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Acharya et al.

(54) WIRELESS PRESENTATION SYSTEM

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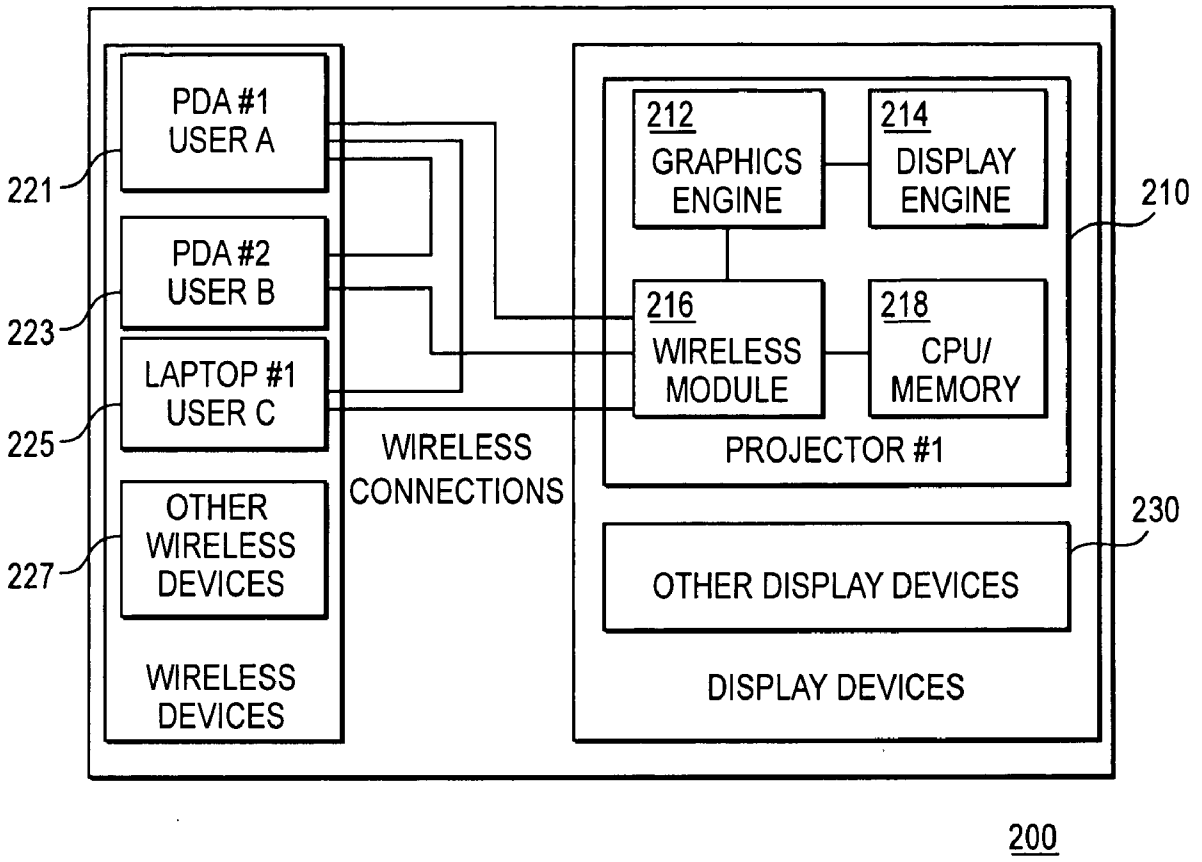
(51) **Int. Cl.**[7] **H04J 3/22**; H04L 5/22; H04Q 11/00; H04L 12/28; H04Q 7/20; H04B 7/14

(52) **U.S. Cl.** **370/466**; 370/467; 370/300; 370/385; 370/401; 455/414.4; 455/432.2; 455/450; 455/20

(57) **ABSTRACT**

A system and method for interactive management of multiple wireless devices (such as PDA's or desktop or laptop computers) making graphical or video presentations while connected wirelessly to a display device whose wireless module converts the transmitted data from the wireless devices to the required format for display.



YEALINK EX. 1057

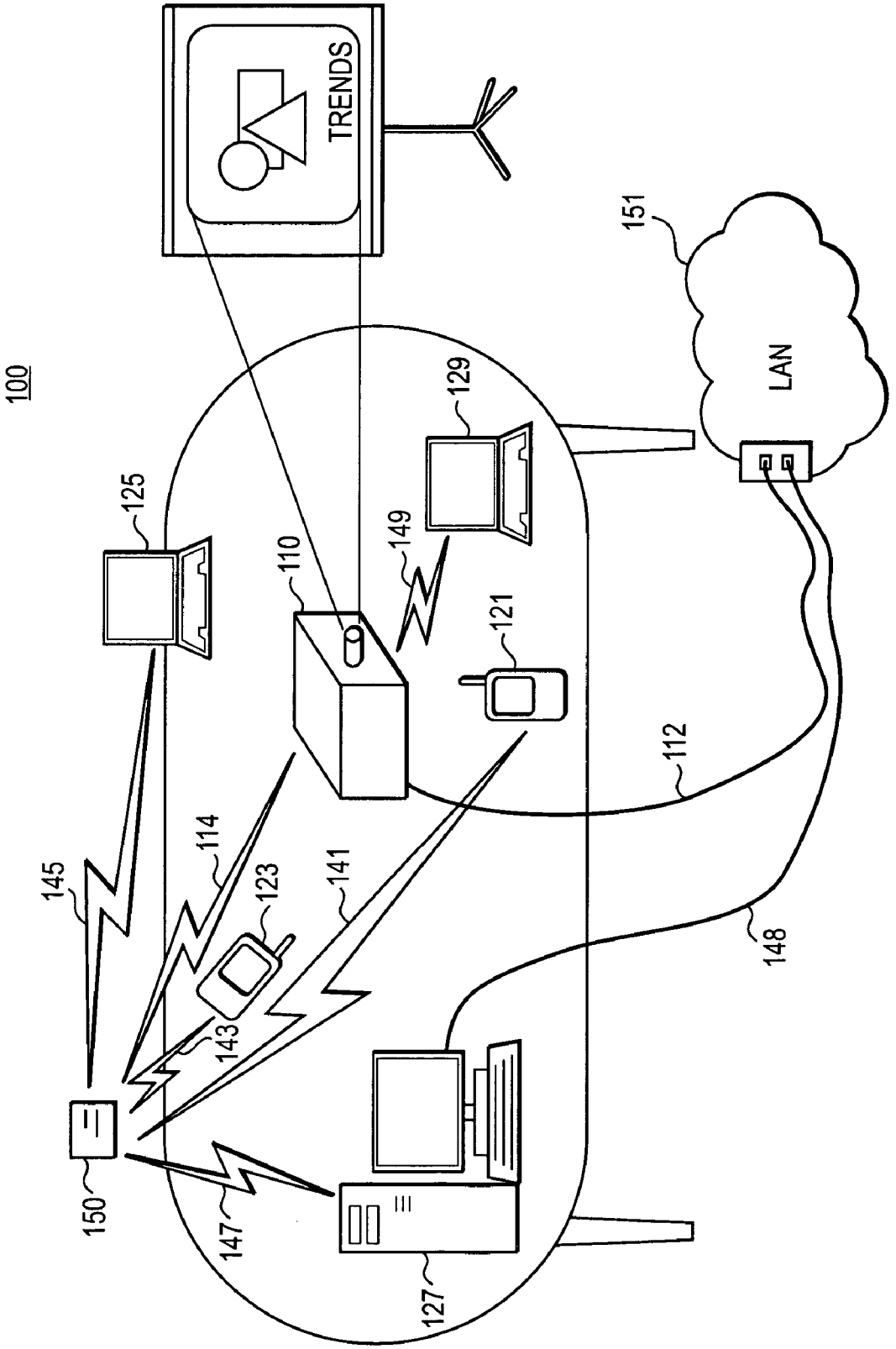

100
TRENDS
151
LAN
129
125
110
149
121
112
145
114
123
141
143
148
150
147
127

FIG. 1

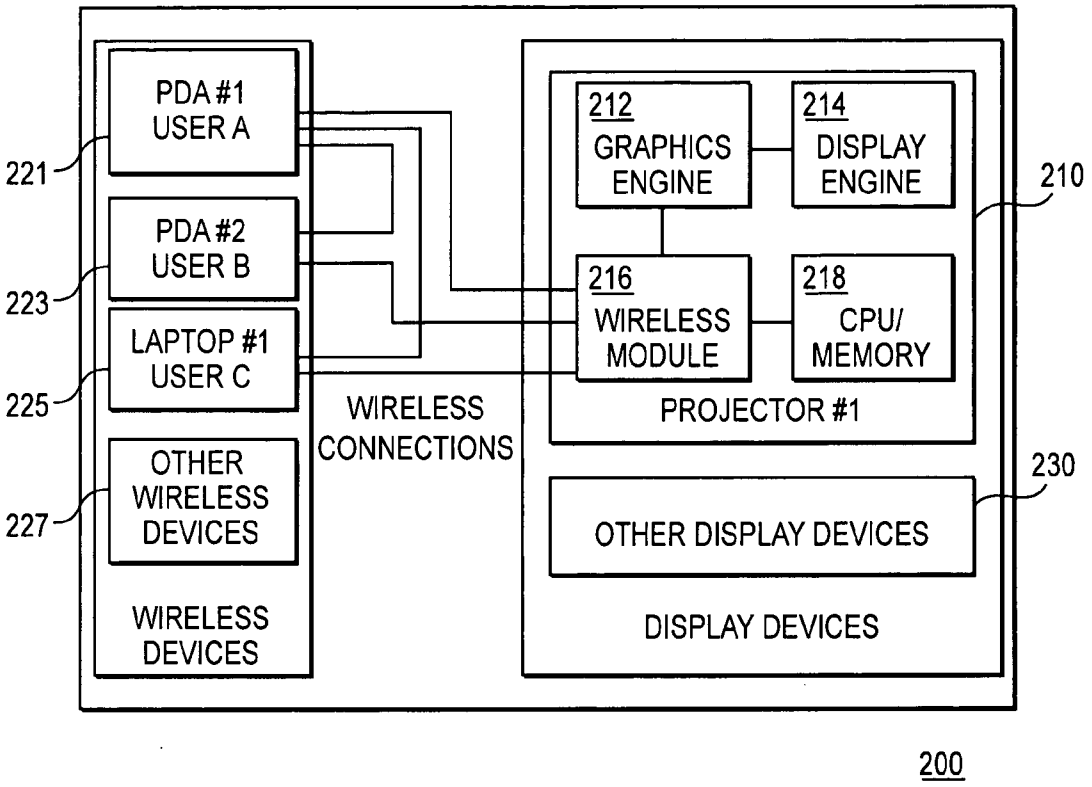

PDA #1
USER A
PDA #2
USER B
LAPTOP #1
USER C
OTHER
WIRELESS
DEVICES
WIRELESS
DEVICES
221
223
225
227
WIRELESS
CONNECTIONS
212
GRAPHICS
ENGINE
214
DISPLAY
ENGINE
216
WIRELESS
MODULE
218
CPU/
MEMORY
PROJECTOR #1
OTHER DISPLAY DEVICES
DISPLAY DEVICES
210
230
200

FIG. 2

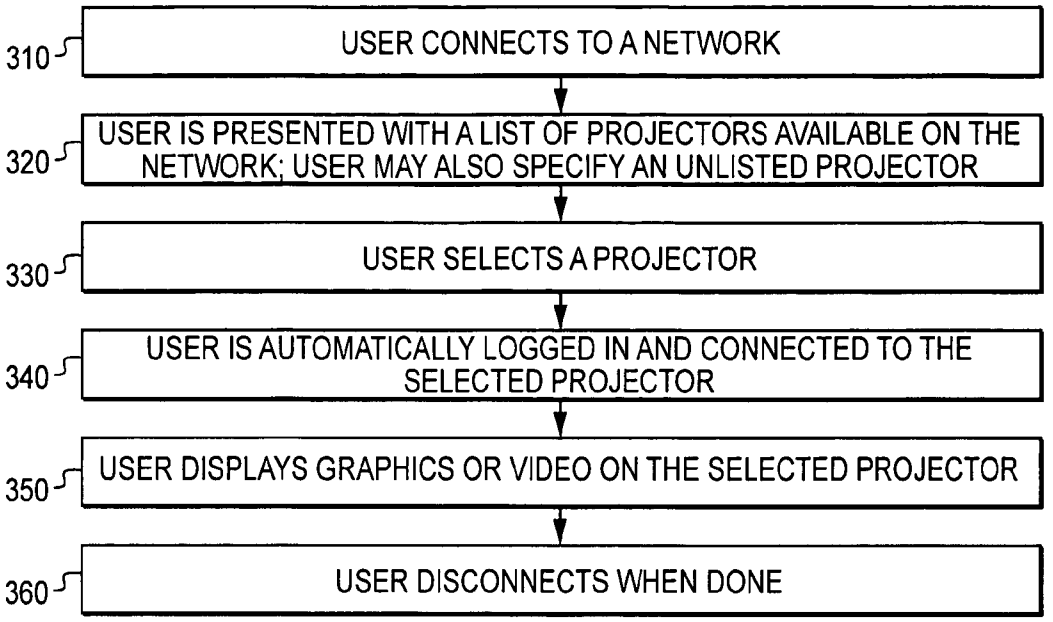

310
USER CONNECTS TO A NETWORK
320
USER IS PRESENTED WITH A LIST OF PROJECTORS AVAILABLE ON THE NETWORK; USER MAY ALSO SPECIFY AN UNLISTED PROJECTOR
330
USER SELECTS A PROJECTOR
340
USER IS AUTOMATICALLY LOGGED IN AND CONNECTED TO THE SELECTED PROJECTOR
350
USER DISPLAYS GRAPHICS OR VIDEO ON THE SELECTED PROJECTOR
360
USER DISCONNECTS WHEN DONE

FIG. 3

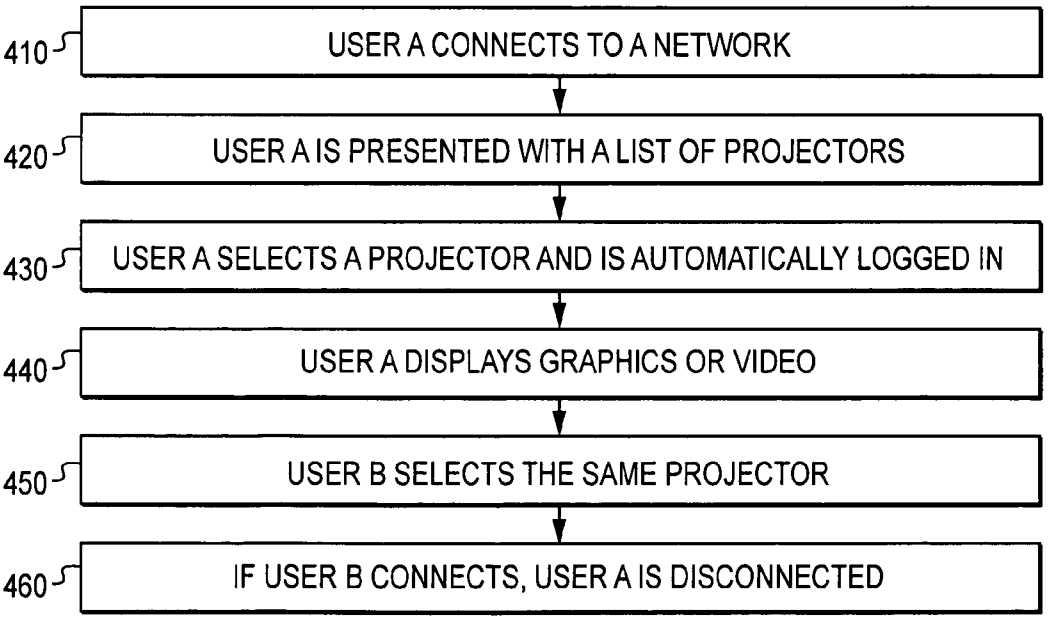

410
USER A CONNECTS TO A NETWORK
420
USER A IS PRESENTED WITH A LIST OF PROJECTORS
430
USER A SELECTS A PROJECTOR AND IS AUTOMATICALLY LOGGED IN
440
USER A DISPLAYS GRAPHICS OR VIDEO
450
USER B SELECTS THE SAME PROJECTOR
460
IF USER B CONNECTS, USER A IS DISCONNECTED

FIG. 4

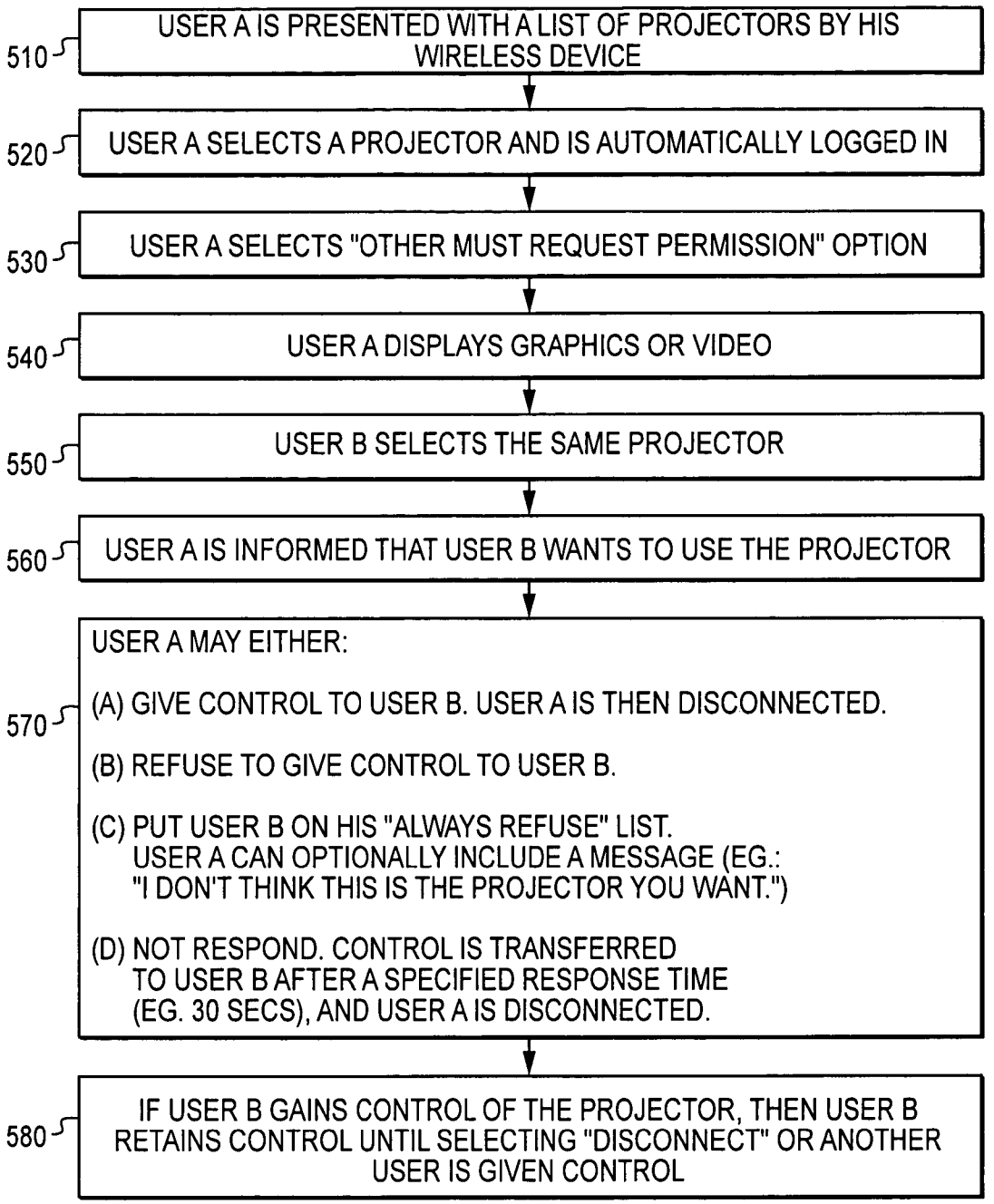

510
USER A IS PRESENTED WITH A LIST OF PROJECTORS BY HIS WIRELESS DEVICE
520
USER A SELECTS A PROJECTOR AND IS AUTOMATICALLY LOGGED IN
530
USER A SELECTS "OTHER MUST REQUEST PERMISSION" OPTION
540
USER A DISPLAYS GRAPHICS OR VIDEO
550
USER B SELECTS THE SAME PROJECTOR
560
USER A IS INFORMED THAT USER B WANTS TO USE THE PROJECTOR
570
USER A MAY EITHER:
(A) GIVE CONTROL TO USER B. USER A IS THEN DISCONNECTED.
(B) REFUSE TO GIVE CONTROL TO USER B.
(C) PUT USER B ON HIS "ALWAYS REFUSE" LIST. USER A CAN OPTIONALLY INCLUDE A MESSAGE (EG.: "I DON'T THINK THIS IS THE PROJECTOR YOU WANT.")
(D) NOT RESPOND. CONTROL IS TRANSFERRED TO USER B AFTER A SPECIFIED RESPONSE TIME (EG. 30 SECS), AND USER A IS DISCONNECTED.
580
IF USER B GAINS CONTROL OF THE PROJECTOR, THEN USER B RETAINS CONTROL UNTIL SELECTING "DISCONNECT" OR ANOTHER USER IS GIVEN CONTROL

FIG. 5

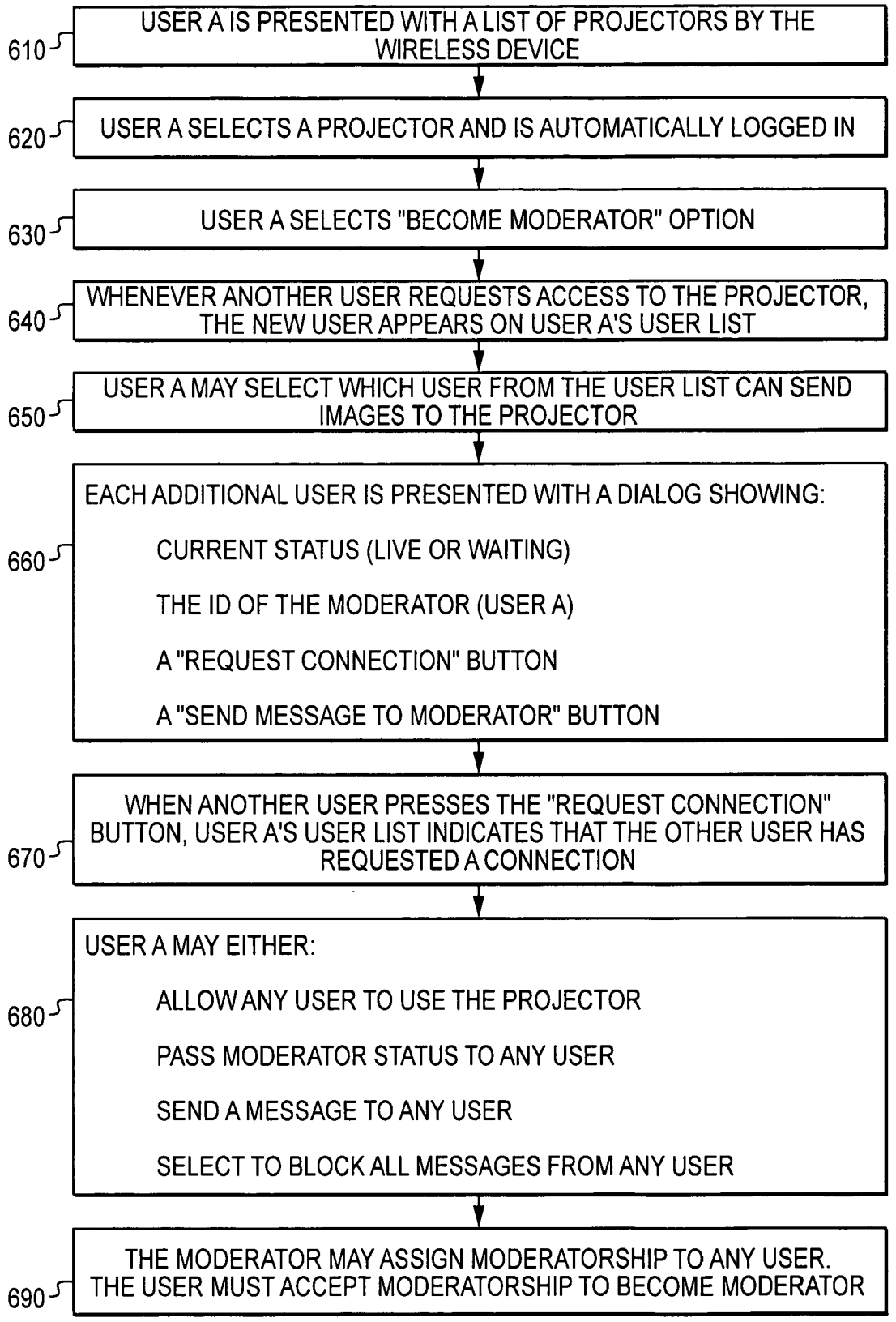

610
USER A IS PRESENTED WITH A LIST OF PROJECTORS BY THE WIRELESS DEVICE
620
USER A SELECTS A PROJECTOR AND IS AUTOMATICALLY LOGGED IN
630
USER A SELECTS "BECOME MODERATOR" OPTION
640
WHENEVER ANOTHER USER REQUESTS ACCESS TO THE PROJECTOR, THE NEW USER APPEARS ON USER A'S USER LIST
650
USER A MAY SELECT WHICH USER FROM THE USER LIST CAN SEND IMAGES TO THE PROJECTOR
660
EACH ADDITIONAL USER IS PRESENTED WITH A DIALOG SHOWING:
CURRENT STATUS (LIVE OR WAITING)
THE ID OF THE MODERATOR (USER A)
A "REQUEST CONNECTION" BUTTON
A "SEND MESSAGE TO MODERATOR" BUTTON
670
WHEN ANOTHER USER PRESSES THE "REQUEST CONNECTION" BUTTON, USER A'S USER LIST INDICATES THAT THE OTHER USER HAS REQUESTED A CONNECTION
680
USER A MAY EITHER:
ALLOW ANY USER TO USE THE PROJECTOR
PASS MODERATOR STATUS TO ANY USER
SEND A MESSAGE TO ANY USER
SELECT TO BLOCK ALL MESSAGES FROM ANY USER
690
THE MODERATOR MAY ASSIGN MODERATORSHIP TO ANY USER. THE USER MUST ACCEPT MODERATORSHIP TO BECOME MODERATOR

FIG. 6

WIRELESS PRESENTER

PRESS [BACK] TO RETURN.

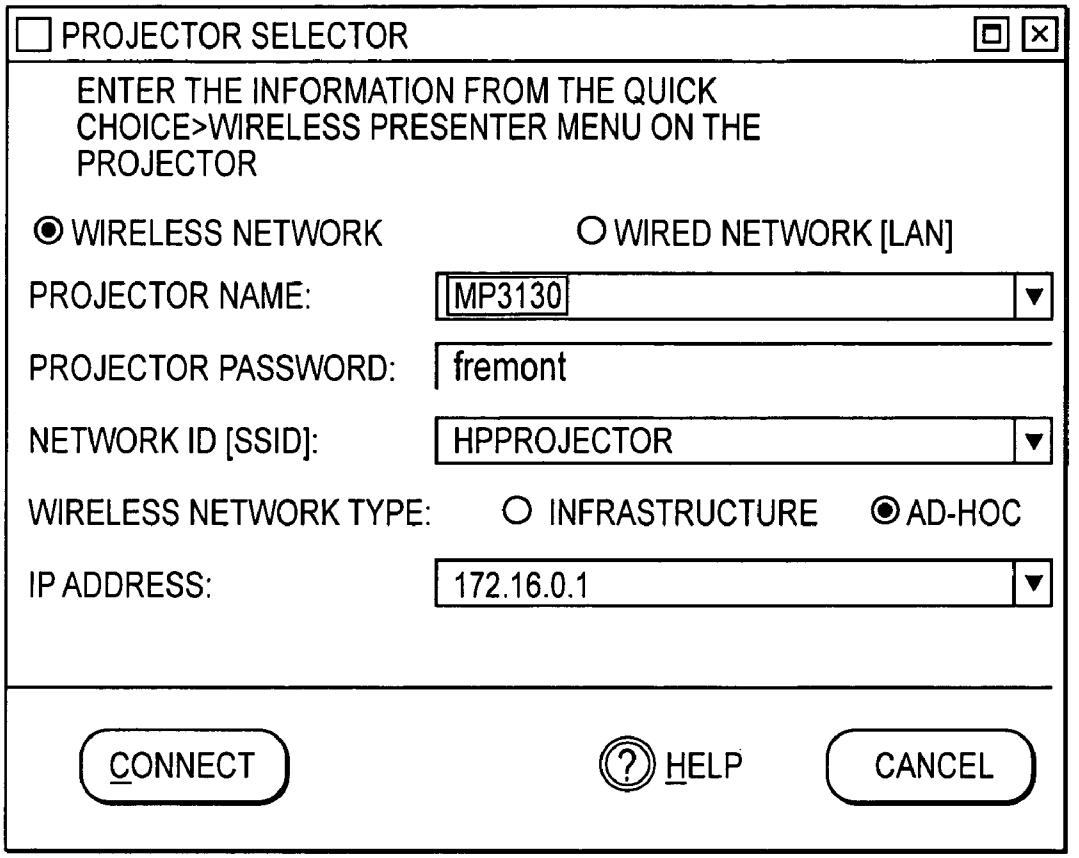
PROJECTOR NAME: MP3130
PROJECTOR PASSWORD: FREMONT

WIRED NETWORK
IP ADDRESS:

WIRELESS NETWORK
IP ADDRESS: 172.16.0.1
WIRELESS.NETWORK TYPE: AD-HOC
NETWORK ID (SSID): HPPROJECTOR
ENCRYPTION: NO
WEP KEY:
KEY INDEX:

700

FIG. 7


PROJECTOR SELECTOR
ENTER THE INFORMATION FROM THE QUICK CHOICE>WIRELESS PRESENTER MENU ON THE PROJECTOR
WIRELESS NETWORK
WIRED NETWORK [LAN]
PROJECTOR NAME:
MP3130
PROJECTOR PASSWORD:
fremont
NETWORK ID [SSID]:
HPPROJECTOR
WIRELESS NETWORK TYPE:
INFRASTRUCTURE
AD-HOC
IP ADDRESS:
172.16.0.1
CONNECT
HELP
CANCEL

800

FIG. 8

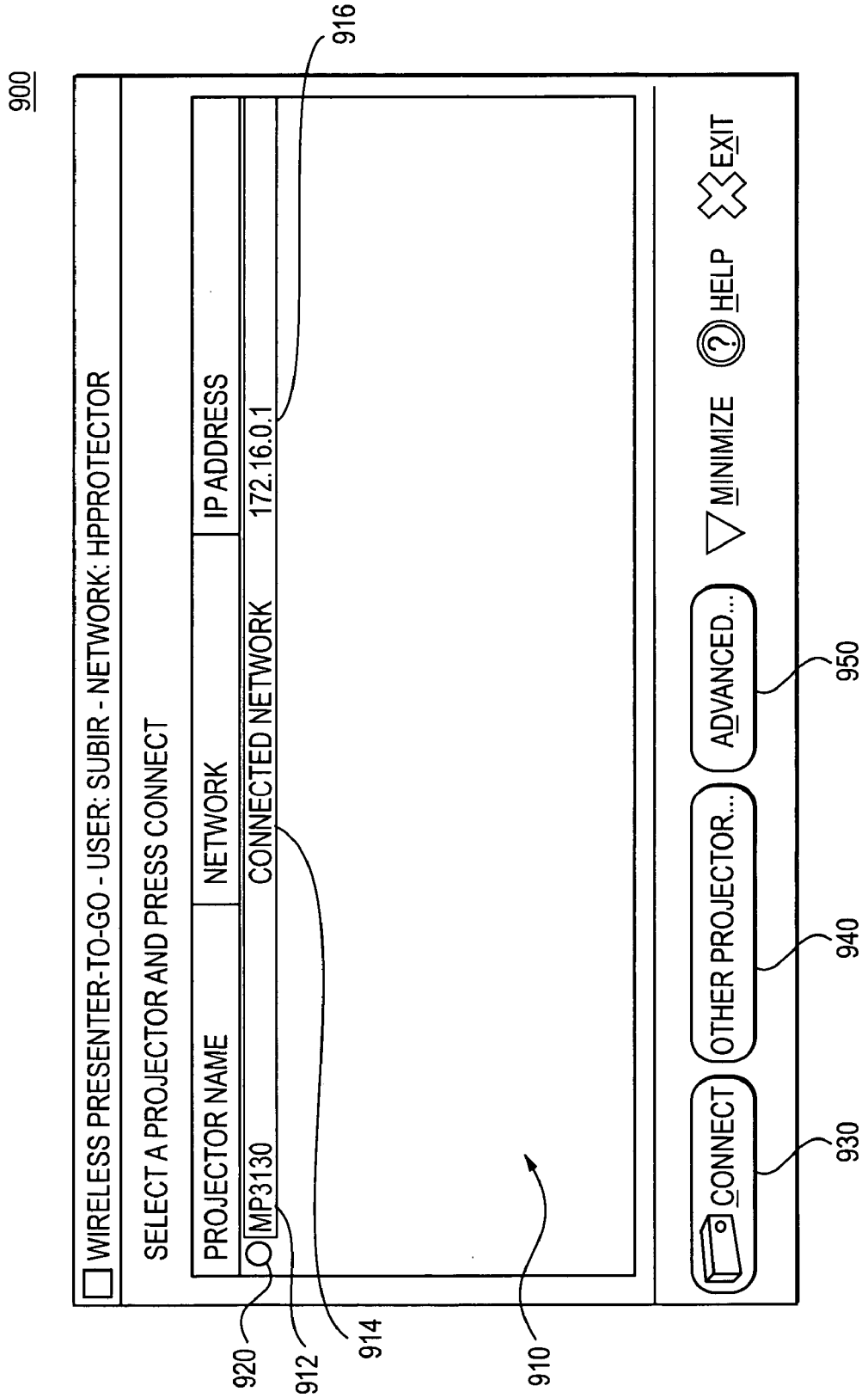

900
WIRELESS PRESENTER-TO-GO - USER: SUBIR - NETWORK: HPPROTECTOR
SELECT A PROJECTOR AND PRESS CONNECT
PROJECTOR NAME
NETWORK
IP ADDRESS
MP3130
CONNECTED NETWORK
172.16.0.1
CONNECT
OTHER PROJECTOR...
ADVANCED...
MINIMIZE
HELP
EXIT
920
912
914
910
916
930
940
950

FIG. 9

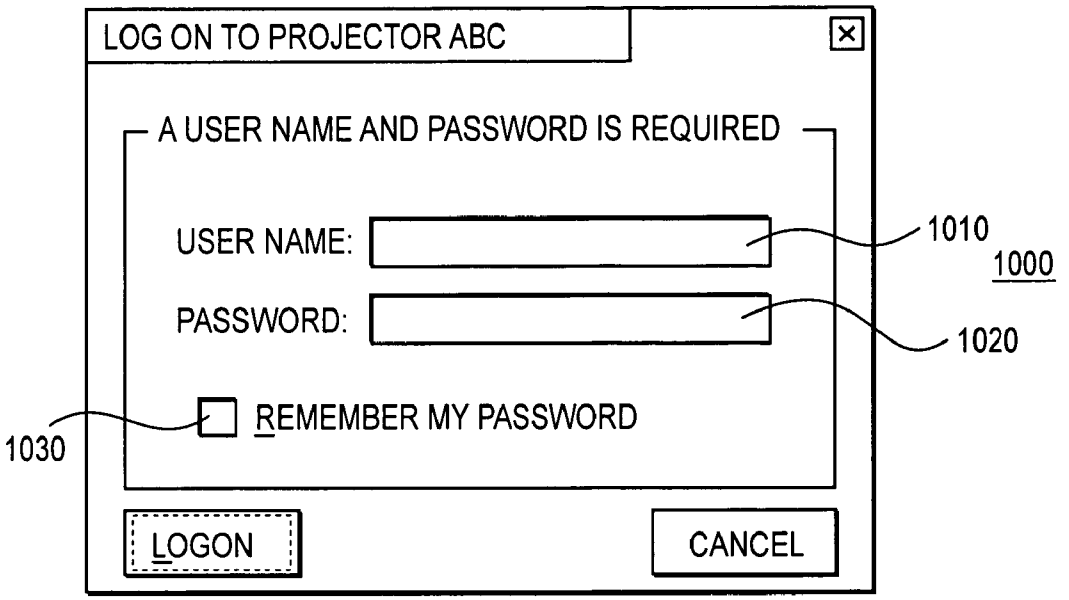

LOG ON TO PROJECTOR ABC
A USER NAME AND PASSWORD IS REQUIRED
USER NAME:
PASSWORD:
REMEMBER MY PASSWORD
LOGON
CANCEL
1010
1000
1020
1030

FIG. 10

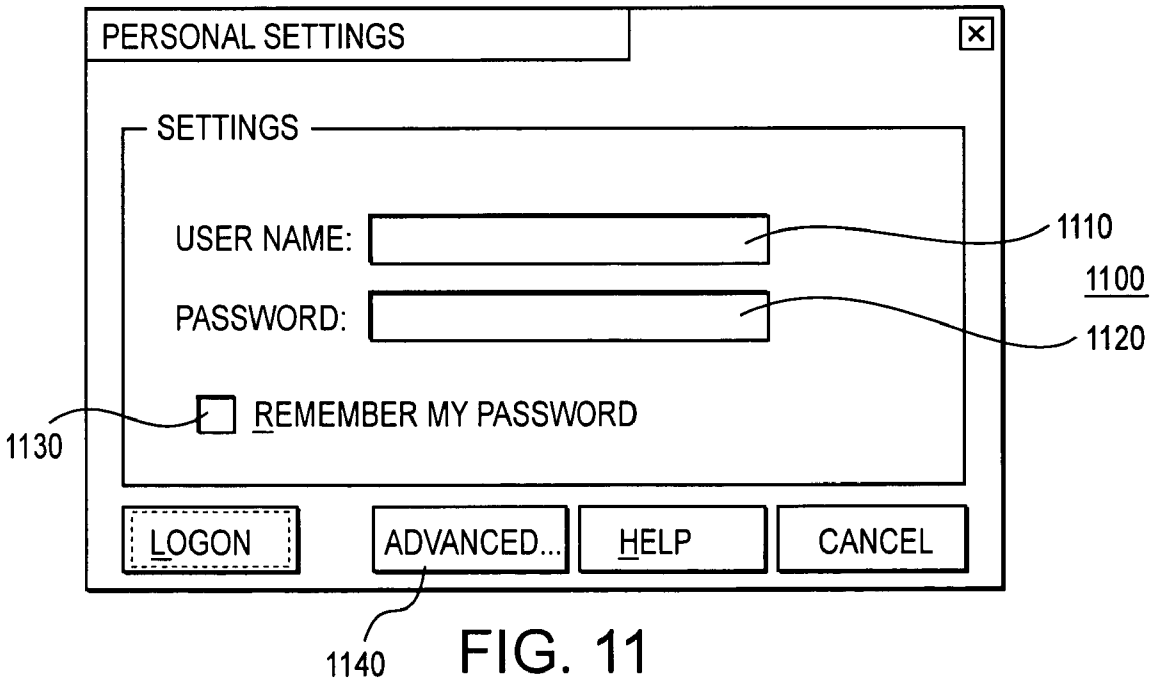

PERSONAL SETTINGS
SETTINGS
USER NAME:
PASSWORD:
REMEMBER MY PASSWORD
LOGON
ADVANCED...
HELP
CANCEL
1110
1100
1120
1130
1140

FIG. 11

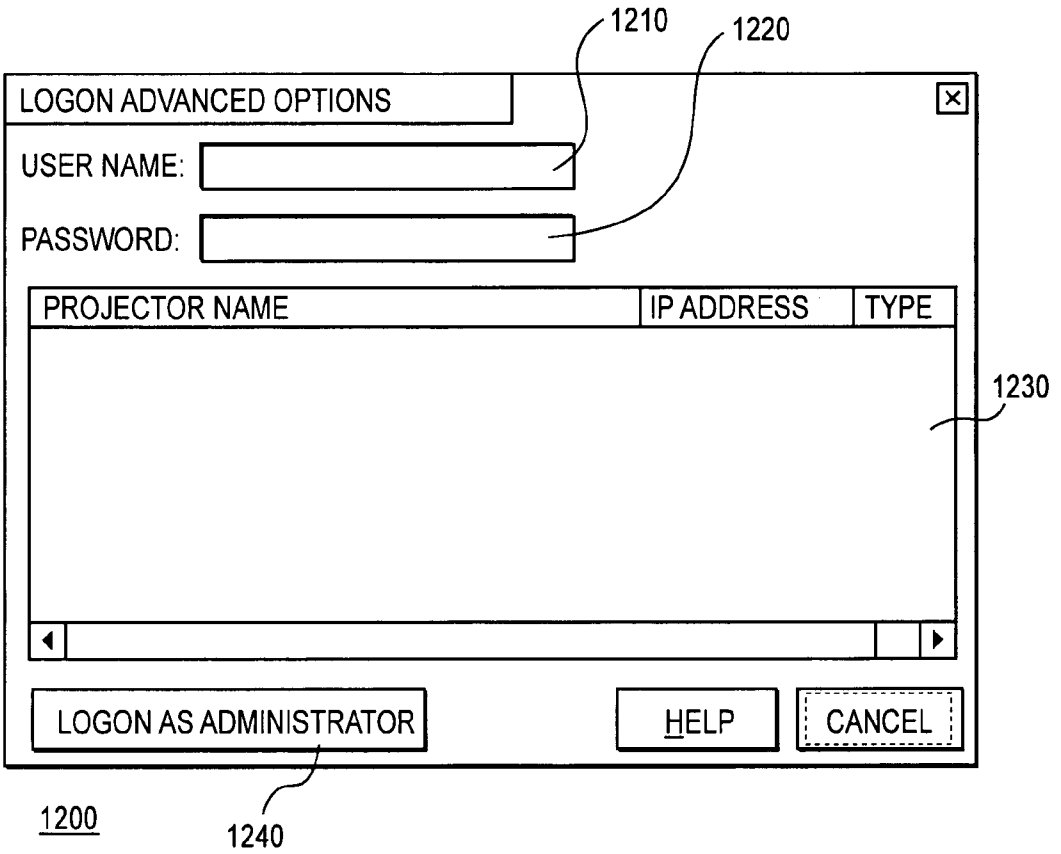

1210
1220
LOGON ADVANCED OPTIONS
USER NAME:
PASSWORD:
PROJECTOR NAME
IP ADDRESS
TYPE
1230
LOGON AS ADMINISTRATOR
HELP
CANCEL
1200
1240

FIG. 12

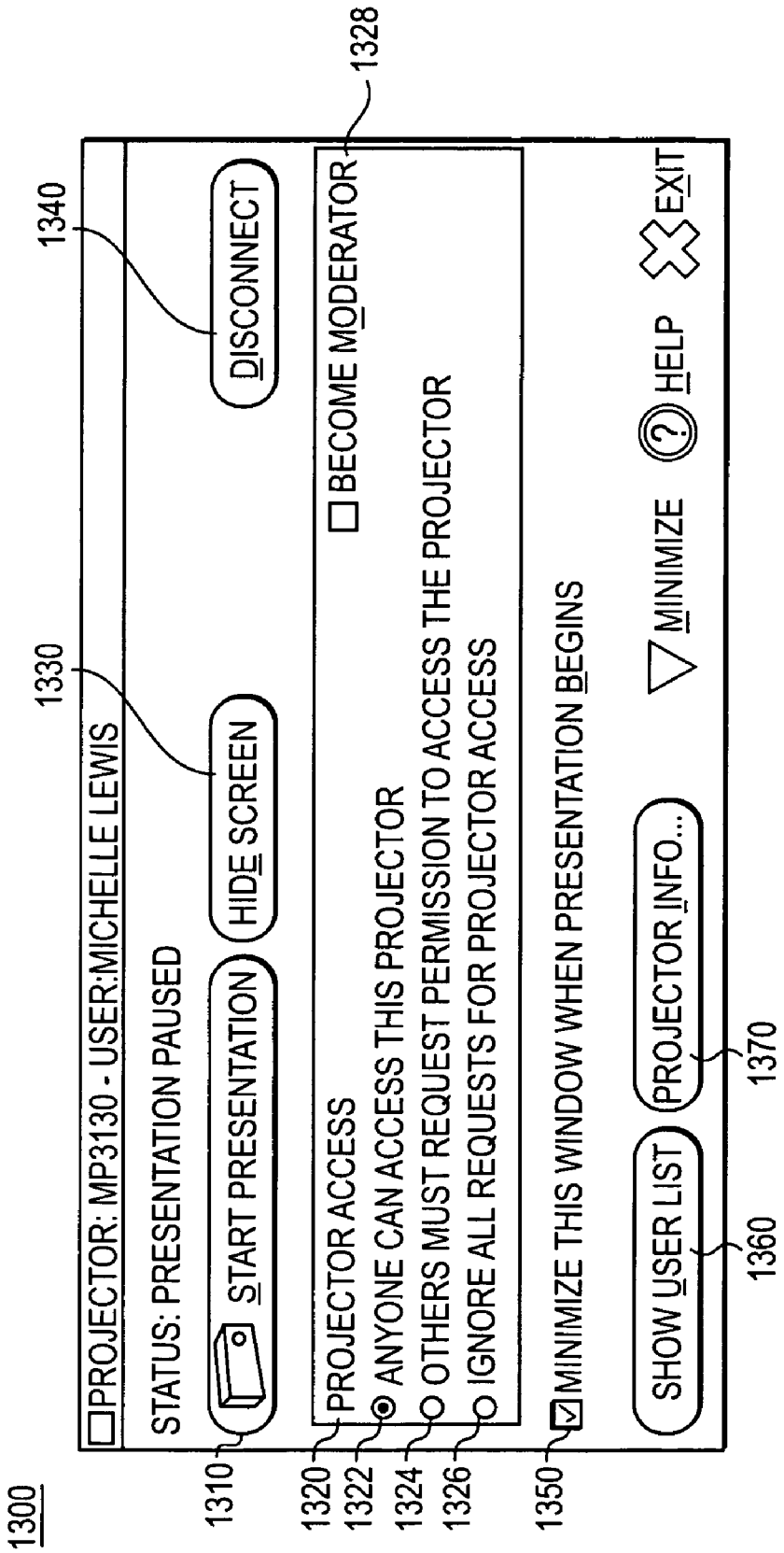

1300
PROJECTOR: MP3130 - USER:MICHELLE LEWIS
STATUS: PRESENTATION PAUSED
START PRESENTATION
HIDE SCREEN
DISCONNECT
BECOME MODERATOR
PROJECTOR ACCESS
ANYONE CAN ACCESS THIS PROJECTOR
OTHERS MUST REQUEST PERMISSION TO ACCESS THE PROJECTOR
IGNORE ALL REQUESTS FOR PROJECTOR ACCESS
MINIMIZE THIS WINDOW WHEN PRESENTATION BEGINS
SHOW USER LIST
PROJECTOR INFO...
MINIMIZE
HELP
EXIT
1310
1320
1322
1324
1326
1328
1330
1340
1350
1360
1370

FIG. 13

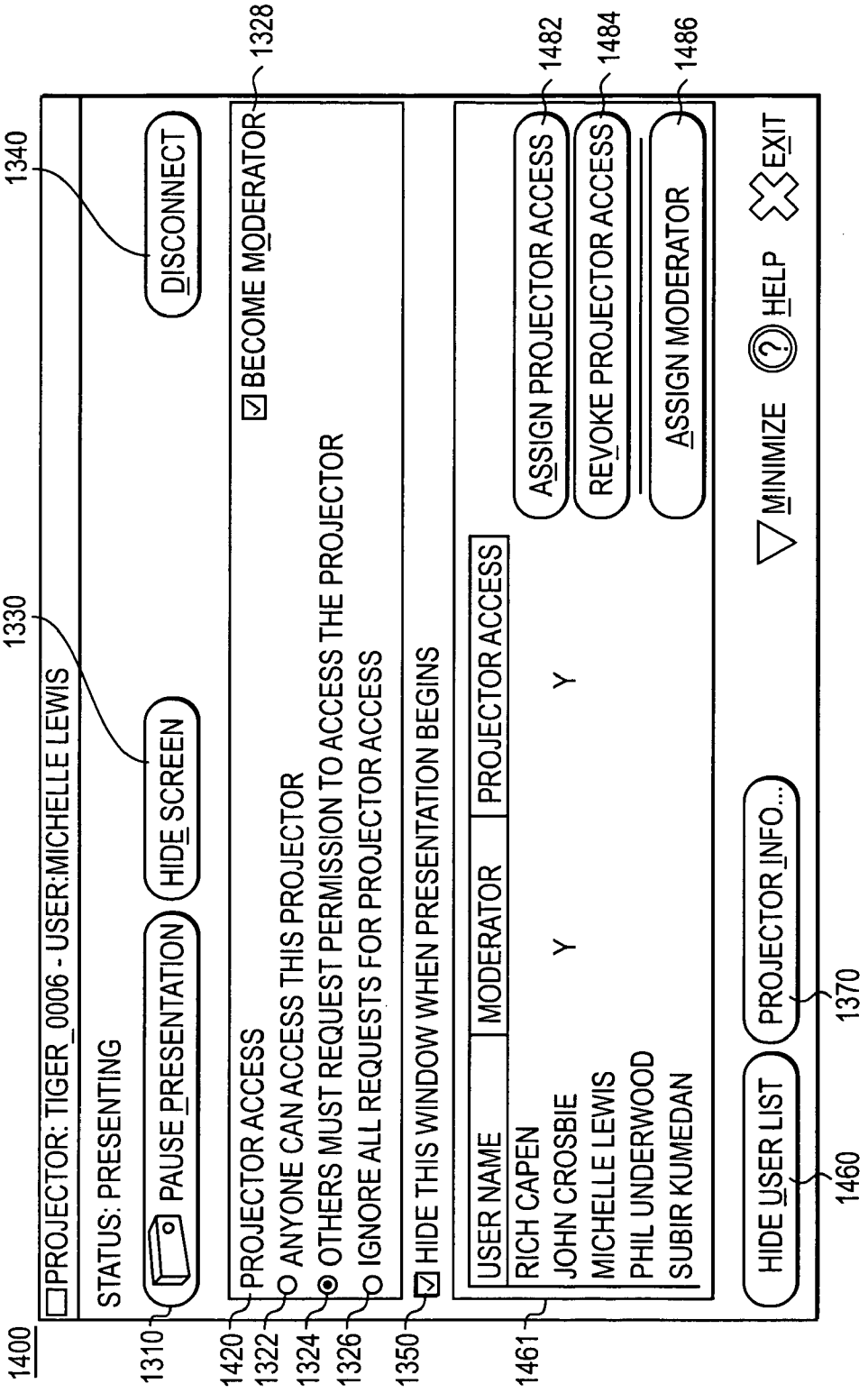

1400
PROJECTOR: TIGER_0006 - USER:MICHELLE LEWIS
STATUS: PRESENTING
1310
PAUSE PRESENTATION
1330
HIDE SCREEN
1340
DISCONNECT
1420
PROJECTOR ACCESS
1322
ANYONE CAN ACCESS THIS PROJECTOR
1324
OTHERS MUST REQUEST PERMISSION TO ACCESS THE PROJECTOR
1326
IGNORE ALL REQUESTS FOR PROJECTOR ACCESS
1328
BECOME MODERATOR
1350
HIDE THIS WINDOW WHEN PRESENTATION BEGINS
1461
USER NAME
MODERATOR
PROJECTOR ACCESS
RICH CAPEN
JOHN CROSBIE
Y
MICHELLE LEWIS
Y
PHIL UNDERWOOD
SUBIR KUMEDAN
1482
ASSIGN PROJECTOR ACCESS
1484
REVOKE PROJECTOR ACCESS
1486
ASSIGN MODERATOR
MINIMIZE
HELP
EXIT
1460
HIDE USER LIST
1370
PROJECTOR INFO...

FIG. 14

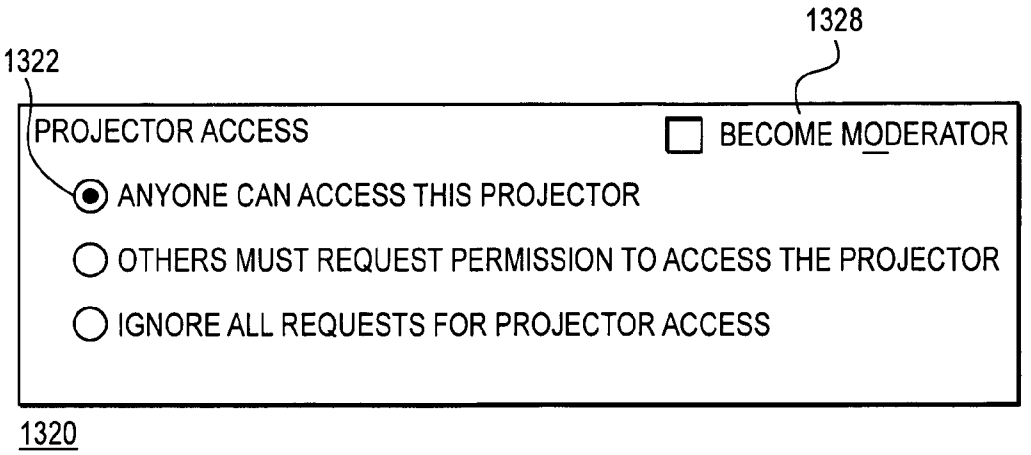

1328
1322
PROJECTOR ACCESS
BECOME MODERATOR
ANYONE CAN ACCESS THIS PROJECTOR
OTHERS MUST REQUEST PERMISSION TO ACCESS THE PROJECTOR
IGNORE ALL REQUESTS FOR PROJECTOR ACCESS
1320

FIG. 15

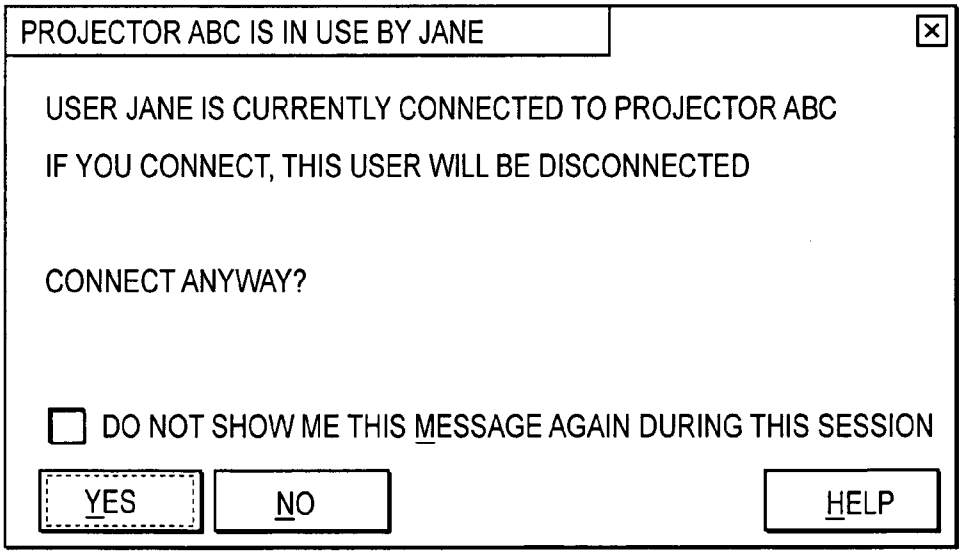
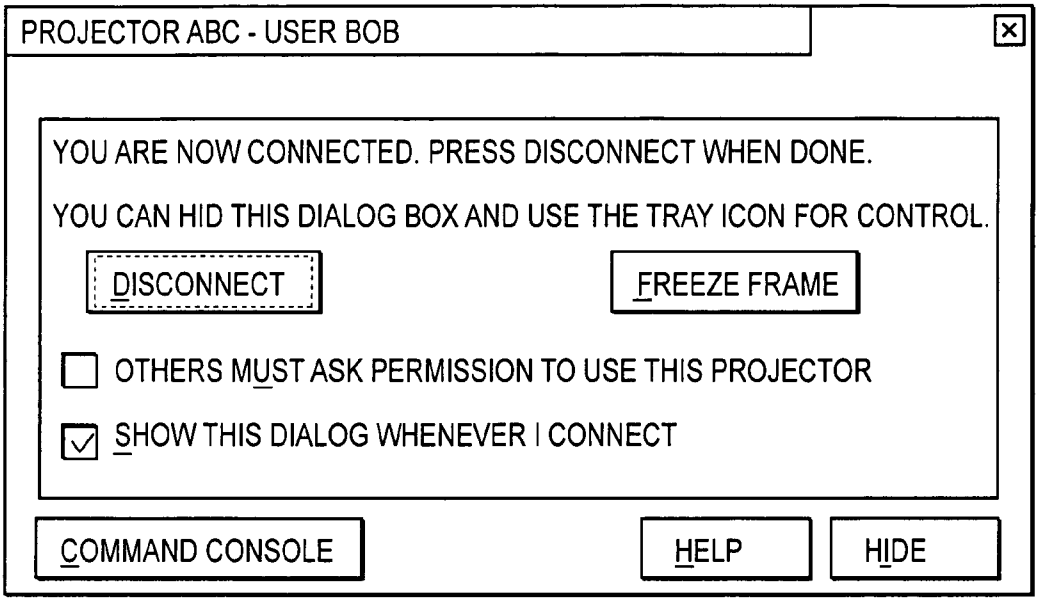
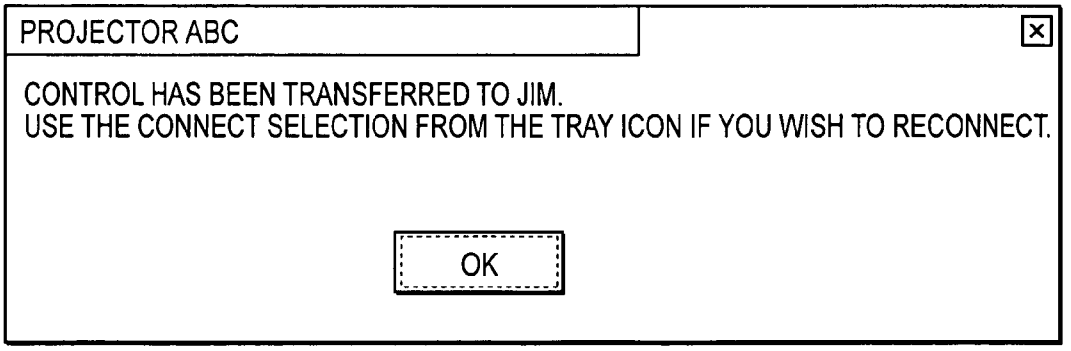

PROJECTOR ABC IS IN USE BY JANE
USER JANE IS CURRENTLY CONNECTED TO PROJECTOR ABC
IF YOU CONNECT, THIS USER WILL BE DISCONNECTED
CONNECT ANYWAY?
DO NOT SHOW ME THIS MESSAGE AGAIN DURING THIS SESSION
YES
NO
HELP
1600

FIG. 16



1700

FIG. 17



1800

FIG. 18

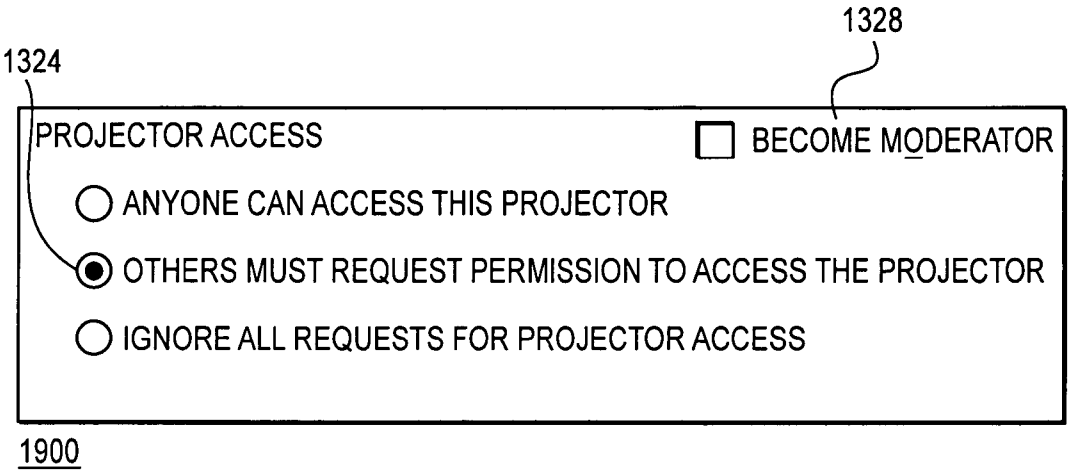

1328
1324
PROJECTOR ACCESS
BECOME MODERATOR
ANYONE CAN ACCESS THIS PROJECTOR
OTHERS MUST REQUEST PERMISSION TO ACCESS THE PROJECTOR
IGNORE ALL REQUESTS FOR PROJECTOR ACCESS
1900

FIG. 19

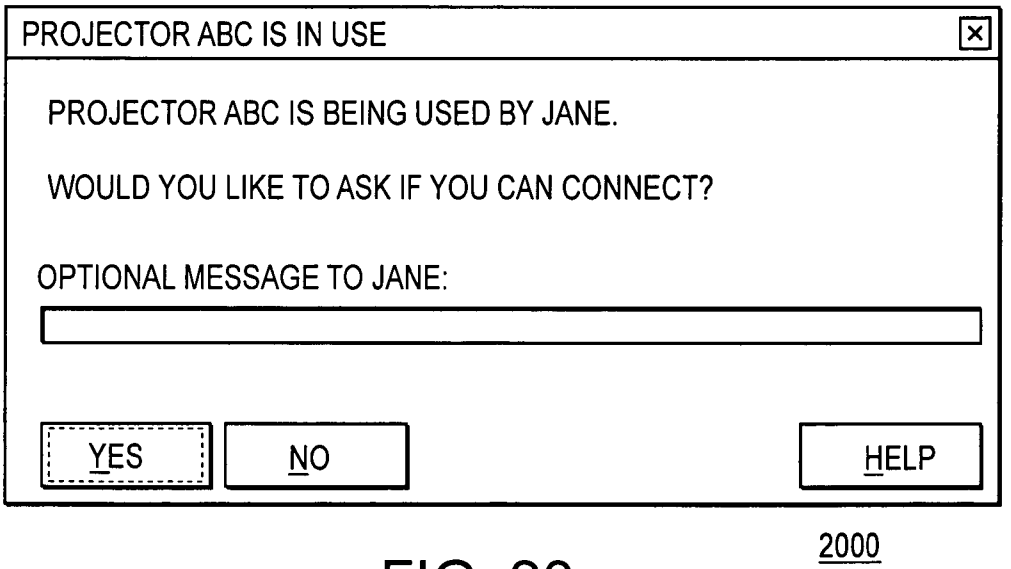

PROJECTOR ABC IS IN USE
PROJECTOR ABC IS BEING USED BY JANE.
WOULD YOU LIKE TO ASK IF YOU CAN CONNECT?
OPTIONAL MESSAGE TO JANE:
YES
NO
HELP
2000

FIG. 20

CONNECTION REQUEST FOR PROJECTOR ABC

YOU HAVE RECEIVED A REQUEST TO CONNECT TO THIS PROJECTOR FROM JIM.

IF YOU DO NOT RESPOND WITHIN 1 MINUTE, JIM WILL BE GIVEN CONTROL.

MESSAGE FROM JIM: MY TURN?

ALLOW JIM TO CONNECT?

OPTIONAL MESSAGE TO JIM:

YES | NO | BLOCK USER... | HELP

2100

FIG. 21

2210

PROJECTOR ABC - USER BOB

YOU ARE NOW CONNECTED - PRESS DISCONNECT WHEN DONE.

YOU CAN HIDE THIS DIALOG BOX AND USE THE TRAY ICON FOR CONTROL.

DISCONNECT | FREEZE FRAME

☑ OTHERS MUST ASK PERMISSION TO USE THIS PROJECTOR.

☑ SHOW THIS DIALOG BOX WHENEVER I CONNECT.

COMMAND CONSOLE... | HELP | HIDE

FIG. 22

2200

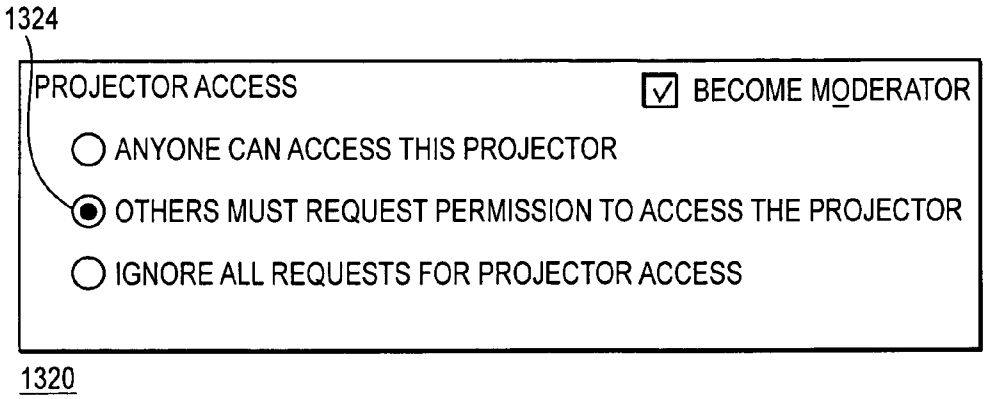

1324
PROJECTOR ACCESS
BECOME MODERATOR
ANYONE CAN ACCESS THIS PROJECTOR
OTHERS MUST REQUEST PERMISSION TO ACCESS THE PROJECTOR
IGNORE ALL REQUESTS FOR PROJECTOR ACCESS
1320

FIG. 23

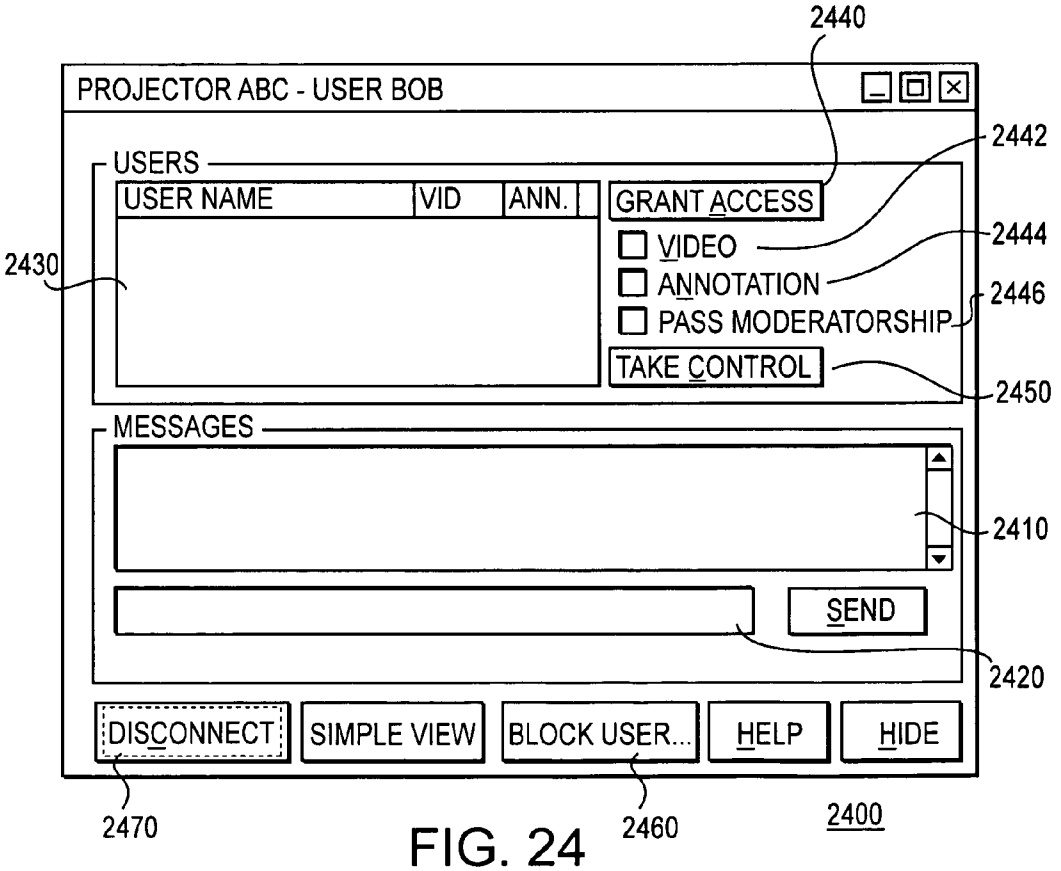

2440
PROJECTOR ABC - USER BOB
2442
USERS
USER NAME
VID
ANN.
GRANT ACCESS
2444
VIDEO
2430
ANNOTATION
2446
PASS MODERATORSHIP
TAKE CONTROL
2450
MESSAGES
2410
SEND
2420
DISCONNECT
SIMPLE VIEW
BLOCK USER...
HELP
HIDE
2470
2460
2400

FIG. 24

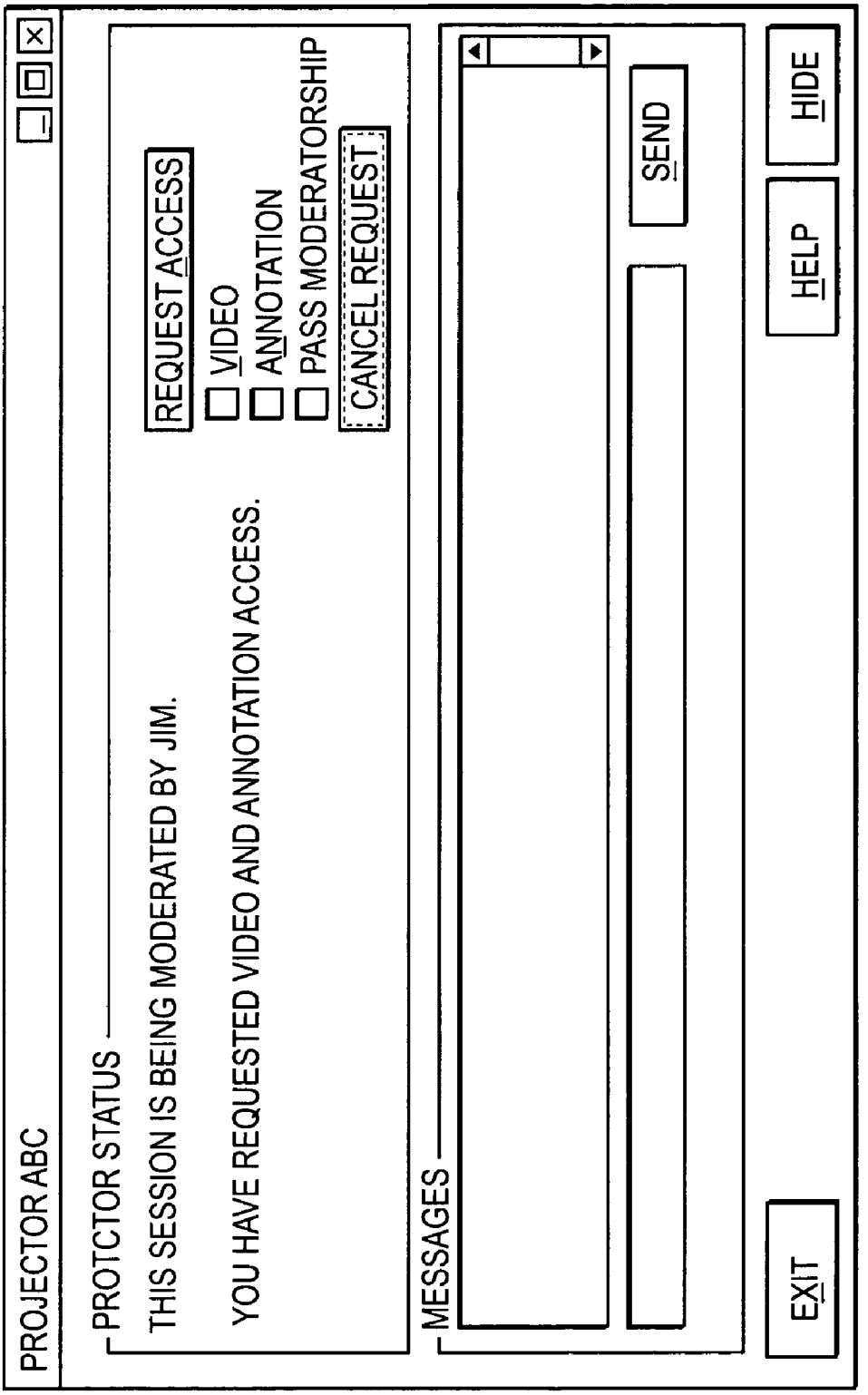

PROJECTOR ABC
PROTCTOR STATUS
THIS SESSION IS BEING MODERATED BY JIM.
YOU HAVE REQUESTED VIDEO AND ANNOTATION ACCESS.
REQUEST ACCESS
VIDEO
ANNOTATION
PASS MODERATORSHIP
CANCEL REQUEST
MESSAGES
SEND
EXIT
HELP
HIDE
2500

FIG. 25

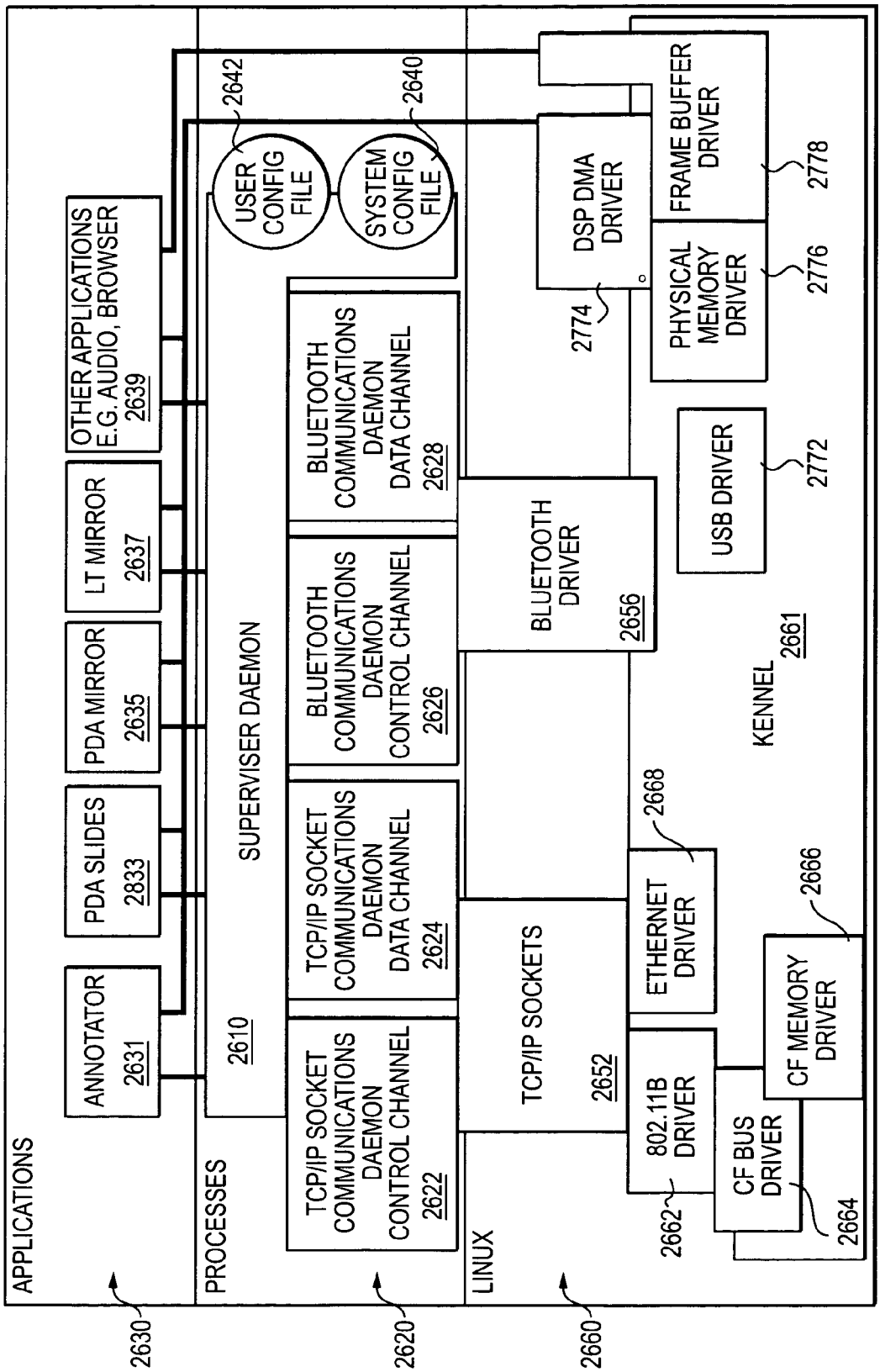

APPLICATIONS
PROCESSES
LINUX
2630
2620
2660
ANNOTATOR 2631
PDA SLIDES 2833
PDA MIRROR 2635
LT MIRROR 2637
OTHER APPLICATIONS E.G. AUDIO, BROWSER 2639
2610
SUPERVISER DAEMON
2642
USER CONFIG FILE
2640
SYSTEM CONFIG FILE
TCP/IP SOCKET COMMUNICATIONS DAEMON CONTROL CHANNEL 2622
TCP/IP SOCKET COMMUNICATIONS DAEMON DATA CHANNEL 2624
BLUETOOTH COMMUNICATIONS DAEMON CONTROL CHANNEL 2626
BLUETOOTH COMMUNICATIONS DAEMON DATA CHANNEL 2628
TCP/IP SOCKETS 2652
BLUETOOTH DRIVER 2656
DSP DMA DRIVER
2774
FRAME BUFFER DRIVER
2778
PHYSICAL MEMORY DRIVER
2776
USB DRIVER
2772
KENNEL 2661
ETHERNET DRIVER
2668
802.11B DRIVER
2662
CF BUS DRIVER
2664
CF MEMORY DRIVER
2666

FIG. 26

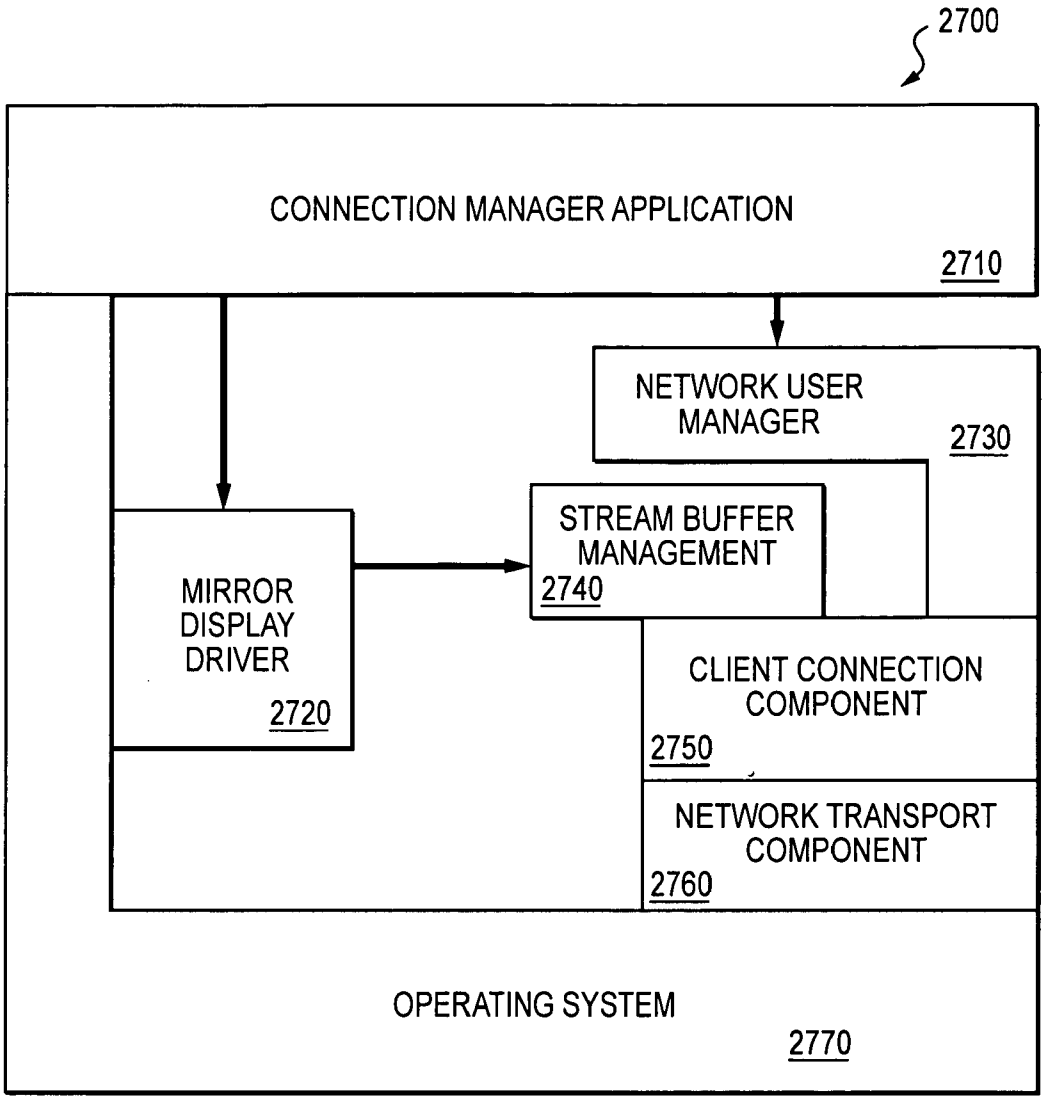

2700
CONNECTION MANAGER APPLICATION
2710
NETWORK USER MANAGER
2730
STREAM BUFFER MANAGEMENT
2740
MIRROR DISPLAY DRIVER
2720
CLIENT CONNECTION COMPONENT
2750
NETWORK TRANSPORT COMPONENT
2760
OPERATING SYSTEM
2770

FIG. 27

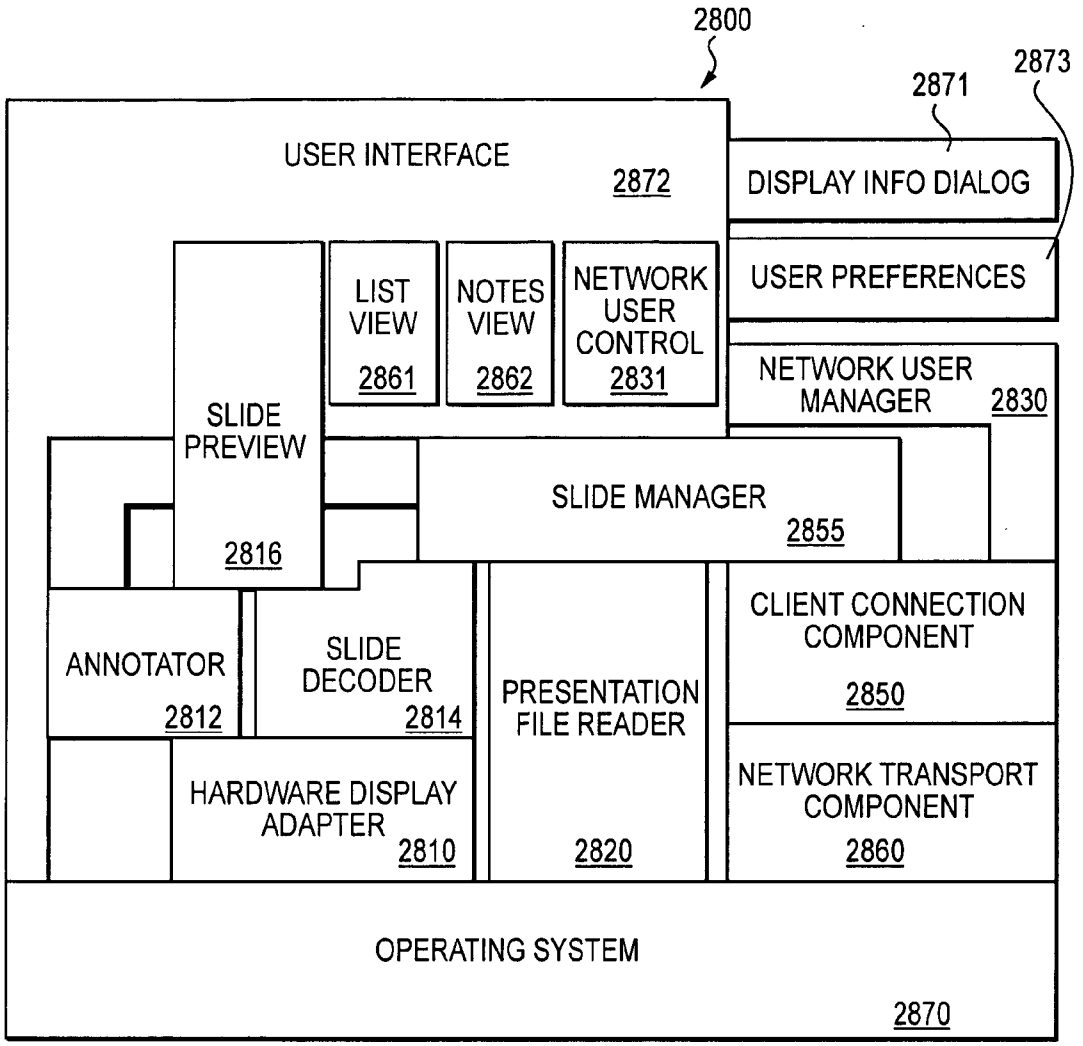

2800
2871
2873
USER INTERFACE
2872
DISPLAY INFO DIALOG
USER PREFERENCES
LIST VIEW
2861
NOTES VIEW
2862
NETWORK USER CONTROL
2831
NETWORK USER MANAGER
2830
SLIDE PREVIEW
2816
SLIDE MANAGER
2855
ANNOTATOR
2812
SLIDE DECODER
2814
PRESENTATION FILE READER
2820
CLIENT CONNECTION COMPONENT
2850
HARDWARE DISPLAY ADAPTER
2810
NETWORK TRANSPORT COMPONENT
2860
OPERATING SYSTEM
2870

FIG. 28

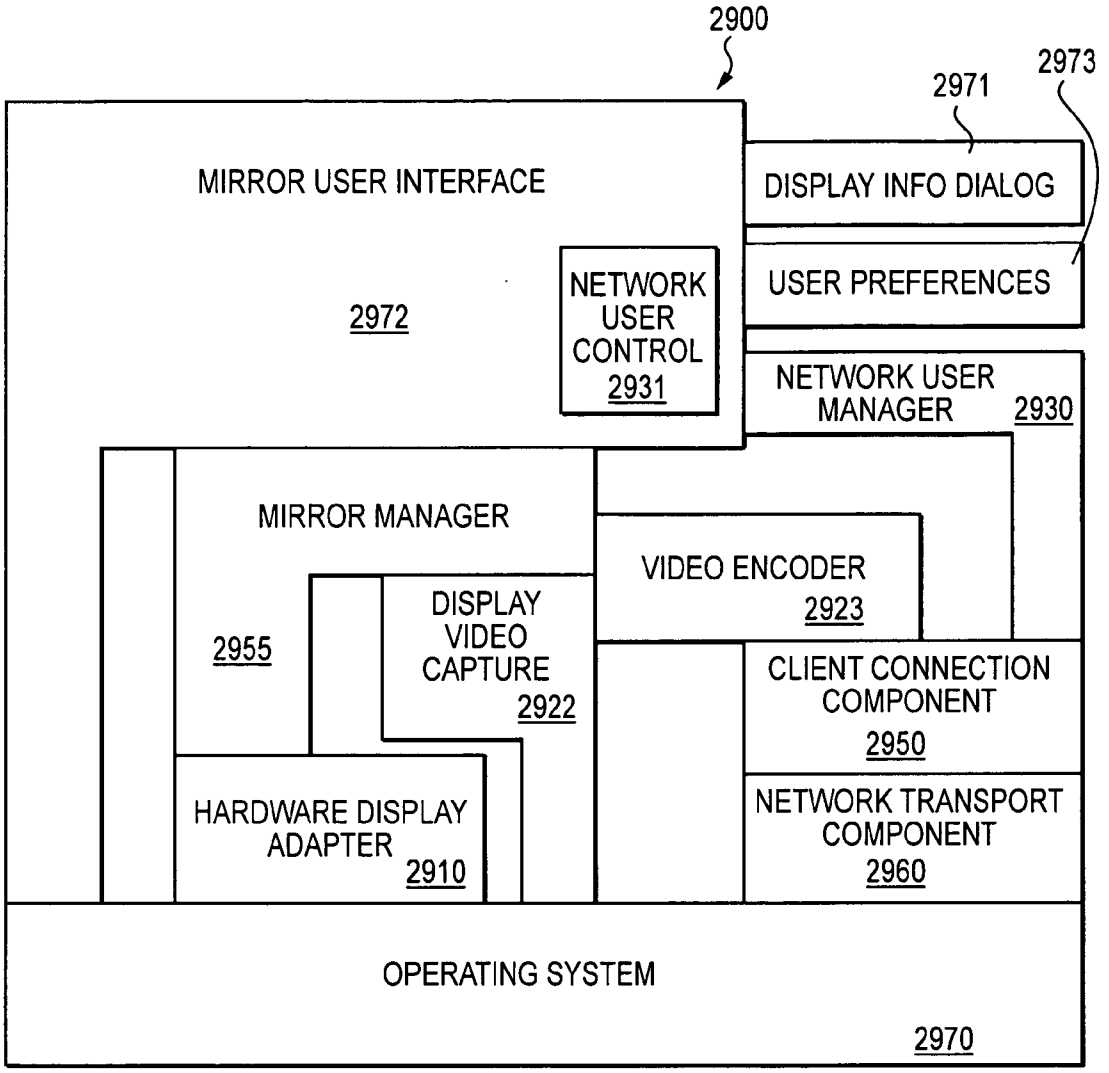

2900
2971
2973
MIRROR USER INTERFACE
DISPLAY INFO DIALOG
NETWORK USER CONTROL 2931
USER PREFERENCES
2972
NETWORK USER MANAGER 2930
MIRROR MANAGER
VIDEO ENCODER 2923
DISPLAY VIDEO CAPTURE 2922
2955
CLIENT CONNECTION COMPONENT 2950
HARDWARE DISPLAY ADAPTER 2910
NETWORK TRANSPORT COMPONENT 2960
OPERATING SYSTEM
2970

FIG. 29

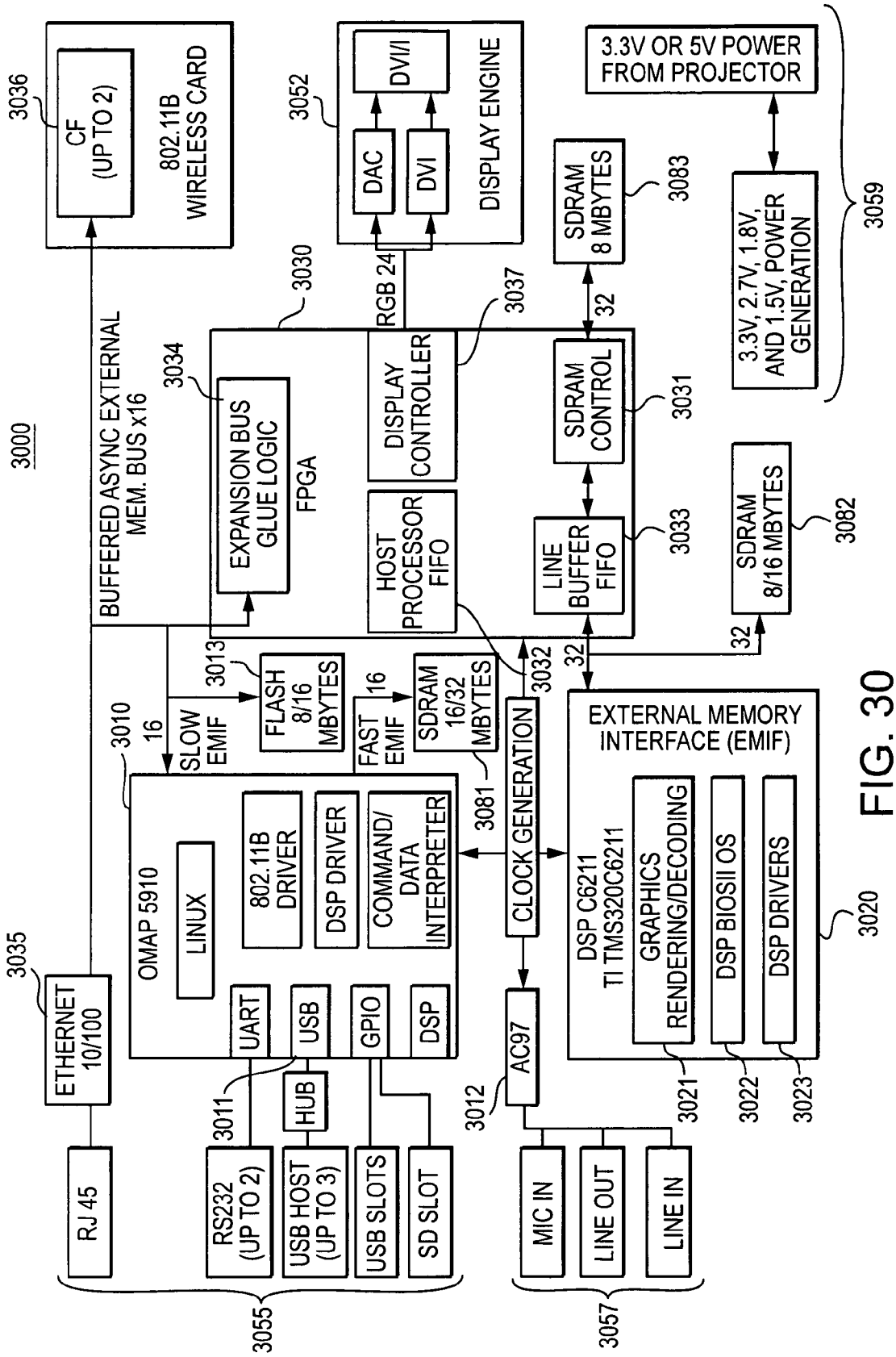

3000
3036
CF (UP TO 2)
802.11B WIRELESS CARD
3052
DAC
DVI
DVI/I
DISPLAY ENGINE
3.3V OR 5V POWER FROM PROJECTOR
SDRAM 8 MBYTES
3083
3.3V, 2.7V, 1.8V, AND 1.5V, POWER GENERATION
3059
BUFFERED ASYNC EXTERNAL MEM. BUS x16
3030
RGB 24
3037
32
3034
EXPANSION BUS GLUE LOGIC
FPGA
DISPLAY CONTROLLER
SDRAM CONTROL
3031
HOST PROCESSOR FIFO
LINE BUFFER FIFO
3033
SDRAM 8/16 MBYTES
3082
3013
FLASH 8/16 MBYTES
SLOW EMIF
16
FAST EMIF
SDRAM 16/32 MBYTES
3032
3010
3081
CLOCK GENERATION
EXTERNAL MEMORY INTERFACE (EMIF)
OMAP 5910
LINUX
802.11B DRIVER
DSP DRIVER
COMMAND/ DATA INTERPRETER
DSP C6211 TI TMS320C6211
GRAPHICS RENDERING/DECODING
DSP BIOSII OS
DSP DRIVERS
3020
3035
ETHERNET 10/100
UART
USB
GPIO
DSP
AC97
3011
HUB
3012
3021
3022
3023
RJ 45
RS232 (UP TO 2)
USB HOST (UP TO 3)
USB SLOTS
SD SLOT
MIC IN
LINE OUT
LINE IN
3055
3057

FIG. 30

WIRELESS PRESENTATION SYSTEM

PRIORITY CLAIM

[0001] This application claims the benefit of U.S. Provisional Application No. 60/475,751, filed Jun. 3, 2003. The disclosure of the above application is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Technical Field

[0003] This invention relates to computers, and more specifically to wireless computer communications.

[0004] 2. Related Art

[0005] Portable computers have used a variety of peripherals and software tools for the projection of presentations for viewing by an audience. One example is the use of a laptop computer connected to a liquid crystal display (LCD) projector to present a PowerPoint® document onto a projection screen in a darkened room. The LCD projector may be aligned in the room so that its projected image is viewable to the audience. The projection is created by a variety of technologies, such as the passing of light through an LCD panel that selectively transmits monochrome or color pixels to form the projected image.

[0006] Wireless devices capable of wireless data transmission include laptop computers and handheld computing devices such as PDAs (Personal Digital Assistants) and cellular telephones. Relative to laptop computers, the advantage of PDAs is their smaller size, lower cost, and ease of portability. The PDAs disadvantage is that their screens are of low resolution, primarily intended for viewing by a single user, and that they have relatively slow microprocessors. A wired presentation solution for PDAs is Presenter-to-Go® by MARGI Systems® that provides a wired interface from the various I/O ports available on PDAs to the VGA port of display devices (e.g., projectors). Compressed data is transmitted into the PDA (from a personal computer) and decompressed by the Presenter-to-Go® module which contains a graphic engine that allows high resolution graphics output. Thus PowerPoint® and anything printable from a PC (personal computer) application may be transmitted to be presented on the PDA for high resolution color presentation. The Presenter-to-Go® is a wired system and allows use by only one presenter at a time.

SUMMARY

[0007] Described herein are techniques and systems for connecting computing units such as laptops and PDAs with display units such as presentation projectors. These techniques and systems may be used in a display system that may be shared by a group of users, each of whom wishes to present video data on a shared digital projector, computer monitor, or other video display. The video data may include data for still images, or may include various types of information suitable for delivery to a video display, such as images, text, graphics, moving pictures, or presentations.

[0008] The video data may be information usable purely for visual display. Additionally, the video data may also be audiovisual information, such as purely audio information or a mixture of audio and visual information. We note that the techniques described herein for a display system may be also adapted for purely audio implementations. Thus, the data provided by a controller may be used on a video display or on other audiovisual presentation devices, such as speakers, personal computers, home audio systems, cellular telephones, and other systems. Thus, the video data provided by a controller may be audio, video, graphics, still images, moving images, or other data types, or combinations thereof. The video data may include compressed or uncompressed content information, or rendering instructions, or telemetry information, or combinations thereof. Rendering instructions include commands or other instructions for creating or displaying audio, graphics, video, or other audiovisual content. Telemetry information includes maintenance information, such as the status of a projector bulb in a display projector, or upgrading software that may be loaded onto a display system.

[0009] The various users may have a variety of different computing devices that connect with the video display, such as laptop computers, networked computers, or hand-held devices such as PDAs, cellular telephones, mobile telephones, audio receivers, wireless audio receivers, wireless speaker systems, or others. The computing devices may be networked or directly linked with the display system, and may be connected through wired links (such as Ethernet or USB connections) or wireless links (such as wireless Ethernet or Bluetooth® connections).

[0010] One implementation of a shareable display system includes a video display, a data port, and a controller. The video display may be a video projector or other form of display device, such as an LCD monitor or a CRT monitor, and may use wired or wireless data connections between the controller and the video display. The video display may include more than one display device, which may be useful in situations where audiences may need more than one display device.

[0011] Alternately, or in addition, the video display may be an interface that provides analog or digital video signals to one or more display devices. Accordingly, the display system may include a display device, or may be connectable to a display device, or may be configured so that it can be mechanically attached or piggybacked onto a display device.

[0012] The data port is configured to receive video data through data links with two or more computing devices. The data links may be hard-wired network connections or wireless connections. The controller may be coupled to the video display and to the data port, and may be configured to select video data for the video display from various video data sets available from the plurality of computing devices. The controller may arbitrate between video data received through the first and second data links.

[0013] This arbitration may be performed in a variety of modes. For example, in a self-serve mode, users send video data to the shareable display system, and the shareable display system updates the display with the most recently received video data received. In a roundtable mode, a user must relinquish control over the display system before another user may send video data to be displayed. In a moderated mode, a single user moderates the sharing of the display system by other users.

[0014] Other systems, methods, features and advantages of the invention will be, or will become, apparent to one with

skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description, be within the scope of the invention, and be protected by the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The invention can be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like referenced numerals designate corresponding parts throughout the different views.

[0016] **FIG. 1** and **FIG. 2** illustrate environments in which a display system is shared by several users.

[0017] **FIG. 3** is a flow chart illustrating a single-user mode for access to a display device.

[0018] **FIG. 4** is a flow chart illustrating a self-service multiple-user mode for access to a display device.

[0019] **FIG. 5** is a flow chart illustrating a roundtable multiple-user mode for access to a display device.

[0020] **FIG. 6** is a flow chart illustrating a moderated multiple-user mode for access to a display device.

[0021] **FIG. 7** shows an example of a settings summary **700** that may be displayed by a shared display device.

[0022] **FIG. 8** shows an example of a selection and login interface **800** for connecting to a wireless network.

[0023] **FIG. 9** shows an example of a display-selection interface **900** for a user connecting to a shared presentation system on a wireless network.

[0024] **FIG. 10** illustrates an example of a user-login interface.

[0025] **FIG. 11** shows a dialog box for updating user login information on a display device.

[0026] **FIG. 12** shows a dialog box for an administrator to login to a shared display device.

[0027] **FIG. 13** and **FIG. 14** show examples of a display-sharing interface for a user connected to a shared presentation system.

[0028] **FIG. 15**, **FIG. 16**, **FIG. 17**, and **FIG. 18** illustrate examples of user dialog windows that may be implemented in a self-service multiple-user access mode.

[0029] **FIG. 19**, **FIG. 20**, **FIG. 21**, and **FIG. 22** illustrate examples of user dialog windows that may be implemented in a roundtable multiple-user access mode.

[0030] **FIG. 23**, **FIG. 24**, and **FIG. 25** illustrate examples of user dialog windows that may be implemented in a moderated multiple-user access mode.

[0031] **FIG. 26** is a block diagram of one implementation of an architecture for embedded software for a display system.

[0032] **FIG. 27** is a block diagram of one implementation of mirroring software that may be used in a laptop computer.

[0033] **FIG. 28** is a block diagram of one implementation of PDA slide presentation software.

[0034] **FIG. 29** is a block diagram of one implementation of mirroring software that may be used in a PDA.

[0035] **FIG. 30** is a block diagram of one implementation of a wireless module in a display device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] **FIG. 1** illustrates an environment **100** in which a display system is shared by several users. A projector **110** may be shared by several users for projecting video onto a projection screen. The various users may control the projector **110** through a variety of computing devices, such as laptop computers **125** and **129**, a desktop computer **127**, or PDAs **121** and **123**. Other computing devices may also be used, including portable and non-portable computing devices. Portable devices include devices such as PDA's, cellular telephones and other mobile telephones, and integrated devices such as palm-held computing devices with or without wireless telephone or network connectivity. The computing devices may connect to the projector **110** through a variety of links. In this illustration, the projector **110** is connected into a computer network through a wireless access point **150** through a wireless link **114**. The wireless access point **150** also connects with four of the computing devices **121**, **123**, **125**, and **127** through wireless links **141**, **143**, **145**, and **147**, respectively. These wireless connections allow digital communications between these computing devices and the projector. Alternatively or additionally, a wired network connection may be used to provide communications between computing devices and the projector **110**. For example, desktop computer **127** has a wired connection **148** with a wired local area network (LAN) **151**. A wired connection **112** connects the projector **110** to the wired LAN **151**. The wired LAN **151** and the wireless access point **150** may use coordinating protocols to manage communications among the various devices connected thereto. Alternatively or in addition, connections with the projector **110** may be made on an ad-hoc basis. For example, computing device **129** communicates with the projector **110** through an ad-hoc network link **149**.

[0037] The display system may maintain a cached list of users that have previously logged in to the system. This cache may be stored in a memory in the display system, or may be stored on a server computer accessible through a network. The user's computing devices may store a cached list identifying display systems onto which they have previously connected, thereby facilitating reconnections in the future.

[0038] To prevent unwanted users from gaining access to the video display, the display system may include authentication procedures for identifying users that connect to the display system. For example, at the start of a meeting, the video display may project a settings summary with connection information for viewing by an audience. The connection information may include a wireless encryption passphrase or other password information, thereby enabling only audience members to connect to the display system. Alternatively, or in addition, the display system may maintain a list of approved users, who may then log into the display system.

[0039] The controller may include firmware stored in a memory and a processor for running the firmware. To increase versatility of the display system, the firmware may be configured to allow the display system to interface with a variety of computing devices running a variety of operating systems, such as various versions of Windows®, Mac OS®, or Palm OS® operating systems, among others. The firmware may also be configured to accept uncompressed data or data compressed according to a variety of compression protocols to create images for display. Compression formats that may be implemented include, for example, JPEG, GIF, TIFF, MPEG, WAV, run-length encoding, MP3, and AC3, among others. Alternatively, or in addition, the video data may use display instructions or graphics commands to compactly communicate video information. Other techniques for compressing, encoding, and transferring video data may also be implemented, such as, for example, approaches described in U.S. patent application Ser. No. 09/746,841 for "INFORMATION TRANSMISSION AND DISPLAY METHOD AND SYSTEM FOR A HANDHELD COMPUTING DEVICE," and in U.S. patent application Ser. No. 10/066,402 for "TRANSFER OF IMAGES TO A MOBILE COMPUTING TOOL," the disclosures of which are hereby incorporated by reference herein in their entirety.

[0040] The display system may include a memory-card interface that enables the display system to read video data from a removable memory, such as CompactFlash® memory, a SmartMedia® memory, or a USB memory stick, among others, and display images based on the data from the removable memory. The display system may include a network interface that enables the display system to read video data from an archive, or a server, or an internet address, or a data file accessible through the network connection.

[0041] The display system may include interfaces and support for obtaining software updates over a computer network. A computer network may also be used to link the display system to other supporting tools, such as a database of users authorized to access the display system. Such a database may also be stored in a memory on the display system. Users may similarly store cached information that includes identifying characteristics of display systems onto which they have previously connected.

[0042] Instead of (or in addition to) projecting images on a separate display, the display system may be configured to employ the users' computing devices to display video. In this mode, the projected images are displayed on one or more users' computing devices, which may be useful in situations where users can not view a single projected display. The display system may serve as a hub to which several users may connect their computing devices. The display system may then allow one of the users to project video onto the screens of one or more of the other users' computing devices.

[0043] The display system may serve as a mirroring display for a user who sends video data to the display system. In this implementation, once a user gains access to the display system, the video display projects a copy of visual information that appears on the screen of the user's computing device. Alternatively, the display system may be configured so that the video display serves as an extended monitor for the user, working in tandem with the screen of the user's computing device. In this implementation, the video display may simulate an adjacent screen or an overlapping screen that works in conjunction with the screen of the user's computing device, and may allow contiguous cursor movement or scrolling between the screen of the user's computing device and the video display. Still further, the video display may be implemented as a separate display tool, that displays video independently from the operation of the screen of the user's computing device. These and other implementations may be combined so that a user may select among them in various operating modes.

[0044] Various data-transfer protocols may be used in display systems that implement a display-mirroring function. One protocol, for example, may involve "screen scraping," in which an entire screen image is captured on a user's laptop computer or other computing device. The captured screen image may then be compressed and transmitted to the display system, where it is received, decoded, and displayed. Depending on the performance characteristics of the capturing computing device and the display system, this process may limit the frame rate that can be achieved by the display system.

[0045] A data-transfer protocol may also include an enhanced approach with conditional replenishment of the screen contents on a user's laptop computer or other computing device, coupled with reducing the screen graphics into a set of GDI (Graphics Display Interface) commands that may be transmitted to the display system. The display system may then re-paint the screen onto the shared display device. While this enhancement may use more complicated procedures, it may also enhance the performance of the system by reducing a required channel capacity or increasing a refresh rate.

[0046] By only updating the changed areas on the screen, the data-transfer protocol may reduce the amount of update data that has to be sent across a wireless conduit between a user's computing device and the display system. A GDI engine may be installed on the user's computing device. The GDI interface may be configured to understand the commands of the user's computing device, thereby largely eliminating the need to transmit actual images over a wireless link to the display system. Instead, the GDI interface may perform GDI trapping. The GDI interface may harvest graphics commands or instructions being used on the user's computing device, and may send those commands or instructions to the display system. Exceptions may occur when a certain figure or area would require an excessive amount of trapped GDI commands to be transmitted. In such situations, the data-transfer protocol may transfer regular graphics information: the area may be converted into a bitmap or other graphics element and transmitted to the display device.

[0047] If a user's computing device has sufficient processing capability (for example, if the user's computing device is a sophisticated laptop computer), a GDI trap may be created on the user's computing device. The GDI trap may capture all the commands provided to the user's display hardware, and transmit these commands to the shared display system. If the GDI engines match on the user's computing device and on the shared display system, then the trapped commands may enable the shared display system to replicate the display on the user's computing device. In

some situations, the shared display system may include tools for accomplishing partial or substantial translations of the received GDI commands.

[0048] The data transfer protocol may employ image sectioning so that transmissions from a user's computing device to a shared display system need only include information describing recently updated sections of the display on the user's computing device. This sectioning of the image into its multiple components may be implemented with object oriented tools or data-flow driven tools, and may be used to enhance the performance of the shared display system.

[0049] GDI trapping, sectioning, and other data-transfer techniques may also be used for display modes other than mirroring modes. For example, sectioning may be employed with or without additional compression techniques to reduce the communications traffic between a user's computing device and a shared display device used as an extended monitor. Other combinations of techniques described herein may also be readily implemented.

[0050] The display system may be implemented with a blanking mode. In this mode, a user may issue a command to remove an image from the video display. This mode may be useful, for example, for speakers who wish to remove any distracting images during question and answer sessions at the conclusion of a presentation, or for temporary periods during a presentation. The blanked video display may be configured to present a darkened screen, a solid-color screen, an image of the user's selection, or some other image.

[0051] **FIG. 2** is a block diagram illustrating an environment for an example of a multi-user display system. A first PDA **221** with the IEEE 802.11b wireless communications protocol is controlled by User A. Other suitable wireless protocols are IEEE 802.11a, 802.11g, 802.11n, 802.15.3a, Bluetooth®, and infra-red, among others. A second PDA **223** is another wireless device in the system, controlled by User B. A laptop computer **225** controlled by User C and other wireless devices **227** are also present in this example. The PDAs **221** and **223**, the laptop computer **225**, and the other wireless devices **227** may be used to control various display devices, such as a projector **210** and other display devices **230**. The projector **210** may be, for example, a digital projection display device with 802.11b wireless communication protocol and a suitable firmware program loaded in its program memory. The projector **210** as shown here has a wireless module **216** to send and receive data or command signals by a wireless protocol, a CPU and memory **218** having a processor and associated memory for processing commands and reformatting data, a graphics engine **212** for setup timing, color information, image and scaling as required by the associated display, and a display engine **214** that provides interface circuitry to a display projector.

[0052] Negotiation procedures may be implemented on the portable computing devices **221**, **223**, **225**, and **227** to allow negotiation among the devices **221**, **223**, **225**, and **227** in gaining access to the display devices **210** and **230**. Alternatively, these procedures may be implemented by the display devices **210** or **230**. In one configuration, the computing devices **221**, **223**, **225**, and **227** include software for facilitating sharing of display devices, and the display devices **210** and **230** include corresponding software for coordinating use by the computing devices **221**, **223**, **225**, and **227**.

[0053] Various levels of complexity may be offered in the procedures for coordinating the sharing of the projector **210**, as described below. For example, a single-user mode may be offered as an option to users with a simple feature set that gives users a way of accessing the system with very little training. A second mode, enabling self-service by multiple users, may give more sophisticated users a powerful interface based on more complex interaction. Additional modes, such as roundtable and moderated multi-user modes, may provide for other advanced features.

[0054] **FIG. 3** is a flow chart illustrating a single-user mode for access to a display device. This mode may be employed by a single user for using one or more display devices, such as a projector, without sharing the display devices with other users. A user initially connects with a network to which a projector is also connected in act **310**. The network may be wired or wireless. The network may also include a combination of wired and wireless connections, as illustrated above with reference to **FIG. 1**. Creating the connection with the network may include network sign-in or authentication procedures. Upon connecting with a network through a wireless device, a user may be presented in act **320** with a list of projectors and other display devices available on the network. The user then selects one or more display devices and completes any sign-in or authentication procedures required by the projector in act **330**. The user is then automatically granted access to the projector, and may be logged in as the controlling user connected to the projector in act **340**. The user may then use the projector, displaying video information or audiovisual information on the projector in act **350**. The user may then disconnect when desired in act **360**.

[0055] Various implementations are possible for procedures for accessing a display device. For example, acts **320** and **330** described above may be replaced or supplemented with the ability of a user to specify a particular projector or other display device, including display devices that may not be included on a list of available display devices.

[0056] **FIG. 4** is a flow chart illustrating a self-service multiple-user mode for access to a display device. This mode may be helpful, for example, in a conference room meeting with many users taking the podium in sequence, or in the situation of a single user switching between two wireless PDAs or other computing devices during a presentation. One feature that may be included is a safety mechanism: if a user does not log off after a presentation, the next user may nonetheless readily obtain control of the projector. In this implementation of the self-service multiple-user mode, an initial user, designated User A, connects with a network in act **410** through a computing device such as a laptop computer. In act **420**, User A's computing device presents User A with a list of projectors available on the network. User A then selects a projector, completes any sign-in or authentication procedures required by the projector in act **430**, and is automatically granted control as the initial user. User A may then use the projector in act **440**.

[0057] While User A has control over the projector, a new user, designated User B, may select the same projector, as noted in act **450**. User B's computing device may commu-

nicate with the projector through the same network as User A. Depending on the connectivity of the projector, however, Users A and B may each reach the projector through different networks, or one of the users may communicate with the projector through a networked link while the other user communicates with the projector through a direct or ad-hoc link. Upon initially selecting the in-use projector, User B may be alerted to the fact that the projector is already in use by User A. User B may then decide not to obtain control of the projector. However, as noted in act **460**, if User B nonetheless connects to the projector, User A is then logged off from the projector and User B gains control over the projector.

[**0058**] **FIG. 5** is a flow chart illustrating a roundtable multiple-user mode for access to a display device. This mode may be useful in a boardroom-type meeting, where participants are engaged in a meeting with formal rules of order.

[**0059**] In this implementation of the roundtable multiple-user mode, an initial user—User A—connects with network and is presented in act **510** with a list of projectors available on the network. User A then selects a projector, completes any sign-in or authentication procedures required by the projector in act **520**, and is automatically granted control as the initial user. In act **530**, User A may then select a "others must request permission" setting that dictates that any subsequent users seeking access to the projector must request permission from User A. Depending on the particular system implementation, this setting may be selected in a variety of ways. For example, User A may select an appropriate radio button on a dialog interface panel that is presented on User A's computing device after User A gains control of the projector. Alternatively, or in addition, User A may select the request-permission setting by operating a switch or other manual control on the projector housing. Alternatively, the projector may be configured so that the request-permission setting is a default setting, or is the only option for operating the projector. User A may then use the projector in act **540**.

[**0060**] While User A has control over the projector, a new user, designated User B, may select the same projector, as noted in act **550**. User A is then alerted to User B's desire to use the projector in act **560**. This alert may be delivered, for example, in the form of a pop-up window on User A's computing device. User A may then choose a variety of responses to the alert in act **570**, which may be selected, for example, through radio buttons on the pop-up window. User A may relinquish control of the projector, in which case User A is then disconnected from the projector. Alternatively, User A may refuse to relinquish control of the projector, in which case User B may be informed that the projector has not been made available. Additional tools may also be available to User A. For example, User A may be provided with an option to always refuse any future requests from User B, or from a specified list of users, or from all other users. User A may also have the option of responding with a customized message, such as a text message, to User B. Such a message may be helpful in situations where User A suspects that there may be some confusion in User B's selection of the projector, so that User B may have unwittingly requested access to the projector instead of requesting access to a different projector.

[**0061**] As noted in act **570**, User A may choose not to respond. In the implementation depicted in **FIG. 5**, this choice may be interpreted to mean that User A has stepped away from his computing device or otherwise is no longer using the projector. The access mode then specifies that control of the projector is transferred from the nonresponsive User A to the requesting User B after an appropriate waiting period, such as a half a minute or some number of minutes.

[**0062**] If User B gains control following User A's response (or lack of response) in act **570**, User B may then use the projector in act **580**. Depending on the particular implementation of the access mode, User B may then have the option to select (or de-select) the "others must request permission" setting. User B retains control of the projector until another user obtains control or is granted control, or until User B disconnects from the projector.

[**0063**] **FIG. 6** is a flow chart illustrating a moderated multiple-user mode for access to a display device. This access mode may be useful in a moderated situation where one user is designated as the master controller and controls of the switching between users. In this implementation of the moderated multiple-user mode, an initial user—User A—connects with network and is presented in act **610** with a list of projectors available on the network. User A then selects a projector, completes any sign-in or authentication procedures required by the projector in act **620**, and is automatically granted control as the initial user. In act **630**, User A may then select a "become moderator" setting that gives User A an ability to dictate which of various users have control over the projector. Depending on the particular system implementation, this setting may be selected in a variety of ways. For example, User A may select an appropriate radio button or a check-box on a dialog interface panel that is presented on User A's computing device after User A gains control of the projector. Alternatively, or in addition, User A may select the become-moderator setting by operating a switch or other manual control on the projector housing. Alternatively, the projector may be configured so that the moderator setting is a default setting, or is the only option for operating the projector. User A may then use the projector, and may be provided with a list of users that are eligible to use the projector. This list may be based on a hierarchy of permissions, or may simply be a list of users that are linked to the network or linked directly to the projector. As the moderator, User A may be notified in act **640** whenever another user indicates a desire to use the projector. In act **650**, User A may select among the eligible users to determine which user has control of the projector.

[**0064**] As indicated in act **660**, eligible users may be provided with access information for the projector, including whether the user is "live" (currently having control of the projector), or is waiting to be granted control over the projector. The access information may also indicate who the current moderator is. The access information may be presented in a variety of forms, such as a pop-up window, or a toolbar, or a control panel, or a pull-down menu, or through other interfaces. The interface may also include a button or icon other input selection device for allowing a user to request control over the projector. The interface may also enable users to send and receive messages with each other or with the moderator (User A).

[0065] When a user requests control over the projector, the moderator is notified of the request in act **670**. The moderator may then select among a variety of responses in act **680**. The moderator may select any of the eligible users to control the projector. The selected user may then deliver data to the projector, such as images, video, audio, or audiovisual material as appropriate for the projector. The moderator may also have additional options, such as discontinuing the moderated multiple-user mode, or passing moderator status to another user, as noted in act **690**, or sending messages to any user, or sending messages to all users, among others.

[0066] Procedures may also be included in the moderated multiple-user mode to facilitate smooth operation of the projector in the event that a moderator steps away from the moderator's computing device without first relinquishing moderator status. For example, the moderated multiple-use mode may be configured so that users are also provided with an input selection device for requesting that the moderator be disconnected. When a user selects this input, the moderator is notified. If the moderator does not respond within a set time period, the moderator loses the moderator status. Depending on the implementation of this feature, the moderator may be disconnected from the projector, or the projector may be switched to a non-moderated mode of operation.

[0067] Projection interface systems may be implemented with any one or more of the above access modes. Other operating modes for sharing access to a display device may also be implemented, combining various features noted above for the single-user, self-service multiple-user, round-table multiple-user, and moderated multiple-user access modes. In interface systems offering two or more different access modes, users may be allowed to switch between access modes. For example, an interface system may have a manual control switch that allows users to select an access mode. Alternatively, users may select access modes through pop-up window interfaces or other graphical or textual on-screen interfaces. Such interfaces may query users to select an access mode upon connection to a display device, as illustrated in the foregoing examples by acts **530** and **630**.

[0068] A variety of approaches are contemplated for enabling users to establish communications with projectors and other display devices, and for negotiating control over shared display devices. Described below are examples of user interfaces, as displayed to the user on their respective computing devices, for accessing and sharing display devices such as projectors **110** and **210**. The various user interfaces may be displayed by software running on the user's laptop computer, PDA, or other computing device to coordinate sharing among the various users. The software may also enable the user to display video material on the shared display device.

[0069] An initial consideration is the ability of users to identify the display devices to which they may wish to connect. A user entering a conference room such as depicted in **FIG. 1** may wish to join other users in sharing the use of a display device such as projector **110**. Identifying the projector has not been an issue in previous systems, where a user might directly connect a laptop computer to a projector though a communications cable. However, in situations where a user may wish to make a connection to a display device either through a network, or wirelessly, or to one of several available display devices, the user would be aided by information that identifies the desired display device. This information may then be used by the user to ensure that a link is formed with that display device.

[0070] **FIG. 7** shows an example of a settings summary **700** that may be displayed by a shared display device to show connection information for the display device. At the start of a meeting, a display device such as projector **110** in **FIG. 1** may display such a settings summary for the benefit of users who may wish to establish a link between their respective computing devices and the display device. A settings summary may reveal a network node identity for the display device, and any passwords that may be required for establishing links with the display device. This approach may help prevent undesired links from people not in attendance at the location of the display system.

[0071] As depicted, the settings summary **700** indicates a name of the display device and a password for linking to the display device. In addition, the settings summary **700** also includes network identification information for a wireless network to which the display device is connected, such as an IP address of the display device on the network, the type of network connectivity (such as an ad-hoc/peer-to-peer organization or an infrastructure-based organization), a service set identifier (SSID) that identifies the wireless network to which the display device is connected, and whether or not any encryption is used in the wireless network. If encryption is being used, the settings summary **700** may display the wireless encryption protocol (WEP) key and index, or the Wi-Fi Protected Access (WPA) key information, or other passphrase information needed for communicating on the wireless network. Similarly, if the display device is connected to a wired network, an IP address of the display device on the wired network, or other appropriate information, may be displayed on the settings summary **700**.

[0072] In the depicted example, the settings summary **700** is being displayed by a digital projector named "MP3130." In this example, the projector requires a password of "fremont." This projector is connected to an wireless network whose network ID (SSID) is "HPPROJECTOR," and the IP address of the projector on the wireless network is 172.16.0.1. The wireless network in this example uses no encryption. Further, this wireless network is an ad-hoc wireless network, such as illustrated by the wireless link **149** from **FIG. 1**.

[0073] In the depicted example, unauthorized access to the projector is provided by the use of the projector password ("fremont"). In other situations, administrators may choose not to have a password for the projector, but may protect the projector by requiring encryption on the wireless network to which the projector is connected. Administrators may also choose to use both network encryption and a projector password to thwart unauthorized access to the projector.

[0074] **FIG. 8** shows an example of a selection and login interface **800** for connecting to a wireless network. Users attempting to establish a connection with a wireless network may use this interface to login to a wireless network on which a display device resides. For example, a user of the laptop computer **125** from **FIG. 1** may invoke the selection and login interface **800** on the laptop computer **125** to establish a wireless ad-hoc network link with projector **110**. In the depicted example, **FIG. 8** shows such a connection

being made with an ad-hoc wireless network using the information that was depicted in the settings summary **700**. These settings indicate that a user is logging in to the ad-hoc "HPPROJECTOR" wireless network. The user is selecting the "MP3130" projector with IP address 172.16.0.1 on that network, and is providing the projector password "fremont."

[**0075**] Other interfaces may also be used for logging into a network or selecting a projector. For example, a Windows XP® standard interface may be used for logging into a wireless network.

[**0076**] **FIG. 9** shows an example of a display-selection interface **900** for a user connecting to a shared presentation system on a wireless network. Once a user has established a link with a wireless network, the display-selection interface **900** may be used to select a display devices from a list of display devices available on that wireless network. The depicted display-selection interface **900** includes a listing **910** of display devices, along with corresponding status markers **920**, as well as a connect/disconnect button **930**, an "Other Projector" button **940**, and an "Advanced" button **950**.

[**0077**] The listing **910** may include all display devices that are connected to the same network as the user's computing device. These connected display devices may be readily available for use. The listing **910** may include columns for display device names **912**, network names **914**, and IP addresses **916** of the display devices. The listing **910** may also include unavailable display devices, whose identifying information may be cached in memory on the user's computing device. The stored information on the unavailable display devices may be remembered from past sessions in which the user previously had access to the now-unavailable display devices.

[**0078**] The status markers **920** for each display device may indicate the display devices' readiness or availability. In one implementation of the display-selection interface **900**, the status markers **920** are green, yellow, or red circles placed next to the names of each display device in the listing **910**. Green circles may indicate that the corresponding display device is connected to the same network as the user's computing device, and may thus be immediately available for use. Red circles may indicate that corresponding display device is remembered in the cached information as a projector that used to be connected to the current network, but is not currently connected to the network, and thus appears to be no longer available. Yellow circles may indicate that the corresponding display device is remembered in the cached information as a projector connected to a different network, and which thus may be available if the user were to disconnect from the current network and login to the different network.

[**0079**] The "Other Projector" button **940** may be used to invoke an interface for selecting an unlisted projector. The "Advanced" button **950** may be used to invoke other interface tools, such as for configuring settings of a projector or of network connection.

[**0080**] A variety of security tools may be employed to protect access to shared projectors. In addition to the network encryption and the passwords for display devices discussed above, a system for sharing display devices may also employ user identification to limit access to approved users.

[**0081**] **FIG. 10** illustrates an example of a user-login interface **1000**. Depending on a particular implementation, the user-login interface **1000** may be presented on a user's computing device when the user requests a connection with a particular display device limited to a select group of users. The user-login interface **1000** may request a user name **1010** and a user password **1020**. The user-login interface **1000** may also include an option **1030** allowing the user to locally store the user password on the user's computing device. The user name and user password may be initially set by an administrator with special access to the display device. In various implementations, the user names and user passwords may be managed and updated by users. **FIG. 11** shows an example of a personal settings interface **1100** in which a user may update the user name **1110** or the user password **1120** or both, after first logging in through the user-login interface **1000**. The personal settings interface **1100** may also include an option **1130** allowing the user to locally store the user password, and an advanced options button **1140** for use by administrators of display devices.

[**0082**] **FIG. 12** shows an example of an administrator logon interface **1200** that allows entry of a administrator name **1210** and the administrator password **1220** while also displaying information on available display devices **1230** that an administrator may select for access. The advanced logon interface **1200** may be invoked when a user selects the advanced options button **1140** from **FIG. 11**. The advanced logon interface **1200** may also include an administrator logon button that initiates access to advanced administrator features of a display device, such as maintenance features, the maintenance of user lists, and software upgrade opportunities.

[**0083**] Once a user has established communication with a selected display device, the user's computing device may display an interface that the user may use to coordinate sharing of the display device with other users. **FIG. 13** and **FIG. 14** show examples of a display-sharing interface for a user connected to a shared presentation system.

[**0084**] **FIG. 13** shows an example of a display-sharing interface **1300** that may be displayed on a user's computing device once the user establishes communication with a shared display device, such as the projector **110** in **FIG. 1**, and gains control over the display device. The display-sharing interface **1300** depicted here includes a Start Presentation button **1310**, a Sharing Mode section **1320** (which may also be called a Projector Access section), a window minimizing checkbox **1350**, a Show User List button **1360**, a Projector Info button **1370**, a Hide Screen button **1330**, and a Disconnect button **1340**.

[**0085**] When the user selects the Start Presentation button **1310**, the user's computing system initiates a presentation or other pre-selected video display or other pre-selected audio-visual display for presentation on the display device. The window minimizing checkbox **1350** may be selected if the user wishes the display-sharing interface **1300** to be removed from the main view of the user's computing device after the user's presentation is initiated. If the user wishes the presentation to be blanked or hidden, the user may select the Hide Screen button **1330**. This button **1330** enables a user to temporarily blank the display being viewed by an audience when the user wishes to discusses a point without the distractions of a visible display. This button **1330** also

allows a user to blank the display device at the conclusion of the user's presentation. As an alternative to blanking the display, the Hide Screen button **1330** may cause the display device to present a pre-determined graphic selected by the user. The Projector Info button **1370** calls an informational interface with information for monitoring the display device, and may also be used for maintaining the display device and administering lists of approved users on the display device. The Disconnect button **1340** may be selected by a user to terminate the user's control over the display device at the conclusion of the user's presentation.

[**0086**] The Sharing Mode section **1320** depicted in **FIG. 13** includes options for selecting a mode for sharing access to the display device. As depicted in this example, this section includes radio buttons to select one of three access modes. A first access mode **1322** is designated to allow any user to gain control of the projector. This first access mode **1322** may implement the access-sharing protocol described above for the self-service multiple-user access mode (illustrated by example in **FIG. 4**). A second access mode **1324** is designated to force any other users to obtain the permission of the current user (the user currently with control and use of the display device) before the other users may use the display device. This second access mode **1324** may implement the access-sharing protocol described above for the roundtable multiple-user access mode (illustrated by example in **FIG. 5**). A third access mode **1326** ignores all requests for control of the display device. This third access mode may implement the access-sharing protocol described above for the single-user access mode (illustrated by example in **FIG. 3**).

[**0087**] The Sharing Mode section **1320** depicted in **FIG. 13** also includes a moderator option **1328** checkbox for initiating a moderated access protocol. Enabling the moderator option **1328** may implement the access-sharing protocol described above for the moderated multiple-user access mode (illustrated by the example in **FIG. 6**). Depending on the implementation, the moderator option may be modified by the selection of the radio buttons **1322**, **1324**, and **1326**. For example, the moderated multiple-user access mode may be augmented by allowing the moderator-user to select whether anyone may be granted access by the moderator, or whether only requesters may be granted access by the moderator or whether the moderator may ignore all requests for access while maintaining the privilege of granting access. Alternatively, the moderator option **1328** may override the selections made in radio buttons **1322**, **1324**, and **1326**. As depicted in **FIG. 13**, the display-sharing interface **1300** illustrates the selection of the single-user access mode (radio button **1322**), without the use of the moderator option **1328**.

[**0088**] The Show User List button **1360** expands the view presented by the display-sharing interface **1300** to include a list of users currently in communication with the projector. An example of this expanded display-sharing interface is depicted in **FIG. 14**.

[**0089**] **FIG. 14** shows an expanded display-sharing interface **1400** that is similar to the display-sharing interface **1300** from the previous figure, with many common elements. The expanded display-sharing interface **1400** additionally includes a user list **1461** showing users currently connected to the display device. **FIG. 14** also illustrates the selection of a "request permission" multiple-user access mode (radio button **1324**), combined with the use of the moderator option **1328**. Accordingly, the user list **1461** indicates which of the listed users has moderator status, along with indicating which user currently has use of the display device. The expanded display-sharing interface **1400** also includes buttons for revoking access from the current user **1484**, assigning access to a selected user **1482**, and assigning moderator status to a selected user **1486**.

[**0090**] **FIG. 15**, **FIG. 16**, **FIG. 17**, and **FIG. 18** illustrate examples of user dialog windows that may be implemented in a self-service multiple-user access mode. In this example, a user Jane initially has control over a display device named Projector ABC. Another user Bob takes control of Projector ABC from Jane. **FIG. 15** shows the Sharing Mode section **1320** in **FIG. 13**, as configured by Jane with radio button **1322** selected, and with the moderator option **1328** not selected. When Bob requests control of the projector, Bob's computing device displays a dialog box **1600** from **FIG. 16**, informing Bob that "Projector ABC is in Use by Jane," and that Jane will be disconnected if Bob elects to connect nonetheless. If Bob indicates that he wishes to connect nonetheless, his computing device then displays a message such as a dialog box **1700** in **FIG. 17**, informing him that he now has control over Projector ABC. At the same time, Jane's computing device displays a message such as a dialog box **1800** in **FIG. 18**, informing her that she has lost control over Projector ABC to Bob.

[**0091**] **FIG. 19**, **FIG. 20**, **FIG. 21**, and **FIG. 22** illustrate examples of user dialog windows that may be implemented in a roundtable multiple-user access mode. In this example, user Jane again initially has control over the display device named Projector ABC. Another user Jim requests and obtains control of Projector ABC from Jane. **FIG. 19** shows a Sharing Mode section **1900**, as configured by Jane—now with radio button **1324** selected, and with the moderator option **1328** again not selected. When Jim requests control of the projector, Jim's computing device displays a dialog box **2200** in **FIG. 20**, informing Jim that "Projector ABC is in Use," and offering to request control from the current user Jane. The dialog box **2200** may offer Jim the opportunity to send a customized request message to Jane. If Bob indicates that he wishes to request control, Jane's computing device then displays a message such as a dialog box **2100** in **FIG. 21**, informing her that Jim wishes to obtain control of Projector ABC. Dialog box **2100** may also relay any custom message from Jim ("My Turn?"). If Jane refuses the request, an appropriate notice is sent to Jim. If Jane approves the request, a notice such as dialog box **2200** in **FIG. 22** is sent to Jim, informing Jim that he now has control over Projector ABC.

[**0092**] Dialog box **2200** also illustrates another control tool that may be offered in various implementations of software for sharing display devices. A Freeze Frame button **2210** may be provided, enabling users to stop any motion in an ongoing video or other presentation. The Freeze Frame button may be provided instead of, or as a complement to, the Hide Screen button **1330** discussed above with respect to **FIG. 13**.

[**0093**] **FIG. 23**, **FIG. 24**, and **FIG. 25** illustrate examples of user dialog windows that may be implemented in a moderated multiple-user access mode. **FIG. 23** shows a

Sharing Mode section **1320**, with radio button **1324** selected, and also with the moderator option **1328** selected. This selection allows the controlling user to have moderator status regarding interactions with the display device.

[**0094**] A variety of implementations are contemplated for moderated multiple-user access mode. For example, **FIG. 24** shows a dialog box **2400** that may be displayed to a user having moderator control over a display device. The dialog box **2400** may include a listing **2430** of other users in communication with the display device, a text screen **2410** that may display text messages received from the other users, an input line **2420** allowing the moderator-user to send messages to the other users, a button **2460** for blocking communications from a specific user, a button **2440** for granting control of the display device to a selected user, a button **2450** for the moderator to himself or herself take control of the display device, a checkbox **2442** to indicate that the type of control being transferred includes privileges for presenting video on the display device (an example of partial control of the display device), a checkbox **2444** to indicate that the type of control being transferred includes privileges for making annotations on another user's presentation (another example of partial control of the display device), a checkbox **2446** to indicate that the type of control being transferred is the moderator status, and a button **2470** for the moderator to disconnect from the display device. Other features may also be included, such as an option to broadcast a message simultaneously to all users in the user listing **2430**, or an option to grant temporary control of the display device, among others.

[**0095**] Various types of annotation tools may be included in the interface for a multi-user display system. Annotations may be an option, such as check box **2444**, available in a moderated multiple-user access mode, or in a roundtable multiple-user access mode, or in other access modes. An interface may offer one or more annotating users the ability to partly modify a presentation being controlled by another user. One or more levels of annotation control may be provided. For example, annotation access may include only an ability to control a mouse-type pointer on a shared display screen. Alternatively, or in addition, annotation access may offer an annotating user the ability to edit a displayed item, highlight displayed text, add notes in a separate font color, circle portions of a displayed graphic, or combinations of these tools, among others.

[**0096**] When a user requests a connection to a display device that already has a moderator, a dialog box **2500** in **FIG. 25** is displayed on that user's computing device. It allows the user to request full or partial access to the display device and to send messages to the current moderator.

[**0097**] A variety of approaches may be used to enable laptop computers, PDAs, and other computing devices to display video on a display device. Depending on implementation, PDAs may generally have slower operating microprocessors than laptop computers. In some situations, compression and storage techniques may be used to compensate for any lower processing speeds in a handheld computing device used in shared-display situations. For example, compressed high resolution data may be initially created on a laptop or desktop computer and downloaded onto a PDA. This compressed data may subsequently be sent to the display device using a wireless protocol. Examples of data coding and compression techniques are disclosed in commonly owned U.S. patent applications Ser. No. 09/746,841 and Ser. No. 10/066,402, referenced and incorporated above. The microprocessor in the display device then de-compresses the image before it is presented to the graphics engine. The relevant firmware (or software) may reside in the display device and may run on the display device's microprocessor.

[**0098**] This firmware in the display device may be configured to recognize two PDA data formats. One format may be used for reading and decompressing compressed presentations as described above. Another format may bring in a real-time un-compressed and scaled version of the graphics image being displayed on the PDA screen, regardless of the application running, thereby mirroring the PDA's local display.

[**0099**] In cases where laptop computers and other computing devices with substantially faster processing capabilities are used for sending video to a display device, different compression techniques may be used to compress the graphics on the laptop computer prior to transmitting the graphics. At the display device side, the firmware may determine from the data type which data compression type in the laptop computer is being used. The firmware may support a variety of different compression schemes, and may be able to provide high-resolution video, such as 1024×768 pixels×32 bits of color depth.

[**0100**] A collection of interoperative software and firmware in a shared display system may have several components, such as: an embedded projector program that runs on a wireless module embedded in or connected to a display device (see **FIG. 2**); a high-speed mirroring program that runs on a client laptop or desktop computer; a low-speed mirroring program that runs on a PDA; PDA Slide Presentation software which runs on the PDA; and a graphics creation program that runs on a laptop or desktop computer to create a presentation for display.

[**0101**] **FIG. 26** is a block diagram of one implementation of an architecture **2600** for embedded software for a shared display system (such as the projector **110**). Various portions of the software may be stored in a memory of the shared display system, such as memory in the CPU and memory block **218** shown in **FIG. 2**, for example. The memory may be a nonvolatile memory, such as a flash memory, or a hard disk drive, among others. Some or all of the software may be firmware, permanently installed on the display system. The software may be coded to run on an operating system **2660** such as a Linux operating system, for example.

[**0102**] In the depicted implementation, the first process to start after the operating system has booted is a supervisor daemon **2610**. The supervisor daemon **2610** may perform a variety of tasks, including: (1) determining a communications configuration of the system using a system configuration file **2640** to determine which communication daemons are available and should be started; (2) providing a conventional operating system daemon (such as a Linux operating system daemon, not shown) for network configuration; (3) maintaining client connections and a user configuration file **2642** with user credential requirements, so that all client requests may be handled through the supervisor daemon; (4) maintaining a list of logged-in users, keeping track of a user's Controller or Attendee status, keeping track of user

permissions (e.g., presenter, annotator, pointer); (5) blocking access to particular applications when user permission has not been not granted (blocking may also be enforced in client software on a user's computing device and may be re-enforced in the shared display system); (6) launching and controlling applications based on requests from users' computing devices; (7) managing data stream FIFO's, providing connections between various communication daemons and user applications, and transferring data; and (8) performing a "healthy check" to test the status of communications connections among devices connected by a wireless network to report on and maintain the network's operating state.

[**0103**] The supervisor daemon **2610** may be configured to supports human language localization. Language localization may be used to allow interface messages in a variety of user-selectable languages, such as English, French, Spanish, or Chinese, for example. In addition to language localization implemented by the supervisor daemon **2610** on a shared display device, additional language selection may be available to individual users for their respective computing devices.

[**0104**] Data may be transferred using a transfer protocol such as NetDisp to route data to appropriate applications running on the shared display system. Various transfer protocols may be implemented to provide a simple, low overhead protocol for transferring control and graphics data. In one example, a transfer protocol includes a header that identifies packet length, data type and user so the supervisor daemon **2610** can route the packets as required. This header may be passed to the corresponding application so the application may verify data type and sort according to the originating user. The front of the header may have a guaranteed fixed format, including, for example, a header length field so the header may be extended as required by the supervisor daemon **2610**.

[**0105**] One or more communication daemons **2620** may be started by the supervisor daemon **2610** to provide common connection interfaces for applications, with the connection interfaces independent of underlying network services. The example in **FIG. 26** depicts four communications daemons: a TCP/IP socket communications daemon for a control channel **2622**, a TCP/IP socket communications daemon for a data channel **2624**, a Bluetooth® communications daemon for a control channel **2626**, and a Bluetooth® communications daemon for a data channel **2628**. These communications daemons may interface with corresponding support software in the operating system **2660**, such as TCP/IP sockets **2652** and a Bluetooth driver **2656**, for example. A kernel **2661** may support the sockets and drivers **2652** and **2656**, as well as other interfaces such as an IEEE 802.11b driver **2662**, a CompactFlash® bus driver **2664**, a CompactFlash® memory driver **2666**, an Ethernet driver **2668**, a USB driver **2772**, a DSP DMA driver **2774**, a RAM driver **2776**, and a frame buffer driver **2778**.

[**0106**] The communications daemons **2620** may perform a variety of tasks, including: (1) communicating to client devices with a specific protocol (control or data); (2) supporting multiple clients with a single port, for example, by routing data from each user's computer to a corresponding target application through a host processor FIFO; and (3) performing communication "health" checks, for example by checking the status of wireless connections to various wireless devices and display devices connected to the shared display device.

[**0107**] Various applications **2630** may be started by the supervisor daemon **2610** and may each handle multiple users in a single instance. Examples of applications include an annotator **2631**, a PDA slide presentation application **2633**, a PDA mirror application **2635**, a laptop mirror application **2637**, and others, such as an audio browser **2639**. Control and data may be received via a pipe configured by the supervisor daemon **2610**. The supervisor daemon **2610** may launch each application when a user first requests the application. The supervisor daemon **2610** may close an application when the last user releases it. The supervisor daemon **2610** may be used to arbitrate access to a graphics engine or a display engine or other components that process images for display on a shared display device. Such arbitration may be unnecessary for applications that do not share access with other applications. Arbitration may be necessary for some applications, such as the annotator application **2631**, which may require simultaneous control over the display in conjunction with other applications.

[**0108**] The annotator application **2631** may be configured to display a mouse cursor or other annotation overlaid on a display of the shared display device. The annotator application **2631** may share the display with one of the other applications. Thus, when one user moves a cursor on the display of the user's wirelessly connected computing system, the annotator may in response cause a cursor may to be moved on the shared display.

[**0109**] The PDA slide presentation application **2633** may be configured to interact with client software installed on a user's PDA (such as PDA **121** from **FIG. 1**, for example) that is wirelessly connected to the shared display system. The PDA slide presentation application **2633** may be configured to receive PDA slide data and transfer the slide data to the display processing portions of a wireless module (such as wireless module **216** shown in **FIG. 2**, for example). The PDA slide presentation application **2633** may be configured to manage a cache of received slides. The client software may pre-send slides to reduce any latency due to transmission time. The PDA slide presentation application **2633** may be configured to manage decoded slides in the display processing portions of the wireless module. The wireless module may store one slide being viewed and buffer one slide (the predicted next slide) or more that are ready to be viewed. The PDA slide presentation application **2633** may work with a single user at a time. If the user changes, then any previous cached data may be flushed. Variations may be implemented to manage multiple slide caches or to allow multiple users in a single cache.

[**0110**] The PDA mirror software **2635** may also be configured to interact with client software installed on a user's PDA that is wirelessly connected to the shared display system. The PDA mirror software **2635** may be configured to receive PDA mirror data and transfer the mirror data to DSP display processing portions of the wireless module for decoding and display.

[**0111**] The laptop mirror software **2637** may be configured to interact with client software installed on a user's laptop computer that is wirelessly connected to the shared display system (such as laptop computer **125** from **FIG. 1**, for

example). The laptop mirror software **2637** may be configured to receive laptop mirror data and transfer the mirror data to DSP display processing portions of the wireless module for display. The laptop mirror data may be transmitted without compression. In various implementations, however, the laptop mirror data may be compressed prior to transmission.

[**0112**] **FIG. 27** is a block diagram of one implementation of mirroring software that may be used in a laptop computer (such as laptop computer **125** from **FIG. 1**, for example) connected to a shared display system (such as the projector **110**, for example). A laptop mirror software **2700** may be configured to run on a user's laptop computer as a client software that works in cooperation with the laptop mirror software **2637** from **FIG. 26**. The laptop mirror software **2700** may receive laptop mirror (image) data and transfers the image data to display processing portions of a wireless module of a shared display device for decoding and display. Additional features may be added such as browser, audio, video or other functions.

[**0113**] The laptop mirror software **2700** may include several components, such as a connection manager application **2710**, a mirror display driver **2720**, a network user manager **2730**, a stream buffer manager **2740**, a client connection component **2750**, and a network transport component **2760**. The laptop mirror software **2700** may be adapted to run on an operating system **2770** such as, for example, the Windows 2000® or Windows XP® operating systems, among others.

[**0114**] The connection manager application **2710** may be configured to interface with driver components to provide a user with control over a connection to the shared display system. The mirror display driver **2720** may be configured to receive or intercept display driver commands and code the commands into GDCP (Graphics Data-gram Communications Protocol) instructions under control from the connection manager application **2710**. Also under control from the connection manager application **2710**, the network user manager **2730** may provide platform independent support for user control. The client connection component **2750** may be configured as a platform-independent module that communicates with the network user manager **2730** and the mirror display driver **2720**. The client connection component **2750** may be configured to provide a client connection to the shared display device, and may accept GDCP data and wrap the GDCP data in NetDisp protocol for transmission. The network transport component **2760** may be a platform-independent module providing an abstraction of a lower level network interface for the client connection component **2750**. In one implementation, the network transport component **2760** uses a TCP/IP socket interface. Other implementations may also be used, such as interfaces that support Bluetooth® or RS-232. The laptop mirror software **2700** may also provide language localization, for example in the connection manager application **2710**.

[**0115**] **FIG. 28** is a block diagram of one implementation of PDA slide presentation software **2800** useable on a PDA (such as PDA **121** from **FIG. 1**, for example) for interfacing with a shared display device (such as the projector **110** shown in **FIG. 1**, for example). The software **2800** may also be used on other handheld devices, such as a cell phone. The software **2800** may be configured to seamlessly interface with an operating system **2870** for a handheld device. Examples of operating systems **2870** include Palm OS®, Windows CE®, Linux, and Embedded Linux. The software **2800** may be used with PDAs connected wirelessly or through wired connections to shared display systems, and may optionally be configured to interface with a hardware display adapter **2810** connected to the PDA. An example of a hardware display adapter is the Presenter-to-Go® from Margi Systems.

[**0116**] The hardware display adapter **2810** may interface with the operating system **2870**. The software **2800** may also include other components that interface with the operating system **2870**, such as a file reader **2820** for reading presentation files, a network transport component **2860** that uses a TCP/IP socket interface or other drivers (such as Bluetooth® or RS-232) to provide a wireless or wired connection to the network, and a client connection component **2850** that may receive presentation data and wrap the data in a transfer protocol for transmission, among others.

[**0117**] Components that may be associated with the hardware display adaptor **2810** include an annotator **2812** for slides that are shown through the adapter, and a slide decoder **2814** that may be used to decode presentation files. The slide decoder **2814** may be configured to parse standard-formatted presentation files, such as GIF, JPEG, text, or Microsoft PowerPoint® files, for example. Alternatively, or in addition, the file reader **2820** may be configured to decode encoded presentation files, such as files that may be stored in a compacted, compressed, or encrypted format customized for the software **2800**. The annotator **2812** may also used in conjunction with a slide preview applet **2816** on the PDA screen. A user interface **2872** may convey user instructions and information between PDA I/O interfaces and various software components, such as the operating system **2870**, the annotator **2812**, and the slide preview applet **2816**. The user interface **2872** may offer tools such as a list view **2861** (to list all slide headers for the user), a notes view **2862** (to display notes associated with each slide), and a network user control **2831** (to provide for a user's selection of security options, connection options, and other user options).

[**0118**] A slide manager **2855** may be included in the software **2800**. The slide manager **2855** may communicate with the file reader **2820** and the slide decoder **2814** to organize various presentations from which a user may choose to present to an audience through a shared display system. A network user manager **2830** may be included to implement a meeting management protocol using communication with user interface **2872**. A user preferences block **2873** and a display info block **2871** may also communicate with the user interface **2872**.

[**0119**] **FIG. 29** is a block diagram of one implementation of mirroring software **2900** that may be used on a PDA (such as PDA **121** from **FIG. 1**, for example) or other hand held computing device for interfacing with a shared display device (such as the projector **110** shown in **FIG. 1**, for example). The PDA mirroring software **2900** may be configured to run on a user's handheld computing device as a client software that works in cooperation with the PDA mirror software **2635** from **FIG. 26**. The mirroring software **2900** may be used to reproduce a display screen of the PDA onto the shared display device. The software **2900** may be

used with PDAs connected wirelessly or through wired connections to shared display systems, and may optionally be configured to interface with a hardware display adapter **2910** connected to the PDA. An operating system **2970** on the PDA may interface with the hardware display adapter **2910**. The software **2900** may also include other components that interface with the operating system **2970**, such as a network transport component **2960** that uses a TCP/IP socket interface or other drivers (such as Bluetooth® or RS-232) to provide a wireless or wired connection to the network, and a client connection component **2950** that may receive presentation data and wrap the data in a transfer protocol for transmission, among others.

[**0120**] A user interface **2972** may convey user instructions and information between PDA I/O interfaces and various software components, such as the operating system **2970** and a mirror manager **2955**. The user interface **2972** may offer tools such as a network user control **2931** to provide for a user's selection of security options, connection options, and other user options for making and managing the connection to the shared display device. A network user manager **2930** may be included to implement a meeting management protocol using communication with user interface **2972**. A user preferences block **2973** and a display info block **2971** may also communicate with the user interface **2972**.

[**0121**] The mirror manager **2955** may communicate with a display video capture block **2922** and a video encoder **2923**. The display video capture block **2922** may be configured to perform screen scraping. The scraped data may then be compressed in the video encoder **2923** using standard compression techniques such as JPEG formatting or various other standard compression techniques. Customized techniques adapted for presentation-format video may also be used. The mirror manager **2955** may be configured to receive data from the encoder **2923** and deliver the data to the network transport component **2960**. The mirror user interface **2972** may provide a user with options for the size of the screen, orientation, and other parameters to be used in configuring the shared display.

[**0122**] **FIG. 30** is a block diagram of a circuit **3000** that may be used in a shared display device, such as the projector **110** shown in **FIG. 1**, for example. The circuit **3000** may be implemented in a wireless module, such as wireless module **216** shown in **FIG. 2**, for example. Circuit **3000** includes a processor **3010**, a digital signal processor (DSP) **3020**, and a frame display manager **3030**. The processor **3010** may be an OMAP 5910 controller running Embedded Linux, for example. Various components, such as frame display manager **3030** for example, may be implemented in field programmable gate array (FGPA) circuitry.

[**0123**] The processor **3010** may include a USB host **3011**, and may be coupled to an AC97 audio DSP interface **3012**, and a flash memory **3013** holding Linux operating system software and programs. The AC97 audio DSP interface **3012** may support a microphone interface and an audio line-out to speakers **3057**. Communication interfaces may be provided to the processor **3010** and the frame display manager **3030** through a variety of interfaces **3055**, such as RJ45/Ethernet, RS232, USB, USB 2.0, and IEEE 1394, among others.

[**0124**] The DSP **3020** may include a graphics rendering and decoding section **3021**, a DSP BIOS **3022**, and DSP Drivers **3023**. The frame display manager **3030** may include a display controller **3037** that operates with an SDRAM controller **3031**, a host FIFO interface **3032**, a line buffer FIFO **3033**, and an expansion bus logic **3034**. The Expansion Bus Logic **3034** may be configured to provide interfaces to an Ethernet controller **3035** and a CompactFlash® (CF) interface **3036**. The CF interface **3036** may support two CF slots, one dedicated to wireless CF cards and the other to storage cards.

[**0125**] The Ethernet controller **3035** and the CF interface **3036** may be configured to work with the processor **3010** and the DSP **3020** so that the circuit **3000** includes the ability to receive video data from a CF memory card or from a remote file accessible through an Ethernet connection. For example the circuit **3000** may be adapted to provide a user with the ability to store a presentation on a CF card or on an Internet-accessible file, and to access and present the presentation on a display system. Thus, a user may be able to plug a CF card into a display system and issue a command to the display system to display an audiovisual presentation stored on the CF card. The command may be provided to the display system through buttons or switches on the display system, or through a user interface on a computing device connected to the display system. In addition to CF cards, the use of other memory storage media is also contemplated, such as USB memories (eg. through USB host **3011**) and other portable semiconductor memories, CD ROM's and other optical storage, or floppy disks and other magnetic storage, or other memory media. Similarly, a user may be able to issue a command to the display system to display an audiovisual presentation stored in a file or on a server or at a URL accessible through an internet connection or other network connection. The user may be able to instruct the display system to access the remotely stored audiovisual presentation, for example, through a user interface on a PDA wirelessly coupled to the display system.

[**0126**] Video data (which may include graphics, or video, or audio, or combinations thereof) may be received by a CF wireless card in the CF interface **3036** and delivered to the frame display manager **3030**, which in turn sends packets of the video data to the processor **3010** for parsing and processing. The processor **3010** parses the data and determines the content. If the content is graphics, the processor **3010** may send the graphics to the DSP **3020** for processing. If the content is encoded, the processor **3010** decodes the data and sends it to the frame display manager **3030** for display though a video interface **3052**.

[**0127**] Various memory circuits, such as ROM, RAM, SRAM, DRAM, flash, EEPROM, and the like may be provided, such as memories **3081**, **3082**, and **3083**, connected respectively to processor **3010**, DSP **3020**, and frame display manager **3030**, respectively. Memory circuits may be shared through common busses, such as for example, memory **3082**, which is shared with frame display manager **3030**. Power may be supplied to various components in circuit **3000** through a power conversion module **3059** that accepts supplied power (at 3.3 VDC or 5 VDC, for example) and provides power at voltage levels appropriate for a particular implementation (for example 3.3 VDC, 2.7 VDC, or 1,8 VDC).

[**0128**] While various embodiments of the invention have been described, it will be apparent to those of ordinary skill in the art that many more embodiments and implementations

are possible within the scope of the invention. Accordingly, the invention is not to be restricted except in light of the attached claims and their equivalents.

What is claimed is:

1. A shareable display system comprising:

a video display;

a data port configured to receive video data through a first data link with a first computing device and configured to receive video data through a second data link with a second computing device;

where at least one of the first and second data links comprise a wireless data link; and

a controller coupled to the video display and to the data port, and configured to select video data for the video display.

2. The shareable display system of claim 1, where the controller is configured to select between video data received through the first data link and video data received through the second data link.

3. The shareable display system of claim 1, where the controller is configured to arbitrate between video data received through the first and second data links in a round-table mode.

4. The shareable display system of claim 1, where the controller is configured to receive an initiate command from a first user through the first data link, where the controller is configured to receive a relinquish command from the first user, and where the controller is configured to query the first user to ignore or allow display requests from users other than the first user during a time period between receiving the initiate command and receiving the relinquish command.

5. The shareable display system of claim 1, where the controller is configured to receive an initiate command from a first user through the first data link, where the controller is configured to receive a relinquish command from the first user, and where the controller is configured to ignore users other than the first user during a time period between receiving the initiate command and receiving the relinquish command.

6. The shareable display system of claim 1, where the controller is configured to arbitrate between video data received through the first and second data links in a moderated mode.

7. The shareable display system of claim 1, where the controller is configured to select video data for the video display in response to receiving video data through any of the first or second data links.

8. The shareable display system of claim 1, where the controller is configured to respond to display commands received from any user in a predetermined set of users.

9. The shareable display system of claim 8, where the predetermined set of users includes any user transmitting display commands to the controller.

10. The shareable display system of claim 1, where the controller is further configured to test a credential of a user providing video data through the first data link, and to refuse the initiate command if the user fails the test.

11. The shareable display system of claim 10, where the test of the credential of the user comprises a password check of the user.

12. The shareable display system of claim 1, where the data port is further configured to test a credential of a user by requiring wireless encryption protection over the first data link.

13. The shareable display system of claim 1, where the first computing device operates under a first operating system, and where the second computing device operates under a second operating system different from the first operating system.

14. The shareable display system of claim 1, where the first computing device comprises a portable computer and the first data link receives high-bandwidth data from the portable computer, and where the second computing device comprises a handheld computing device and the second data link receives low-bandwidth data from the handheld computing device.

15. The shareable display system of claim 14, where the handheld computing device comprises a PDA.

16. The shareable display system of claim 14, where the handheld computing device comprises a cellular telephone.

17. The shareable display system of claim 1, further comprising a memory-card interface, where the data port is further configured to receive data from a memory card removably coupled to the memory-card interface.

18. The shareable display system of claim 1, where the first and second computing devices are notebook computers.

19. The shareable display system of claim 1, where the first and second computing devices are PDAs.

20. The shareable display system of claim 1, where the video data includes annotation instructions.

21. The shareable display system of claim 1, where the data port is further configured to receive the video data as compressed data in a plurality of compressed data formats, the shareable display system further comprising:

a memory;

a processor coupled to the memory, the video display, and the data port;

where the memory comprises:

a plurality of decompression routines usable by the processor for the plurality of compressed data formats, and

instructions for detecting a compression format of video data received through the first data link, identifying a corresponding decompression routine in the plurality of decompression routines, and decompressing video data received from the data port according to the corresponding decompression routine.

22. The shareable display system of claim 21, where the plurality of compressed data formats includes JPEG and run-length encoding.

23. The shareable display system of claim 1, where the controller is configured to receive an initiate command from the first computing device, and where the controller is configured to project a graphical interface on the video display in response to the initiate command.

24. The shareable display system of claim 1, where the controller is configured to receive an initiate command from the first computing device, and where the controller is configured to provide a graphical interface to the first computing device in response to the initiate command.

25. The shareable display system of claim 24, where the graphical interface requests entry of a password on the first computing device.

26. The shareable display system of claim 24, where the graphical interface requests entry of display information on the first computing device.

27. The shareable display system of claim 1, where the first computing device comprises a PDA unit.

28. The shareable display system of claim 1, where the second computing device comprises a laptop computer.

29. The shareable display system of claim 1, where the shareable display system comprises a video projector.

30. The shareable display system of claim 1, where the shareable display system comprises a wireless audio receiver, and where the selected video data includes compressed audio data.

31. The shareable display system of claim 1, where the shareable display system is comprised in a module configured to be removably attached to a video projector.

32. The shareable display system of claim 1, where the video display includes an interface for displaying images on the first computing device.

33. The shareable display system of claim 1, where the video display includes an interface for displaying images on the first and second computing devices.

34. The shareable display system of claim 1, where the controller comprises a processor and a memory coupled to the processor, where the memory includes computer instructions for providing video information to the video display.

35. The shareable display system of claim 1, where the first data link comprises a wireless Ethernet link from the first computing device.

36. The shareable display system of claim 1, where the first data link comprises a wired Ethernet link from the first computing device.

37. The shareable display system of claim 1, where the first data link comprises a wireless Bluetooth® link from the first computing device.

38. The shareable display system of claim 1, where video data received through the first data link includes compressed image information.

39. The shareable display system of claim 1, where video data received through the first data link includes uncompressed image information.

40. The shareable display system of claim 1, where video data received through the first data link includes compressed video information.

41. The shareable display system of claim 1, where video data received through the first data link includes uncompressed video information.

42. The shareable display system of claim 1, where video data received through the first data link includes display instructions.

43. The shareable display system of claim 1, where video data received through the first data link includes audio data.

44. The shareable display system of claim 1, where the data port is configured to interface with the first computing device so that the video display comprises an extended monitor for the first computing device.

45. The shareable display system of claim 1, where the data port is configured to interface with the first computing device so that the video display reproduces an image displayed on a local screen of the first computing device.

46. The shareable display system of claim 1, where the controller is configured to blank the video display in response to a blanking command from the first computing device.

47. The shareable display system of claim 1, where the first and second data links are formed with a network server.

48. The shareable display system of claim 1, where the first and second data links are ad-hoc links.

49. The shareable display system of claim 1, where the controller is configured to display a communications dialog interface on the first computing device.

50. The shareable display system of claim 49, where the communications dialog interface is user-configurable to include text in a native language of a user.

51. The shareable display system of claim 1, further comprising an update module configured to receive update information from a server computer through a network connection, where the update information is useable in updating the controller.

52. The shareable display system of claim 51, where the controller comprises a processor and a memory holding computer instructions for the processor, and where the update information comprises updated computer instructions.

53. The shareable display system of claim 1, further comprising an identification module coupled to the data port and configured to identify the first and second computing devices.

54. The shareable display system of claim 1, further comprising an identification module coupled to the data port and configured to identify users of the first and second computing devices.

55. The shareable display system of claim 54, where the identification module includes a memory comprising identifying characteristics of the first and second computing devices.

56. The shareable display system of claim 54, where the identification module includes an interface to a data file accessible through a computer network, where the data file comprises identifying characteristics of the first and second computing devices.

57. A shareable display system comprising:

a video display; and

a controller coupled to the video display and configured to control images presented on the video display;

where the controller is configured to receive display instructions from a plurality of computing devices;

where the controller is configured to arbitrate between display instructions received from two or more of the computing devices.

58. The shareable display system of claim 57, where the controller is configured to arbitrate between display instructions received from two or more of the computing devices in a self-serve mode.

59. The shareable display system of claim 57, where the controller is configured to arbitrate between display instructions received from two or more of the computing devices in a roundtable mode.

60. The shareable display system of claim 57, where the controller is configured to arbitrate between display instructions received from two or more of the computing devices in a moderated mode.

61. The shareable display system of claim 57, where the controller is configured to receive an initiate command from a first computing device, where the controller is configured to receive a relinquish command from the first computing device, and where the controller is configured to ignore computing devices other than the first computing device during a time period between receiving the initiate command and receiving the relinquish command.

62. The shareable display system of claim 57, where the controller is configured to receive an initiate command from a first computing device, where the controller is configured to receive a relinquish command from the first computing device, and where the controller is configured to query the first computing device to ignore or allow display requests from computing devices other than the first computing device during a time period between receiving the initiate command and receiving the relinquish command.

63. The shareable display system of claim 57, where the controller is configured to immediately respond to display instructions received from any of the two or more computing devices.

64. The shareable display system of claim 57, where the controller is configured to respond to display commands received from any computing device in a predetermined set of computing devices.

65. The shareable display system of claim 57, where the predetermined set of computing devices includes any computing device transmitting display commands to the controller.

66. The shareable display system of claim 57, where the controller is configured to receive display instructions through a plurality of wireless connections from one or more computing devices in the plurality of computing devices.

67. The shareable display system of claim 57, where the controller is further configured to test a credential of a computing device providing display instructions, and to refuse the initiate command if the computing device fails the test.

68. The shareable display system of claim 57, where the controller is further configured to test a credential of a computing device by requiring wireless encryption protection for communications with the computing device.

69. The shareable display system of claim 57, where a first computing device in the plurality of computing devices operates under a first operating system, and where a second computing device in the plurality of computing devices operates under a second operating system different from the first operating system.

70. The shareable display system of claim 57, further comprising a memory-card interface coupled to the controller, where the controller is further configured to receive data from a memory card removably coupled to the memory-card interface.

71. The shareable display system of claim 57, where the computing devices include one or more notebook computers.

72. The shareable display system of claim 57, where the computing devices include one or more PDAs.

73. The shareable display system of claim 57, further comprising:

a data port configured to receive the display instructions comprising compressed video data in a plurality of compressed data formats;

a memory;

a processor coupled to the memory, the video display, and the data port;

where the memory comprises:

a plurality of decompression routines usable by the processor for the plurality of compressed data formats, and

instructions for detecting a compression format of received video data, identifying a corresponding decompression routine in the plurality of decompression routines, and decompressing video data according to the corresponding decompression routine.

74. The shareable display system of claim 57, where the controller is configured to receive an initiate command from a computing device in the plurality of computing devices, and where the controller is configured to project a graphical interface on the video display in response to the initiate command.

75. The shareable display system of claim 57, where the controller is configured to receive an initiate command from a first computing device in the plurality of computing devices, and where the controller is configured to provide a graphical interface to the computing device in response to the initiate command.

76. The shareable display system of claim 75, where the graphical interface requests entry of a password on the first computing device.

77. The shareable display system of claim 75, where the graphical interface requests entry of display information on the first computing device.

78. The shareable display system of claim 57, where the shareable display system comprises a video projector.

79. The shareable display system of claim 57, where the shareable display system comprises a wireless speaker system, and where the selected video data includes uncompressed audio data.

80. The shareable display system of claim 57, where the shareable display system is comprised in a module configured to be removably attached to a video projector.

81. The shareable display system of claim 57, where the video display includes an interface for displaying images on one or more computing devices in the plurality of computing devices.

82. The shareable display system of claim 57, where the controller is configure to receive display instructions through a wireless Ethernet link from one or more of the computing devices.

83. The shareable display system of claim 57, where the controller is configure to receive display instructions through a wired Ethernet link from one or more of the computing devices.

84. The shareable display system of claim 57, where the controller is configure to receive display instructions through a wireless Bluetooth® link from one or more of the computing devices.

85. The shareable display system of claim 57, where the display instructions comprise compressed image information.

86. The shareable display system of claim 57, where the display instructions comprise uncompressed image information.

87. The shareable display system of claim 57, where the display instructions comprise compressed video information.

88. The shareable display system of claim 57, where the display instructions comprise uncompressed video information.

89. The shareable display system of claim 57, where the controller is configured to interface with a first computing device among the plurality of computing devices so that the video display comprises an extended monitor for the first computing device.

90. A system comprising:

a memory;

a local display screen;

a data port; and

a processor coupled to the memory, the local display screen, and the data port;

where the memory comprises instructions to the processor for transmitting a first set of video data to the local display screen;

where the memory further comprises instructions to the processor for transmitting a second set of video data through the data port to a remote display unit;

where the memory further comprises instructions to the processor for constructing the second set of video data as an extended monitor of the local display screen.

91. The shareable display system of claim 90, where the data port is configured to communicate with the remote display unit through a wireless Ethernet link.

92. The shareable display system of claim 90, where the data port is configured to communicate with the remote display unit through a wired Ethernet link.

93. The shareable display system of claim 90, where the data port is configured to communicate with the remote display unit through a wireless Bluetooth® link.

94. The shareable display system of claim 90, where the second set of video data comprises compressed image information.

95. The shareable display system of claim 90, where the second set of video data comprises uncompressed image information.

96. The shareable display system of claim 90, where the second set of video data comprises compressed video information.

97. The shareable display system of claim 90, where the second set of video data comprises uncompressed video information.

98. The shareable display system of claim 90, where the instructions to the processor for transmitting the second set of video data through the data port to the remote display unit comprise instructions to update a changed section of a displayed image.

99. The shareable display system of claim 90, where the instructions to the processor for transmitting the second set of video data through the data port to the remote display unit comprise graphics instructions.

100. The shareable display system of claim 90, where the instructions to the processor for transmitting the second set of video data through the data port to the remote display unit comprise trapped graphics instructions.

101. The shareable display system of claim 90, where the instructions to the processor for transmitting the second set of video data through the data port to the remote display unit comprise font information.

102. The shareable display system of claim 90, where the instructions to the processor for transmitting the second set of video data through the data port to the remote display unit comprise text rendering instructions.

103. A method of communicating between at least one wireless device and at least one display device, comprising the acts of:

providing a wireless protocol;

transmitting data from the wireless device to the display device using the wireless protocol; and

displaying on the display device an image corresponding to the transmitted data.

104. The method of claim 103, further comprising the act of selecting one of a plurality of user modes of the display device.

105. The method of claim 104, wherein the modes include self-server, roundtable, and moderator.

106. The method of claim 105, there being a plurality of wireless devices in communication with the display device; and further comprising the act of selecting one of the wireless devices to transmit data to the display device.

107. The method of claim 103, wherein there is a plurality of display devices in communication with the wireless device, and further comprising the act of determining which of the display devices are capable of displaying images transmitted by the wireless protocol.

108. The method of claim 103, further comprising the act of logging onto the display device from the wireless device.

109. The method of claim 108, further comprising the act of logging onto a list of users for the display device.

110. The method of claim 103, there being a plurality of wireless devices in communication with the display device; and further comprising the act of selecting one of the wireless devices to transmit data to the display device.

111. The method of claim 103, wherein the image comprises a graphic or video.

112. The method of claim 103, further comprising the acts of moving a location indicator on a display of the wireless device; transmitting an indication of the movement to the display device; and displaying the indication of the movement on the display device.

113. The method of claim 112, there being a plurality of wireless devices in communication with the display device; and further comprising the act of selecting one of the wireless devices to transmit data to the display device.

114. The method of claim 103, further comprising the acts of annotating an image displayed on the wireless device; transmitting the annotation to the display device; and displaying the annotation on the display device.

115. The method of claim 114, there being a plurality of wireless devices in communication with the display device; and further comprising the act of selecting one of the wireless devices to transmit data to the display device.

116. The method of claim 103, there being at least one additional wireless device in communication with the display device, and further comprising the act of transmitting the image from the display device to the additional display device.

117. The method of claim 103, wherein the wireless device comprises a computer device, and further comprising the act of displaying the image corresponding to the data on the computer device prior to transmitting the data to the display device.

118. The method of claim 117, wherein the computer devices comprise one of a desktop computer, a laptop computer, and a personal digital assistant.

119. The method of claim 103, there being a plurality of wireless devices in communication with the display device, further comprising at least one of the acts of:

transmitting commands from one of the wireless devices to the display device;

transmitting the transmitted data in a compressed format; and

controlling the display device from one of the wireless devices.

120. Apparatus adapted to connect to a display for communicating between at least one source of a wireless signal and the display via a wireless protocol, the apparatus comprising;

a wireless circuit which receives the wireless signal conforming to the wireless protocol;

a display circuit which receives data and thereby drives the display; and

a processor coupled between the wireless circuit and the display circuit, wherein the apparatus displays on the display an image corresponding to data in the wireless signal.

121. The apparatus of claim 120, wherein the image comprise a graphic or video.

122. The apparatus of claim 120, wherein there is a plurality of display devices in communication with a wireless device, and further comprising means for determining which of the display devices are capable of displaying images transmitted by the wireless protocol.

123. The apparatus of claim 122, further comprising means for logging onto the display device from a wireless device.

124. The apparatus of claim 122, further comprising means for logging onto a list of users for the display device.

125. The apparatus of claim 122, there being a plurality of wireless devices in communication with the display device; further comprising means for selecting one of the wireless devices to transmit data to the display device.

126. The apparatus of claim 122, the wireless device having a movable location indicator on its display, and further comprising:

means for receiving an indication of the location indicator movement at the display device; and

means for displaying the indication of the movement on the display device.

127. The apparatus of claim 126, there being a plurality of wireless devices in communication with the display device; further comprising means for selecting one of the wireless devices to transmit data to the display device.

128. The apparatus of claim 122, the wireless device having an annotation of a displayed image, and further comprising:

means for receiving the annotation at the display device; and

means for displaying the annotation on the display device.

129. The apparatus of claim 128, there being a plurality of wireless devices in communication with the display device; further comprising means for selecting one of the wireless devices to transmit data to the display device.

130. The apparatus of claim 122, further comprising means for selecting one of a plurality of user modes of the display device.

131. The apparatus of claim 130, wherein the modes include self-server, roundtable, and moderator.

132. The apparatus of claim 131, there being a plurality of wireless devices in communication with the display device; further comprising means for selecting one of the wireless devices to transmit data to the display device.

133. The apparatus of claim 122, there being at least one additional wireless device in communication with the display device, and further comprising means for transmitting the image from the display device to the additional display device.

134. The apparatus of claim 122, wherein the wireless device comprises a computer device, and further comprising means for displaying the image corresponding to the data on the computer device prior to transmitting the data to the display device.

135. The apparatus of claim 134, wherein the computer device comprises one of a desktop computer, a laptop computer, and a personal digital assistant.

136. The apparatus of claim 122, there being a plurality of wireless devices in communication with the display device, further comprising at least one of:

means for receiving commands from one of the wireless devices at the display device;

means for receiving the transmitted data in a compressed format; and

means for controlling the display device from one of the wireless devices.

137. Apparatus adapted to transmit a wireless signal to a display device via a wireless protocol, comprising:

a computer device which displays an image on its display; and

a mirror module which receives the image and converts it for transmission to the display device.

138. The apparatus of claim 137, wherein the computer device comprises one of a PDA or computer.

139. A shareable display system comprising:

a presentation device; and

a controller coupled to the presentation device and configured to control a presentation on the presentation device;

where the controller is configured to receive presentation instructions from one or more of: a file located on a memory device removably coupled to the controller or a file accessible to the controller through a network connection.

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