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United States Patent [19]

Freund

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[45] **Date of Patent: Nov. 16, 1999**

[54] **SYSTEM AND METHODOLOGY FOR MANAGING INTERNET ACCESS ON A PER APPLICATION BASIS FOR CLIENT COMPUTERS CONNECTED TO THE INTERNET**

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[73] Assignee: **Zone Labs, Inc.**, San Francisco, Calif.

[21] Appl. No.: **08/851,777**

[22] Filed: **May 6, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/033,975, Dec. 31, 1996.

[51] **Int. Cl.**[6] **G06F 13/00**

[52] **U.S. Cl.** **713/201**

[58] **Field of Search** 395/187.01, 186; 364/222.5, 286.4, 286.5; 711/163; 707/9, 10, 203; 713/200, 201

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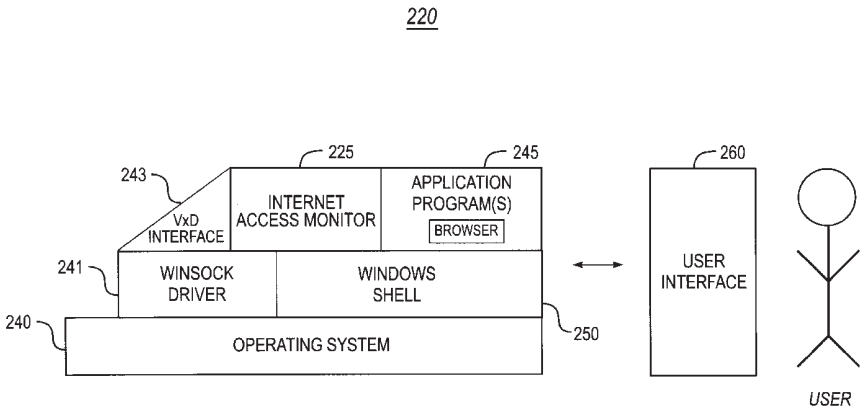
Assistant Examiner—Stephen C. Elmore
Attorney, Agent, or Firm—John A. Smart

[57] **ABSTRACT**

A computing environment with methods for monitoring access to an open network, such as a WAN or the Internet, is described. The system includes one or more clients, each operating applications or processes (e.g., Netscape Navigator™ or Microsoft Internet Explorer™ browser software) requiring Internet (or other open network) access (e.g., an Internet connection to one or more Web servers). Client-based monitoring and filtering of access is provided in conjunction with a centralized enforcement supervisor. The supervisor maintains access rules for the client-based filtering and verifies the existence and proper operation of the client-based filter application. Access rules which can be defined can specify criteria such as total time a user can be connected to the Internet (e.g., per day, week, month, or the like), time a user can interactively use the Internet (e.g., per day, week, month, or the like), a list of applications or application versions that a user can or cannot use in order to access the Internet, a list of URLs (or WAN addresses) that a user application can (or cannot) access, a list of protocols or protocol components (such as Java Script™) that a user application can or cannot use, and rules to determine what events should be logged (including how long are logs to be kept). By intercepting process loading and unloading and keeping a list of currently-active processes, each client process can be checked for various characteristics, including checking executable names, version numbers, executable file checksums, version header details, configuration settings, and the like. With this information, the system can determine if a particular process in question should have access to the Internet and what kind of access (i.e., protocols, Internet addresses, time limitations, and the like) is permissible for the given specific user.

30 Claims, 38 Drawing Sheets



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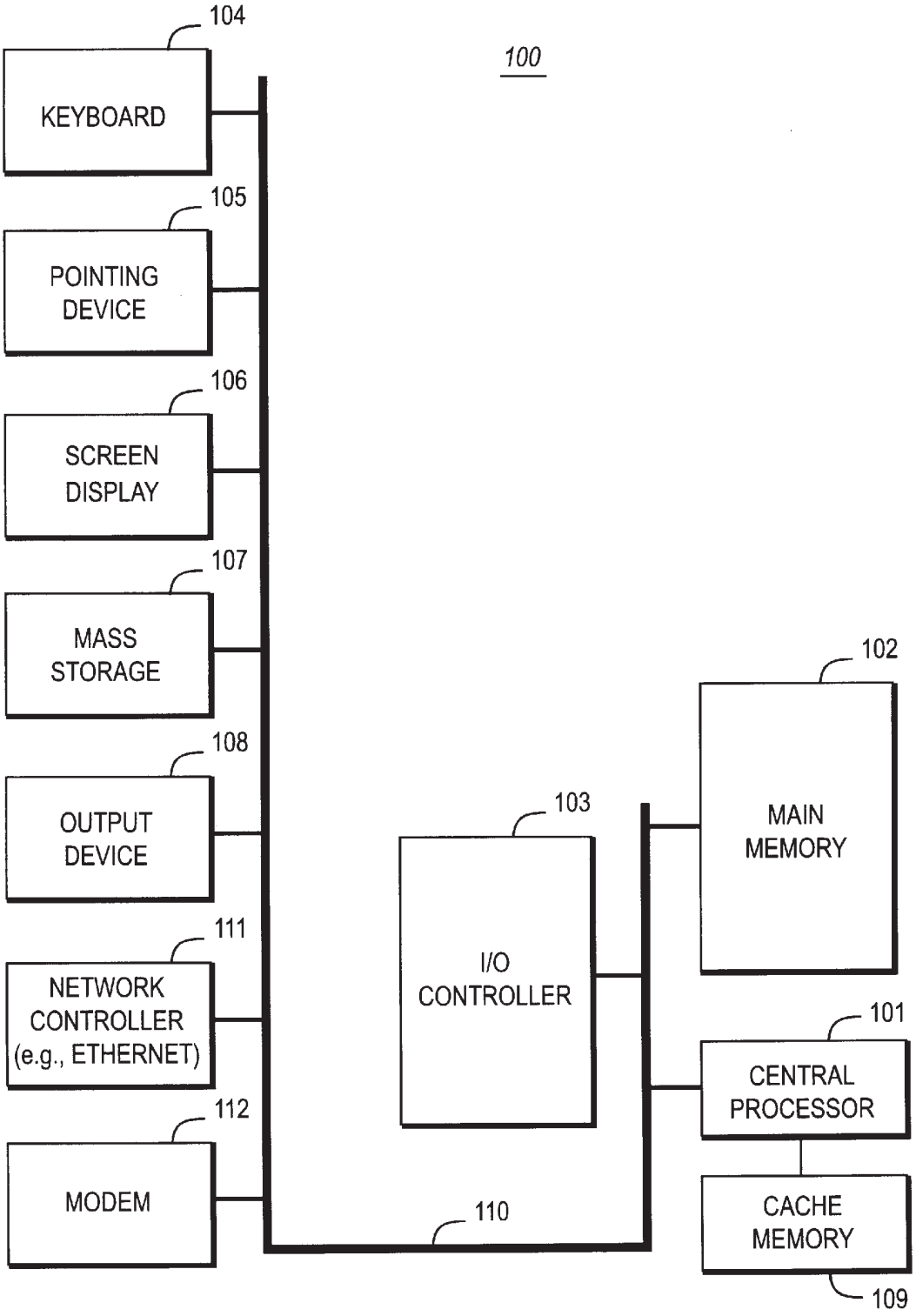
100
104
KEYBOARD
105
POINTING DEVICE
106
SCREEN DISPLAY
107
MASS STORAGE
108
OUTPUT DEVICE
111
NETWORK CONTROLLER (e.g., ETHERNET)
112
MODEM
103
I/O CONTROLLER
102
MAIN MEMORY
101
CENTRAL PROCESSOR
CACHE MEMORY
109
110

FIG. 1

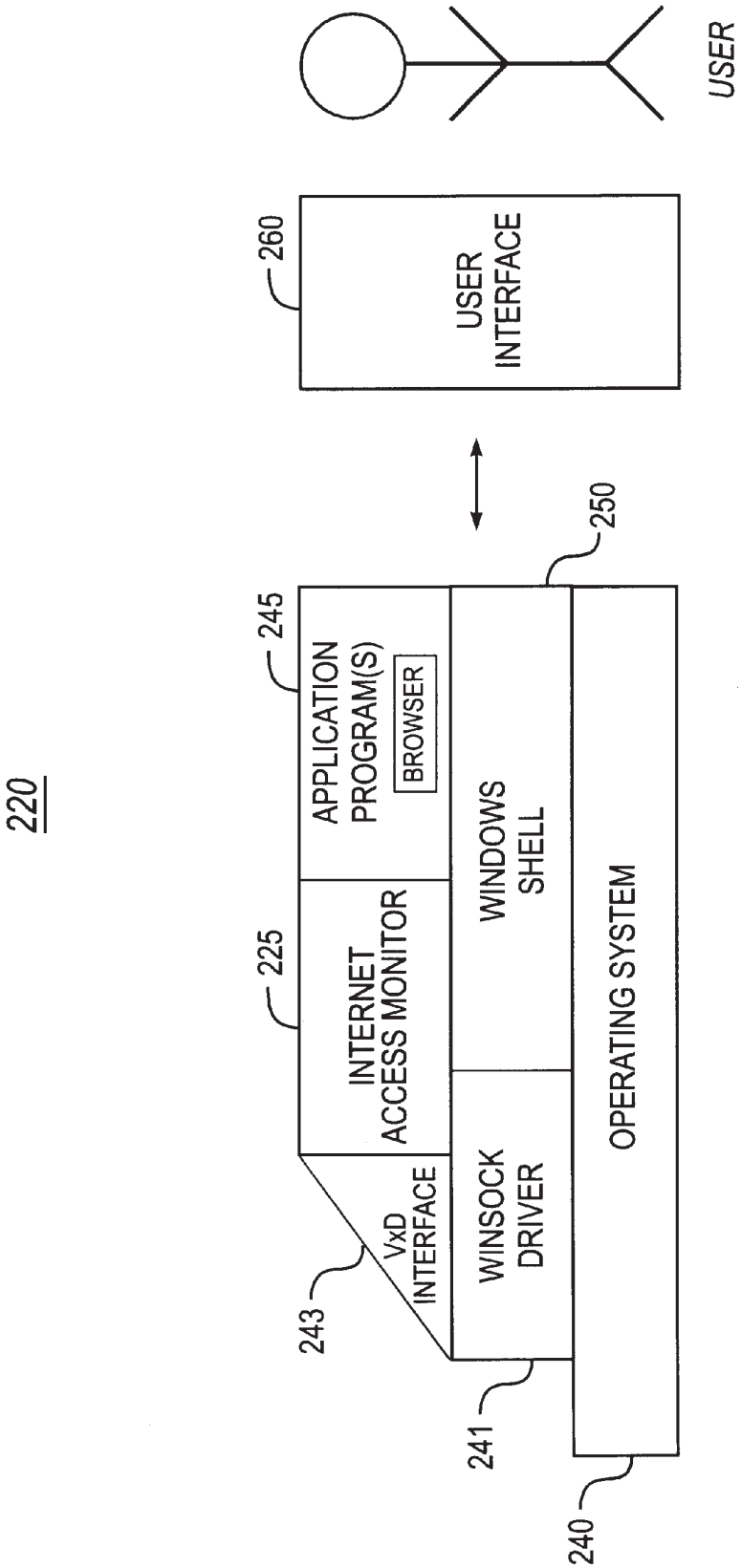
220
USER
260
USER INTERFACE
245
APPLICATION PROGRAM(S)
BROWSER
250
225
INTERNET ACCESS MONITOR
WINDOWS SHELL
OPERATING SYSTEM
243
VxD INTERFACE
WINSOCK DRIVER
241
240

FIG. 2

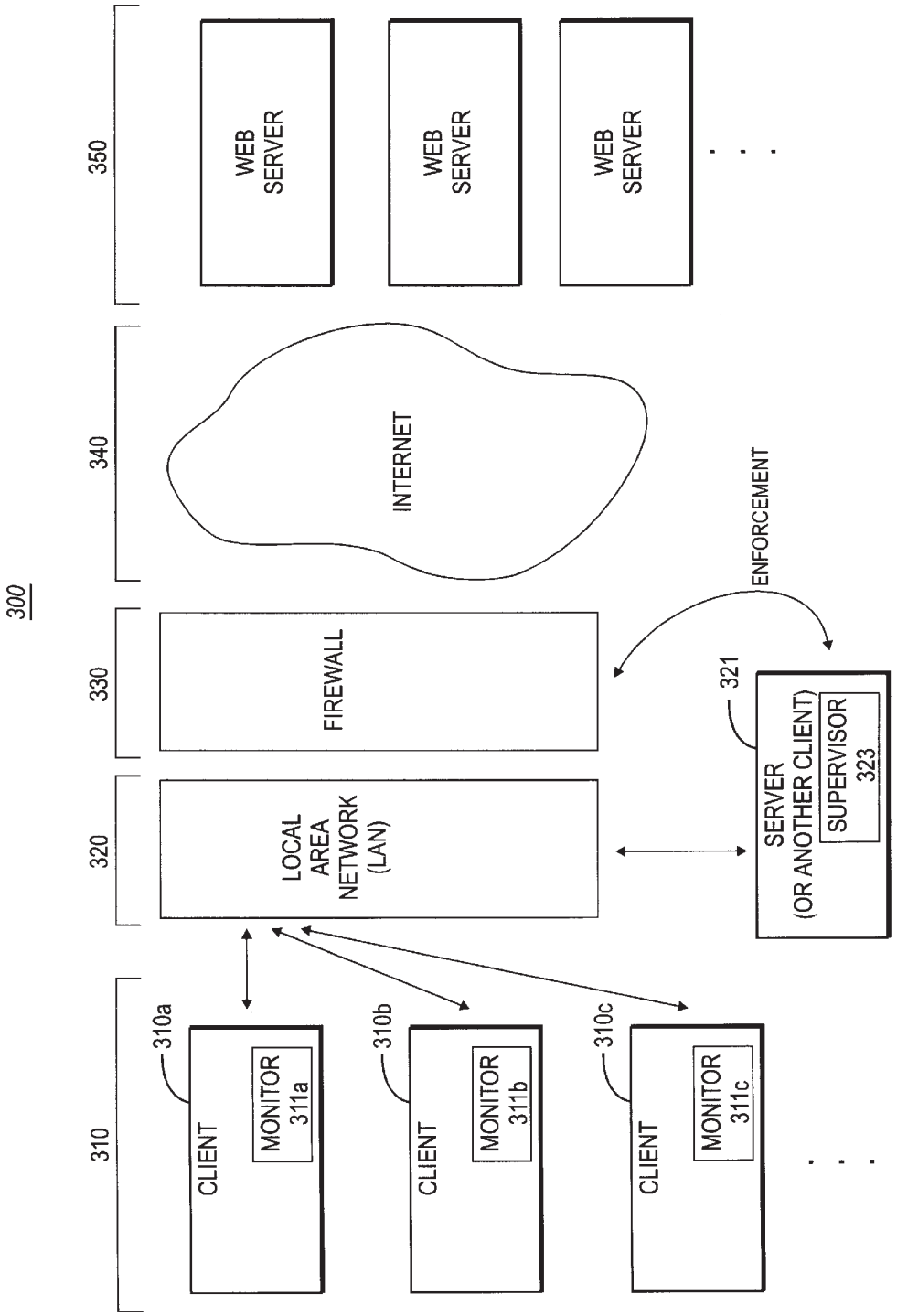
300
310
320
330
340
350
CLIENT
MONITOR 311a
310a
CLIENT
MONITOR 311b
310b
CLIENT
MONITOR 311c
310c
LOCAL AREA NETWORK (LAN)
FIREWALL
INTERNET
WEB SERVER
WEB SERVER
WEB SERVER
ENFORCEMENT
SERVER (OR ANOTHER CLIENT)
SUPERVISOR 323
321

FIG. 3A

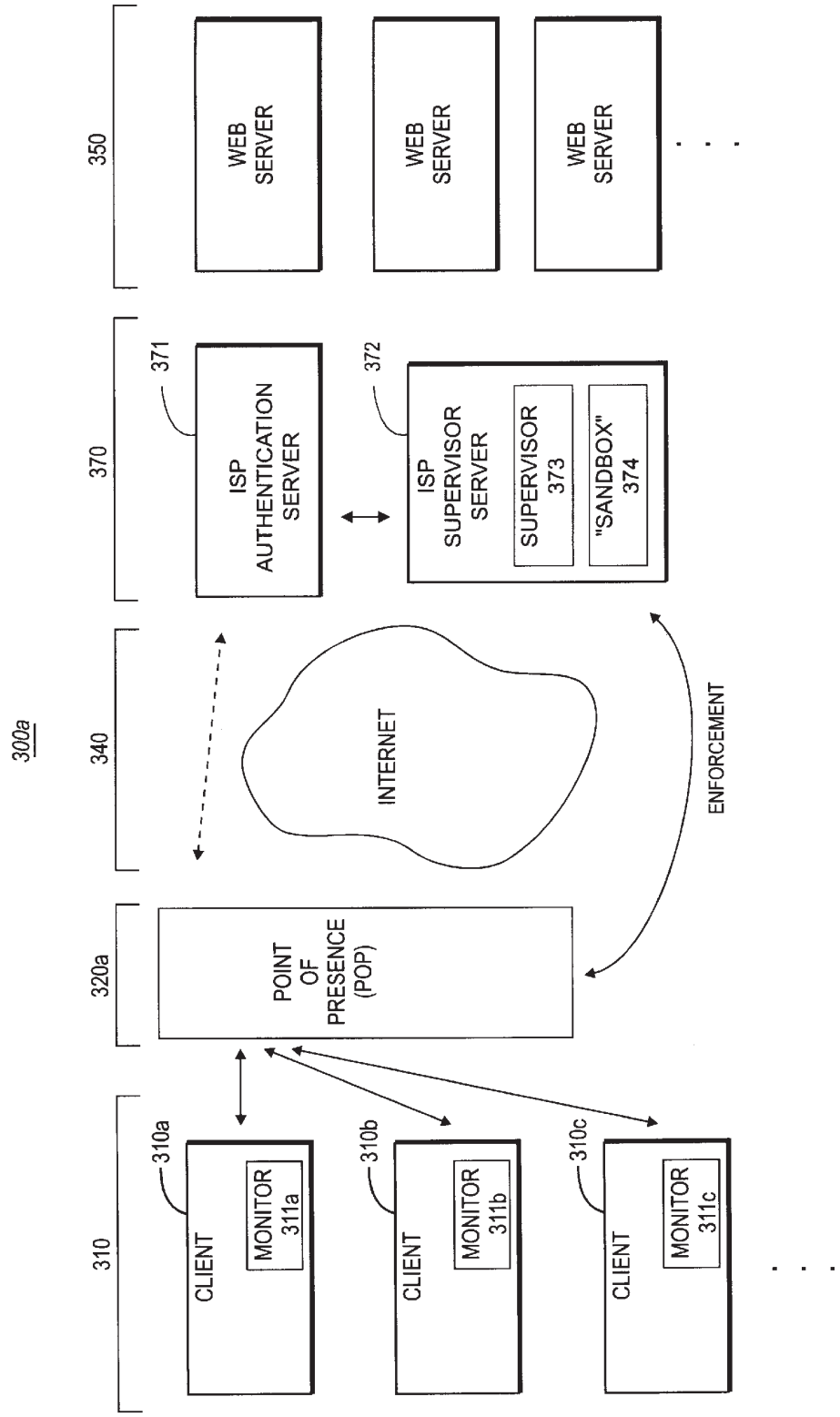
300a
310
320a
340
370
350
CLIENT
MONITOR 311a
310a
CLIENT
MONITOR 311b
310b
CLIENT
MONITOR 311c
310c
POINT OF PRESENCE (POP)
INTERNET
ISP AUTHENTICATION SERVER
371
ISP SUPERVISOR SERVER
SUPERVISOR 373
"SANDBOX" 374
372
ENFORCEMENT
WEB SERVER
WEB SERVER
WEB SERVER

FIG. 3B

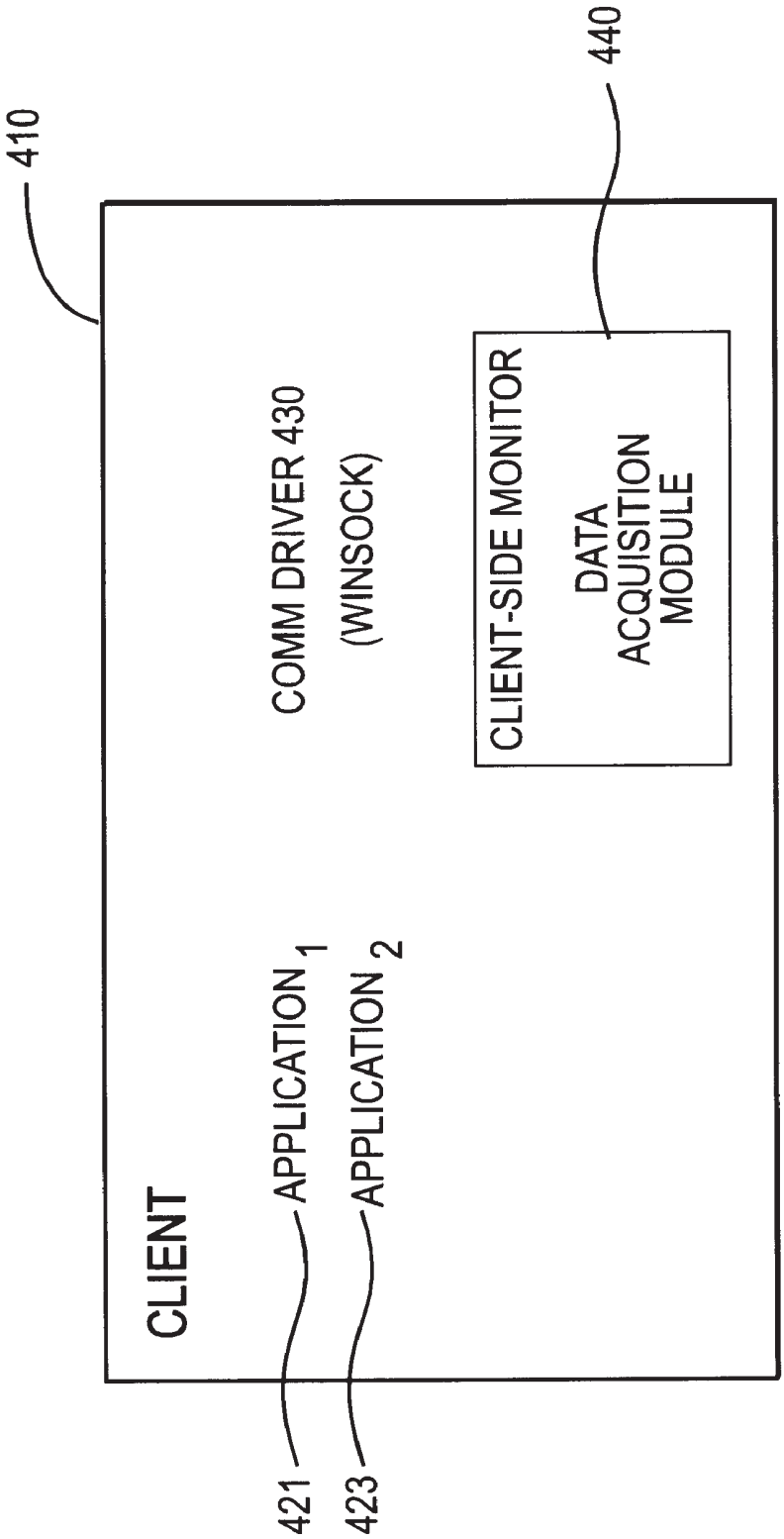
410
CLIENT
APPLICATION 1
APPLICATION 2
421
423
COMM DRIVER 430
(WINSOCK)
CLIENT-SIDE MONITOR
DATA
ACQUISITION
MODULE
440

FIG. 4

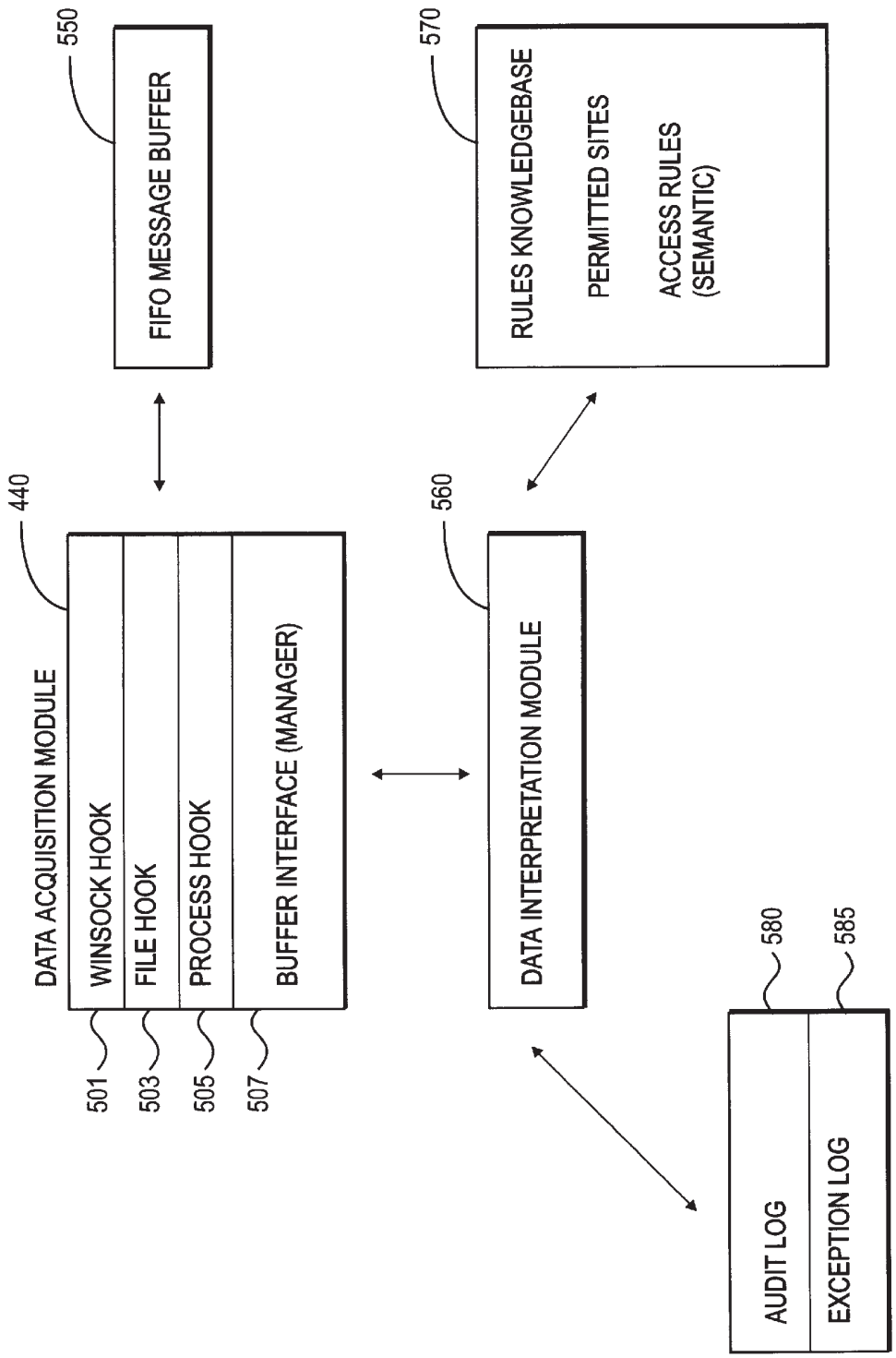
550
FIFO MESSAGE BUFFER
570
RULES KNOWLEDGEBASE
PERMITTED SITES
ACCESS RULES
(SEMANTIC)
440
DATA ACQUISITION MODULE
WINSOCK HOOK
FILE HOOK
PROCESS HOOK
BUFFER INTERFACE (MANAGER)
501
503
505
507
560
DATA INTERPRETATION MODULE
580
585
AUDIT LOG
EXCEPTION LOG

FIG. 5

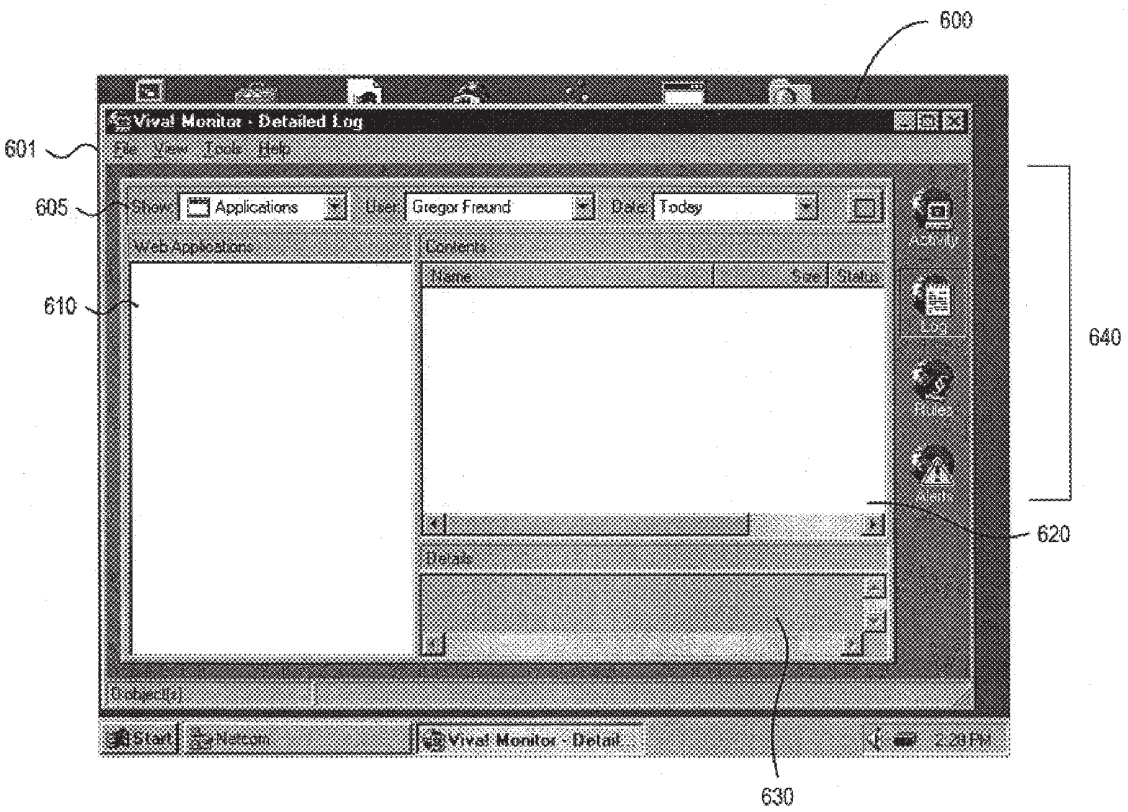
600
601
605
610
620
630
640
Vival Monitor - Detailed Log
File View Tools Help
Show: Applications
User: Gregor Freund
Date: Today
Web Applications
Contents
Name
Size
Status
Details
Start
Vival Monitor - Detail

FIG. 6A

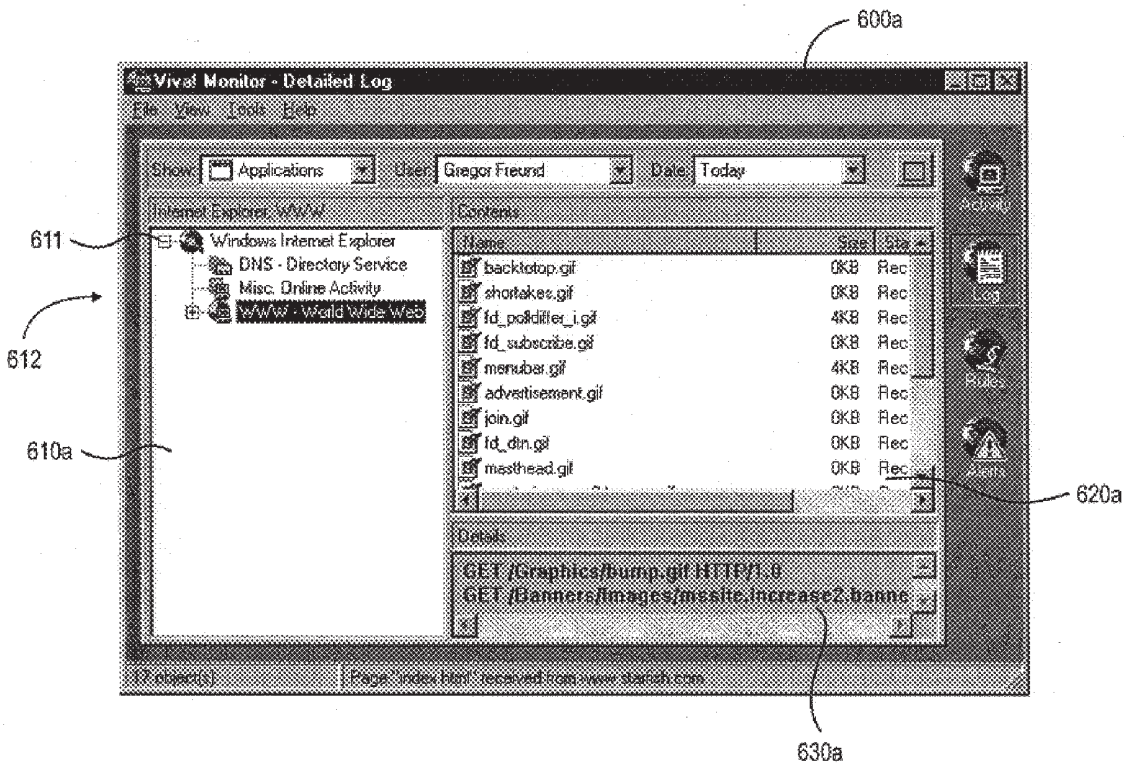
600a
Vivat Monitor - Detailed Log
File View Tools Help
Show: Applications
User: Gregor Freund
Date: Today
Internet Explorer, WWW
Contents
611
Windows Internet Explorer
DNS - Directory Service
Misc. Online Activity
WWW - World Wide Web
612
610a
backtotop.gif
shortakes.gif
fd_polldiffer_i.gif
fd_subscribe.gif
menubar.gif
advertisement.gif
join.gif
fd_dtn.gif
masthead.gif
620a
Details
GET /Graphics/bump.gif HTTP/1.0
630a

FIG. 6B

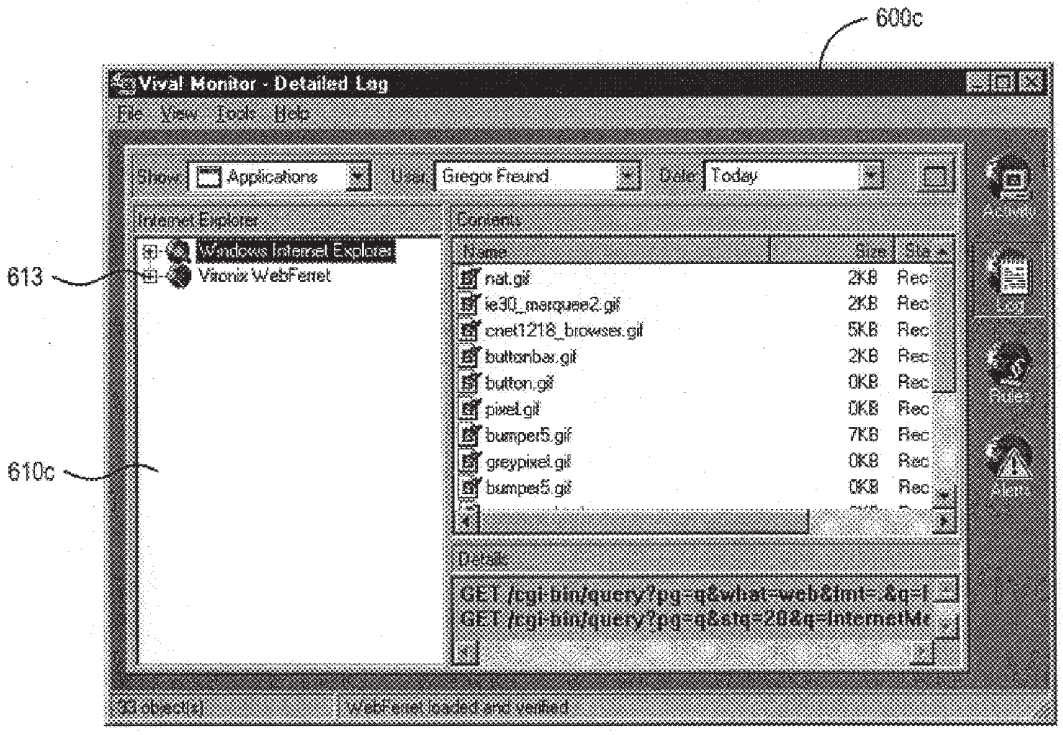
600c
Vival Monitor - Detailed Log
File View Tools Help
Show Applications
User Gregor Freund
Date Today
Internet Explorer
Windows Internet Explorer
Vitronix WebFerret
613
610c
Contents
Name
Size
nat.gif 2KB
ie30_marquee2.gif 2KB
cnet1218_browser.gif 5KB
buttonbar.gif 2KB
button.gif 0KB
pixel.gif 0KB
bumper5.gif 7KB
greypixel.gif 0KB
bumper5.gif 0KB
Detail
GET /cgi-bin/query?pg=q&what=web&lmt=.&q=I
GET /cgi-bin/query?pg=q&stq=20&q=InternetMr
33 object(s)
WebFerret loaded and verified

FIG. 6C

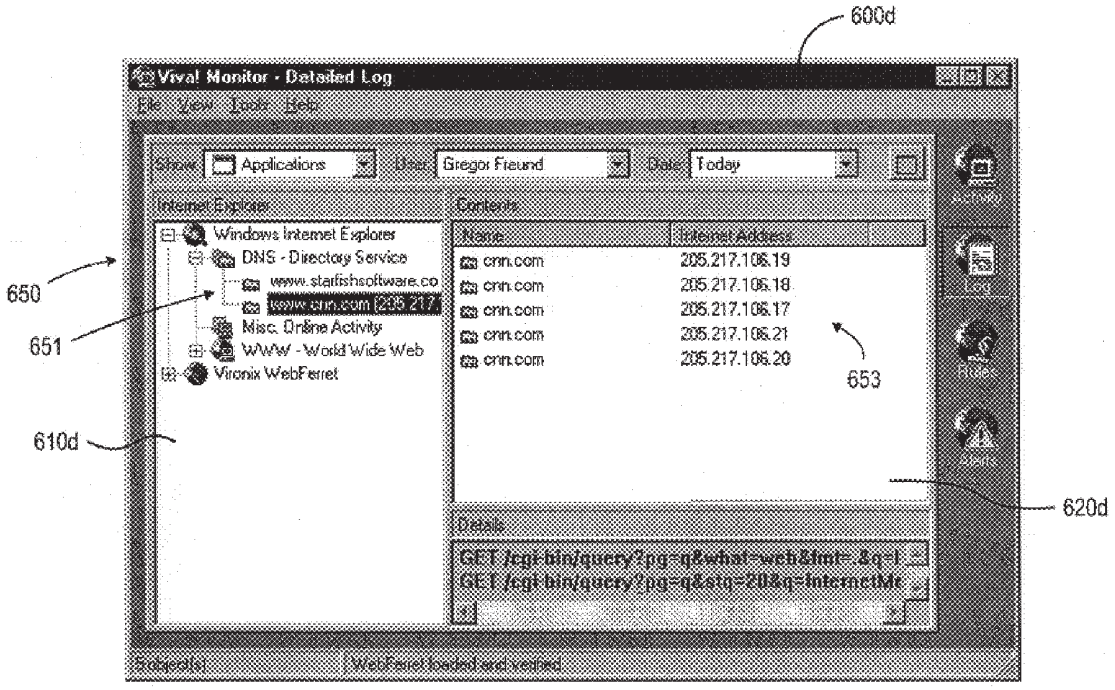
600d
Viva! Monitor - Detailed Log
File View Tools Help
Show
Applications
User
Gregor Freund
Date
Today
Internet Explorer
Contents
Windows Internet Explorer
DNS - Directory Service
www.starfishsoftware.co
www.cnn.com [205.217.
Misc. Online Activity
WWW - World Wide Web
Vironix WebFerret
Name
Internet Address
cnn.com 205.217.106.19
cnn.com 205.217.106.18
cnn.com 205.217.106.17
cnn.com 205.217.106.21
cnn.com 205.217.106.20
Details
650
651
610d
653
620d

FIG. 6D

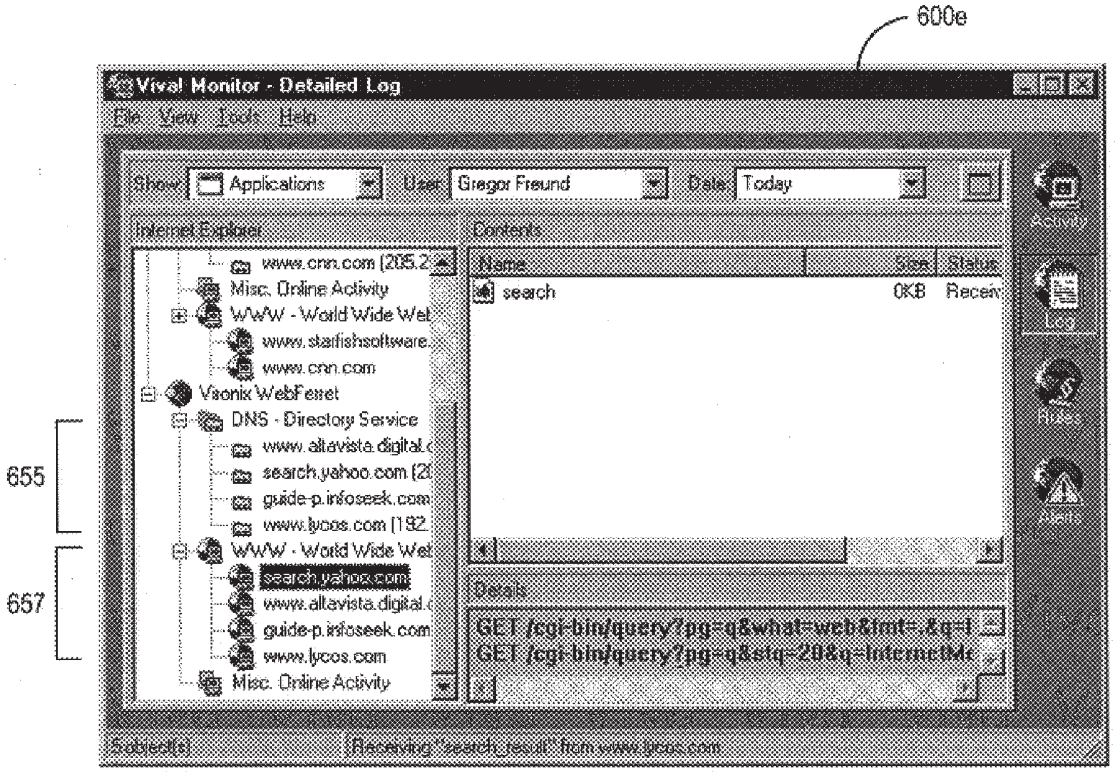
600e
Vivat Monitor - Detailed Log
File View Tools Help
Show Applications
User Gregor Freund
Date Today
Internet Explorer
Contents
www.cnn.com (205.2
Misc. Online Activity
WWW - World Wide Wet
www.starfishsoftware.
www.cnn.com
Vaonix WebFerret
DNS - Directory Service
www.altavista.digital.
search.yahoo.com (2
guide-p.infoseek.com
www.lycos.com (192.
WWW - World Wide Wet
search.yahoo.com
www.altavista.digital.
guide-p.infoseek.com
www.lycos.com
Misc. Online Activity
Name
Size
Status
search
0KB
Recen
Details
GET /cgi-bin/query?pg=q&what=web&fmt=.&q=
GET /cgi-bin/query?pg=q&stq=20&q=InternetMe
Activity
Log
Rules
Alerts
5 object(s)
Receiving "search_result" from www.lycos.com
655
657

FIG. 6E

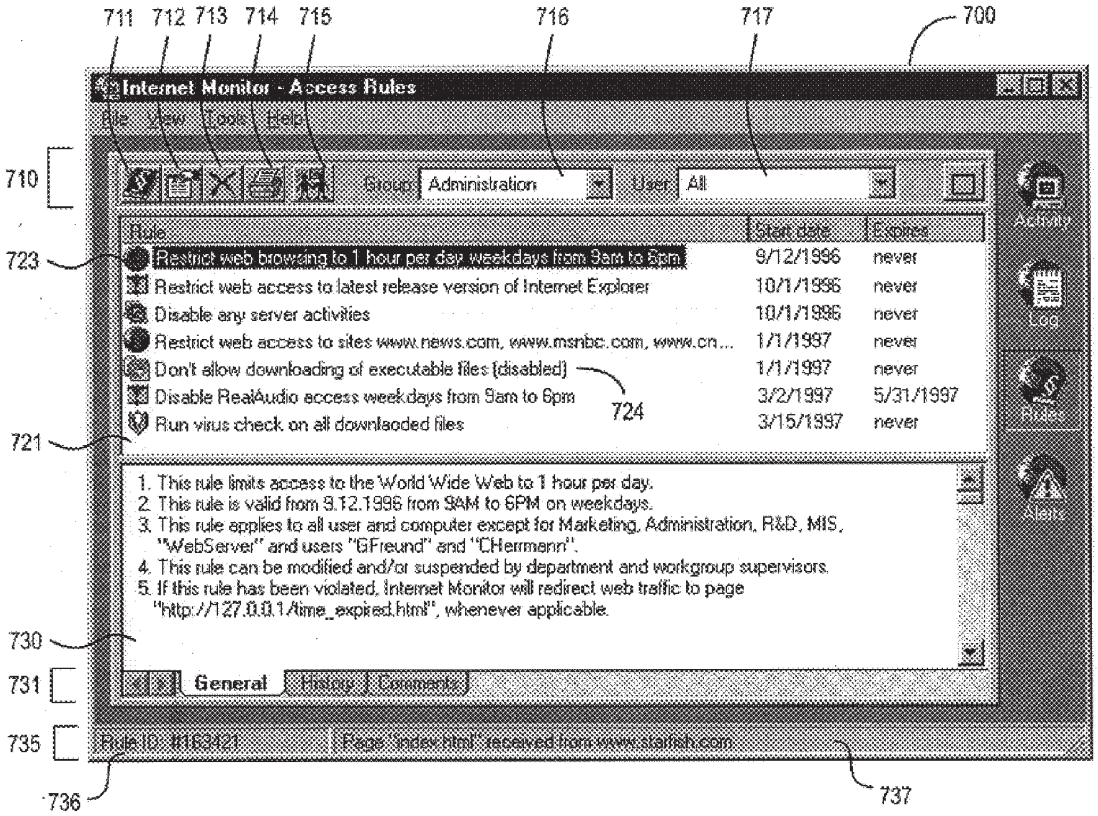
711
712
713
714
715
716
717
700
Internet Monitor - Access Rules
File View Tools Help
710
Group Administration
User All
Rule
Start date
Expires
723
Restrict web browsing to 1 hour per day weekdays from 9am to 6pm 9/12/1996 never
Restrict web access to latest release version of Internet Explorer 10/1/1996 never
Disable any server activities 10/1/1996 never
Restrict web access to sites www.news.com, www.msnbc.com, www.cn... 1/1/1997 never
Don't allow downloading of executable files (disabled) 1/1/1997 never
Disable RealAudio access weekdays from 9am to 6pm 3/2/1997 5/31/1997
Run virus check on all downloaded files 3/15/1997 never
724
721
1. This rule limits access to the World Wide Web to 1 hour per day.
2. This rule is valid from 9.12.1996 from 9AM to 6PM on weekdays.
3. This rule applies to all user and computer except for Marketing, Administration, R&D, MIS, "WebServer" and users "GFreund" and "CHermann".
4. This rule can be modified and/or suspended by department and workgroup supervisors.
5. If this rule has been violated, Internet Monitor will redirect web traffic to page "http://127.0.0.1/time_expired.html", whenever applicable.
730
731
General
History
Comments
735
Rule ID: ff163421
Page "index.html" received from www.starish.com
736
737
Activity
Log
Rules
Alerts

FIG. 7A

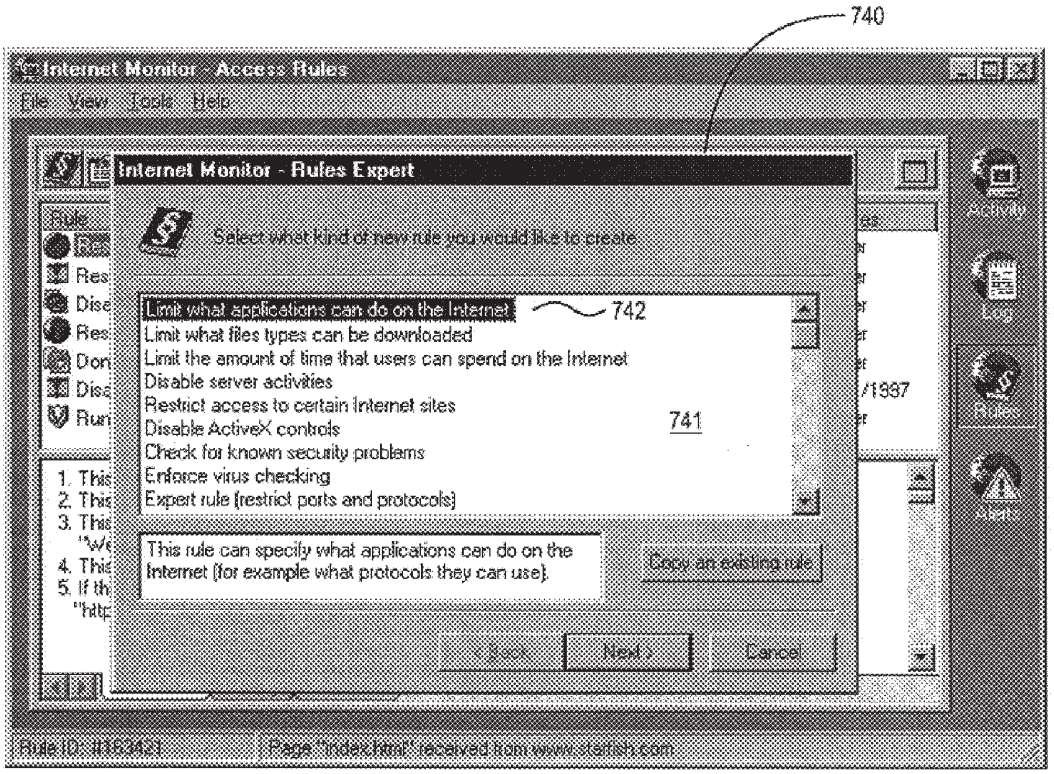
740
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Select what kind of new rule you would like to create
Limit what applications can do on the Internet
742
Limit what files types can be downloaded
Limit the amount of time that users can spend on the Internet
Disable server activities
Restrict access to certain Internet sites
Disable ActiveX controls
741
Check for known security problems
Enforce virus checking
Expert rule (restrict ports and protocols)
This rule can specify what applications can do on the Internet (for example what protocols they can use).
Copy an existing rule
< Back
Next >
Cancel
Activity
Log
Rules
Alerts

FIG. 7B

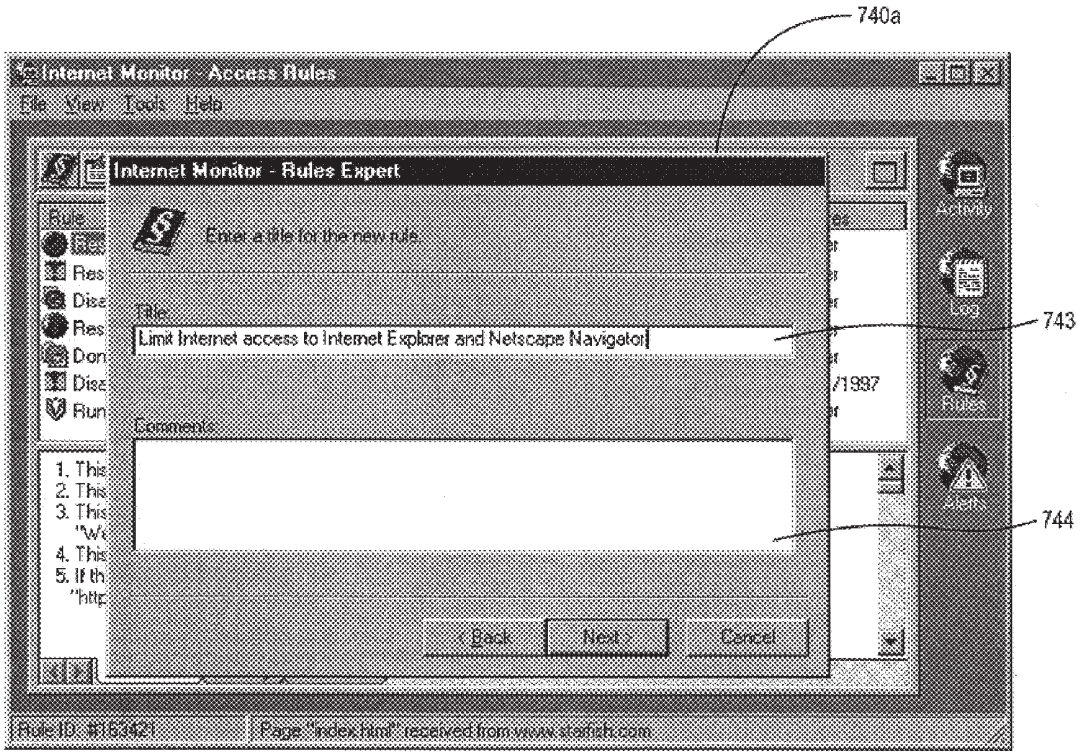
740a
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Enter a title for the new rule.
Title:
Limit Internet access to Internet Explorer and Netscape Navigator
743
Comments:
744
< Back
Next >
Cancel
Rule ID: #153421
Page "index.html" received from www.starfish.com

FIG. 7C

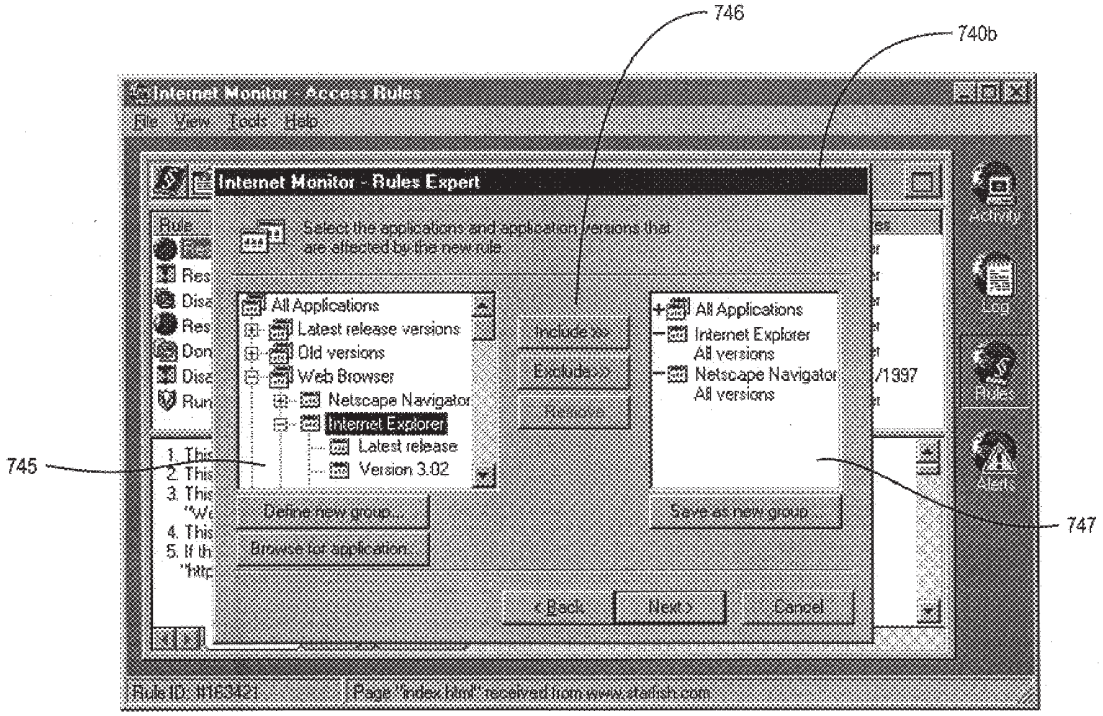
746
740b
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Select the applications and application versions that are affected by the new rule.
All Applications
Latest release versions
Old versions
Web Browser
Netscape Navigator
Internet Explorer
Latest release
Version 3.02
Include >>
Exclude >>
Remove
All Applications
Internet Explorer
All versions
Netscape Navigator
All versions
745
747
Define new group...
Browse for application...
Save as new group...
< Back
Next >
Cancel
Activity
Log
Rules
Alert

FIG. 7D

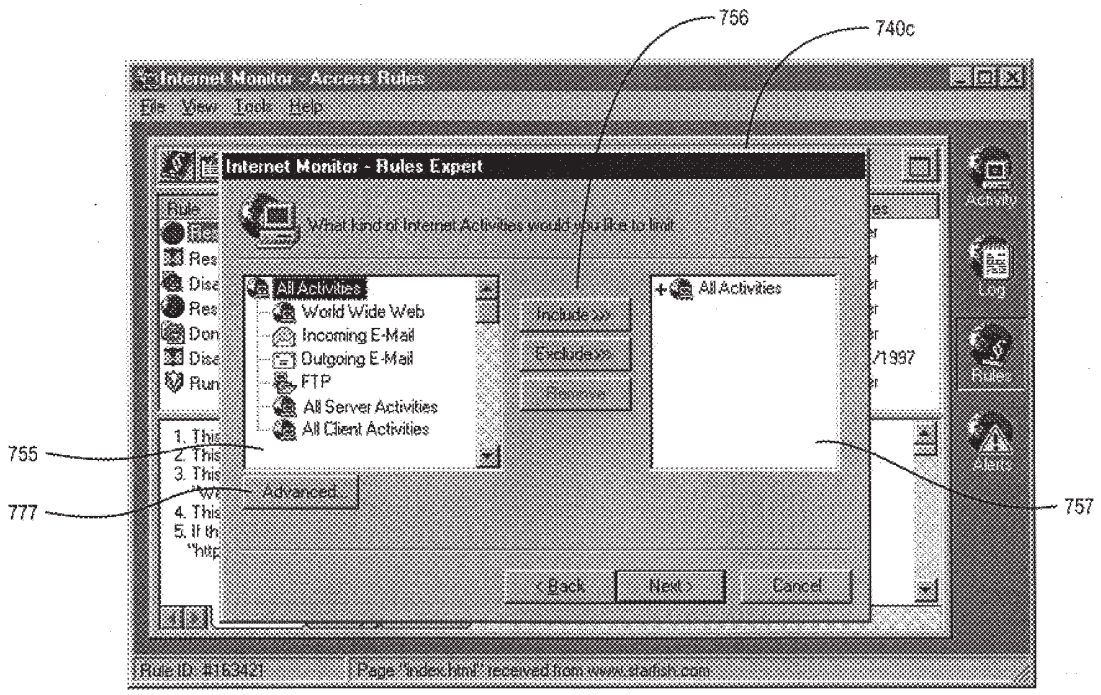
756
740c
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
What kind of Internet Activities would you like to limit
All Activities
World Wide Web
Incoming E-Mail
Outgoing E-Mail
FTP
All Server Activities
All Client Activities
Include >>
Exclude >>
All Activities
755
777
757
Advanced...
< Back
Next >
Cancel
Rule ID: #163421
Page 'index.html' received from www.stadish.com

FIG. 7E

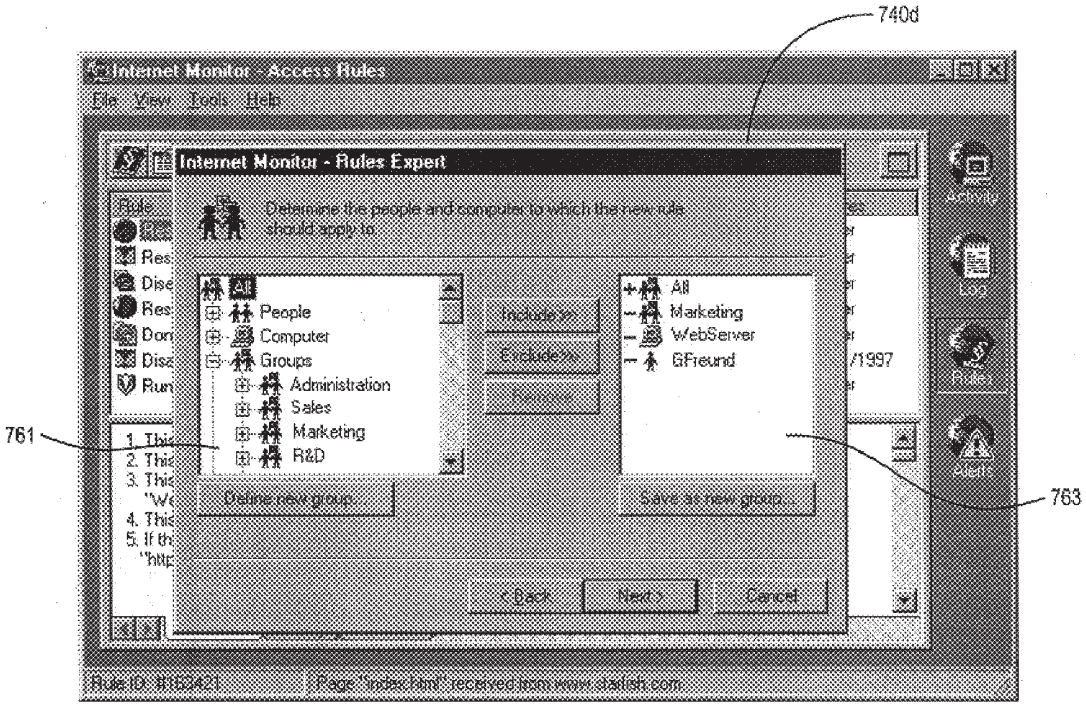
740d
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Determine the people and computers to which the new rule should apply to
All
People
Computer
Groups
Administration
Sales
Marketing
R&D
Include>>
Exclude>>
Remove
All
Marketing
WebServer
GFreund
Define new group...
Save as new group...
< Back
Next >
Cancel
761
763

FIG. 7F

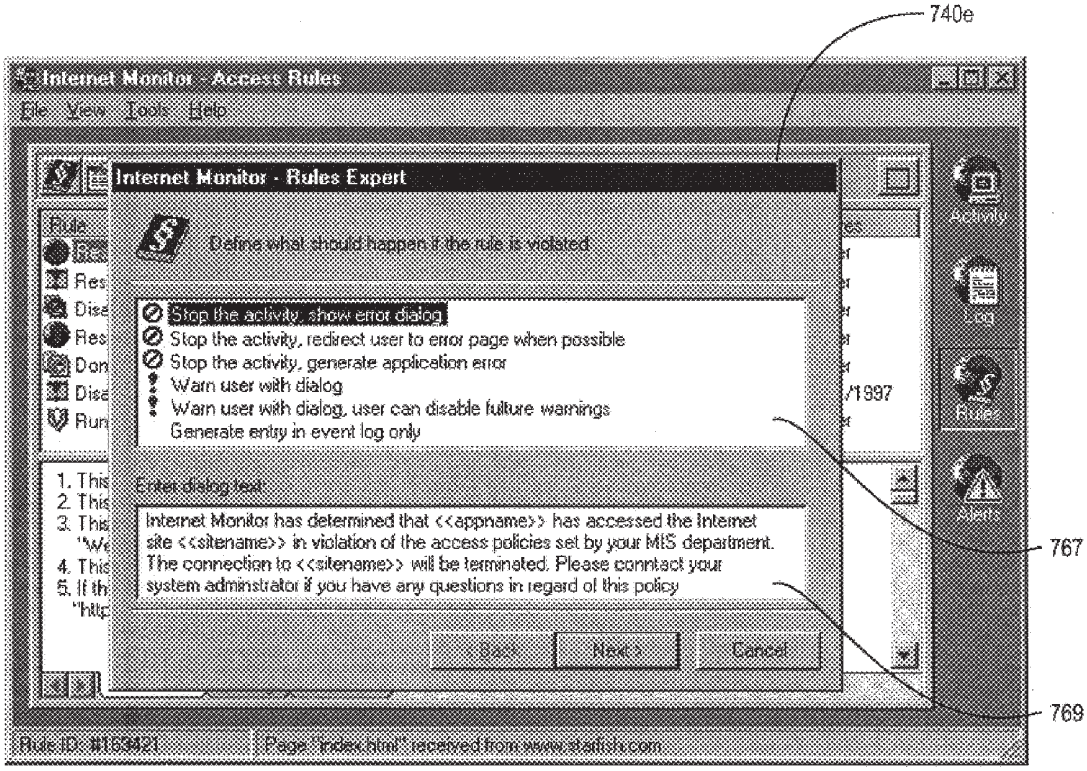
740e
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Define what should happen if the rule is violated
Stop the activity, show error dialog
Stop the activity, redirect user to error page when possible
Stop the activity, generate application error
Warn user with dialog
Warn user with dialog, user can disable failture warnings
Generate entry in event log only
Enter dialog text
Internet Monitor has determined that <<appname>> has accessed the Internet site <<sitename>> in violation of the access policies set by your MIS department. The connection to <<sitename>> will be terminated. Please conntact your system adminstrator if you have any questions in regard of this policy
< Back
Next >
Cancel
767
769

FIG. 7G

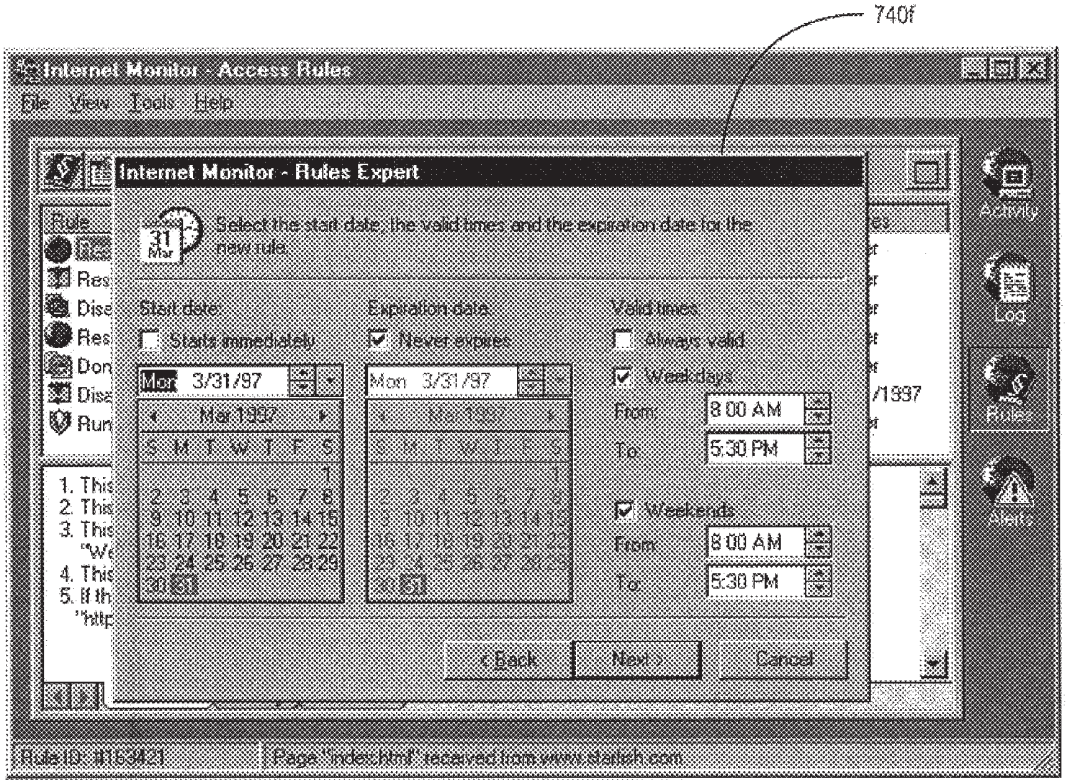
740f
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Select the start date, the valid times and the expiration date for the new rule.
Start date:
Starts immediately
Expiration date:
Never expires
Valid times:
Always valid
Weekdays
From: 8:00 AM
To: 5:30 PM
Weekends
From: 8:00 AM
To: 5:30 PM
< Back
Next >
Cancel
Activity
Log
Rules
Alerts

FIG. 7H

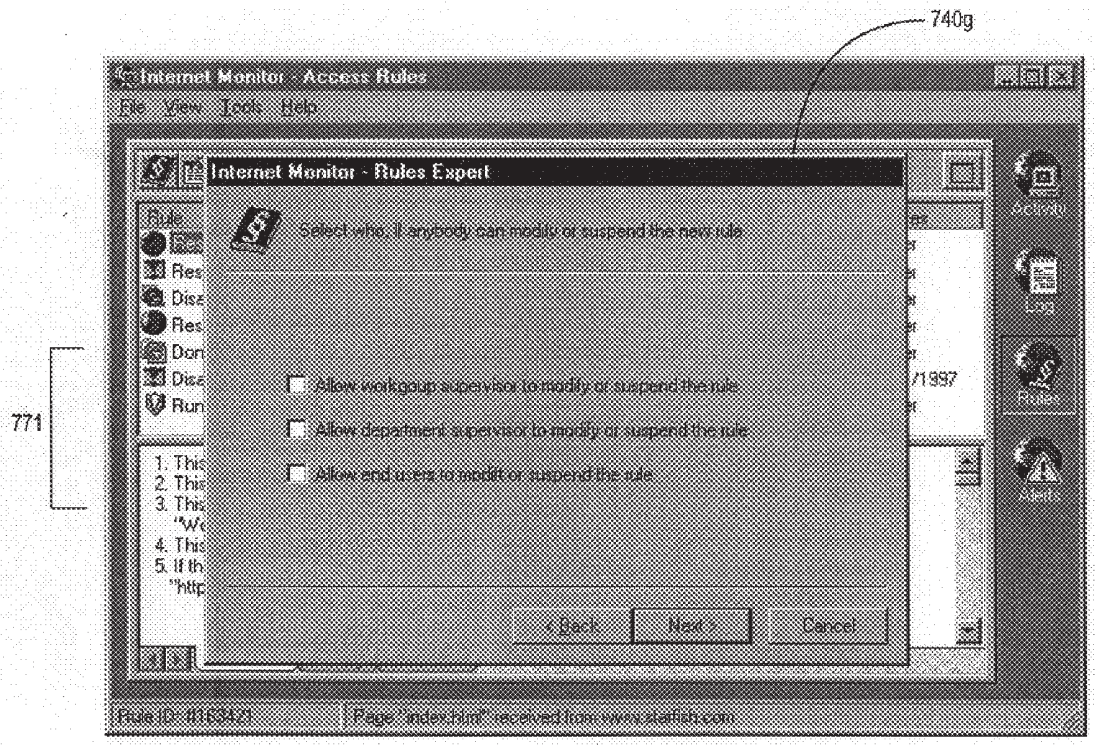
740g
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Select who, if anybody, can modify or suspend the new rule
Allow workgroup supervisor to modify or suspend the rule
Allow department supervisor to modify or suspend the rule
Allow end users to modify or suspend the rule
< Back
Next >
Cancel
771

FIG. 7I

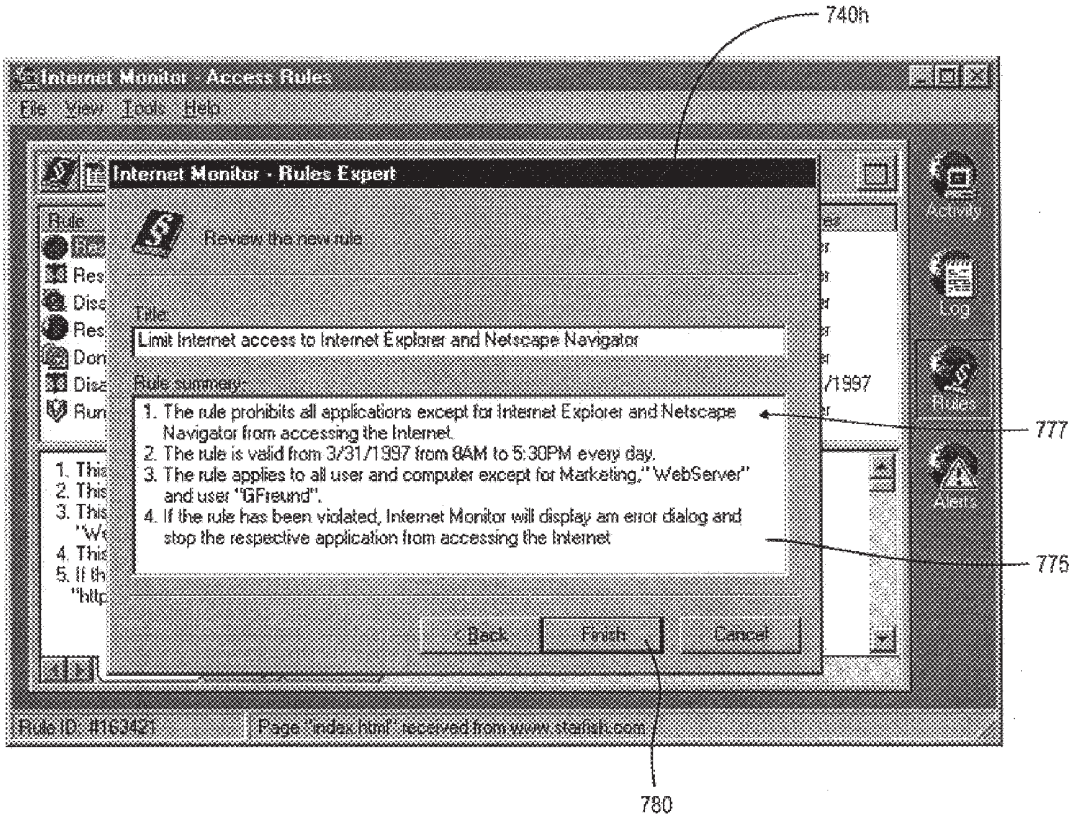
740h
Internet Monitor - Access Rules
File View Tools Help
Internet Monitor - Rules Expert
Review the new rule
Title:
Limit Internet access to Internet Explorer and Netscape Navigator
Rule summary:
1. The rule prohibits all applications except for Internet Explorer and Netscape Navigator from accessing the Internet.
2. The rule is valid from 3/31/1997 from 8AM to 5:30PM every day.
3. The rule applies to all user and computer except for Marketing," WebServer" and user "GFreund".
4. If the rule has been violated, Internet Monitor will display am error dialog and stop the respective application from accessing the Internet
< Back
Finish
Cancel
Activity
Log
Rules
Alerts
Rule ID: #163421
Page "index.html" received from www.starfish.com
777
775
780

FIG. 7J

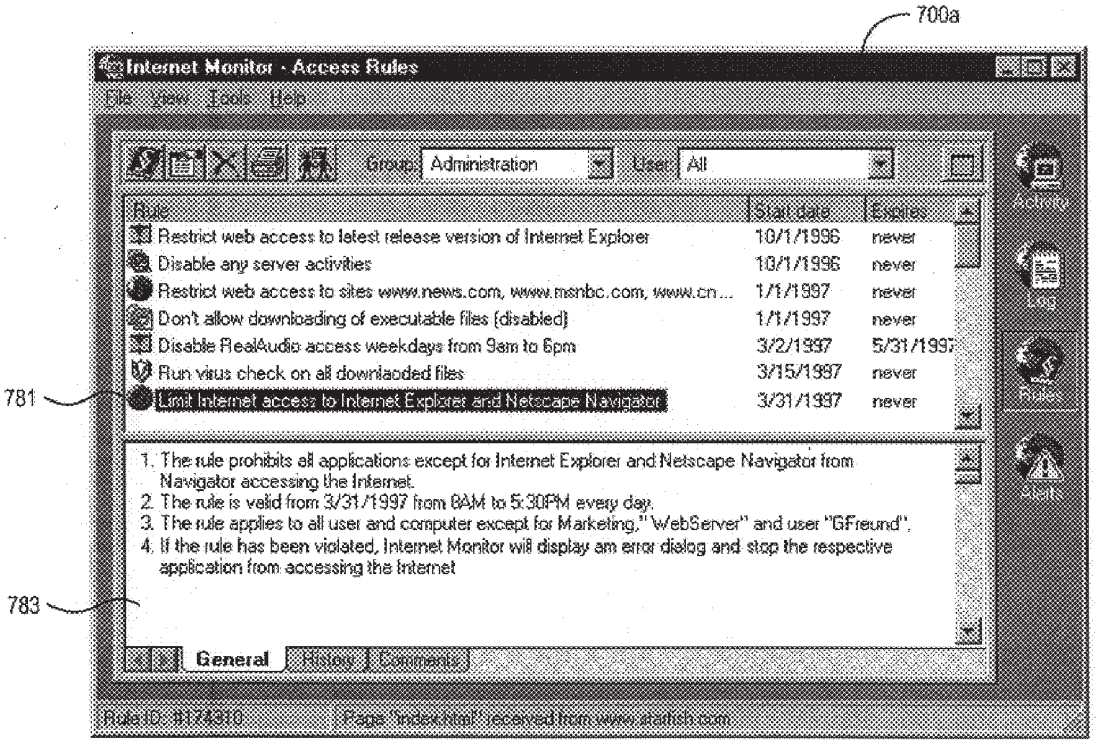
700a
Internet Monitor - Access Rules
File View Tools Help
Group: Administration
User: All
Rule
Start date
Expires
Restrict web access to latest release version of Internet Explorer 10/1/1996 never
Disable any server activities 10/1/1996 never
Restrict web access to sites www.news.com, www.msnbc.com, www.cn... 1/1/1997 never
Don't allow downloading of executable files (disabled) 1/1/1997 never
Disable RealAudio access weekdays from 9am to 6pm 3/2/1997 5/31/1997
Run virus check on all downlaoded files 3/15/1997 never
Limit Internet access to Internet Explorer and Netscape Navigator 3/31/1997 never
781
1. The rule prohibits all applications except for Internet Explorer and Netscape Navigator from Navigator accessing the Internet.
2. The rule is valid from 3/31/1997 from 8AM to 5:30PM every day.
3. The rule applies to all user and computer except for Marketing," WebServer" and user "GFreund".
4. If the rule has been violated, Internet Monitor will display am error dialog and stop the respective application from accessing the Internet
783
General
History
Comments
Activity
Log
Rules
Alerts
Rule ID: #174310
Page "index.html" received from www.starfish.com

FIG. 7K

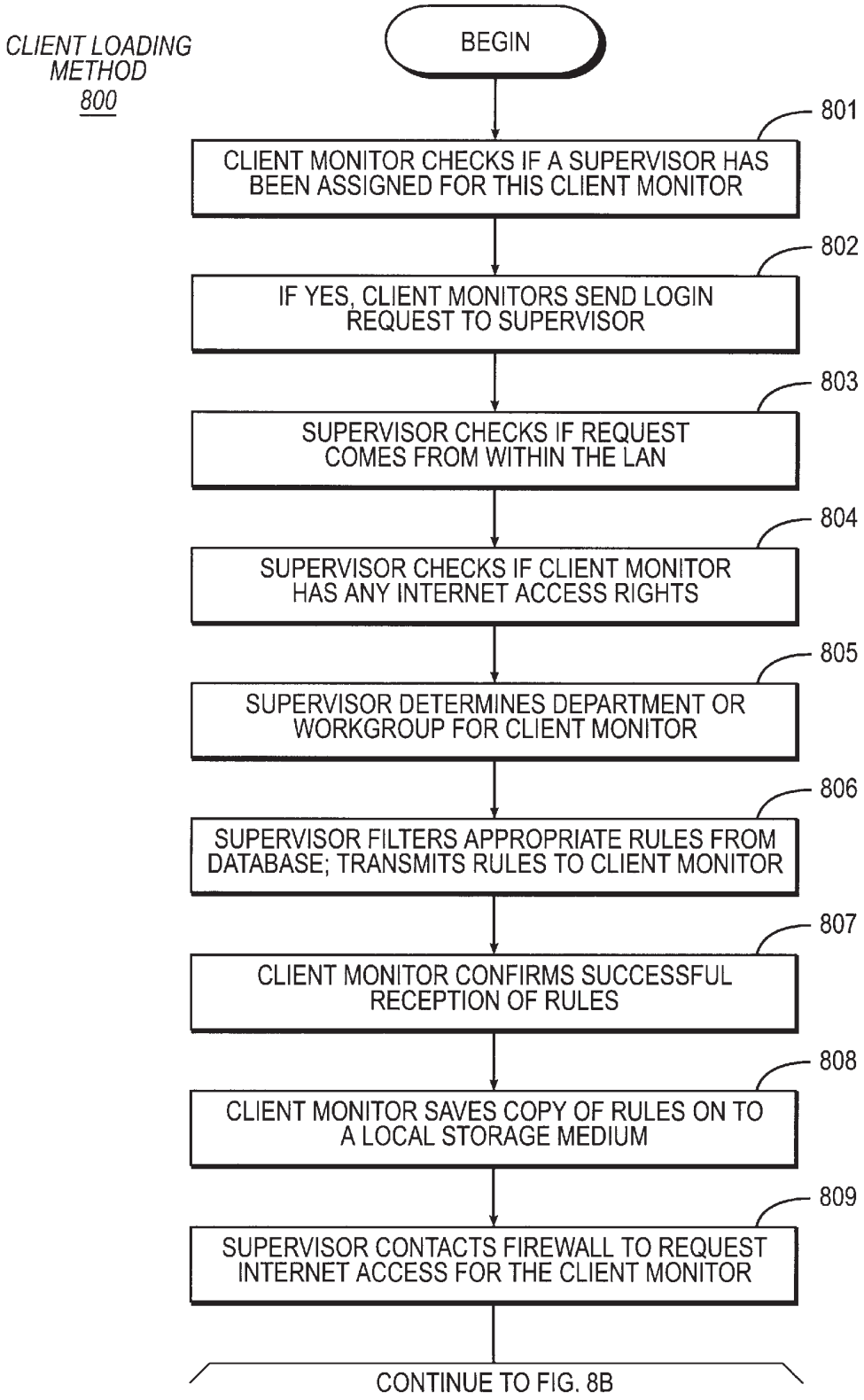
CLIENT LOADING METHOD 800
BEGIN
801
CLIENT MONITOR CHECKS IF A SUPERVISOR HAS BEEN ASSIGNED FOR THIS CLIENT MONITOR
802
IF YES, CLIENT MONITORS SEND LOGIN REQUEST TO SUPERVISOR
803
SUPERVISOR CHECKS IF REQUEST COMES FROM WITHIN THE LAN
804
SUPERVISOR CHECKS IF CLIENT MONITOR HAS ANY INTERNET ACCESS RIGHTS
805
SUPERVISOR DETERMINES DEPARTMENT OR WORKGROUP FOR CLIENT MONITOR
806
SUPERVISOR FILTERS APPROPRIATE RULES FROM DATABASE; TRANSMITS RULES TO CLIENT MONITOR
807
CLIENT MONITOR CONFIRMS SUCCESSFUL RECEPTION OF RULES
808
CLIENT MONITOR SAVES COPY OF RULES ON TO A LOCAL STORAGE MEDIUM
809
SUPERVISOR CONTACTS FIREWALL TO REQUEST INTERNET ACCESS FOR THE CLIENT MONITOR
CONTINUE TO FIG. 8B

FIG. 8A

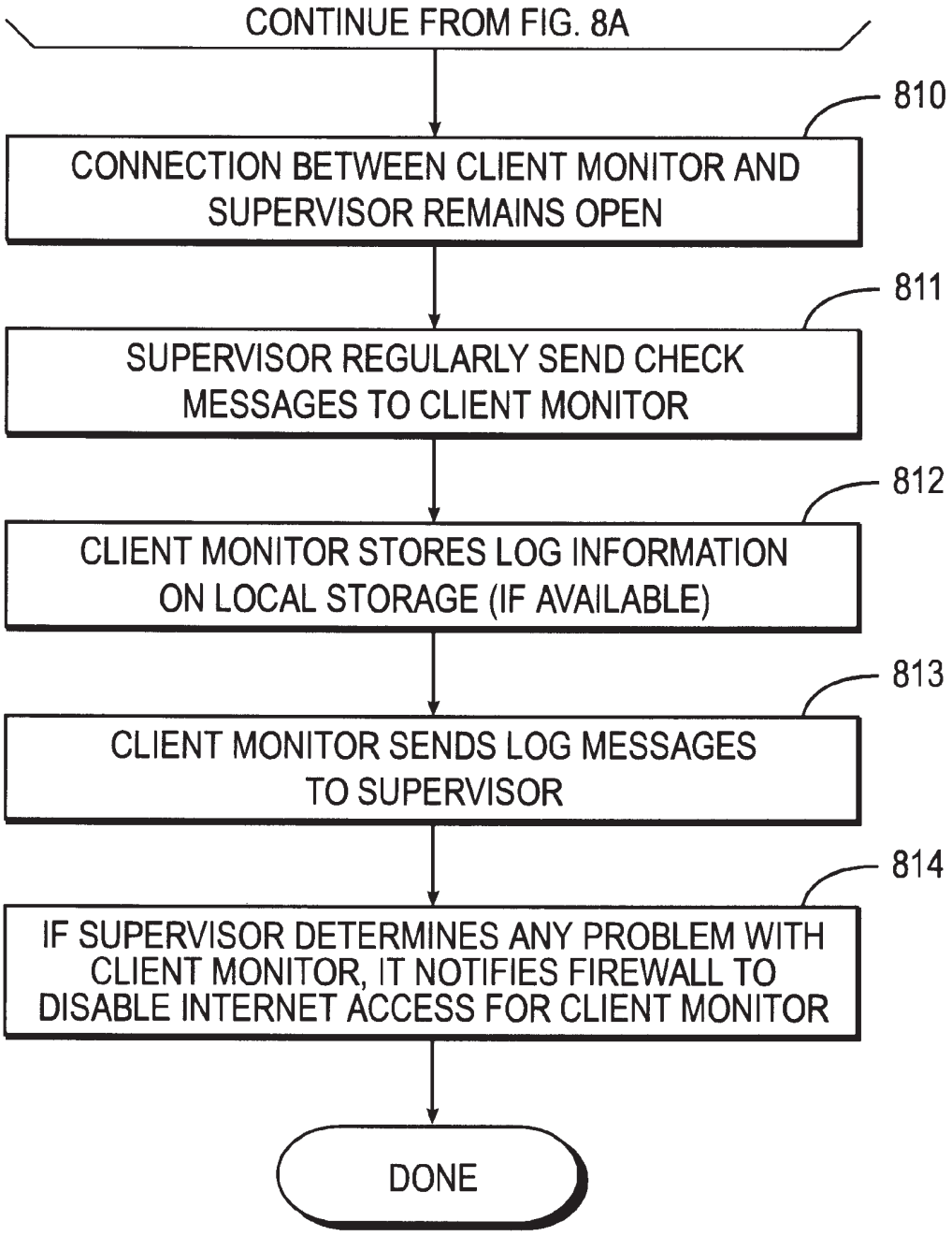
CONTINUE FROM FIG. 8A
810
CONNECTION BETWEEN CLIENT MONITOR AND SUPERVISOR REMAINS OPEN
811
SUPERVISOR REGULARLY SEND CHECK MESSAGES TO CLIENT MONITOR
812
CLIENT MONITOR STORES LOG INFORMATION ON LOCAL STORAGE (IF AVAILABLE)
813
CLIENT MONITOR SENDS LOG MESSAGES TO SUPERVISOR
814
IF SUPERVISOR DETERMINES ANY PROBLEM WITH CLIENT MONITOR, IT NOTIFIES FIREWALL TO DISABLE INTERNET ACCESS FOR CLIENT MONITOR
DONE

FIG. 8B

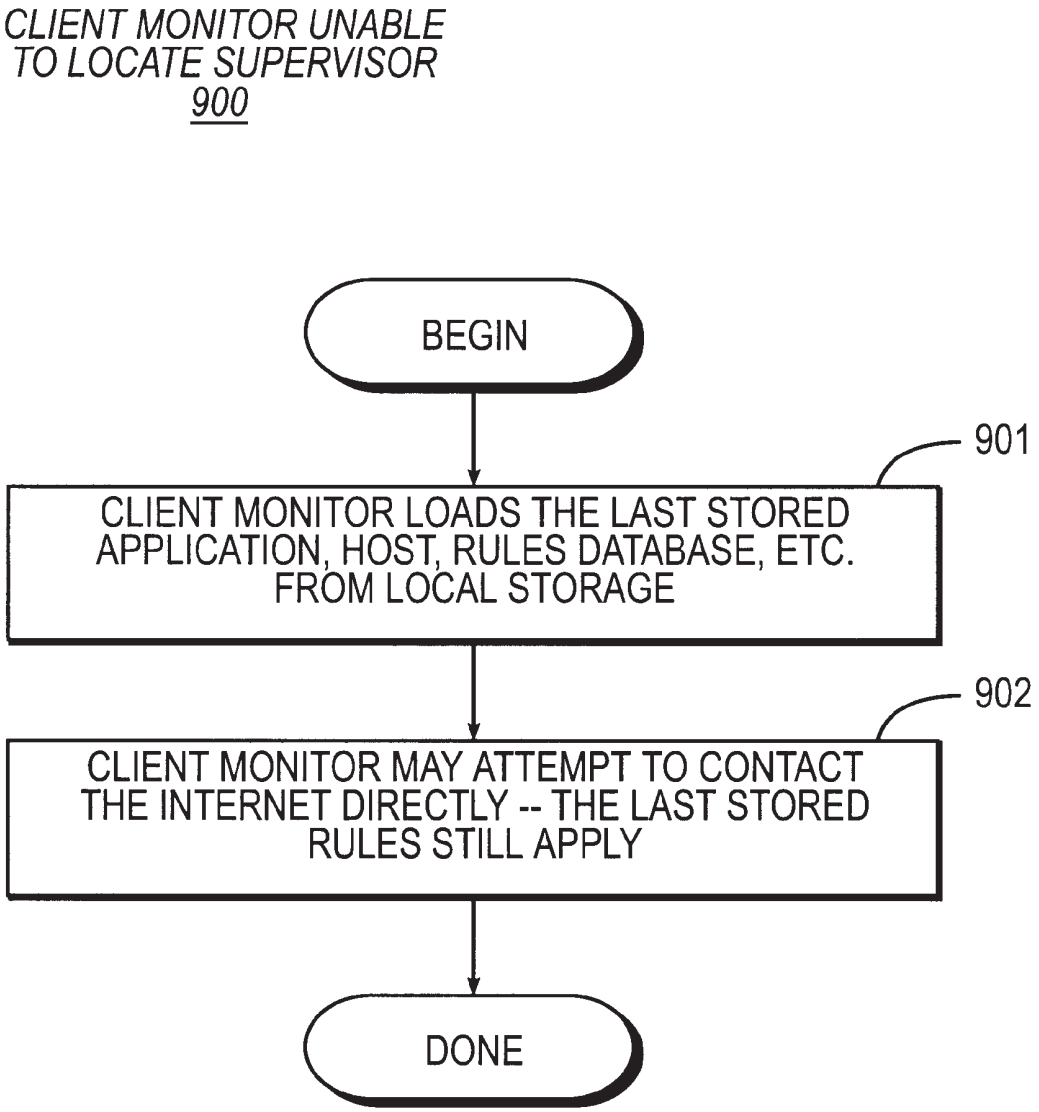
CLIENT MONITOR UNABLE
TO LOCATE SUPERVISOR
900
BEGIN
901
CLIENT MONITOR LOADS THE LAST STORED APPLICATION, HOST, RULES DATABASE, ETC. FROM LOCAL STORAGE
902
CLIENT MONITOR MAY ATTEMPT TO CONTACT THE INTERNET DIRECTLY -- THE LAST STORED RULES STILL APPLY
DONE

FIG. 9

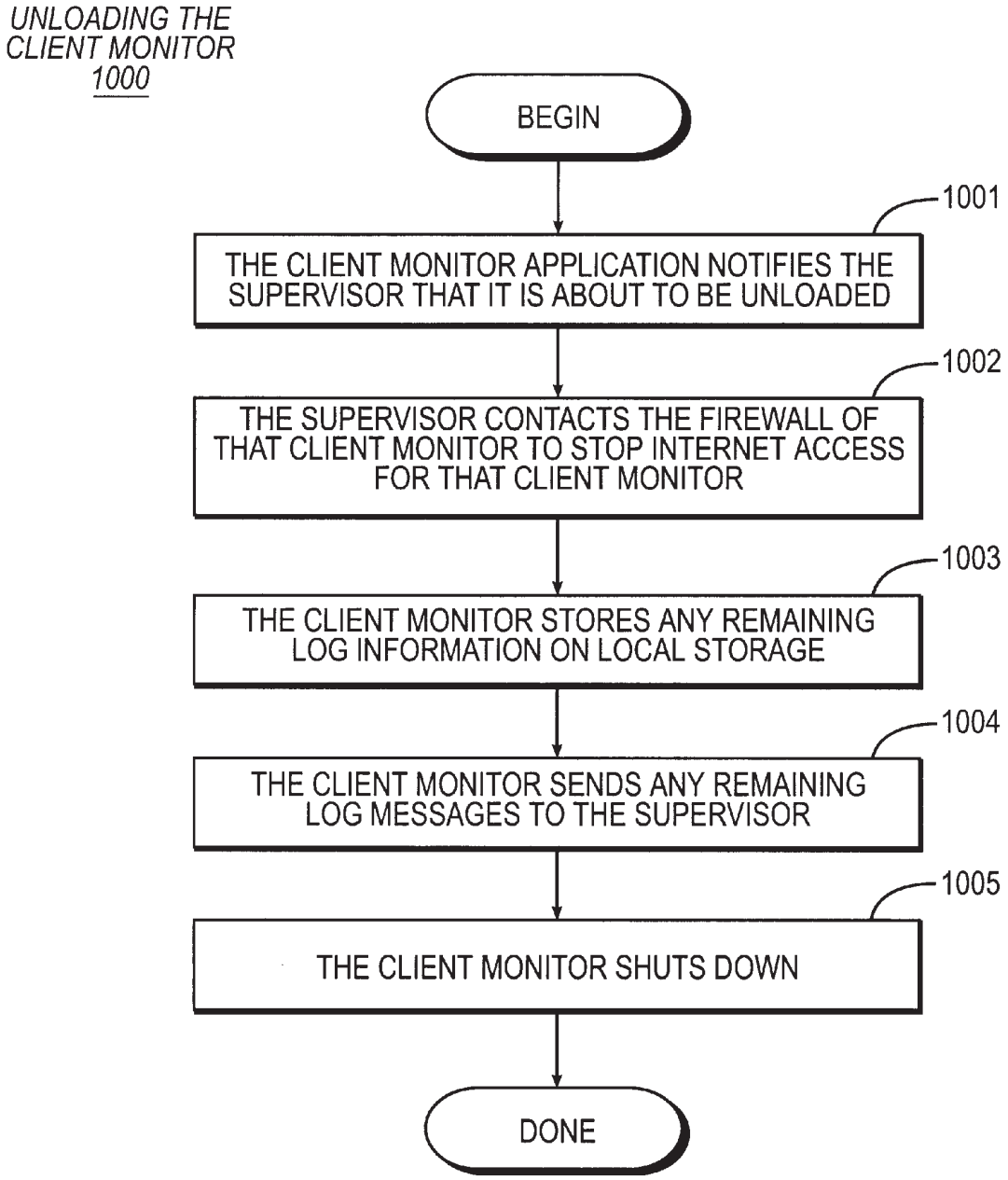
UNLOADING THE CLIENT MONITOR 1000
BEGIN
1001
THE CLIENT MONITOR APPLICATION NOTIFIES THE SUPERVISOR THAT IT IS ABOUT TO BE UNLOADED
1002
THE SUPERVISOR CONTACTS THE FIREWALL OF THAT CLIENT MONITOR TO STOP INTERNET ACCESS FOR THAT CLIENT MONITOR
1003
THE CLIENT MONITOR STORES ANY REMAINING LOG INFORMATION ON LOCAL STORAGE
1004
THE CLIENT MONITOR SENDS ANY REMAINING LOG MESSAGES TO THE SUPERVISOR
1005
THE CLIENT MONITOR SHUTS DOWN
DONE

FIG. 10

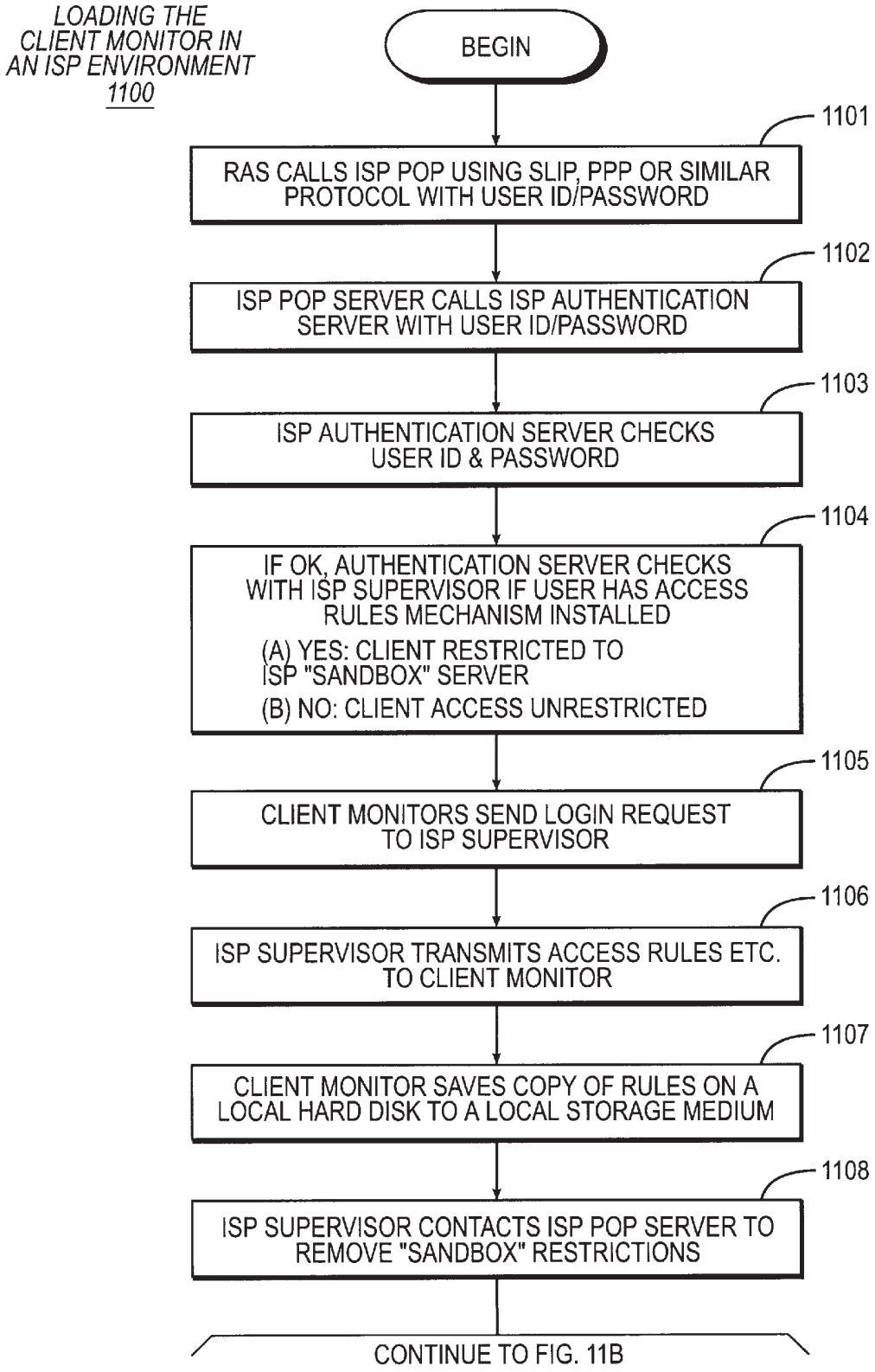
LOADING THE CLIENT MONITOR IN AN ISP ENVIRONMENT
1100
BEGIN
1101
RAS CALLS ISP POP USING SLIP, PPP OR SIMILAR PROTOCOL WITH USER ID/PASSWORD
1102
ISP POP SERVER CALLS ISP AUTHENTICATION SERVER WITH USER ID/PASSWORD
1103
ISP AUTHENTICATION SERVER CHECKS USER ID & PASSWORD
1104
IF OK, AUTHENTICATION SERVER CHECKS WITH ISP SUPERVISOR IF USER HAS ACCESS RULES MECHANISM INSTALLED
(A) YES: CLIENT RESTRICTED TO ISP "SANDBOX" SERVER
(B) NO: CLIENT ACCESS UNRESTRICTED
1105
CLIENT MONITORS SEND LOGIN REQUEST TO ISP SUPERVISOR
1106
ISP SUPERVISOR TRANSMITS ACCESS RULES ETC. TO CLIENT MONITOR
1107
CLIENT MONITOR SAVES COPY OF RULES ON A LOCAL HARD DISK TO A LOCAL STORAGE MEDIUM
1108
ISP SUPERVISOR CONTACTS ISP POP SERVER TO REMOVE "SANDBOX" RESTRICTIONS
CONTINUE TO FIG. 11B

FIG. 11A

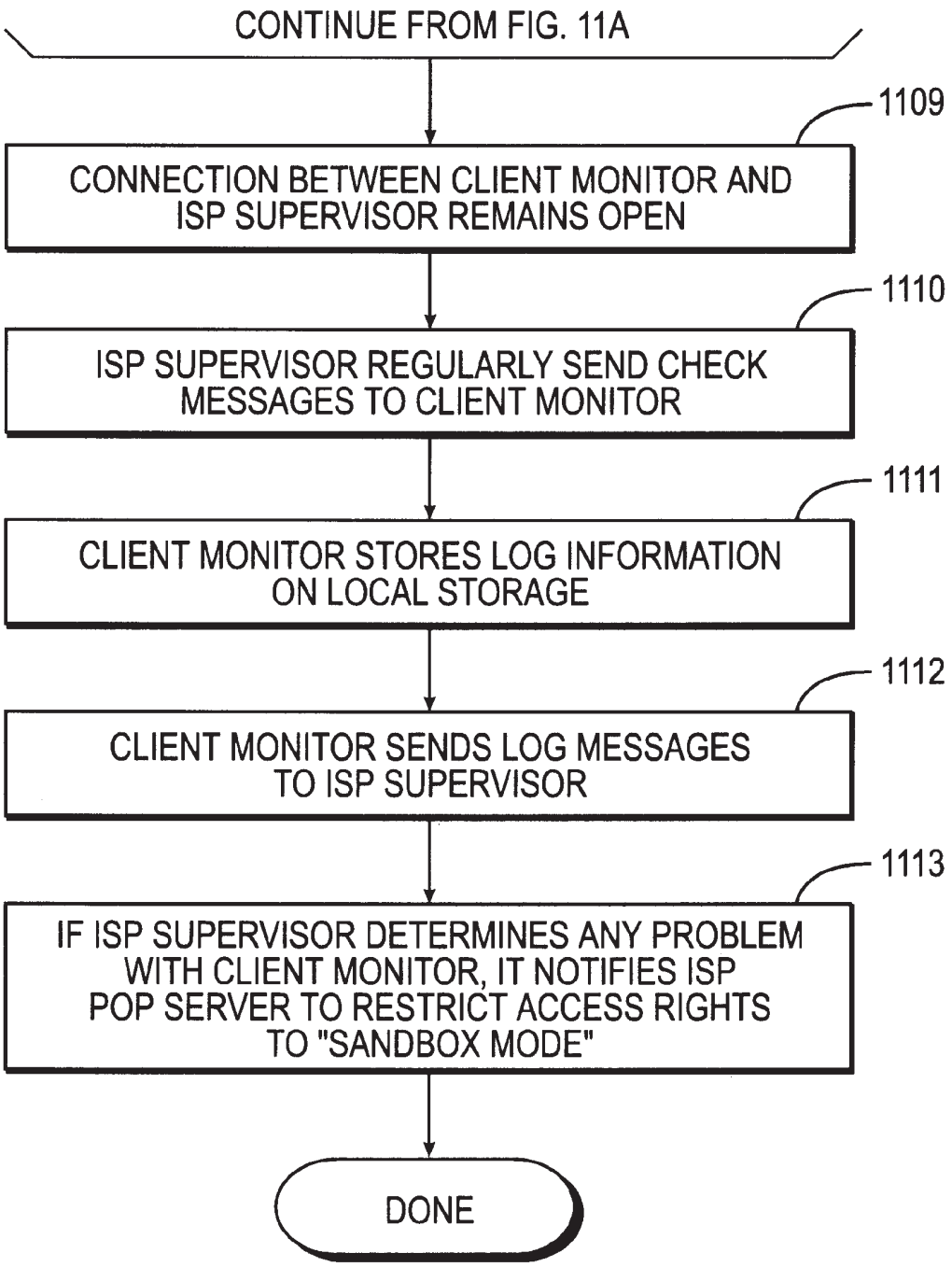
CONTINUE FROM FIG. 11A
1109
CONNECTION BETWEEN CLIENT MONITOR AND ISP SUPERVISOR REMAINS OPEN
1110
ISP SUPERVISOR REGULARLY SEND CHECK MESSAGES TO CLIENT MONITOR
1111
CLIENT MONITOR STORES LOG INFORMATION ON LOCAL STORAGE
1112
CLIENT MONITOR SENDS LOG MESSAGES TO ISP SUPERVISOR
1113
IF ISP SUPERVISOR DETERMINES ANY PROBLEM WITH CLIENT MONITOR, IT NOTIFIES ISP POP SERVER TO RESTRICT ACCESS RIGHTS TO "SANDBOX MODE"
DONE

FIG. 11B

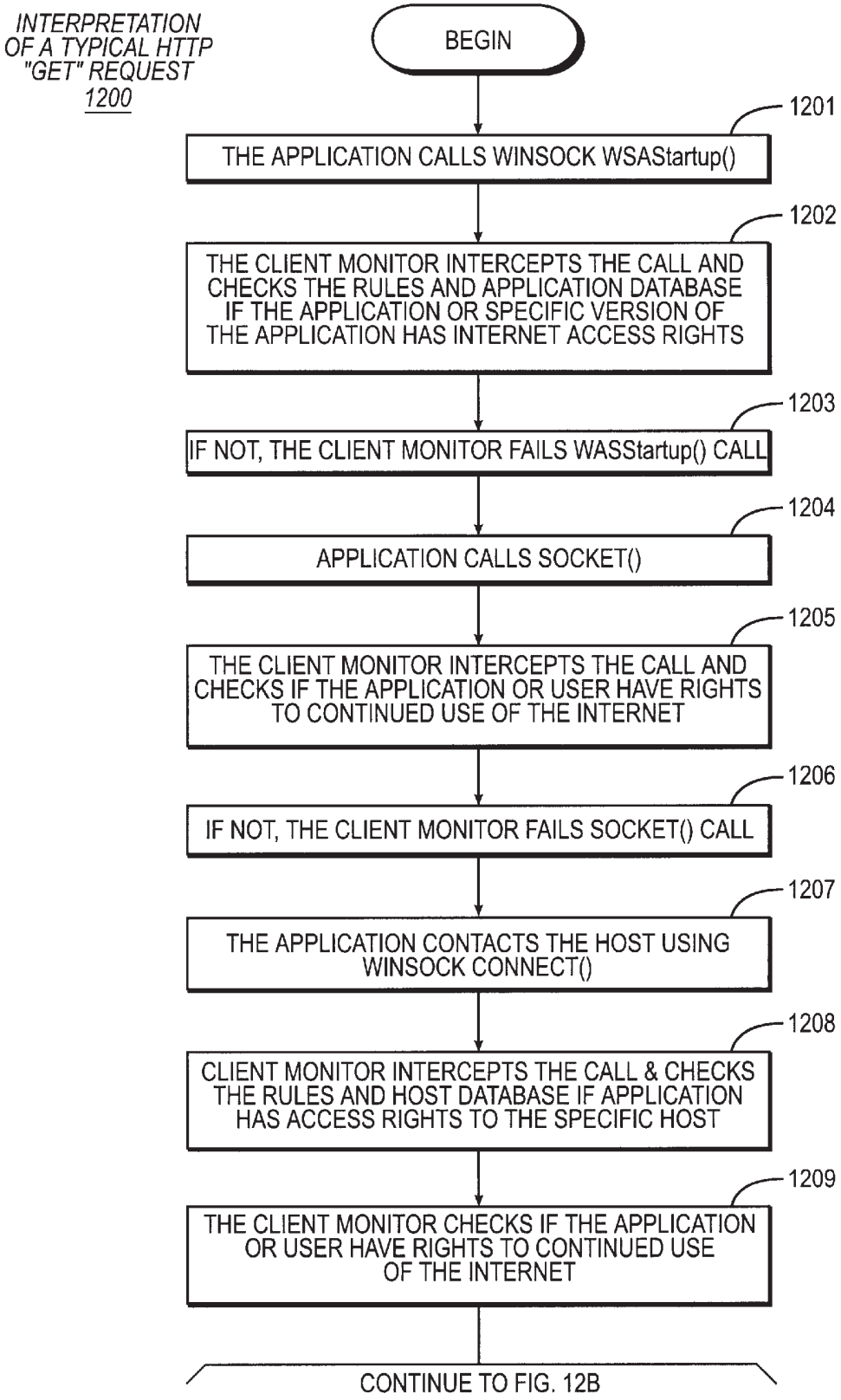
INTERPRETATION OF A TYPICAL HTTP "GET" REQUEST
1200
BEGIN
1201
THE APPLICATION CALLS WINSOCK WSAStartup()
1202
THE CLIENT MONITOR INTERCEPTS THE CALL AND CHECKS THE RULES AND APPLICATION DATABASE IF THE APPLICATION OR SPECIFIC VERSION OF THE APPLICATION HAS INTERNET ACCESS RIGHTS
1203
IF NOT, THE CLIENT MONITOR FAILS WASStartup() CALL
1204
APPLICATION CALLS SOCKET()
1205
THE CLIENT MONITOR INTERCEPTS THE CALL AND CHECKS IF THE APPLICATION OR USER HAVE RIGHTS TO CONTINUED USE OF THE INTERNET
1206
IF NOT, THE CLIENT MONITOR FAILS SOCKET() CALL
1207
THE APPLICATION CONTACTS THE HOST USING WINSOCK CONNECT()
1208
CLIENT MONITOR INTERCEPTS THE CALL & CHECKS THE RULES AND HOST DATABASE IF APPLICATION HAS ACCESS RIGHTS TO THE SPECIFIC HOST
1209
THE CLIENT MONITOR CHECKS IF THE APPLICATION OR USER HAVE RIGHTS TO CONTINUED USE OF THE INTERNET
CONTINUE TO FIG. 12B

FIG. 12A

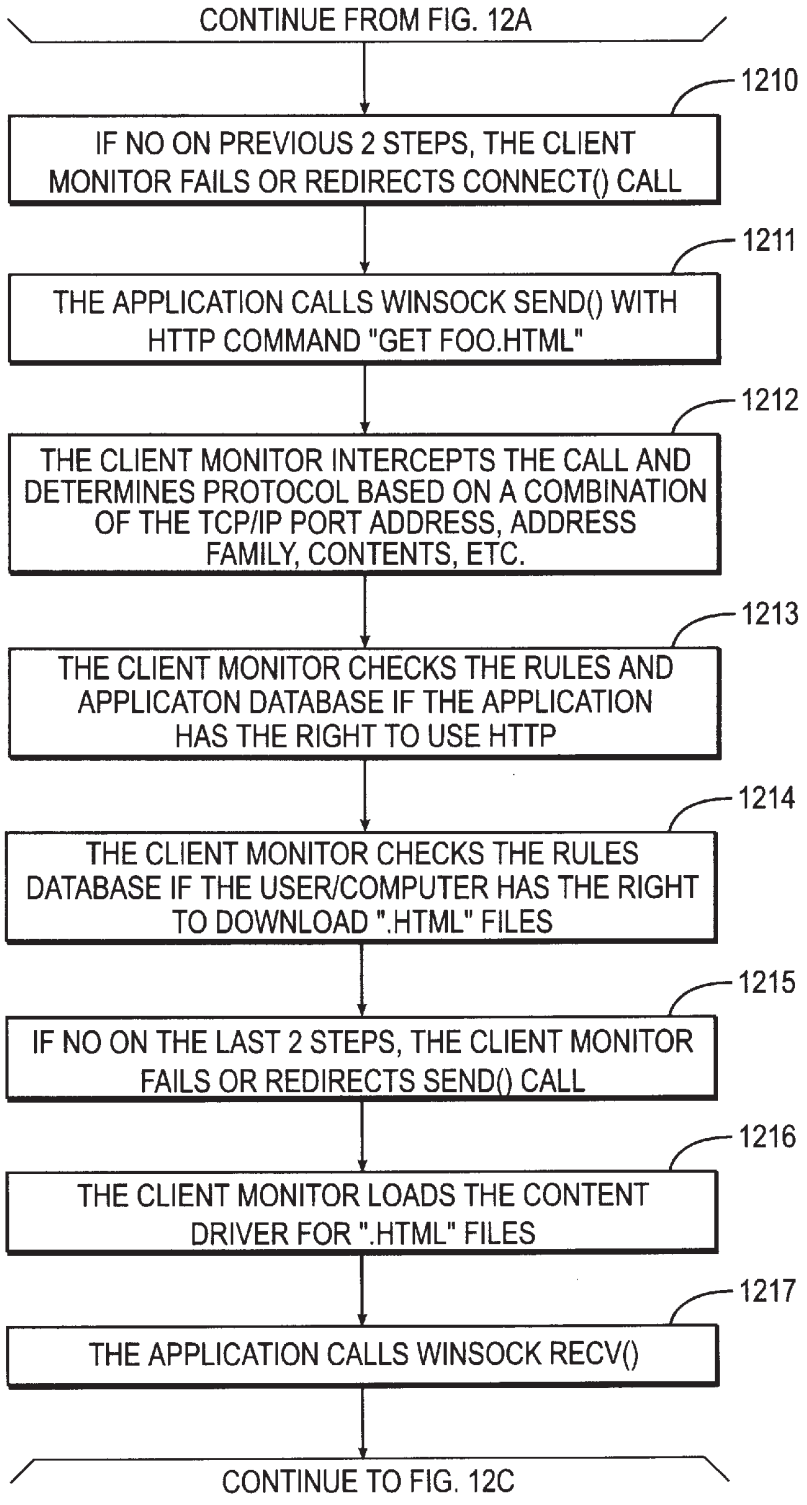
CONTINUE FROM FIG. 12A
1210
IF NO ON PREVIOUS 2 STEPS, THE CLIENT MONITOR FAILS OR REDIRECTS CONNECT() CALL
1211
THE APPLICATION CALLS WINSOCK SEND() WITH HTTP COMMAND "GET FOO.HTML"
1212
THE CLIENT MONITOR INTERCEPTS THE CALL AND DETERMINES PROTOCOL BASED ON A COMBINATION OF THE TCP/IP PORT ADDRESS, ADDRESS FAMILY, CONTENTS, ETC.
1213
THE CLIENT MONITOR CHECKS THE RULES AND APPLICATON DATABASE IF THE APPLICATION HAS THE RIGHT TO USE HTTP
1214
THE CLIENT MONITOR CHECKS THE RULES DATABASE IF THE USER/COMPUTER HAS THE RIGHT TO DOWNLOAD ".HTML" FILES
1215
IF NO ON THE LAST 2 STEPS, THE CLIENT MONITOR FAILS OR REDIRECTS SEND() CALL
1216
THE CLIENT MONITOR LOADS THE CONTENT DRIVER FOR ".HTML" FILES
1217
THE APPLICATION CALLS WINSOCK RECV()
CONTINUE TO FIG. 12C

FIG. 12B

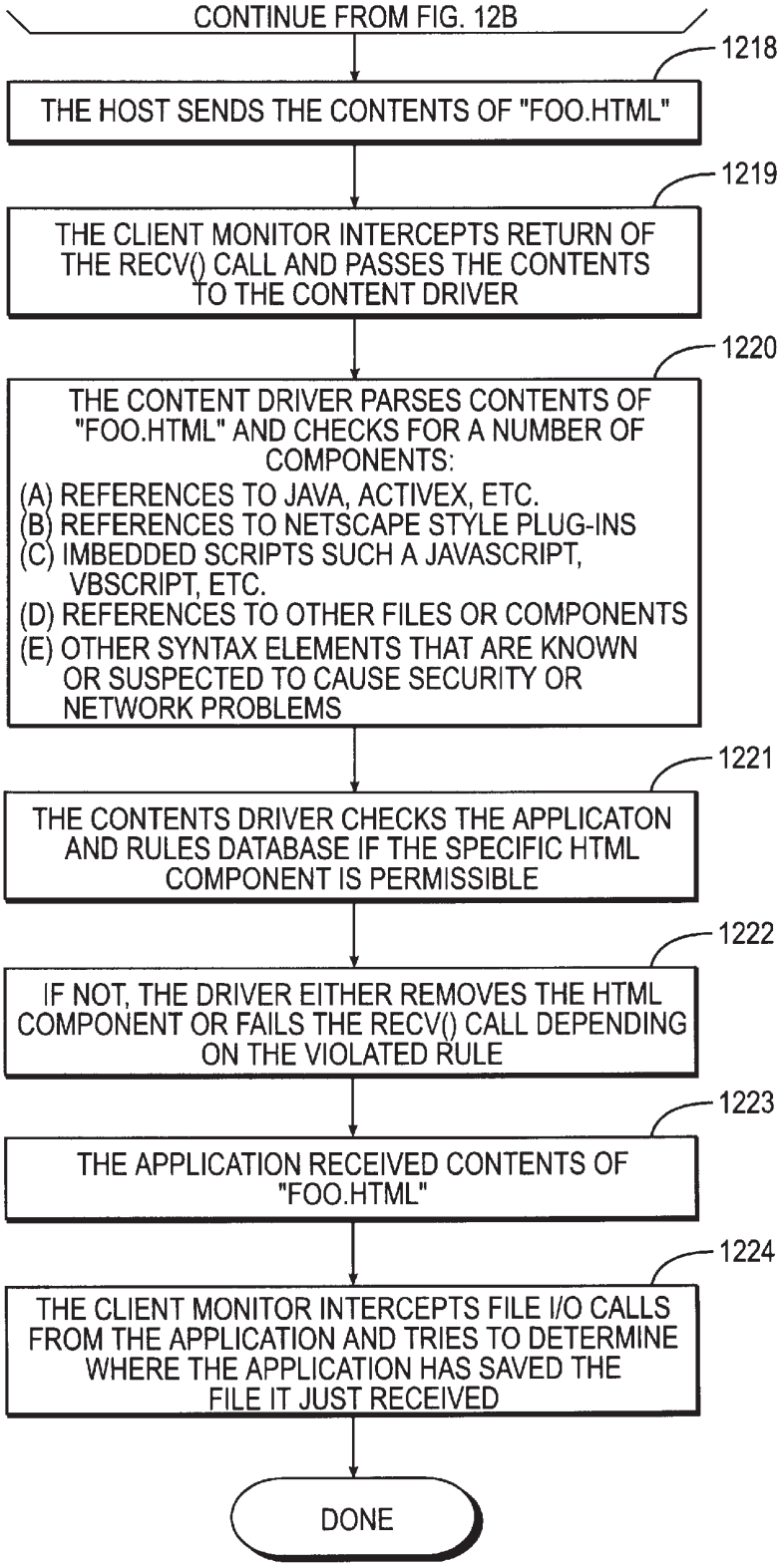
CONTINUE FROM FIG. 12B
1218
THE HOST SENDS THE CONTENTS OF "FOO.HTML"
1219
THE CLIENT MONITOR INTERCEPTS RETURN OF THE RECV() CALL AND PASSES THE CONTENTS TO THE CONTENT DRIVER
1220
THE CONTENT DRIVER PARSES CONTENTS OF "FOO.HTML" AND CHECKS FOR A NUMBER OF COMPONENTS:
(A) REFERENCES TO JAVA, ACTIVEX, ETC.
(B) REFERENCES TO NETSCAPE STYLE PLUG-INS
(C) IMBEDDED SCRIPTS SUCH A JAVASCRIPT, VBSCRIPT, ETC.
(D) REFERENCES TO OTHER FILES OR COMPONENTS
(E) OTHER SYNTAX ELEMENTS THAT ARE KNOWN OR SUSPECTED TO CAUSE SECURITY OR NETWORK PROBLEMS
1221
THE CONTENTS DRIVER CHECKS THE APPLICATON AND RULES DATABASE IF THE SPECIFIC HTML COMPONENT IS PERMISSIBLE
1222
IF NOT, THE DRIVER EITHER REMOVES THE HTML COMPONENT OR FAILS THE RECV() CALL DEPENDING ON THE VIOLATED RULE
1223
THE APPLICATION RECEIVED CONTENTS OF "FOO.HTML"
1224
THE CLIENT MONITOR INTERCEPTS FILE I/O CALLS FROM THE APPLICATION AND TRIES TO DETERMINE WHERE THE APPLICATION HAS SAVED THE FILE IT JUST RECEIVED
DONE

FIG. 12C

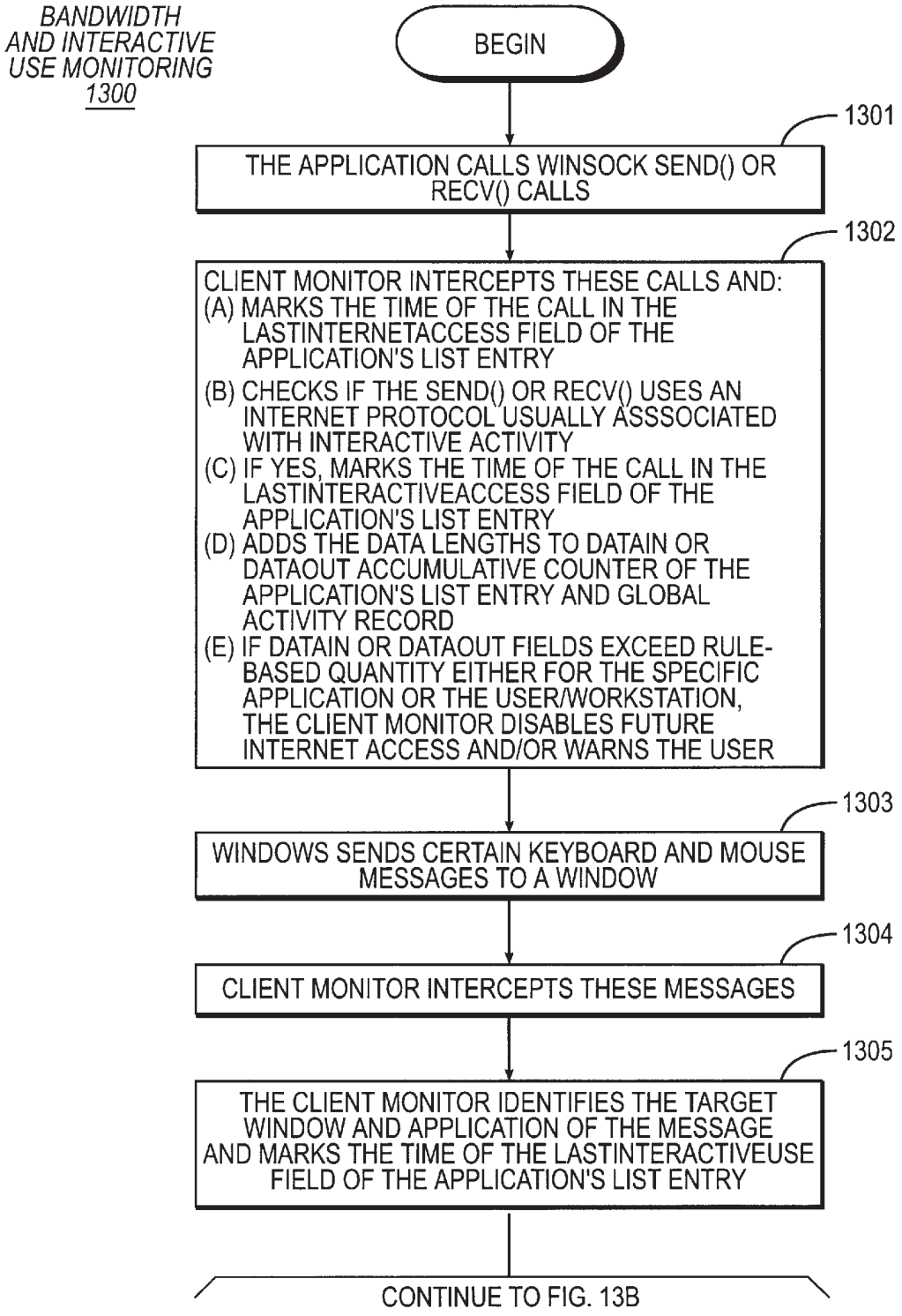
BANDWIDTH AND INTERACTIVE USE MONITORING 1300
BEGIN
1301
THE APPLICATION CALLS WINSOCK SEND() OR RECV() CALLS
1302
CLIENT MONITOR INTERCEPTS THESE CALLS AND:
(A) MARKS THE TIME OF THE CALL IN THE LASTINTERNETACCESS FIELD OF THE APPLICATION'S LIST ENTRY
(B) CHECKS IF THE SEND() OR RECV() USES AN INTERNET PROTOCOL USUALLY ASSSOCIATED WITH INTERACTIVE ACTIVITY
(C) IF YES, MARKS THE TIME OF THE CALL IN THE LASTINTERACTIVEACCESS FIELD OF THE APPLICATION'S LIST ENTRY
(D) ADDS THE DATA LENGTHS TO DATAIN OR DATAOUT ACCUMULATIVE COUNTER OF THE APPLICATION'S LIST ENTRY AND GLOBAL ACTIVITY RECORD
(E) IF DATAIN OR DATAOUT FIELDS EXCEED RULE-BASED QUANTITY EITHER FOR THE SPECIFIC APPLICATION OR THE USER/WORKSTATION, THE CLIENT MONITOR DISABLES FUTURE INTERNET ACCESS AND/OR WARNS THE USER
1303
WINDOWS SENDS CERTAIN KEYBOARD AND MOUSE MESSAGES TO A WINDOW
1304
CLIENT MONITOR INTERCEPTS THESE MESSAGES
1305
THE CLIENT MONITOR IDENTIFIES THE TARGET WINDOW AND APPLICATION OF THE MESSAGE AND MARKS THE TIME OF THE LASTINTERACTIVEUSE FIELD OF THE APPLICATION'S LIST ENTRY
CONTINUE TO FIG. 13B

FIG. 13A

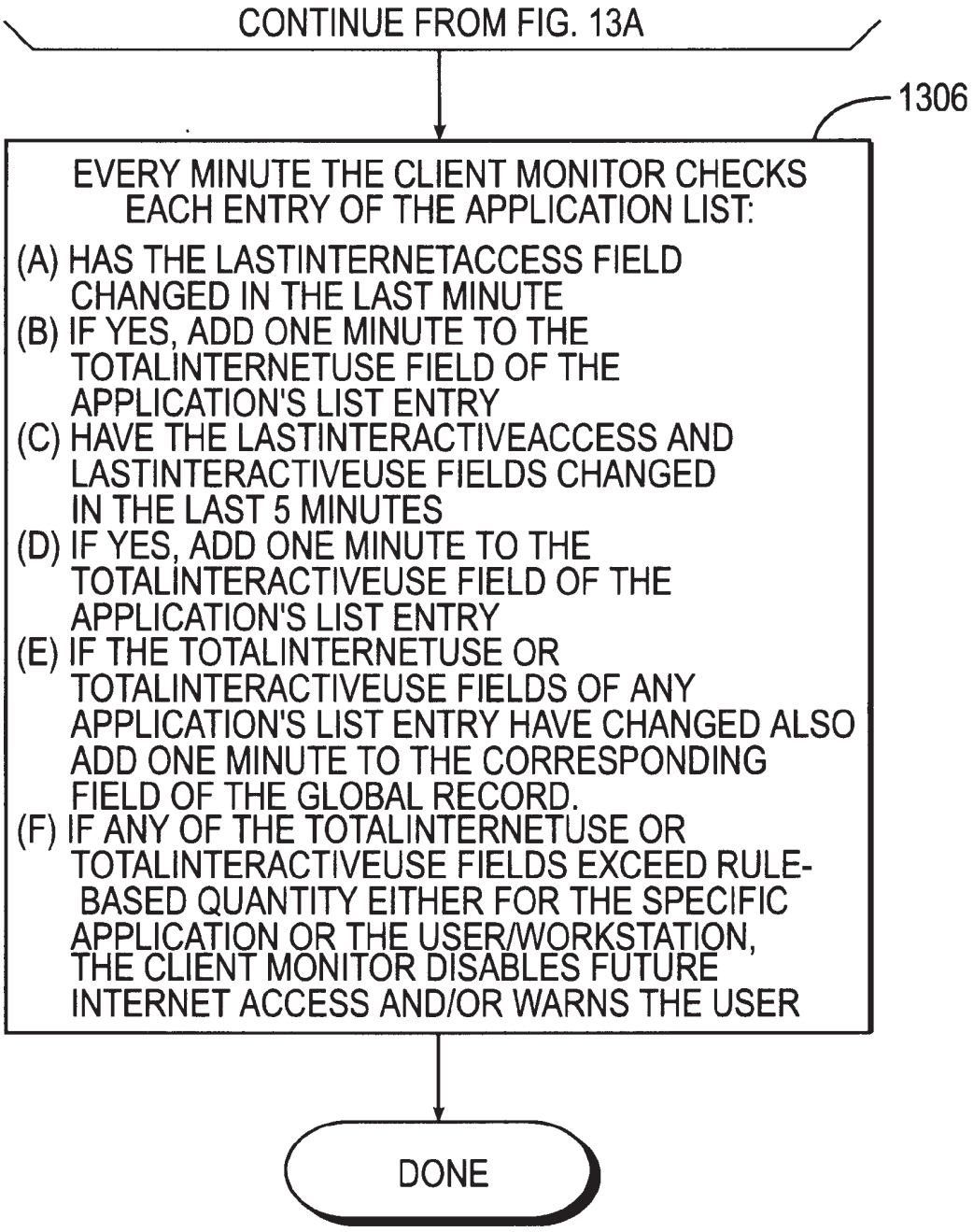
CONTINUE FROM FIG. 13A
1306
EVERY MINUTE THE CLIENT MONITOR CHECKS EACH ENTRY OF THE APPLICATION LIST:
(A) HAS THE LASTINTERNETACCESS FIELD CHANGED IN THE LAST MINUTE
(B) IF YES, ADD ONE MINUTE TO THE TOTALINTERNETUSE FIELD OF THE APPLICATION'S LIST ENTRY
(C) HAVE THE LASTINTERACTIVEACCESS AND LASTINTERACTIVEUSE FIELDS CHANGED IN THE LAST 5 MINUTES
(D) IF YES, ADD ONE MINUTE TO THE TOTALINTERACTIVEUSE FIELD OF THE APPLICATION'S LIST ENTRY
(E) IF THE TOTALINTERNETUSE OR TOTALINTERACTIVEUSE FIELDS OF ANY APPLICATION'S LIST ENTRY HAVE CHANGED ALSO ADD ONE MINUTE TO THE CORRESPONDING FIELD OF THE GLOBAL RECORD.
(F) IF ANY OF THE TOTALINTERNETUSE OR TOTALINTERACTIVEUSE FIELDS EXCEED RULE-BASED QUANTITY EITHER FOR THE SPECIFIC APPLICATION OR THE USER/WORKSTATION, THE CLIENT MONITOR DISABLES FUTURE INTERNET ACCESS AND/OR WARNS THE USER
DONE

FIG. 13B

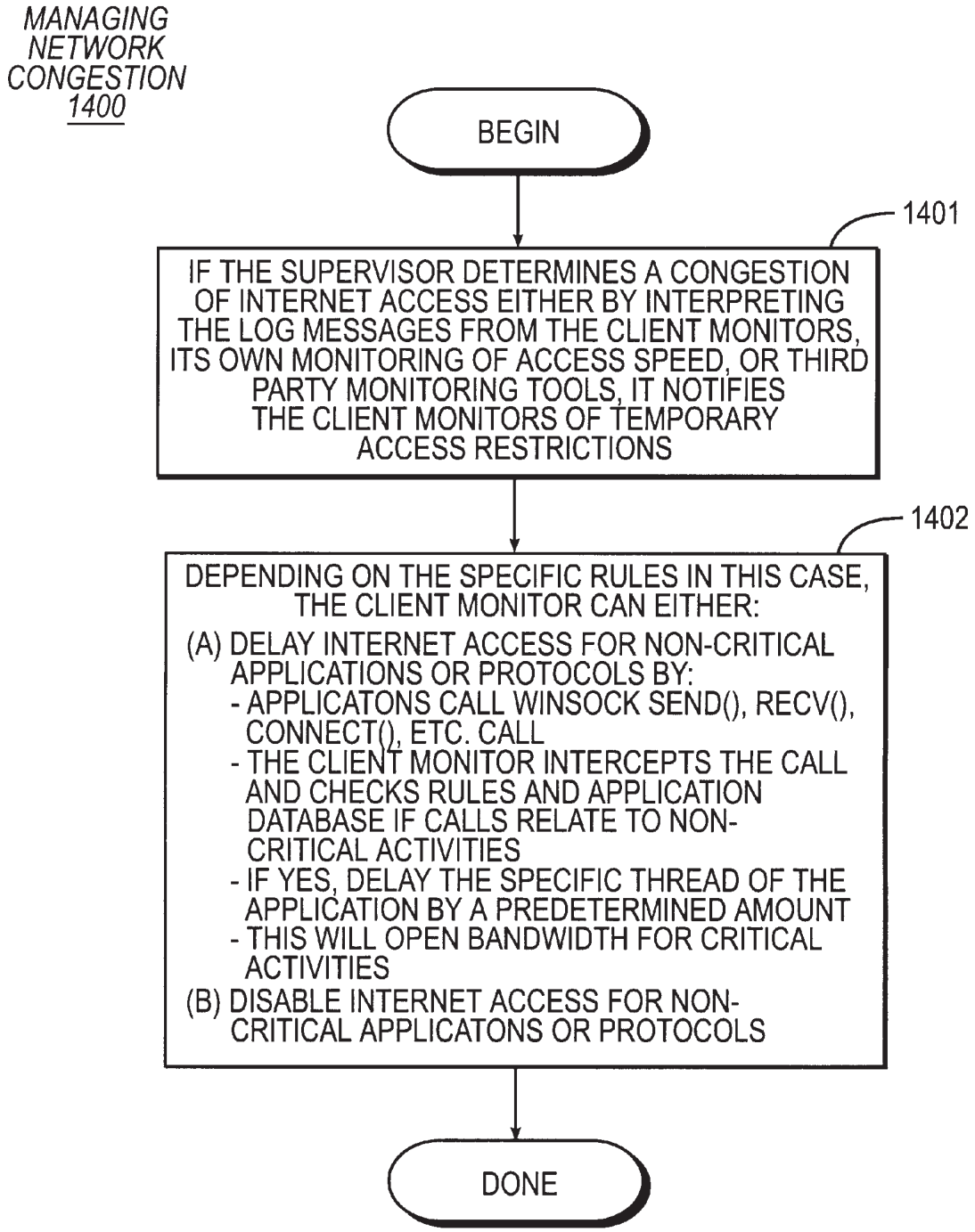
MANAGING NETWORK CONGESTION 1400
BEGIN
1401
IF THE SUPERVISOR DETERMINES A CONGESTION OF INTERNET ACCESS EITHER BY INTERPRETING THE LOG MESSAGES FROM THE CLIENT MONITORS, ITS OWN MONITORING OF ACCESS SPEED, OR THIRD PARTY MONITORING TOOLS, IT NOTIFIES THE CLIENT MONITORS OF TEMPORARY ACCESS RESTRICTIONS
1402
DEPENDING ON THE SPECIFIC RULES IN THIS CASE, THE CLIENT MONITOR CAN EITHER:
(A) DELAY INTERNET ACCESS FOR NON-CRITICAL APPLICATIONS OR PROTOCOLS BY:
- APPLICATONS CALL WINSOCK SEND(), RECV(), CONNECT(), ETC. CALL
- THE CLIENT MONITOR INTERCEPTS THE CALL AND CHECKS RULES AND APPLICATION DATABASE IF CALLS RELATE TO NON-CRITICAL ACTIVITIES
- IF YES, DELAY THE SPECIFIC THREAD OF THE APPLICATION BY A PREDETERMINED AMOUNT
- THIS WILL OPEN BANDWIDTH FOR CRITICAL ACTIVITIES
(B) DISABLE INTERNET ACCESS FOR NON-CRITICAL APPLICATONS OR PROTOCOLS
DONE

FIG. 14

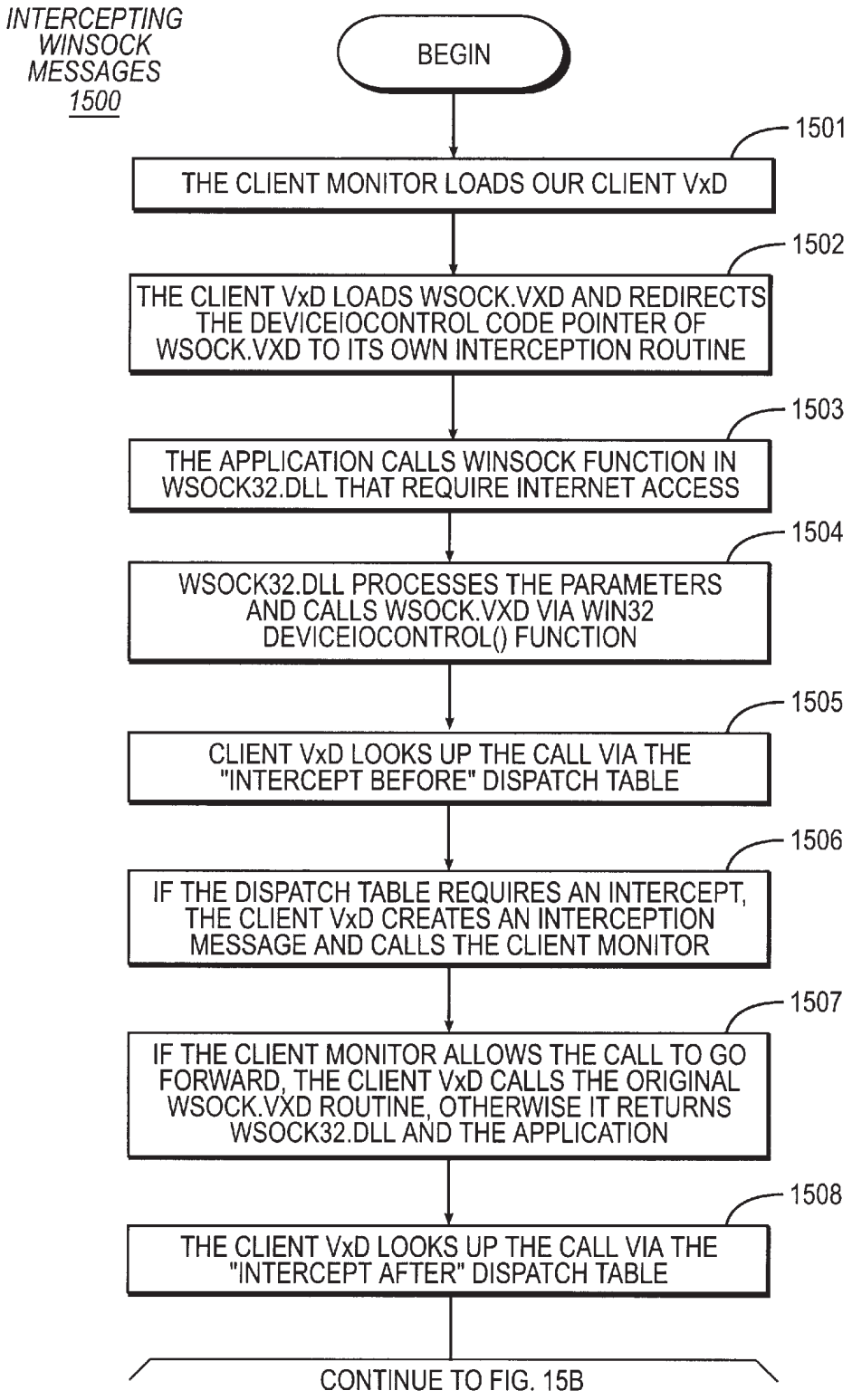
INTERCEPTING WINSOCK MESSAGES 1500
BEGIN
1501
THE CLIENT MONITOR LOADS OUR CLIENT VxD
1502
THE CLIENT VxD LOADS WSOCK.VXD AND REDIRECTS THE DEVICEIOCONTROL CODE POINTER OF WSOCK.VXD TO ITS OWN INTERCEPTION ROUTINE
1503
THE APPLICATION CALLS WINSOCK FUNCTION IN WSOCK32.DLL THAT REQUIRE INTERNET ACCESS
1504
WSOCK32.DLL PROCESSES THE PARAMETERS AND CALLS WSOCK.VXD VIA WIN32 DEVICEIOCONTROL() FUNCTION
1505
CLIENT VxD LOOKS UP THE CALL VIA THE "INTERCEPT BEFORE" DISPATCH TABLE
1506
IF THE DISPATCH TABLE REQUIRES AN INTERCEPT, THE CLIENT VxD CREATES AN INTERCEPTION MESSAGE AND CALLS THE CLIENT MONITOR
1507
IF THE CLIENT MONITOR ALLOWS THE CALL TO GO FORWARD, THE CLIENT VxD CALLS THE ORIGINAL WSOCK.VXD ROUTINE, OTHERWISE IT RETURNS WSOCK32.DLL AND THE APPLICATION
1508
THE CLIENT VxD LOOKS UP THE CALL VIA THE "INTERCEPT AFTER" DISPATCH TABLE
CONTINUE TO FIG. 15B

FIG. 15A

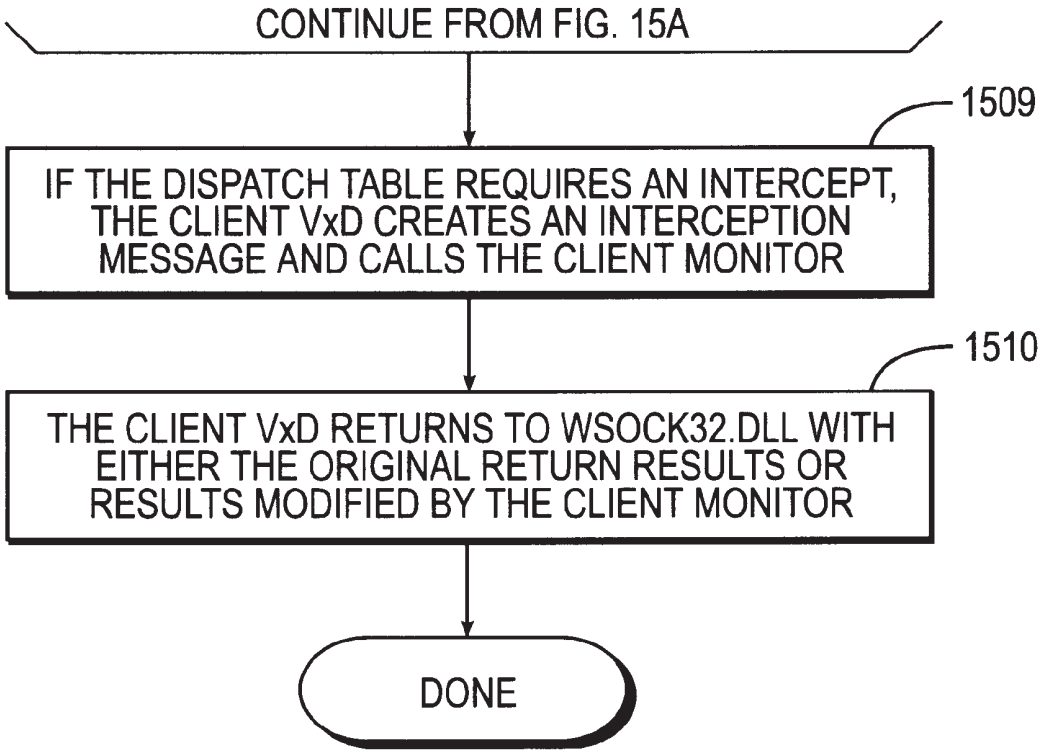
CONTINUE FROM FIG. 15A
1509
IF THE DISPATCH TABLE REQUIRES AN INTERCEPT, THE CLIENT VxD CREATES AN INTERCEPTION MESSAGE AND CALLS THE CLIENT MONITOR
1510
THE CLIENT VxD RETURNS TO WSOCK32.DLL WITH EITHER THE ORIGINAL RETURN RESULTS OR RESULTS MODIFIED BY THE CLIENT MONITOR
DONE

FIG. 15B

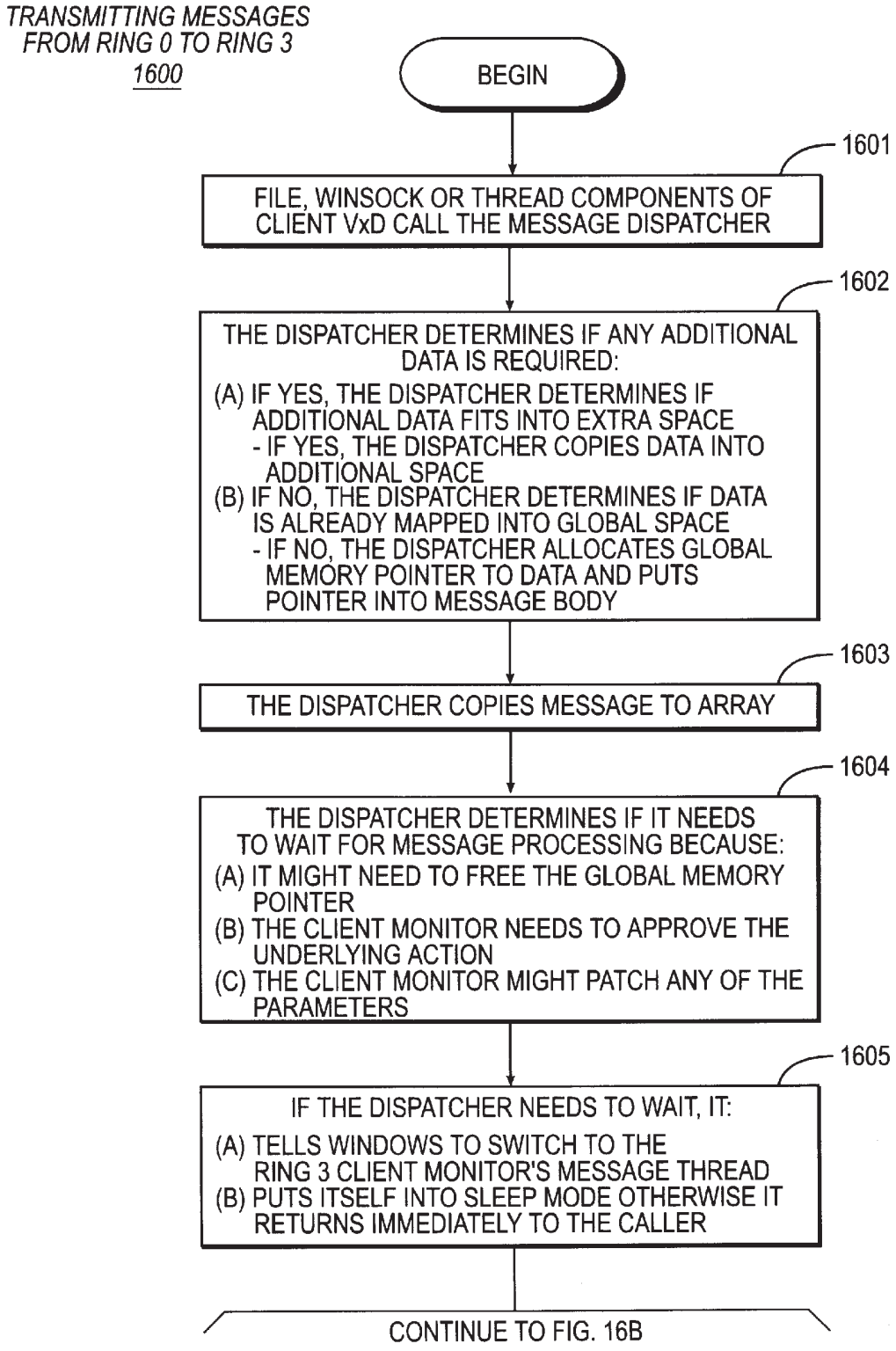
TRANSMITTING MESSAGES FROM RING 0 TO RING 3
1600
BEGIN
1601
FILE, WINSOCK OR THREAD COMPONENTS OF CLIENT VxD CALL THE MESSAGE DISPATCHER
1602
THE DISPATCHER DETERMINES IF ANY ADDITIONAL DATA IS REQUIRED:
(A) IF YES, THE DISPATCHER DETERMINES IF ADDITIONAL DATA FITS INTO EXTRA SPACE
- IF YES, THE DISPATCHER COPIES DATA INTO ADDITIONAL SPACE
(B) IF NO, THE DISPATCHER DETERMINES IF DATA IS ALREADY MAPPED INTO GLOBAL SPACE
- IF NO, THE DISPATCHER ALLOCATES GLOBAL MEMORY POINTER TO DATA AND PUTS POINTER INTO MESSAGE BODY
1603
THE DISPATCHER COPIES MESSAGE TO ARRAY
1604
THE DISPATCHER DETERMINES IF IT NEEDS TO WAIT FOR MESSAGE PROCESSING BECAUSE:
(A) IT MIGHT NEED TO FREE THE GLOBAL MEMORY POINTER
(B) THE CLIENT MONITOR NEEDS TO APPROVE THE UNDERLYING ACTION
(C) THE CLIENT MONITOR MIGHT PATCH ANY OF THE PARAMETERS
1605
IF THE DISPATCHER NEEDS TO WAIT, IT:
(A) TELLS WINDOWS TO SWITCH TO THE RING 3 CLIENT MONITOR'S MESSAGE THREAD
(B) PUTS ITSELF INTO SLEEP MODE OTHERWISE IT RETURNS IMMEDIATELY TO THE CALLER
CONTINUE TO FIG. 16B

FIG. 16A

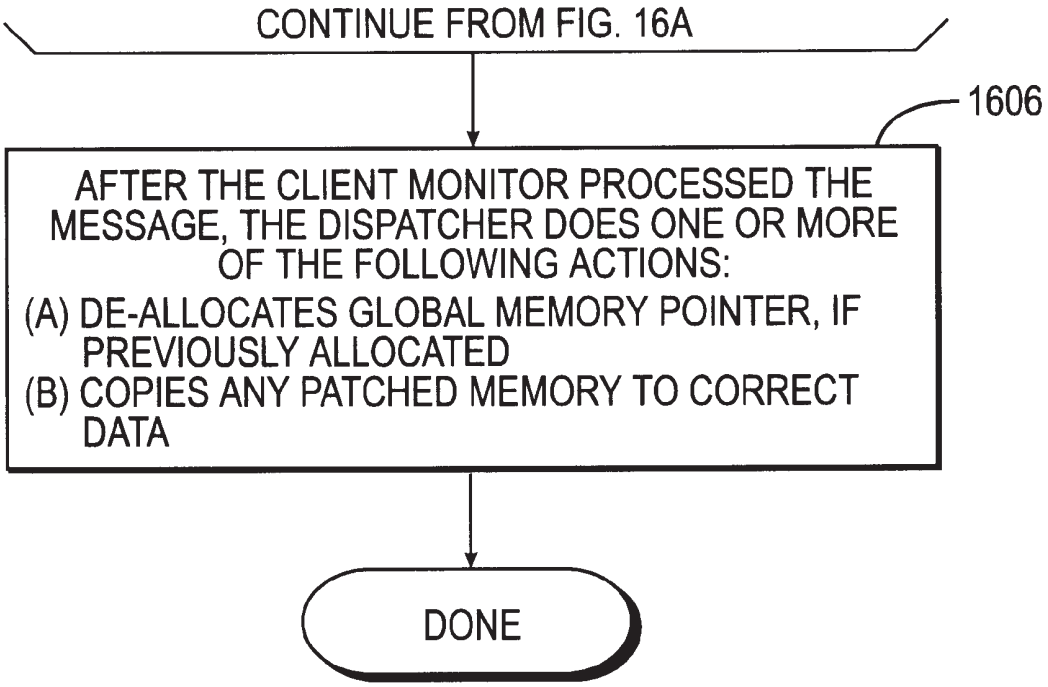
CONTINUE FROM FIG. 16A
1606
AFTER THE CLIENT MONITOR PROCESSED THE MESSAGE, THE DISPATCHER DOES ONE OR MORE OF THE FOLLOWING ACTIONS:
(A) DE-ALLOCATES GLOBAL MEMORY POINTER, IF PREVIOUSLY ALLOCATED
(B) COPIES ANY PATCHED MEMORY TO CORRECT DATA
DONE

FIG. 16B

SYSTEM AND METHODOLOGY FOR MANAGING INTERNET ACCESS ON A PER APPLICATION BASIS FOR CLIENT COMPUTERS CONNECTED TO THE INTERNET

The present application claims priority from commonly-owned provisional patent application Ser. No. 60/033,975, filed Dec. 31, 1996, entitled SYSTEM AND METHODS FOR MONITORING INTERNET ACCESS, and listing as inventor Gregor P. Freund, the disclosure of which is hereby incorporated by reference.

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BACKGROUND OF THE INVENTION

The present invention relates generally to information processing and, more particularly, to system and methods for regulating access and maintaining security of individual computer systems and local area networks (LANs) connected to larger open networks (Wide Area Networks or WANs), including the Internet.

The first personal computers were largely stand-alone units with no direct connection to other computers or computer networks. Data exchanges between computers were mainly accomplished by exchanging magnetic or optical media such as floppy disks. Over time, more and more computers were connected to each other using Local Area Networks or "LANs." In both cases, maintaining security and controlling what information a user of a personal computer can access was relatively simple because the overall computing environment was limited and clearly defined.

With the ever-increasing popularity of the Internet, particularly the World Wide Web ("Web") portion of the Internet, however, more and more personal computers are connected to larger networks. Providing access to vast stores of information, the Internet is typically accessed by users through Web "browsers" (e.g., Microsoft Internet Explorer™ or Netscape Navigator™ browser software) or other "Internet applications." Browsers and other Internet applications include the ability to access a URL (Universal Resource Locator) or "Web" site. The explosive growth of the Internet had a dramatic effect on the LANs of many businesses and other organizations. More and more employees need direct access through their corporate LAN to the Internet in order to facilitate research, competitive analysis, communication between branch offices, and send e-mail, to name just a few.

As a result, corporate IS (Information Systems) departments now face unprecedented challenges. Specifically, such departments, which have to date operated largely in a clearly defined and friendly environment, are now confronted with a far more complicated and hostile situation. As more and more computers are now connected to the Internet, either directly (e.g., over a dialup connection with an Internet Service Provider or "ISP") or through a gateway between a LAN and the Internet, a whole new set of challenges face LAN administrators and individual users

alike: these previously-closed computing environments are now opened to a worldwide network of computer systems. Specific challenges, for example, include the following: (1) attacks by perpetrators (hackers) capable of damaging the local computer systems, misuse these systems, or steal proprietary data and programs; (2) unauthorized access to external data (e.g., pornographic or other unsuitable Web sites); (3) infiltration by viruses and "Trojan Horse" programs; (4) abuse of the local computer system for unauthorized personal activities (e.g., extensive Web browsing or game playing) with subsequent loss of productivity; and (5) hording available network bandwidth through use of bandwidth-intensive applications (e.g., real-time audio programs).

The software industry has, in response, introduced a myriad of products and technologies to address and minimize these threats, including "firewalls," proxy servers, and similar technologies—all designed to keep outside hackers from penetrating the LAN. Firewalls are applications that intercept the data traffic at the gateway to a wide area network (WAN) and try to check the data packets (i.e., Internet Protocol packets or "IP packets") being exchanged for suspicious or unwanted activities. Initially firewalls have been used primarily to keep intruders from the LAN by filtering data packets. More recently, the concept has been expanded to include "Stateful Inspection." Here, a firewall not only looks at the IP packets but also inspects the data packets transport protocol (e.g., TCP) header (and even the application level protocols) in an attempt to better understand the exact nature of the data exchange.

Proxy server or Application Gateways, on the other hand, are LAN server-based applications that act on behalf of the client application. Accessing the Internet directly, the application first submits a request to the proxy server which inspects the request for unsafe or unwanted traffic. Only after this inspection will the proxy server consider forwarding the request to the destination on the Internet.

Both strategies are based on a centralized filter mechanism, with most of the filtering work being performed at the server (as opposed to the individual client PCs). Such an approach is problematic, however. Because of the centralized nature of firewalls and proxy servers, each approach extracts significant performance penalties. During operation of a typical system employing either approach, a single server might have to do the filtering work for hundreds or even thousands of PCs or workstations. This represents a major bottleneck to overall system performance. Further, a centralized filter poses a significant bottleneck even when client PCs are idly awaiting data. As emerging technologies on the Internet require still faster data delivery (e.g., real-time audio and video fees) and use more complex protocols, this problem will likely be exacerbated. In the case of firewalls employing "Stateful Inspection" technology, performance problems are aggravated by the fact that the firewall software needs to duplicate much of the protocol implementation of the client application as well as the transport protocol (e.g., TCP and UDP protocol) in order to understand the data flow.

As another problem, centralized filter architectures are missing vital information to correctly interpret the data packets because the underlying protocols were designed for effective data transfer and not for data monitoring and interception. For instance, monitoring based on an individual client application (or versions thereof) is not supported, all despite the fact that two identical data packets (or series of data packets) can have completely different meanings based on the underlying context—that is, how the

client application actually interprets the data packets. As a result, computer viruses or Trojan Horse applications can camouflage data transmissions as legitimate traffic.

There are still other disadvantages to centralized filtering. The approach is difficult to configure and administer. The task of setting up different rights for different users, workstations, or workgroups, for instance, is particularly difficult. No facilities are provided for delegating certain access and monitoring authority, for example, in order to allow a workgroup supervisor to manage less critical aspects of the Internet access for his or her group without going through a central authority. Also, a centralized filter cannot distinguish between "active" use of the Internet (i.e., when user interaction with the PC causes the Internet access) and "background" use (i.e., when an application accesses the Internet without user interaction). Still further, a centralized filter is easily circumvented, for example by a user employing a modem for establishing a dial-up connection to an ISP (Internet Service Provider). Similarly, the proxy-server approach is unattractive. Special versions or specialized configurations of client applications are required, thus complicating system administration. Internet setup for portable computers employed at remote locations is especially complicated.

Providing a client-based filter (e.g., SurfWatch and CyberPatrol) for preventing users from accessing undesirable World Wide Web sites does not adequately overcome the disadvantages of centralized filtering. Designed largely as parental control tools for individual PCs, these programs are easily disabled by uninstalling (accidentally or intentionally) the filter. A Windows user can, for example, simply reinstall Windows, replacing certain driver files of the filter. This disables the filter and provides the user with unrestricted access to the Internet.

All told, comparably little has been done to date to effectively minimize or eliminate the risks posed from within one's own corporate LAN, specifically, how one manages access to the Internet or other WAN from client machines. Quite simply, the technical framework to successfully implement an Internet access management product does not exists. What is needed are system and methods providing network administrators, workgroup supervisor, and individual PC users with the ability to monitor and regulate the kinds of exchanges permissible between one's local computing environment and external network or WANs, including the Internet. The present invention fulfills this and other needs.

SUMMARY OF THE INVENTION

The present invention provides system and methods for client-based monitoring and filtering of access, which operates in conjunction with a centralized enforcement supervisor. In accordance with the present invention, a central filter is not employed. Instead, the present invention provides a client-side filter that is controlled by the centralized authority as long as the centralized authority has a way of enforcing non-compliance, for example, by blocking access to an open network, such as a WAN or the Internet.

At a general level, the present invention provides a system comprising one or more access management applications that set access rules for the entire LAN for one or more workgroups or individual users, a client-based filter application (installed at each client), and a central supervisor application that maintains the access rules for the client based filter and verifies the existence and proper operation of the client-based filter application. Typically, the system includes (optionally) a firewall or similar application, which works together with the supervisor application in order to block all clients that have not been verified by the supervisor application.

The access management application is employed by the LAN administrator, workgroup administrator, and/or LAN user to maintain a database of the access rules for the workstations being administrated. These access rules can include criteria such as total time a user can be connected to the Internet (e.g., per day, week, month, or the like), time a user can interactively use the Internet (e.g., per day, week, month, or the like), a list of applications or application versions that a user can or cannot use in order to access the Internet, a list of URLs (or WAN addresses) that a user application can (or cannot) access, a list of protocols or protocol components (such as Java Script™) that a user application can or cannot use, and rules to determine what events should be logged (including how long are logs to be kept). These access rules can be qualified by optionally specifying: to whom should a rule apply (list of users, list of workgroups, or all); start date and expiration date of a rule; time of day when the rule should be applied (for example from 9 am to 5 pm); whether the rule is "disclosed" to the user or workgroup manager or remains hidden; whether a rule can be overwritten or modified by the workgroup manager or user; and what should happen if a rule is violated (e.g., denying Internet access, issue a warning, redirecting the access, creating a log entry, or the like).

The client-based filter application, which in a preferred embodiment performs all of the monitoring, logging, and filtering work, is responsible for intercepting process loading and unloading. Other responsibilities include keeping a list of currently active processes; intercepting certain keyboard, mouse and other interactive user activities in order to determine which process is actively used; intercepting and interpreting all TCP/IP communication and build a comprehensive representation of these TCP/IP activities; and intercepting certain file activity and assign them to the originating process.

By intercepting process loading and unloading and keeping a list of currently active processes, each client process can be checked for various characteristics, including checking executable name, version numbers, executable file checksums, version header details, configuration settings, and the like. With this information, the system can determine if the process in question should have access to the Internet and what kind of access (i.e., protocols, Internet addresses, time limitations, and the like) is permissible for the given specific user.

By intercepting and interpreting all TCP/IP communication and building a comprehensive representation of these TCP/IP activities, the system can monitor TCP/IP activities on a per process or per application basis. If a particular process has access rights to the Internet (and is permitted to use the detected protocol and no other rules are violated), the communication of the process is logged and allowed to go forward. Otherwise, the prescribed remedial action for any violated rule is performed, including logging an exception log entry and, depending on the rules the TCP/IP activity, the communication is either terminated, redirected, modified, or continued. In a similar fashion, any possible time limitation rules are evaluated and enforced at this point.

By intercepting certain file activity and assigning them to the originating process, the system can track files being created and changed by any process in order to match TCP/IP activities with corresponding file activities. If a

process uses FTP to download a file, for example, the system will match that activity to a file being saved by the same process by checking file name and size. If a match is found, a log entry is generated. This allows the immediate application of internal or external virus checkers.

The centralized supervisor application is installed on a computer on the LAN that can be reached from all workstations that need access to the Internet; this is typically (although not necessarily) a server computer. The supervisor monitors whether a client has the filter application loaded and provides the filter application with the rules for the specific user or workstation. The filter application maintains a local copy of these rules so that rule enforcement continues even when the user accesses the Internet but bypasses the LAN (e.g., a mobile computer on the road). The communication between the client-based filter and the centralized supervisor application, as well as between the supervisor application and the firewall, employs encryption to ensure secure communication and avoid any possible attack on that level.

The system of the present invention works together with existing firewalls which allow a program (e.g., the supervisor application) to dynamically set the addresses of the workstations that should have access to the Internet. The supervisor application signals the firewall which client applications have been "certified" so that the firewall only grants Internet access to those clients. At the same time, a firewall can continue to perform its usual duties, such as protecting the LAN from outside intruders or protecting the LAN and server operating system(s).

Exemplary methodologies of the present invention include the following.

I. Client Monitor with Supervisor/Firewall Backup and Enforcement

a) Installing at a particular client computer a client monitoring process;

b) Installing at another computer on the local area network a supervisor process, which specifies rules which govern Internet access by the client computers including the particular client computer;

c) Transmitting a filtered subset of the rules to the particular client computer;

d) At the client monitoring process, trapping a request for Internet access from the particular client computer;

e) Determining whether the request for Internet access would violate any of the rules transmitted to the particular client computer, and

f) If the request for Internet access violates any of the rules transmitted to the particular client computer, denying the request for Internet access.

II. Using Application Properties to Determine Legitimate Internet Traffic

a) Application attempts to access Internet;

b) Client Monitor compares application properties (version, executable name, and the like) with database of application allowed to access the Internet and checks what kind of activity the application is allowed to do (mail, browsing, and the like); and

c) If application is not allowed to access the Internet or not allowed to use the specific protocol then client monitor can stop application from accessing the Internet and/or warn user.

III. Using Application Properties to Determine if an Applications has Known Security Flaws

a) Application attempts to access Internet;

b) Client Monitor compares application properties (version, executable name, and the like) with database of application with known security problems; and

c) If application has know security problems, client monitor stops the application from accessing the Internet and/or warns the user.

IV. Monitoring User Interaction (e.g., keyboard/mouse and the like) to Distinguish and Regulate Time Spent Online;

a) Client Monitor detects interactive commands (e.g., keyboard/mouse) for an application that uses the Internet via "browsing" protocols (e.g., HTTP);

b) Client monitor determines whether the user interactively uses the Internet and restrict the activity if required.

V. Using Client Monitor to Alleviate Network Congestion

a) Supervisor Application notifies client that network is congested; and

b) Client Monitor delays transmission of non-time critical information and data.

VI. Using Local and Remote Stored Rules Databases to Allow Client Monitor Functioning Even if Supervisor Application is Not Available

a) Client monitor attempts but is unable to access the supervisor application; and

b) Access rules are still enforced because Client Monitor employs a local copy of rules (previously downloaded).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating a computer system in which the present invention may be embodied.

FIG. **2** is a block diagram of a computer software system for controlling the operation of the computer system of FIG. **1**.

FIGS. **3**A–B are block diagrams providing an overview of Internet-based (client/server) systems in which the present invention may be embodied.

FIG. **4** is a block diagram illustrating client-side operation of the system.

FIG. **5** is a block diagram illustrating a client-side monitor or data acquisition module.

FIGS. **6**A–E are bitmap screenshots illustrating a preferred user interface provided by the client-side monitoring component of the present invention.

FIGS. **7**A–K are bitmap screenshots illustrating a preferred user interface or "wizard" dialog for configuring rules.

FIGS. **8**A–B comprise a flowchart illustrating a method of the present invention for loading the Client Monitor component.

FIG. **9** is a flowchart illustrating a method of the present invention for handling the scenario of when the Client Monitor is unable to locate a Supervisor.

FIG. **10** is a flowchart illustrating a method of the present invention for unloading the Client Monitor component.

FIGS. **11**A–B comprise a flowchart illustrating a method of the present invention for loading the Client Monitor in an Internet Service Provider (ISP) environment.

FIGS. **12**A–C comprise a flowchart illustrating a method of the present invention for interpreting protocol commands, such as a typical HTTP "GET" request.

FIGS. **13**A–B comprise a flowchart illustrating a method of the present invention for bandwidth and interactive use monitoring.

FIG. **14** is a flowchart illustrating a method of the present invention for managing network congestion.

FIGS. **15**A–B comprise a flowchart illustrating a method of the present invention for intercepting communication driver (e.g., WinSock) messages.

FIGS. **16**A–B comprise a flowchart illustrating a method of the present invention for transmitting messages from one memory protection ring to another (e.g., from highly-privileged Ring **0** to lesser-privileged Ring **3**).

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The following description will focus on the presently-preferred embodiment of the present invention, which is operative in an Internet-connected environment, including, for instance, client machines running under the Microsoft® Windows environment and connected to an open network, such as a WAN or the Internet. The present invention, however, is not limited to any particular one application or any particular environment. Instead, those skilled in the art will find that the system and methods of the present invention may be advantageously applied to a variety of system and application software, including database management systems, word processors, spreadsheets, and the like, operating on a variety of different platforms, including the Macintosh® operating system, the UNIX® operating system, NextStep® operating system, and the like. Therefore, the description of the exemplary embodiments which follows is for purposes of illustration and not limitation.

System Architecture

A. System hardware (for client and/or server machines)

The invention is generally embodied on a computer system including one or more computer systems, such as computer system **100** of FIG. **1**, operating on a network. System **100** comprises a central processor **101**, a main memory **102**, an input/output controller **103**, a keyboard **104**, a pointing device **105** (e.g., mouse, track ball, pen device, or the like), a display or screen device **106**, and a mass storage **107** (e.g., hard or fixed disk, removable floppy disk, optical disk, magneto-optical disk, or flash memory), a network interface card or controller **111** (e.g., Ethernet), and a modem **112** (e.g., 28.8K baud modem or ISDN modem). Although not shown separately, a real-time system clock is included with the system **100**, in a conventional manner. Processor **101** includes or is coupled to a cache memory **109** for storing frequently accessed information; memory **109** may be an on-chip cache or external cache (as shown). One or more input/output device(s) **108**, such as a printing device or slide output device, are included in the system **100**, as desired. As shown, the various components of the system **100** communicate through a system bus **110** or similar architecture. The system itself communicates with other systems via a network interface card **111** (e.g., available from 3Com) and/or modem **112** (e.g., available from U.S. Robotics). In a preferred embodiment, the system **100** includes an IBM PC-compatible personal computer, available from a variety of vendors (including IBM of Armonk, N.Y.). I/O device **108** may include a laser printer, such as an HP Laserjet printer, which is available from Hewlett-Packard of Palo Alto, Calif.

B. System software (for controlling clients and server machines)

Illustrated in FIG. **2**, a computer software system **220** is provided for directing the operation of the computer system **100**. Software system **220**, which is stored in system memory **102** and on storage (e.g., disk memory) **107**, includes a kernel or operating system (OS) **240** and a windows shell **250**. One or more application programs, such as client application software or "programs" **245** may be "loaded" (i.e., transferred from storage **107** into memory **102**) for execution by the system **100**. In a preferred embodiment, client application software includes a Web browser (e.g., Netscape Navigator™ or Microsoft Internet Explorer™ browser software) which communicates through a communication layer or driver **241** (e.g., Winsock) with the Internet.

System **220** includes a user interface (UI) **260**, preferably a Graphical User Interface (GUI), for receiving user commands and data. These inputs, in turn, may be acted upon by the system **100** in accordance with instructions from operating module **240**, windows **250**, and/or client application module(s) **245**. The UI **260** also serves to display the results of operation from the OS **240**, windows **250**, and application (s) **245**, whereupon the user may supply additional inputs or terminate the session. OS **240** and windows **245** can be provided by Microsoft® Windows 95, by Microsoft® Windows NT, or by Microsoft® Windows 3.x (operating in conjunction with MS-DOS); these are available from Microsoft Corporation of Redmond, Wash. Alternatively, OS **240** and windows **245** can be provided by IBM OS/2® (available from IBM of Armonk, N.Y.) or Macintosh® OS (available from Apple Computers of Cupertino, Calif.). Although shown conceptually as a separate module, the UI is typically provided by interaction of the application modules with the windows shell, both operating under OS **240**.

Of particular interest, the system **220** includes a client-side Internet access monitoring module **225** of the present invention. Internet access monitoring module **225** interfaces directly with Winsock driver **241** via a Windows VxD driver interface surfaced by the driver **241**, as shown at **243**. Construction and operation of the client-side Internet access monitoring module **225**, including its interaction with server-based components employed in a preferred embodiment, will now be described in further detail.

Preferred Monitoring and Management of Internet Access

A. Introduction

1. General design

An Internet access monitoring system, constructed in accordance with the present invention, preferably includes the following.

(1) The system should preferably be capable of restricting access to the Internet (or other Wide Area Network) to certain approved applications or/and application versions.

(2) The system should preferably support centrally-maintained access rules (e.g., defining basic access rights), but at the same time allow individual work-group managers or even individual users to set rules for their area of responsibility, if so desired by the organization.

(3) The system should preferably prevent users from circumventing Internet access rules, either accidentally or intentionally. It should be difficult, for instance, for a user to circumvent access rules by connecting to the Internet through a dial-up connection (e.g., connecting to an ISP with a modem). Similarly, it should be difficult for a user to circumvent access rules by uninstalling or tampering with components of the system, from his/her own PC.

(4) The system should preferably regulate the amount of time users can access the Internet, with specific considerations for detecting interactive or "active" use by the user versus background or "passive" use by certain applications. This differentiation prevents the system

from mistakenly blocking access of a user based on excessive use, when in fact a background application is instead responsible for the activity.

(5) The system should preferably be capable of restricting individual users, workgroups, or an entire organization to undertaking certain permissible on-line activities, such as allowing use of Web browsing programs but disallowing use of Web radio programs (e.g., RealAudio™).

(6) The system should preferably be capable of restricting individual users, workgroups, or an entire organization to accessing certain external computer sites or to prohibit access to a specific list of sites.

(7) The system should preferably be capable of filtering incoming data, including binary files, for detecting viruses and Trojan Horse programs.

(8) The system should preferably maintain a detailed log of access related activities, for facilitating administration needs.

2. Managing Internet access along organizational structures

In order to effectively manage Internet access, a system should support existing organizational structures. A department supervisor, for example, should be able to determine the needs of his/her subordinates within a safe overall framework. This is important for the overall success of Internet access within the organization as it allows supervisors to address any problems which arise early on (before they become serious personnel issues). Accordingly, the Internet access monitoring system of the present invention supports a hierarchical structure where individual supervisors can monitor and set the access rules for their individual workgroups without affecting others in the organization. At the same time, a central authority (e.g., corporate IS department) still can establish general rules that cannot be overwritten on the workgroup level.

Two examples demonstrate the effectiveness of this strategy. Consider, for instance, employee Bill who begins routinely accessing pornographic sites on the Internet using company resources, despite the fact that such activity is prohibited by company policy. Using current technology, the company's IS department would likely not detect the activity for weeks, or even months, as the department's main focus is to keep the company's networks running smoothly, not to track individual activities. At the point when the activity is uncovered, Bill might have already violated company policy to the point where his manager has no choice but to dismiss Bill. If Bill's Internet access activity is monitored locally by Bill's supervisor, however, the supervisor can notice the prohibited activity almost immediately. After sternly reminding Bill of company policy, the supervisor can continue to monitor Bill's online activities and head off the need to terminate Bill.

As another example, consider Jane, an employee who normally has no Internet access but needs to write a competitive analysis for a new product. To complete this task effectively, Jane requires Internet access for performing required research. Conventionally, Jane's supervisor would call the company's IS department to arrange Internet access, a process requiring days or even weeks. However using the Internet access monitoring system of the present invention, Jane's supervisor can grant her access for a limited time within seconds.

3. Monitoring and regulating time spent on the Internet

Perhaps the aspect of Internet access most important to productivity of an organization is the ability to monitor and regulate the amount of time employees spend on the Internet. Although the Internet is an increasingly important business tool, it also poses a temptation to employees for use to pursue their own private interests while seemingly working.

The Internet access monitoring system of the present invention addresses this problem by allowing an organization to monitor and control the time its employees spend on the Internet. The actual monitoring can be done in a variety of ways, including monitoring the time spend by an employee to actively interact with the Internet, monitoring the total time applications access the Internet, and/or montoring the total time particular users/workstations access the Internet. The option of employing different approaches is an important one, as no one approach will likely answer all monitoring needs of an organization.

Consider, for example, the monitoring of time spent by an employee for "actively" interacting with the Internet. Active use occurs when a user directly interacts with an Internet application (e.g., Web browser) while that application accesses the Internet. This is distinguished from background use which occurs when an application or process executing in the background (i.e., does not have "focus") accesses the Internet, such as a mail client which intermittently polls an Internet-based mail server. Here, certain Internet applications, such as news collecting programs (e.g., PCN), access the Internet in the background while the user attends to other unrelated tasks in the foreground. The Internet access time of a user for a given day, therefore, is not necessarily equivalent to the time the user actively spends browsing Web sites. Conventional technologies cannot distinguish between this "active" versus "passive" access and therefore cannot present an accurate picture of the actual time the user has spent on on-line activities. Accordingly, it is desirable to monitor the time an employee spends "actively" interacting with the Internet, so that management goals of controling counterproductive Web browsing can be realized. In the currently-preferred embodiment, the system may be configured such that access to the Internet which occurs in the background is not counted against the per-day time limit imposed on users. A given application itself can be examined for determining whether it is "active" by determining whether the application receives "focus" and/or receives user input (e.g., mouse clicks or key strokes).

4. Monitoring application usage

Taken a step further, monitoring the total time particular applications access the Internet provides enhanced control. Unlike traditional monitoring technology, the Internet access monitoring system of the present invention can track Internet access on a per application basis—that is, access broken down by the application or applications used for the access. This affords much better tracking and regulating of Internet activities. By monitoring total time users/workstations access the Internet, an organization can better determine the overall Internet access requirements and loads.

The ability to monitor and regulate Internet access on a per application basis is particularly advantageous. Advantages include, for instance, the ability to specify which applications can (and cannot) access the Internet. IS departments have a strong interest in limiting the number of applications used on their LANs, including limiting available applications to a uniform set of "approved" applications. For one, user support is simplified if fewer different applications are in use. More importantly, the overall integrity of one's corporate networks is improved if known applications (or unknown versions of applications) are used. This is increasingly important as more and more applications are downloaded from the Internet, including applica-

tions which an IS department has little control over. Some of these applications might include ones which are unstable (e.g., "beta" software), have security flaws, or are even intentionally destructive (e.g., computer viruses and "Trojan Horse" programs). By monitoring abilities of individual applications to access the Internet and limiting such access to approved applications only, the Internet access monitoring system of the present invention can greatly reduce or eliminate the risk of such attacks.

In a corresponding manner, monitoring access to the Internet by individual applications allows the system of the present invention to not only track Internet traffic but also can determine in many cases data exchanged on a per application basis, including the ability to determine the name of individual files dowloaded as well as target directories to where such files are copied. The approach creates an audit trail of downloaded files, thus allowing one to trace the source of files found to contain offensive contents or pose security risks. This information can also be used to ease a user's housekeeping chores of deleting files that a Web site has copied onto the user's hard disk.

Further, per application monitoring simplifies the task of tracking bandwidth utilization for a network, including providing detailed review on how the Internet access is being used. This greatly eases planning of hardware and connection requirements. Inadvertent disruptions of the network by individual users, such as bandwidth hording by a user using RealAudio for listening to a Web audio "broadcast," can be averted.

B. Internet protocols

In order to facilitate understanding of the present invention, it is helpful to review basic architecture of the Internet and techniques for providing Internet access. For clarity, the following description of the Internet architecture focuses on those aspects which are relevant to the present invention.

The Internet is essentially an open network of computers and LANs. Computers within this open network communicate using multiple protocol layers. Each of the layers addresses a distinct concern of the communication process. As a core protocol of the Internet, Internet Protocol (IP) provides a layer for exchanging data packets between computers connected to the Internet, including providing data encapsulation and header formatting, data routing across the Internet, and fragmentation and reassembly. According to the protocol, data is transmitted by attaching a header with a destination address (IP address) and then transmitting the data packet from one computer to another until the data packet arrives at the desired destination. Along this journey, each computer uses an implementation of the IP Protocol to route the data packet to the next destination until the data packet reaches its final destination. Except for checking the integrity of the IP header, no error detection or recovery capabilities are performed. When the data packet arrives at its ultimate destination, any necessary integrity checks are carried out.

Another protocol—the transport protocol—serves as a layer responsible for guaranteeing the integrity of application data. It is, therefore, used only at the original source and final destination of the data. The Internet currently uses two different transport protocols. One protocol, User Datagram Protocol (UDP), does not offer reliable connectionless services; in practice, therefore, it is up to the target application to check data integrity. In contrast, Transmission Control Protocol (TCP), another transport portocol, provides reliable connection-oriented service, which establishes a connection with a remote computer and guarantees data integrity and delivery (or notifies the application in case of an error).

Both TCP and UDP data transmissions each provide specific headers, in addition to the IP header. In order to simplify forwarding the data packets to a target application, these headers include a port number. The port number functions to identify an application-level protocol. Port number 80, for instance, is normally used for the World Wide Web protocol (Hypertext Transport Protocol or HTTP).

TCP/IP refers to IP Protocol combined with TCP and UDP. Normally, application programs communicate with an available TCP/IP implementation (e.g., Windows "WinSock") through an Application Programming Interface (API). For Windows computers, the WinSock API simply encapsulates the TCP/IP architecture. WinSock is patterned after the popular Berkeley Sockets programming model, which is generally considered the de facto standard for TCP/IP networking.

Internet applications generally implement more specialized protocols on top of TCP/IP. For example, a Web browser implements the client portions of the HyperText Transfer Protocol (HTTP) in order to communicate with Web servers. A Web browser also might implement other protocols, such as the older File Transfer Protocol (FTP) for downloading data. Electronic mail applications (i.e., E-mail clients) implement the client portion of the Simple Mail Transfer Protocol (SMTP) and the Post Office Protocol (POP). Still other protocols exist for use in the Internet, many of which are documented in the technical, trade, and patent literature; see e.g., the Internet Engineering Task Force (IETF) RFCs ("Requests For Comments") publications available from the Internet Network Information Center (NIC), via FTP access to the NIC archive nic.ddn.mil. Due to the accelerated development of the Internet, many more protocols are unpublished or are in developmental stages. As long as a client application and a corresponding server application understand how to interpret the data packets they exchange, this generally does not pose a major problem. For applications that monitor the Internet traffic in order to detect security or other problems, however, this does pose an additional challenge. Accordingly, the preferred embodiment of the present invention is constructed to facilitate accommodation of new protocols.

Detailed Construction of the Preferred Embodiment

A. Overview

The present invention provides system and methods for client-based monitoring and filtering of access, which operates in conjunction with a centralized enforcement supervisor. In accordance with the present invention, a central filter is not employed. Instead, the present invention provides a client-side filter that is controlled by the centralized authority as long as the centralized authority has a way of enforcing non-compliance (for example by blocking access to the WAN).

At a general level, the present invention provides a system comprising one or more access management applications that set access rules for the entire LAN for one or more workgroups or individual users, a client-based filter application (installed at each client), and a central supervisor application that maintains the access rules for the client based filter and verifies the existence and proper operation of the client-based filter application. Typically, the system includes (optionally) a firewall or similar application, which works together with the supervisor application in order to block all clients that have not been verified by the supervisor application.

The access management application is employed by the LAN administrator, workgroup administrator, and/or LAN

user to maintain a database of the access rules for the workstations being administrated. These access rules can include criteria such as total time a user can be connected to the Internet (e.g., per day, week, month, or the like), time a user can interactively use the Internet (e.g., per day, week, month, or the like), a list of applications or application versions that a user can or cannot use in order to access the Internet, a list of URLs (or WAN addresses) that a user application can (or cannot) access, a list of protocols or protocol components (such as Java Script™) that a user application can or cannot use, and rules to determine what events should be logged (including how long are logs to be kept). These access rules can be qualified by optionally specifying: to whom should a rule apply (list of users, list of workgroups, or all); start date and expiration date of a rule; time of day when the rule should be applied (for example from 9 am to 5 pm); whether the rule is "disclosed" to the user or workgroup manager or remains hidden; whether a rule can be overwritten or modified by the workgroup manager or user; and what should happen if a rule is violated (e.g., denying Internet access, issuing a warning, redirecting the access, creating a log entry, or the like).

The client-based filter application, which in a preferred embodiment performs all of the monitoring, logging, and filtering work, is responsible for intercepting process loading and unloading. Other responsibilities include keeping a list of currently active processes; intercepting certain keyboard, mouse and other interactive user activities in order to determine which process is actively used; intercepting and interpreting all TCP/IP communication and build a comprehensive representation of these TCP/IP activities; and intercepting certain file activity and assign them to the originating process.

By intercepting process loading and unloading and keeping a list of currently active processes, each client process can be checked for various characteristics, including checking executable names, version numbers, executable file checksums, version header details, configuration settings, and the like. With this data, the filter application can determine if the process in question should have access to the Internet and what kind of access (i.e., protocols, Internet addresses, time limitations, and the like) is permissible for the given specific user.

By intercepting and interpreting all TCP/IP communication and building a comprehensive representation of these TCP/IP activities, the system can monitor TCP/IP activities on a per process or per application basis. If a particular process has access rights to the Internet (and is permitted to use the detected protocol and no other rules are violated), the communication of the process is logged and allowed to go forward. Otherwise, the prescribed remedial action for any violated rule is performed, including logging an exception log entry and, depending on the rules the TCP/IP activity, the communication is either terminated, redirected, modified, or continued. In a similar fashion, any possible time limitation rules are evaluated and enforced at this point.

By intercepting certain file activity and assigning them to the originating process, the system can track files being created and changed by any process in order to match TCP/IP activities with corresponding file activities. If a process uses FTP to download a file, for example, the system will match that activity to a file being saved by the same process by checking file name and size. If a match is found, a log entry is generated. This allows the immediate application of internal or external virus checkers.

The centralized supervisor application is installed on a computer on the LAN that can be reached from all workstations that need access to the Internet; this is typically (although not necessarily) a server computer. The supervisor monitors whether a client has the filter application loaded and provides the filter application with the rules for the specific user or workstation. The filter application maintains a local copy of these rules so that rule enforcement continues even when the user accesses the Internet but bypasses the LAN (e.g., a mobile computer on the road). The communication between the client-based filter and the centralized supervisor application, as well as between the supervisor application and the firewall, employs encryption to ensure secure communication protocol, thus avoiding any possible attack on that level.

The system of the present invention works together with existing firewalls which allow a program (e.g., the supervisor application) to dynamically set the addresses of the workstations that should have access to the Internet. The supervisor application signals the firewall which client applications have been "certified" so that the firewall only grants Internet access to those clients. At the same time, a firewall can continue to perform its usual duties, such as protecting the LAN from outside intruders or protecting the LAN and server operating system(s).

B. System architecture

1. Terminology

For purposes of describing the architecture of the system of the present invention, it is helpful to define the following terms.

Client Monitor	The monitor component or program that runs on every workstation that can access the Internet
Client VxD	Kernel mode component of Client Monitor
Supervisor	The central program that runs on a server or a secure Client Monitor and coordinates the system
Application	Third party application that can access the Internet or WAN via the WinSock API or a similar API
Firewall	Third party filter program that sits between the LAN and the Internet
Host	Third party server prograrn that can be contacted through the Intemet
ISP Server	Internet Service Provider Server application that authenticates user and serves as gateway to Internet
ISP Supervisor	Version Qf Supervisor that coordinates Internet access with ISP Server
RAS	Remote Access Service component of Windows 95/NT that dials the remote computer and initializes the contact
ISP Authentication Server	Internet Service Provider Server application that authenticates user and serves as gateway to Internet
ISP "Sandbox" Server	HTTP Server used when client has only restricted Internet access
ISP POP	Internet Service Provider Point-Of-Presence comprising modems, server, and router
ISP POP Server	Server component of ISP POP

2. LAN-based embodiment

FIG. **3**A provides an overview of an Internet-based (client/server) system **300** in which the present invention may be embodied. As shown, the system includes multiple clients **310** (e.g., clients **310***a*, **310***b*, **310***c*, each of which comprises a personal computer or workstation, such as system **100**) connected to a network **320**, such as a Windows NT Local Area Network (Microsoft Corporation of Redmond, Wash.). Each client includes a client-side monitoring component for monitoring Internet access in accordance with the present invention, as specifically shown at **311***a*, **311***b*, and **311***c*. The network **320** is connected to a server **321** (or another client) having a supervisor or verifier component **323**. The supervisor component **323** provides independent verification of the clients, for allowing or disallowing requests of each particular client. In effect, the supervisor **323** directs runtime monitoring operations.

The network **320** itself can be a server-based network (e.g., Windows NT Server providing services to network clients) or, alternatively, a peer-to-peer network. Communications to the outside (e.g., Internet) are typically achieved using TCP/IP protocol. The local network **320** communicates with the Internet, shown at **340**, preferably through a "firewall" **330**. The firewall **330** itself may be implemented in a conventional manner, such as employing a router-based or server-based firewall process for monitoring communications with various Web servers **350** connected to the Internet **340**.

With reference to FIG. **4**, client-side operation of the system is shown in further detail. As shown in FIG. **4** for client **410**, a given client generally includes one or more applications (e.g., applications **421**, **423**) which require Internet access. A Web browser (e.g., Netscape Navigator™ or Microsoft Internet Explorer™ browser software) is but one of a multitude of such applications. Each application, in turn, communicates directly with a client-side communication driver, such as Winsock driver **430**—a Windows implementation and encapsulation of TCP/IP.

The client **410** includes a client-side monitor—data acquistion module **440**—which "hooks into" the communication driver **430**. In the instance of Windows Winsock communication driver, for example, a process can hook into the driver using Winsock VxD extensions. As the various applications submit requests to the communication driver **430**, the data acquisition module **440** can intercept the communications for determining whether the request is permitted under the rules. For instance, when a request for access is received from an application, the monitor first verifies that, according to the rules in place, such an application is permitted to access the Internet. Rules currently in force might specify that only particular applications (or particular versions of those applications) can access the Internet; all other applications are denied access. For a Winsock-based implementation, the data acquisition module **440** can, in effect, trap the request at the VxD driver level, thereby effectively blocking the request at the level of the Winsock communication driver.

In addition to checking whether the application itself should have access, the data acquisition module **440** monitors the individual messages which are exchanged between the applications and the communication driver. For instance, the data acquisition module **440** can trap an HTTP "SEND" command generated by an application. By analyzing the message and any accompanying context information, the data acquisition module **440** can determine whether the command is permitted under the rules in place. By examining port address context information provided with the command, for example, the data acquisition module **440** can readily determine the underlying protocol. For Web server access, the data acquisition module **440** would identify HTTP—the underlying protocol used to communicate with the Web. Having determined the protocol, the data acquisition module **440** would verify that the protocol is permitted for the application (or for the client). As an example of a typical rule which might be in place, a supervisor might establish a rule blocking FTP (file transfer protocol) by Web browsers, for preventing users from tying up the network with large FTP file transfers.

The actual flow of messages or message "traffic" monitored by the system is perhaps best illustrated by example. An exemplary use of the system for accessing a Web site generates the following trace of messages.

```
#0000   Msg:    10020024  Process:  ffff38ff   Handle:  c307bd1c  open
        Len:    00000016  Address:  82859080
        C:\WINDOWS\SYSTEM.DAT
#0001   Msg:    0002000b  Process:  ffff38ff   Handle:  c307bd1c  close
        Size: 00000000:000a752c
#0002   Msg:    00010010  Process:  fffae7b7   Handle:  00000000  socket
#0003   Msg:    00010110  Process:  fffae7b7   Handle:  c34075cc  socket-x
#0004   Msg:    80010003  Process:  fffae7b7   Handle:  c34075cc  connect
        Family: 0002 Port: 0053 IP: 204.94.129.65
#0005   Msg:    00010103  Process:  fffae7b7   Handle:  c34075cc  connect-x
        Family: 0002 Port: 0053 IP: 204.94.129.65
#0006   Msg:    00010004  Process:  fffae7b7   Handle:  c34075cc  getpeername
#0007   Msg:    00010104  Process:  fffae7b7   Handle:  c34075cc  getpeername-x
#0008   Msg:    0001000d  Process:  fffae7b7   Handle:  c34075cc  send
        Family: 0002 Port: 0053 IP: 204.94.129.65
         Len:   00000023  Address:  82859890
    00:
#0009   Msg:    0001010d  Process:  fffae7b7   Handle:  c34075cc  send-x
#000a   Msg:    0001000a  Process:  fffae7b7   Handle:  00000000  select_setup
#000b   Msg:    0001010a  Process:  fffae7b7   Handle:  00000000  select_setup-x
#000c   Msg:    0001000b  Process:  fffae7b7   Handle:  00000000  select_cleanup
#000d   Msg:    0001010b  Process:  fffae7b7   Handle:  00000000  select_cleanup-x
#000e   Msg:    80010003  Process:  fffae7b7   Handle:  c34075cc  connect
#000f   Msg:    00010103  Process:  fffae7b7   Handle:  c34075cc  connect-x
#0010   Msg:    00010004  Process:  fffae7b7   Handle:  c34075cc  getpeername
#0011   Msg:    00010104  Process:  fffae7b7   Handle:  c34075cc  getpeername-x
        Result: 00002749 WSAENOTCONN
#0012   Msg:    0001000d  Process:  fffae7b7   Handle:  c34075cc  send
        Family: 0002 Port: 0053 JP: 204.94.129.66
         Len:   00000023  Address:  8285a290
    00:
#0013   Msg:    0001010d  Process:  fffae7b7   Handle:  c3407Scc  send-x
        Family: 0002 Port: 0053 IP: 204.94.129.66
#0014   Msg:    0001000a  Process:  fffae7b7   Handle:  00000000  select_setup
#0015   Msg:    0001010a  Process:  fffae7b7   Handle:  00000000  select_setup-x
#0016   Msg:    0001000b  Process:  fffae7b7   Handle:  00000000  select_cleanup
#0017   Msg:    0001010b  Process:  fffae7b7   Handle:  00000000  select_cleanup-x
#0018   Msg:    00010009  Process:  fffae7b7   Handle:  c34075cc  recv
```

-continued

```
#0019   Msg:     00010109  Process:   fffae7b7     Handle:  c34075cc   recv-x
        Len:     000000ad  Address:   8285a990
    00: 00 06  85  80  00  01  00  03  00  02  00  02  03  77  77  77  . . . . . . . . . . . . .www
    10: 09 77  65  62  6d  6f  6e  6b  65  79  03  63  6f  6d  00  00  .webmonkey.com. .
    20: 01 00  01  c0  0c  00  01  00  01  00  00  a8  c0  00  04  cc  . . . . . . . . . . . . . . . .
    30: 3e 81  13  c0  0c  00  01  00  01  00  00  a8  c0  00  04  cc  >. . . . . . . . . . . . . . .
    40: 3e 81  93  c0  0c  00  01  00  01  00  00  a8  c0  00  04  cc  >. . . . . . . . . . . . . . .
    50: 3e 83  93  09  77  65  62  6d  6f  6e  6b  65  79  03  63  6f  >. . .webmonkey.co
    60: 6d 00  00  02  00  01  00  00  a8  c0  00  0f  03  6e  73  31  m . . . . . .ns1
    70: 08 68  6f  74  77  69  72  65  64  c0  5d  c0  53  00  02  00  .hotwired.].S . . .
    80: 01 00  00  a8  c0  00  06  03  6e  73  32  c0  70  c0  6c  00  . . . . . .ns2.p.1.
    90: 01 00  01  00  00  a8  c0  00  04  cc  3e  84  20  c0  87  00  . . . . . .>. . .
    a0: 01 00  01  00  00  a8  c0  00  04  cc  3e  82  7c              . . . . . .>.|
#001a   Msg:     00010002  Process:   fffae7b7     Handle:  c34075cc   closesocket
#001b   Msg:     00010102  Process:   fffae7b7     Handle:  c34075cc   closesocket-x
#001c   Msg:     00010010  Process:   fffae7b7     Handle:  000000CO   socket
#001d   Msg:     00010110  Process:   fffae7b7     Handle:  c34075cc   socket-x
#001e   Msg:     00010007  Process:   fffae7b7     Handle:  c34075cc   ioctisocket
#001f   Msg:     00010107  Process:   fffae7b7     Handle:  c34075cc   ioctlsocket-x
#0020   Msg:     00010001  Process:   fffae7b7     Handle:  c34075cc   bind
#0021   Msg:     0O010101  Process:   fffae7b7     Handle:  c34075cc   bind-x
#0022   Msg:     80010003  Process:   fffae7b7     Handle:  c34075cc   connect
        Family: 0002 Port: 0080 IP: 204.62.129.147
#0023   Msg:     00010103  Process:   fffae7b7     Handle:  c34075cc   connect-x
        Result: 00002733 WSAEWOULDBLOCK
        Family: 0002 Port: 0080 IP: 204.62.129.147
#0024   Msg:     0001000a  Process:   fffae7b7     Handle:  00000000   select__setup
#0025   Msg:     0001010a  Process:   fffae7b7     Handle:  00000000   select__setup-x
#0026   Msg:     0001000b  Process:   fffae7b7     Handle:  0000000a   select__cleanup
#0027   Msg:     0001010b  Process:   fffae7b7     Handle:  00000000   select__cleanup-x
#0028   Msg:     00010009  Process:   fffae7b7     Handle:  c0f005f4   recv
#0029   Msg:     00010109  Process:   fffae7b7     Handle:  c0f00Sf4   recv-x
        Family: 0002 Port: 1028 IP: 127.0.0.1
         Len:    00000001  Address:   8285b990
    00: @
#002a   Msg:     0001000a  Process:   fffae7b7     Handle:  00000000   select__setup
#002b   Msg:     0001010a  Process:   fffae7b7     Handle:  00000000   select__setup-x
#002c   Msg:     0001000b  Process:   fffae7b7     Handle:  00000000   seiect__cleanup
#002d   Msg:     0001010b  Process:   fffae7b7     Handle:  000C0000   select__cleanup-x
#002e   Msg:     0001000e  Process:   fffae7b7     Handle:  c34075cc   setsockopt
#002f   Msg:     0001010e  Process:   fffae7b7     Handle:  c34075cc   setsockopt-x
#0030   Msg:     0001000e  Process:   fffae7b7     Handle:  c34075cc   setsockopt
#0031   Msg:     0001010e  Process:   fffae7b7     Handle:  c3407Scc   setsockopt-x
#0032   Msg:     0001000e  Process:   fffae7b7     Handle:  c34075cc   setsockopt
#0033   Msg:     0001010e  Process:   fffae7b7     Handle:  c34075cc   setsockopt-x
#0034   Msg:     00010004  Process:   fffae7b7     Handle:  c34075cc   getpeername
#0035   Msg:     00010104  Process:   fffae7b7     Handle:  c34075cc   getpeername-x
#0036   Msg:     8801000d  Process:   fffae7b7     Handle:  c34075cc   send
        Family: 0002 Port: 0080 IP: 204.62.129.147
        Len:     0000011d  Address:   c279a3a0
    00: GET / HTTP/1.0
    10: Accept: image/gif, image/x-xbitmap, image/jpeg, image/pjpeg, */*
    52: Accept-Language: en
    67: UA-pixels: 640 × 480
    7b: UA-color: color8
    8d: UA-OS: Windows 95
    a0: UA-CPU: ×86
    ad: User-Agent: Mozilla/2.0 (compatible; MSIE 3.01; Windows 95)
    ea: Host: www.webmonkey.com
    03: Connection: Keep-Alive
    1b:
#0037   Msg:     0001010d  Process:   fffae7b7     Handle:  c34075cc   send-x
#0038   Msg:     00010009  Process:   fffae7b7     Handle:  c34075cc   recv
#0039   Msg:     00010109  Process:   fffae7b7     Handle:  c34075cc   recv-x
        Result: 00002733 WSAEWOULDBLOCK
        Family: 0002 Port: 0080 IP: 204.62.129.147
#003a   Msg:     0001000a  Process:   fffae7b7     Handle:  00000000   select__setup
#003b   Msg:     0001010a  Process:   fffae7b7     Handle:  00000000   select__setup-x
#003c   Msg:     0001000b  Prccess:   fffae7b7     Handle:  00000000   select__cleanup
#003d   Msg:     0001010b  Process:   fffae7b7     Handle:  00000000   select__cleanup-x
#003e   Msg:     00010009  Process:   fffae7b7     Handle:  c34075cc   recv
#003f   Msg:     88010109  Process:   fffae7b7     Handle:  c34075cc   recv-x
        Family: 0002 Port: 0080 IP: 204.62.129.147
        Len:     00000149  Address:   c279a544
    00: HTTP/1.0 302 Found
    14: Date: Fri, 03 Jan 1997 23:02:57 GMT
    39: Server: Apache/1.1.1 HotWired/1.0
    5c: Location: http://www.webmonkey.com/webmonkey/
    8b: Content-type: text/html
```

-continued

```
      a4:
      a6: <HEAD><TITLE>Document moved</TITLE></HEAD>
      d1: <BODY><H1>Document moved</H1>
       ef: The document has moved <A
HREF="http://www.webmonkey.com/webmonkey/">here
      38: </A>.<P>
      41: </BODY>
#0040   Msg:    00010009  Process:  fffae7b7   Handle:  c34075cc  recv
#0041   Msg:    00010109  Process:  fffae7b7   Handle:  c34075cc  recv-x
        Family: 0002 Port: 0080 IP: 204.62.129.147
#0042   Msg:    00010002  Process:  fffae7b7   Handle:  c34075cc  closesocket
#0043   Msg:    00010102  Process:  fffae7b7   Handle:  c34075cc  closesocket-x
#0044   Msg:    00010010  Process:  fffae7b7   Handle:  00000000  socket
#0045   Msg:    00010110  Process:  fffae7b7   Handle:  c34075cc  socket-x
#0046   Msg:    00010007  Process:  fffae7b7   Handle:  c34075cc  ioctlsocket
#0047   Msg:    00010107  Process:  fffae7b7   Handle:  c3407Scc  ioctlsocket-x
#0048   Msg:    00010001  Process:  fffae7b7   Handle:  c34075cc  bind
#0049   Msg:    00010101  Process:  fffae7b7   Handle:  c34075cc  bind-x
#004a   Msg:    80010003  Process:  fffae7b7   Handle:  c34075cc  connect
        Family: 0002 Port: 0080 IP: 204.62.131.147
#004b   Msg:    00010103  Process:  fffae7b7   Handle:  c34075cc  connect-x
        Result: 00002733 WSAEWOULDBLOCK
        Family: 0002 Port: 0080 IP: 204.62.131.147
#004c   Msg:    0001000a  Process:  fffae7b7   Handle:  00000000  select_setup
#004d   Msg:    0001010a  Process:  fffae7b7   Handle:  00000000  select_setup-x
#004e   Msg:    0001000b  Process:  fffae7b7   Handle:  00000000  select_cleanup
#004f   Msg:    0001010b  Process:  fffae7b7   Handle:  00000000  select_cleanup-x
#0050   Msg:    0001000e  Process:  fffae7b7   Handle:  c34075cc  setsockopt
#0051   Msg:    0001010e  Process:  fffae7b7   Handle:  c34075cc  setsockopt-x
#0052   Msg:    0001000e  Process:  fffae7b7   Handle:  c34075cc  setsockopt
#0053   Msg:    0001010e  Process:  fffae7b7   Handle:  c34075cc  setsockopt-x
#0054   Msg:    0001000e  Process:  fffae7b7   Handle:  c34075cc  setsockopt
#0055   Msg:    0001010e  Process:  fffae7b7   Handle:  c34075cc  setsockopt-x
#0056   Msg:    00010004  Process:  fffae7b7   Handle:  c34075cc  getpeername
#0057   Msg:    00010104  Process:  fffae7b7   Handle:  c34075cc  getpeername-x
#0058   Msg:    8801000d  Process:  fffae7b7   Handle:  c34075cc  send
        Family: 0002 Port: 0080 IP: 204.62.131.147
        Len:    00000127  Address:  c279a3a0
      00: GET /webmonkey/ HTTP/1.0
      1a: Accept: image/gif, image/x-xbitmap, image/jpeg, image/pjpeg, */*
      5c: Accept-Language: en
      71: UA-pixels: 640 × 480
      85: UA-color: color8
      97: UA-OS: Windows 95
       aa: UA-CPU: ×86
      b7: User-Agent: Mozilla/2.0 (compatible; MSIE 3.01; Windows 95)
       f4: Host: www.webmonkey.com
      0d: Connection: Keep-Alive
      25:
```

As shown, the trace shows commands for "file open" and "file close." This is followed by a command for creating a socket and a command for connecting to a particular site. At this point, for instance, one can discern that the system is using port **53**—the DNS port—for looking up an address (IP address) on the Web. In response to this request, the system receives a series of IP addresses, which have been encoded in a particular format. Once the IP address has been received by the system, the particular Internet application making the request can now issue various commands (e.g., HTTP "GET" command) for retrieving information from a particular Web site. In response to these requests, the corresponding server at the Web site sends appropriate responses, including transmitting requested content. Since the system of the present invention monitors the message traffic at the level of individual messages, the system is able to selectively block access, as dictated by the configurable rules.

For determining whether the requested access of the client's application is accessing a permitted site, the data acquisition module **440** examines the IP address for the site which the application seeks to communicate with and compares that address against a list of allowed addresses (or conversely against a list of disallowed addresses). Certain sites can have multiple IP addresses. Accordingly, the system of the present invention stores the IP addresses with the respective Web sites, so that a particular site can be resolved at the level of its individual IP addresses. In this manner, the system of the present invention permits access based either on a Web site name (e.g., www.cnn.com) or based on a particular IP address.

As shown in FIG. **5**, the monitor or data acquisition module **440**, which is preferably implemented as a Windows VxD driver, includes the following subcomponents. Winsock Hook **501** includes functionality for connecting or "hooking" into the Winsock communication driver. File Hook **503**, in a similar manner, includes functionality allowing the driver **440** to hook into the file subsystem provided by the underlying operating system. Process Hook **505**, another subcomponent which hooks into the underlying operating system, tracks all currently-executing applications or processes. All of these hooks, as implemented in a Windows VxD, are capable of executing at ring **0**—that is, execution at the highest privileged level of the operating system.

Also shown, the module **440** includes a buffer interface (manager) **507** which interfaces directly with a client system-maintained FIFO (first-in, first-out) message buffer **550**. The message buffer **550** comprises an array of mes-

sages maintained in a fixed-size (i.e., pre-allocated) block of client memory. The buffer **550** itself is shared between the data acquisition module **440** and the various other executing applications. In a preferred embodiment, the data acquisition module **440** utilizes the shared message buffer **550**, so that the module itself need not undertake various allocation/deallocation operations (which might degrade performance).

Actual access to individual messages within the buffer is achieved by mapping globally-accessible selectors, thus permitting the data acquisition module **440** with the ability to access individual messages (and content thereof) within the message buffer **550**. With direct access to the underlying messages themselves, the data acquisition module can patch (i.e., modify) dynamically at runtime the content of various messages. For instance, a request to access a particular Web site can be patched to instead redirect that request to another site. More generally, since the module **440** can trap individual messages, individual messages can be modified in an arbitrary manner according to the rules in place, including disallowing (i.e., blocking) specific messages.

Actual interpretation of individual messages is performed by data interpretation module **560** which co-exists with the data acquisition module **440**. The data interpretation module **560**, which communicates directly with the data acquisition module **440**, keeps track of all currently-executing processes. To intelligently determine the action which it should undertake for a given message, the module **560** refers to a rules database or knowledgebase **570**. Here, the various rules which define permitted activity in the Internet-based system are stored in a format which is readily accessible by the data interpretation module **560**. Contained within the rules database **570** are individual databases fully characterizing the administrator-specified rules for the system. When the data interpretation module **560** is first loaded at a given client machine, it attempts to download from the supervisor module into its local knowledgebase **570** a copy of those system rules pertinent to the client. In the event that such a copy is not available (or has not changed since last download), the data interpretation module **560** employs the last downloaded local copy.

Finally, the data interpretation module **560** maintains log information, including an audit (transaction) log **580** and an exception log **585**. The former provides a time-sequence log of messages processed by the system; the latter provides a time-sequence log of exceptions (e.g., access violations attempted by users) which have occurred in the system.

3. ISP-based embodiment

Although the previously-described embodiment focuses on monitoring LAN-based access to the Internet and other WANs, the present invention can alternately be implemented for establishing a monitoring and filtering system for Internet Service Providers (ISPs) or similar organizations. This allows ISPs to offer their users a tamper-proof, safe, and managed access to the Internet and protects the users from many security threats. It enables users to control how, when, and who accesses the Internet with their account.

FIG. **3**B illustrates certain modifications to the system **300** (of FIG. **3**A) for creating the alternative embodiment, shown as system **300***a*. Most ISPs use decentralized installations called Points-Of-Presence (POPs), such as POP **320***a*. These installations comprises a series of modems to connect to client PCs or client LANs, a server or LAN, and one or more router to connect the installation to the Internet (normally via high-speed dedicated lines). ISPs normally have one or more POPs in the areas that they serve. When a user dials into a POP (e.g., using a protocol such as SLIP), the POP server in return contacts the central ISP authentication server either via the Internet or a dedicated line. The central authentication server checks the user's ID and password and signals the POP server whether the user is allowed or denied access to the Internet. If the user is allowed to access the Internet, the POP enables the access autonomously without further involvement of central ISP servers.

In this alternate embodiment, the ISP installs an additional central server component **370** to host the central supervisor application; this new component comprises an ISP authentication server **371** and an ISP supervisor server **372** (which includes a central supervisor application **373**). After the central ISP authentication server **371** has established the authenticity of the user, it contacts the central supervisor application **373** in order to find out if the user has established additional access monitoring services. In such a case, the ISP authentication server **371** signals the POP server **320***a* to only allow limited access to the Internet and redirect all requests to a "Sandbox" server application, shown at **374**, on the central supervisor server **372**. This "Sandbox" server **374** restricts the client's Internet access to a very limited account maintenance site.

The Client Monitor on the client PC (e.g., monitor **311***a*) monitors the log-on process. Once the limited access to the Internet is established, the monitor contacts the central supervisor application **373** on the ISP supervisor server **372** in order to receive access rules and other required components. Once the central supervisor application **373** is satisfied that the Client Monitor has received the appropriate access rules and is working satisfactory, it contacts the POP server **320***a* to signal that the user now has full Internet access. The central supervisor application **373** will continue to check the Client Monitor and, in case of any problems, signals the POP server **320***a* to fall back to limited access to the Internet.

If the user does not have a Client Monitor installed, or the Client Monitor is not functioning or has been tampered with, the user will only have access to the "Sandbox" server **374**. The user will not gain access to the rest of the Internet until the user downloads the Client Monitor component from the "Sandbox" server **374** or otherwise reinstall the Client Monitor application.

C. Preferred user interface

1. General

The client-side monitoring component provides a preferred user interface **600**, as shown in FIG. **6**A. The interface **600** serves to display the user's current Internet activity and/or past log. As illustrated, the interface **600** includes a main menu **601**, a selection or tool bar **605**, a Web applications panel **610**, a contents panel **620**, and a details panel **630**. The tool bar **605** provides a display filtering mechanism, affecting the actual information displayed by the various panels. For instance, the user can employ the tool bar **605** for selecting what type of information to show (e.g., applications), which user the system should display information for (e.g., the current user or another named user), and what time frame is of interest to the user (e.g., "today"). Selection icons **640**, positioned along one side of the interface **600**, provide one-click access to user commands (which correspond to those available from the menu **601**).

FIG. **6**B illustrates appearance of the interface **600** (now **600***a*) during operation of a Web browser (e.g., Netscape Navigator™ or Microsoft Internet Explorer™ browser software). The applications panel **610** (now **610***a*) shows the currently-executing applications or processes. As shown at **611**, current Web processes for this example include Internet Explorer. In the currently-preferred embodiment, processes are illustrated in an outline (hierarchical) view, with indi-

vidual processes represented by nodes of the outline. Upon the user selecting to expand an application node (e.g., by clicking on node **611**), the system, in response, displays dependent or child nodes representing protocols employed by that application. For the application node **611**, for instance, the system displays child nodes **612**.

In a corresponding manner, the contents panel **620** and the details panel **630** provide further information for the currently-selected application or process. Specifically, the contents panel **620** (now shown as **620***a*) displays the details (contents) which comprise the Web object (e.g., Web page) selected by the user (e.g., from a Web browser). In conjunction with this contents view, the details panel **630** (now shown at **630***a*) displays a details or transaction list—a list of transactions (e.g., HTTP commands) which have occurred for the currently-selected Web object. In the example shown in FIG. **6**B, for instance, the display transactions include HTTP "GET" commands, for getting (fetching) various bitmaps which comprise the Web page currently viewed in the browser. FIG. **6**C illustrates appearance of the interface **600** (now **600***c*) as additional Web processes are launched. For instance, the applications panel **610** (now **610***c*) displays a new node **613**, for indicating the new executing process, here WebFerret (a search utility application).

Using the current example of a system executing Internet Explorer and WebFerret, operation of the interface **600** for monitoring protocols will now be illustrated. FIG. **6**D illustrates the interface **600** (now **600***d*) with full expansion of the "DNS" protocol node **650**, as shown in the applications panel **610** (now **610***d*). The DNS or Directory Name Service protocol is the main protocol employed to look up the address of a name (i.e., "www.cnn.com") on the Internet. For the current example, the user has "visited" two Web sites: Starfish Software (www.starfishsoftware.com) and CNN (www.cnn.com). These are illustrated as children nodes **651**, which depend from (i.e., hang off of) the DNS node **650**. Upon the user selecting a particular one of the dependent nodes **651**, the interface **600***d* displays corresponding information in the contents panel **620***d*. For the particular example of a DNS-based Web name of www.cnn.com, the contents panel **620***d* displays corresponding Internet addresses, as shown at **653**. In this specific example, the CNN Web site has five Internet or IP (Internet protocol) addresses.

During system operation, therefore, the Internet monitor performs monitoring of different types of Internet access protocols. Support for any given type of access protocol is provided via a dynamically-loaded driver. For instance, the system includes driver supporting HTTP, FTP, SMTP, and POP3 protocols. Other drivers are provided for different content types, for instance, supporting parsing of HTTP files, executable files, ZIP files, ActiveX controls, or Java classes. Each driver is responsible for monitoring and filtering access for its particular type, including ensuring that any user activity which employs that access type conforms to any rules or conditions specified for the Internet monitor.

FIG. **6**E illustrates operation of the interface **600** (now **600***e*) for the WebFerret application. As shown at **655**, the application employs the DNS protocol for looking up the addresses of several Web search engines, including Alta Vista™, Yahoo™, Infoseek™, and Lycos™ search engines.

In a corresponding manner, as indicated at **657**, the WebFerret application employs World Wide Web protocol (HTTP) for communicating with each of the foregoing Web search engines.

2. Rule wizard interface

The system allows user (e.g., administrator) configuration of rules which govern use of the protocols monitored by the system. For instance, an administrator can establish a rule based on a particular application, such as a rule presenting Internet access by a real audio player application (ra32.exe). Rules can also be established on the basis of including and/or excluding access to particular Internet sites. For instance, an administrator can establish a rule allowing users to only access a limited number of approved sites. On the other hand, the administrator can set a rule blocking user access to particular sites (e.g., pornographic sites). Rules can also be set which are time-based in nature. For instance, an administrator can establish a rule setting a time limit (e.g., 30 minutes) for how long a user can access the Internet each day. More important in the business environment, the system allows such a time limit to be set according to a user's "active" use of the Internet.

FIGS. **7**A–K illustrate a preferred user interface or "wizard" dialogs for configuring rules. As shown in FIG. **7**A, a preferred interface **700** provides a "view" of rules governing operation of the Internet access monitor, displaying all of the rules which are available for a current configuration. As shown, the interface **700** includes a toolbar **710** having the following buttons. Button **711** allows the user to create a new rule. Button **712** allows the user to edit an existing rule. Button **713** allows the user to delete a rule. Button **714** allows the user to print out a hard copy of a rule. Finally, button **715** allows the user to group rules together (i.e., into user-defined groups). The toolbar **710** also includes a group list field **716** and a user list field **717**. Together, these fields allow the user to manage groups of computers and/or groups of users.

Below the toolbar **710** is a rule panel **721** which lists the current rules in place for the system (for the currently-selected group). For each rule, the rule panel **721** displays a description, a start date, and an expiration date (if any). In this fashion, individual rules can be presented in a self-explanatory manner. For instance, rule **723** specifies that Web browsing is restricted to one hour per day for weekdays, from 9 a.m. to 6 p.m. The rule, which has a start day of Sep. 12, 1996, is currently configured to never expire. The rule panel **721** displays all rules, whether they are created by the system administrator or a group manager, or pre-existing (default) rules provided by the system. Enforcement of any given rule can be suspended by "disabling" the rule, such as shown at **724**.

Below the rule panel **721**, the interface **700** includes a rule details panel **730**. As illustrated by tabs **731**, the panel **730** itself includes the following pages: general, history, and comment. The details panel **730** provides detail information for the particular rule which is currently selected in the panel **721**. For the rule **723** as the currently selected rule, for instance, the panel **730** displays on its "general" page detail information which describes general features of the rule. On the "history" page (not shown), the panel **730** displays history/revision information for the selected rule. In a similar manner, on the "comments" page (not shown), the panel **730** provides any comments which the user has entered for the rule. The interface **700** also includes a status bar **735** which displays, at **736**, a rule ID (internally-maintained identifier) for the currently-selected rule. The ID is employed internally for tracking and cross referencing rules. The status bar **735** also displays current on-line activity at **737**, such as a status message indicating which objects are currently being received from a Web site.

Operation of the interface **700** will now be described by demonstrating the user task of creating a new rule. The user begins the process by selecting "new rule" button **711**. In response, the system displays rules expert or wizard dialog

740, as shown in FIG. 7B. At the outset, the wizard dialog 740 asks the user what kind or type of new rule should be created. Generally, any given rule is a combination of access rights granted on the basis of available applications, permitted time limits, permitted user activities, permitted protocols, and the like. At the outset, the system provides pre-defined or "canned" rules which pre-package access rights (based on common combinations of the foregoing attributes). The wizard dialog 740 provides a list 741 of rule types currently defined for the system. As shown, for instance, the user can select type 742 for limiting what applications (including individual applications) can do on the Internet.

After selecting a rule type, the user proceeds to the next pane or page of the wizard dialog (by clicking the "next" button). As shown in FIG. 7C, the wizard dialog 740 (now 740*a*) displays a "title" edit field 743 and a "comments" edit field 744. Here, the user can enter information for the title and comments, respectively.

Proceeding to the next page, the wizard dialog 740 (now 740*b*) displays an outline list 745 of all applications known to the system. Using include/exclude buttons 746, the user can instruct the system to selectively include or exclude applications (and versions thereof) which are to be affected by the new rule. The user's current selection is displayed at application list 747. The applications affected by a given list are the cumulative sum of the applications on the list. For instance, list 747 indicates that all applications are added to the list except for Internet Explorer and Netscape Navigator (as these have been excluded from the list). If desired, the user can save a particular list as a user-defined group. For the list shown at 747, for example, the user could save the list as "All applications except Web browsers."

Note also that the applications outline 745 provides a version-based list of applications. Under "Internet Explorer," for instance, the outline displays "latest release," "version 3.02," and subsequent prior versions (not shown). By tracking applications on a per version basis, the system can selectively enforce rules against individual versions of an application. Versions 3.01 and 3.00 of Microsoft's Internet Explorer™browser software, for instance, have known security flaws. Using a per-version rule in accordance with the present invention, the user can create a rule blocking Internet access for Internet Explorer versions 3.01 and 3.00, yet allow access for other versions (e.g., version 3.02).

Internally, the system defines "latest release" and "all versions" for each application. "Latest release" represents the most recent version of a given application. As each new version of an application is released, "latest release" is automatically updated to that most recent release. "All versions" is defined internally, in contrast, to simply include all versions of a given application.

After specifying which application or applications (and versions thereof) should be affected by the new rule, the user proceeds to specify which activities are to be limited. As illustrated in FIG. 7E, the wizard dialog 740 (now 740*c*) includes an activity pane which allows the user to select one or more activities limited by the new rule. In a manner similar to that described for selecting applications, activities are selected from an outline list 755 for inclusion or exclusion, by using include/exclude buttons 756. Again, the user creates a set representing the sum of included or excluded activities; these are displayed by outline list 757. In an exemplary embodiment, the system provides default activities which can be limited, including, for instance, Worldwide Web (Internet) activity, receiving incoming e-mail, and sending outgoing e-mail. The limitation on outgoing e-mail can be employed, for example, to prevent unknown "spy" applications from using e-mail services (e.g., Microsoft MAPI) to steal confidential information from the user's system. Note that a firewall, in contrast, cannot provide an effective defense against such spy applications, because firewalls do not have the capability to understand the underlying applications. For the new rule being created for the example at hand, all activities have been restricted for all applications except Internet Explorer™ browser software (all versions) and Netscape Navigator™ browser software (all versions).

Also shown, the wizard dialog 740*c* includes an "advance" button 777 which allows the user to define his or her own activities. The user-defined activities are defined based on Internet port, address families, and the like. In this manner, the user can create his or her own Internet access activities for use in rules.

The user is now ready to specify to which people and/or to which computers the new rule is to apply. As shown in FIG. 7F, the wizard dialog 740 (now 740*d*) includes a pane which allows the user to define a set which includes or excludes people, computers, and/or groups thereof. In a manner to that previously described for defining activities and for specifying applications, the pane includes an outline list 761 from which the user can select to include or exclude items. People, computers, and groups which have been included or excluded are displayed on the right hand side of the dialog, by list 763. As before, the list is a set representing the cumulative sum of items which have been included or excluded.

"People" represent individual users who can log on to the system (from one or more computers). A "computer", on the other hand, represents an individual workstation or other device connected to the system; typically, such a device has a unique IP address assigned to it. A "group" represents a set which includes or excludes certain people and/or computers. This approach permits the system to allow a Web server (a device), for instance, to have unlimited Internet access regardless of which user is logged onto that computer. At the same time, the system can prevent a given user from undertaking certain activity, regardless of which computer that user has logged onto. By using groups, the user can conveniently encapsulate certain people or computers (or subgroups thereof) into a user-specified group, such as a "marketing" group. For the new rule of the example at hand, the rule disallows Internet access for all applications except Internet Explorer™ and Netscape Navigator™ browser software for all users and computers except for the marketing group, the Web server computer, and one individual (the user having username of gfreund).

FIG. 7G illustrates the next pane of the wizard dialog 740 (now 740*e*). Here, the wizard dialog 740 displays a selection of actions 767 which the system should undertake in the event of an attempted rule violation. Choices include, for instance, stopping the activity and showing an error dialog, stopping the activity and redirecting the user to an error page (when possible), stopping the activity and generating an application error, and the like. Additionally, the user can specify at this point that the system should generate an entry in a system alert or error log. This last option is helpful, for instance, when the access monitor is first deployed; this allows the system administrator to establish a log of potential rule violations before he or she decides to activate rule enforcement. For those response actions associated with a dialog, the wizard dialog provides a dialog text field 769 for entering messages. Messages can include tags or macros for allowing certain text to be specified at runtime, such as

replacing <application name> or <Web site name> with the current application name or Web site name, respectively, for the instant rule being violated.

As illustrated in FIG. **7**H, the wizard dialog **740** (now **740***f*) includes a start date/expiration date pane. Here, the user can specify the start date and expiration date (if any) for the new rule being created. Further, the user can also specify particular time intervals (e.g., during weekdays and/or during weekends) when the rule is enforced. This allows an administrator, for instance, to specify that a rule blocking a RealAudio application remains in force during working hours on weekdays—that is, at times when network traffic is already congested. At other times, however, the rule is not enforced. For the example shown in FIG. **7**H, the rule has a start date of Mar. 31, 1997 and never expires; the rule is enforced weekdays and weekends from 8 a.m. to 5:30 p.m.

As shown in FIG. **71**, the wizard dialog **740** (now **740***g*) includes a pane allowing the user to specify "who," if anybody, can modify or suspend the new rule. Recall that, in general, rules will be modified by a system administrator or by workgroup or department supervisors. Additionally, however, an end user might be in a position to modify or suspend rules, particularly for those rules which the end user has created to control Internet access by applications on his or her system. In this manner, the system of the present invention allows rules to be modified in a distributed manner. Thus, an organization can control network use (through Internet access) along organizational or personnel structures, without requiring involvement of IS personnel. Accordingly, the dialog **740***g* provides check boxes **771** permitting the new rule to be modified or suspended by: (1) a workgroup supervisor, (2) a department supervisor, and/or (3) end users. For the present example, since none of the check boxes have been "checked," the new rule cannot be modified by anyone other than the user who has authority to create new system-wide rules (e.g., system administrator).

As illustrated in FIG. **7**J, the wizard dialog **740** (now **740***h*) next displays a summary pane allowing the user to review the new rule. In particular, the dialog **740***h* displays a rule summary **775** comprising a prose description summarizing user input for the wizard dialog. For instance, user inputs for dialog **740***b* and **740***c* are summarized by rule summary #1 (shown at **777**). The user can backtrack through the wizard panes, if needed, for modifying the new rule. Once the user is satisfied with the definition for the new rule, the user selects Finish button **780** for adding the new rule to the system. As shown in FIG. **7**K, the interface **700** (now **700***a*) adds the new rule to the rule panel, at **781**. General information for the rule is provided in the rule details panel, as shown at **783**.

D. Internal methodologies

1. General

Detailed internal operation of the system of the present invention is perhaps best described by dividing the internal operation into the following general methods.

I. Loading the Client Monitor

II. Client Monitor did not find Supervisor (operation outside of LAN)

III. Unloading the Client Monitor (normally at workstation shutdown)

IV. Loading the Client Monitor in an ISP environment

V. Interpretation of a typical HTTP "GET" request

VI. Bandwidth and interactive use monitoring

VII. Managing network congestion

VIII. Intercepting WinSock messages

IX. Transmitting messages to Ring **3**

Each will now be described in turn.

2. Loading the Client Monitor

As illustrated in FIG. **8**, a method **800** for loading the Client Monitor component comprises the following steps. At step **801**, the Client Monitor checks if a Supervisor has been assigned for this Client Monitor. If a Supervisor has been assigned (i.e., yes), the Client Monitor sends a login request to the Supervisor, at step **802**. At step **803**, the Supervisor checks if the request comes from within the LAN. Then, at step **804**, the Supervisor checks if the Client Monitor (computer/user) has any Internet access rights; also, the Supervisor determines the department or workgroup for the Client Monitor, as indicated at step **805**.

Based on these determinations, the Supervisor filters rules appropriate for the client (i.e., application, Host, and other rules), and transmits them to the Client Monitor, at step **806**. Thereafter, at step **807**, the Client Monitor confirms successful reception of rules. The Client Monitor saves a copy of the rules onto a local hard disk (i.e., to a local storage medium), if available, as shown at step **808**. The Supervisor contacts the Firewall, at step **809**, to request Internet access for the Client Monitor. Connection between the Client Monitor and the Supervisor remains open; this is indicated at step **810**. Now, the Supervisor regularly sends check messages to the Client Monitor, as shown at step **811**. The Client Monitor can now store log information on local storage (if available), at step **812**. In a complementary fashion, the Client Monitor sends log messages to the Supervisor, at step **813**. If the Supervisor detects any problem with the Client Monitor, it notifies the Firewall to disable Internet access for the Client Monitor, as indicated by step **814**.

3. Client Monitor unable to locate Supervisor

As illustrated in FIG. **9**, a method **900** for handling the scenario of when the Client Monitor is unable to locate a Supervisor (operation outside of the LAN) comprises the following steps. At step **901**, the Client Monitor loads the last stored application, Host, rules database, and the like from local storage. At step **902**, the Client Monitor attempts to contact the Internet directly (for example via a dialup connection), but the last-stored rules continue to apply.

4. Unloading the Client Monitor

As illustrated in FIG. **10**, a method **1000** for unloading the Client Monitor (normally at workstation shutdown) comprises the following steps. At step **1001**, the Client Monitor component or application notifies the Supervisor that it is about to be unloaded. At step **1002**, the Supervisor contacts the Firewall of that Client Monitor to stop Internet access for that Client Monitor. At step **1003**, the Client Monitor stores any remaining log information on local storage (if available). At step **1004**, the Client Monitor sends any remaining log messages to the Supervisor. At step **1005**, the Client Monitor shuts down.

5. Unloading the Client Monitor

As illustrated in FIGS. **11**A-B, a method **1100** for loading the Client Monitor in an Internet Service Provider (ISP) environment comprises the following steps. At step **1101**, the RAS calls the ISP POP server using SLIP, PPP or similar protocol with user ID/password. At step **1102**, the ISP POP Server calls the ISP Authentication Server with user ID/password. At step **1103**, the ISP Authentication Server checks user ID and password. If these are valid, the Authentication Server checks with the ISP Supervisor if the user has access rules (mechanism) installed, at step **1104**. If rules are install, the ISP Authentication Server notifies ISP POP that client has Internet access restricted to the ISP "Sandbox" Server. Otherwise, the ISP Authentication Server notifies the

ISP POP that the client has unrestricted Internet access. At step **1105**, the Client Monitors send login requests to the ISP Supervisor. The Supervisor then transmits access rules and the like to the Client Monitor at step **1106**. At step **1107**, the Client Monitor saves a copy of the rules on a local hard disk to a local storage medium, if available. At step **1108**, the ISP Supervisor contacts the ISP POP Server to remove "sandbox" restrictions. At step **1109**, the connection between the Client Monitor and the Supervisor remains open. At step **1110**, the ISP Supervisor regularly sends check messages to the Client Monitor. At step **1111**, the Client Monitor stores log information on local storage (if available). At step **1112**, the Client Monitor sends log messages to the ISP Supervisor. If the ISP Supervisor determines any problems with the Client Monitor, it notifies the ISP POP Server to restrict access rights to "sandbox mode" at step **1113**.

6. Interpreting protocol commands (e.g., HTTP requests)

FIGS. **12**A–C illustrates a method **1200** for interpreting protocol commands, such as a typical HTTP "GET" request. At any time during the method, the Client Monitor can fail or redirect a call; it also can show the user a warning dialog but permit the command or request call to continue unchanged. The method **1200** comprises the following steps. At step **1201**, the application calls WinSock WSAStartup() API command. At step **1202**, the Client Monitor intercepts the call and checks the rules and application database to see if the application or a specific version of the application has Internet access rights. If not, the Client Monitor fails the WSAStartup() call at step **1203**. At step **1204**, the Application invokes socket(). At step **1205**, the Client Monitor intercepts the call and checks if the application or user has the right to continued use of the Internet (see also Bandwidth and interactive use monitoring). If not, the Client Monitor fails the socket() call at step **1206**. At step **1207**, the Application contacts the Host using WinSock connect(). At step **1208**, the Client Monitor intercepts the call and checks the rules and Host database to see if the application has access rights to the specific Host. At step **1209**, the Client Monitor checks if the application or user has the right to continued use of the Internet (see also Bandwidth and interactive use monitoring). If the answer is no at steps **1208** and **1209**, the Client Monitor fails or redirects the connect().call at step **1210**. At step **1211**, the Application calls WinSock send() with the HTTP get command (e.g., "GET foo.html"). At step **1212**, the Client Monitor intercepts the call and determines the protocol based on a combination of the TCP/IP port address, the address family, contents, and the like. At step **1213**, the Client Monitor checks the rules and application database to see if the Application has the right to use HTTP. At step **1214**, the Client Monitor checks the rules database to see if the user/computer has the right to download ".html" files. If the answer is no at steps **1213** or **1214**, the Client Monitor fails or redirects the send() call at step **1215**.

At step **1216**, the Client Monitor loads the content driver for ".html" files. At step **1217**, the application invokes WinSock recv(). At step **1218**, the Host sends the contents of "foo.html". At step **1219**, the Client Monitor intercepts the return of the recv() call and passes the contents to the content driver. At step **1220**, the content driver parses the contents of "foo.html" and checks for the following components: (a) References to Java™, ActiveX, and the like (<APPLET> or <OBJECT> tags); (b) References to Netscape style plug-ins (<EMBED> tag); (c) Imbedded scripts such as Java Script™, VBScript, and the like (<SCRIPT> tag); (d) References to other files or components (<A HREF=\f "Symbol">, or <IMG SRC=\f "Symbol"> tags); and (e) Other syntax elements that are known or suspected to cause security or network problems. At step **1221**, the Contents driver checks the application and rules database to see if the specific HTML component is permissible. If it is not permissible, the driver either removes the HTML component or fails the recv() call depending on the violated rule at step **1222**. At step **1223**, the Application received (sometimes modified) contents of "foo.html". At step **1224**, the Client Monitor intercepts the file I/O calls from the application and tries to determine where (if at all) the Application has saved the file it just received.

7. Bandwidth and interactive use monitoring

FIGS. **13**A–B illustrate a method **1300** for bandwidth and interactive use monitoring. During the method, the Client Monitor maintains a list of active Applications (processes) with various fields to track activities and a global activity record. The method **1300** comprises the following steps. At step **1301**, the Application calls WinSock send() recv() calls. At step **1302**, the Client Monitor intercepts these calls and: (a) Marks the time of the call in a LastInternetAccess field of the Application's list entry; (b) Checks if the send() or recv() uses an Internet protocol usually associated with interactive activity (HTTP—Web browsing, online games, and the like); (c) If such a protocol is used, marks the time of the call in a LastInteractiveAccess field of the Application's list entry; (d) Adds the data lengths to a DataIn or DataOut accumulator or counter of the Application's list entry and global activity record; (e) If the DataIn or DataOut fields exceed rule-based quantity either for the specific Application or the user/workstation, the Client Monitor disables future Internet access and/or warns the user.

At step **1303**, the operating system, Windows, sends certain keyboard (WM_KEY), and mouse (WM_?BUTTONDOWN) messages to a window. At step **1304**, the Client Monitor intercepts these messages. At step **1305**, the Client Monitor identifies the target window and Application of the message and marks the time of the LastInteractiveUse field of the Application's list entry. At step **1306**, every minute the Client Monitor checks each entry of the Application list as follows: (a) Has the LastInternetAccess field changed in the last minute; (b) If yes, add one minute to a TotalInternetUse field of the Application's list entry; (c) Have the LastInteractiveAccess and LastInteractiveUse fields changed in the last five minutes; (d) If yes, add one minute to a TotalInteractiveUse field of the Application's list entry; (e) If the TotalInternetUse or TotalInteractiveUse fields of any Application's list entry have changed, also add one minute to the corresponding field of the global record; and (f) If any of the TotalInternetUse or TotalInteractiveUse fields exceed rule-based quantity either for the specific Application or the user/workstation, the Client Monitor disables future Internet access and/or warns the user.

8. Managing network congestion

As illustrated in FIG. **14**, a method **1400** for managing network congestion comprises the following steps. At step **1401**, if the Supervisor determines that congestion exists for Internet access (either by interpreting the log messages from the Client Monitors, its own monitoring of access speed, or third party monitoring tools), it notifies the Client Monitors of temporary access restrictions. At step **1402**, depending on the specific rules in force, the individual Client Monitors can either: (a) Delay Internet access for non-critical Applications or Protocols by: (i) Applications call WinSock send(), recv(), connect() calls, and the like, (ii) the Client Monitor intercepts the call and checks the rules and Application database if calls relate to non-critical activities, (iii) If yes—delay the specific thread of the Application by a predetermined amount (e.g., 10 seconds), or (iv) open bandwidth for critical activities; or (b) Disable Internet Access for non-critical Applications or protocols.

9. Intercepting communication messages (e.g., WinSock messages)

FIGS. **15**A–B illustrate a method **1500** for intercepting communication driver (e.g., WinSock) messages. The following method description focuses on a Windows 95 implementation with the following standard Microsoft WinSock component: Wsock32.dll and Wsock.vxd. The implementation is similar under Windows NT and other operating systems.

The method operates as follows. At step **1501**, the Client Monitor loads the Client VxD (Windows virtual driver file). At step **1502**, the Client VxD loads the WinSock virtual driver file, Wsock.vxd, and redirects the WinSock DeviceIOControl code pointer of Wsock.vxd to its own interception routine. At step **1503**, the application calls the WinSock function in the WinSock dynamic link library, Wsock32.dll, that requires Internet access. At step **1504**, Wsock32.dll processes the parameters and calls Wsock.vxd via the the Windows Win32 DeviceIoControl() function call. At step **1505**, the Client VxD looks up the call via an "intercept before" dispatch table. At step **1506**, if the dispatch table requires an intercept, the Client VxD creates an interception message and calls the Client Monitor. At step **1507**, if the Client Monitor allows the call to go forward, the Client VxD calls the original Wsock.vxd routine, otherwise it returns Wsock32.dll and the Application. At step **1508**, the Client VxD looks up the call via the "intercept after" dispatch table. If the dispatch table requires an intercept, the Client VxD creates an interception message and calls the Client Monitor at step **1509**. At step **1510**, the Client VxD returns to Wsock32.dll with either the original return results or results modified by the Client Monitor.

10. Transmitting messages from Ring **0** to Ring **3**

FIGS. **16**A–B illustrate a method **1600** for transmitting messages from one memory protection ring to another (e.g., from highly-privileged Ring **0** to lesser-privileged Ring **3**). Ring **3** and Ring **0** refer to execution protection rings available on Intel-based computers (e.g., having Intel 80386 and later CPUs) and specify the application execution mode (Ring **3**) or the kernel execution mode (Ring **0**). Ring **3** programs and their components have a separate memory address space for each application. Ring **0** components (VxDs), on the other hand, share a common memory space. One can create a pointer that is accessible both from Ring **0** and all Ring **3** processes.

A difficult task is forwarding intercepted data from Ring **0** to Ring **3**, and later applying any modifications that the Ring **0** component has made to the call parameters and return results. Difficulties include: (1) the intercept occurs in the memory context of the Application's process, thus one needs to wait until the process received its time share from Windows; and (2) the call parameters (memory pointers) are valid only in the context of the Application's process. The Client VxD and the Client Monitor share a common array of messages and two pointers into that array. The Client VxD adds a message to that array and the Client Monitor picks it up using a standard first-in/first-out (FIFO) approach. Each fixed size message record has some space for additional data, if that size is not sufficient the additional data (e.g., recv() or send() data) is mapped into global memory space so it is accessible for the Client Monitor's process. Because the events occur asynchronously, particular care is needed to avoid situations where Windows switches the executing thread at critical sections, leading to possible deadlocks.

Messages are generated from the following sources (intercepted WinSock calls).

1. Threads created and destroyed (to keep track of Applications); and
2. File activities (using the ring **0** IFSMgr_InstallFileSystemApiHook mechanism)

Some messages require that the Client Monitor processes the message (and possibly stop or modify the underlying activities) before the Application's process can be allowed to continue, while other messages are just for information purposes.

The method **1600** comprises the following steps. At step **1601**, File, WinSock, or Thread components of Client VxD call a message dispatcher, "Dispatcher." At step **1602**, the Dispatcher determines if any additional data is required. If additional data is required, the Dispatcher determines if additional data fits into extra space, and then copies data into the additional space. If additional data is not required, the Dispatcher determines if data is already mapped into global memory space—if it is not, the Dispatcher allocates a global memory pointer to data and puts the pointer into the message body. At step **1603**, the Dispatcher copies the message to an array. At step **1604**, the Dispatcher determines if it needs to wait for message processing because: (a) It might need to free the global memory pointer; (b) the Client Monitor needs to approve the underlying action; or (c) the Client Monitor might patch any of the parameters.

At step **1605**, if the Dispatcher needs to wait, it: (a) tells the operating system (e.g., Windows) to switch to the Ring **3** Client Monitor's message thread; or (b) puts itself (and therefore the application thread) into sleep mode, otherwise it returns immediately to the caller. After the Client Monitor has processed the message, the Dispatcher does one or more of the following actions at Step **1606**: (a) De-allocates the global memory pointer, if previously allocated; and/or (b) Copies any patched memory to correct data.

While the invention is described in some detail with specific reference to a single-preferred embodiment and certain alternatives, there is no intent to limit the invention to that particular embodiment or those specific alternatives. Thus, the true scope of the present invention is not limited to any one of the foregoing exemplary embodiments but is instead defined by the appended claims.

What is claimed is:

1. In a system comprising a plurality of client computers connected to a network and having Internet access, a method for managing Internet access for a particular client computer, the method comprising:

providing at the particular client computer a client monitoring process;

providing at another computer on the network a supervisor process, said supervisor process specifying rules which govern Internet access by the client computers;

transmitting at least a subset of said rules to the particular client computer;

at the client monitoring process, trapping a request for Internet access from the particular client computer; and

processing the request for Internet access by performing substeps of:

(i) determining whether the request for Internet access violates any of the rules transmitted to the particular client computer, and

(ii) if the request for Internet access violates any of the rules transmitted to the particular client computer, denying the request for Internet access.

2. The method of claim **1**, wherein the particular client computer includes a communication driver for processing requests for Internet access and wherein said step of providing at the particular client computer a client monitoring process comprises:

providing at the particular client computer a process which traps at the communication driver requests for Internet access.

3. The method of claim **1**, wherein said step of providing at the particular client computer a client monitoring process includes:

installing at the particular client computer a client monitoring process which executes anytime the communication driver processes requests for Internet access.

4. The method of claim **1**, wherein said another computer includes a server computer connected to the network.

5. The method of claim **1**, wherein said another computer includes another client computer connected to the network.

6. The method of claim **1**, wherein said rules transmitted to the particular client computer specify whether the particular client computer is allowed any Internet access.

7. The method of claim **1**, wherein said rules transmitted to the particular client computer specify which applications are allowed Internet access.

8. The method of claim **1**, wherein said rules transmitted to the particular client computer specify a particular type of Internet access which is allowed.

9. The method of claim **1**, wherein said system includes a "firewall" application for selectively blocking Internet access and wherein said substep of denying the request for Internet access includes:

instructing said firewall application to block Internet access for the particular client computer.

10. The method of claim **9**, wherein said firewall application operates independently to block Internet access for any client according to rules specified for the firewall application.

11. The method of claim **1**, wherein said rules which govern Internet access by the client computers include rules which are enforced against selected ones of users, computers, and groups thereof.

12. The method of claim **11**, wherein said transmitting at least a subset of said rules step includes:

determining, based on identification of users, computers, or groups thereof and for which rules have been defined, a subset of said rules filtered for a given user at the particular client computer.

13. The method of claim **12**, wherein said users are identified by user name.

14. The method of claim **12**, wherein said computers are identified by Internet Protocol (IP) addresses.

15. The method of claim **1**, wherein said transmitting at least a subset of said rules to the particular client computer includes:

transmitting a set of default rules for the particular client, if no particular rules are already defined for the client.

16. In a system comprising a plurality of client computers connected to a network and having Internet access, a method for managing Internet access for a particular client computer on a per application basis, the method comprising:

storing at a supervisor computer a list of applications and versions thereof defining which applications are permitted Internet access;

transmitting said list from the supervisor computer to the client computer;

at the client computer, trapping a request for Internet access from a particular application;

based on said list, determining whether the request for Internet access is from an application or version thereof which is permitted Internet access; and

if the request for Internet access is from an application or version thereof which is not permitted Internet access, blocking Internet access for the application.

17. The method of claim **16**, wherein said storing step includes:

storing with a supervisor process executing on a server computer connected to the network the list of applications and versions thereof which are permitted Internet access.

18. The method of claim **16**, wherein said storing step includes:

storing with a supervisor process executing on another client computer connected to the network the list of applications and versions thereof which are permitted Internet access.

19. The method of claim **16**, wherein said list includes executable names and version numbers for applications which are permitted Internet access.

20. The method of claim **16**, wherein said list includes executable names and version numbers for applications which are not permitted Internet access.

21. The method of claim **16**, wherein said list includes Internet access activities which are permitted or restricted for applications or versions thereof.

22. The method of claim **21**, wherein Internet access activities comprise use of particular communication protocols.

23. The method of claim **22**, wherein said communication protocols include at least one of Hypertext Transport Protocol (HTTP) and File Transport Protocol (FTP).

24. The method of claim **22**, wherein said communication protocols include an e-mail protocol.

25. The method of claim **16**, wherein said Internet access activities comprise at least one of browsing activity and e-mail activity.

26. A computer system regulating access by client computers comprising:

a plurality of client computers which can connect to at least one open network;

supervisor means provided at a computer which is in communication with each client computer to be regulated, said supervisor means including a database of enforcement rules governing access of client computers to said at least one open network;

means for transferring rules from the database of enforcement rules to each computer requiring access to said at least one open network and which is to be regulated; and

monitoring means provided at each client computer which is to be regulated, for selectively blocking access to said at least one open network based on said transferred rules.

27. The system of claim **26**, further comprising:

means for selectively blocking access based on properties of applications executing at said client computers which attempt access to said at least one open network.

28. The system of claim **27**, wherein said properties of applications include version and executable name for each application.

29. The system of claim **27**, wherein said properties of applications include types of activities which applications are either allowed to perform or restricted from performing.

30. The system of claim **29**, wherein said types of activities include at least one of using e-mail and browsing.

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