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(54) **Title:** WIDE AREA SYSTEM FOR MONTITORING OF ENVIRONMENTAL CONDITIONS
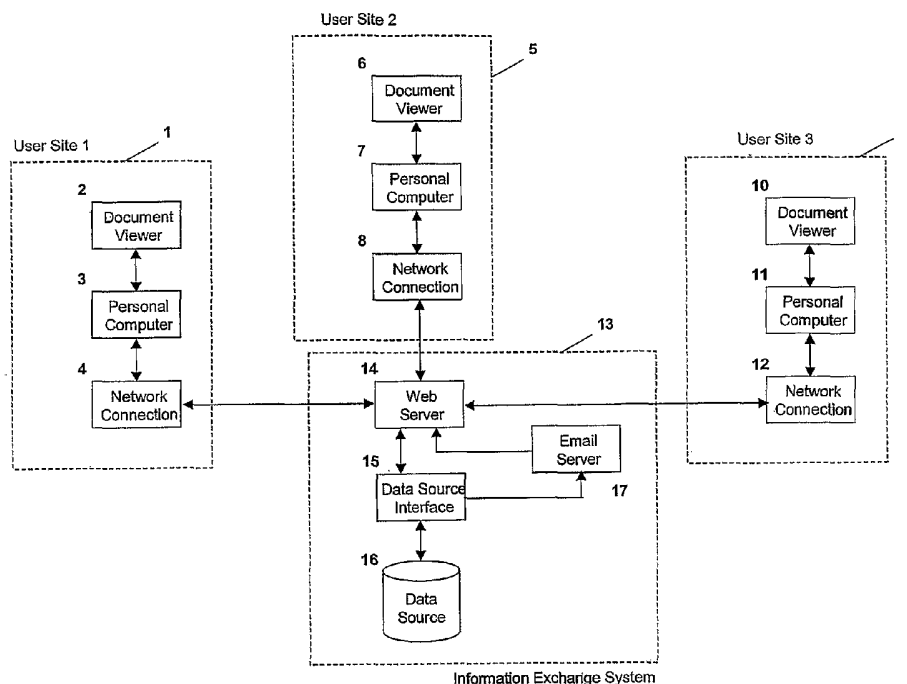
(57) **Abstract:** An information system for exchanging environmental information received from remote geographic locations including a data integrator programmed to integrate environmental data received from a plurality of environmental sensors located at one or more geographical locations and from at least one mobile input for inputting responder data; and a data manager for providing access to the environmental and/or responder data.

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WIDE-AREA SYSTEM FOR MONTITORING
OF ENVIRONMENTAL CONDITIONS

FIELD OF THE INVENTION

5   The field of the invention is that of monitoring systems, and more particularly that of wide-area monitoring systems for environmental conditions.

BACKGROUND OF THE INVENTION

Since events such as the September 11, 2001 attack and the anthrax attacks on the

10   U.S. Senate and U.S. Postal Service, the nation has been apprehensive of possible terrorist attacks, both abroad and on our own soil.   Homeland Security was immediately thrust to the front of the national consciousness, and concerns over weapons of mass destruction (WMD) have been heightened. With the ongoing threat of WMD attacks, it is critical that federal, industrial, and commercial enterprises be

15   prepared by having early detection procedures and response plans in place.

U.S. Patent No. 6,574,561 discloses a system for automating the gathering of field information that describes the condition of specific geographical locations at specific times. Information and space-time coordinates are transmitted to a management center for processing over a communication network. Upon receipt, the field information is

20   integrated into a geographic database such that the information generates a template showing the current state or condition of the identified geographical location on an automated basis. The template and the associated geographical portion of the geographical database are distributed to users via the Internet, intranet or other communication means.

25   It would be advantageous, however, to provide a more dependable and flexible "all hazards" system that supplements national Homeland Security Initiatives, such as a Web-based all hazards monitoring and crisis management system capable of providing ambient air monitoring, first responder data collection, and existing system integration for federal, industrial, and commercial enterprises; and capable of integrating

30   information received from a variety of different sensors and monitoring equipment, irrespective of the type of system.

SUMMARY OF THE INVENTION

One embodiment of the invention may include an information exchange system incorporating three primary functional components: a Web-enable network system for wide-area monitoring of environmental conditions, a localized (e.g., personal digital assistant based) response system, and remote monitoring data integration system with existing fixed or mobile.

Embodiments of the invention may incorporate an open software architecture to help ensure adaptability to specific application needs. Each component in the system of the invention may be utilized as a stand-alone application or as an entire all-hazards monitoring, incident data collection, and management system. Individual systems may be integrated by a flexible and adaptable data processing system. This flexible data processing system allows for new off-the-shelf sensor and communication technologies to be easily integrated into the system of the invention, allowing the best available products to be used with the system. This provides an extremely cost-effective and rapidly deployable solution.

Another embodiment of the invention may include an information system for exchanging environmental information received from remote geographic locations including: a data integrator programmed to integrate environmental data received from a plurality of environmental sensors located at one or more geographical locations and from at least one mobile input for inputting responder data; and a data manager for providing access to the environmental and/or responder data.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a schematic illustrating typical components used in one embodiment of the invention;

Figure 2 is a diagram illustrating the basic overall functional components of the invention; and

Figures 3(a)-(g) are illustrations of a data management portal of the invention.

DETAILED DESCRIPTION

The invention will be understood more fully from the detailed description given below and from the accompanying drawings of the preferred embodiments of the invention; which, however, should not be taken to limit the invention to a specific
5   embodiment, but are for explanation and understanding only.

The system of the invention may incorporate an area-wide perimeter, in-facility, or site system to detect and report WMD compounds and selected airborne industrial chemicals, as well as meteorological and environmental data and video images to support a wide variety of command and control, emergency management, plume
10   modeling, and other applications that support incident management and recovery efforts. The system of the invention may incorporate proven instrumentation for the measurement of WMD-related and other types of airborne contaminants, communication systems based on current computer networking protocols, and a simple intuitive interactive user interface for real-time display of data.

15   The following is a description of an information collection and exchange system that may be used with the system of the invention. In one embodiment of the invention (although not limited thereto), information and data related to a monitored or inputted condition may be submitted over some medium, such as the Internet (or cellular phone networks, conventional telephone networks, satellite networks, etc.), such as through
20   the use of a series of HTML forms, to a centralized information server, which may store this information in a data source. From this data and other stored or inputted data, information may be generated that may be sent to other users of the system.

Figure 1 is a schematic demonstrating typical components used in one embodiment of the invention. In this example, there are three User Sites, which may be located, for
25   example, at a monitored location, and emergency location, at the home of one of the use, at a central office, etc. An electronic document of some sort, such as a Web page created using HTML, may be loaded into Document Viewer 2, 6, or 10 by a user. The document viewer may be any software application capable of viewing electronic documents and loading additional electronic documents from within the original
30   document, such as through the use of a hypertext link (although not limited thereto).

For example, the document viewer could include a Web browser, such as Navigator from Netscape Communications or Microsoft's Internet Explorer. The

electronic document may be loaded automatically when the document viewer is first started, or may be opened into the viewer by the user from a file stored locally or at a remote URL. For example, the user may load the document by typing the document's URL into the Web browser's command line.

5   Document Viewer 2, 6, or 10 may be accessed by the user through any of a number of systems, such as through the use of a terminal connected to a mainframe system, from a personal computer, from a computer connected to a local computer network, from a cellular phone, from a personal digital assistant (PDA), etc.

Document Viewer 2, 6, or 10 may be connected to the network along with other
10   document viewers and computers, such as Personal Computer 3, 7, or 11 through Network Connection 4, 8, or 12. This connection is typically made through local telephone lines using an analog, ISDN, or DSL modem, though it can be over a direct network connection, such as an Ethernet network, cellular network, etc. The administrator of the network connection (e.g. an Internet Service Provider or "ISP")
15   maintains a network that routes any requests from the document viewer to the appropriate location. This may be accomplished in a conventional manner, such as through the use of a modem pool connected to a local server and gateway (not shown). The network connects the document viewer to Information Exchange System 13 through any of a number of well-known connection schemes, such as through the use
20   of leased lines.

Information Exchange System 13 may, in one embodiment, comprise Web Server 14, Data Source Interface 15, Data Source 16, and Email Server 17, the operation and interrelation of which will be described in more detail below.

Web Server 14 is typically a software application running on a remote computer
25   that is capable of forwarding or processing HTTP requests from each document viewer. For example, Web Server 14 may include any one of a number of well-known server applications, such as the NSCA Web server, the Apache Web server, etc. Web Server 14 passes a document request from a document viewer to Data Source 16 using Data Source Interface 15.

30   Information transmitted over the Internet uses the TCP/IP protocol. With this protocol, each location on the Internet, typically a specific computer or Web server, has

its own unique IP (Internet Protocol) address. This address identifies where that computer or server is located on the network..

After a Web document is loaded into the document viewer, the document viewer waits until the hypertext link is activated, generating a signal to Web Server 14 in

5   Information Exchange System 13. This is preferably in the form of an HTTP request sent over the Internet using TCP/IP and SSL. The HTTP request may include a request for scoring information, submitted scoring information, or both. It will be appreciated that the details of HTTP operation in conjunction with TCP/IP are well known to those of ordinary skill in the art and will, therefore, not be elaborated on here.

10   When the HTTP request is received by Web Server 14, Web Server 14 accesses Data Source 16 using Data Source Interface 15 to retrieve any requested information, or to submit information, based upon signal from the document viewer. In one embodiment of the invention, Web Server 14 would receive the HTTP request from Document Viewer 2, parsing the request to determine the desired information. In this

15   embodiment, the requested information is accessed in Data Source 16 by using a common gateway interface ("CGI") program, well known to those of skill in the art, as Data Interface 15. This program acts as an interface between the server and the data source by executing a set of instructions based upon the information received by the server in the HTTP request and passed by the server to the CGI program.

20   The CGI program can take a number of forms which are well known in the art. The interaction of Web servers and CGI programs and the sending of information therebetween is well known to those of ordinary skill in the art and will not be further described herein.

The CGI program may extract the document location information, e.g. the URL,

25   from the information passed to it by Web Server 14 and retrieve a record or records from the data source. Conversely, it may also submit information as well. This may be accomplished in a number of ways known to those of ordinary skill in the art. For example, a database access module may be used in connection with any number of database packages, such as to interface with the majority of commercial relational

30   database applications. Examples of such databases include Oracle, Sybase, Microsoft Access, and the like.

Records may be stored and retrieved by passing SQL statements to the database and loading the results into the CGI program. The CGI program may then compare the records stored in Data Source 16 with any new data received from the document viewer.

5   One embodiment of the basic overall functional components of the invention is illustrated in Figure 2. Those of ordinary skill in the art will appreciate that the components are illustrated in this manner for purposes of explanation of the invention only, and that the invention may be configured in any functional manner using any number or arrangement of components that operate in a similar or equivalent manner.

10   As shown in Figure 2, the system may include one or more remote and localized monitoring stations 202 from which information of a given condition may be transmitted (e.g., one more monitoring sensors). The system may also include one or more responder units 204 (e.g., a mobile data entry unit such as a PDA used by an operator on-site or near a given location).

15   The system may communicate data gathered from the instrumentation via a local area network (LAN) connected to the Internet via multiple methods, depending on the availability and requirements of each solution. Options that may be used include, for example, analog phone lines, wireless Internet cards, satellite Internet connections, and other land-based broad-band connections (e.g., DSL, ISDN, Frame Relay). Although,

20   those of ordinary skill in the art will appreciate that the invention is not limited thereto. These flexible communication methods allow the system to provide real-time data collection and dissemination from a broad spectrum of instrumentation.

An integration component 206 may also be used to integrate data from sensors or data entry terminals at one or more monitoring stations and responder units. This

25   allows the system to utilize an open architecture and to integrate a variety of sensors, such as those outputting an analog or digital signal via RS-232/485. The system of the invention may be built around proven methods and instrumentation, with the adaptability to allow updates as new sensor and communication hardware become available. The system may be configured using a complete suite of detectors and

30   monitors or just a single sensor that can be discreetly mounted in facilities and subway stations, or rapidly deployed in emergency situations.

All of this information may then be transferred to and from a data management portal (DMP) 208 that is capable of processing information received from the remote units irrespective of the data format or nature of the transmitting system. From data management portal 208, information on the detected or submitted condition may be

5   sent to a variety of action systems, such as disaster recovery 210, on-scene emergency response 212, and command and control 214 – although the invention is not limited thereto. DMP 208 may be programmed so as to present information received from the fixed monitoring stations 202 or the mobile first responder units 204 in an intuitive and integrated system. This system may also incorporate other information, such as

10   weather data, or links to other information. One manner in which the data may be access is via a graphical map-based system, where users may click on various data points to gain access to data. Examples of such an intuitive interface are illustrated in Figures 3(a)-(e).

As shown in Figure 3(a), a Web based data portal may be used to access various

15   parts of the system, such as administrative tools, reports on received data, emergency action plans, a logbook, and directly accessing data provided by responders using mobile responder units 204 (or from fixed monitoring stations 202).

The interface of the remote response aspect of the system of the invention also allows for both spatial and tabular query representation of data, as shown in Figures

20   3(b)-(c). A simple map interface may be used to display and plot sampling locations in real-time, allowing the user to select points on the map that will return sample results from the database of sample information in the data management portal. Alternatively, users may also query the database and then view the resulting locations on a map.

DMP 208 may also be used to access and control aspects of the fixed monitoring

25   stations 202 or mobile responder units 204. For example, DMP 208 may be used to manipulate a Web cam at a given location as shown in Figure 3(d). A Web based map may even be used to zoom in on a specific area to visually locate and determine the status of sensors at fixed monitoring stations 202 or information inputted by first responders using mobile units 204. This is illustrated in Figure 3(e)-(g).

30   The system may thus incorporate Web-based modules and components to allow information to be plotted real time on Geographic Information System (GIS) maps presented in tabular formats for intuitive data interpretation. This allows

users to access data from any computer with Internet access, a Web browser, and a user account with appropriate access privileges. Data may thus be accessed at any time from an office, client location, or home. Encryption schemes, such as SSL (Secured Sockets Layer) and others, may be used to secure data for transmission from one

5   location to another.

Information from remote monitoring locations may be augmented with real-time field or emergency responder data using the remote responder units and related software. For such an application, the remote responder unit may be, for example, field data entry system (such as a PDA and the like) for first responders or other field

10   personnel utilizing standard database and GIS technologies. In this manner the system may provide ease of use for both first responders and decision-makers, while at the same time electronically collecting and maintaining valuable initial response information.

Typical sensors/instrumentation that may be used with the invention includes the

15   following: chemical agent detectors employed to screen ambient air entering federal buildings; radiation monitoring applications currently utilized at many nuclear facilities; meteorological sensors used by the military to provide current weather conditions; aerosol samplers used to monitor air quality at hazardous waste remediation sites; industrial chemical sensors to detect specific chemicals utilized by

20   local industry; Web-cams for "real-time" photographs of monitored area; and Global Positioning System (GPS) units integrated into the system, providing auto-locating. The flexibility of the system of the invention allows for nearly any sensor identified to be integrated into any client-specific application.

The system may also provides multiple-level notifications to emergency operations

25   centers, decision-makers, and emergency responders with automated voice or data via conventional pagers, PDAS, cell phones, or any other communication device.

The system may utilize existing off-the-shelf hardware and communications services, while integrating secure Web services and GIS software. It may be run, for example, on a PDA integrated with a GPS receiver that has the ability to capture data

30   locally on the PDA. If a wireless signal is not available, data may be stored and later merged using a central field or command post computer, or loaded directly to a secure Web site. Data from a command station may be merged with a database residing on a

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Web server of the data management portal when connectivity is present. The system may also be utilized should information be recorded on paper and entered later.

In addition to providing the benefits of the monitoring system and responder tool functionality discussed above, the system of the invention may also provide remote
5   monitoring data integration for existing fixed or mobile stations. First, the system may conduct a survey of all existing remote monitoring and wide-area monitoring and sampling systems on the network to identify ownership, parameters measured, data capabilities, quality assurance, communication protocols, integration capability, O&M requirements, and system limitations. Next, the system may determine monitoring data
10   and system gaps that might hamper effective response in a terrorist attack, and provides suggestions on how to minimize these gaps. Then, the system may integrate the existing systems with a secure, Web-based data management platform to format and multiplex all existing data into useful information. The system integration component or functionality of the invention may be customized to fit specific needs,
15   and integrate and format newly collected data so it can be utilized by various emergency response and management command systems and centers.

Using the above-mentioned Web-based data management portal, the existing systems' data may be captured in real-time and results from these systems may then be queried in spatial, graphical, and tabular formats, supporting most downstream client
20   software applications (e.g., plume modeling, command and control system resource tracking). In additional to data management, the data management portal also may provide a document repository for storing incident documentation, emergency response plans, heath and safety reports, exceedance reports, and more. Utilizing existing monitoring stations, along with a remote first responder system, data integration
25   system provides the most complete all-hazards monitoring and crisis management system available today.

The system of the invention, which may be implemented, in one embodiment, in the manner described above, provides many benefits over systems of the prior art. The system integrates easily with existing monitoring and early warning systems. It
30   provides real-time access to data, including temperature, weather conditions, and airborne contaminants from all monitoring locations to multiple users, and increases efficiency by streamlining the reporting process and reducing report production time

(such as by eliminating manual sampling and data entry, eliminating the need for hard copy reports, automatically producing exceedance reports, automatically charting data, and providing incident documentation). The system thus also eliminates delays in emergency response and deployment through ready access of critical information.

5   Man-hour costs may be decreased, along with costly typographical errors.

Documents, procedures, protocols may be aligned with user requirements for ready access of data and reference materials and costs may be mitigated by reducing the manpower needed to continuously monitor locations. The system provides valuable data for modeling, simulation, and deployment activities; and may be used to

10   continuously monitor for WMD.

The system may be used to assist in tracking progress of first responder sampling efforts; providing instant data transmission from incident site to command-center location; and incorporating first responder data with the monitoring system and existing client monitoring stations.

15   Having thus described a few particular embodiments of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications and improvements as are made obvious by this disclosure are intended to be part of this description though not expressly stated herein, and are intended to be within the spirit and scope of the invention.

20   Accordingly each of the blocks of the drawings, and combinations of blocks of the drawings, may be embodied in many different ways, as is well known to those of skill in the art. The foregoing description is by way of example only, and not limiting. The invention is limited only as defined in the following claims and equivalents thereto.

CLAIMS

What is claimed is:

1. An information system for exchanging environmental information received from remote geographic locations comprising:

 a data integrator programmed to integrate environmental data received from a plurality of environmental sensors located at one or more geographical locations and from at least one mobile input for inputting responder data; and

 a data manager for providing access to said environmental and/or responder data.

2. The system of Claim 1, wherein said data manager is programmed to send at least a portion of said environmental and/or responder data to one or more action systems selected from the group consisting of disaster recovery, on-scene emergency response, and a command and control center.

3. The system of Claim 1, wherein said data manager and said data integrator are programmed to process said environmental and/or responder data in substantially real time.

4. The system of Claim 1, wherein said data manager is programmed for presenting at least a portion of said environmental and/or responder data through a graphical interface in a spatial and/or tabular form.

5. The system of Claim 4, wherein said data manager is programmed for presenting at least a portion of said environmental and/or responder data using interactive geographic maps.

6. The system of Claim 4, wherein said interface is Web based.

7. The system of Claim 1 wherein said data manager is programmed to provide one or more selected from the group consisting of administrative tools, reports on received data, emergency action plans, a logbook, and direct access to said environmental and/or responder data.

8. The system of Claim 1, further comprising a data source for storing at least a portion of said environmental and/or responder data.

9. The system of Claim 1, whereon said data manager is programmed for actuating at least one aspect of said sensors and/or said input.

10. The system of Claim 1, wherein said input comprises one or more selected from a handheld personal computer and a personal digital assistant.

11. The system of Claim 1, wherein said sensor comprises one or more selected from the group consisting of chemical agent detectors employed to screen ambient air entering federal buildings; radiation monitoring applications currently utilized at many nuclear facilities; meteorological sensors used by the military to provide current
5   weather conditions; aerosol samplers used to monitor air quality at hazardous waste remediation sites; industrial chemical sensors to detect specific chemicals utilized by local industry; Web-cams for "real-time" photographs of monitored area; and Global Positioning System (GPS) units integrated into the system, providing auto-locating.

12. The system of Claim 1, wherein said data manager is programmed for providing one or more multiple-level notifications to one or more selected from the group consisting of emergency operations centers, decision-makers, and emergency responders.

13. The system of Claim 12, wherein said data manager is programmed for providing said notification via one or more selected from the group consisting of via conventional pagers, PDAS, and cell phones.

14. The system of Claim 1, wherein said data manager is programmed for performing one or more tasks selected from the group consisting of a survey of a plurality of said sensors to identify ownership, parameters measured, data capabilities, quality assurance, communication protocols, integration capability, O&M requirements, and/or

5   system limitations;   determine monitoring data and/or system gaps, provide suggestions on how to minimize monitoring data and/or system gaps; presenting said environmental and/or responder data in a format to be used with client software applications for plume modeling, command and/orol system resource tracking; storing incident documentation, emergency response plans, heath and safety reports, and

10   exceedance reports.
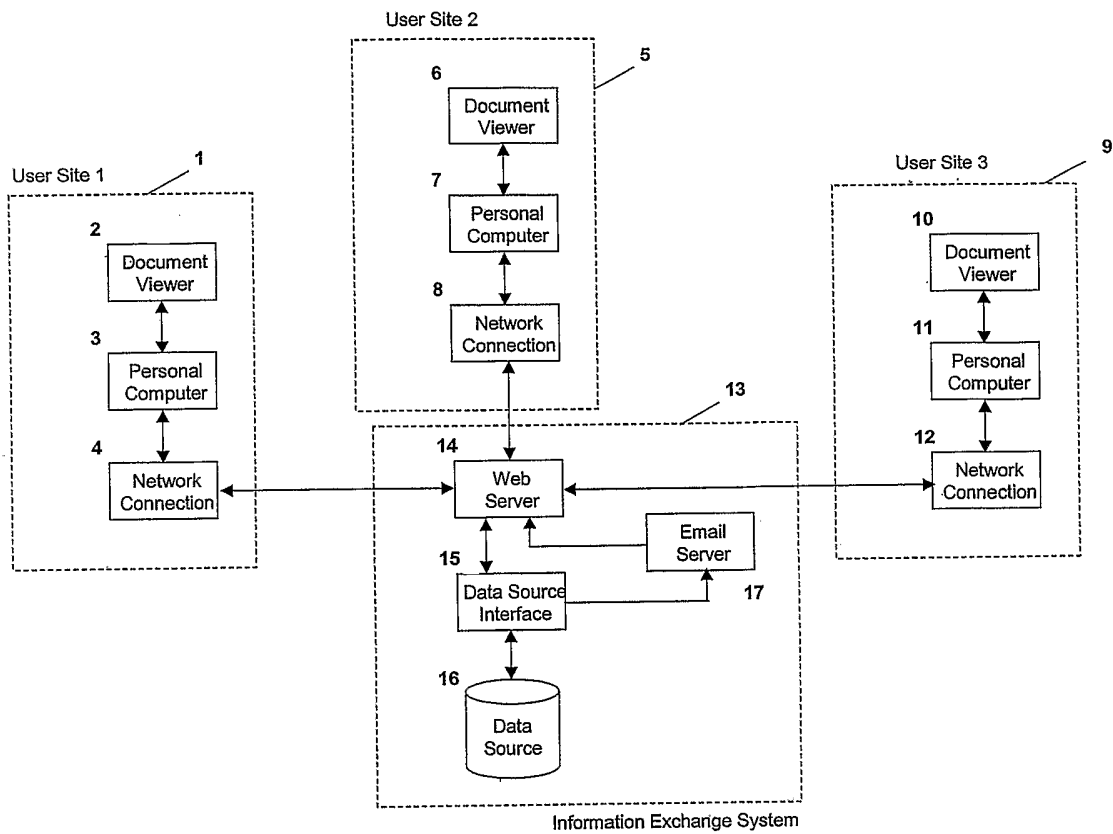
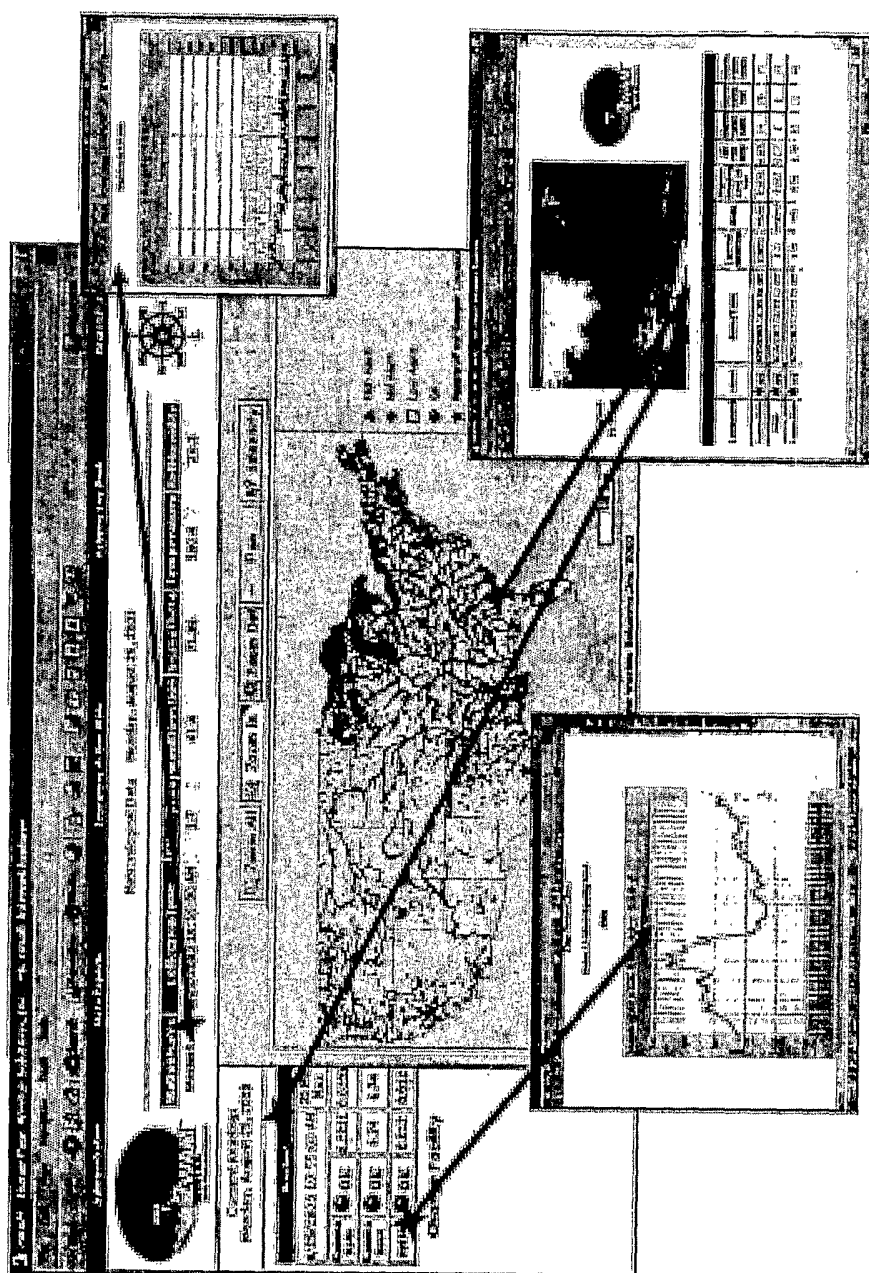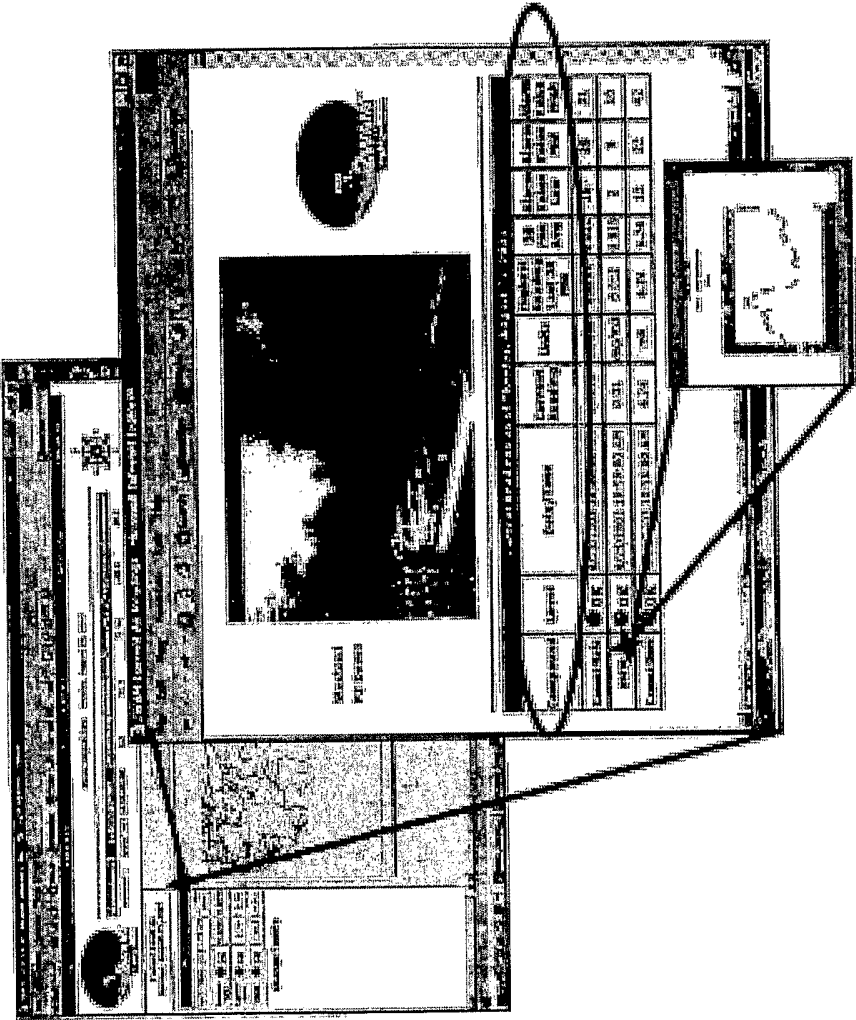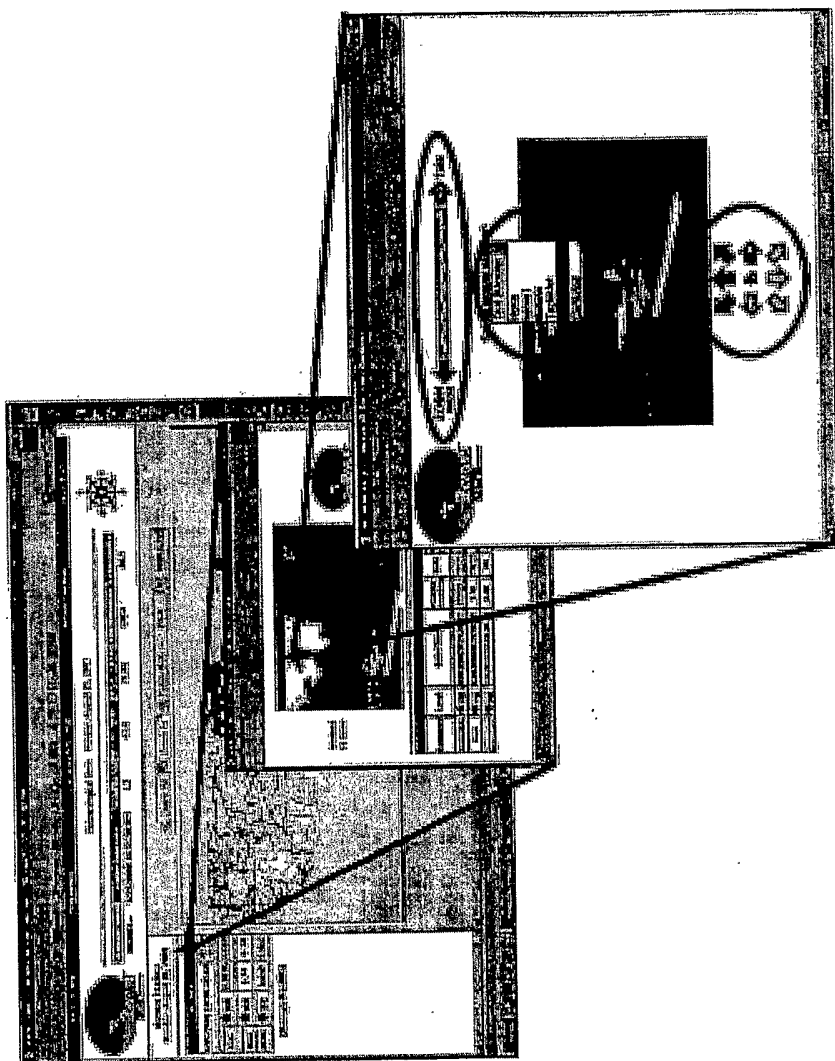**Figure 1**
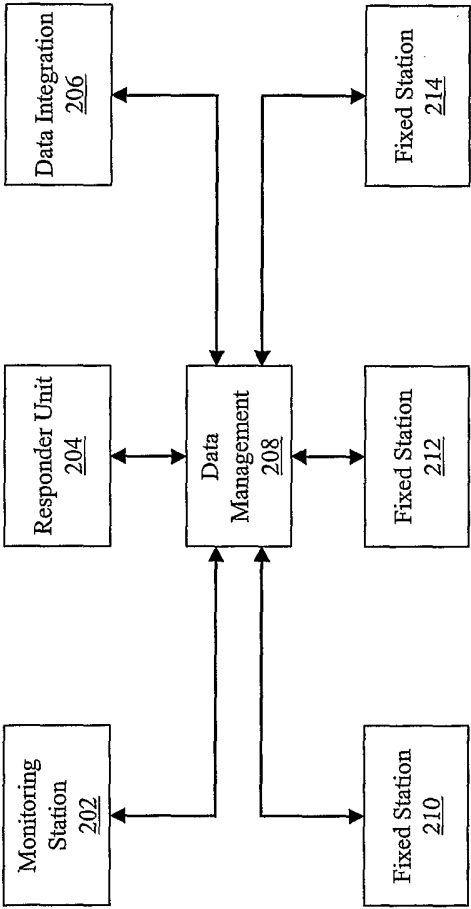
Figure 2
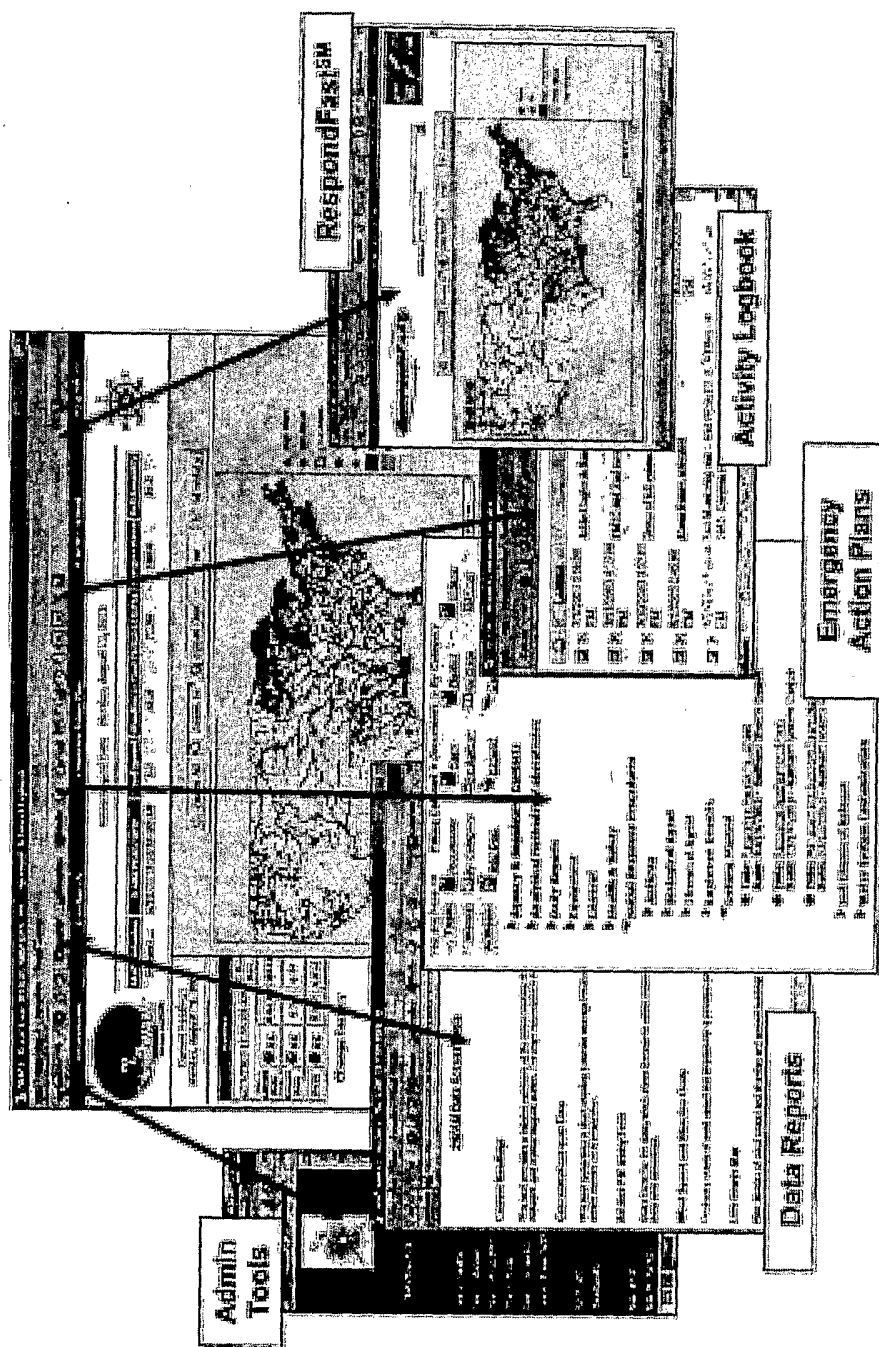
Figure 3(a)

Figure 3(b)

Figure 3(c)

Figure 3(d)

Figure 3(e)

Figure 3(f)

Figure 3(g)