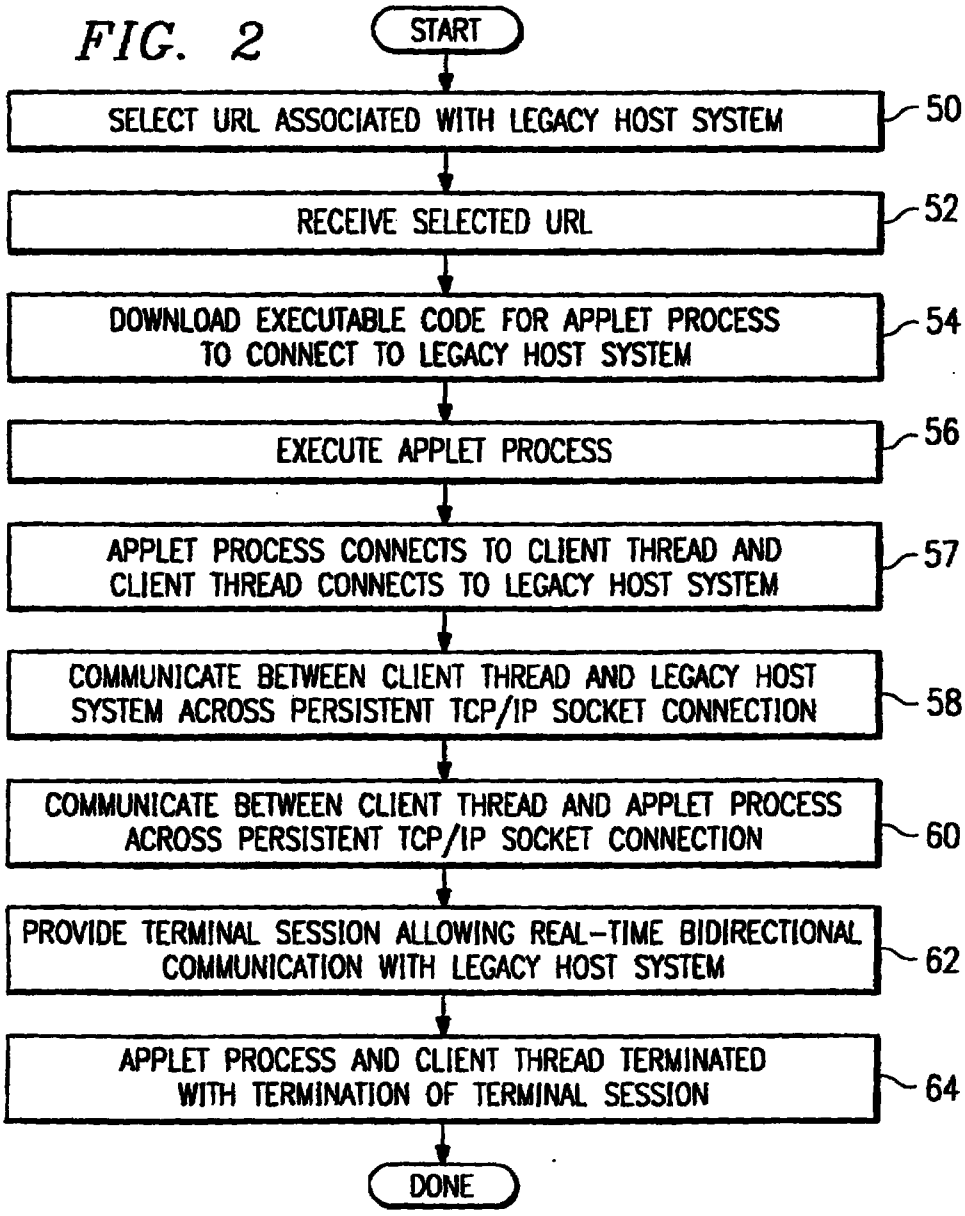

10
LEGACY/SNA
12
TCP/IP
14
PUBLIC INTERNET/INTRANET (HTTP)
16
CLIENT SYSTEM
WEB BROWSER
VIRTUAL MACHINE
APPLET PROCESS
42
36
38
40
PERSISTENT TCP/IP SOCKET CONNECTION
44
SERVER SYSTEM
WEB/EMULATOR SERVER
CLIENT THREAD
28
26
24
APPLET CODE
32
34
PERSISTENT TCP/IP SOCKET CONNECTION
30
30
30
TN3270 TN5250
TN3270 TN5250
NVT VT220
GATEWAY SYSTEM
20
22
IBM HOST SYSTEM
18
UNIX HOST SYSTEM
19

FIG. 1

FIG. 2


START
SELECT URL ASSOCIATED WITH LEGACY HOST SYSTEM
50
RECEIVE SELECTED URL
52
DOWNLOAD EXECUTABLE CODE FOR APPLET PROCESS TO CONNECT TO LEGACY HOST SYSTEM
54
EXECUTE APPLET PROCESS
56
APPLET PROCESS CONNECTS TO CLIENT THREAD AND CLIENT THREAD CONNECTS TO LEGACY HOST SYSTEM
57
COMMUNICATE BETWEEN CLIENT THREAD AND LEGACY HOST SYSTEM ACROSS PERSISTENT TCP/IP SOCKET CONNECTION
58
COMMUNICATE BETWEEN CLIENT THREAD AND APPLET PROCESS ACROSS PERSISTENT TCP/IP SOCKET CONNECTION
60
PROVIDE TERMINAL SESSION ALLOWING REAL-TIME BIDIRECTIONAL COMMUNICATION WITH LEGACY HOST SYSTEM
62
APPLET PROCESS AND CLIENT THREAD TERMINATED WITH TERMINATION OF TERMINAL SESSION
64
DONE

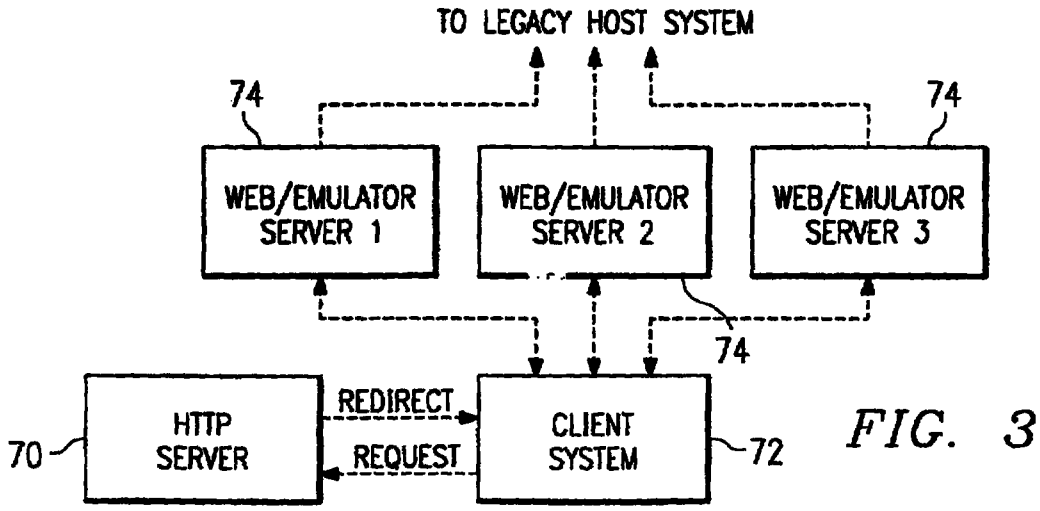

TO LEGACY HOST SYSTEM
74
74
WEB/EMULATOR SERVER 1
WEB/EMULATOR SERVER 2
WEB/EMULATOR SERVER 3
74
70
HTTP SERVER
REDIRECT
REQUEST
CLIENT SYSTEM
72

FIG. 3

WHAT IS CLAIMED IS:

1. Cancelled.

2. The server of Claim 6, wherein the client thread and the applet process are operable to communicate using a data flow based upon a specified communication protocol.

3. The server of Claim 2, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the data flow used by the applet process.

4. The server of Claim 3, wherein the applet code comprises executable code for a JAVA applet to be executed under a JAVA-capable web browser.

5. The server of Claim 4, wherein the first and second persistent connections are persistent TCP/IP socket connections.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997

6. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997



7. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

This Sheet Has Been Replaced



REPLACEMENT SHEET
31 OCT 1997

8. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997

9. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET

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10. Cancelled.

11. The web browser terminal emulator of Claim 35, wherein the client thread and the applet process are operable to communicate using a data flow based upon a specified communication protocol.

12. The web browser terminal emulator of Claim 11, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the data flow used by the applet process.

13. The web browser terminal emulator of Claim 12, wherein the applet process comprises a JAVA applet executing under a NETSCAPE NAVIGATOR web browser.

14. The web browser terminal emulator of Claim 13, wherein the first and second persistent connections are persistent TCP/IP socket connections.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997

15. Cancelled.

16. The computer network environment of Claim 23, wherein the client thread and the applet process are operable to communicate using a data flow based upon a specified communication protocol.

17. The computer network environment of Claim 16, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the data flow used by the applet process.

18. The computer network environment of Claim 23, wherein the legacy host system comprises a mainframe computer system.

19. The computer network environment of Claim 23, wherein the legacy host system comprises a mid-range computer system.

20. The computer network environment of Claim 23, wherein the legacy host system comprises a computer workstation executing a UNIX environment.

21. The computer network environment of Claim 17, wherein the applet process comprises a JAVA applet executing under a NETSCAPE NAVIGATOR web browser.

22. The computer network environment of Claim 21, wherein the first and second persistent connections are persistent TCP/IP socket connections.

REPLACEMENT SHEET
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AMENDED SHEET



23. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

REPLACEMENT SHEET
31 OCT 1997

This Sheet Has Been Replaced





24. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

This Sheet Has Been Replaced



REPLACEMENT SHEET
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PCT/US 97/05196
IPEA/US 31 OCT 1997

25. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997

REPLACEMENT SHEET

26. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET
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PCT/US 97/05196
IPEA/US 31 OCT 1997

27. Cancelled.

28. The method of Claim 31, wherein communicating between the client thread and the legacy host system is accomplished using a legacy data flow.

29. The method of Claim 28, wherein communicating between the client thread and the applet process is accomplished using a data flow based upon a specified communication protocol.

30. The method of Claim 29, wherein executing the applet process comprises executing a JAVA applet under a NETSCAPE NAVIGATOR web browser.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997

31. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing a 3270 type terminal session.

REPLACEMENT SHEET
31 OCT 1997

This Sheet Has Been Replaced

32. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing a 5250 type terminal session.

REPLACEMENT SHEET
31 OCT 1997
This Sheet Has Been Replaced

33. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing an NVT type terminal session.

34. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing a VT220 type terminal session.

This Sheet Has Been Replaced

35. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997



36. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

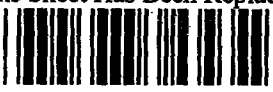
a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

This Sheet Has Been Replaced



37. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

This Sheet Has Been Replaced

REPLACEMENT SHEET
31 OCT 1997

38. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

39. The method of Claim 31, wherein the first and second persistent connections are persistent TCP/IP socket connections

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SERVER AND WEB BROWSER TERMINAL EMULATOR FOR PERSISTENT CONNECTION TO A LEGACY HOST SYSTEM AND METHOD OF OPERATION

TECHNICAL FIELD OF THE INVENTION

This invention relates in general to the field of electronic systems, and more particularly to a server and a web browser terminal emulator for persistent connection to a legacy host system and a method of operation.

BACKGROUND OF THE INVENTION

Many organizations operate computer network environments that include legacy host systems which store data and provide applications important to the operation of the organization. Such legacy host systems can include IBM mainframes (MVS, VM and VSE environments), IBM AS/400 systems and UNIX host systems.

It is desirable for such organizations to provide connection to the legacy host systems through terminal sessions on distributed client systems such as personal computers and computer workstations. This connection to the legacy host system provides access for users of the client systems to the data and applications on the legacy host system. These terminal sessions can include 3270, 5250, NVT and VT220 type terminal sessions.

One conventional method for providing terminal sessions is to execute a terminal emulator application on the client systems that connects directly to a host legacy system using a TCP/IP socket connection. Another conventional method is to provide connection through a web browser application by translating standard legacy data flows into HTML pages. However, such conventional web browser methods suffer from an inability to handle real-time host updates to user screens as well as other significant problems. For example, forms-based HTML/TN3270 packages are unable to overcome a range of problems associated with common HTML implementations such as real-time host updates to user screens or finding a user's browser platform address on the network.

REPLACEMENT SHEETS SG
☑ Description : paged 1 ... to paged 18
☑ Claim(s) : paged 19 ... to paged 30
☐ Drawing(s) : paged .... to paged .....
☑ Abstract : paged 31 ... to paged .....
DATE OF RECEIPT 1/10/99

SUMMARY OF THE INVENTION

In accordance with the present invention, a server and a web browser terminal emulator for persistent connection to a legacy host system and a method of operation are provided that substantially eliminate or reduce disadvantages and problems associated with previously developed methods

According to one aspect of the present invention, a computer network environment allowing connection of a client system to a legacy host system using a server is provided. The computer network environment includes a legacy host system having TCP/IP connectivity. The legacy host system is operable to support a terminal session for access to the legacy host system. The computer network environment also includes a server system executing a client thread under a server. The client thread is operable to communicate with the legacy host system across a persistent TCP/IP socket connection. The computer network environment further includes a client system executing an applet process under a web browser. The applet process is operable to communicate with the client thread across another persistent TCP/IP socket connection and is operable to provide a terminal session to a user of the client system This terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system.

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0.1 OCT 1999

According to another aspect of the present invention, a server for providing a persistent connection between a client system and a legacy host system is provided. The server includes a client thread operable to communicate with a legacy host system across a persistent TCP/IP socket connection. The server also includes applet code operable to create an applet process executing under a web browser on a client system. When executed, the applet process is operable to communicate with the client thread across another persistent TCP/IP socket connection and to provide a terminal session to a user of the client system. The emulator is operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system.

According to a further aspect of the present invention, a method is provided for connecting a client system to a legacy host system using a server. A uniform resource locator associated with a legacy host system is selected from a web browser executing on a client system. The uniform resource locator is received by a server executing on a server system. Executable code for an applet process is then downloaded to the client system, and the applet process is executed under the web browser on the client system. The applet process is connected to a client thread executing under the server via a persistent TCP/IP socket connection. The client thread is connected to a legacy host system associated with the uniform resource locator via another persistent TCP/IP socket connection. The client thread and the legacy host system communicate across the first persistent TCP/IP socket connection, and the client thread and the applet process communicate across the second persistent TCP/IP socket connection. A terminal session is provided by the applet process to a user of the client system which allows real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system.

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A technical advantage of the present invention is the ability to allow users to access legacy host system data, such as IBM mainframe data, from client systems, such as desk top personal computers and computer workstations, using a web browser where the access is provided through a persistent TCP/IP socket connection to the legacy host system. This ensures a persistent bidirectional connection to the legacy host system such that real-time host updates, security, encryption, help-desk support, and other real-time features can be supported. One embodiment of the present invention uses SUN MICROSYSTEMS' JAVA technology and includes JAVA-capable web browsers and embedded JAVA applet processes to provide terminal session connectivity to the distributed client systems.

Another technical advantage of the present invention is the provision of connectivity to a legacy host system through web browsers without the need for specialized emulation software to be manually loaded on each client computer system and without the need for user programming.

A further technical advantage of the present invention is allowing the expansion of access to existing data and applications on legacy host systems from existing client systems using existing network capabilities. The present invention provides a network environment that allows the use of a web browser environment, having web browser tools, such as JAVA tools, and web-serving, to incorporate Internet-type technologies, through the Internet or an intranet, with existing network architectures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a computer network environment that allows connection of a client system to a legacy

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01 OCT 1999

host system using a web/emulator server according to the teachings of the present invention;

FIG. 2 is a flow chart of a method for connecting a client system to a legacy host system using a web/emulator server according to the teachings of the present invention; and

FIG. 3 is a block diagram of load-balancing across multiple web/emulator servers according to the teachings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 is a block diagram of a computer network environment, indicated generally at 10. Network environment 10 includes a legacy/SNA environment 12, a TCP/IP environment 14 and a public Internet/intranet environment 16.

Legacy/SNA environment 12 includes one or more legacy host systems such as an IBM host system 18 and a UNIX host system 19. IBM host system 18 can comprise an IBM mainframe (MVS, VM and VSE environment) or an IBM AS/400 system. UNIX host system 19 can comprise a computer workstation or server running a UNIX-type environment.

A gateway system 20 can be coupled to IBM host system 18 via a connection 22. Connection 22 can comprise an SNA or channel attachment to IBM host system 18. Gateway system 20 provides an interface between legacy/SNA environment 12 and TCP/IP environment 14. Gateway system 20 can be integral with IBM host system 18 or can be a separate, add-on system extending the functionality of IBM host system 18. For example, gateway system 20 can comprise an OC SERVER II™ gateway product available from OPENCONNECT SYSTEMS. UNIX host systems 19 and some IBM host systems 18 have built in TCP/IP connectivity such that the use of a gateway system 20 is unnecessary.

TCP/IP environment 14 includes a server system 24.

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Server system 24 executes one or more web/emulator servers 26. Web/emulation server 26 provides an interface between TCP/IP environment 14 and public

Internet/intranet environment 16 and is operable to execute one or more client threads 28. Web/emulator server 26 is operable to connect to gateway system 20, to IBM host system 18 and to UNIX host system 19 via a persistent TCP/IP socket connection 30. Server system 24 includes a data storage device 32 that stores applet code 34. Applet code 34 comprises executable code for an applet process. Web/emulation server 26 can comprise an OC:// WEBCONNECT™ server available from OPENCONNECT SYSTEMS. and applet code 34 can comprise a JAVA applet for use within SUN MICROSYSTEM's JAVA environment.

Public Internet/intranet environment 16 includes one or more client systems 36. Client system 36 can comprise a desk top computer such as a personal computer or computer workstation. Client system 36 is operable to execute a web browser 38. Web browser 38 is operable to establish a virtual machine 40 for executing an applet process 42. Applet process 42 comprises an instance of applet code 34 downloaded to client system 36 by web/emulator server 26 Applet process 42 is connected to client thread 28 via a persistent TCP/IP socket connection 44. Web browser 38 can comprise a commercially available web browser application such as NETSCAPE NAVIGATOR that is JAVA-capable and applet process 42 can comprise a JAVA applet.

In operation, web/emulator server 26, client thread 28 and applet process 42 form a web browser terminal emulator

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providing a persistent bidirectional connection between client system 36 and a legacy host system such as IBM host system 18 or UNIX host system 19. Applet process 42 communicates with client thread 28 across persistent TCP/IP socket connection 44. Client thread 28 communicates with an appropriate legacy host system, either IBM host system 18 or UNIX host system 19, across a persistent TCP/IP socket connection 30. Client thread 28 and applet process 42 allow a user of client system 36 to use web browser 38 to invoke a terminal session for accessing data and applications on a legacy host system. Each web/emulation server 26 is operable to manage a plurality of client threads 28 associated with a plurality of applet processes 42. In one embodiment of the present invention, each web/emulation server 26 is operable to manage a thousand such connections

Client thread 28 executes under web/emulator server 26 and is operable to communicate with a legacy host system across a persistent TCP/IP socket connection 30. Client thread 28 is operable to interface between TCP/IP environment 14 and public Internet/intranet environment 16. Applet process 42 executes under web browser 38 and is operable to communicate with client thread 28 across persistent TCP/IP socket connection 44. In one embodiment of the present invention, client thread 28 and applet process 42 using a web/emulator data flow. Applet process 42 is further operable to provide a terminal session to a user of the client system 36. The terminal session can comprise a 3270, 5250, NVT or VT220 type terminal session. This terminal session provided by applet process 42 and client thread 28 is supported by a persistent TCP/IP socket connection which allows real-time time bidirectional communication with the legacy host system.

In one embodiment of the present invention, the applet process uses three threads to implement the terminal session. The applet process uses a READ thread, a WRITE thread and an EMULATION thread. The READ thread provides a buffer interface to persistent TCP/IP socket connection 44 and reads information from the socket. The WRITE thread

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provides a buffer interface to persistent TCP/IP socket connection 44 and writes to the socket. The EMULATION thread provides the user interface representing the terminal session on the legacy host system. In this embodiment, the applet process and the client thread communicate using a web/emulator data flow based upon the communication protocol that is set forth in APPENDIX A.

According to the present invention, a user of client system 36 can access data and applications on the legacy host system using web browser 38 where the access is provided through a persistent bidirectional connection to the legacy host system. Persistent TCP/IP socket connections 30 and 44 provide this persistent bidirectional connection to IBM host system 18 or UNIX host system 19 such that real-time host updates, security, encryption, help-desk support, and other real-time features are supported. One embodiment of the present invention uses SUN MICROSYSTEMS' JAVA technology and includes JAVA-capable web browsers 38 and embedded JAVA applet processes 42 to provide terminal session connectivity to client systems 36.

The present invention provides connectivity to legacy host systems such as IBM host system 18 and UNIX host system 19 through web browser 38 without the need for specialized emulation software to be manually loaded on each client system 36 and without the need for user programming. Web/emulator server 26 downloads applet code 34 to client system 36 when the uniform resource locator (URL) of the legacy host system is selected by the user. This is accomplished automatically without requiring service personnel to load software on client system 36.

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The present invention also allows the expansion of access to existing data and applications on legacy host systems from existing client systems 36 using existing network capabilities. The present invention provides a network environment 10 that allows the use of a public Internet/intranet environment 16 having web browser tools, such as JAVA tools, and web-serving to incorporate Internet-type technologies, through the Internet or an intranet, with existing network architectures. Thus, an organization can implement web browser 38 based access to legacy host systems, such as IBM host systems 18 and UNIX host systems 19, without scrapping or significantly restructuring existing network resources.

FIG. 2 is a flow chart of a method for connecting a client system to a legacy host system using a web/emulator server according to the teachings of the present invention.

In step 50, a uniform resource locator (URL) associated with a legacy host system is selected from a web browser executing on a client system. The web browser can comprise a JAVA-capable NETSCAPE NAVIGATOR web browser as mentioned above. The selected uniform resource locator is received by a web/emulator server in step 52. In step 54, the web/emulator server downloads executable code for an applet process to the client system for connecting to the legacy host system In step 56, the client system executes the applet process under the web browser. The applet process can comprise a JAVA applet for execution within a JAVA virtual machine within the NETSCAPE NAVIGATOR web browser.

In step 57, the applet process connects to a client thread executed by the web/emulator server, and the client thread connects to the legacy host system across persistent TCP/IP socket connections. In step 58, the client thread then com-

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municates with the legacy host system across the persistent TCP/IP socket connection. This communication allows the client thread to establish and maintain a terminal connection to the legacy host system. In step 60, the client thread communicates with the applet process across a persistent TCP/IP socket connection. This communication can be accomplished using a web/emulator data flow such as that based upon the communication protocol set forth in APPENDIX A.

In step 62, the applet process provides a terminal session to a user of the client system. According to the present invention, this terminal session allows real-time bidirectional communication with the legacy host system across a persistent TCP/IP socket connection to the legacy host system. This terminal session, as mentioned above, can comprise a 3270, 5250, NVT or VT220 type terminal session.

The terminal session can be terminated by the user of the client system as desired. The applet process and client thread are terminated, in step 64, when the terminal session is terminated. In one embodiment, after termination, the applet process is removed from execution memory and is no longer present on the client system. In another embodiment, the executable code for the applet can be stored on a data storage device associated with the client system. In this embodiment, the web/emulation server can check the client system to determine whether new executable code for the applet needs to be downloaded based upon the version present, if any, on the data storage device of the client system.

The present invention provides an interface to legacy data flows, such as telnet (TN) data flows, across persistent TCP/IP socket connections to give users persistent bidirec-

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tional access to legacy host system data in terminal sessions, such as 3270, 5250, NVT and VT220 type terminal sessions. According to the present invention, terminal emulation is partially provided by applet executable code downloaded from the web/emulation server. The user can select the uniform resource locator (URL) of the legacy host system via a web browser package, such as NETSCAPE's NETSCAPE NAVIGATOR, and transparently receive the applet code which is executed and invokes an appropriate terminal session.

The present invention provides users of the client system access to real-time legacy host system data and applications using a web browser The web/emulator server system converts standard legacy data flows into web/emulator data flows and vice versa permitting multi-session, multi-protocol access to legacy data and applications. The applet process converts the web/emulator data flows into a terminal session for display to the user. As mentioned above, the web browser can comprise a JAVA-capable web browser, the applet process can be a JAVA applet, and the web/emulator data flow can be based upon the protocol set forth in Appendix A. This embodiment of the present invention can blend web browsers enhanced by SUN MICROSYSTEMS' JAVA with legacy host systems having TCP/IP connectivity to allow users on any client system platform to connect to and access legacy host systems via 3270, 5250, NVT and VT220 type terminal emulation.

FIG. 3 is a block diagram of load-balancing across multiple web/emulator servers according to the teachings of the present invention An HTTP server 70 is coupled to a client system 72. HTTP server 70 receives request information, REQUEST, from client system 72 in the form of a uniform resource locator (URL) and provides redirection information, REDIRECT, to client system 72. Client

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system 72 is then coupled to one of a plurality of web/emulation servers 74 according to the redirection information. In this manner HTTP server 70 can redirect access by a plurality of client systems 72 to manage the load on web/emulation servers 74 to ensure a balance across all available web/emulation servers 74.

This load-balancing can remain transparent to a user of client system 72. The user enters the uniform resource locator associated with the legacy host system That information is transmitted to HTTP server 70 as a request. HTTP server 70 interprets the request, identifies the selected legacy host system. and selects a web/emulation server 74 to manage the connection. This selection of a web/emulation server 74 can be based upon information of the current loading of each web/emulation server 74. HTTP server 70 transparently provides redirect information to client system 72 which identifies the uniform resource locator of the selected web/emulation server 74. Client system 72 then initiates the above described terminal session through the selected web/emulation server 74 and the selected web/emulation server 74 connects to the legacy host system as described above.

The present invention provides web browser connectivity with relatively low initial and recurring cost. The need for individual emulation software products based upon each particular client system is removed. This eliminates many technical support. help desk and software distribution problems, including version level control and configuration management issues. Extensive user training is no longer necessary because web browsers generally offer intuitive common user interfaces and are known by many users. Implementation time is improved by taking advantage of an existing widely-installed web browser base. Specifically. the

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platform independence provided by the JAVA architecture allows the web browser terminal emulator of the present invention to avoid problems with operation differences between computer environments. In addition, numerous users can be supported concurrently by each web/emulation server For example, the OC://WEBCONNECT™ product from OPENCONNECT SYSTEMS can support a thousand users per instance.

The present invention provides connectivity from any client system, such as a personal computer or computer workstation, to a legacy host system, such as a mainframe or mid-range system, without costly redesign or rebuilding of legacy applications. The benefits of a distributed client/server type data exchange can be realized without requiring systems redesign. This approach means that the many advantages of Internet-type access and functionality can be blended into an organizations network architecture simply and efficiently, thus protecting existing information technology infrastructures and investments.

Although the present invention has been described in detail, it should be understood that various changes, substitutions and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

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APPENDIX A

The following provides one implementation of a communication protocol for web/emulation data flow between a client thread and an applet process. (For all values with a length, length = 0 indicates the field is not present. All fields are byte values.)

Client (applet process) to Server (client thread)

Connect Session

/ S / emutype / hostlen / hostname .../ lunamelen / luname ... / portnolen / portno ... / sessionlen sessionname...

emutype: Emulation type to create 01 = 3270, 02 = 5250, 04 @ VT220 *hostlen, hostname:* length and content of gateway hostname to connect with *lunamelen, luname:* length and content of luname name for session

portnolen, portno: length and content of port number (as ASCII text) for gateway *sessionlen, sessionname:* length and content of session name

Field Update

/ F / reason / reasonparm / curposhigh / curposlow / fieldcounthigh / fieldcountlow / bufposhigh / bufposlo lengthy / lengthlow / fieldchars

reason: Reason for field update. 0 1 = Unsolicited, 02 - reply to Query Field Update from server.

reasonparm: If reason = 01, AID value from client. If *reason = 02, reasonparm from* Query Field Update command from server.

curposhigh, curposlow: Cursor Position at time of update

fieldcounthigh, fieldcountlow: count of fields

bufposhigh, bufposlow: Buffer position of field

lengthy, lengthlow: Length of field data (16 bits)

fieldchars: field data in ASCII

row, column, length,fieldchars ... are repeatedfieldcount times.

NVT Keystroke

/ N / asciikey

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asciikey: value of keystroke as an ASCII character

Run Script
/ R / *scriptnamelen* / *scriptname*...
scriptnamelen, scriptname: length and name of TCL script to execute

Query Help Desk
/ H /

Process Emulation Keystroke
/ K / *keyvaluehigh I keyvaluelow*
keyvaluehigh I keyvaluelow: Emulation key value to process

Server (client thread) to Client (applet process)

Erase Display
/ E /

Set Display Size
/ S / *rows* / *columns*
rows: Number of rows for display
columns: Number of columns for display

Set Cursor Position
/ C / *bufposhigh, bufposlow*
bufposhigh, bufposlow: Position for cursor

Display Text
/ D / *bufposhigh I bufposlow I lengthhigh I lengthlow I text*...
bufposhigh, bufposlow: Position for text (Ignored when in NVT mode) *lengthhigh, lengthlow:* Len-th of text (16 bits)
text: ASCII text for display

OIA Text
/ O / *column* / *length* / *oiatext* ...

Field List
/ F / *fieldcounthigh, fieldcountlow* / *bufposhigh* / *bufposlow* / *fieldattr* / *xattr* / *lengthhigh* / *lengthlow fieldcounthigh, fieldcountlow:* Number of fields (0 = unformatted screen) *bufposhigh, bufposlow:* Position for start of field *fieldattr:* Field attribute byte

3270 bits	definition use
0	Modified Data Tag (I = field modified)
0	Reserved (0)

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2 - 3 00 = Display/non-detectable, 01 = Display/detectable, 10=Intensitied Display/detectable, 11 =Nondisplay/non-detectable
4 0= Alphanumeric, 1 = Numeric
5 0 = Unprotected, 1 = Protected

xattr: Field extended attribute byte 3270 Definition

3270 Definition

bits	use
7	field mark
6	unused
5	transparent/opaque
4-3	highlighting (00=default, 01 =blinking, 10=reverse, 11=underline)
2-0	color(00 1=blue, 010= red, 011=pink, 100=green, 101=turquoise,110=yellow, 111=white)

lengthhigh, lengthlow: length of field (16 bits, may wrap off initial row)

bufposhigh, btifposlow, fieldattr. lengthhigh, lengthlow are repeatedfieldcounthigh, fieldcountlow times.

Character Override Attribute List

/A / attrcounthigh / attrcountlow / bufposhigh / bufposlow / lengthhigh / lengthlow / attrbyte1

attrcounthigh, attrcountlow: Count of attributes

bufposhigh, biifposlow: Position of attribute

lengthhigh, lengthlow: length of field (16 bits, may wrap off initial row)

attrbyte1: Attribute byte 1

3270 bits	Definition use
0 - 2	color bits (1 = Blue, 2 = Red, 3 = Pink, 4 = Green, 5 = Turquoise, 6 = Yellow, 7 =White)
3 - 4	Extended highlighting (mutually exclusive)(01= Blinking, 10 = Reverse, 11 = Underline)
7	Field mark (1= Start of field position)

bufposhigh, bufposlou,, lengthhigh, lengthlow, attrbyte1 are repeated *attrcounthigh, attrcountlow times.*

Query Field Update

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/ Q / *reasonparm*
reasonparm: Reason value returned in Field Update message from client

Set NVT Mode
/ N / *nvtmode*
nvtmode: 00 = Emulation mode, 0 1 = NVT mode

Keyboard Lock State
/ K / *mode*
mode: 00 = KB Free, 01 = KB Locked

Sound Alarm
/ B / *length* / *filenametext* ...
length - Length of filename
filenametext: Name of audio file for alarm

Error Message
/ M / *length* / *messagetext*...
length, messagetext: Length and content of error message

Protocol Version
/ V / *verhigh* / *verlow*
verhigh, verlow: Protocol version number

Help Desk Reply
/ H /
length / *versionstr:* Server version
sessionIDhigh / *sessionIDlow:* server session ID for this client connection
emulationtype: 01 = 3270, 02 = 5250
(if emulation type is 3270)
displaytype: 00 = 3278, 01 = 3279, 02 = 3179, 03 = 3472
status: 00 = Unowned, 01 = SSCP, 02 =LULU
defaultPartition. default model size 2 - 5
alternatepartition: alternate model size 2 - 5
currentpartition: current model size 2 - 5
(if emulation type is 5250)
displaytype: 00 = 3477, 01 = 3179, 02 = 5151, 03 = 3196
screensize: screen size, 2 or 5
ocserver: 01= connected to OC server, 00 = other type of server
ptsoverride: 01 = passthru screen override, 00 = no override

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monochrome: 00= color, 01 = monochrome
protocoltype: 0 1 = RUI, 02 =TN
(if protocol type is RUI)
length /requstedLUname: configured LU name
length/grantedLUname: LU name returned by server
length/ruiversion: Version of RUI support in use
sessIDhigh I sessIDlow: RUI session ID
(if protocol type is T-N)
length, termTypeString: terminal type string negoiated with TN server *is*
TN3270EI: 00 = not 3270E, 01 = using 3270E
length, devicename: device name in use
length, puLuName: PU/LU name for session (OCS gateways only)
transporttype. 00= None (valid if protocol is RUI), 01 = Network (if transport type is Network)
length, configuredHostName: host name in session configuration
length, configuredport: port in session configuration
length, connectedHostName: host name (ip address) in actual use
length, connectedport: port in actual use

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What is claimed is:

1. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

2. The server of claim 1, wherein the client thread and the applet process are operable to communicate using a data flow based upon a specified communication protocol.

3. The server of claim 2, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the data flow used by the applet process.

4. The server of claim 3, wherein the applet code comprises executable code for a JAVA applet to be executed under a JAVA-capable web browser.

5. The server of claim 4, wherein the first and second persistent connections are persistent TCP/IP socket connections.

6. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy

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host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

7. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using a NVT data flow and the applet process is operable to provide a NVT type terminal session.

8. A server for providing a persistent connection between a client system and a legacy host system, comprising:

a client thread operable to communicate with a legacy host system across a first persistent connection; and

applet code operable to create an applet process executing under a web browser on a client system, the applet

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process operable to communicate with the client thread across a second persistent connection and to provide a terminal session to a user of the client system;

the server operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system;

wherein the client thread is operable to communicate using an VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

9. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

10. The web browser terminal emulator of claim 9, wherein the client thread and the applet process are operable to communicate using a data flow based upon a specified communication protocol.

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11. The web browser terminal emulator of claim 10. wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the data flow used by the applet process.

12. The web browser terminal emulator of claim 11. wherein the applet process comprises a JAVA applet executing under a NETSCAPE NAVIGATOR web browser.

13. The web browser terminal emulator of claim 12. wherein the first and second persistent connections are persistent TCP/IP socket connections.

14. A computer network environment allowing connection of a client system to a legacy host system using a server. the computer network environment comprising:

a legacy host system having TCP/IP connectivity. the legacy host system operable to support a terminal session for access to the legacy host system.

a server system executing a client thread under a server. the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser. the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN3270 data flow and the applet process is operable to provide a 3270 type terminal session.

15. The computer network environment of claim 14. wherein the client thread and the applet process are operable to communicate using a data flow based upon a specified communication protocol.

16. The computer network environment of claim 15, wherein the client thread is further operable to interface between a legacy data flow used by the legacy system and the data flow used by the applet process.

17. The computer network environment of claim 16, wherein the applet process comprises a JAVA applet executing under a NETSCAPE NAVIGATOR web browser.

18. The computer network environment of claim 17, wherein the first and second persistent connections are persistent TCP/IP socket connections.

19. The computer network environment of claim 14, wherein the legacy host system comprises a mainframe computer system.

20. The computer network environment of claim 14, wherein the legacy host system comprises a mid-range computer system.

21. The computer network environment of claim 14, wherein the legacy host system comprises a computer workstation executing a UNIX environment.

22. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

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such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

23. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

24. A computer network environment allowing connection of a client system to a legacy host system using a server, the computer network environment comprising:

a legacy host system having TCP/IP connectivity, the legacy host system operable to support a terminal session for access to the legacy host system;

a server system executing a client thread under a server, the client thread operable to communicate with the legacy host system across a first persistent connection; and

a client system executing an applet process under a web browser, the applet process operable to communicate with the client thread across a second persistent connection and operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

25. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy

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host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing a 3270 type terminal session.

26. The method of claim 25, wherein communicating between the client thread and the legacy host system is accomplished using a legacy data flow.

27. The method of claim 26, wherein communicating between the client thread and the applet process is accomplished using a data flow based upon a specified communication protocol.

28. The method of claim 27, wherein executing the applet process comprises executing a JAVA applet under a NETSCAPE NAVIGATOR web browser.

29. The method of claim 25, wherein the first and second persistent connections are persistent TCP/IP socket connections.

30. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

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connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing a 5250 type terminal session.

31. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

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communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing an NVT type terminal session.

32. A method for connecting a client system to a legacy host system using a server, comprising:

receiving a uniform resource locator by a server executing on a server system, the uniform resource locator associated with a legacy host system and selected from a web browser executing on a client system;

downloading executable code for an applet process to the client system;

executing the applet process under the web browser on the client system;

connecting the applet process to a client thread executing under the server via a first persistent connection;

connecting the client thread to a legacy host system associated with the uniform resource locator via a second persistent connection;

communicating between the client thread and the legacy host system across the first persistent connection;

communicating between the client thread and the applet process across the second persistent connection; and

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providing a terminal session to a user of the client system by the applet process, the terminal session allowing real-time bidirectional communication with the legacy host system across a persistent connection to the legacy host system;

wherein providing a terminal session comprises providing a VT220 type terminal session.

33. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a TN5250 data flow and the applet process is operable to provide a 5250 type terminal session.

34. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

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an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using an NVT data flow and the applet process is operable to provide an NVT type terminal session.

35. A web browser terminal emulator for connecting a client system to a legacy host system, comprising:

a client thread executing under a server on a server system, the client thread operable to communicate with a legacy host system across a first persistent connection; and

an applet process executing under a web browser on a client system, the applet process operable to communicate with the client thread across a second persistent connection, and the applet process further operable to provide a terminal session to a user of the client system;

such that the terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system;

wherein the client thread is operable to communicate using a VT220 data flow and the applet process is operable to provide a VT220 type terminal session.

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ABSTRACT

A computer network environment (10) allowing connection of a client system (36) to a legacy host system (18.19) using a server (26) is provided. The computer network environment (10) includes a legacy host system (18.19) having TCP/IP connectivity. The legacy host system (18.19) is operable to support a terminal session for access to the legacy host system (18.19). The computer network environment (10) also includes a server system (24) executing a client thread (28) under a server (26). The client thread (28) is operable to communicate with the legacy host system (18.19) across a persistent TCP/IP socket connection (30). The computer network environment (10) further includes a client system (36) executing an applet process (42) under a web browser (38). The applet process (42) is operable to communicate with the client thread (28) across another persistent TCP/IP socket connection (44) and is operable to provide a terminal session to a user of the client system (36). This terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system (18.19).

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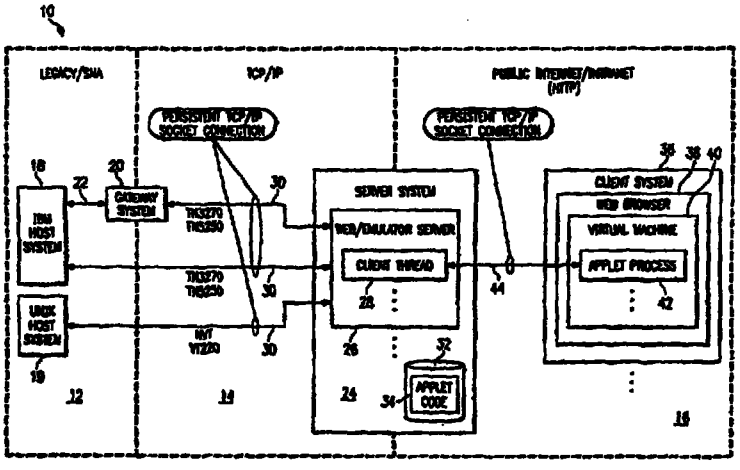
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(54) Title: WEB/EMULATOR SERVER AND WEB BROWSER TERMINAL EMULATOR FOR PERSISTENT CONNECTION TO A LEGACY HOST SYSTEM OPERATION



(57) Abstract

A computer network environment (10) allowing connection of a client system (36) to a legacy host system (18, 19) using a web/emulator server (26) is provided. The computer network environment (10) includes a legacy host system (18, 19) having TCP/IP connectivity. The legacy host system (18, 19) is operable to support a terminal session for access to the legacy host system (18, 19). The computer network environment (10) also includes a server system (24) executing a client thread (28) under a web/emulator server (26). The client thread (28) is operable to communicate with the legacy host system (18, 19) across a persistent TCP/IP socket connection (30). The computer network environment (10) further includes a client system (36) executing an applet process (42) under a web browser (38). The applet process (42) is operable to communicate with the client thread (28) across another persistent TCP/IP socket connection (44) and is operable to provide a terminal session to a user of the client system (36). This terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system (18, 19).

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SERVER AND WEB BROWSER TERMINAL EMULATOR FOR PERSISTENT CONNECTION TO A LEGACY HOST SYSTEM AND METHOD OF OPERATION

TECHNICAL FIELD OF THE INVENTION

This invention relates in general to the field of electronic systems, and more particularly to a server and a web browser terminal emulator for persistent connection to a legacy host system and a method of operation.

BACKGROUND OF THE INVENTION

Many organizations operate computer network environments that include legacy host systems which store data and provide applications important to the operation of the organization. Such legacy host systems can include IBM mainframes (MVS, VM and VSE environments), IBM AS/400 systems and UNIX host systems.

It is desirable for such organizations to provide connection to the legacy host systems through terminal sessions on distributed client systems such as personal computers and computer workstations. This connection to the legacy host system provides access for users of the client systems to the data and applications on the legacy host system. These terminal sessions can include 3270, 5250, NVT and VT220 type terminal sessions.

One conventional method for providing terminal sessions is to execute a terminal emulator application on the client systems that connects directly to a host legacy system using a TCP/IP socket connection. Another

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conventional method is to provide connection through a web browser application by translating standard legacy data flows into HTML pages. However, such conventional web browser methods suffer from an inability to handle real-time host updates to user screens as well as other significant problems. For example, forms-based HTML/TN3270 packages are unable to overcome a range of problems associated with common HTML implementations such as real-time host updates to user screens or finding a user's browser platform address on the network.

SUMMARY OF THE INVENTION

In accordance with the present invention, a server and a web browser terminal emulator for persistent connection to a legacy host system and a method of operation are provided that substantially eliminate or reduce disadvantages and problems associated with previously developed methods.

According to one aspect of the present invention, a computer network environment allowing connection of a client system to a legacy host system using a server is provided. The computer network environment includes a legacy host system having TCP/IP connectivity. The legacy host system is operable to support a terminal session for access to the legacy host system. The computer network environment also includes a server system executing a client thread under a server. The client thread is operable to communicate with the legacy host system across a persistent TCP/IP socket connection. The computer network environment further includes a client system executing an applet process under a web browser. The applet process is operable to communicate with the client thread across another persistent TCP/IP socket connection and is operable to provide a terminal session to a user

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of the client system. This terminal session is supported by a persistent connection allowing real-time bidirectional communication with the legacy host system.

According to another aspect of the present invention, a server for providing a persistent connection between a client system and a legacy host system is provided. The server includes a client thread operable to communicate with a legacy host system across a persistent TCP/IP socket connection. The server also includes applet code operable to create an applet process executing under a web browser on a client system. When executed, the applet process is operable to communicate with the client thread across another persistent TCP/IP socket connection and to provide a terminal session to a user of the client system. The web/server emulator is operable to download the applet code to a client system in response to receiving a uniform resource locator associated with the legacy host system.

According to a further aspect of the present invention, a method is provided for connecting a client system to a legacy host system using a server. A uniform resource locator associated with a legacy host system is selected from a web browser executing on a client system. The uniform resource locator is received by a server executing on a server system. Executable code for an applet process is then downloaded to the client system, and the applet process is executed under the web browser on the client system. The applet process is connected to a client thread executing under the server via a persistent TCP/IP socket connection. The client thread is connected to a legacy host system associated with the uniform resource locator via another persistent TCP/IP socket connection. The client thread and the legacy host

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