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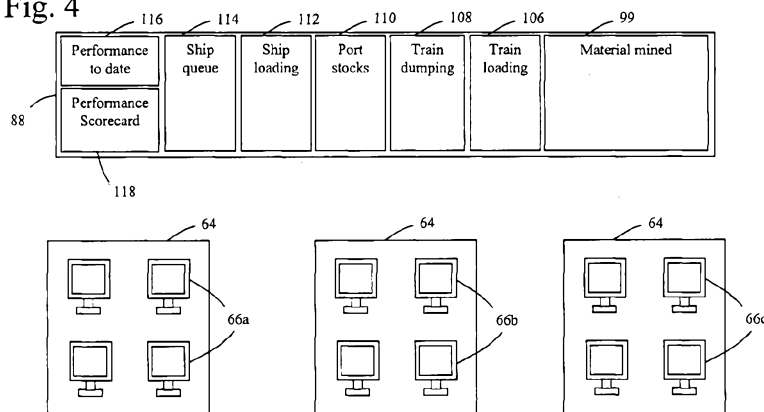
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Fig. 4



(57) **Abstract:** A system for scheduling mine activities is disclosed. The system comprises a plurality of sources of operational data indicative of scheduling relevant information associated with a plurality of mine operations, at least some of which are inter-dependent, a scheduling facility remotely disposed relative to the mine operations, the scheduling facility comprising at least one display, and a communications network arranged to facilitate transfer of the operational data from the mine operations to the scheduling facility. The scheduling facility is arranged to use the operational data to display scheduling relevant information indicative of the status of a production workflow such that a scheduling operator at the scheduling facility is provided with an overview of production workflow across at least the interdependent mine operations.

A MINE SCHEDULING SYSTEMField of the Invention

5 The present invention relates to a mine scheduling system for scheduling activities at a plurality of mine operations.

Background of the Invention

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It is known to provide a mine operation, such as a mine rail network, with a scheduling system arranged to facilitate scheduling of operations in the rail network.

15 However, with such a scheduling system it is necessary for operators to travel to the mine operation, which can be expensive for mining operators.

Summary of the Invention

20

It will be understood that in the present specification a mine operation means any operation or facility associated with extracting, handling, processing and/or transporting bulk commodities in a resource extraction environment or
25 part of such a process, for example mine sites, rail facilities, port facilities, and associated infrastructure. It will also be understood that in this specification interdependence in relation to a plurality of mine operations is intended to mean that at least one
30 mine operation is common to several other mine operations in a production and/or transportation workflow, such as at least part of a rail facility which is common to several mine sites and/or common to several port facilities; or that an activity or occurrence at one of the mine
35 operations has an effect on at least one other mine operation, for example the quality of ore extracted from a mine site and disposed in a stockpile at the mine site

affects the quality of ore in a port stockpile, or disruption to extraction of ore at a mine site has an effect on operation of the rail network, and so on.

- 5 In accordance with a first aspect of the present invention, there is provided a system for dynamically scheduling mine activities at a plurality of mine operations including mine sites and associated infrastructure distributed across at least one regional
- 10 area and together producing ore, the associated infrastructure including a rail network servicing the mine sites and a plurality of trains associated with the rail network, the system comprising:
- 15 a plurality of sources of operational data indicative of scheduling relevant information associated with a plurality of mine operations and associated infrastructure, the operational data including information indicative of the locations of trains on the rail network;
 - 20 a scheduling facility common to the plurality of mine sites and associated infrastructure;
 - a communications network arranged to facilitate transfer of the operational data from the mine operations and associated infrastructure to the scheduling facility;
 - 25 the scheduling facility arranged to receive operational data from the plurality of mine sites and associated infrastructure, and to use a selected sub-set of the operational data to display information at the scheduling facility indicative of a production rate of ore from said mine sites and associated infrastructure and of
 - 30 the locations of trains on the rail network, so that a production rate at a mine site below a scheduled production rate is identifiable and in response an alternate mine site to the mine site experiencing a production rate below the scheduled production rate at
 - 35 which to load ore is identifiable.

In an embodiment, the scheduling facility is arranged to

use the operational data to display performance information at the operations facility, and to communicate deviations from expected performance by changing the appearance of the performance information.

5

In one embodiment, the sources of operational data comprise a plurality of interface devices, each interface device being arranged to monitor operation of at least one item of mine equipment. At least one interface device may
10 comprise at least one programmable logic controller (PLC).

In one embodiment, the sources of operational data comprise data derived from assays.

15 In one embodiment, the system comprises a data warehousing facility in networked communication with the mine operations and the scheduling facility, the data

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warehousing facility being arranged to store operational data and/or scheduling information derived from the mine operations for use by the scheduling facility.

- 5 The system may be arranged to provide scheduling relevant information in a format usable by a web browser such that the scheduling relevant information is displayable on a web browser.
- 10 In one arrangement, the display is arranged to display a web browser, and the data warehousing facility comprises a web server arranged to serve web pages indicative of the scheduling information to the web browser.
- 15 In one arrangement, a plurality of displays are provided, each display having an associated web browser arranged to display the scheduling relevant information.

In one embodiment, the operational data is indicative of one or more of the following:

- 20
- stock pile levels available for loading onto trains at one or more mine sites
 - ore quality information associated with one or more stock piles of ore at one or more mine sites

25

 - operational status of train loading equipment at one or more mine sites
 - operational status of ore processing facilities at one or more mine sites

30

 - operational status of said train network or part of said train network
 - operational status of train consists on said network
 - operational status of rail wagon unloading equipment at said stock yard

35

 - operational status of stock yard and associated equipment
 - operational status of ship loading equipment
 - ships in port waiting to be berthed

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- ships berthed at port waiting to be loaded
- berth status information for each wharf at said port facilities.

5 In one embodiment, the system is arranged to modify operational data received from at least one of the sources of scheduling relevant information such that the displayed scheduling information in an appropriate format for scheduling personnel.

10

The scheduling information may comprise number metrics indicative of performance of respective aspects of the production workflow.

15 In one embodiment, a target number metric and an actual number metric are provided for at least one of said aspects of the production workflow.

20 In one embodiment, a record number metric indicative of a record performance achieved for the number metric is provided for at least one of said aspects of the production workflow.

25 In one embodiment, the scheduling information comprises time information indicative of any one or more of estimated arrival, commencement and/or finish times.

30 In one embodiment, the scheduling information comprises mine site, port facility, ship identifiers and/or train identifiers.

In one embodiment, the scheduling information is indicative of the number of ship loads of material in a stockpile and/or the number of days until a stockpile is full.

35

In one embodiment, the scheduling information comprises at least one status icon, the appearance of each status icon being indicative of performance of an aspect of the production workflow.

5

In one arrangement, the system comprises at least one status icon indicative of loading or unloading progress.

The status icon may be indicative of loading or unloading progress comprises a representation of a ship and an indication as to fill level of the ship during loading.

10

In one arrangement, the system comprises at least one stockpile status icon indicative of amount of a target material in a stockpile.

15

The stockpile status icon may comprise a plurality of icon segments, each icon segment being associated with a different target material in a stockpile.

20

In one embodiment, the system is arranged to modify the appearance of the scheduling information according to defined conditions. The defined conditions may be performance below target, performance at or above target, record performance, or operational data which is outdated.

25

In one embodiment, the or each display is of sufficient size such that the images on the or each display are easily viewable by scheduling operators at the remote scheduling facility.

30

In one embodiment, the system comprises a single common display for displaying scheduling relevant information.

In one embodiment, the system comprises a plurality of displays, each display being arranged to display the

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scheduling relevant information or part of the scheduling relevant information.

5 In one arrangement, the display includes at least some of a material mined display area, a mine stockpile display area, a train loading display area, a train dumping display area, a port stocks display area, a ship loading display area, and a ship queue display area.

10 In one arrangement, the mine operations comprise at least one mine site, at least one rail facility and at least one port facility, and the system is arranged to display status information indicative of progress of an ore mining workflow from extraction of ore at at least one mine site,
15 through transportation of the ore from the at least one mine site to the at least one port facility, and shipping of the ore from the at least one port facility.

In one embodiment, the system comprises a local VOIP
20 device at each mine operation and a remote VOIP device at the remote scheduling facility, the local and remote VOIP devices facilitating audio communications between the mine operations and the remote scheduling facility through the communications network.

25 In one embodiment, the system comprises at least one still and/or video camera disposed at a mine operation, the system being arranged to display images captured by said at least one camera at the scheduling facility.

30 In one embodiment, the system is arranged such that images associated with multiple still and/or video cameras located at multiple mine operations are viewable on the common display.

35 In one embodiment, the system is arranged to monitor whether communications between the remote scheduling

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facility and the mine operations are possible and to generate an alarm signal when an indication is obtained that an outage may have occurred between the remote scheduling facility and one of more mine operations.

5

In one arrangement, the system is arranged to prioritise communications between the mine operations and the remote scheduling facility according to communication type.

- 10 In one embodiment, the system comprises a plurality of monitoring stations, each monitoring station being arranged to monitor mine equipment at a different mine operation. Each monitoring station may comprise a plurality of computer terminals, each terminal being
15 arranged to monitor mine equipment at a mine operation.

In one arrangement, the computer terminals are realized using multiple computing devices, or using at least one terminal server and at least one thin client device.

20

In one embodiment, the monitoring stations are arranged to control mine equipment at a mine operation.

- 25 In one embodiment, the system comprises a control server at each mine operation, the control server being arranged to receive control signals from remote scheduling facility and to control mine equipment according to the received control signals.

- 30 In one arrangement, the system comprises multiple network connection arrangements for connecting the scheduling facility with the communications network so that a backup network connection is available should one of the connections between the scheduling facility and the
35 communications network fail.

In one arrangement, the system comprises multiple power

supply arrangements for supplying electrical power to the scheduling facility such that should supply of electrical power by one of the power supply arrangements to the scheduling facility fail, another power supply arrangement
5 is used to provide the scheduling facility with electrical power.

The monitoring facility may be disposed at or adjacent an airport.
10

In accordance with a second aspect of the present invention, there is provided a scheduling facility for scheduling mine activities, said scheduling facility being arranged to receive operational data indicative of mine
15 activities at a plurality of mine sites and associated infrastructure through a communications network from a plurality of sources of operational data, the associated infrastructure including a rail network servicing the mine sites and a plurality of trains associated with the rail
20 network, and the operational data indicative of scheduling relevant information including the locations of trains on the rail network;

the scheduling facility comprising at least one display; and

25 the scheduling facility being arranged to use a subset of the operational data to display scheduling relevant information indicative of a production rate of ore from the mine sites and associated infrastructure and of the locations of trains on the rail network, so that a
30 production rate at a mine site below a scheduled production rate is identifiable and in response an alternate mine site to the mine site experiencing a production rate below the scheduled production rate at which to load ore is identifiable.

35 A method of scheduling mine activities is also described. The method comprises:

providing a plurality of sources of operational data indicative of scheduling relevant information associated with a plurality of mine operations, at least some of which are interdependent;

5 providing a scheduling facility remotely disposed relative to the interdependent mine operations;

gathering operational data indicative of scheduling relevant information associated with a plurality of mine operations;

10 displaying scheduling relevant information indicative of the status of a production workflow at the scheduling facility such that a scheduling operator at the scheduling facility is provided with an overview of production workflow across at least the interdependent mine

15 operations; and

modifying scheduling of mine activities as necessary based on the displayed scheduling information.

A method of integrating the operations of a plurality of mine sites and associated infrastructure distributed across a regional area and producing one or more bulk commodities is also described. The method comprises the steps of:

20 scheduling mining activities at each one of said plurality of mine sites so as to produce a scheduled level of ore at each said mine site and associated infrastructure;

transmitting operational data from equipment at each one of said plurality of mine sites to an operations facility common to said plurality of mine sites and associated infrastructure;

30 selecting a sub-set of said operational data from each said mine site and associated infrastructure and displaying information indicative of said sub-sets on a common display to identify a reduced production rate from one or more of said mines sites and associated

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infrastructure below said scheduled level of production;
and

re-scheduling said mining activities at one or more
of the mine sites and/or associated infrastructure so as
5 to minimise any reduction to aggregate output from said
plurality of mine sites.

In one embodiment, the associated infrastructure comprises
a network of rail lines servicing said mine sites and said
10 mining activities include loading trains with said ore at
said mine sites and said re-scheduling includes re-
scheduling at least one of said trains so that ore is
loaded at at least one alternate mine site to the mine
site experiencing said reduced production rate.

15

In one embodiment, the associated infrastructure comprises
at least one stock yard common to said plurality of mines
and said mining activities include stockpiling ore from
said plurality of mine sites at said stock yard and
20 wherein said rescheduling of mining activities includes
rescheduling said stockpiling of ore at said stock yard.

In one embodiment, ore is loaded onto ships berthed at a
port associated with said stock yard and said mining
25 activities include loading of ore onto said ships and
wherein said rescheduling of said mining activities
includes rescheduling supply of ore from said stock yard
to said ships.

30 In one embodiment, said associated infrastructure
comprises at least one stock yard common to said plurality
of mines and said mining activities include blending of
ore from said plurality of mine sites at said stock yard
so as to produce at least one stock pile of blended ore
35 and wherein said rescheduling of mining activities
includes comparing ores available for transportation to
and blending at said stock yard with ore scheduled for

of magnitude slower than the rate at which operational data displayed on said operating stations is refreshed.

5 In one embodiment, said operations facility is located remotely from said plurality of mine sites and associated infrastructure and at least one of said selected sub-sets of data is sourced from operational data transmitted by said equipment to at least one of said operating stations whereby transmission of data between said operations
10 facility and said mine sites and associated infrastructure is minimised.

In one embodiment, said monitoring of said sub-sets to identify a reduced production rate comprises monitoring
15 said sub-sets for equipment breakdown or other outage.

In one embodiment, said sub-sets of data are derived from said operational data.

- 20 In one embodiment, said sub-sets of data include one or more of the following:
- stock pile levels available for loading onto trains at one or more mine sites
 - ore quality information associated with one or more
25 stock piles of ore at one or more mine sites
 - operational status of train loading equipment at one or more mine sites
 - operational status of ore processing facilities at one or more mine sites
 - 30 ▪ operational status of said train network
 - operational status of train consists on said network
 - operational status of rail wagon unloading equipment at said stock yard
 - operational status of stock yard and associated
35 equipment
 - operational status of ship loading equipment
 - ships in port waiting to be berthed

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of magnitude slower than the rate at which operational data displayed on said operating stations is refreshed.

In one embodiment, said operations facility is located
5 remotely from said plurality of mine sites and associated infrastructure and at least one of said selected sub-sets of data is sourced from operational data transmitted by said equipment to at least one of said operating stations whereby transmission of data between said operations
10 facility and said mine sites and associated infrastructure is minimised.

In one embodiment, said monitoring of said sub-sets to identify a reduced production rate comprises monitoring
15 said sub-sets for equipment breakdown or other outage.

In one embodiment, said said sub-sets of data are derived from said operational data.

20 In one embodiment, said said sub-sets of data include one or more of the following:

- stock pile levels available for loading onto trains at one or more mine sites
- ore quality information associated with one or more
25 stock piles of ore at one or more mine sites
- operational status of train loading equipment at one or more mine sites
- operational status of ore processing facilities at one or more mine sites
- 30 ▪ operational status of said train network
- operational status of train consists on said network
- operational status of rail wagon unloading equipment at said stock yard
- operational status of stock yard and associated
35 equipment
- operational status of ship loading equipment
- ships in port waiting to be berthed

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- ships berthed at port waiting to be loaded
- berth status information for each wharf at said port facilities

5 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:

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

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

 Figure 3 is a diagrammatic representation showing components of the present invention disposed at a remote scheduling facility;

20 Figure 4 is a conceptual diagram illustrating an example layout of components of a mine scheduling system according to an embodiment of the present invention disposed at the remote scheduling facility;

 Figure 5 is a diagrammatic representation of a
25 plurality of mine operations, at least some of which are serviced by a common rail facility and/or port facilities;

 Figures 6 to 12 illustrate example representations of display areas shown at the remote scheduling facility;

 Figure 13 is a diagrammatic representation of an
30 example screen displayed to an operator at a monitoring station at a mine operation or at the remote scheduling facility; and

 Figure 14 is a software architecture diagram illustrating storage and handling of data in the mine
35 scheduling system shown in Figure 2.

Description of an Embodiment of the Invention

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An example conceptual diagram 10 illustrating a plurality of mine operations is shown in Figure 1. In this example, the mine operations comprise several mine sites 12, a port facility 14 and a rail facility 16, although it will be understood that the invention is applicable to any operation or facility associated with extracting, handling, processing and/or transporting bulk commodities in a resource extraction environment or part of such a process. For example, the invention is also applicable to a transportation operation including a port operation and a rail operation servicing a plurality of independent mine sites and wherein it is desirable to facilitate scheduling and rescheduling transportation activities by a scheduling operator in order to maximize transportation efficiency and throughput.

Scheduling operations are coordinated from a remote scheduling facility 18 in networked communication with the mine operations 12, 14, 16.

In this example, the remote scheduling facility 18 is remotely located relative to the mine sites 12, the rail network 16 and the port facility 14. Typically, the remote scheduling facility 18 is situated at a significant distance from the mine sites 12, the rail network 16 and the port facility 14 such that it is impractical for daily commuting by operators via road or rail to the mine sites, the port facility and the rail network, for example a distance exceeding 250km.

The conceptual diagram 10 shows a plurality of mine sites 12 which may be of open pit or underground type. The mine sites 12 typically produce a single bulk commodity, such as iron ore, coal or bauxite, and are serviced by the rail network 16 comprising rail lines 20 that transport the bulk commodities produced at the mine sites 12 to a port

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facility 14 incorporating a stock yard 29 for storage and/or processing of the bulk commodities, or other facility.

5 The mine operations 12, 14, 16 each include a plurality of equipment interface devices arranged to interface with plant and equipment so as to gather data relevant to mine scheduling from the plant and equipment and control the plant and equipment in response to control signals, for
10 example received from the remote scheduling facility 18.

The mine operations may also be arranged to provide scheduling relevant data from other sources, such as data derived from assays indicative of the amount of a
15 particular target material in a sample. Such data, and any other scheduling relevant data, may be stored in or generated in association with one or more appropriate databases and provided to the remote scheduling facility 18 as required.

20

The interface devices may be arranged to provide data, and data from other sources may be provided, in a format which is most appropriate for mine scheduling personnel, and the scheduling system may be arranged to convert data to a
25 more appropriate scheduling relevant format if the data derived from the interface devices or from other sources is not in the most appropriate format. For example, the data provided by plant and equipment may indicate that 50,000 tonnes of material is present in a stockpile at a
30 port facility, and this information converted to a number indicative of how many shiploads are present in the stockpile (if it is being reclaimed onto a ship) or the number of days until full if it is being stacked.

35 Still and/or video cameras may also be provided to obtain image and/or video information indicative of mine

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operations and which may also be relevant to mine scheduling.

In the present example, each mine site 12 has associated
5 locally disposed mine equipment interface devices 22, the
rail network 16 has associated locally disposed rail
equipment interface devices 24 and the port facility 14
has associated locally disposed port equipment interface
devices 26. Each of the equipment interfaces 22, 24, 26
10 communicates with a regional communications network 25
that in turn communicates with the remote scheduling
facility 18 via a wide area network (WAN) 28. The remote
scheduling facility 18 may be in communication with a
metropolitan area network (MAN) 30 connected to the WAN
15 28.

Each of the mine sites 12, the rail facility 16 and the
port facility 16 may also include one or more local
databases (not shown) arranged to store data relevant to
20 production activities, including mine scheduling, which is
received from sources other than interface devices, such
as from laboratories undertaking sample assays of mined or
in-ground material.

25 Using the remote scheduling facility 18, and in particular
operational data obtained from the equipment interface
devices 22, 24, 26 located at the mine operations and from
other sources, scheduling personnel located at the remote
scheduling facility 18 monitor the production workflow, in
30 this example a workflow incorporating extraction of
material at the mine sites 12, transportation on the rail
network 16, and loading on ships at a port facility, and
the scheduling personnel use the information derived from
the monitoring process to make decisions as to how to
35 appropriately modify mine operation scheduling as
necessary, and typically to maximize throughput of ore on

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the rail and port facilities in response to operational situations arising from time to time.

5 The equipment interface devices may be arranged to gather operational related data including any one or more of the following:

- stock pile levels available for loading onto trains at one or more mine sites
- ore quality information associated with one or more stock piles of ore at one or more mine sites
- 10 ▪ operation status of train loading equipment at one or more mine sites
- operational status of ore processing facilities at one or more mine sites
- 15 ▪ operational status of the ore transportation rail network and sections of the network
- operational status of train consists on the rail network
- operational status of rail wagon unloading equipment at the stock yard
- 20 ▪ operational status of stock yard and associated equipment
- operational status of ship loading equipment
- ships in port waiting to be berthed
- 25 ▪ ships berthed at port waiting to be loaded
- berth status information for each wharf at the port facilities

30 Additionally, one or more of the mine sites, port facility and rail network may include one or more data gathering devices in the form of still and/or video cameras.

In this example, the scheduling system also includes a data warehousing facility 19 in networked communication
35 with the mine operations 12, 14, 16 and the remote scheduling facility 18. The data warehousing facility 19 is arranged to receive operational data from the mine

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operations 12, 14, 16 and store the operational data in a data warehouse. The operational data stored in the data warehouse is subsequently retrieved by the remote scheduling facility, in this example by serving requested data to a web browser implemented in association with one or more displays at the remote 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. 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 product of uniform specification 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 the event of a significant outage of plant/equipment at a mine site 12, at the port facility 14 or within the rail network 16, it may be necessary to dynamically reschedule production at one or more of the mine sites 12 so that a desired amount of ore is still loaded onto the ships 38 at the port facility 14. Similarly, it may be necessary to reschedule rail services to different mine sites and to reschedule the stock pile building operations, for example

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based on identified reductions in stock pile quality. Such rescheduling is facilitated by the remote scheduling facility 18 that gathers scheduling relevant data from the mine sites 12, the rail network 16 and the port facility 14 and displays relevant information derived from the data at a centralised location. This enables scheduling personnel located at the remote scheduling facility 18 to overview aggregate production activities across all mine operations and to rapidly identify outages or other situations likely to affect production levels. Once such an issue is identified, the scheduling personnel can reschedule activities at the mine sites, rail or port facilities as necessary so as to minimise any loss of production or to maintain production quality. Where the mines operate independently but are serviced by common rail and port facilities, such rescheduling may be specific to the rail and/or port facility.

The operational data relevant to scheduling personnel and derived from each mine site 12, from the rail network 16 and from the port facility 14 is displayed centrally at the remote scheduling facility 18 typically on a common display so as to facilitate dynamic scheduling and re-scheduling of activities at the mine operations 12, 14, 16.

In this example, the common display is sufficiently large that scheduling personnel are able to easily view the scheduling relevant information.

While the present embodiment is described in relation to a scheduling system wherein a single relatively large common display is provided for displaying scheduling relevant information, it will be appreciated that other arrangements are possible. For example, several relatively large displays may be provided for displaying the scheduling relevant information, each display showing

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the same or different scheduling relevant information, or multiple screens may be provided, for example for each scheduling operator, with each screen being capable of showing the scheduling relevant information or part of the
5 scheduling relevant information.

Rescheduling of one or more operations may be carried out as necessary, for example through operator monitoring stations at the remote scheduling facility, VOIP
10 communications, conventional telephone communications, or in any other way.

In one arrangement, activities at the mine sites associated with scheduled production activities and re-
15 scheduled production activities are effected by operators of the operator monitoring stations at the remote scheduling facility 18. In this instance, operators of the operator monitoring stations transmit operating commands to plant and equipment located at the mine sites
20 12, within the rail network 16 and at the port facility 14 (including the stock yard facility 30) via a communications network that includes the MAN 30, the WAN 28, and regional networks 25. Plant and equipment transmit operational data to the remote scheduling
25 facility which in turn displays the operational data on display screens for operators of the equipment at the remote scheduling facility 18.

In one arrangement, plant and equipment servers located on
30 site and in communication with the equipment interface devices, including the mine, port and rail equipment interface devices 22, 24, 26 receive operating commands from the remote scheduling facility 18. The plant and equipment servers translate these operating commands into
35 signals which may be implemented by the relevant item of plant / equipment associated with the signal and operating command. The plant and equipment transmits operating

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signals to the relevant server which in turn transmits operational data to the remote scheduling facility for display.

5 In circumstances wherein the remote scheduling facility 18 communicates with the mine operations over a corporate network that also carries e-mail, and other non-time-critical data traffic, it is preferable that operating commands transmitted from the remote scheduling facility
10 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 remote scheduling facility 18 perceives an average system response time between transmitting operating
15 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 a mine operation scheduling
20 system for a plurality of mine operations 12, 14, 16 will now be described with reference to Figures 2 to 13 of the drawings.

As shown in Figure 2, each mine operation 12, 14, 16
25 includes equipment 40 which may be distributed around the mine operation, and each item of equipment 40 is electronically monitorable by an equipment interface device 42, and may also be controllable by the equipment interface device. In this example, each equipment
30 interface device comprises an equipment controller which may be in the form of a programmable logic controller (PLC).

The equipment 40 may include one or more of the following:
35 ▪ train loading equipment
 ▪ mobile equipment, such as trucks and front end loaders

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- ore processing plant and equipment
- train control equipment
- rail wagon unloading equipment at the stock yard
- stock yard equipment
- 5 ▪ ship loading equipment

However, it will be understood that any other mine equipment which is relevant to the operation of a mine and the scheduling of mining operations, including other
10 infrastructure associated with mine sites and port and rail facilities, is envisaged.

The equipment interface devices 42 are each connected to a local network 44, which may be of LAN type, so that the
15 equipment interfaces 42 can provide monitoring signals and/or can receive control signals for the equipment 40. Also connected to the local network 44 is a control server 48 which is arranged to coordinate monitoring and in this example control of the items of mine equipment by the
20 remote scheduling facility 18, the control server 48 in one example receiving control signals from terminals 66 at the remote monitoring stations 64, for example in accordance with re-scheduled activities.

25 The remote scheduling 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.

30

As shown in Figure 3, the remote scheduling facility 18 comprises a plurality of monitoring stations 64, each of which comprises a plurality of terminals 66 arranged to display information indicative of (and optionally
35 facilitate control of) different items of equipment 40 associated with the mine operations 12, 14, 16. This allows equipment on the mines to be controllable by

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operators located at the remote scheduling facility 18. Typically, each mine site, the port facility and the rail facility are controlled from monitoring stations 64 at the remote scheduling facility. Where the mines operate
5 independently, but are serviced by a common rail line and/or port facility, the level of control over mining activities may be reduced, for example to control of rail loading equipment and may be limited to control of rail and port activities only.

10

In the present example, the terminals 66 are of thin client type and, as such, a terminal server 70 and a plurality of thin client devices 68 are provided. This arrangement allows multiple computing devices to be
15 realised without the need to provide multiple full function personal computers. With this arrangement, most of the processing activity occurs at the terminal server 70 with the thin client devices 68 functioning to drive the respective displays on the terminals 66 and receive
20 inputs from terminal operators.

However, it will be understood that other arrangements are possible. For example, instead of providing each terminal 66 with a respective thin client device 68, a single thin
25 client device may be provided to drive the multiple terminals 66. As a further alternative, multiple full function computing devices may be used. In the present example, the terminals 66 communicate with the equipment 40 through the control server 70, with each terminal 66
30 being arranged to send communications to and receive communications from the control server 70 particular to one or more different groups of equipment 40.

Preferably, the scheduling information for central display
35 at the remote scheduling 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 66

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is updated. This updating may be in the order of once every minute through to once every 10 to 15 minutes. This reduces, and preferably minimises, the bandwidth requirements between the remote scheduling facility 18 and the mine sites 12, the rail network 16 and the port facility 14.

In operation, based on the displayed scheduling information scheduling operators may decide that rescheduling is required and modification of the production workflow is necessary. This may be achieved by placing telephone calls with operators at the affected mine operation(s), using the monitoring stations, or in any other way. For example, operators of the monitoring stations may use terminals 66 at the monitoring stations 64 to modify operational parameters of one or more items of plant and equipment as required in order to modify an aspect of production workflow.

It will be understood that by providing a remote scheduling facility 18 associated with multiple mine operations 12, 14, 16, it is possible to monitor and control all of the mine operations from the same remote location and as a consequence to carry out scheduling activities relevant to one or more of the mine operations from the remote scheduling facility. It is also possible to minimise lost production through rapid identification of outages across the mining operations, including support infrastructure such as port and rail, at a facility from which said mining operations are scheduled and/or controlled. Having identified a need for re-scheduling of mining activities, operators positioned at monitoring stations 64 can implement the re-scheduling activities at the mining operation.

35

It will be understood that by scheduling operations for multiple mine operations at the same location, significant

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cost savings can be achieved, particularly if the remote scheduling facility is disposed at a metropolitan location since the need for operators to travel to the mine operations, which are often at remote locations, is
5 reduced.

It will be understood that in this example the remote scheduling facility 18 provides scheduling information relevant to scheduling personnel, that is information
10 relevant to operation of the production workflow, and operational information relevant to operational personnel, that is information relevant to operation and control of specific plant and equipment, at the same location. While
15 displayed on a relatively large common screen, and the operational information is displayed on terminals 66 of the remote monitoring stations 64, it will be understood that other arrangements are envisaged. For example,
20 scheduling information may optionally be displayed on the terminals 66, or on one or more other displays specific to the scheduling personnel, and operational information may be displayed on a common relatively large screen. The
important aspect is that scheduling specific information and operational specific information is provided to a
25 common remote monitoring facility so that scheduling and operational actions can be carried out efficiently from the same location.

As shown in Figure 2, in this example each mine operation
30 12, 14, 16 also has one or more associated VOIP devices 80, each of which is capable of communicating with a VOIP device 82 disposed at the remote scheduling facility 18, the VOIP devices 80, 82 being usable by personnel located
at the mine operations 12, 14, 16 and at the remote
35 scheduling facility 18 to communicate with each other through the wide area network 60 as required. As an alternative, the VOIP devices may be videoconferencing

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devices.

The system 10 in this example also includes an A/V server 84 disposed at each mine operation 12, 14, 16, the A/V server 84 being associated with an A/V client 86 disposed at the remote scheduling facility 18 and arranged to communicate with the A/V servers 84 so as to receive audio/visual information from the mine operations 12, 14, 16 and in particular video information for displaying at the mine scheduling facility 18, for example on the common display 88. For this purpose, the A/V server 84 may communicate with one or more still and/or video cameras disposed at selected locations at the mine operation 12, 14, 16 for example so that the status of particular activities occurring at the mine operations 12, 14, 16 may be visually monitored and/or verified from the remote scheduling facility 18. In one arrangement, the cameras are also controllable from the remote scheduling facility 18 so that the direction and/or magnification of the cameras may be modified from the remote scheduling facility 18.

The A/V servers 84 may use a multi-cast protocol to transmit video images to the remote scheduling facility 18. Typically, each remote monitoring station 64 accommodates a number of operators each with a number of terminals. Each operator may view simultaneously several video feeds of the plant and/or equipment they are controlling. A number of the operators at a remote monitoring station 64 may have a number of the same video feeds open on their terminals at the same time in order to effectively monitor and control the plant and/or equipment they are responsible for and to be aware of upstream and downstream activities within the operations they are controlling. Use of a multi-cast protocol in the transmission of video images from the mine operations to the central monitoring facility avoids unnecessary

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duplication of images and therefore unnecessary utilisation of bandwidth over the WAN.

In order to improve the reliability of communications
5 between the remote scheduling facility 18 and the mine
operations 12, 14, 16, the system 10 may incorporate
quality of service measures such as prioritizing
communications through the WAN according to type. For
example, the system may be arranged to allocate different
10 bandwidth percentages to different types of
communications, such as to communications related to
monitoring and control activities, VOIP communications,
CCTVV data, email, file transfers, and so on. In the
present example, communications related to monitoring and
15 control activities, and VOIP communications are given
higher bandwidth percentages than CCTVV data, email and
file transfers. In an alternative arrangement, different
types of communications are allocated different priority
values which are used by routers in the WAN to manage
20 queues in the routers and thereby the speed of transfer of
the communication through the routers.

In the present embodiment, in order to provide a degree of
protection against system failure, multiple network
25 connection arrangements 90 may be provided for connecting
the remote mine monitoring stations 64 with the wide area
network 60 so that a backup network connection is
available should one of the connections between the
central monitoring facility 16 and the wide area network
30 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
35 suitable sensor 96 which activates a backup generator 98 to
commence providing electrical power to the central
monitoring facility 16.

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For this reason, the remote scheduling facility according to the present embodiment is 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 remote scheduling facility 18 and the mine operations are reaching their destination, for example by requiring a handshake to occur periodically between the remote scheduling facility 18 and the mine operations 12, 14, 16. In the present example, this is achieved by configuring the equipment interfaces 42 to periodically send a heartbeat communication to the remote scheduling facility 18. On receipt of the heartbeat communication, the remote scheduling facility 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 at the mine and at the remote scheduling facility that an outage may have occurred between the remote scheduling facility 18 and one or more of the mine operations 12, 14, 16.

Referring to Figure 4, an example conceptual layout of the remote scheduling facility 18 is shown. In this example, all associated mine operations are monitored and/or controlled from the remote scheduling facility 18, including at least one mine operation 12a, at least one port operation 14, and at least one a rail network 16.

A display 88 is provided that is of sufficiently large size such that information, images and/or video shown on the display are easily viewable by all operators at the scheduling facility 18, and in particular by scheduling personnel. In this example, the display 88 includes a

plurality of display areas, each of which is associated with a particular aspect of the production workflow associated with the mine operations.

5 In the present example, the display 88 which shows information indicative of operation of the general production workflow in an ore mining process wherein ore is extracted from a plurality of distributed mine operations, loaded onto trains, transported through a rail
10 facility, and unloaded from the trains to ships at a port facility. In this way, the common display is able to provide scheduling personnel with an overview of the entire ore production and transportation operation, and in particular to provide scheduling personnel with
15 information usable to determine whether to carry out rescheduling activities and, if so, the most appropriate rescheduling activity to carry out. Where the mines operate independently, scheduling personnel may only see limited information on the mines, such as stockpile
20 information at a train loadout and whether a mine is producing ore or is experiencing an outage.

The display 88 in this example comprises a material mined display area 99, a train loading display area 106, a train
25 dumping display area 108, a port stockpile display area 110, a ship loading display area 112 and a ship queue display area 114.

The display 88 also comprises a performance summary
30 display area 116 and a performance scorecard display area 118.

In this example, the mine operations serviced by the scheduling facility are distributed over a relatively
35 large area as depicted diagrammatically in Figure 5. The mining operations include mine sites 130, port facilities 132 and rail facilities 134 connecting the mine sites 130

to the port facilities 132.

In the present example, the display 88 includes text and icons representative of the performance and/or status of aspects of the production and transportation process in a plurality of mine operations. Text representing performance indicators, for example in the form of number metrics, may be represented differently, for example in different colours, depending on how the performance indicator compares to defined targets. For example, white text on a black background may indicate that the performance indicator concerned has no related target, white text on a red background may indicate that the performance indicator concerned is below target, green text on a black background may indicate that the performance indicator concerned is above or equal to target, and grey text on a black background may indicate a record performance indicator. Similarly, white text on a grey background may correspond to white text on a black background but represents outdated data, grey text on a red background may correspond to white text on a red background but represents outdated data, and grey text on a green background corresponds to green text on a black background but represents outdated data.

The present display 88 also includes icons arranged to graphically represent quality of ore in stockpiles. For example, as shown in Figure 6a, a stockpile icon 140 having a plurality of segments 142 associated with respective target materials may be used. Each segment 142 may be represented differently, for example in different colours, depending on the level of stockpile quality compared to a target quality. In the present example, a green segment indicates that the quantity of the material in the stockpile associated with the relevant segment is within target, blue indicates that the quantity of the associated material in the stockpile is better than

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target, and red indicates that the quantity of the associated material in the stockpile is worse than target.

As shown in Figure 6b, the stockpile icon 140 may be modified to provide additional information. For example, a grey ring 144 around the stockpile icon 140 may indicate that the data represented by the stockpile icon is outdated.

10 The present common display 88 also includes loading and dumping icons 146 arranged to graphically indicate train loading or dumping progress. For example, a full white loading/dumping icon 146 indicates that a train is ready to commence loading or dumping, a progressively increasing green sector 148 on a white background 150 indicates that loading or dumping is progressing with the size of the green sector indicating percentage completed, a full yellow loading/dumping icon 146 indicates that the loading/dumping operation is between target and 10% over target, a flashing red loading/dumping icon 146 indicates that the loading/dumping operation is more than 10% over target, a progressively increasing grey sector 148 on a white background 150 indicates that loading or dumping is progressing but the data is outdated, a solid grey icon 25 indicates that the loading/dumping operation is between target and 10% over target and the data is outdated, and a flashing grey icon indicates that the loading/dumping operation is more than 10% over target and the data is outdated. For a loading/dumping operation, the target performance may be time to complete the loading/dumping operation.

The performance summary display area 116 is shown more particularly in Figure 7. The performance display area 35 116 shows the current amount of material shipped for the present week, and estimated and target values for weekly, monthly and yearly amounts of material shipped.

The performance scorecard display area 118 is shown more particularly in Figure 8. The performance scorecard display area 118 consecutively shows five key metrics, in this example cycling through the metrics at 20s intervals. In this example, the key metrics are trains loaded, trains dumped, ship loading, railed ore and mined ore.

The performance scorecard for each key metric has 4 sections and an example of a performance scorecard for a trains loaded metric is shown in Figure 8. The scorecard shows values represented as bar charts, with bars of the charts shown in different colours according to whether the bar represents a trains loaded target 160, a trains loaded value 162 which is greater than or equal to a corresponding trains loaded target, or a trains loaded value 164 which is less than a corresponding trains loaded target.

A first section 166 shows the daily performance of the train loading operation for the current week compared to target, a second section 168 shows the weekly performance of the train loading operation compared to target, a third section 170 shows a prediction for the performance of the train loading operation for the current week compared to target, and a fourth section 172 shows a prediction for the performance of the train loading operation for the current month compared to target. Similar sections are shown for train dumping, ship loading, railed ore and mined ore performance scorecards.

It will be appreciated that the performance scorecards show snapshots of performance of the key metrics concerned and as such provide a useful overview of performance for mine scheduling personnel.

The material mined display area 99 is shown in more detail in Figure 9. The material mined display area includes TMM (total material mined), plant throughput and stockpiles display areas 100, 102, 104. The display areas 100, 102, 104 include a plurality of rows, each of which corresponds to a particular mine site. Metrics of actual 180, 186, target 182, 188 and record 184, 190 figures for total tonnes mined, processing plant performance and stockpiled ore for each mine site are displayed. Combined metrics 186, 192 for all mine sites are also shown.

The stockpile display area 104 shows metrics for stock quality at the associated mine sites. Each row includes metrics for reclaiming of stockpiles and stacking of stockpiles and each of the reclaiming and stacking metrics includes a stockpile icon 140 having several segments 142, each of which is associated with one of the materials indicated in a material key 144. As discussed above in relation to Figure 6, each segment 142 is colour coded so as to indicate the quality of the material associated with the segment 142 in the stockpile in the sense of the amount of a target material in the stockpile relative to specifications. In the present example 2 stockpile icons 140 are provided to indicate metrics associated with the stockpiles being reclaimed and stacked at the mine rail head. This includes a lump stockpile icon representing lump type material and a fines stockpile icon representing fines type material along with train stock metrics 194 indicative of how many train loads of material are present in the stockpiles being reclaimed. The stacking metrics include fill time metrics 196 indicative of how many days until the stockpiles being stacked are full.

It will be understood that the total tonnes mined, plant throughput and stockpiled ore metrics provide mine scheduling personnel with information indicative of material extraction performance at several mine sites and

the quality and quantity of the various materials in the stockpiles at the mine sites. Any significant deviations from expected performance are readily communicated to the scheduling personnel by the appearance of the information and/or icons, in this example by displaying text and/or icons in different colours.

Train loading and train dumping display areas 106, 108 are shown diagrammatically in Figure 10 together with a diagrammatic representation of a rail network 198 linking a plurality of mine sites 200 to one or more port operations 201.

The train loading display area 106 includes train identifiers 202 indicative of the trains currently being loaded at the various mine sites, loading icons 146 indicative of loading progress for each train, an estimated completion metric 204 indicative of the expected time that loading of each train will be complete, and a next train time metric 206 indicative of the expected time of arrival of the next train at the train loading station. As shown in Figure 6, in the present example, the loading icons 146 are colour coded to indicate progress of the train loading operation towards completion and to indicate whether the train loading operation is in accordance with relevant targets.

Combined train loading metrics for all mine sites are also shown, in this example by total tonnes loaded 208 and number of trains loaded 209.

The rail network 198 may be represented differently according to rail infrastructure status. For example rail segments 209 may be displayed in grey when rail segments are online and in red when the rail segments are off line.

The train dumping display area 108 also includes train

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identifiers 202 indicative of the trains currently being unloaded at a port facility, a dumping icon 146 indicative of dumping progress, an estimated completion metric 210 indicative of the expected time when the current train
5 dumping operation will be complete, and a next train time metric 212 indicating expected time of arrival of the next train at the train dumping facility. As shown in Figure 6, in the present example, the dumping icons 146 are colour coded to indicate progress of the train dumping
10 operation towards completion and to indicate whether the train dumping operation is in accordance with relevant targets.

Combined train dumping metrics for all mine sites are also
15 shown, in this example by total tonnes dumped 214 and number of trains dumped 215.

It will be understood that the train loading and train dumping display areas 106, 108 provide mine scheduling
20 personnel with information indicative of material transportation performance from mine sites to port facilities. Any significant deviations from expected performance or outages on the rail network likely to affect performance are readily communicated to the
25 scheduling personnel by the appearance of the information and/or icons, in this example by displaying text and/or icons (including train loading, train dumping and sections of track) in different colours.

30 Port stocks, ship loading and ship queue display areas 110, 112, 114 are shown diagrammatically in Figure 11.

The port stocks display area 110 shows metrics for stock quality at port stockpiles being reclaimed or stacked.
35 Each of the reclaiming and stacking metrics includes a stockpile icon 140 having several segments 142, each of which is associated with one of the materials indicated in

a material key 144. As discussed above in relation to Figure 6, each segment is colour coded so as to indicate the quality and/or quantity of the material associated with the segment 142 in the stockpile, in particular, whether the quantity of material is above, below or in accordance with target specifications for the stockpile. In the present example 2 stockpile icons are provided for each of the stockpiles being reclaimed and stacked, a lump stockpile icon representing lump type material and a fines stockpile icon representing fines type material. In this example, the reclaiming metrics also include ship stock metrics 220 indicative of how many ship loads of material are present in the stockpiles being reclaimed, and the stacking metrics include fill time metrics 222 indicative of how many days until the stockpiles being stacked are full. Combined ship loading metrics 234 for all mine sites are also shown.

The ship loading display area 112 shows metrics for estimated tonnage loaded for today 224, target tonnage loaded 226, record tonnage loaded 228, and ship icons 230 representing ships currently being loaded at the port operations. Each ship icon 230 is associated with a particular ship and the name of the ship may be displayed next to the ship icon 230. The ship icon 230 may vary according to the fill level of the ship, and a loading indicator 232 may be displayed to indicate that ship loading is in progress. Information indicative of the time left until completion of ship loading may also be displayed adjacent each ship icon 230.

The ship queue display area 114 shows loading information 236 and ship names 238 indicative of the next ships to arrive at port, the expected time to commence loading 236, and ship arrived icons 240 and authority to load icons 242 indicative respectively of whether a ship has arrived at port and whether authority to load the ship has been

given.

It will be understood that the port stocks, ship loading and ship queue display areas 110, 112, 114 provide mine
5 scheduling personnel with information indicative of train unloading and ship loading performance at port facilities. Any significant deviations from expected performance (including delays to scheduled activities and below stock quality) are readily communicated to the scheduling
10 personnel by the appearance of the information and/or icons, in this example by displaying text and/or icons in different colours.

The ship queue display area 114 may also include general
15 ship information 244 indicative of how many ships have arrived, how many have authority to load (ATL) and how many are berthed in relation to each port.

The display 88 may also include a maintenance display area
20 250, as shown in Figure 12, which indicates the maintenance operations in progress and the expected finish time.

It will be appreciated that the remote scheduling facility
25 may be used to monitor operation of the rail network and determine whether rescheduling of any train on the rail network is necessary because of outages at one or more of the mine operations, to monitor operation of the port facility and determine whether modification of any of the
30 port activities is necessary because of outages at one or more of the mine operations, or to monitor any other activity at any of the mine operations, including associated infrastructure such as port and rail, and determine whether modification of any of the activities
35 occurring at any of the mine operations is necessary in order to maximize production.

Moreover, by displaying scheduling related information on the display 88 the scheduling operator is able to obtain important scheduling relevant information which may assist in determining an appropriate scheduling action.

5

In this example, a scheduling action may be at least partly implemented using one or more terminals 66 of a remote monitoring station 64. An example screen 90 displayed to an operator at a terminal 66 disposed at the remoter scheduling facility 18 is shown in Figure 13.

10

The screen 90 includes navigation controls 92 usable to display desired control and/or monitoring screens associated with one or more items of plant and/or equipment.

15

In the screen shown in Figure 13, a reclaimer is being monitored and controlled and a representation of the reclaimer 94 is shown on the screen. The representation of the reclaimer 94 may be modified according to the operational status of the reclaimer. For example, the colour of the reclaimer may change depending on whether the reclaimer is functioning correctly or not, or whether the reclaimer is idle or operational. The representation of the reclaimer 94 may also show that the reclaimer is functioning by showing parts of the reclaimer moving.

20

25

The screen 90 also shows an operational data display area 96 including relevant operational data 97 indicative of current status of the reclaimer such as the reclaim rate, speed of bucketwheel, maintenance information, and so on.

30

The screen 90 also shows a control display area 98 including control buttons 99 usable to modify operational parameters, such as speed of bucketwheel, to turn the reclaimer on or off, and so on.

35

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In this example, the screen 90 displayed to an operator is implemented using a web browser arranged to communicate with control servers 48 associated with the mine operations 12, 14, 16.

5

The scheduling relevant data may be stored in a common database or may be stored in a plurality of associated databases which may be disposed at the same or different locations.

10

An example of the data storage and distribution infrastructure 260 used in the present scheduling system is shown in Figure 14.

15 The infrastructure 260 includes a data source layer 262 having a plurality of databases 264, each of which is arranged to derive data from one or more sources from one or more mine operations, including the equipment interfaces 42 and other sources, and an
20 extraction/transformation layer 266 arranged to act on the data in the databases to produce data of suitable type for storage in a common data warehouse 268 in a data warehouse layer 270. For example, data from control systems and mining production databases may be transformed into
25 scheduling specific information, such as the number of ship loads of material in a stockpile being reclaimed at a port. By way of a further example, operational data such as the number of wagons in a train and typical dumping times per wagon can be transformed into scheduling
30 specific information such as the estimated time to complete the unloading of a train.

Average stockpile composition data calculated from laboratory assays can be transformed into a graphical
35 depiction of stockpile quality relative to the relevant specification for the stockpile in question. The average composition data can be transformed into graphical

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representations of whether certain materials in the stockpile are above target, below target or out of specification.

- 5 The data in the data warehouse 268 is organized into data cubes at a cubes layer 272 such that near real-time pre aggregated and highly indexed data is produced.

The infrastructure 260 also includes a presentation layer
10 274 arranged to serve data in the data cubes to users on request, and a user front end layer 276 which comprises the common display 88 and the terminals 66. The presentation layer 274 may be implemented using web
15 browsers or any other suitable interface arranged to communicate with the presentation layer 274. This allows some or all of the information displayed on the display 88 to be displayed at monitoring stations 64, for use by operators of these stations.

- 20 Similarly, some or all of the information displayed on the screen 88 can be displayed on work stations used by schedulers who monitor activities across the mining operations and reschedule activities in response to equipment breakdowns, failures and other unexpected
25 outages and/or disruptions to the production workflow.

Present embodiments provide a system for centralised scheduling and control of multiple mining operations, including associated rail and port activities. The
30 embodiments enable retrieval, transformation and display of production and control data in a manner that is specific to scheduling and coordination of these activities.

- 35 Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

The claims defining the invention are as follows:

1. A system for dynamically scheduling mine activities at a plurality of mine operations including mine sites and associated infrastructure distributed across at least one regional area and together producing ore, the associated infrastructure including a rail network servicing the mine sites and a plurality of trains associated with the rail network, the system comprising:
- 5
- 10 a plurality of sources of operational data indicative of scheduling relevant information associated with a plurality of mine operations and associated infrastructure, the operational data including information indicative of the locations of trains on the rail network;
- 15 a scheduling facility common to the plurality of mine sites and associated infrastructure;
- a communications network arranged to facilitate transfer of the operational data from the mine operations and associated infrastructure to the scheduling facility;
- 20 the scheduling facility arranged to receive operational data from the plurality of mine sites and associated infrastructure, and to use a selected sub-set of the operational data to display information at the scheduling facility indicative of a production rate of ore from said mine sites and associated infrastructure and of the locations of trains on the rail network, so that a production rate at a mine site below a scheduled production rate is identifiable and in response an alternate mine site to the mine site experiencing a production rate below the scheduled production rate at which to load ore is identifiable.
- 25
2. A system as claimed in claim 1, wherein the scheduling facility is arranged to use the operational data to display performance information at the operations facility, and to communicate deviations from expected performance by changing the appearance of the performance
- 35

information.

3. A system as claimed in claim 1 or claim 2, wherein the sources of operational data comprise a plurality of
5 interface devices, each interface device being arranged to monitor operation of at least one item of mine equipment, and

at least one interface device comprising at least one programmable logic controller (PLC).

10

4. A system as claimed in any one of claims 1 to 3, wherein the sources of operational data comprise data derived from assays.

15 5. A system as claimed in any one of claims 1 to 4, comprising a data warehousing facility in networked communication with the mine operations and the scheduling facility, the data warehousing facility being arranged to store operational data and/or scheduling information
20 derived from the mine operations for use by the scheduling facility.

6. A system as claimed in claim 5, wherein the system is arranged to provide scheduling relevant information in a
25 format usable by a web browser such that the scheduling relevant information is displayable on a web browser.

7. A system as claimed in any one of the preceding claims, wherein the operational data is indicative of one
30 or more of the following:

- stock pile levels available for loading onto trains at one or more mine sites
- ore quality information associated with one or more stock piles of ore at one or more mine sites
- 35 ▪ operational status of train loading equipment at one or more mine sites

- operational status of ore processing facilities at one or more mine sites
- operational status of said train network or part of said train network
- 5 ▪ operational status of train consists on said network
- operational status of rail wagon unloading equipment at said stock yard
- operational status of stock yard and associated equipment
- 10 ▪ operational status of ship loading equipment
- ships in port waiting to be berthed
- ships berthed at port waiting to be loaded
- berth status information for each wharf at said port facilities.

15

8. A system as claimed in any one of the preceding claims, wherein the system is arranged to modify operational data received from at least one of the sources of scheduling relevant information such that the displayed
20 scheduling information is in an appropriate format for scheduling personnel.

9. A system as claimed in any one of the preceding claims, wherein the scheduling information comprises
25 number metrics indicative of performance of respective aspects of the production workflow.

10. A system as claimed in claim 9, comprising for at least one of said aspects of the production workflow a
30 target number metric and an actual number metric, and/or a record number metric indicative of a record performance achieved for the number metric.

11. A system as claimed in any one of the preceding
35 claims, wherein the scheduling information comprises time information indicative of any one or more of estimated arrival, commencement and/or finish times;

mine site, port facility, ship identifiers and/or
train identifiers; and/or

at least one status icon, the appearance of each
status icon being indicative of performance of an aspect
5 of the production workflow.

12. A system as claimed in claim 11, comprising at least
one status icon indicative of loading or unloading
progress.

10

13. A system as claimed in claim 12, wherein the status
icon indicative of loading or unloading progress comprises
a representation of a ship and an indication as to fill
level of the ship during loading.

15

14. A system as claimed in any one of claims 11 to 13,
comprising at least one stockpile status icon indicative
of amount of a target material in a stockpile.

20

15. A system as claimed in claim 14, wherein the
stockpile status icon comprises a plurality of icon
segments, each icon segment being associated with a
different target material in a stockpile.

25

16. A system as claimed in any one of the preceding
claims, wherein the scheduling information is indicative
of the number of ship loads of material in a stockpile
and/or the number of days until a stockpile is full.

30

17. A system as claimed in any one of the preceding
claims, wherein the system is arranged to modify the
appearance of the scheduling information according to
defined conditions.

35

18. A system as claimed in claim 17, wherein the defined
conditions are any two or more of performance below

target, performance at or above target, record performance, or operational data which is outdated.

19. A system as claimed in any one of the preceding
5 claims, comprising a single common display for displaying scheduling relevant information.

20. A system as claimed in any one of the preceding
10 claims, comprising a plurality of displays, each display being arranged to display the scheduling relevant information or part of the scheduling relevant information.

21. A system as claimed in claim 19 or claim 20, wherein
15 the display includes at least some of a material mined display area, a mine stockpile display area, a train loading display area, a train dumping display area, a port stocks display area, a ship loading display area, and a ship queue display area.

20 22. A system as claimed in any one of the preceding claims, wherein the mine operations comprise at least one port facility, and the system is arranged to display status information indicative of progress of an ore mining
25 workflow from extraction of ore at at least one mine site, through transportation of the ore from the at least one mine site to the at least one port facility, and shipping of the ore from the at least one port facility.

30 23. A system as claimed in any one of the preceding claims, comprising a local VOIP device at each mine site and a remote VOIP device at the remote scheduling facility, the local and remote VOIP devices facilitating audio communications between the mine operations and the
35 remote scheduling facility through the communications network.

24. A system as claimed in any one of the preceding claims, comprising at least one still and/or video camera disposed at a mine operation, the system being arranged to display images captured by said at least one camera at the
5 scheduling facility.

25. A system as claimed in claim 21 or claim 22, wherein the system is arranged such that images associated with multiple still and/or video cameras located at multiple
10 mine operations are viewable on the common display.

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

20 27. 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 scheduling facility according to communication type.

25 28. A system as claimed in any one of the preceding claims, comprising at least one monitoring station, each monitoring station being arranged to monitor mine equipment at a mine operation.

30 29. A system as claimed in claim 28, comprising a plurality of monitoring stations, each monitoring station being arranged to monitor mine equipment at a different mine operation.

35 30. A system as claimed in claim 29, wherein each monitoring station comprises at least one computer terminal, each terminal being arranged to monitor mine

equipment at a mine operation.

31. A system as claimed in claim 30, wherein the computer terminals are realized using multiple computing devices,
5 or using at least one terminal server and at least one thin client device.

32. A system as claimed in any one of claims 28 to 31,
10 wherein at least one monitoring station is arranged to control mine equipment at a mine operation.

33. A system as claimed in 32, wherein at least one monitoring station is arranged to facilitate
15 implementation of a rescheduling action based on the displayed scheduling information.

34. A system as claimed in claim 33, comprising a control server at each mine operation, the control server being
20 arranged to receive control signals from the scheduling facility and to control mine equipment according to the received control signals.

35. A system as claimed in any one of the preceding claims, comprising multiple network connection
25 arrangements for connecting the scheduling facility with the communications network so that a backup network connection is available should one of the connections between the scheduling facility and the communications network fail.

30

36. A system as claimed in any one of the preceding claims, comprising multiple power supply arrangements for
supplying electrical power to the scheduling facility such
that should supply of electrical power by one of the power
35 supply arrangements to the scheduling facility fail,
another power supply arrangement is used to provide the scheduling facility with electrical power.

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

5

38. A scheduling facility for scheduling mine activities, said scheduling facility being arranged to receive operational data indicative of mine activities at a plurality of mine sites and associated infrastructure through a communications network from a plurality of sources of operational data, the associated infrastructure including a rail network servicing the mine sites and a plurality of trains associated with the rail network, and the operational data indicative of scheduling relevant information including the locations of trains on the rail network;

10

the scheduling facility comprising at least one display; and

the scheduling facility being arranged to use a subset of the operational data to display scheduling relevant information indicative of a production rate of ore from the mine sites and associated infrastructure and of the locations of trains on the rail network, so that a production rate at a mine site below a scheduled production rate is identifiable and in response an alternate mine site to the mine site experiencing a production rate below the scheduled production rate at which to load ore is identifiable.

20

25

39. A scheduling facility as claimed in claim 38, wherein the sources of operational data comprise data derived from assays.

30

40. A scheduling facility as claimed in claim 38 or claim 39, wherein the scheduling relevant information is in a format usable by a web browser, and the scheduling facility comprises at least one web browser arranged to

35

display the scheduling relevant information.

41. A scheduling facility as claimed in claim 40, wherein the display is arranged to display a web browser arranged
5 to display the scheduling relevant information.

42. A scheduling facility as claimed in any one of claims 38 to 41, wherein the operational data is indicative of one or more of the following:

- 10 ▪ stock pile levels available for loading onto trains at one or more mine sites
- ore quality information associated with one or more stock piles of ore at one or more mine sites
- operational status of train loading equipment at one
15 or more mine sites
- operational status of ore processing facilities at one or more mine sites
- operational status of said train network or part of said train network
- 20 ▪ operational status of train consists on said network
- operational status of rail wagon unloading equipment at said stock yard
- operational status of stock yard and associated equipment
- 25 ▪ operational status of ship loading equipment
- ships in port waiting to be berthed
- ships berthed at port waiting to be loaded
- berth status information for each wharf at said port facilities.

30

43. A scheduling facility as claimed in any one of claims 38 to 42, wherein the scheduling facility is arranged to display scheduling information in an appropriate format for scheduling personnel or alternatively to modify
35 operational data received from at least one of the sources of scheduling relevant information such that the displayed

scheduling information in an appropriate format for scheduling personnel.

44. A scheduling facility as claimed in any one of claims
5 38 to 43, wherein the scheduling information comprises number metrics indicative of performance of respective aspects of the production workflow.

45. A scheduling facility as claimed in claim 44,
10 comprising for at least one of said aspects of the production workflow a target number metric and an actual number metric and/or a record number metric indicative of a record performance achieved for the number metric.

15 46. A scheduling facility as claimed in any one of claims 44 to 53, wherein the scheduling information comprises time information indicative of any one or more of estimated arrival, commencement and/or finish times, and/or at least one status icon, the appearance of each
20 status icon being indicative of performance of an aspect of the production workflow.

47. A scheduling facility as claimed in claim 46,
25 comprising at least one status icon indicative of loading or unloading progress.

48. A scheduling facility as claimed in claim 47, wherein the status icon indicative of loading or unloading progress comprises a representation of a ship and an
30 indication as to fill level of the ship during loading.

49. A scheduling facility as claimed in any one of claims 46 to 48, comprising at least one stockpile status icon indicative of amount of a target material in a stockpile.
35

50. A scheduling facility as claimed in claim 49, wherein the stockpile status icon comprises a plurality of icon

segments, each icon segment being associated with a different target material in a stockpile.

5 51. A scheduling facility as claimed in any one of claims 38 to 50, wherein the scheduling information is indicative of the number of ship loads of material in a stockpile, and/or the number of days until a stockpile is full.

10 52. A scheduling facility as claimed in any one of claims 38 to 51, wherein the scheduling facility is arranged to display scheduling information according to defined conditions or alternatively to modify the appearance of the scheduling information according to defined conditions.

15 53. A scheduling facility as claimed in claim 52, wherein the defined conditions are any two or more of performance below target, performance at or above target, record performance, or operational data which is outdated.

20 54. A scheduling facility as claimed in claim 53, comprising a single common display for displaying scheduling relevant information.

25 55. A scheduling facility system as claimed in any one of claims 38 to 54, comprising a plurality of displays, each display being arranged to display the scheduling relevant information or part of the scheduling relevant information.

30 56. A scheduling facility as claimed in any one of claims 53 to 55, wherein the display includes at least some of a material mined display area, a mine stockpile display area, a train loading display area, a train dumping display area, a port stocks display area, a ship loading display area, and a ship queue display area.

35

57. A scheduling facility as claimed in any one of claims 38 to 56, wherein the mine operations comprise at least one mine site, at least one rail facility and at least one port facility, and the scheduling relevant information is
5 indicative of progress of an ore mining workflow from extraction of ore at at least one mine site, through transportation of the ore from the at least one mine site to the at least one port facility, and shipping of the ore from the at least one port facility.

10

58. A scheduling facility as claimed in any one of claims 38 to 57, wherein the scheduling facility is arranged to receive and display images associated with multiple still and/or video cameras located at multiple mine operations.

15

59. A scheduling facility as claimed in any one of claims 38 to 58, comprising at least one monitoring station, each monitoring station being arranged to monitor mine equipment at a mine operation.

20

60. A system as claimed in claim 59, comprising a plurality of monitoring stations, each monitoring station being arranged to monitor mine equipment at a different mine operation.

25

61. A scheduling facility as claimed in claim 60, wherein each monitoring station comprises a plurality of computer terminals, each terminal being arranged to monitor mine equipment at a mine operation.

30

62. A scheduling facility as claimed in claim 60 or claim 61, wherein the monitoring stations are arranged to control mine equipment at a mine operation.

35

63. A system as claimed in claim 62, wherein at least one monitoring station is arranged to facilitate implementation of a rescheduling action based on the

displayed scheduling information.

64. A scheduling facility system as claimed in any one of
claims 38 to 63, wherein the monitoring facility is
5 disposed at or adjacent an airport.

65. A system for scheduling mine activities substantially
as hereinbefore described with reference to the
accompanying drawings.

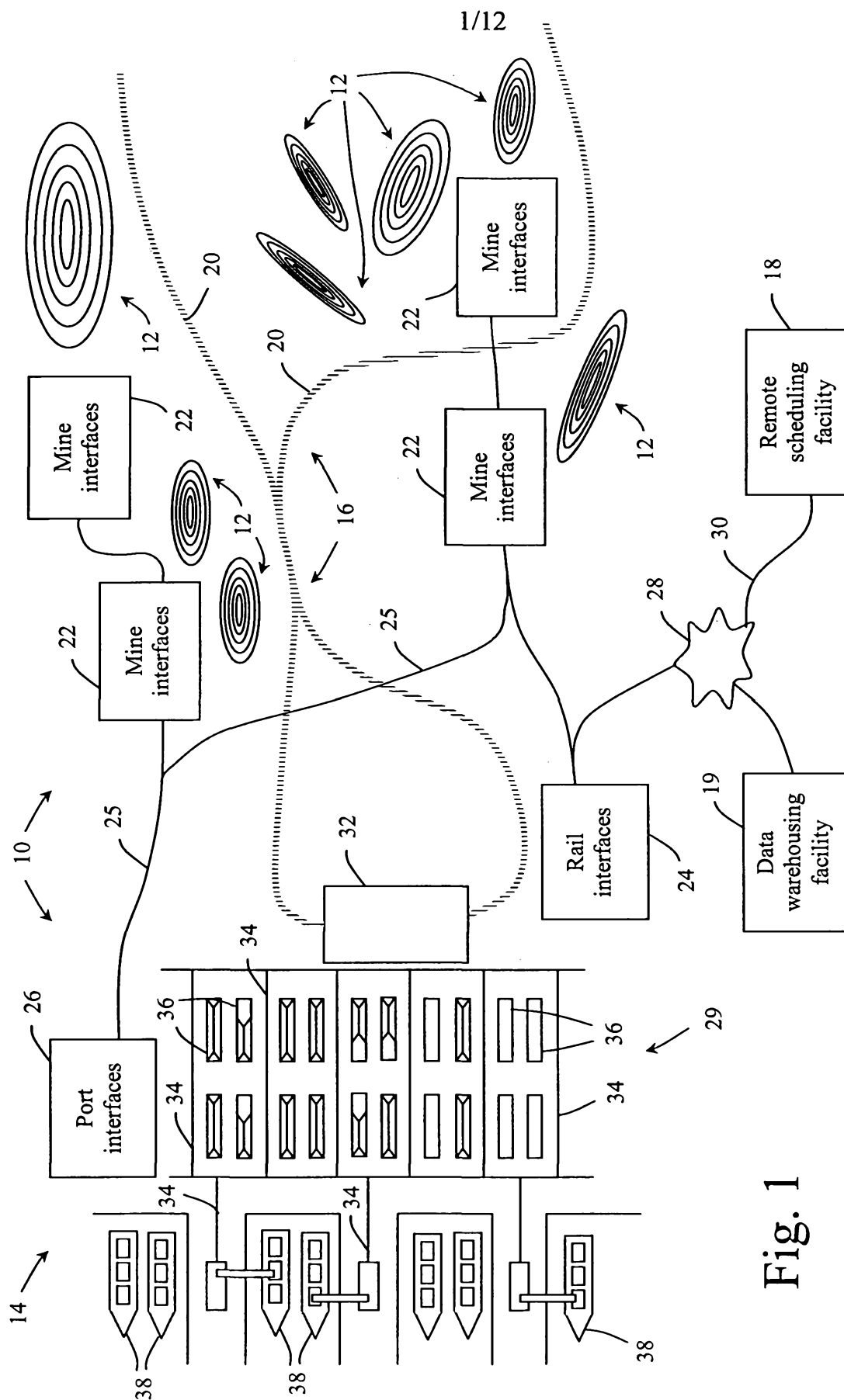


Fig. 1

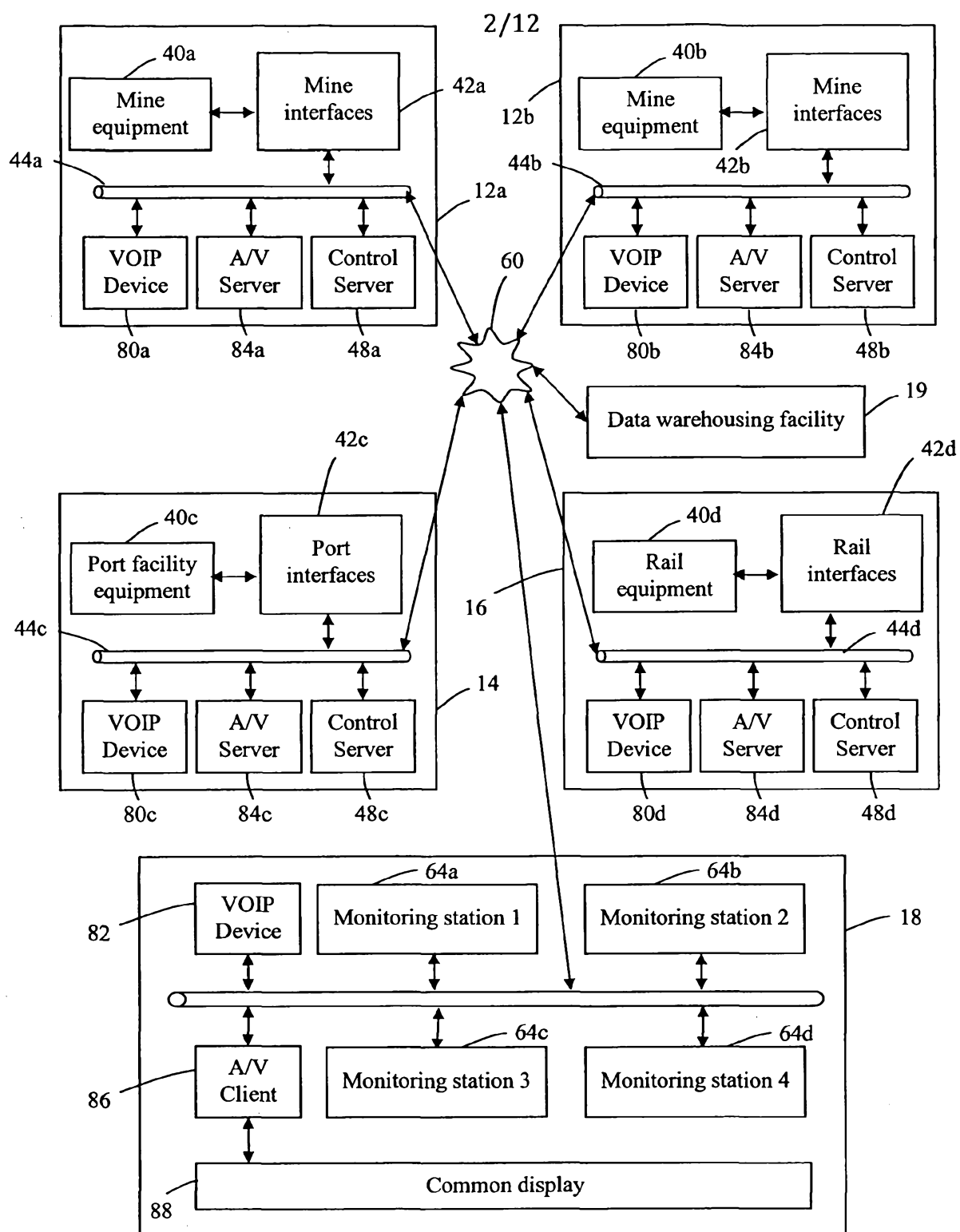


Fig. 2

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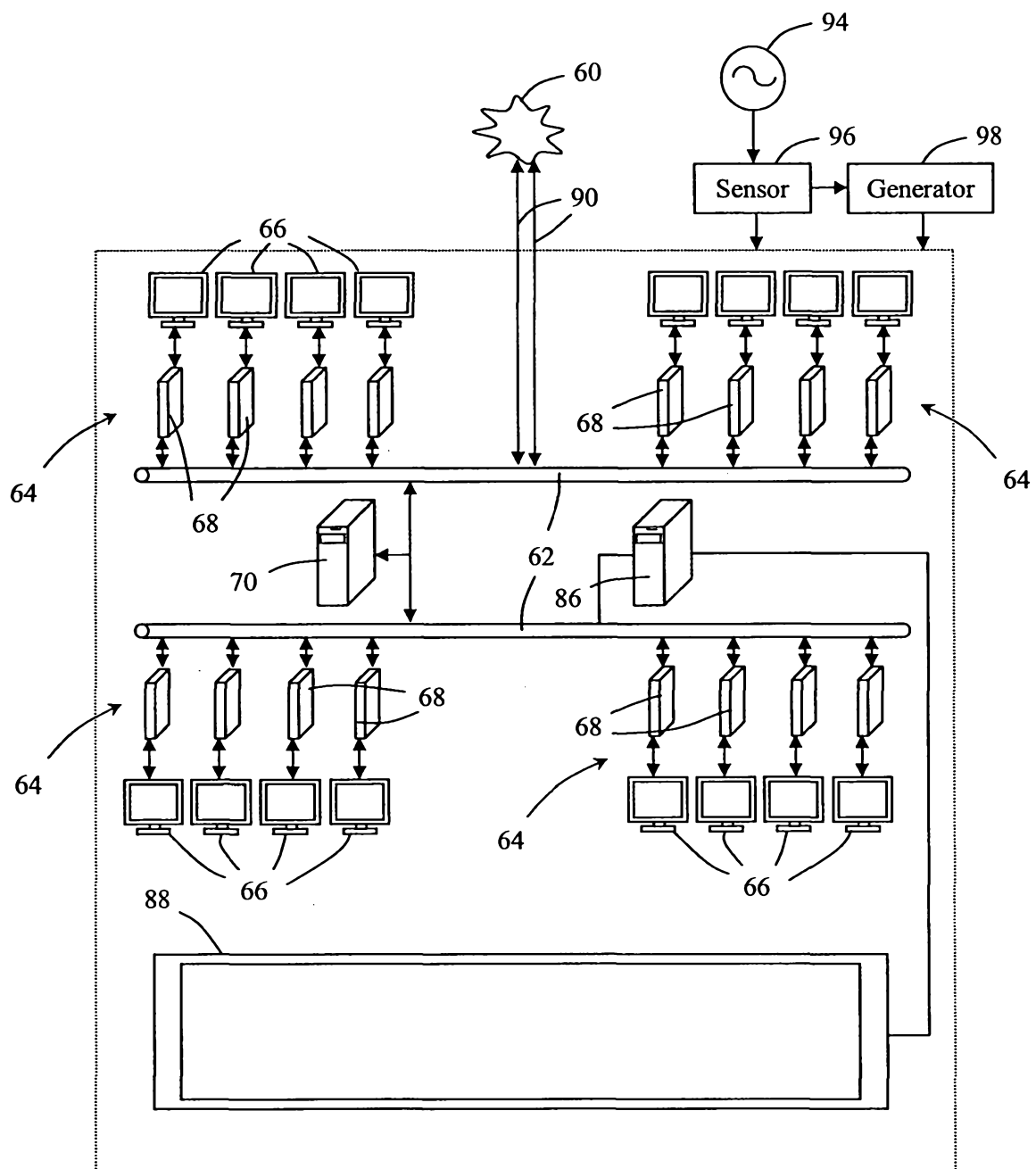


Fig. 3

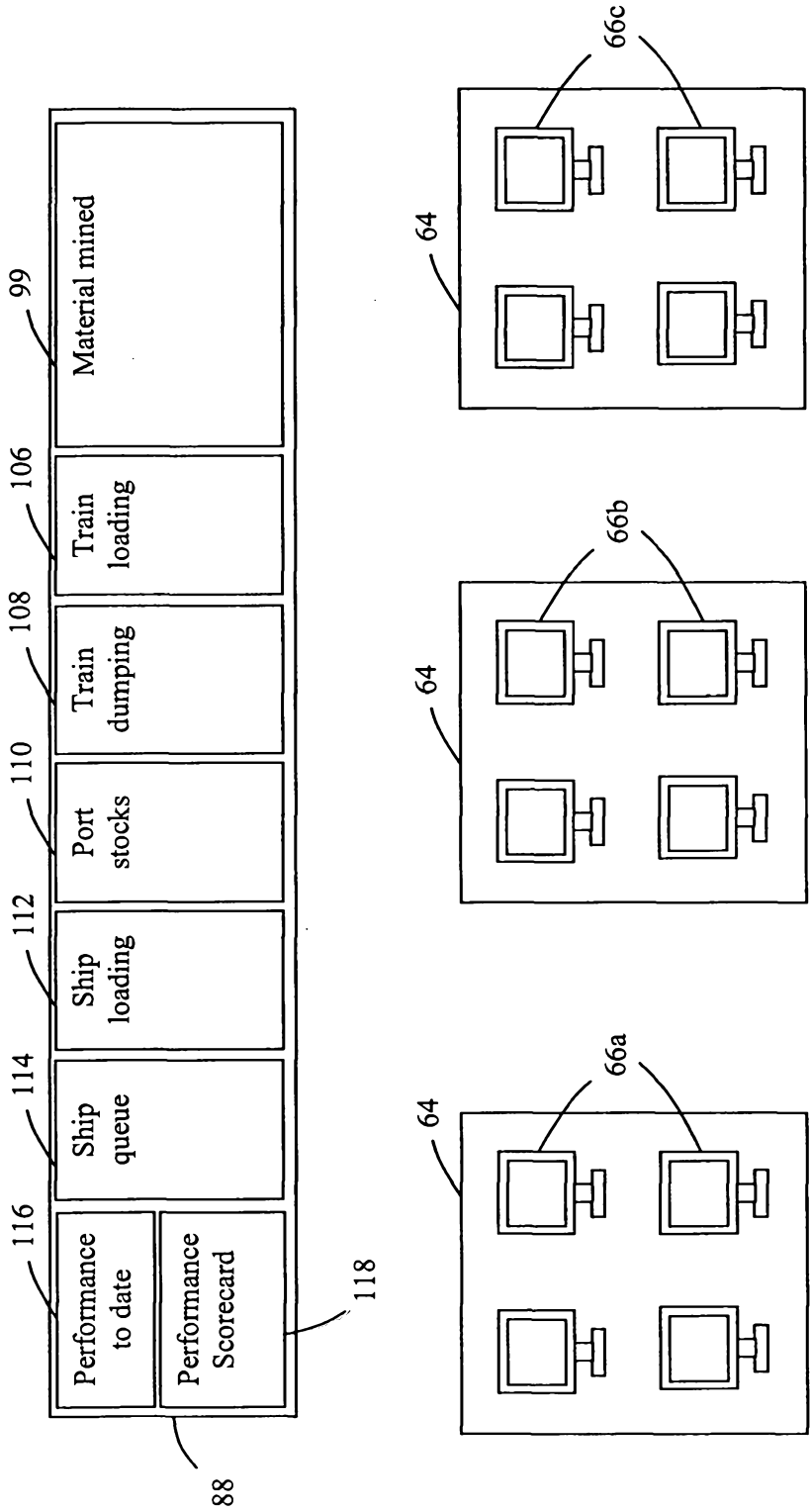


Fig. 4

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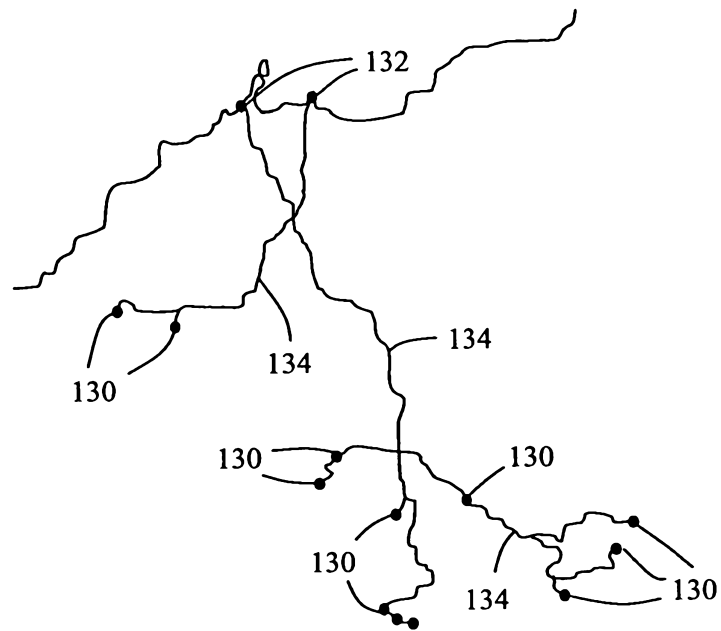


Fig. 5

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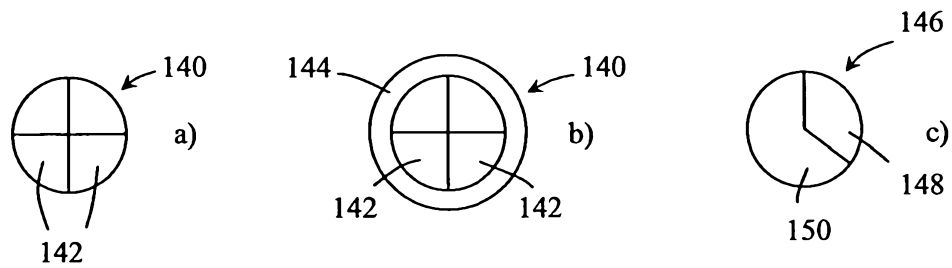


Fig. 6

Performance to Date		
Week to date (kt)		
2,300		
	Estimate	Target
Week (kt)	5,000	4,300
Month (Mt)	19	18
Year (Mt)	200	190

Fig. 7

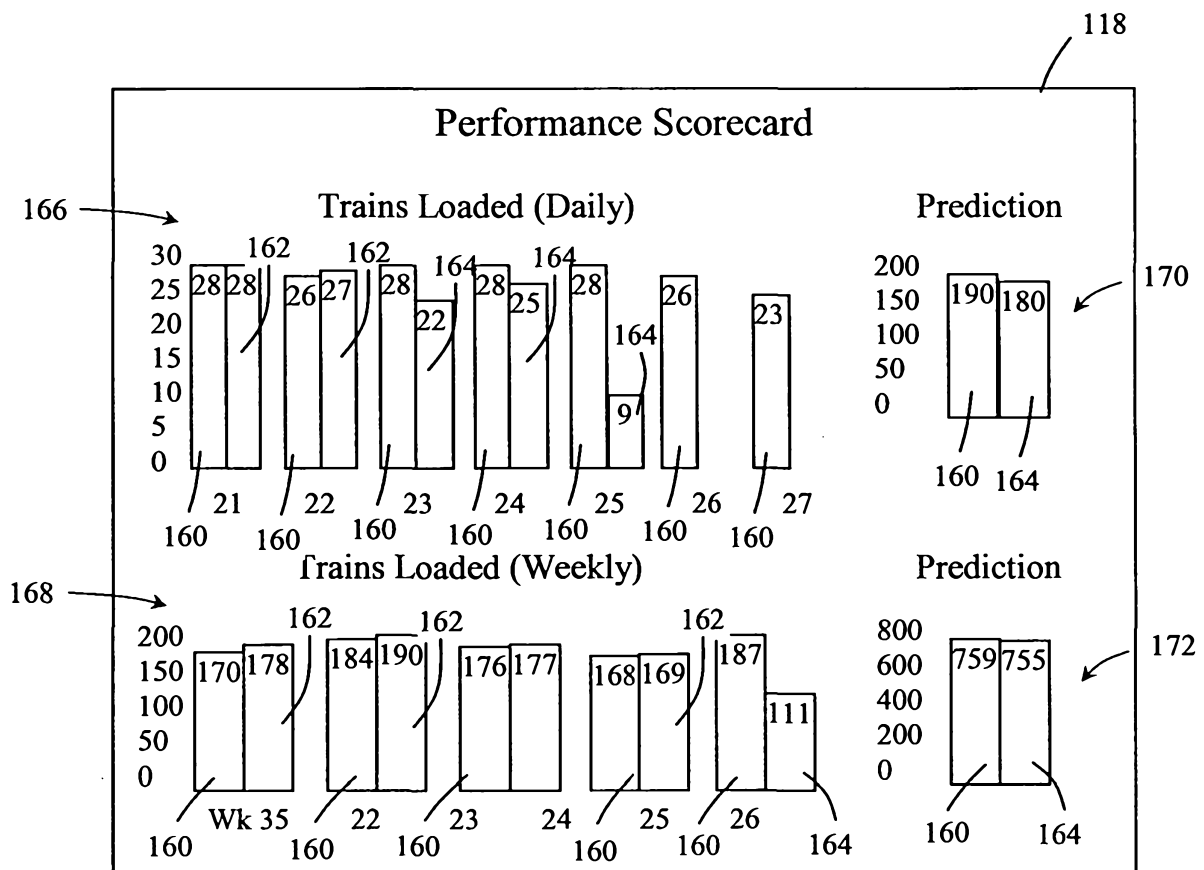


Fig. 8

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Stockpiles			Plant throughput			TMM		
			Actual (Rate)	Plan	Record	Actual (Rate)	Plan	Record
Fe $\oplus$ SiO ₂			466.90	497.4	755.6	1,448.6	1,680.1	1,926.9
P $\oplus$ Al ₂ O ₃								
Reclaim			Stack					
L	F	F	L	F	L	F	L	F
$\oplus$	$\oplus$	$\oplus$	6	2	$\oplus$	$\oplus$	4	13
$\oplus$	$\oplus$	$\oplus$	1	0	$\oplus$	$\oplus$	-	-
$\oplus$	$\oplus$	$\oplus$	4	13	$\oplus$	$\oplus$	0	2
$\oplus$	$\oplus$	$\oplus$	8	0	$\oplus$	$\oplus$	7	6
$\oplus$	$\oplus$	$\oplus$	2	1	$\oplus$	$\oplus$	29	2
$\oplus$	$\oplus$	$\oplus$	9	8	$\oplus$	$\oplus$	6	11
$\oplus$	$\oplus$	$\oplus$	1	2	$\oplus$	$\oplus$	18	7
$\oplus$	$\oplus$	$\oplus$	20	-	$\oplus$	$\oplus$	-	-
271 - Not available			0	50	200	180	250	280

Fig. 9

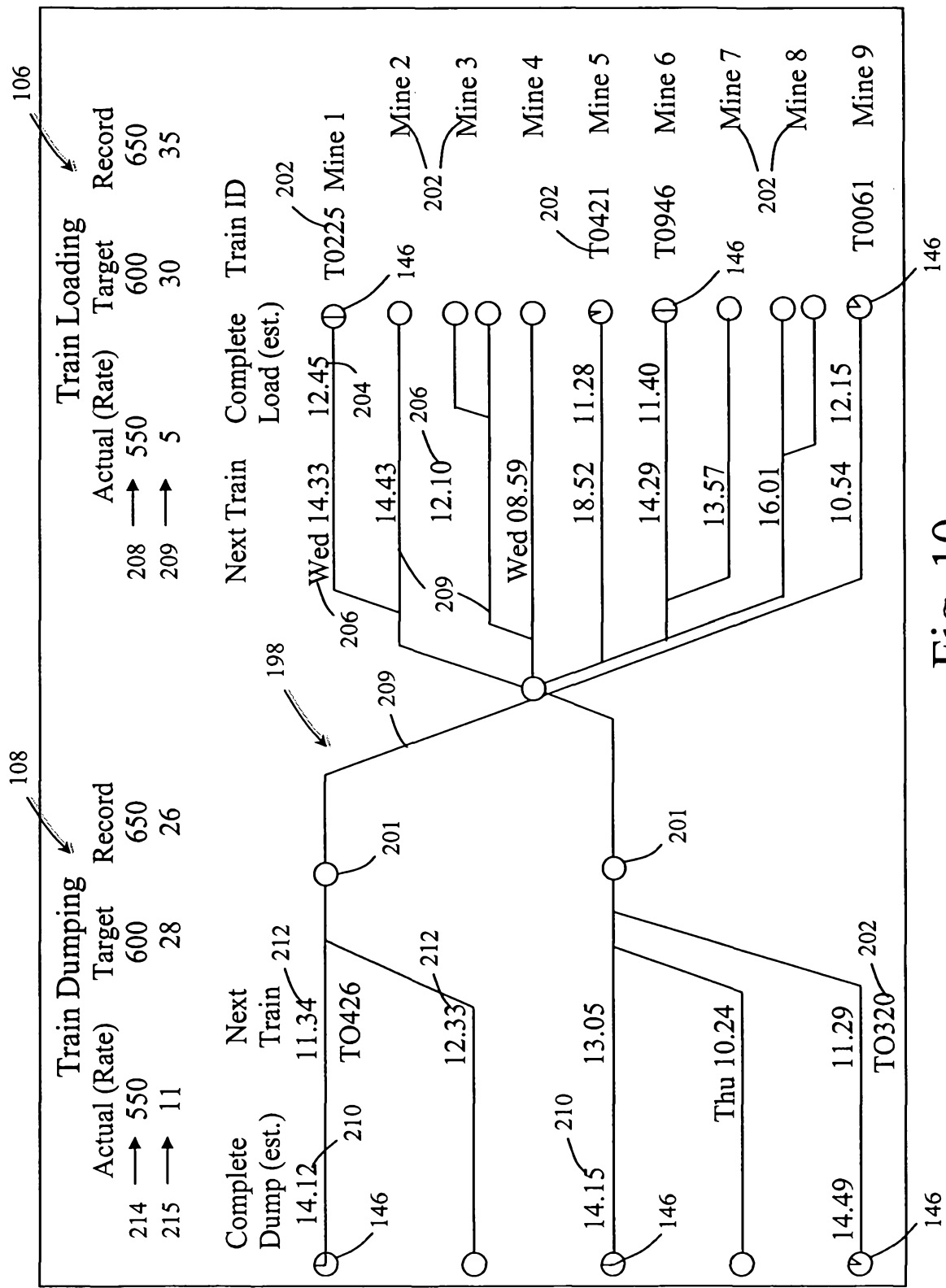


Fig. 10

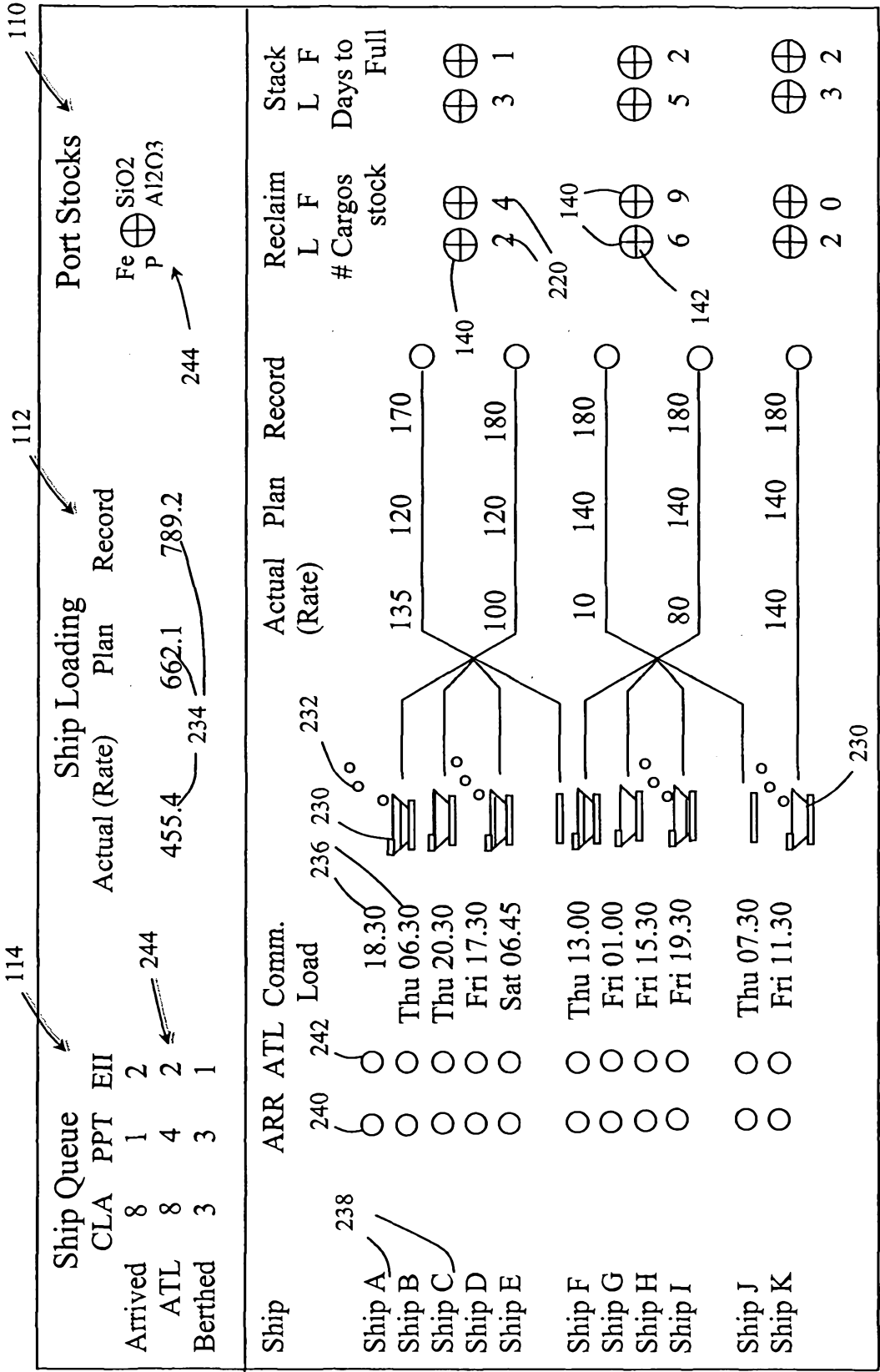


Fig. 11

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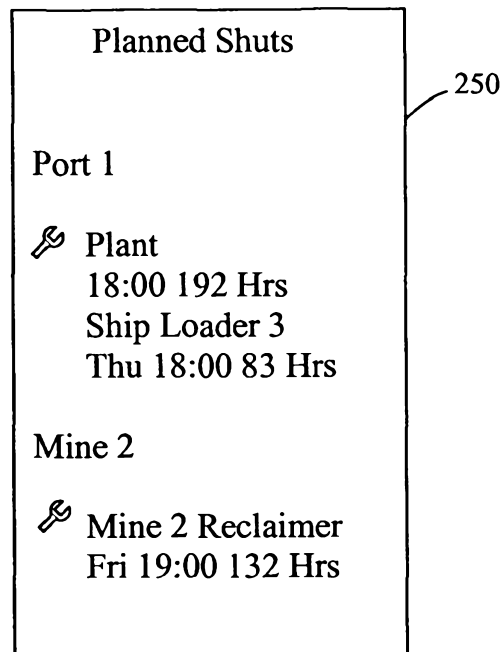


Fig. 12

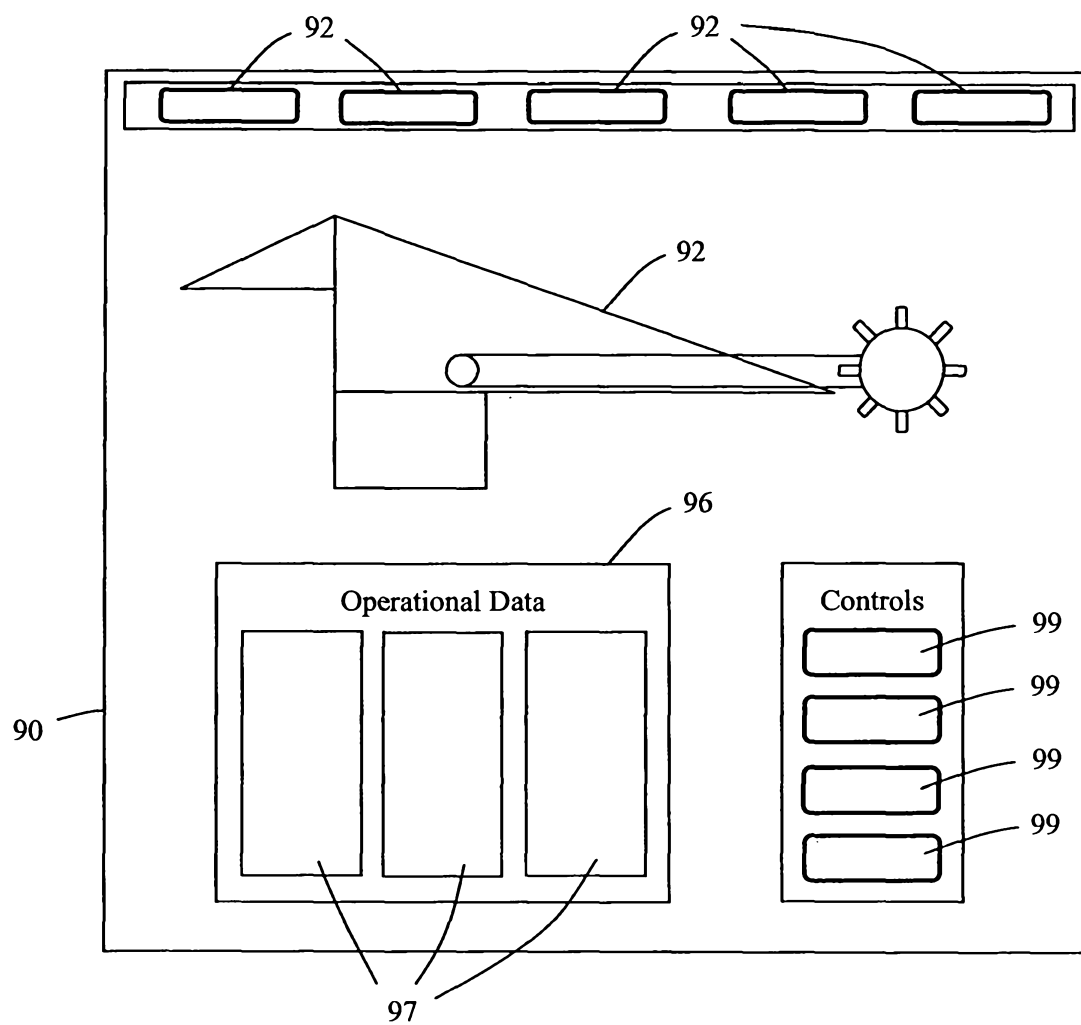


Fig. 13

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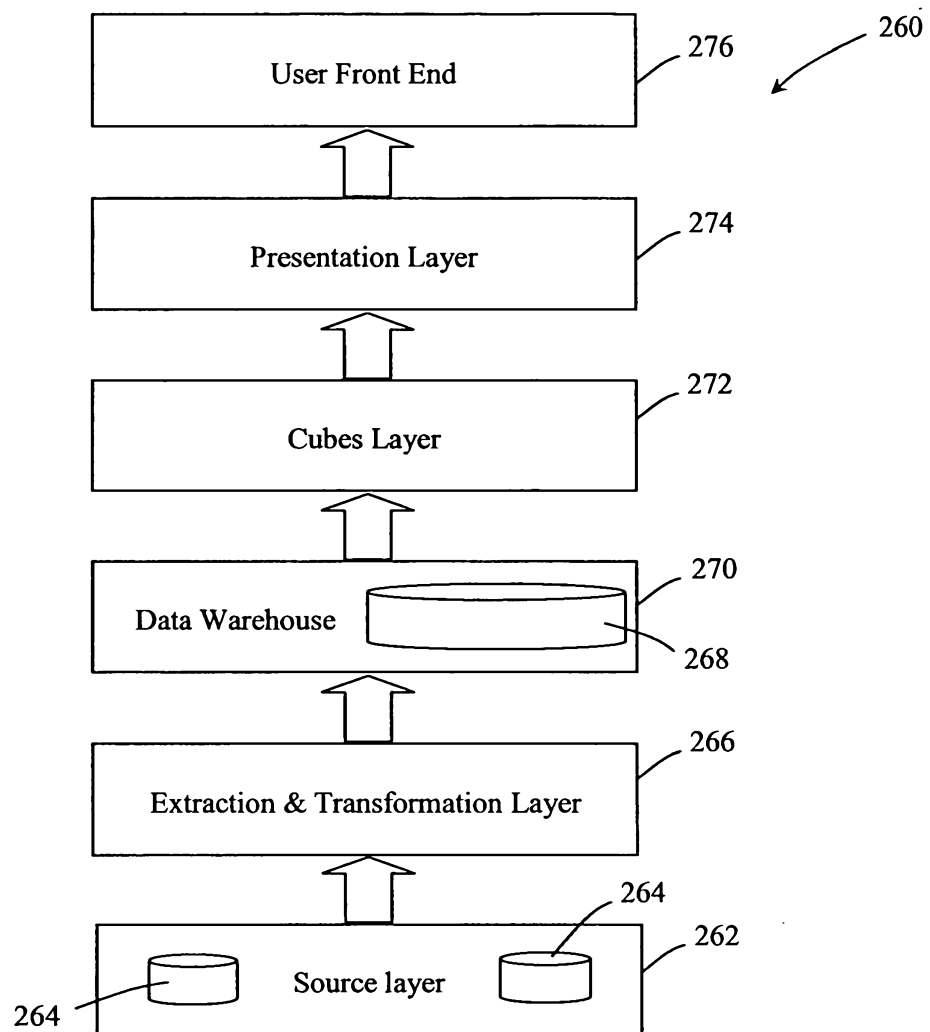


Fig. 14