ABSTRACT

"A MINE OPERATION MONITORING SYSTEM"

A mine operation monitoring system is disclosed which comprises a plurality of mine equipment interfaces, each mine equipment interface being located at a mine operation and being associated with at least one item of mine equipment, and each mine equipment interface being arranged to monitor operation of the at least one associated item of mine equipment. The system also comprises a plurality of remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility, each remote monitoring station being arranged to communicate with at least one equipment interface associated with a different mine operation so as to monitor operation of at least one item of mine equipment associated with said at least one equipment interface from the remote locations. The system also comprises a plurality of local monitoring stations, each local monitoring station being located at a mine operation, and being arranged to communicate with the at least one mine equipment interface associated with the mine operation so as to monitor operation of the at least one item of equipment associated with said at least one equipment interface from the mine operation. The system also comprises a communications network arranged to facilitate communications between the equipment interfaces, the local monitoring stations and the remote monitoring stations. The system enables a plurality of items of equipment associated with multiple mine operations to be monitorable either from the remote monitoring facility or from respective local monitoring stations.

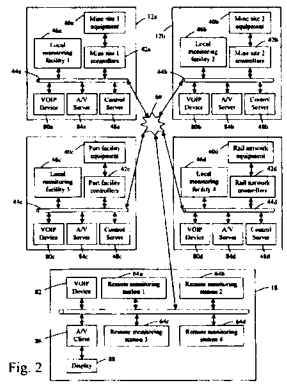

Fig. 2

CLAIMS:

1. A mine operation monitoring system comprising:

a plurality of equipment interfaces, each equipment interface being located at a mine operation and being associated with at least one item of mine equipment, and each mine equipment interface being arranged to monitor operation of the at least one associated item of mine equipment;

a plurality of remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility, each remote monitoring station being arranged to communicate with at least one equipment interface associated with a different mine operation so as to monitor operation of at least one item of mine equipment associated with said at least one equipment interface from the remote location;

a plurality of local monitoring stations, each local monitoring station being located at a mine operation, and being arranged to communicate with the at least one mine equipment interface associated with the mine operation so as to monitor operation of the at least one item of equipment associated with said at least one equipment interface from the mine operation; and

a communications network arranged to facilitate communications between the equipment interfaces, the local monitoring stations and the remote monitoring stations;

whereby a plurality of items of equipment associated with multiple mine operations are monitorable either from the remote monitoring facility or from respective local monitoring stations.

2. A system as claimed in claim 1, wherein each mine equipment interface is arranged to control operation of the at least one associated item of mine equipment in response to a control signal, and each of the local and remote monitoring stations is arranged to send control

signals to the mine equipment interfaces in response to operator input.

3. A system as claimed in claim 2, wherein each mine equipment interface comprises at least one programmable logic controller (PLC).

4. A system as claimed in claim 2 or claim 3, wherein at least one of the mine operations is provided with a control server arranged to receive control commands from the remote and/or local monitoring stations and generate control signals in response to the control commands.

5. A system as claimed in any one of claims 1 to 4, comprising a local VOIP device at at least one mine operation and a remote VOIP device at the remote monitoring facility, the local and remote VOIP devices facilitating audio communications between the at least one mine operation and the remote monitoring facility through the communications network.

6. A system as claimed in any one of the preceding claims, comprising a local A/V server at at least one mine operation and at least one remote A/V client device, the local A/V server and each remote A/V client device facilitating audio/visual communications between the at least one mine operation and one or more operators respectively associated with the at least one A/V client device.

7. A system as claimed in claim 6, wherein the A/V server is arranged to use a multi-cast protocol to transmit A/V communications to the at least one A/V client device such that multiple operators are able to simultaneously receive the A/V communication.

8. A system as claimed in any one of the preceding

claims, comprising a still and/or video camera at at least one mine operation, and a display disposed at the remote monitoring facility, the system being arranged to display images captured by said at least one camera on the display.

9. A system as claimed in claim 8, wherein the display is of sufficient size such that the images on the display are viewable by all operators at the remote monitoring facility.

10. A system as claimed in claim 8 or claim 9, wherein the system is arranged such that images associated with multiple still and/or video cameras are viewable on the display.

11. A system as claimed in any one of the preceding claims, wherein the mine operations comprise at least one mine site, at least one port facility and/or at least one rail network.

12. A system as claimed in any one of the preceding claims, wherein the system is arranged to monitor whether communications between the remote monitoring facility and the mine operations are possible and to generate an alarm signal when an indication is obtained that a communications outage may have occurred between the remote monitoring facility and one of more mine operations.

13. A system as claimed in claim 12, wherein the system is arranged to require that a handshake occurs periodically between the remote monitoring facility and the mine operations.

14. A system as claimed in any one of the preceding claims, wherein the system is arranged to prioritise communications between the mine operations and the remote

monitoring facility according to communication type.

15. A system as claimed in claim 14, wherein the system is arranged to allocate different bandwidth percentages to different types of communications.

16. A system as claimed in claim 14, wherein different types of communications are allocated different priority values usable by routers in the communications network to manage queues in the routers and thereby the speed of transfer of the communications through the routers.

17. A system as claimed in claim 16, wherein the priority values are allocated according to the IP addresses associated with a communication.

18. A system as claimed in claim 17, wherein the IP addresses of all network enabled devices in the system are recorded in system routers and the priority level allocated by the routers according to the priority level recorded for the network addresses in the routers.

19. A system as claimed in claim 17 or claim 18, wherein all communications to or from a network enabled device having an IP address that is not associated with a communication between a mine operation and the remote monitoring facility are allocated a priority level lower than communications between a mine operation and the remote monitoring facility.

20. A system as claimed in any one of the preceding claims, wherein the communications network comprises a plurality of nodes between a mine operation and the remote monitoring facility, the communications network being arranged such that network traffic through the communications network is re-routable through the nodes should an outage occur at a communications link between at

least two nodes.

21. A system as claimed in any one of the preceding claims, wherein each remote or local monitoring station comprises at least one computer terminal, each terminal being arranged to monitor mine equipment at a mine operation.

22. A system as claimed in claim 21, wherein at least one remote or local monitoring station comprises a plurality of computer terminals.

23. A system as claimed in claim 22, wherein a plurality of terminals are provided for at least one operator so that the operator is able to monitor a plurality of mine equipment simultaneously.

24. A system as claimed in any one of claims 21 to 23, wherein at least one of the terminals comprises a web browser and the system is arranged such that mine equipment is monitorable and controllable within a web browser.

25. A system as claimed in any one of claims 21 to 24, wherein the system is arranged such that a representation of the mine equipment being monitored and/or controlled is displayed on a terminal.

26. A system as claimed in any one of claims 21 to 25, wherein the computer terminals are realized using multiple computing devices, or using at least one terminal server and at least one thin client device.

27. A system as claimed in any one of the preceding claims, comprising an audio messaging system usable to send audio between personnel at a mine operation and the remote monitoring facility.

28. A system as claimed in claim 27, wherein the audio messaging system includes a remote audio device disposed at the central monitoring facility and a radio transmitter disposed at the mine operation, audio information received by the remote audio device being communicated to the radio transmitter through the communications network, and the radio transmitter being arranged to cooperate with a radio antenna to transmit a radio signal indicative of the audio message to radio receiving devices carried by mine personnel, and to receive a radio signal indicative of an audio message from radio receiving devices carried by mine personnel.

29. A system as claimed in any one of the preceding claims, wherein the system comprises multiple network connection arrangements for connecting the remote mine monitoring stations with the communications network so that a backup network connection is available should one of the network connections between the central monitoring facility and the communications network fail.

30. A system as claimed in any one of the preceding claims, wherein the system comprises multiple power supply arrangements for supplying electrical power to the central monitoring facility such that should supply of electrical power by one of the power supply arrangements to the central monitoring facility fail, another power supply arrangement is used to provide the central monitoring facility with electrical power.

31. A system as claimed in any one of the preceding claims, wherein the central monitoring facility is disposed at or adjacent an airport.

32. A system as claimed in any one of the preceding claims, comprising at least 4 remote monitoring stations.

33. A mine operation monitoring system comprising:

a plurality of equipment interfaces, each equipment interface being located at a mine operation and being associated with at least one item of mine equipment, and each equipment interface being arranged to monitor operation of the at least one associated item of equipment;

a plurality of remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility, each remote monitoring station being arranged to communicate with at least one equipment interface associated with a different mine operation so as to monitor operation of the at least one item of equipment associated with said at least one equipment interface from the remote location; and

a communications network arranged to facilitate communications between the equipment interfaces and the remote monitoring stations;

whereby a plurality of items of equipment associated with multiple mine operations are monitorable from the remote monitoring facility.

34. A system as claimed in claim 33, comprising at least 4 remote monitoring stations.

35. A mine operation central monitoring facility for a plurality of equipment interfaces, each equipment interface being located at a mine operation and being associated with at least one item of equipment at a mine operation, and each equipment interface being arranged to monitor operation of said at least one item of equipment, the facility comprising:

a plurality of adjacently disposed remote monitoring stations remotely located relative to the mine operations, each remote monitoring station being arranged to communicate through a wide area network with at least one

equipment interface associated with a different mine operation so as to control operation of the at least one item of equipment associated with said at least one mine equipment interface from the remote location;

whereby a plurality of items of equipment associated with multiple mine operations are monitorable from the same remote location.

36. A facility as claimed in claim 35, comprising a still and/or video camera at at least one mine operation, and a display disposed at the remote monitoring facility, the system being arranged to display images captured by said at least one camera on the display.

37. A facility as claimed in claim 35 or claim 36, wherein each remote monitoring station comprises a plurality of computer terminals, each terminal being arranged to monitor mine equipment at a mine operation.

38. A facility as claimed in any one of claims 35 to 37, comprising at least 4 remote monitoring stations.

39. A method of monitoring mine equipment at a plurality of mine operations, said method comprising:

providing a plurality of mine equipment interfaces, each mine equipment interface being located at a mine operation and being associated with at least one item of mine equipment;

arranging each mine equipment interface to monitor operation of the at least one item of mine equipment associated with the mine equipment interface;

providing a plurality of adjacently disposed remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility;

facilitating communications between each remote monitoring station and at least one equipment interface associated with a different mine operation so as to

monitor operation of the items of mine equipment associated with said at least one equipment interface from the remote location;

providing a plurality of local monitoring stations, each local monitoring station being locally located at a mine operation;

facilitating communications between each local monitoring station and the at least one mine equipment interface associated with the mine operation so as to monitor operation of the items of equipment associated with said at least one equipment interface from the mine operation; and

monitoring a plurality of items of equipment associated with multiple mine operations either from the remote monitoring facility or from respective local monitoring stations.

40. A method as claimed in claim 39, comprising controlling operation of the at least one associated item of mine equipment in response to a control signal, and sending control signals to the mine equipment interfaces from a local or remote monitoring station in response to operator input.

41. A method as claimed in claim 40, comprising providing each mine equipment interface with at least one programmable logic controller (PLC).

42. A method as claimed in claim 40 or claim 41, comprising providing at least one of the mine operations with a control server, receiving control commands from the remote and/or local monitoring stations at the control server, and sending control signals from the control server in response to the control commands.

43. A method as claimed in any one of claims 39 to 42, comprising providing a local VOIP device at at least one

mine operation and a remote VOIP device at the remote monitoring facility, the local and remote VOIP devices facilitating audio communications between the at least one mine operation and the remote monitoring facility through the communications network.

44. A method as claimed in any one of claims 39 to 43, comprising providing a local A/V server at at least one mine operation and providing at least one remote A/V client device, the local A/V server and each remote A/V client device facilitating audio/visual communications between the at least one mine operation and one or more operators respectively associated with the at least one A/V client device.

45. A method as claimed in claim 44, comprising sending communications from the A/V server using a multi-cast protocol.

46. A method as claimed in any one of claims 39 to 45, comprising providing a still and/or video camera at at least one mine operation, providing a display disposed at the remote monitoring facility, and displaying images captured by said at least one camera on the display.

47. A method as claimed in claim 46, wherein the display is of sufficient size such that the images on the display are viewable by all operators at the remote monitoring facility.

48. A method as claimed in claim 46 or claim 47, comprising displaying images associated with multiple still and/or video cameras on the display.

49. A method as claimed in any one of claims 39 to 48, wherein the mine operations comprise at least one mine site, at least one port facility and/or at least one rail

network.

50. A method as claimed in any one of claims 39 to 49, comprising monitoring whether communications between the remote monitoring facility and the mine operations are possible and generating an alarm signal when an indication is obtained that a communications outage may have occurred between the remote monitoring facility and one of more mine operations.

51. A method as claimed in claim 50, comprising requiring a handshake to occur periodically between the remote monitoring facility and the mine operations.

52. A method as claimed in any one of claims 39 to 51, comprising prioritising communications between the mine operations and the remote monitoring facility according to communication type.

53. A method as claimed in claim 52, comprising allocating different bandwidth percentages to different types of communications.

54. A method as claimed in claim 52, comprising allocating different priority values usable by routers in the communications network to different types of communications so as to manage queues in the routers and thereby the speed of transfer of the communications through the routers.

55. A method as claimed in claim 54, comprising allocating priority values for a communication according to the IP addresses associated with a communication.

56. A method as claimed in claim 55, comprising recording the IP addresses of all network enabled devices in the system in system routers and allocating the priority level

according to the priority level recorded for the network addresses in the routers.

57. A system as claimed in claim 55 or claim 56, comprising allocating all communications to or from a network enabled device having an IP address that is not associated with a communication between a mine operation and the remote monitoring facility a priority level lower than communications between a mine operation and the remote monitoring facility.

58. A method as claimed in any one of claims 39 to 57, wherein the communications network comprises a plurality of nodes between a mine operation and the remote monitoring facility, the method comprising re-routing network traffic through the communications network when an outage occurs at a communications link between at least two nodes.

59. A method as claimed in any one of claims 39 to 58, comprising providing each remote or local monitoring station with at least one computer terminal, each terminal being arranged to monitor mine equipment at a mine operation.

60. A method as claimed in claim 59, comprising providing at least one remote or local monitoring station with a plurality of computer terminals.

61. A method as claimed in claim 60, comprising providing at least one operator with a plurality of terminals so that the operator is able to monitor a plurality of mine equipment simultaneously.

62. A method as claimed in any one of claims 59 to 61, wherein at least one of the terminals comprises a web browser and the system is arranged such that mine

equipment is monitorable and controllable within a web browser.

63. A system as claimed in any one of claims 59 to 62, wherein the system is arranged such that a representation of the mine equipment being monitored and/or controlled is displayed on a terminal.

64. A method as claimed in any one of claims 59 to 63, comprising realizing the computer terminals using multiple computing devices, or using at least one terminal server and at least one thin client device.

65. A method as claimed in any one of claims 39 to 64, comprising providing an audio messaging system usable to send audio between personnel at a mine operation and the remote monitoring facility.

66. A method as claimed in claim 65, comprising providing a remote audio device disposed at the central monitoring facility and a radio transmitter disposed at the mine operation, communicating audio information received by the remote audio device to the radio transmitter through the communications network, using the radio transmitter to transmit a radio signal indicative of the audio message to radio receiving devices carried by mine personnel, and receiving a radio signal indicative of an audio message from radio receiving devices carried by mine personnel.

67. A method as claimed in any one of claims 39 to 66, comprising providing multiple network connection arrangements for connecting the remote mine monitoring stations with the communications network so that a backup network connection is available should one of the network connections between the central monitoring facility and the communications network fail.

68. A method as claimed in any one of claims 39 to 67, comprising providing multiple power supply arrangements for supplying electrical power to the central monitoring facility such that should supply of electrical power by one of the power supply arrangements to the central monitoring facility fail, another power supply arrangement is used to provide the central monitoring facility with electrical power.

69. A method as claimed in any one of claims 39 to 68, comprising disposing the central monitoring facility at or adjacent an airport.

70. A method as claimed in any one of claims 39 to 69, comprising providing at least 4 remote monitoring stations.

71. A mine operation monitoring system for monitoring at least 4 mine operations, said system comprising:

a plurality of mine equipment interfaces, each mine equipment interface being located at a mine operation and being associated with at least one item of mine equipment, and each mine equipment interface being arranged to monitor operation of the at least one associated item of mine equipment;

at least 4 remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility, each remote monitoring station being arranged to communicate with at least one equipment interface associated with a different mine operation so as to monitor operation of at least one item of mine equipment associated with said at least one equipment interface from the remote location;

at least 4 local monitoring stations, each local monitoring station being located at a mine operation, and being arranged to communicate with the at least one mine equipment interface associated with the mine operation so

as to monitor operation of the at least one item of equipment associated with said at least one equipment interface from the mine operation; and

a communications network arranged to facilitate communications between the equipment interfaces, the local monitoring stations and the remote monitoring stations;

whereby a plurality of items of equipment associated with at least 4 mine operations are monitorable either from the remote monitoring facility or from respective local monitoring stations.

72. A system for controlling from a central operations facility plant and equipment associated with a plurality of mine sites for producing bulk commodities and associated with one or more networks or rail lines for transportation of said bulk commodities produced at said mine sites a distance exceeding 250km to one or more port facilities and associated with said one or more port facilities,

the plant and equipment connected to a communications network to thereby receive operating commands transmitted from operating stations connected to said communications network and operated by personnel and said operating stations receiving operating data transmitted by said plant and equipment over said communications network for display by said operating stations;

each one of said plurality of mine sites and each one of said one or more networks of rail lines and each one of said one or more port facilities having an associated operating station for local operation of said facilities;

the central operations facility having an operating station for each one of said plurality of mine sites and each one of said one or more networks of rail lines and each one of said one or more port facilities for remote operation of said facilities;

the communications network configured to carry at least real time voice traffic and e-mail traffic between

said mine sites, said rail facilities, said port facilities and other facilities connected to said communications network; and said communications network configured to provide a latency of less than 1 second between:

i) transmittal of an operating command from an operating station located at the central operations facility to receipt of said command by said plant and equipment; or

ii) transmittal of operating data from plant and equipment to receipt of said operating data at said operations facility.

73. A system for controlling from a centralised operations facility plant and equipment associated with a plurality of mine sites distributed across a distance exceeding 250km,

the plant and equipment connected to a communications network to thereby receive operating commands transmitted from operating terminals connected to said communications network and operated by personnel;

said operating terminals receiving operating data transmitted by said plant and equipment over said communications network for display by said operating terminals;

each one of said plurality of mine sites having a plurality of operating terminals for local operation of said mine sites;

the centralised operations facility having a plurality of operating terminals for each one of said plurality of mine sites;

the communications network configured to carry at least real time voice traffic and e-mail traffic between said mine sites, said central operating facility and other facilities connected to said communications network; and said communications network configured to provide a latency of less than 1 second between:

i) transmittal of an operating command from an operating station located at the centralised operations facility to receipt of said command by said plant and equipment; or

ii) transmittal of operating data from plant and equipment to receipt of said operating data at said operations facility.

74. A system as claimed in claim 73, wherein said latency is less than 0.5 seconds.

75. A system as claimed in claim 73 or claim 74, wherein said system further controls operation of a rail network servicing said plurality of mine sites, the centralised operating facility comprising operating terminals for controlling plant and equipment of said rail network.

76. A system as claimed in any one of claims 73 to 75, wherein said system further controls operation of port facilities associated with said plurality of mine sites, the centralised operating facility comprising operating terminals for controlling plant and equipment located at said port facilities.

77. A system for controlling from a centralised operations facility plant and equipment associated with at least four mine sites distributed across a distance exceeding 250km,

the plant and equipment connected to a communications network to thereby receive operating commands transmitted from operating terminals connected to said communications network and operated by personnel;

said operating terminals receiving operating data transmitted by said plant and equipment over said communications network for display by said operating terminals;

each one of said at least four mine sites having a plurality of operating terminals for local operation of said mine sites;

the centralised operations facility having a plurality of operating terminals for each one of said at least four mine sites;

the communications network configured to carry at least real time voice traffic and e-mail traffic between said at least four mine sites, said central operating facility and other facilities connected to said communications network; and said communications network configured to provide a latency of less than 1 second between:

i) transmittal of an operating command from an operating terminal located at the centralised operations facility to receipt of said command by plant and equipment at one of said at least four mine sites; or

ii) transmittal of operating data from plant and equipment at one of said at least four mine sites to receipt of said operating data at said operations facility.

78. A mine operation monitoring system substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

79. A method of monitoring mine equipment at a plurality of mine operations substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

Dated this the 02nd day of January 2012.

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorney for the Applicants

ORIGINAL

0-68/DELNP/12

03 JAN 2012

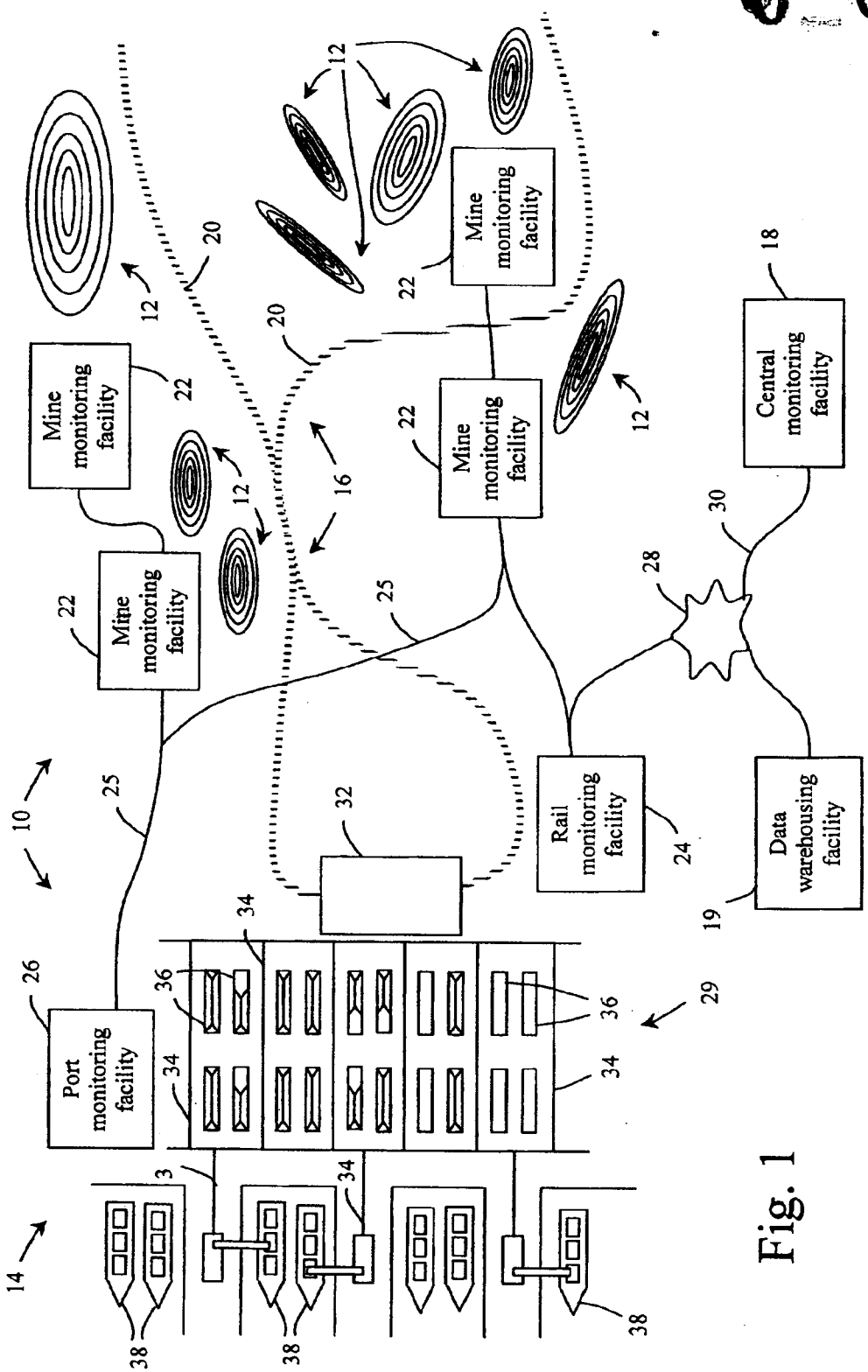

Fig. 1

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

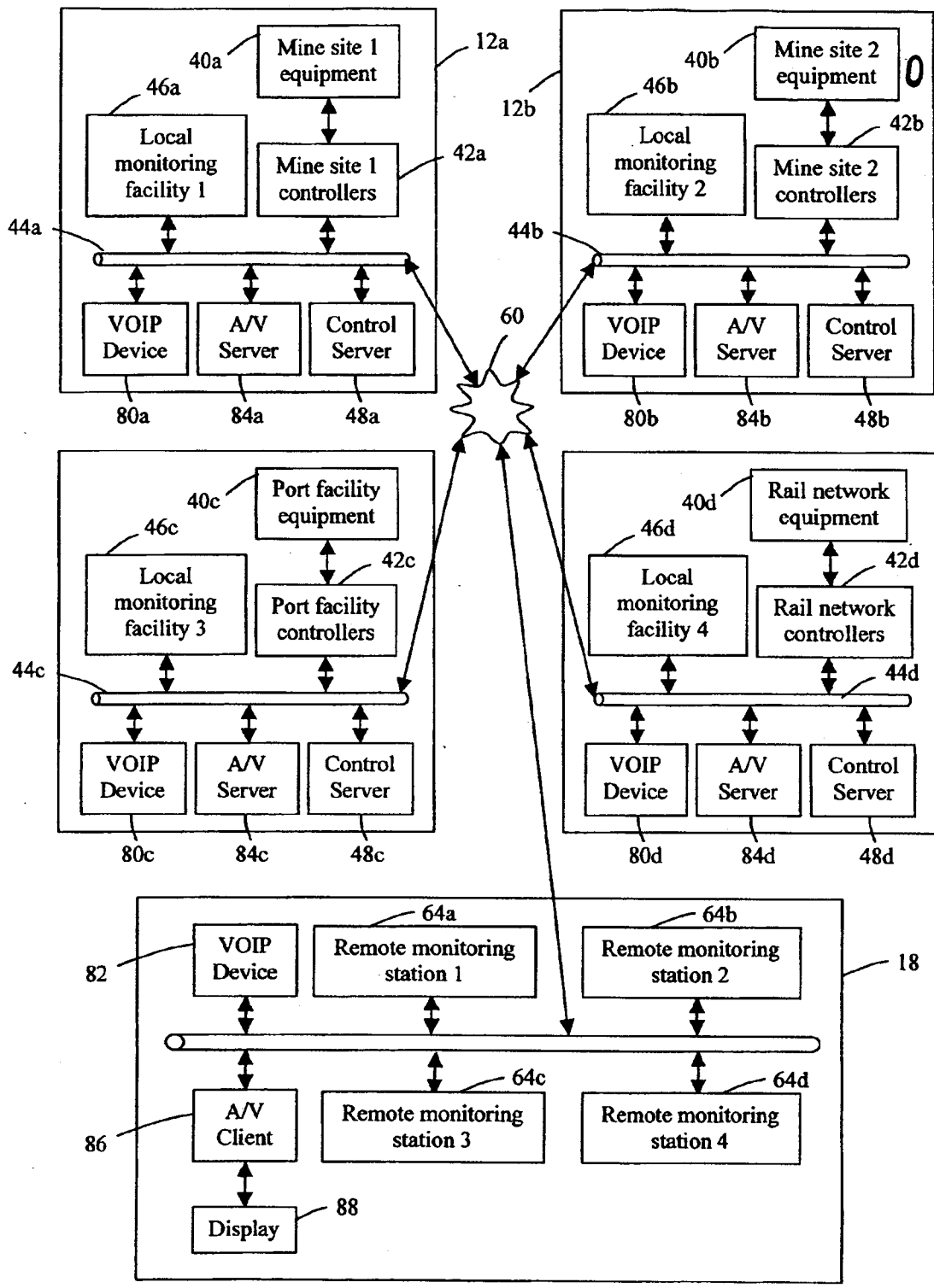

Fig. 2

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

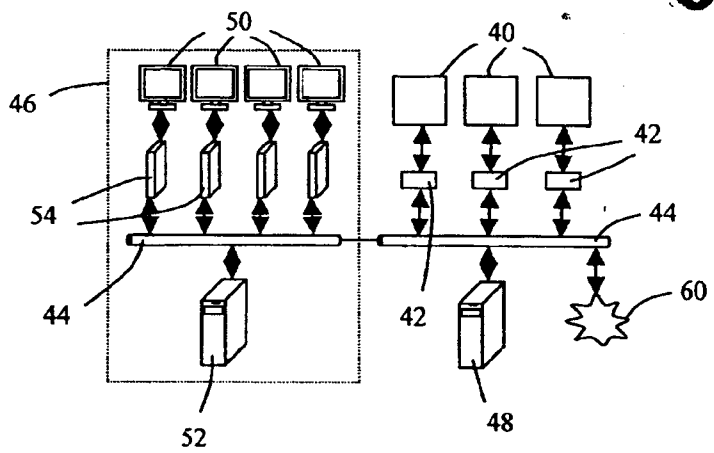

Fig. 3

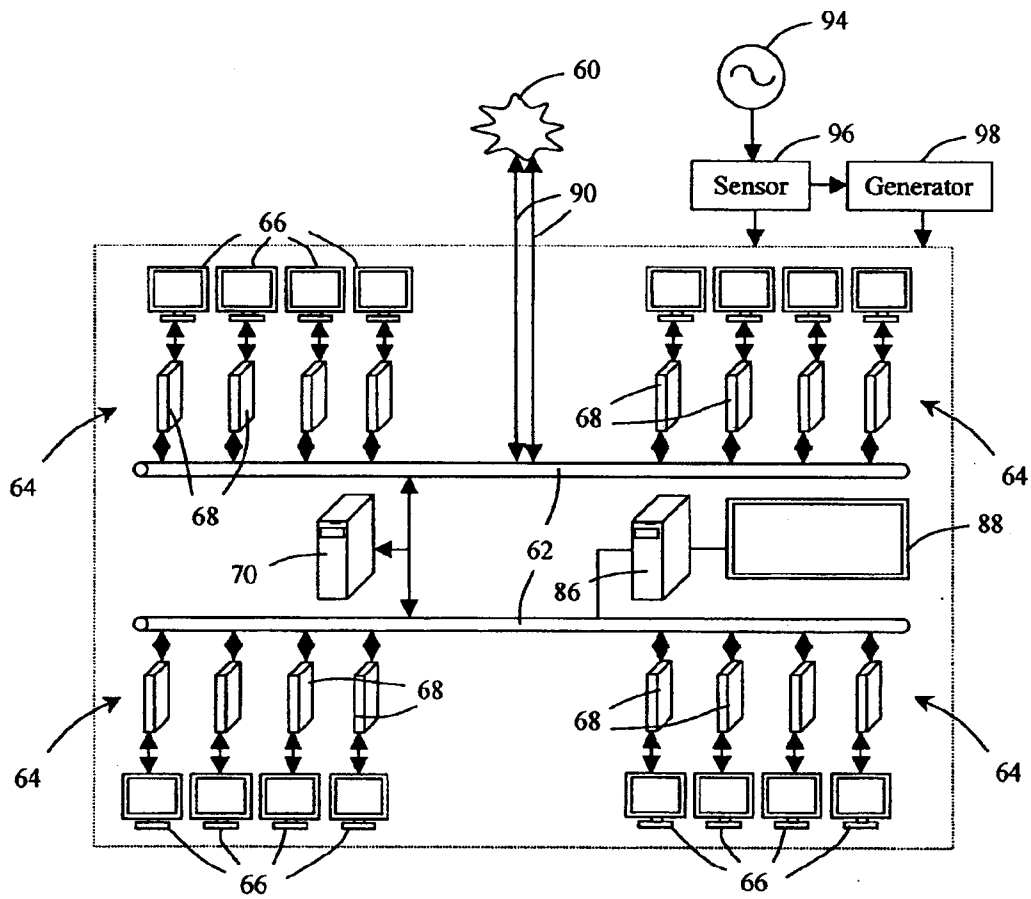

Fig. 4

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

0-68 DELNP 12

03 JAN 2012

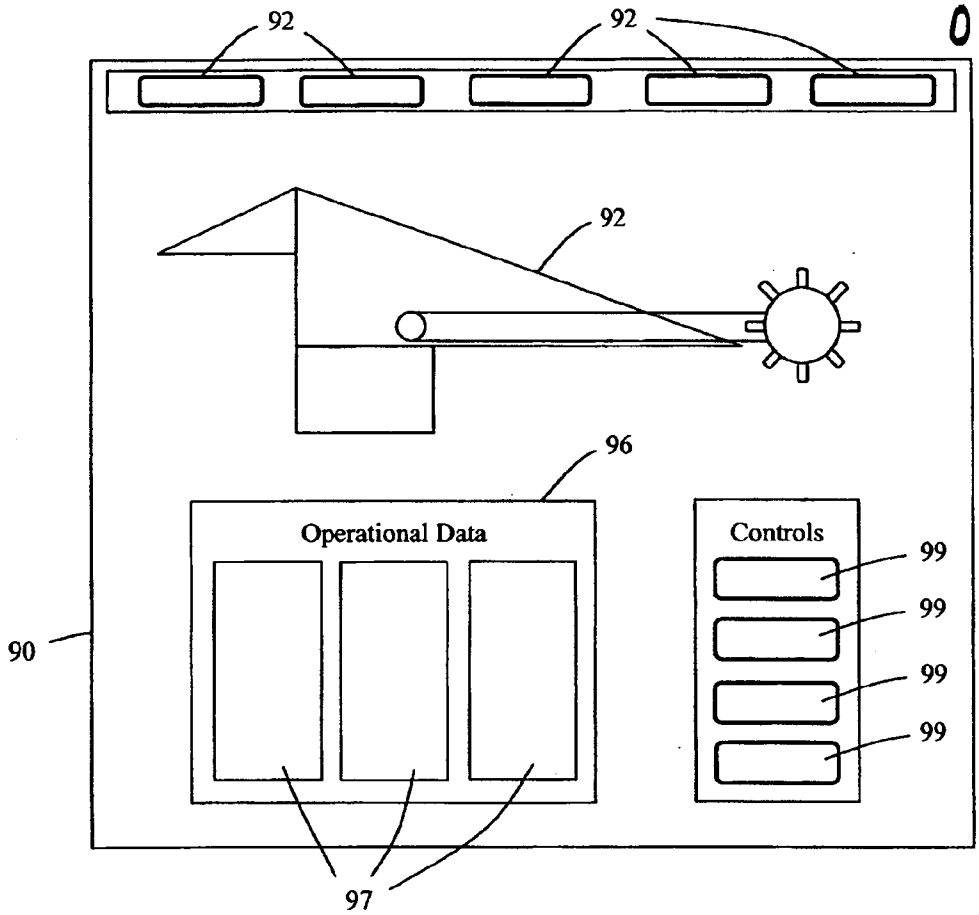

Fig. 5

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

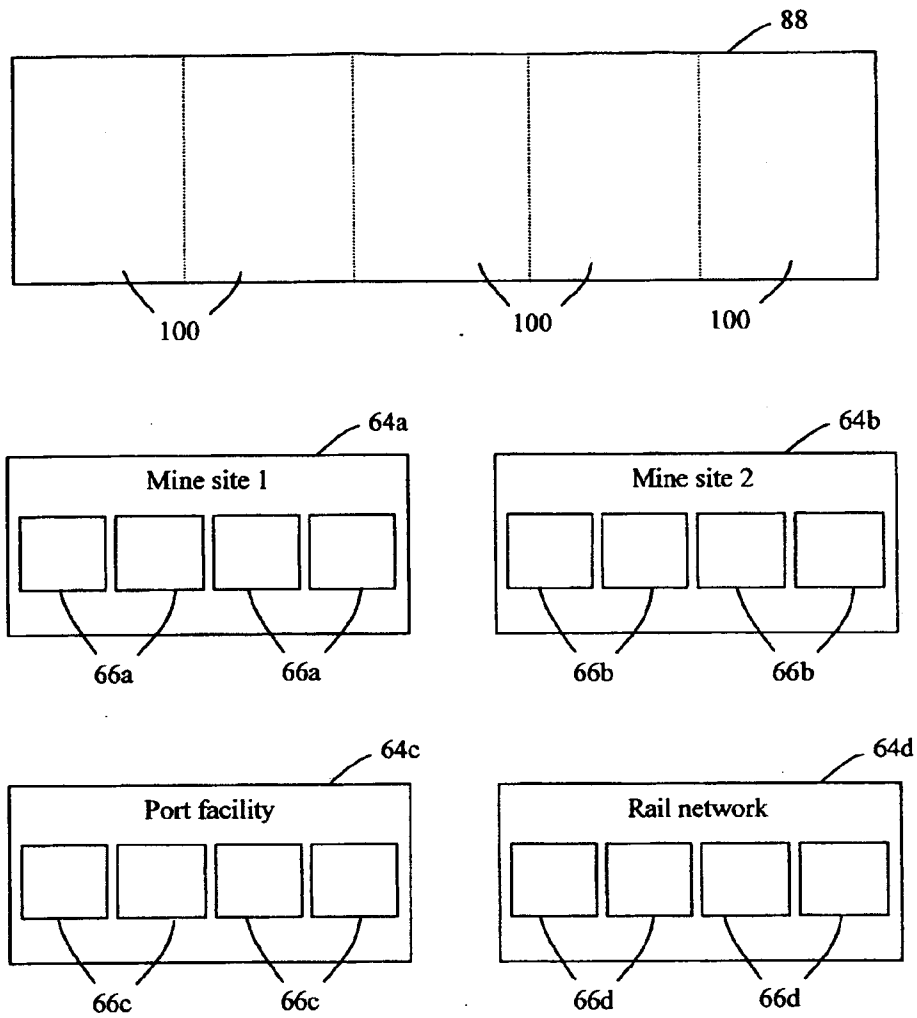

Fig. 6

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

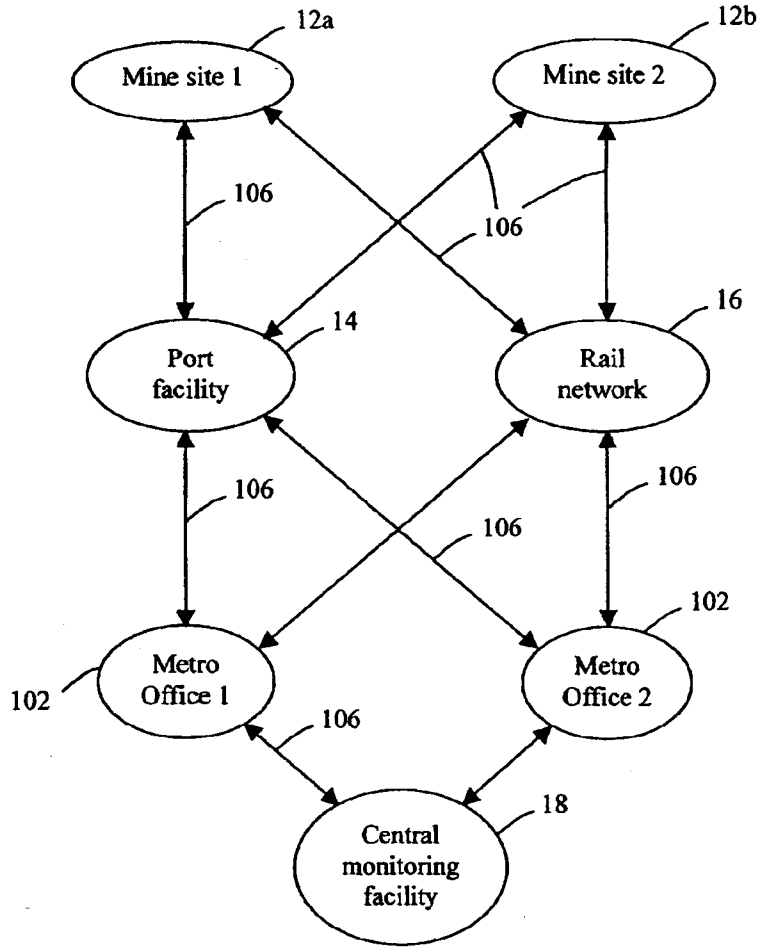

Fig. 7

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

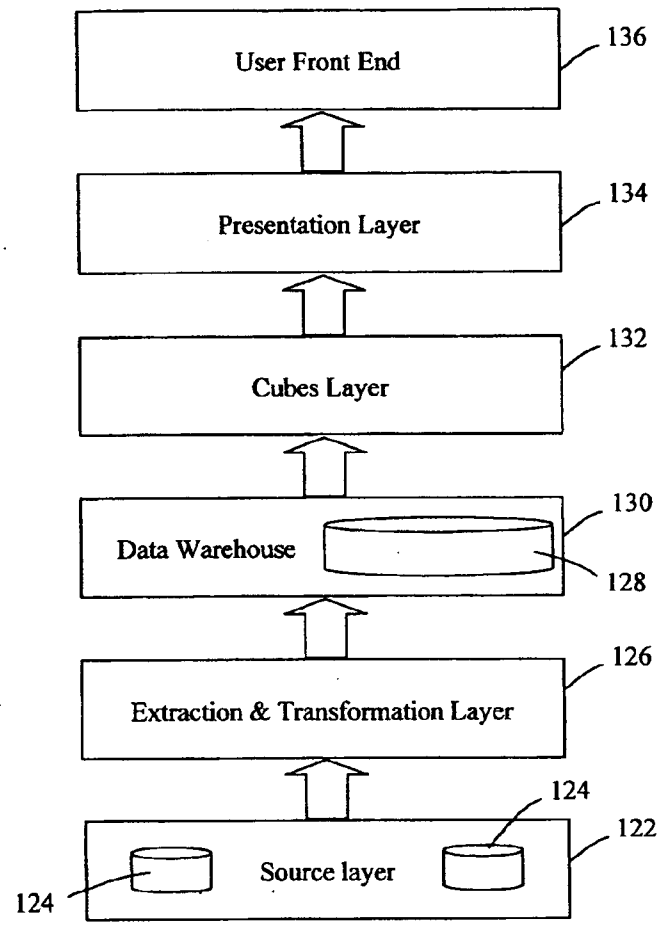

Fig. 8

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

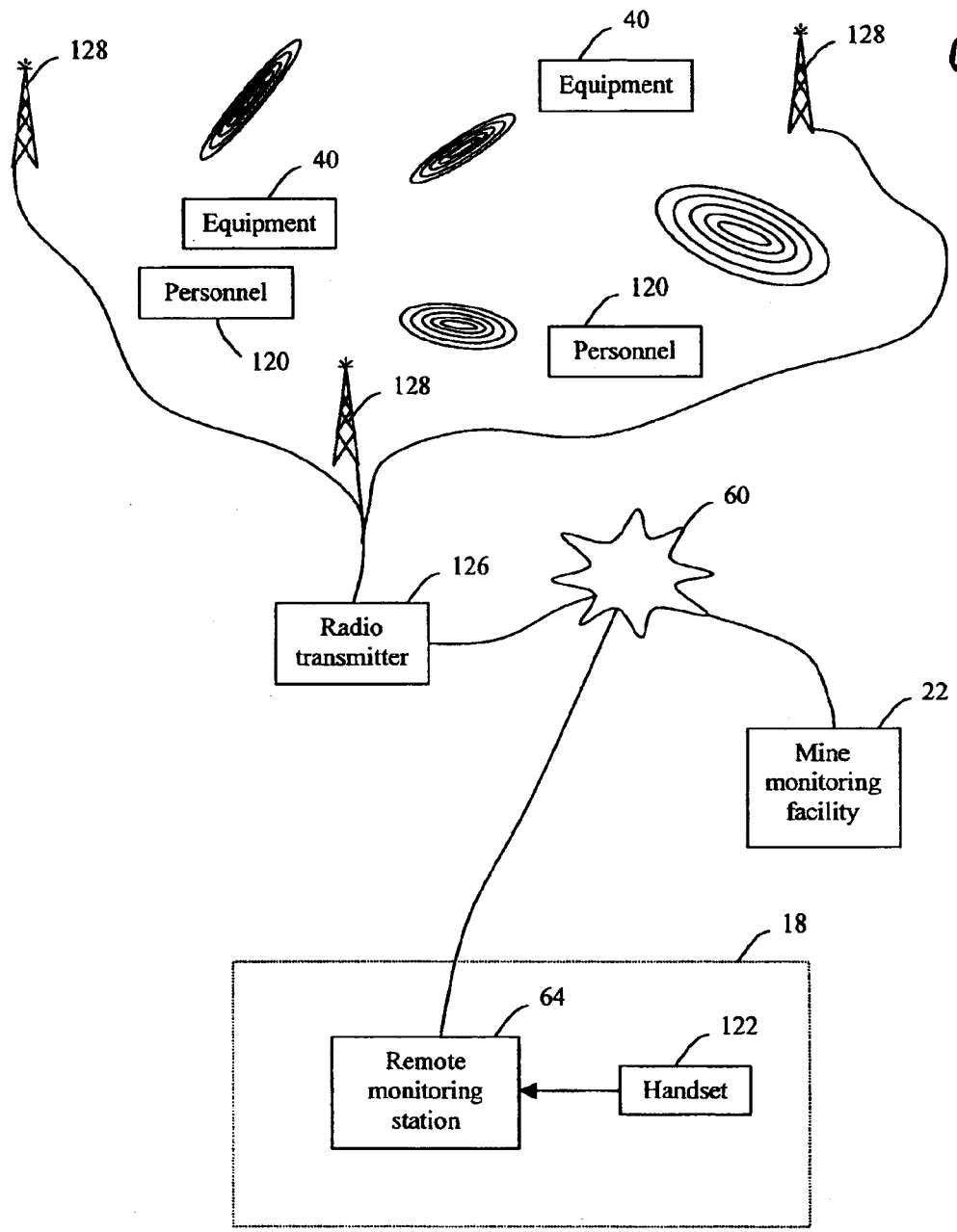

Fig. 9

(DIVYA KAPOOR)
Of SUBRAMANIAM, NATARAJ & ASSOCIATES
Attorneys for the Applicants

invention, there is provided a mine operation monitoring system comprising:

a plurality of equipment interfaces, each equipment interface being located at a mine operation and being associated with at least one item of mine equipment, and each equipment interface being arranged to monitor and control operation of the at least one associated item of equipment;

a plurality of remote monitoring stations remotely located relative to at least one of the mine operations at a remote monitoring facility, each remote monitoring station being arranged to communicate with at least one equipment interface associated with a different mine operation so as to monitor and control operation of the at least one item of equipment associated with said at least one equipment interface from the remote monitoring station; and

a communications network arranged to facilitate communications between the equipment interfaces and the remote monitoring stations;

whereby a plurality of items of equipment associated with multiple mine operations are monitorable and controllable from the remote monitoring facility.

In one embodiment, the system comprises

a plurality of local monitoring stations, each local monitoring station being located at a mine operation, and being arranged to communicate with the at least one equipment interface associated with the mine operation so as to monitor and control operation of the at least one item of equipment associated with the at least one equipment interface from the mine operation;

wherein a plurality of items of equipment associated with multiple mine operations are monitorable and controllable from the remote monitoring facility and each item of equipment is also monitorable and controllable from the respective local monitoring station.

In one embodiment, each mine equipment interface is arranged to control operation of the at least one associated item of mine equipment in response to a control signal, and each of the local and remote monitoring stations is arranged to send control signals to the mine equipment interfaces in response to operator input.

In one embodiment, each mine equipment interface comprises at least one programmable logic controller (PLC).

In one embodiment, at least one of the mine operations is provided with a control server arranged to receive control commands for at least one item of equipment associated with the mine operation and to generate control signals for controlling operation of the at least one item of equipment in response to the control commands.

In one embodiment, the system further comprises a local VOIP device at at least one mine operation and a remote VOIP device at the remote monitoring facility, the local and remote VOIP devices facilitating audio communications between the at least one mine operation and the remote monitoring facility through the communications network.

In one embodiment, the system comprises at least one local A/V device disposed at a mine operation and arranged to capture audio and/or video information from the mine operation and at least one remote A/V client device disposed at the remote monitoring facility, the local and remote A/V devices facilitating audio and/or video communications between the mine operation and the remote monitoring facility.
The system may be arranged to use a multi-cast protocol to transmit A/V communications indicative of the audio and/or video information to the remote monitoring facility such that multiple operators are able to simultaneously receive

the A/V communications.

In one embodiment, the system further comprises a still and/or video camera at at least one mine operation, and a display disposed at the remote monitoring facility, the system being arranged to display images captured by said at least one camera on the display. The display may be of sufficient size such that the images on the display are easily viewable by all operators at the remote monitoring facility. In one embodiment, the system is arranged such that images associated with multiple still and/or video cameras are viewable on the display, and may be arranged such that images associated with multiple still and/or video cameras located at multiple mine operations are viewable on the display.

In one embodiment, the mine operations comprise at least one mine site, at least one port facility and/or at least one rail network.

In one embodiment, the system is arranged to monitor whether communications between the remote monitoring facility and the mine operations are possible and to generate an alarm signal when an indication is obtained that a communications outage may have occurred between the remote monitoring facility and one of more mine operations. The system may be arranged to require that a handshake occurs periodically between the remote monitoring facility and the mine operations, such as by configuring the equipment interfaces to periodically send a heartbeat communication to an associated remote monitoring station, and by configuring the remote monitoring stations to send a reply signal indicating that the heartbeat communication has been received.

The system may further be arranged to prioritise communications between the mine operations and the remote

monitoring facility according to communication type. In one embodiment, the system may be arranged to prioritise communications by allocating different bandwidth percentages to different types of communications, such as to communications related to monitoring and control activities, VOIP communications, CCTV data, email, file transfers, and so on. In one arrangement, communications related to monitoring and control activities, and VOIP communications are given higher bandwidth percentages than CCTV data, email and file transfers. In an alternative embodiment, different types of communications are allocated different priority values which are used by routers in the communications network to manage queues in the routers and thereby the speed of transfer of the communications through the routers.

The priority values may be allocated according to the IP addresses associated with a communication.

In one embodiment, the IP addresses of all network enabled devices in the system are recorded in system routers and the priority level allocated by the routers according to the priority level recorded for the network addresses in the routers.

In one embodiment, all communications to or from a network enabled device having an IP address that is not associated with a communication between a mine operation and the remote monitoring facility are allocated a priority level lower than communications between a mine operation and the remote monitoring facility.

In one embodiment, the communications network comprises multiple network paths for transferring communications between each mine operation and the remote monitoring facility so that a backup network connection is available should one or more network connection fail between the

mine operations and the remote monitoring facility.

In one embodiment, the communications network comprises a plurality of nodes between a mine operation and the remote monitoring facility, the communications network being arranged such that network traffic through the communications network is re-routable through the nodes should an outage occur at a communications link between at least two nodes.

In one embodiment, each remote or local monitoring station comprises at least one computer terminal, each terminal being arranged to monitor mine equipment at a mine operation. At least one remote or local monitoring station may comprise a plurality of computer terminals. In one embodiment, a plurality of terminals are provided for at least one operator so that the operator is able to monitor a plurality of mine equipment simultaneously.

In one embodiment, at least one of the terminals comprises a web browser and the system is arranged such that mine equipment is monitorable and controllable within a web browser. The system may be arranged such that a representation of the mine equipment being monitored and/or controlled is displayed on a terminal.

The computer terminals may be realized using multiple computing devices, or using at least one terminal server and at least one thin client device.

In one embodiment, the system further comprises an audio messaging system usable to communicate audio between personnel at a mine operation and the remote monitoring facility. The audio messaging system may include at least one radio transmitter disposed at the mine operation, and at least one portable radio receiving device for use by mine personnel at the mine operation;

data indicative of audio information received at the monitoring station being communicated to the radio transmitter through the communications network;

the audio messaging system being arranged to convert the data to a radio signal indicative of the audio information; and

the radio transmitter being arranged to transmit the radio signal to one or more of the radio receiving devices.

In one embodiment, the system comprises multiple network connection arrangements for connecting the remote monitoring stations with the communications network so that a backup network connection is available should one of the network connections between the remote monitoring facility and the communications network fail.

In one embodiment, the system comprises multiple power supply arrangements for supplying electrical power to the remote monitoring facility such that should supply of electrical power by one of the power supply arrangements to the remote monitoring facility fail, another power supply arrangement is used to provide the remote monitoring facility with electrical power.

In one embodiment, the remote monitoring facility is disposed at or adjacent an airport.

In accordance with a second aspect of the present invention, there is provided a mine operation monitoring system comprising:

a plurality of equipment interfaces, each equipment interface being located at a mine operation and being associated with at least one item of equipment, and each equipment interface being arranged to monitor and control operation of the at least one associated item of equipment; and

a local monitoring station disposed locally relative to the mine operation and arranged to communicate with the at least one equipment interface so as to monitor and control operation of the at least one item of equipment associated with the at least one equipment interface from the mine operation;

the system being arranged to communicate with a remote monitoring station remotely located relative to the mine operation at a remote monitoring facility such that the at least one item of equipment associated with the mine operation is monitorable and controllable from the remote monitoring facility.

In accordance with a third aspect of the present invention, there is provided a mine operation monitoring facility for a plurality of mine equipment interfaces, each mine equipment interface being located at a mine operation and being associated with at least one item of mine equipment, and each equipment interface being arranged to monitor and control operation of said at least one item of mine equipment, the facility comprising:

a plurality of adjacently disposed monitoring stations remotely located relative to the mine operations, each monitoring station being arranged to communicate through a wide area network with at least one equipment interface associated with a different mine operation so as to monitor and control operation of the at least one item of mine equipment associated with said at least one mine equipment interface from the monitoring facility;

whereby a plurality of items of mine equipment associated with multiple mine operations are monitorable and controllable from the same location.

In accordance with a fourth aspect of the present invention, there is provided a method of monitoring mine equipment at a plurality of mine operations, said method comprising:

providing a plurality of mine equipment interfaces, each mine equipment interface being located at a mine operation and being associated with at least one item of mine equipment;

arranging each mine equipment interface to monitor and control operation of the at least one item of mine equipment associated with the mine equipment interface;

providing a plurality of adjacently disposed remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility;

facilitating communications between each remote monitoring station and at least one equipment interface associated with a different mine operation so as to monitor and control operation of the items of mine equipment associated with said at least one equipment interface from the remote location;

providing a plurality of local monitoring stations, each local monitoring station being locally located at a mine operation;

facilitating communications between each local monitoring station and the at least one mine equipment interface associated with the mine operation so as to monitor and control operation of the items of equipment associated with said at least one equipment interface from the mine operation; and

monitoring and controlling a plurality of items of equipment associated with multiple mine operations either from the remote monitoring facility or from respective local monitoring stations.

In accordance with a fifth aspect of the present invention, there is provided a mine operation monitoring system for monitoring at least 4 mine operations, said system comprising:

a plurality of mine equipment interfaces, each mine equipment interface being located at a mine operation and being associated with at least one item of mine equipment,

and each mine equipment interface being arranged to monitor and control operation of the at least one associated item of mine equipment;

at least 4 remote monitoring stations remotely located relative to the mine operations at a remote monitoring facility, each remote monitoring station being arranged to communicate with at least one equipment interface associated with a different mine operation so as to monitor and control operation of at least one item of mine equipment associated with said at least one equipment interface from the remote location;

at least 4 local monitoring stations, each local monitoring station being located at a mine operation, and being arranged to communicate with the at least one mine equipment interface associated with the mine operation so as to monitor and control operation of the at least one item of equipment associated with said at least one equipment interface from the mine operation; and

a communications network arranged to facilitate communications between the equipment interfaces, the local monitoring stations and the remote monitoring stations;

whereby a plurality of items of equipment associated with at least 4 mine operations are monitorable and controllable either from the remote monitoring facility or from respective local monitoring stations.

In accordance with a sixth aspect of the present invention, there is provided a system for controlling from a central operations facility plant and equipment associated with a plurality of mine sites for producing bulk commodities and associated with one or more networks or rail lines for transportation of said bulk commodities produced at said mine sites a distance exceeding 250km to one or more port facilities and associated with said one or more port facilities,

the plant and equipment connected to a communications network to thereby receive operating commands transmitted

Brief Description of the Drawings

The present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic conceptual diagram illustrating a plurality of mine operations and components of a mine operation monitoring system according to an embodiment of the present invention;

Figure 2 is a block diagram illustrating a mine operation monitoring system according to an embodiment of the present invention;

Figure 3 is a diagrammatic representation showing components of the mine operation monitoring system disposed at a mine operation;

Figure 4 is a diagrammatic representation showing components of the present invention disposed at a central monitoring facility;

Figure 5 is a diagrammatic representation of an example screen displayed to an operator at a monitoring station at a mine operation or at a central monitoring facility

Figure 6 is a conceptual diagram illustrating an example layout of components of the present invention disposed at the central monitoring facility;

Figure 7 is a diagrammatic representation of an example wide area network configuration which may be used in an embodiment of the present invention;

Figure 8 is a software architecture diagram illustrating storage and handling of data in the mine operation monitoring system; and

Figure 9 is a conceptual diagram illustrating a mine operation including an audio messaging system of a mine operation monitoring system according to an embodiment of the present invention.

communicates with the central monitoring facility 18 via a wide area network (WAN) 28. The central monitoring facility 18 may be in communication with a metropolitan area network (MAN) 30 connected to the WAN 28.

The monitoring facilities 22, 24, 26 incorporate operator monitoring stations from which operators may monitor, activate, deactivate and control operation of plant and equipment at the mine sites 12, the rail network 16 and the port facility 14.

The central monitoring facility 18 incorporates a remote monitoring station for each mine operation 12, 14, 16. Using the remote monitoring stations, operators monitor, activate, deactivate and control operation of plant and equipment at the mine sites 12, the rail network 16 and the port facility 14.

The scheduling system may also include a data warehousing facility 19 in networked communication with the mine operations 12, 14, 16 and the central monitoring facility 18. The data warehousing facility 19 may be arranged to receive at least some operational data from the mine operations 12, 14, 16 and store the operational data in a data warehouse. The operational data stored in the data warehouse may be subsequently retrieved by the central monitoring facility 18.

In operation, each mine site 12 typically has daily, weekly, monthly and annual schedules for mining of ore and waste. Transportation of ore from each of the mine sites 12 to the port facility 14 is typically scheduled according to the daily, weekly and monthly schedules of the various mine sites 12. A stock yard 29 receives ore from the rail network 16 at a train load out facility 32 which places the ore onto conveyors 34 that in turn route the ore to a designated stock pile 36. The placement of

ore onto the stockpiles 36 is scheduled so that the ore from the various mine sites 12 is blended to produce a uniform product prior to loading onto ships 38 at the port facility 14. Alternately, the stock piles 36 may be blended into various qualities of ores, such as high grade ore and low grade ore or ore with specific characteristics. Alternately, ore may be blended at each mine site 12 prior to railing so that each mine site 12 produces a specified average grade of ore that is then railed to the port facility 14. Under these conditions the ore is routed from the train load out facility 32 to a designated stock pile 36 without further blending.

In one embodiment, some operational data from each mine site 12, from the rail network 16 and from the port facility 14 is displayed centrally at the central monitoring facility 18. Preferably, the operational data for central display at the central monitoring facility 18 is updated at a rate that is at least an order of magnitude slower than the rate at which data at the operator monitoring stations is updated. This reduces, and preferably minimises, the bandwidth requirements between the central monitoring facility 18 and the mine sites 12, the rail network 16 and the port facility 14. Alternately, or in addition, some or all of the data for central display is sourced in association with the relevant monitoring stations so that bandwidth requirements of the communications network between the central monitoring facility 18 and the mine sites 12, the rail network 16 and the port facility 14 is reduced, and preferably minimised.

Plant and equipment at each mine site 12, within the rail network 16, and at the port facility 14 (including the stock yard facility 29) can be monitored and controlled from the local monitoring stations at the local monitoring

equipment to be monitored, operated and controlled locally in the event of an interruption to communications between the central monitoring facility 18 and any of the various mine, port and rail control facilities 22, 24, 26.

Location of the plant and equipment servers locally at the mine sites 12, the port facility 14 and the rail network 16 also ensures that network overheads are not too large during use.

In circumstances wherein the central monitoring facility 18 communicates with the mine control, rail control and port control facilities 22, 24, 26 over a corporate network that also carries e-mail, and other non-time-critical data traffic, it is preferable that the operating commands transmitted from the remote monitoring stations to plant and equipment servers and operational data received from the plant and equipment servers occur in real time or near real time such that an operator located at the central monitoring facility 18 perceives an average system response time between transmitting operating commands and seeing operational data displayed in response is less than 2.0 seconds. Preferably the delay is less than 1.5 seconds and preferably less than 1.0 seconds.

A particular embodiment of the mine operation monitoring system 10 for the mine operations 12, 14, 16 shown in Figure 1 will now be described with reference to Figures 2, 3 and 4 of the drawings.

Each mine operation 12, 14, 16 includes equipment 40 which may be distributed around the mine operation, and each item of mine equipment 40 is electronically monitorable and controllable by an equipment interface device, in this example a mine equipment controller 42 which may be in the form of a programmable logic controller (PLC).

The equipment 40 at a mine site 12 may include crushers, screens, conveyor belts, stackers & reclaimers, train load out facilities, mobile equipment including trucks and excavators. The equipment at the rail network 16 may include locomotives, track based signalling systems, points, wayside equipment and wayside signals. The equipment at the port facility (including the stock yard 29) may include rail car unloading facilities, conveyor belts, stackers & reclaimers and ship loaders. However, it will be understood that any monitorable and/or controllable equipment for use in a mine operation is envisaged.

The mine equipment controllers 42 are each connected to a local network 44, which may be of LAN type. Also connected to the local network 44 is a control server 48 which is arranged to coordinate control of the items of mine equipment by the local monitoring station 46. The equipment controllers 42 through the control server 48 are arranged to receive control signals from and send signals to a local monitoring station 46 disposed at the mine operation 12, 14, 16.

As shown more particularly in Figure 3, each local monitoring station 46 includes a plurality of terminals 50, each of which is arranged to display information indicative of and facilitate monitoring and/or control of different items of equipment 40 associated with the mine operation 12, 14, 16. For example, the terminals 50 may be arranged to enable mine personnel to monitor and control items of mine equipment 40 grouped by equipment type, equipment location, or in any other way.

In the present example, the terminals 50 are of thin client type and, as such, a terminal server 52 and a plurality of thin client devices 54 are provided. This arrangement allows multiple computing devices to be

The local networks 44 at the respective mine operations 12, 14, 16 are connected to a wide area network (WAN), which may comprise the Internet 60, a dedicated wide area network (WAN), or any other suitable wide area communications network, and through the WAN 60 to the central monitoring facility 18, in this example disposed remotely relative to all of the mine operations 12, 14, 16, for example at a metropolitan location.

The central monitoring facility 18 comprises a network 62 which may be in the form of a local area network (LAN) in communication with the wide area network 60 and thereby with the respective local networks 44 at the mine operations 12, 14, 16.

The central monitoring facility 18 also comprises a plurality of remote monitoring stations 64, each of which in this example is associated with one of the mine operations 12, 14, 16. As shown in Figure 4, each remote monitoring station 64 is similar in configuration to a local monitoring station 46 in that a plurality of terminals 66 are provided, each terminal 66 having an associated thin client device 68 and the thin client devices 68 communicating with a terminal server 70 through the network 62 in order to implement a plurality of computing devices at each monitoring station 64.

The remote monitoring stations 64 operate in a similar way to the local monitoring stations 66 in that a number of operators are able to use the terminals 66 associated with a remote monitoring station 64 to monitor and/or control mine equipment, with each remote monitoring station 64 typically being associated with one mine operation 12, 14, 16 and thereby with equipment 40 associated with the mine operation 12, 14, 16.

central monitoring facility 16 and the wide area network 60 fail.

Similarly, a power backup arrangement is provided such that should mains power 94 to the central monitoring facility 16 fail, the failure condition is detected by a suitable sensor 96 which actives a backup generator 98 to commence providing electrical power to the central monitoring facility 16.

For this reason, the central monitoring facility according to the present embodiment may be located at, or in the vicinity of, an airport of the type which already comprises suitable backup communications and power arrangements.

The system 10 may also be arranged to monitor whether communications between the central monitoring facility 18 and the mine operations are reaching their destination, for example by requiring a handshake to occur periodically between the central control facility 18 and the mine operations 12, 14, 16. In the present example, this is achieved by configuring the equipment controllers 42 to periodically send a heartbeat communication to an associated remote monitoring station 64. On receipt of the heartbeat communication, the remote monitoring station is arranged to send a reply signal indicating that the heartbeat communication has been received.

If the reply signal is not received, an alarm signal may be generated to indicate to appropriate personnel that an outage may have occurred between the central monitoring facility 18 and one of more mine operations 12, 14, 16.

Referring to Figure 6, a conceptual layout of the central monitoring facility 16 is shown. In this example, two mine operations 12a, 12b, one port operation 14, and a

rail network 16 are monitored and controlled from the central monitoring facility, with the port operation, rail network and each mine site having an associated separate monitoring station 64a, 64b, 64c, 64d and associated respective terminals 66a, 66b, 66c, 66d.

A display 88 is provided that is of a sufficiently large size such that information, such as data, images and/or video shown on the display is easily viewable by all operators associated with the remote monitoring stations 64, and in this example the common display 88 is separated into a plurality of display areas 100, each of which is associated with a different aspect of the mine operations.

In this example, each of the mine sites 12 and the port facility 14 has a dedicated remote monitoring station 64a, 64b, 64c such that plant and equipment associated with the port facility 14 or with a particular mine site 12 may be monitored and controlled from one monitoring station 64a, 64b, 64c. Similarly, the rail network 16 may be monitored from a single monitoring station 64d.

A conceptual diagram of a wide area network 102 which may be used with the present invention is shown in Figure 7. The diagram shows interconnected nodes, including mine operations 12, 14, 16 metropolitan offices 104 and the central monitoring facility 18. In order to improve reliability of the WAN 102, each node in the network is connected to at least two other nodes, and in some cases to four other nodes using respective communications links 106 so that should one or more of the communications links fail, traffic may be re-routed through other nodes and other communications links which are still active.

The operational data indicative of the operational status of equipment at the mine operations may be derived directly from the equipment interfaces associated with the

equipment, and/or at least some of the operational data may be stored in a common database or in a plurality of associated databases which may be disposed at the same or different locations and extracted as required.

An example of a data storage and distribution infrastructure 120 used in the present monitoring system is shown in Figure 8.

The infrastructure 120 includes a data source layer 122 having a plurality of databases 124, each of which is arranged to derive data from one or more sources from one or more mine operations, and an extraction/transformation layer 126 arranged to act on the data in the databases to produce data of suitable type for storage in a common data warehouse 128 in a data warehouse layer 130.
The data in the data warehouse 128 is organized into data cubes at a cubes layer 132 such that near real-time pre aggregated and highly indexed data is produced. This allows for sub second response times to queries.

The infrastructure 120 also includes a presentation layer 134 arranged to serve data in the data cubes to users on request, and a user front end layer 136 which comprises the common display and the terminals 66. The presentation layer 134 may be implemented using web browsers or any other suitable interface arranged to communicate with the presentation layer 134.

Referring to Figure 9, there is shown a mine operation which includes an audio messaging system usable to transfer audible messages between personnel 140 at the mine operation and at the central monitoring facility 18. The audio messaging system includes an audio device, for example in the form of a handset 142, disposed at the central monitoring facility 18 and in this example arranged to interface with a remote monitoring station 64