EMERGENCY RADIO COMMUNICATIONS SYSTEM INCORPORATING INTEGRAL PUBLIC SAFETY RADIO BRIDGING CAPABILITY

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ABSTRACT

A communication system and method is provided for handling emergencies wherein public safety radios are used to directly communicate with normally incompatible radios used by organizations such as schools.

The system includes a radio communication bridge that is selectively activated by emergency personnel to contact an organization undergoing an emergency. The bridge is activated via a TCP/IP command over an IP network or alternatively sent by a pre-programmed digital radio.

Computer software or firmware at communication endpoints, emergency responder locations, and at an emergency call center facilitates functionality of the system to include emergency notifications, dissemination of information associated with a particular emergency, and the status of the system to include activation and deactivation of the radio bridge.

FIELD

The present invention relates to communication systems incorporating multiple communication modes, and more particularly, to an emergency communication system for bridging incompatible radio communication elements.

BACKGROUND

Many organizations have internal radio systems to manage day-to-day operations to include organization security.

Various staff or security personnel may be equipped with radios enabling basic two-way communications between personnel.

For many years, emergency or first responders such as law enforcement and fire departments have used radios for communications.

Because of the required range and necessity for reliability, government officials communicating by radio are typically equipped with highly advanced radio systems that are unable to directly communicate with the less complex radio systems used by organizations.

When there is an emergency incident occurring at an organization, the standard method to contact emergency responders is by a telephone call to 911.

A 911-call center is able to obtain the location of the caller in order to dispatch emergency responders.

However, emergency responders have no direct means of radio communication with personnel located at the emergency location.

Regardless of the nature of the incident and the identity of the emergency responders, it is very difficult for organizational personnel to directly speak with the responders prior to the responders arriving at the location.

Many emergency situations are time critical and the ability for organizational personnel to provide instantaneous information as to the status of the emergency can make the difference between emergency responders properly handling the situation as opposed to such responders not having adequate information, and the emergency situation then turning into a tragedy.

No matter the type of emergency situation, the ability to provide accurate and timely information by those directly affected by the emergency situation often results in a more complete and rapid response by emergency responders.

Emergency responders typically have two-way radios installed in their vehicles to allow rapid and reliable communication between these emergency responders and their dispatch center or PSAP to control and coordinate their emergency actions.

Many police officers and firemen also carry hand held radios that operate on the same radio system.

Because of the necessity to ensure that emergency responders have the ability to communicate with one another, Federal regulations limit the types of organizations that may operate on the same frequency bands as emergency personnel.

As mentioned above with respect to organizations who use two-way radio systems for daily operations, these radio systems are not able to communicate with emergency radio systems since each operate on very distinct frequencies, and the nature of the RF signals produced during the communications are very different.

Therefore, other than the 911 telecommunications, affected personnel at the organization cannot communicate with emergency responders until they arrive at the scene.

Therefore, there is a need for a system and method whereby direct communications can be facilitated between emergency responders and affected organizational personnel during emergency situations.

Additionally, there is need to provide a communication system where organizations can avoid the expense of purchasing more sophisticated and expensive radio communication systems, and the ability to directly communicate with emergency personnel can be on a selective and controlled basis.

Additionally, there is a need to provide a communication system that may timely inform a network or group of organizations regarding an emergency situation coupled with the ability of a 911 call center to select which organizations within the group can directly communicate with selected emergency response personnel.

SUMMARY

In accordance with the present invention, a communication system and method is provided for handling emergency situations wherein complex public safety radio systems can be used to directly communicate with normally incompatible radio systems used by organizations such as schools, hospitals, and other large independent facilities.

The system of the present invention includes a radio communication patch or bridge that is selectively activated by emergency personnel to contact one or more selected organizations.

In a preferred embodiment of the present invention, the communication system further includes a communication network, such as a local area network (LAN) or a group of LANs and a high speed interconnecting network such as the Internet.

Activation and deactivation of the bridge is achieved over the LAN(s).

A computer server may be located at one of several locations such as at a 911 call center, school district headquarters, or school district security center.

This server is used to monitor and control the emergency communication system with one or more communication endpoints that are linked to the server.

Each of the communication endpoints, such as separate schools, each have an IP address that allows them to be connected over the network(s) by the server.

Each of the communication endpoints also has their own local two-way radio system and a communication patch or bridge device that is activated or enabled by IP commands over the network(s).

Activation of the bridge is typically prompted by a 911 call by the affected organization at the communication end point.

The 911-call center then evaluates the particular emergency, and can selectively activate over the network(s) the radio bridge.

Once the bridge is activated, personnel located at the communication end point can then directly communicate with the emergency responders who have been dispatched and who are operating their radios on the public safety radio system.

The local radios at the communication endpoints operate on their normal frequency/channel and once the bridge is activated then the local radios are automatically merged with the public safety radio channel or talk group.

When the bridge is deactivated, the radios cease to operate on the public safety radio frequency/channel and are automatically returned to their normal channel operation.

Functionality of the system is achieved through computer software or firmware installed at the 911-call center, at the location of the emergency responders, and at each communication end point.

This software/firmware is used to facilitate a number of functions to include a communication tool wherein upon notification of an emergency, emergency instructions can be conveyed to each of the communication endpoints.

A user having the requisite bridge activation/deactivation authority can control the communications bridge(s) established as well as emergency instructions.

These instructions can be conveyed in the form of email messages coupled with audio and/or visual alarms that are triggered by designated types of email messages.

Two particular features of the system include a Channel Take Over feature and an Audio Detect feature.

Bridging remote radio systems will always give rise to simultaneous radio frequency (RF) collisions or interferences caused by the simultaneous transmission of messages by radio users at separate locations.

Such collisions are common, particularly in larger public safety systems, sometimes referred to wide area systems.

Since radio users at remote locations are unable to see the physical actions of other parties who may be on the same bridged radio network, the RF collisions can disrupt meaningful communications for significant time periods.

With some radio etiquette training, to include use of proper call announcements and acknowledgments, more successful communication exchanges can be conducted over wide area systems.

The determination of which radio user may transmit and which radio user may listen at any particular time is normally a function of the first party to transmit.

Most two-way radio systems carry specifications for transmitter “up time” and receiver sensitivity.

These radio specifications are usually measured in milliseconds, and determine which user is able to transmit; accordingly all the other users on the channel at that time are forced to listen.

For example, if ten radio users are on a particular radio channel and one user presses the transmitter button on their radio first while there is at least some incremental break in transmissions from other users, then the other nine users are unable to transmit and are forced to listen to the first user’s radio transmission.

Despite using proper radio protocol, wide area systems may be much more prone to continual RF collisions.

These collisions can complicate efforts of dispatchers and emergency responders to effectively communicate with local radio users.

While wide area systems have the capability to bridge a great number of remote locations, as large as a city, county, or entire state, there are resulting performance impacts that degrade the ability to prevent RF collisions.

Specifically, there is degradation in overall system recognition of first to transmit signals, thereby resulting in additional occurrences of RF collisions.

One can also appreciate that in an emergency situation, even the most trained radio users may not perform proper radio protocol, resulting in very inefficient radio communication in which RF collisions significantly impede the ability for timely and clear communications.

Therefore, there is a need to provide a solution, particularly for wide area systems, to reduce RF collisions.

The Channel Take Over feature of the present invention provides a solution to this RF collision or interference problem.

The Channel Take Over feature involves a password controlled feature for each remote user interface or selected remote user interfaces.

When activated, this feature will detach or disengage the bridge function at any or all selected locations for a pre-determined period of time, such as measured in seconds.

The user who activates this feature will then have this pre-determined period of time or take over period to begin transmitting, and during which time will lead the flow of communications over the radio network.

Accordingly, all previously bridged users will be required to listen to the transmission during the takeover period.

However, the Channel Take Over feature cannot detach or disengage a user with an analog type radio transmitter who may be transmitting simultaneous with activation of the Channel Take Over feature.

In this instance, in order to interrupt and takeover the previously transmitting remote radio location, the system of the present invention selectively generates a much higher power radio signal from the user activating the Channel Take Over feature, thereby instantly causing interference with the previously transmitting radio user until the user ceases transmitting and starts receiving.

With respect to the Audio Detect feature, a user interface screen may provide the user with a visual indication as to which particular remote location is transmitting at that time.

For example, an icon can be displayed next to the listing of the remote location, and indicating whether or not radio transmissions are occurring.

The user interface screen may also display which location is asserting its Channel Take Over authority at any particular time.

With the Channel Take Over and Audio Detect features, not only is some hierarchy or priority provided for users such as dispatch centers or emergency responders, but a visual user interface is provided to all users within the system which will inherently assist in managing the flow of radio communications to prevent unnecessary radio transmissions.

Another feature of the invention includes tracking and evaluating radio communications at selected communication endpoints to determine whether personnel at the communication endpoint are effectively utilizing the communication system.

This tracking feature is enabled by the Audio Detect feature in which an administrator or evaluator of the communication system may wish to evaluate the performance of personnel at a selected communication endpoint.

The tracking feature is selectively enabled or disabled for any communication endpoint in the system, and the information recorded includes the frequency and length of radio transmissions occurring at the selected communication endpoints.

One example of how this recorded information can be used is for purposes of certifying the level of proficiency of personnel associated with a particular communication endpoint.

More specifically, a communication endpoint may typically include a school location, and it may be desirable to certify whether the personnel at the school location are proficient in the use of the communication system, as well as to determine whether their particular safety protocol at the school location complies with local safety guidelines or regulations.

By evaluating the frequency and length of individual radio transmissions occurring at the communication endpoint, an administrator or evaluator can make some conclusions regarding the overall competency level of the personnel, as well as the safety protocol of the location.

According to one embodiment of the invention, an administrator of a central communications server, such as a server located at the local or district security center, has the capability to select desired communication endpoints for recording of the radio transmissions.

The data is recorded and analyzed to determine the proficiency and/or competency of the personnel and the overall performance of the particular school location being evaluated.

According to yet another embodiment of the invention, control for activating selected features of the invention may be achieved by a separate digital radio network in which selected emergency responders and school personnel may communicate over this dedicated network, but a primary purpose of this network is to enable emergency responders to send a digital RF signal as another means to control the system.

During crisis events, it is well known that an IP network may quickly become overburdened which can significantly slow down messaging.

Further, an event occurring that may not be connected to the crisis at hand can still create a communication problem.

Accordingly, while an IP network may be a reliable communication method in most circumstances, providing a redundant two-way digital radio communication network adds capabilities to the system that ensures timely communications can be conducted under any circumstance.

One particular digital radio protocol that can be used in the present invention is the Digital Mobile Radio protocol (DMR).

Considering the above features of the invention, in one aspect, it may be considered a communication system especially adapted for facilitating emergency communications between communicants having respective radio systems, said system comprising:

- first and second computer processors located at respective communication endpoints;
- a communication server for managing communications between the communication endpoints;
- an IP communications network for interconnecting said communications server and said computer processors, said server and each of said computer processors having respective IP addresses;
- at least one public safety radio associated with one of said communication endpoints;
- at least one local radio associated with the other of said communication endpoints;
- at least one pre-programmed digital radio associated with said communication endpoints and operating on a different channel than said at least one public safety radio and said at least one local radio;
- a radio bridge for facilitating direct radio communications between said at least one public safety radio and said local radio, said radio bridge including hardware to enable connection between the radios, said bridge further including a processor that communicates with said server to receive activation and deactivation instructions sent from an authorized user, said instructions being sent as IP packets over the communications network;
- a digital radio module incorporated with said hardware of said radio bridge, said module providing a capability to control said radio bridge by an RF signal received from said at least one pre-programmed digital radio;
- computer coded instructions associated with said server and said computer processors to selectively control and monitor the system to include
    - activation and deactivation of said radio bridge as controlled by said first computer and to prevent activation and deactivation control at said communication endpoint associated with the at least one local radio, and
    - to produce visual displays on respective user interfaces of said first and second computers; and wherein said visual displays include an indication of whether a radio bridge has been activated or deactivated by said at least one pre-programmed digital radio.

According to another aspect of the invention, it may be considered a method of communicating radio transmissions between communicants having respective radios, said method comprising:

- providing a radio bridge for facilitating direct radio communications between at least one public safety radio and a local radio, said radio bridge including hardware to enable connection between the radios, said bridge further including a computer processor that communicates with a communications server to receive activation and deactivation instructions sent from an authorized user,

- said instructions being sent as IP packets over a communications network of which said public safety radio and local radio are incorporated in;

- providing a digital radio module incorporated with said hardware of said radio bridge, said module providing a capability to alternatively control said radio bridge by an RF signal received from said at least one pre-programmed digital radio that operates on a different channel than said at least one local radio;

- providing computer coded instructions associated with said communications server and said computer processor to selectively control and monitor communications including activation and deactivation of said radio bridge, and to prevent activation and deactivation control at a location associated with said at least one local radio or said at least one pre-programmed digital radio;

- and generating an indication on a user interface of said radio bridge showing activation or deactivation of said radio bridge by said at least one local radio or said at least one pre-programmed digital radio as associated with one or more communication endpoints.

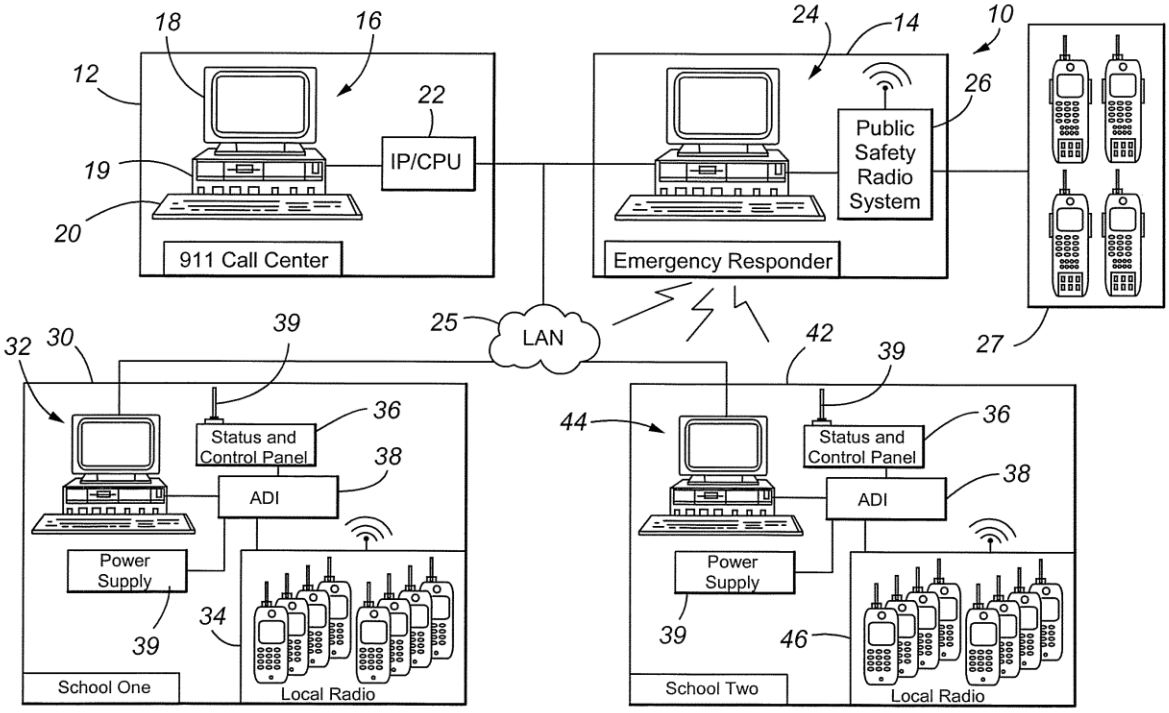

Fig. 1

Figure 1 illustrates a schematic diagram depicting the primary elements of the system of the present invention.

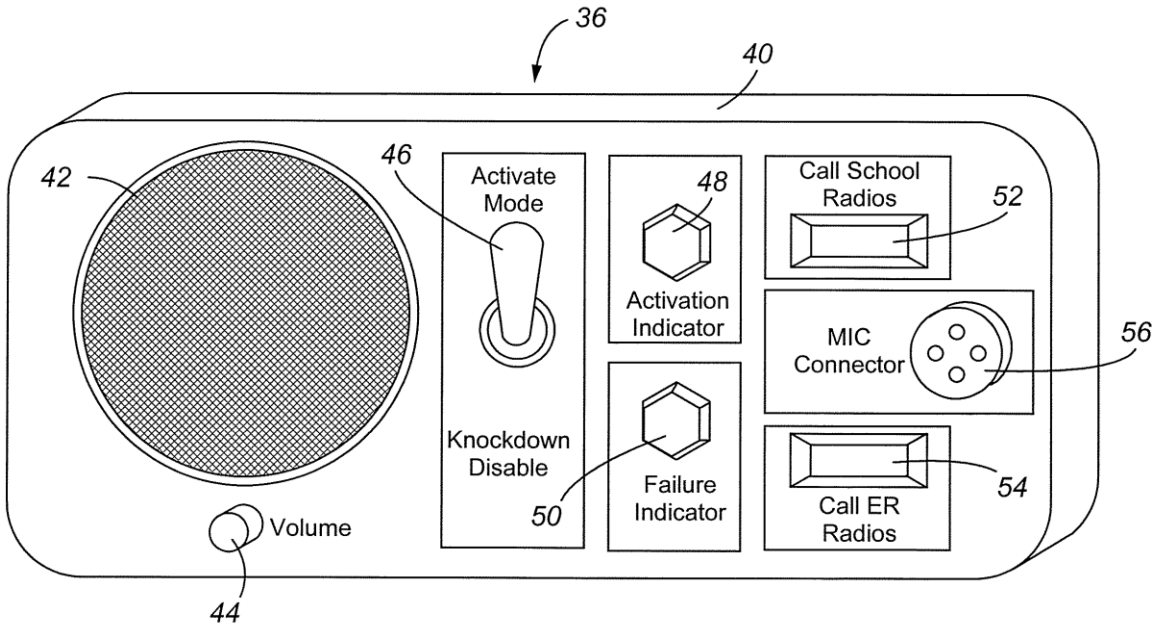

Fig. 2

Figure 2 is a schematic diagram of a sample local control panel installed at a communication endpoint that can be used to facilitate communications in the system of the present invention.

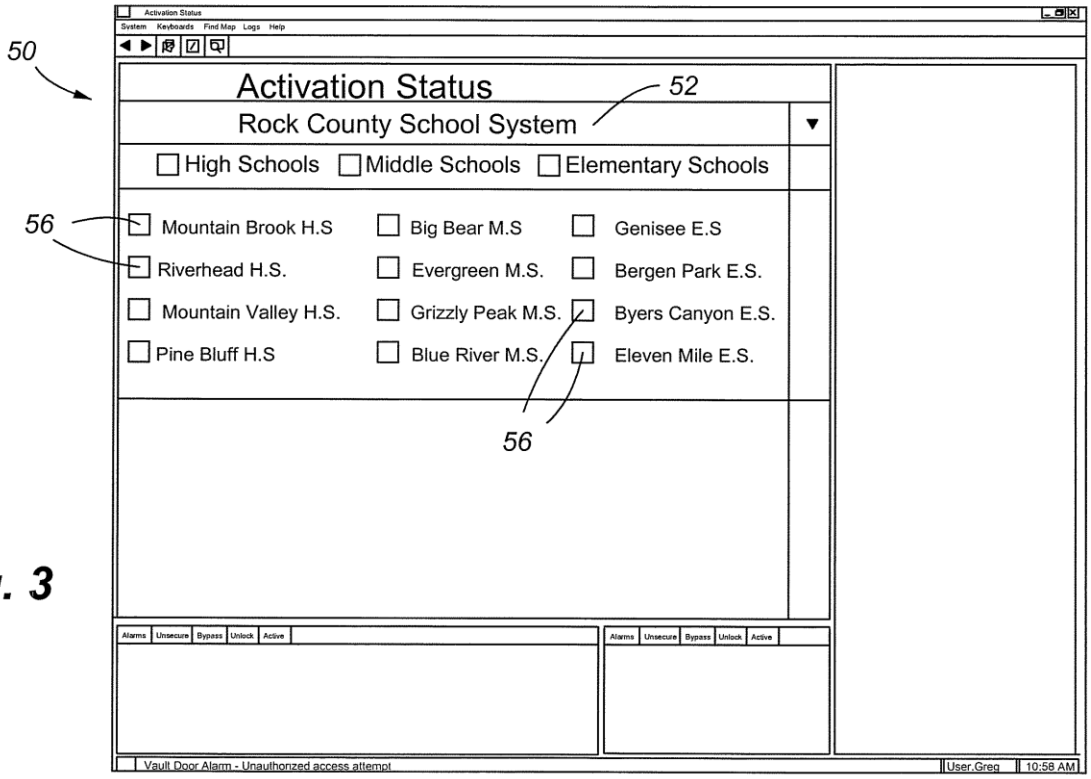

Fig. 3

Figure 3 is an example user interface screen associated with a computer processor having firmware or software that incorporates the functionality of the present invention.

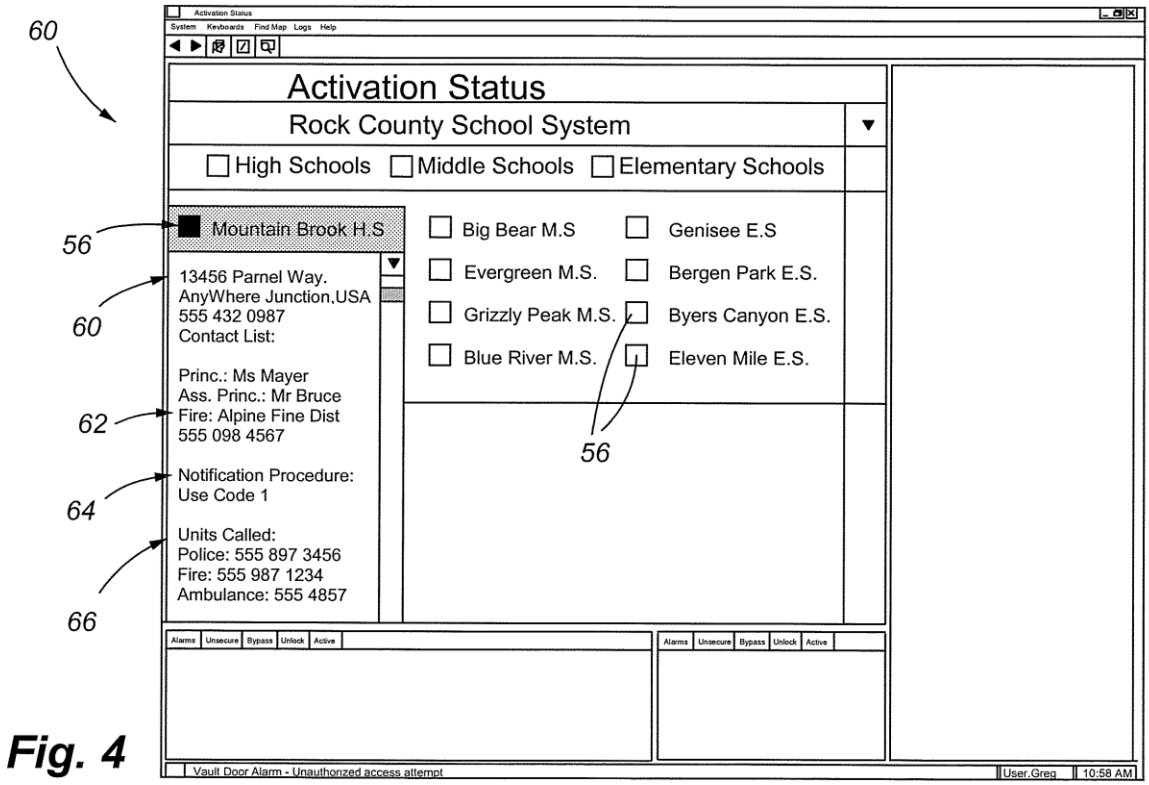

Fig. 4

Figure 4 is another user interface screen illustrating functionality with respect to activation of the radio bridge.

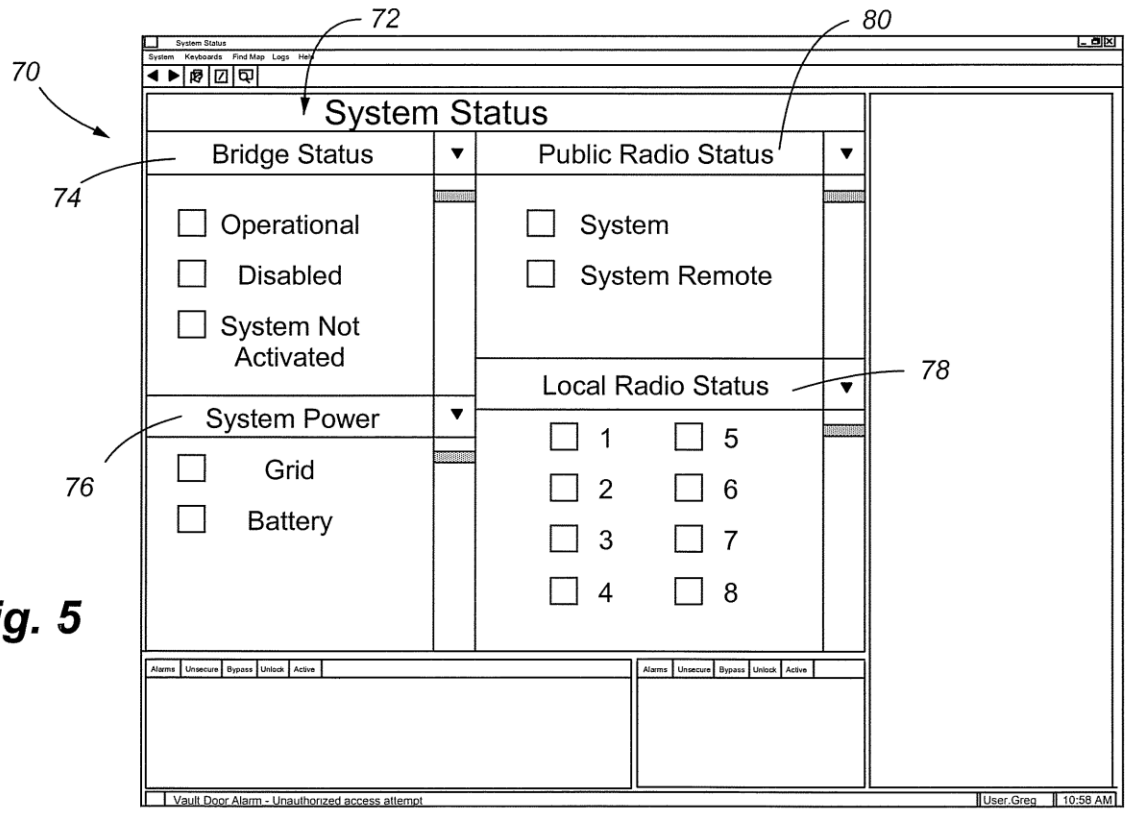

Fig. 5

Figure 5 is another sample user interface screen, but illustrating functionality with respect to a system status.

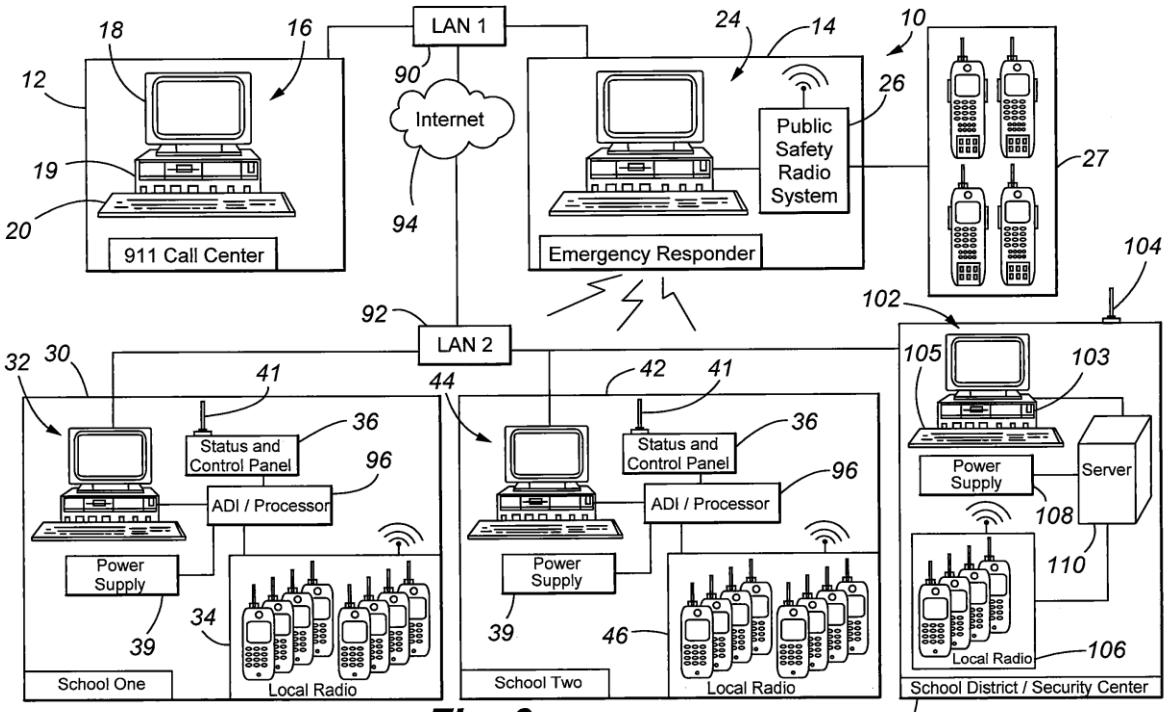

Fig. 6

Figure 6 is another schematic diagram depicting the primary elements of the system of the present invention in another embodiment.

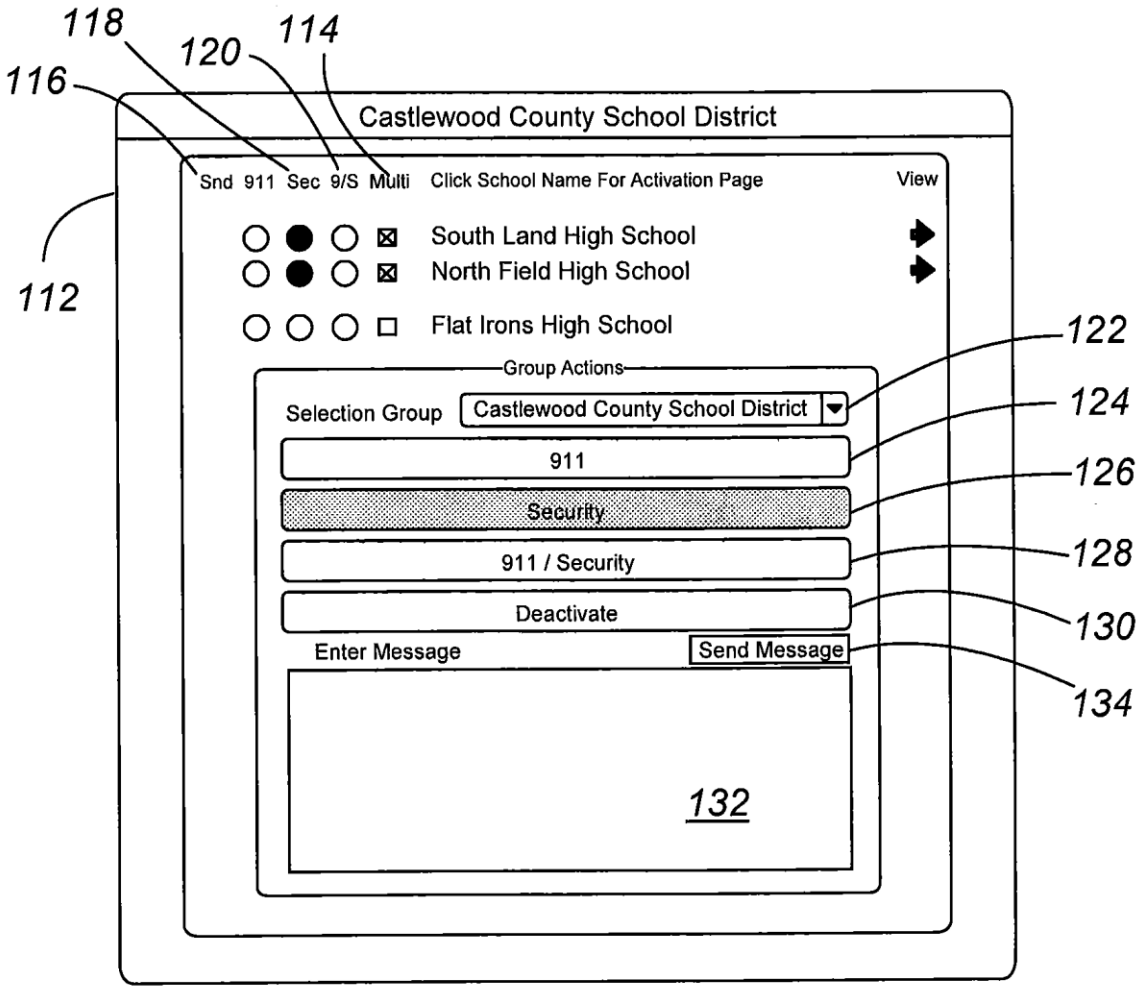

Fig. 7

Figure 7 is another example user interface screen associated with the present invention, namely, a school district activation screen.

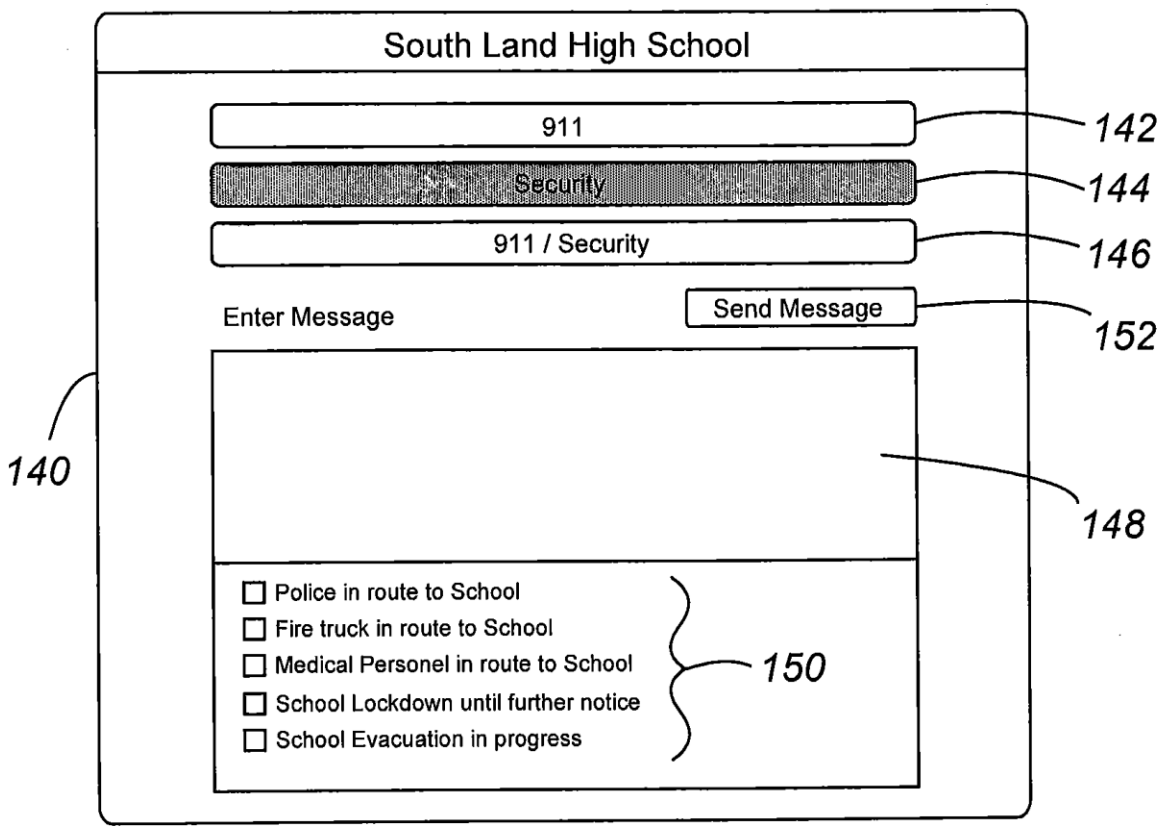

Fig. 8

Figure 8 is another user interface screen, namely, a school activation screen.

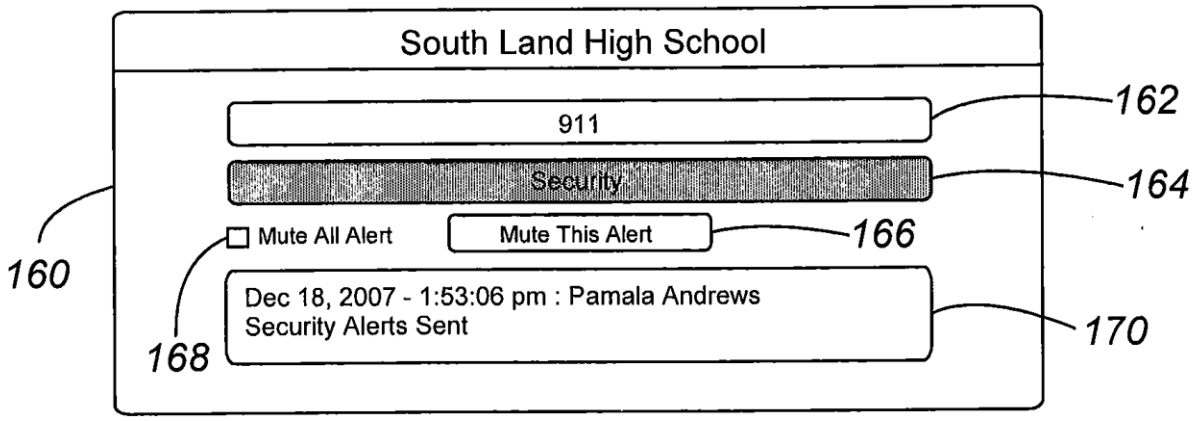

Fig. 9

Figure 9 is another example user interface screen, namely, a school notification screen.

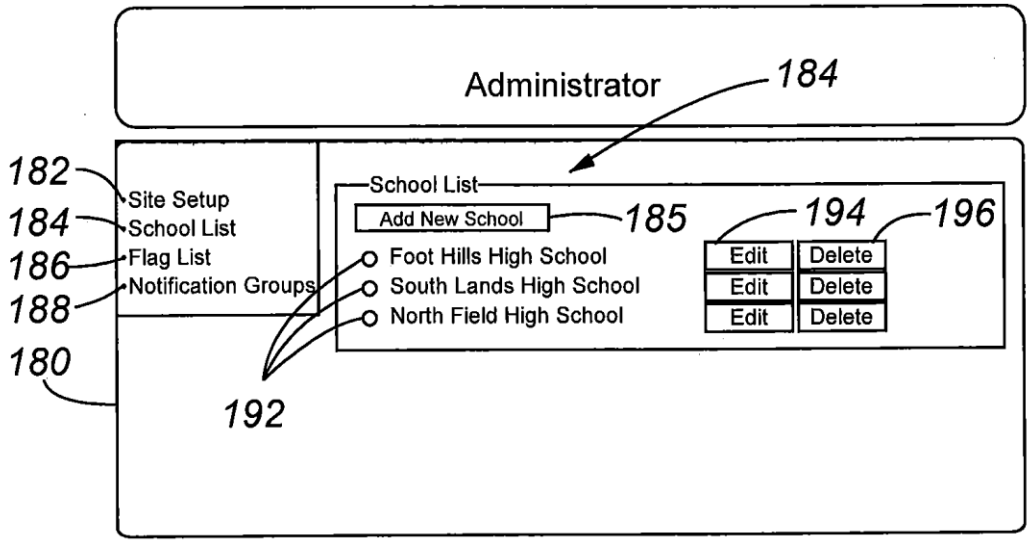

Fig. 10

Figure 10 is another user interface screen, namely, an administrator screen allowing the setup of various communication endpoints within the system, such as schools in a particular school district.

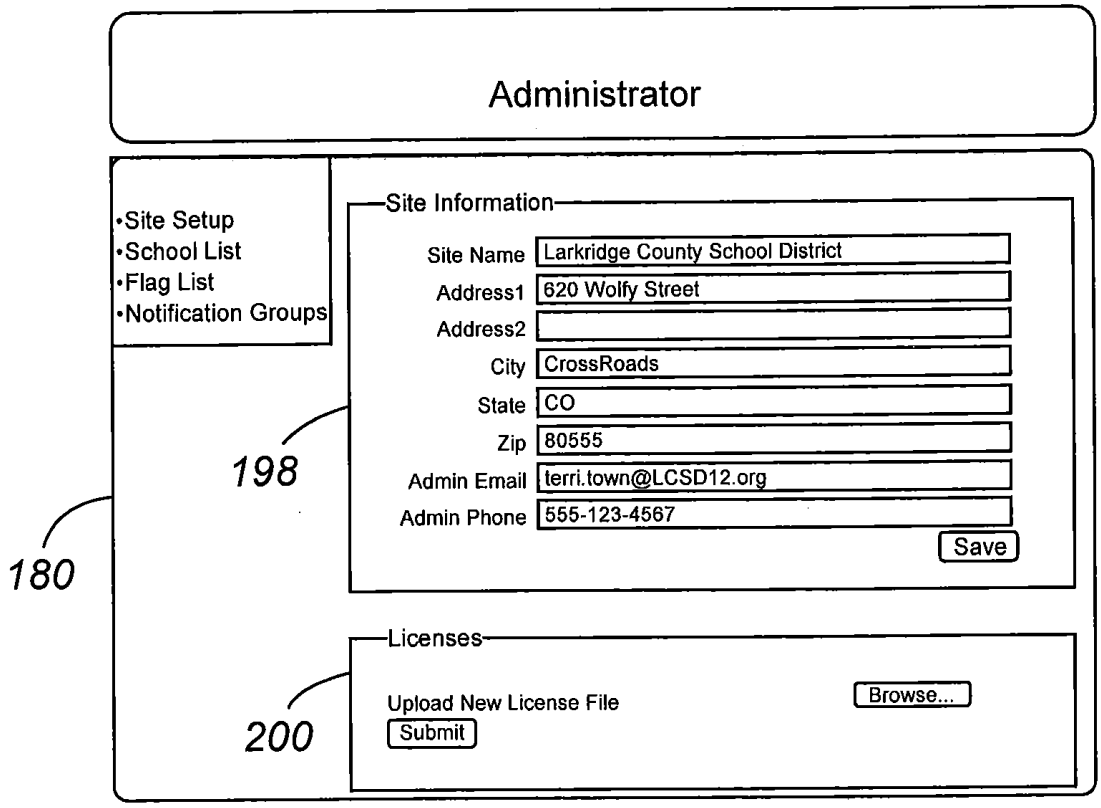

Fig. 11

Figure 11 is another user interface screen, namely, an administrator screen that is used to establish records for a particular school within the communications system.

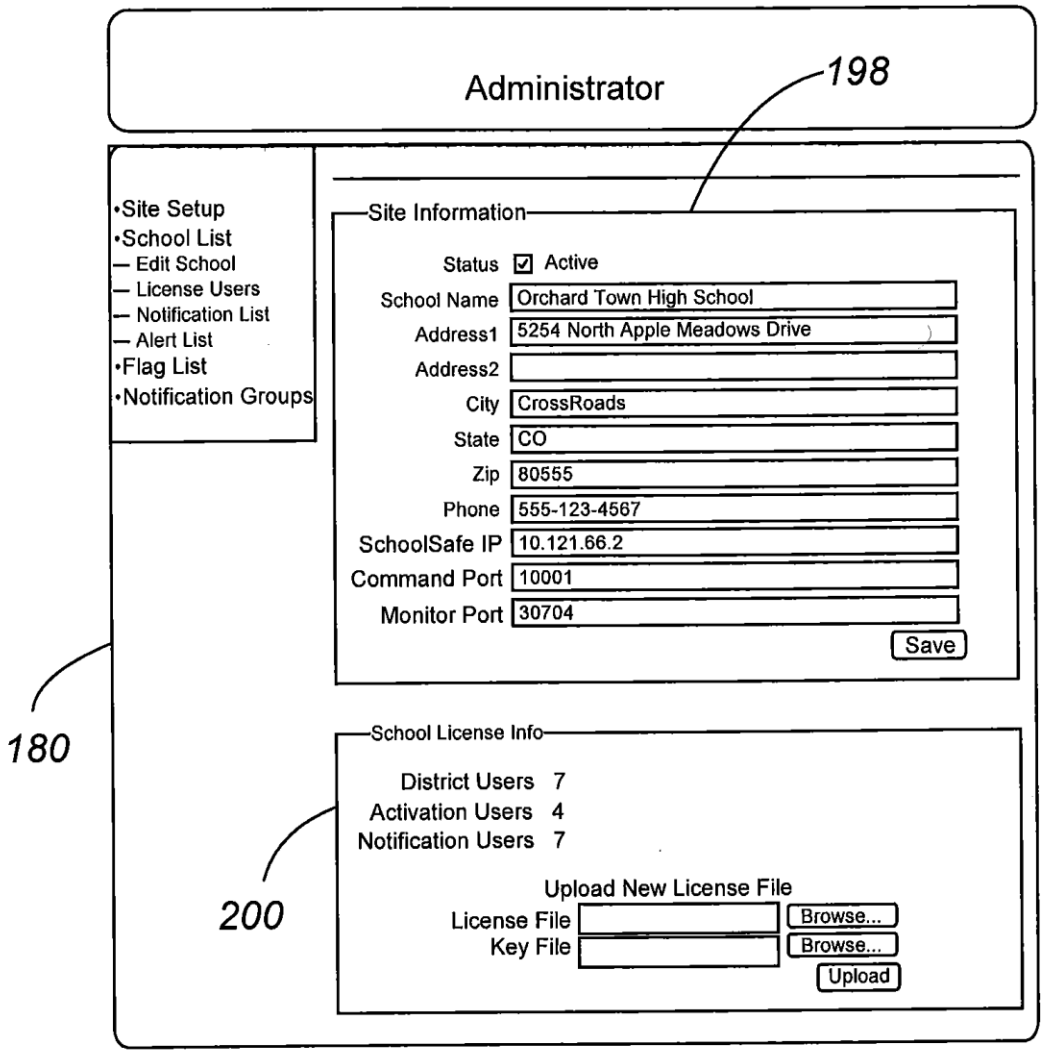

Fig. 12

Figure 12 is yet another user interface screen, namely, an administrator screen allowing necessary information for establishing a school as a communication endpoint within the system to include IP address information, and software user licenses.

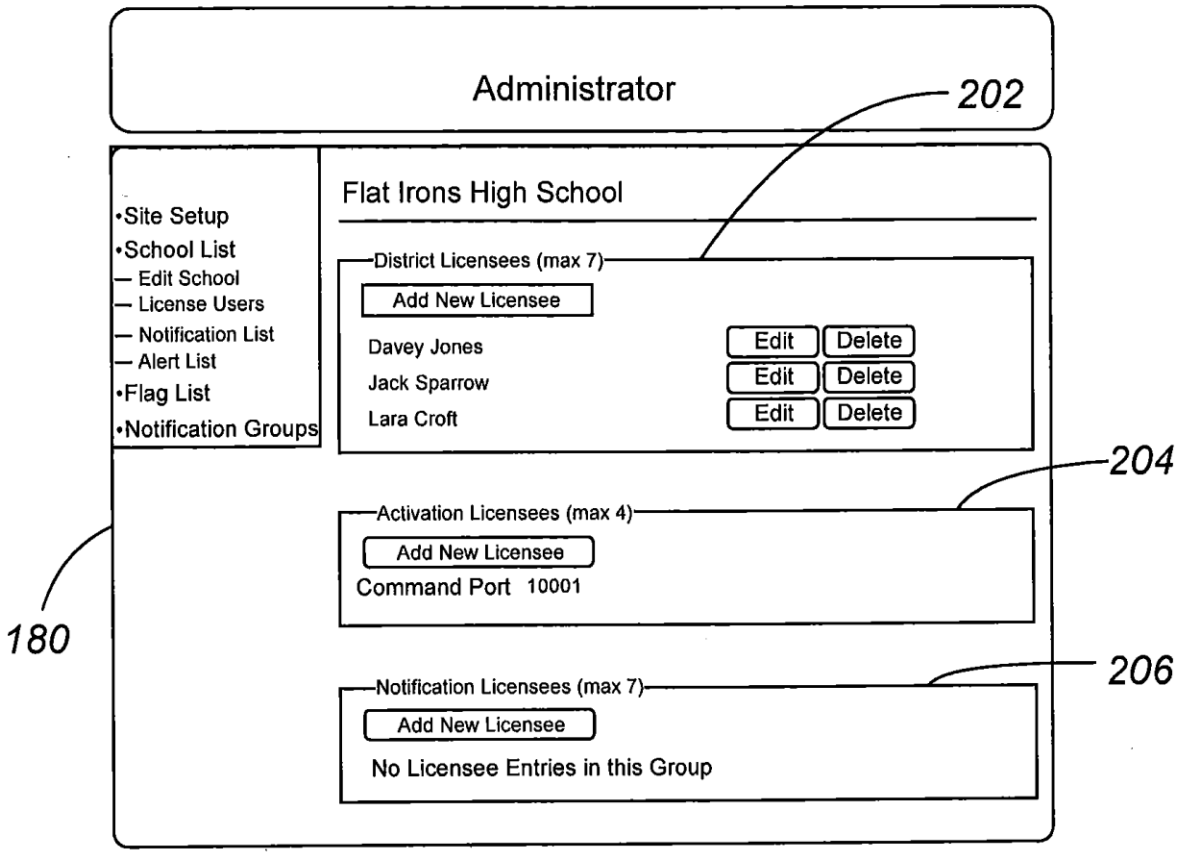

Fig. 13

Figure 13 is another user interface screen, namely, an administrator screen that tracks and records various software license types used within the system.

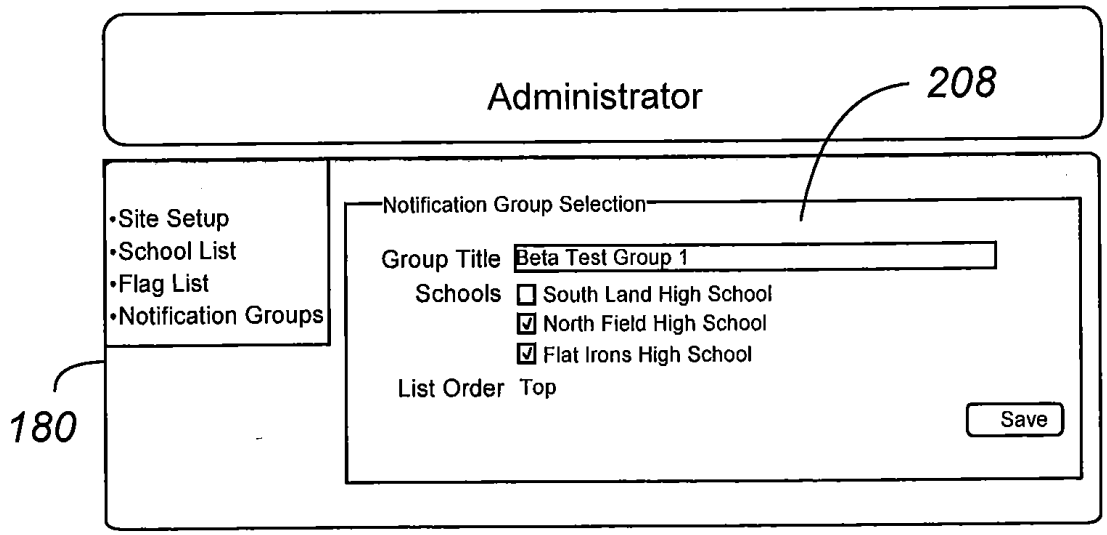

Fig. 14

Figure 14 is yet another user interface screen, namely, an administrator screen that is used to establish notification groups within the system.

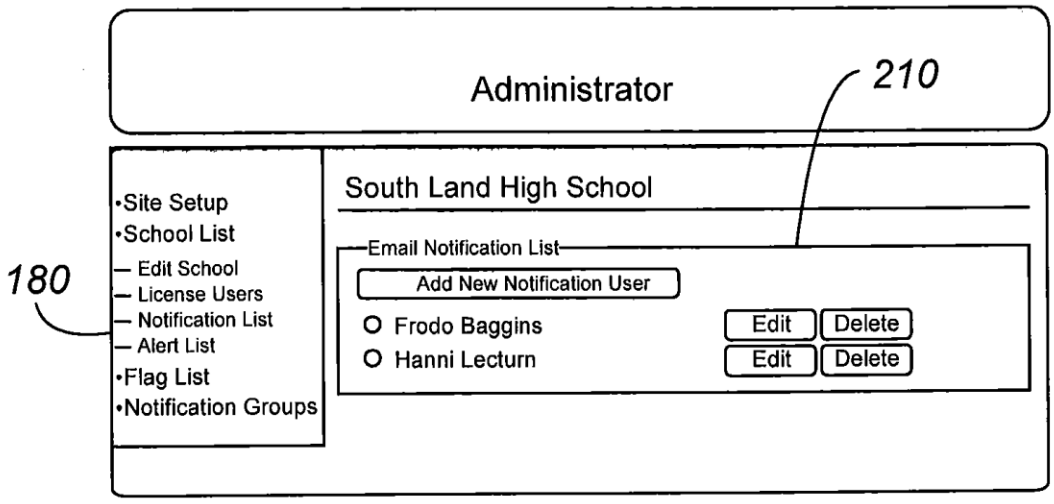

Fig. 15

Figure 15 is yet another user interface screen, namely, an administrator screen that is used for establishing e-mail notification lists within the system.

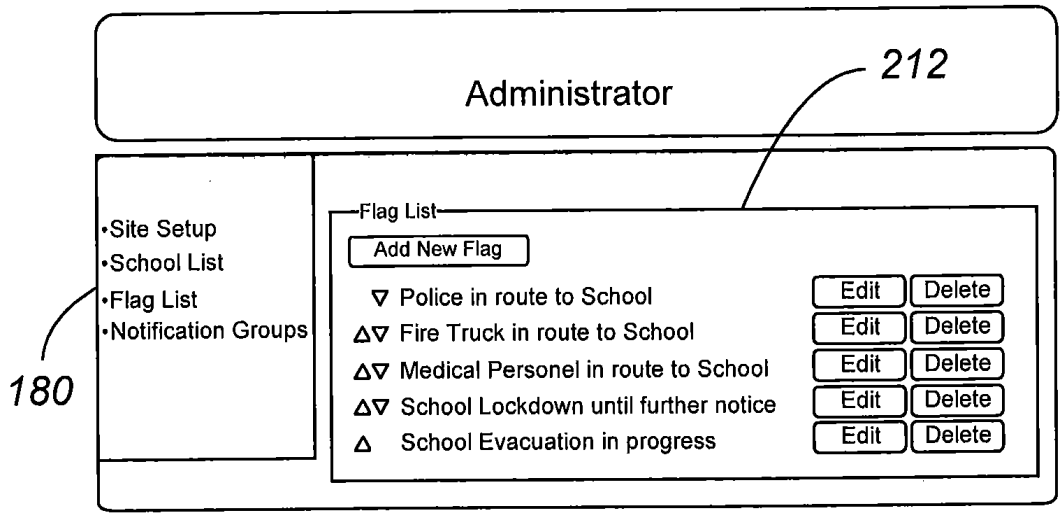

Fig. 16

Figure 16 is yet another user interface screen, namely, an administrator screen that is used to setup the pre-established or preconfigured message lists, referred to as a flags.

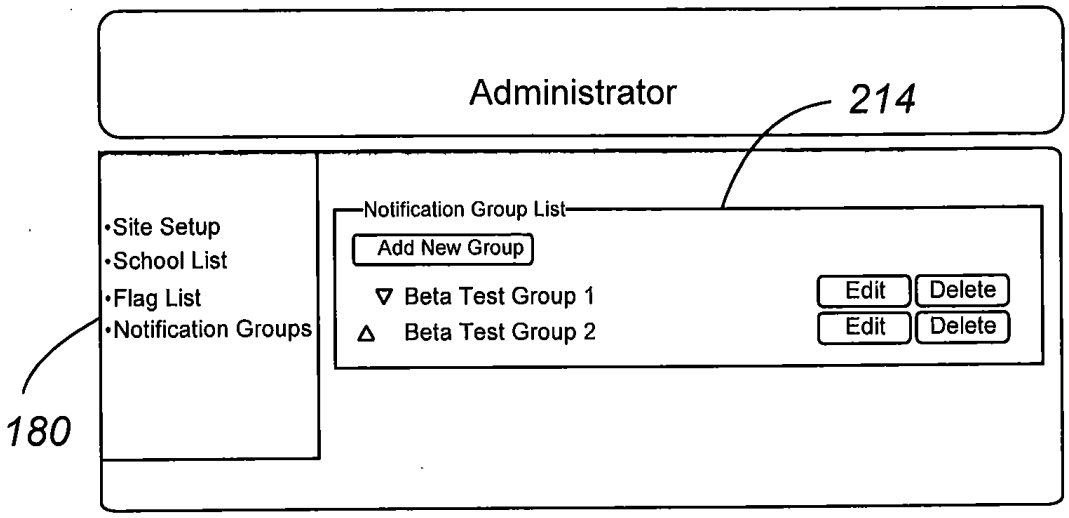

Fig. 17

Figure 17 is another user interface screen, namely, an administrator screen that is used to add, edit, or delete a notification group listing.

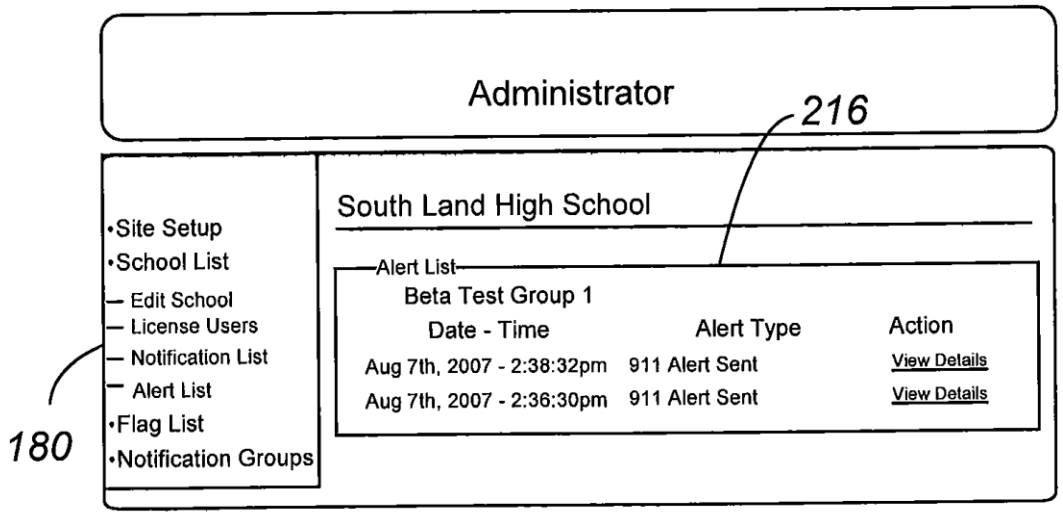

Fig. 18

Figure 18 is yet another user interface screen, namely, an administrator screen illustrating recorded alert messages previously sent within the system.

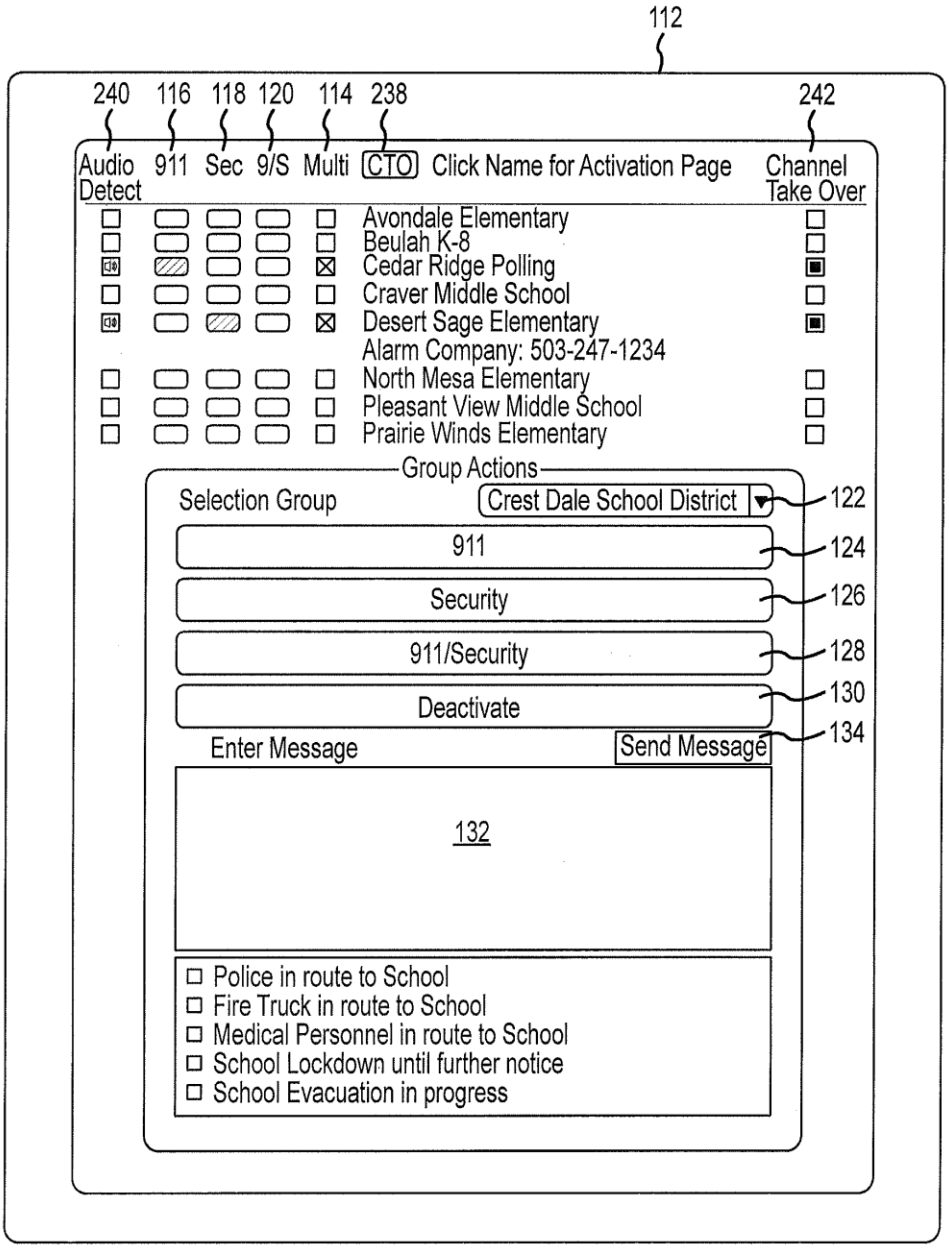

FIG.19

Figure 19 is yet another user interface screen, namely, a school activation and status screen including depiction of an Audio Detect feature and a Channel Take Over feature.

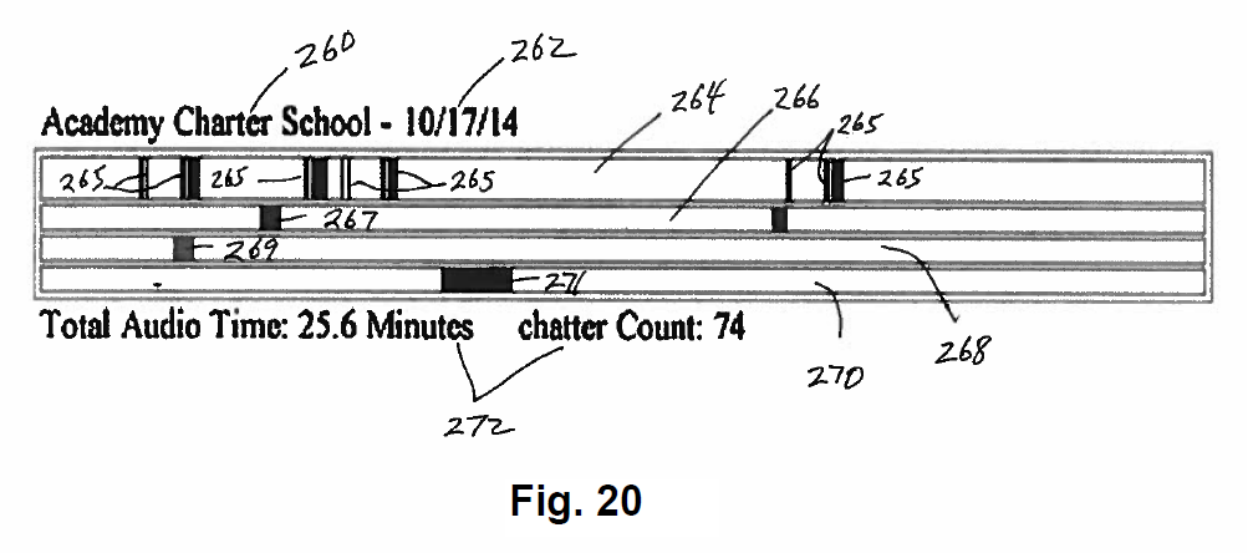

Fig. 20

Figure 20 is a graphical representation of data recorded with respect to a situational awareness tracking feature of the invention; an.

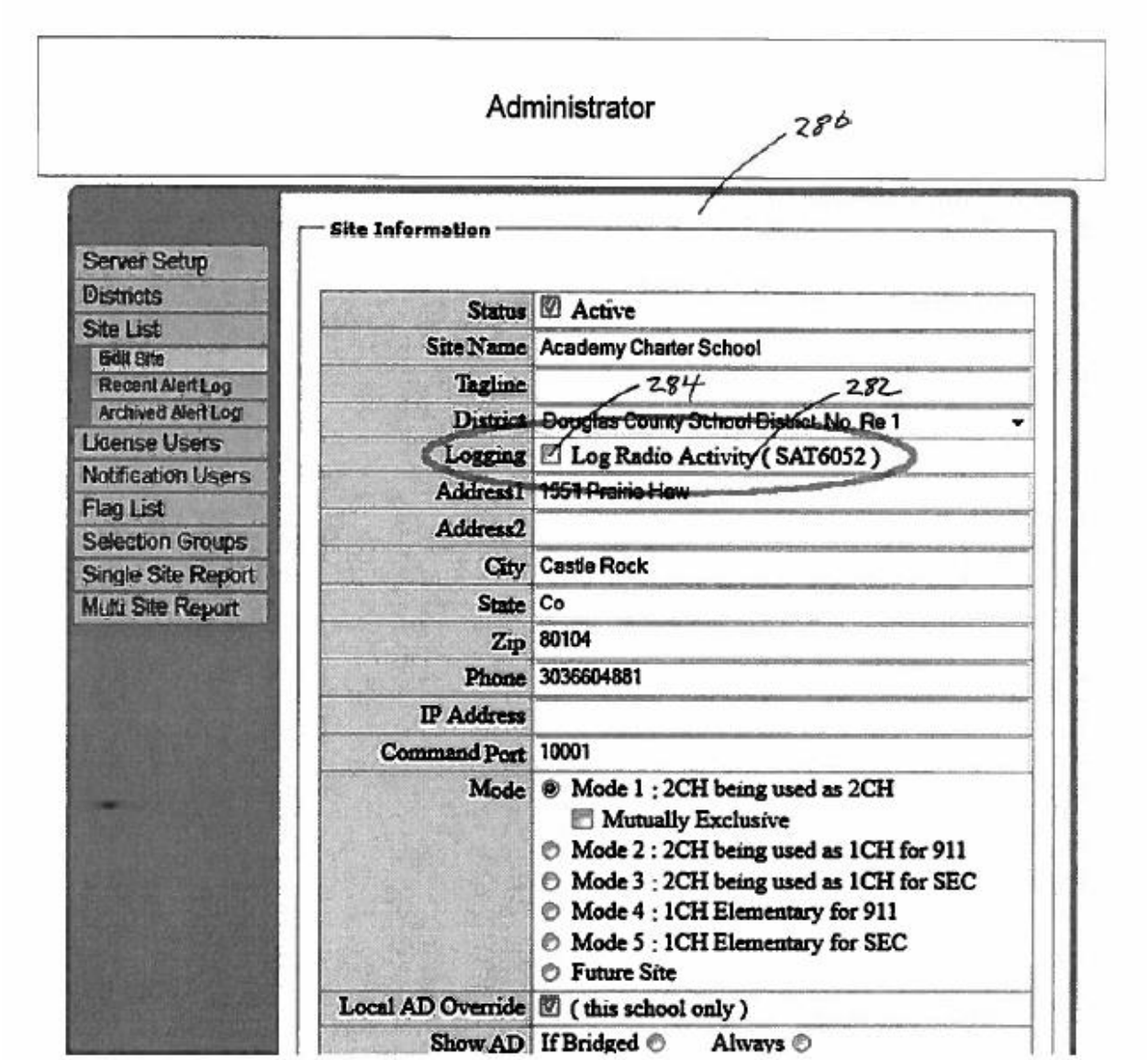

Fig. 21

Figure 21 is another user interface screen, namely, an administrator interface or display illustrating functionality associated with the situational awareness tracking feature.

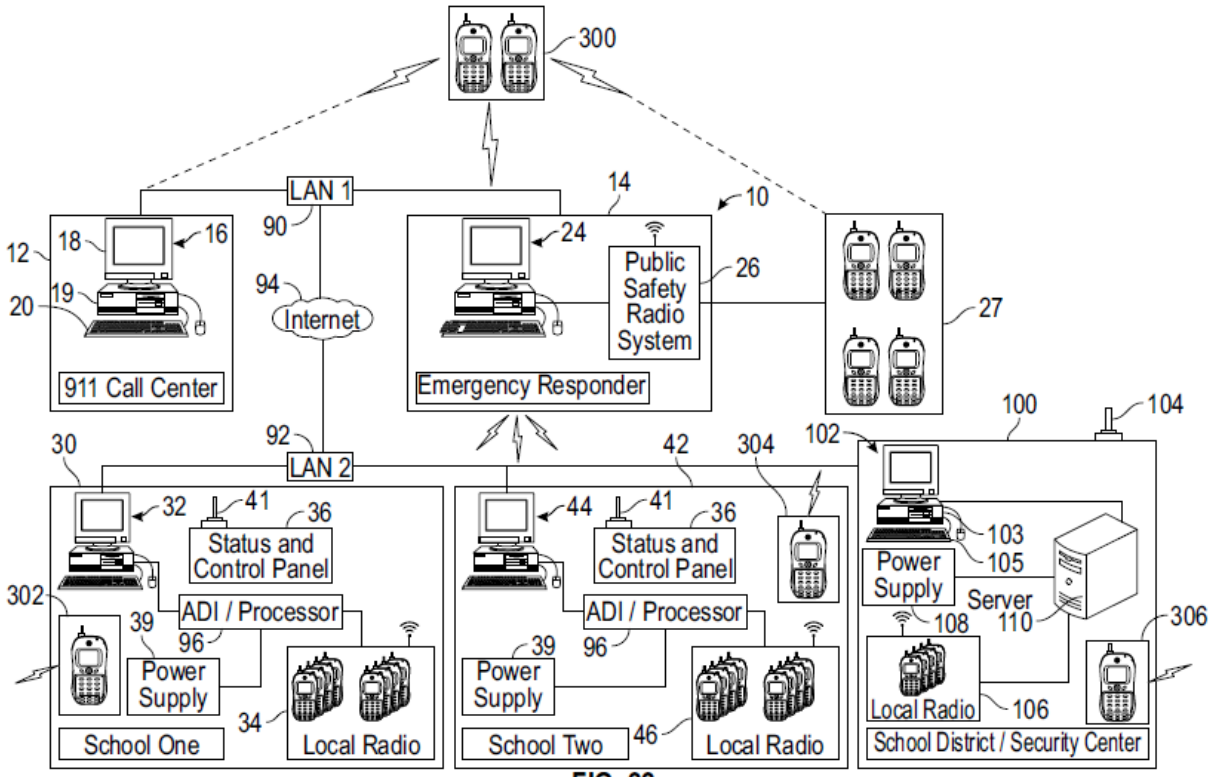

FIG. 22

Figure 22 illustrates a schematic diagram depicting the primary elements of yet another system of the present invention.

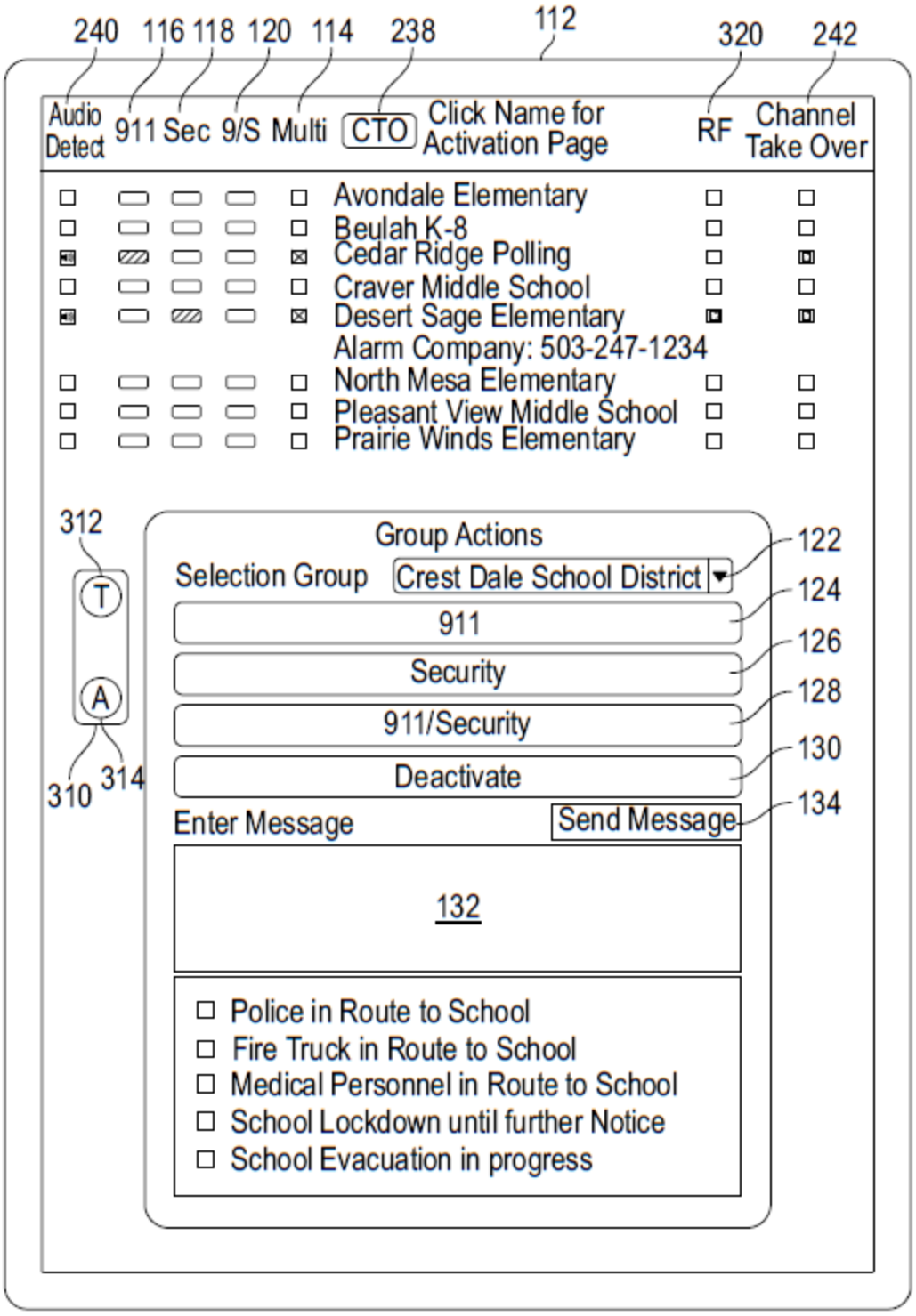

FIG. 23

Figure 23 is another user interface screen displaying functionality associated with control of the system by the redundant two-way digital radio network.

NEW

Referring to Fig. 22, this illustrates a schematic diagram depicting the primary elements of yet another system of the present invention.

The same reference numerals used in this figure correspond to the same elements discussed for the prior embodiments.

This embodiment adds a redundant radio frequency (RF) network that enables the radio bridge to be controlled by authorized pre-programmed digital radios.

This radio network may include digital pre-programmed radios used within a DMR communication protocol.

During a crisis event, an existing IP network may quickly become overwhelmed due to a dramatic increase in messaging traffic.

In this instance, it may be more difficult to control the radio bridge strictly by communications over an IP network.

Therefore according to this embodiment, a separate and independent digital radio network is incorporated such that authorized users of a digital radio may send a preconfigured digital telemetry message that is received and authenticated at the targeted communication endpoints to thereby remotely activate or deactivate a bridge.

The separate and independent digital radio network operates on a different channel as compared to the other radios of the system illustrated, namely, the public safety radios and the user radios at the communication endpoints.

Schematically, the pre-programmed or preconfigured digital radios 300 are shown as selectively communicating with each of the other communication endpoints in the system to include communication with corresponding digital radios at the communication endpoints, 302, 304, and 306.

In one scenario or situation, an emergency responder may be advised that there is an emergency requiring an action to activate or deactivate a bridge at a specific communication endpoint.

The emergency responder then operates the preprogrammed digital radio to send a digital message that is preconfigured to be received and authenticated at the selected communication endpoint to affect the status of the radio bridge.

Therefore, this remote activation through an independent RF signal can be viewed as an additional capability or a redundant capability to ensure that there is no delay in controlling a radio bridge despite what may be happening over an IP network.

Referring to Fig. 23, additional functionality is shown with respect to a user display or user interface with respect to the redundant RF communication capability.

Specifically, a digital radio control indicator 314 provides an indication within the user display showing whether a remote digital RF activation has occurred.

There are two types of digital radio activations that are illustrated, namely, a first digital radio designation 312 denoted by the letter T and a second digital radio designation 314 denoted by the letter A.

The T designation 312 corresponds, for example, to a private DMR network such as used within an organization such as a school district or business.

The A designation 314 corresponds, for example, to a DMR public safety network used by emergency responders.

If the “T” designation 312 is highlighted or illuminated in the user screen, this indicates that some aspect of control has been activated by an authorized radio within the private DMR network and similarly, if the “A” designation is illuminated, this indicates control has been activated by an authorized radio within the public safety DMR network.

Also shown in Fig. 23 is a status column 320 to indicate whether any digital radio control has been executed for any of the pre-programmed digital radios in either DMR network.

As shown, there has been an activation of the bridge for the Desert Sage Elementary communication endpoint in which the corresponding box in the column is filled in or highlighted.

Accordingly, an authorized digital radio transmitted a digital message received by the controller at that communication endpoint in which the radio bridge was then activated solely by the received digital RF signal.

The user display is updated to immediately show a status of the bridge in which the received digital RF signal is shown as active or executed.

This location also shows an active status for Channel Take Over and Audio Detect functions, as mentioned with respect to the prior embodiments.

Another control feature that may be provided by use of the preprogrammed digital radios includes digital commands for controlling a physical security feature at a selected communication endpoint.

For example, in addition to executing connection of a radio bridge or to knock down a radio bridge, another command could be used to activate a PA system at the communication endpoint.

Another example is a command that can be used to activate lights or to activate remote locking or unlocking of entry points to the facility.

Each authorized preprogrammed digital radio may have numerous preprogrammed functions that can be executed by a radio user by simply depressing one or more of the control buttons on the radio.

As mentioned, use of these types of digital RF signals are not affected by an IP network which may be slow to react, especially during extended emergency situations.

By providing a redundant capability to conduct system control through digital radios operating on a DMR protocol, reliability of the system is enhanced to ensure that timely decisions can be made to selectively execute bridging functions, as well as to execute immediate control over external physical security systems at a communication endpoint.

By providing a redundant capability to conduct system control through digital radios on a separate digital RF communications protocol, reliability of the system is enhanced to ensure that timely decisions can be made to selectively execute bridging functions, as well as to execute immediate control over external physical security systems at a communication endpoint.

By the foregoing, a method and system are provided for enhancing communications between emergency responders and personnel located at the communication endpoints.

The communication bridge or patch may be selectively enabled or disabled.

The communication brides between the endpoints, the 911 Call Center and emergency responders is achieved by commands issued over the Internet/Worldwide Web, and the number of communication endpoints can be easily tailored or modified by a sensor that manages communications between locations having their unique IP addresses.

Organizations like schools may still maintain their local radio equipment, but have the capability to directly communicate with emergency responders on an as needed basis.

Accordingly, organizations like schools maintain a public radio system capability, but without the great cost associated with such systems.

The advanced digital interpreters also have other capabilities that not only enable or disable the capability of local radios to communicate with public safety radios, but also to control the specific manner in which the various local radios may communicate, such as by providing patch capability only to selected radios in the local radio set.

School personnel may carry hand-held UHF radios for normal communications within the school building.

These portable radios are typically capable of being programmed to add additional UHF frequencies to minimize interference and to expand their capability to be used with public safety radios.

During initial setup for each location to be a communication endpoint, each of the local radios are evaluated and programmed so they are capable of being bridged with the public safety radios.

At the district level, VHF hand-held radios are preferred.

In the event the local area network for the school district is down at a time when radio bridging is required, then the manual switch 46 on the local control panel may be used.

The ADI may utilize digital audio links between any band radio systems in either one channel or two channel modes.

The bridge activation and deactivation is via web-based, graphical user interface screens, secured with log-on and network security measures.

The system software can be configured as standard web-based applications.

The server may utilize, for example, a Fedora Linux operating system.

The three basic views in the user screens as discussed include a district activation view, a school activation view, and a notification view.

The district view allows a district-wide list and status of bridging activations and alerts.

The notification view only allows the user to view the status of designated bridging and alerts.

The system administrator can manage the installed sites, licenses, users, and notification lists.

The ADI has the intelligence to complete the radio links, report status, and process audio.

The antennae systems for the radio units at the specific school locations are included to complete the radio signal link between the dissimilar radio networks.

As disclosed, the ADI/processor can be a stand-alone unit integrated at each location to facilitate the bridge between the local radio users at that location and the public safety first responders.

A command sent by the activating party in the form of IP packets over one or more communication networks is received by the ADI/processor, the command is recognized by the ADI as an instruction to either make the bridge or to knock down the bridge at that designated communication endpoint, and then the ADI facilitates the commanded bridging function.

The radiating antennas at the user locations provide wireless links to the radio users at the location and the first responders.

The public safety radio system often uses a radio tower or a collection of towers to provide links to their users, such as first responders which exchange dispatch voice messages with the 911 Call Center.

The school district may have its own local area network with suitable network equipment, such as routers or switches.

This local area network is connected to other local area networks via the Internet/Worldwide Web.

The 911 Call Center and emergency responders may operate on their own local area network and which also communicate with the local area network school districts through a network transport or Internet connection.

When the software associated with the invention is configured on terminals at each communication endpoint, users at those locations can operate the system in accordance with the privileges associated with the site software installation.

As also discussed, the software installations at the various communication endpoints provide the proper indications and activation options enabling users to operate the system or to monitor the system.

The software and the status and activation commands are configured and monitored by the network server.

The number of communication endpoints, radios, and public safety communication endpoints is virtually unlimited in the present invention since radio bridging is web based.

So long as each of the communication endpoints have their own IP addresses, the appropriate software can be installed at those locations to enable the communication bridges to be established between selected communicants, as established by an administrator of the system.

As also mentioned, the server has the ability to manage e-mail or text messages to other networks in which activation has been achieved for selected communication endpoints.

It is also contemplated that the server can be programmed to provide other services such as VOIP communications.

Periodic testing can be conducted at the local control panels in order to ensure that the system is operating correctly at that location.

Additional activation buttons/controls may be provided on the panels in order to accomplish these tests.

These tests could also be processed at any operator terminal, to include testing of the integrity of the software to ensure the system as set up by the administrator is properly functioning.

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