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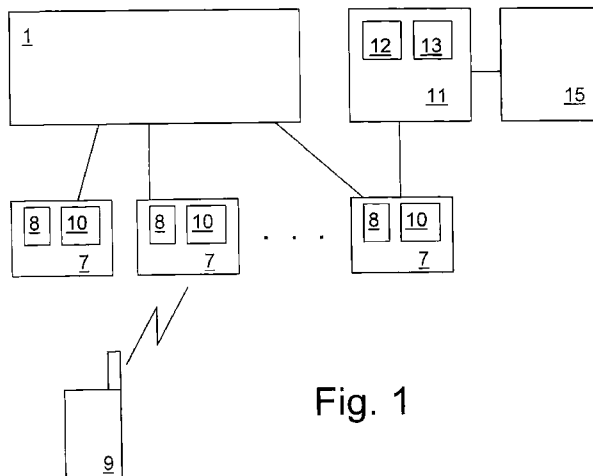


Fig. 1

(57) Abstract: A node (4, 7) and a method for performance monitoring in a communications network, said node comprising a monitoring unit (8) arranged to collect performance data comprising at least one key performance indicator related to the operation of the network and at least one performance indicator associated with the key performance indicator and forwarding at least part of said performance data to a domain manager (11) arranged to control the radio network functions in the communications network. The monitoring unit (8) is arranged to monitor performance data in dependence of the values of at least one kind of performance data. A hierarchy of levels may be defined for performance data and monitoring on each level initiated by exceeding a threshold on the higher level.

WO 2009/072941 A1

Method and apparatus for performance management in a communications network

Technical Field

The present invention relates to a communications node in a cellular communications network, a monitoring node in a cellular communications network and a monitoring method in a cellular communications network.

Background and Related Art

All communications networks today employ some kind of performance monitoring to monitor the function of the nodes or units in the network. Typically, the performance data are reported from each node to a supervising node that is responsible for collecting and processing performance data for the whole network.

For example, in cellular networks today, each network element is arranged to monitor performance management data. Which data to collect, and how they should be handled, is normally predefined in the network. Either a measurement is subscribed to or not. If it is subscribed to, it is stored for a certain amount of time in the network element as well as forwarded to the Domain Manager, where it is stored for a relatively long period of time, typically months. If it is not subscribed to, it is not collected at all.

Depending on how the performance management is configured, there will be an excess amount of data stored at most times, whereas at times when there is a problem the performance data that would be of interest for solving the problem may not be available.

Summary of the Invention

It is an object of the invention to achieve a more efficient monitoring of performance parameters in a communications network.

This object is achieved according to the present invention by a node for use in a communications network, said node comprising a monitoring unit arranged to collect performance data arranged hierarchically on at least a first and a second level, said performance data comprising at least one first level performance indicator related to the operation of the network and at least one second level performance indicator associated with the first level performance indicator, the node being further arranged to forward at least part of said performance data to a domain manager arranged to control the radio network functions in the communications network, said node being characterized in that the monitoring unit is arranged to forward performance data to the domain manager in dependence of the values of at least one kind of performance data.

The object is also achieved by method of performance monitoring in a communications network comprising the steps of

- collecting performance data comprising at least one first level performance indicator related to the operation of the network, and
- forwarding performance data to the domain manager in dependence of the values of the at least one first level performance indicator.

Hence, the invention takes into account that a lot of performance data will only be needed when there is a problem. According to the invention each network element may decide which data to collect, or to forward to the domain manager, in dependence of the situation in the network. The decision is usually made based on one or more key performance indicators. For example, for each key performance indicator a threshold may be set and if the registered value exceeds the threshold, one or more additional performance indicators associated with this key performance indicator are also collected. There may be a hierarchy so that if one or more of the additional performance indicators exceed a preset threshold, data associated with this performance indicator may be collected on a more detailed level.

For clarity, in the claims the key performance indicators are referred to as “first level performance indicators” and the additional performance indicators are referred to as “second level performance indicators”.

- 5 In a preferred embodiment, the monitoring unit is arranged to forward the second level performance indicator to the domain manager only if the associated first level performance indicator is outside of a first acceptable range defined for the first level performance indicator. The method in this case preferably comprises the steps of
- determining if the first level performance indicator is outside of a first predefined
 - 10 range for the first level performance indicator,
 - if the first level performance indicator is outside of the first predefined range, monitoring at least a second level performance indicator associated with the first level performance indicator.
- 15 Typical first level performance indicators (key performance indicators) include the amount of traffic and the number of lost calls.

Typically, in a communications system an acceptable range has been set for each of the key performance indicators or other performance indicators. If an indicator ex-

20 ceeds the acceptable range, an alarm may or may not be generated. For clarity, though, the term “alarm level” will be used in this document for this prior art acceptable range. Performance indicators may be, for example, counters, events, recordings, traces and logs. Counters are simple indicators counting, for example, the number of lost calls. Events may occur once or in an irregular way, or may be peri-

25 odic. For example, status reports may be periodic events. Recordings, traces and logs are used for specific measurements when a problem has been identified by means of counters or events.

According to the invention, an additional acceptable range should be set, that will be

30 exceeded before the key performance indicator or performance indicator reaches the

alarm level. In this way, the node can identify an increased risk that an alarm level will be exceeded and start monitoring additional performance indicators before the alarm level is reached. For example, if a 2% increase in a particular error rate will constitute the alarm level, the threshold for collecting data according to the invention could be 1%. In this way, if the alarm level is reached, performance data related to the situation that led to this situation will have been collected and stored. At the same time, data related to normal situations, in which performance data is of no interest does not have to be collected at all.

10 Alternatively, the network element can collect all data all the time, and the data to be forwarded to the DM and/or NMS may be selected in dependence of the situation. In this way the data collecting functions in the network element do not have to be activated and deactivated, which may simplify the design of the network element. Which data to forward to the DM and/or NMS may be selected by the network element itself, or may be determined by the DM/NMS on the basis of key performance indicators received from the network element. In the latter case, the DM/NMS should request the desired additional data from the network element and the monitoring unit is arranged to collect performance data in dependence of information received from the domain manager.

20 If the node itself collects all performance data and determines on the basis of collected data which data should be forwarded to the DM, it may use the values of data on a higher level to determine which data on the next level should be forwarded. For example, the key performance indicator values may be used to determine which performance indicators should be forwarded. It may also use the value of the data itself to determine if it should be forwarded to the DM. For example, the performance indicators may be sampled at regular intervals and if they fall outside the accepted range they will be reported.

Preferably, the node further comprises memory means, and said monitoring means is arranged to store performance data in the memory means.

For example, the monitoring means may be arranged to collect the key performance indicator only if the key performance indicator is outside of the first acceptable
5 range. In this case, the monitoring step of the method comprises both the step of collecting the data and the step of forwarding the data to the domain manager.

Similarly, the monitoring means may be arranged to collect a more detailed indicator associated with the performance indicator and to forward it to the domain manager,
10 only if the performance indicator is outside of a second acceptable range defined for the performance indicator. In this case, the monitoring step of the method comprises only the step of forwarding the data to the domain manager.

The monitoring means may be arranged to collect the more detailed indicator only if
15 the performance indicator is outside of the second acceptable range, or to collect it all the time but only forward it to the domain manager if it is outside of the second acceptable range.

In a preferred embodiment the network is a cellular communications network. In
20 this case, the node may be a base station, such as an enhanced Node B, for controlling connections between a base station and a mobile terminal in the network. The node may also be a radio network controller or a base station controller.

The invention also relates to a domain manager arranged to receive performance
25 data from at least one node as defined in any one of the preceding claims, said domain manager comprising processing means for determining, on the basis of performance data received from the at least one node, the types of performance data it should receive from the node and communication means for instructing the node to
30 forward the determined types of performance data to the domain manager.

For example, if the key performance indicator is the number of lost calls in the network, and the threshold according to the invention is exceeded, additional performance indicators related to this key performance indicator may be monitored to give
5 more detailed information, for example related to the reasons why calls are lost. Calls may be lost, for example, because the radio conditions are poor, for example because of poor coverage or interference, or because the terminal's battery is empty. The reason why an unusually high amount of calls are lost will be decisive for the actions to be taken.

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There may be counters or events that are not directly related to lost calls as such, but that may also provide useful information related to the lost calls.

Brief Description of the Drawings

15 The invention will be described in more detail in the following, by way of example and with reference to the appended drawings in which:

Figure 1 illustrates a first cellular network in which the invention may be implemented.

20 Figure 2 illustrates a second type of cellular network in which the invention may be implemented.

Figure 3 is an example of how performance indicators may be divided into different levels to be used according to the invention.

Figures 4a and 4b illustrate the recording of performance indicators on different levels in dependence of the performance of the network and over time, respectively.

25 Figure 5 is a flow chart of a method according to the invention.

Detailed Description of Embodiments

As mentioned above, the invention can be implemented in any type of communications network in which one or more nodes collect performance data and report said
30 data to a supervising or monitoring node or system. In the following, a possible im-

plementation of the invention in a cellular network will be discussed. The skilled person will realize that the inventive ideas can also be applied to other types of communications networks.

5 Figure 1 illustrates a cellular network according to the Long Term Evolution (LTE) standard. A core network 1 comprises one or more MMEs and one or more SAE Gateways (not shown) in a way well known to the skilled person. Each core network 1 is connected to a radio network comprising a number of base stations 7, which in LTE are called enhanced node B or eNodeB. The base stations 7 are used to connect
10 to user equipment, which includes various types of user terminals 9. Each base station 7 comprises a monitoring unit 8 for collecting performance data related to the performance in the network and a memory unit 10 for storing the performance data. Typically, the performance data are stored in the base station 7 for a predetermined period of time, for example, 48 hours. In LTE, a domain manager 11 monitors the
15 function of the radio network. Typically, there will be a second domain manager (not shown) for the core network 1. The domain manager 11 comprises communications means 12 for receiving performance data from the base stations 7. According to one embodiment the domain manager 11 also comprises processing means 13 for determining, based on the values of the performance data it has received, which
20 types of performance data it should receive from each base station. In this case, the communications means 12 is also used for transmitting a request for these types of performance data to the base station.

Although the domain manager DM 11 is connected to all base stations 7, Figure 1
25 only shows connections between the domain manager 11 and one of the base stations, for clarity. The domain manager is typically an operation support system OSS which receives performance data recorded by the base stations 7 and may also forward it to a network management system NMS 15. The NMS in turn receives performance data from a number of different domain managers.

Figure 2 illustrates a different type of cellular network, which may be a Global System for Mobile communications (GSM) or a Wideband Code Division Multiple Access (WCDMA) system. The network comprises a core network 1 communicating with a number of base stations 7. In this type of network there is a concentrating element 4 between the core network 1 and the base stations 7, each concentrating element connecting a plurality of base stations 7 to the core network 1. In a GSM network the concentrating element 4 is a Base Station Controller (BSC). In a WCDMA network, the concentrating element 4 is a Radio Network Controller (RNC). Each concentrating element comprises a monitoring unit 8 for monitoring performance indicators in the network and a memory unit 10 for storing the performance indicators. A domain manager 11 is used to monitor the function of the core network 1, the concentrating elements 4 and the base stations 7, and to forward information from the network elements to a network management system 15. Typically the domain manager 11 is arranged to monitor the base stations through the concentrating elements 4. In this type of network, therefore, the domain manager 11 performs the same type of functions as in the network shown in Figure 1, but is arranged to communicate with the concentrating elements 4 instead of directly with the base stations 7.

In a cellular network, each base station and/or each concentrating element, if present, is arranged to collect performance data from each node and report measurement results to the domain manager 11. In the prior art, the rules for which performance data to collect and report are predetermined and are normally not changed very often. Typically, therefore, when making such rules, a compromise is made between the need for adequate data when a problem arises and the desire to keep the measurements and communication at a reasonable level.

According to an embodiment of the invention, the number and types of measurements to be made, and the types of data to be collected and forwarded to the DM are determined dynamically in dependence of the current situation in the network. A

number of key performance indicators should always be collected and forwarded. These key performance indicators should relate to the general functionality of the network and will typically include downlink latency, downlink and uplink throughput, number of calls made, setup success rate, abnormal release rate, and handover success rate.

In an alternative embodiment, all data are always collected by the relevant node. Instead, the inventive method is used to determine which data should be forwarded from the node to the domain manager.

Figure 3 illustrates a hierarchy of three levels: KPI level, PI level and more detailed level, respectively, the KPI level being the highest level, in which the key performance indicators are placed. In the example shown in Figure 3, two key performance indicators are shown, KPI 1 and KPI 2, which may be, for example, downlink latency and downlink throughput. These key performance indicators are always registered by each base station or concentrating element and forwarded to the domain manager. If the value for KPI 1 starts to deteriorate, it will at some level reach an alarm level as defined above, that is, fall outside of an acceptable range defined for this key performance indicator in the network. According to the invention, if KPI 1 starts to deteriorate, the relevant node should start collecting and forwarding more detailed data related to this key performance indicator at some point before the alarm level is reached. In the example shown in Figure 3, the more detailed data related to KPI 1 involves one performance indicator, PI 1.1, which may in this case be, for example, DL Send time, which is located on the pi level. In this case, if monitoring of the PI 1.1 is started, the value of this performance indicator may be used in a similar way, to trigger the monitoring of more detailed indicators on the more detailed level. In this case, the more detailed indicators include three counters, Counter 1.1.1, Counter 1.1.2 and Counter 1.1.3. Counter 1.1.2, in turn, may trigger the monitoring of counters on the next level, Counter 1.1.2.1, Counter 1.1.2.2 and Counter 1.1.2.3.

If, on the other hand the key performance indicator that starts to deteriorate below a certain level is KPI 2. this will trigger the monitoring of several performance indicators on the PI Level, including PI 1.1, PI 2.1, PI 2.2, PI 2.3 and PI 2.4.

5

Deterioration of PI 1.1 will trigger collection and forwarding of more detailed indicators as discussed above. Deterioration of the performance indicator PI 2.1 or PI 2.3 will not trigger any data collection on the next level. Performance indicator PI 2.2 will trigger collection of Counter 2.2.1 and Counter 2.2.2 on the third, more detailed level. Deterioration of the performance indicator PI 2.4 will trigger collection of a number of more detailed indicators on the more detailed level: Counter 2.4.1, Counter 2.4.2 and Counter 2.4.3. Counter 2.4.3 in turn may trigger collection of Counter 2.4.3.1 and Counter 2.4.3.2.

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15

In the discussion of Figure 3 it is assumed that not all performance indicators are being collected at any given time. As mentioned above, the node concerned may alternatively collect all performance indicators and indicators at all times but may select which ones to forward to the domain manager based on the values of the higher level indicators, as discussed above. In any case, the collected data should also be stored in a memory unit in the relevant node for a predetermined period of time, for example 48 hours, in case it becomes useful.

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Figure 4a illustrates variations in the level of detail required for performance data. On the horizontal axis the radio network performance spans from good, to the left, to poor, to the right. On the vertical axis the level of detail ranges from key performance indicators only, through performance indicators and detailed counters up to events and recordings. If the radio network performance is good, only key performance indicators are collected and forwarded to the domain manager. As the radio network performance deteriorates the relevant node will proceed to collect and forward performance indicators on the PI level, more detailed indicators on the more

30

detailed level, such as detailed counters, and finally, logs, traces and recordings, which may be seen as a fourth level but are also shown on the third level in Figure 3. Alternatively, as explained above, all data may be collected and stored at all times, but only some, determined as discussed above, will be forwarded to the domain manager.

Figure 4b shows an example of the variation of level of detail in collecting, storing and/or forwarding performance data over time. The vertical axis shows increasing level of detail in the same way as Figure 4a, while the horizontal axis shows time. As can be seen, in the example of Figure 4b the level of detail increases with time, to decrease again as time progresses further.

The curves shown in Figures 4a and 4b may relate to all collection/forwarding of performance indicators or to performance indicators related to one key performance indicator only, depending on the situation in the network.

Figure 5 is a flow chart of a method according to an embodiment of the invention.

In step S51 a key performance indicator of a node is collected and stored in the node and also forwarded to the DM. At the same time, the performance indicators associated with this key performance indicator are collected and stored in the node. In step S52 it is determined whether the key performance indicator is within limit values set for this key performance indicator, typically, if it is below or above a threshold. If it is within the acceptable range, the node repeats steps S51 and S52 until the key performance indicator falls outside of the acceptable range. If so, the method continues with step S53.

In step S53, the performance indicators related to this key performance indicator are forwarded to the domain manager along with the key performance indicators. At the same time, the node starts collecting and storing the more detailed indicators. In step

- S54 the node determines if each of the performance indicators is within its acceptable range. If so, steps 53 and 54 are repeated. If not, the method continues with step S55, in which the detailed indicators are also forwarded to the domain manager along with the key performance indicators and performance indicators. If at some point during the procedure the problem is solved, and all detailed indicators are within their acceptable range, the procedure may go back to repeating steps S53 and S54. If the performance indicators are also within their acceptable range, the procedure may go back to repeating steps S51 and S52.
- 10 As will be understood by the skilled person, several variations of the method of Figure 5 are possible. For example, the decisions in steps S52 and S54 may be taken by the relevant node as described above. Alternatively, they may be taken by the domain manager or another node arranged to monitor the functions of the network. If the decision steps are performed by the node itself, no data need to be forwarded to the domain manager before a key performance indicator is outside of its acceptable range.
- 15

Claims

- 5 1. A node (4, 7) for use in a communications network, said node comprising a monitoring unit (8) arranged to collect performance data arranged hierarchically on at least a first level and a second level, said performance data comprising at least one first level performance indicator related to the operation of the network and at least one second level performance indicator associated with the first level performance indicator, the node being further arranged to forward at least part of said performance data to a domain manager (11) arranged to control the radio network functions in the communications network, said node being **characterized** in that the monitoring unit (8) is arranged to forward performance data to the domain manager (11) in dependence of the values of at least one kind of performance data.
- 10
- 15 2. A node according to claim 1, wherein the monitoring unit (8) is arranged to forward second level performance data to the domain manager only if associated first level performance data is outside of a first acceptable range defined for the first level performance data.
- 20 3. A node according to claim 1 or 2, further comprising control means arranged to control the monitoring unit (8) in terms of which performance data to forward to the domain manager.
- 25 4. A node according to claim 1 or 2, wherein the monitoring unit is arranged to collect performance data in dependence of information received from the domain manager.

5. A node according to any one of the preceding claims, further comprising memory means (10), said monitoring means being arranged to store performance data in the memory means.
- 5 6. A node according to any one of the preceding claims, wherein the monitoring means is arranged to collect the second level performance indicator only if the first level performance indicator is outside of the first acceptable range.
- 10 7. A node according to any one of the preceding claims, wherein the monitoring means is arranged to collect a more detailed indicator associated with the second level performance indicator and to forward it to the domain manager only if the second level performance indicator is outside of a second acceptable range defined for the second level performance indicator.
- 15 8. A node according to any one of the preceding claims, wherein the monitoring means is arranged to collect the more detailed indicator only if the second level performance indicator is outside of the second acceptable range.
- 20 9. A node according to any one of the preceding claims, wherein the node is arranged for use in a cellular communications network.
- 25 10. A node according to any one of the preceding claims, wherein the node is a base station, such as an enhanced Node B, for controlling connections between a base station (7) and a mobile terminal (9) in the network.
- 30 11. A node according to any one of the preceding claims, wherein the node (4) is a radio network controller or a base station controller.
12. A domain manager (11) arranged to receive performance data from at least one node (4,7) as defined in any one of the preceding claims, said domain

manager (11) comprising processing means (13) for determining, on the basis of performance data received from the at least one node, the types of performance data it should receive from the node (4,7) and communication means (12) for instructing the node to forward the determined types of performance data to the domain manager.

13. A method of performance monitoring in a communications network comprising the steps of

- collecting performance data comprising at least one first level performance indicator related to the operation of the network, and
- forwarding performance data to the domain manager in dependence of the values of at least one first level performance indicator.

14. A method according to claim 13, further comprising the steps of

- determining if the at least one first level performance indicator is outside of a first predefined range for the performance data,
- if the at least one first level performance indicator is outside of the first predefined range, monitoring at least a second level performance indicator associated with the first level performance indicator.

15. A method of performance monitoring according to claim 14, further comprising the step of

- if the second level performance indicator is outside of a second predefined range, monitoring at least one more detailed indicator associated with the second level performance indicator.

16. A method according to any one of the claims 13-15, wherein the communications network is a cellular communications network comprising a radio network.

17. A method of performance monitoring according to claim 16, wherein the first level performance indicator, the second level performance indicator and the more detailed indicator are always collected and the monitoring step comprises reporting the first level performance indicator, the second level performance indicator and/or the more detailed indicator to a domain manager arranged to control the radio network functions in the communications network, in dependence of the value of the first level performance indicator and/or the second level performance indicator.

18. A method of performance monitoring according to claim 16 or 17, wherein each monitoring step comprises collecting the relevant type of performance data and reporting the first level performance indicator, the second level performance indicator and/or the more detailed indicator to a domain manager arranged to control the radio network functions in the communications network, in dependence of the value of the first level performance indicator and/or the second level performance indicator.

19. A method of performance monitoring according to any one of the claims 13 to 18, wherein the determining step is performed in the node performing the monitoring.

20. A method of performance monitoring according to any one of the claims 13 to 18, further comprising the step of receiving in the node performing the monitoring information about which types of performance data should be monitored from the domain manager information.

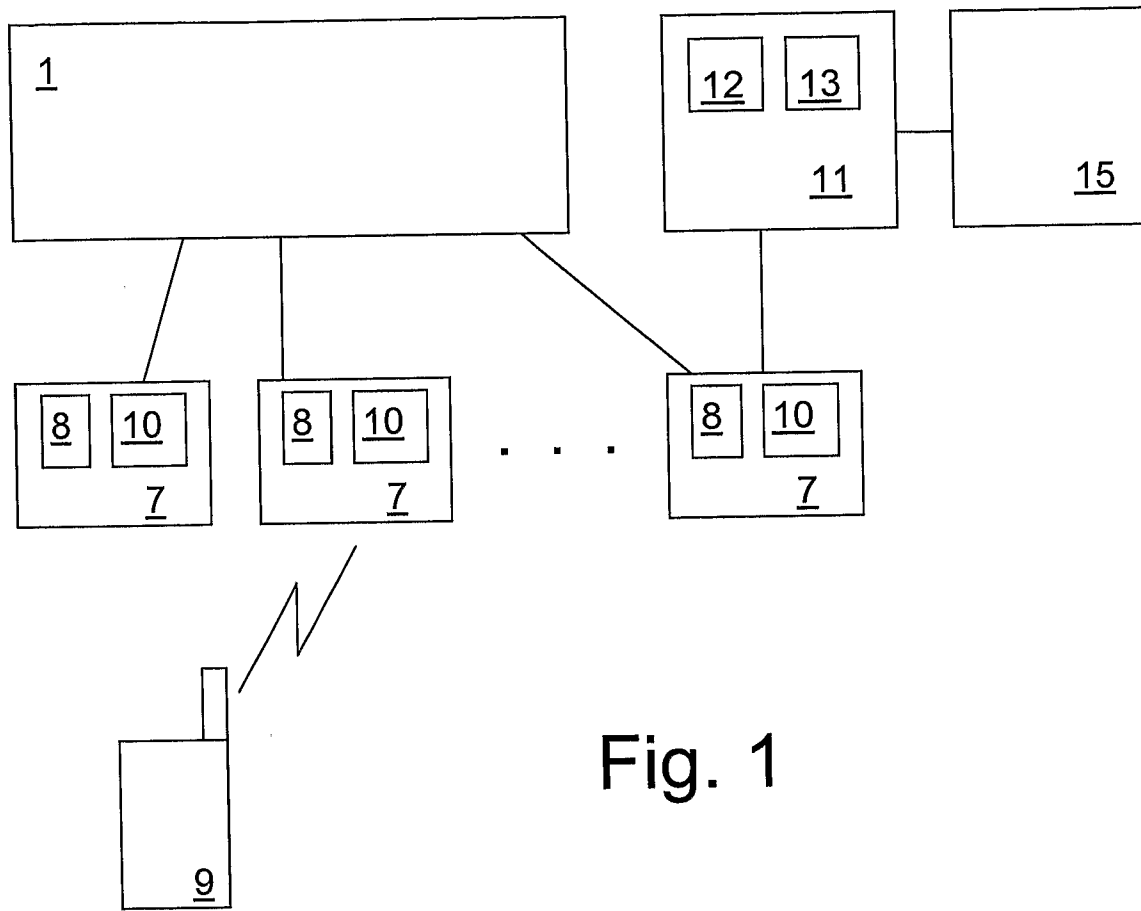


Fig. 1

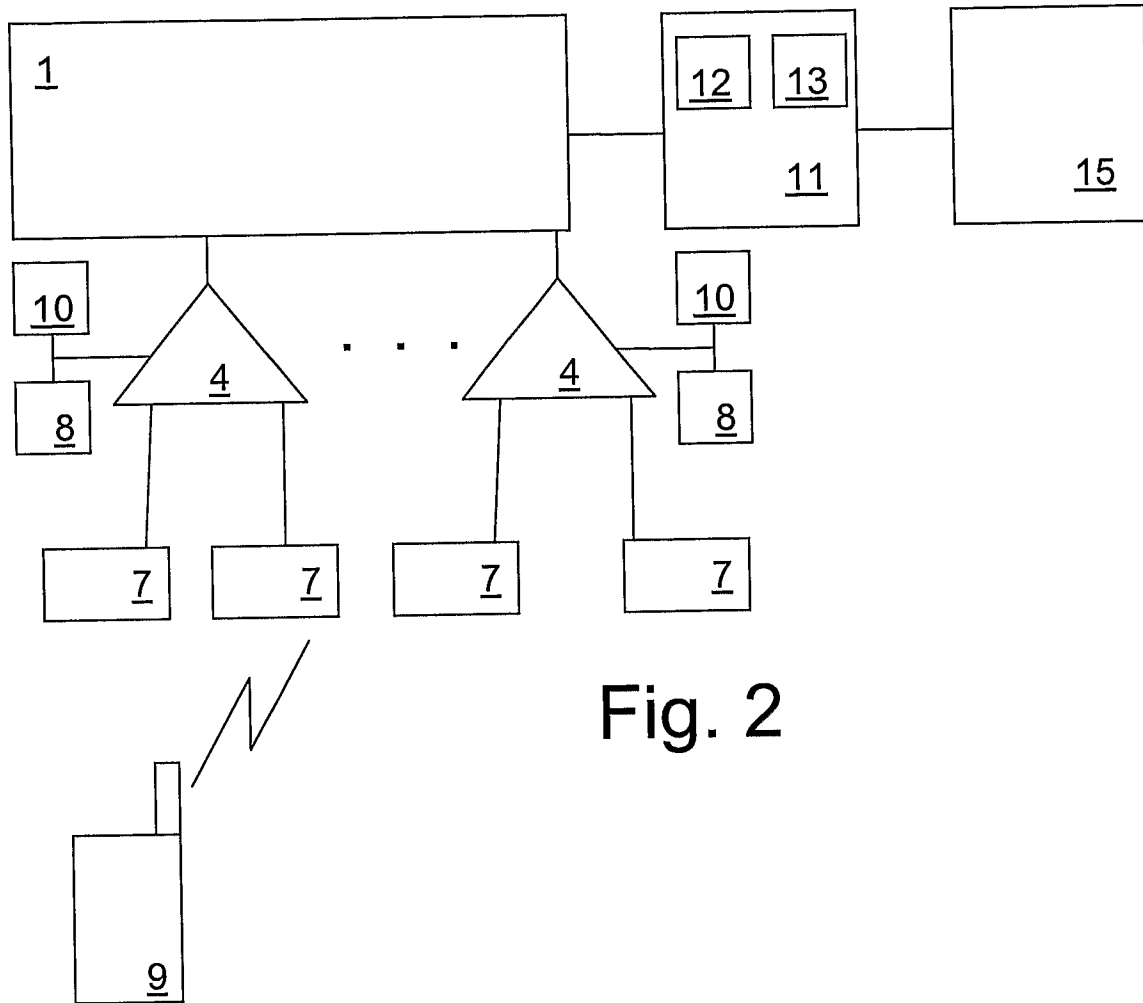


Fig. 2

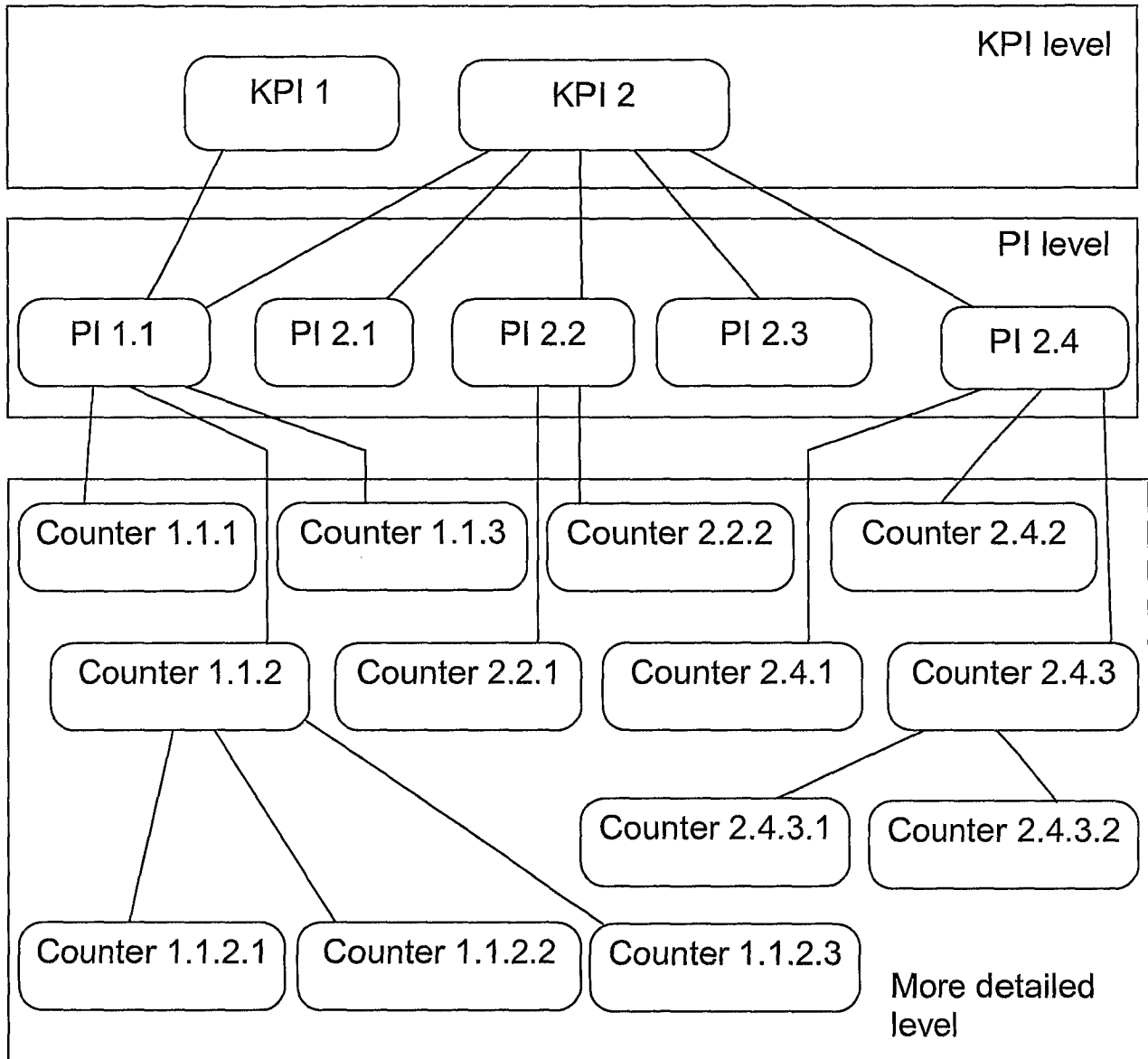


Fig. 3

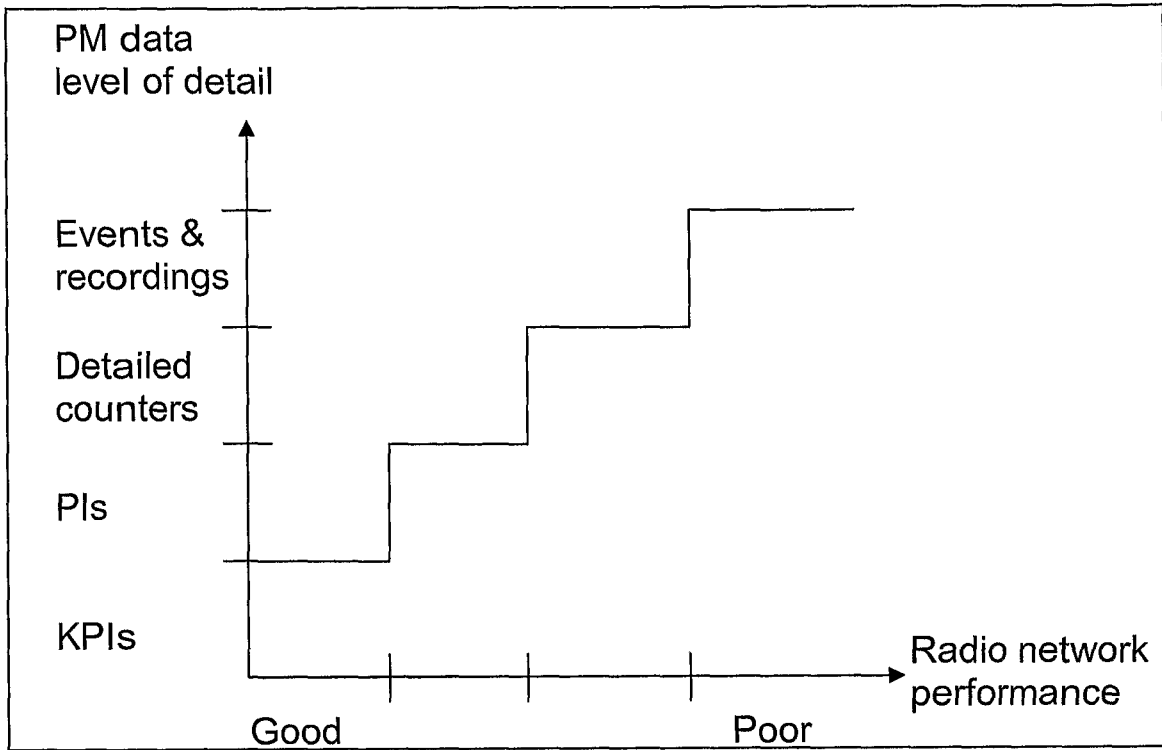


Fig. 4a

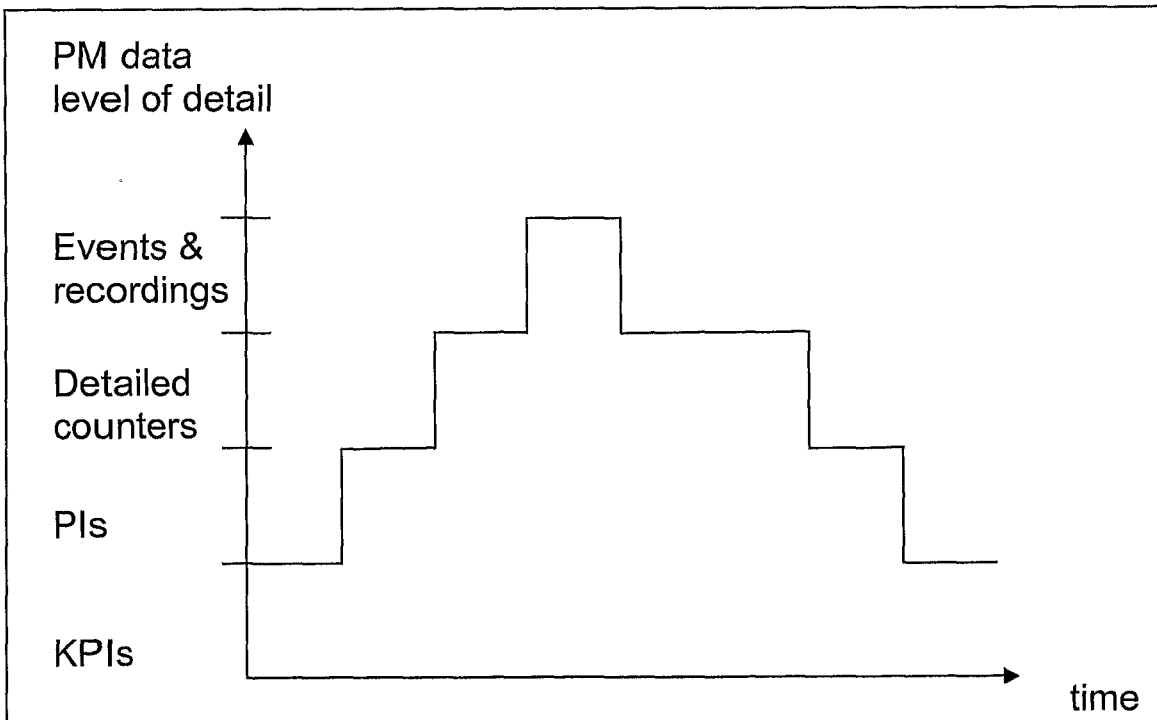


Fig. 4b

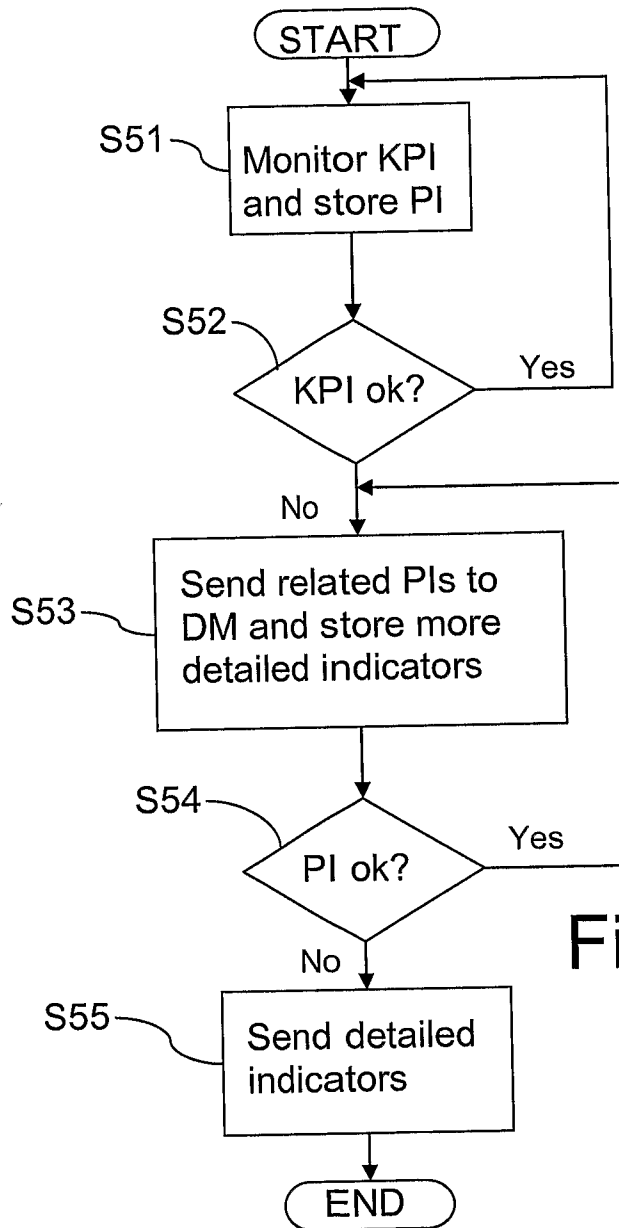


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/050930

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: H04L, H04Q		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-INTERNAL, WPI DATA, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 20060023646 A1 (ROSKOWSKI ET AL), 2 February 2006 (02.02.2006), figure 1, sections [0021], [0039] - [0043], [0049], [0097], [0113]	1-20
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X	US 20040193709 A1 (SELVAGGI ET AL), 30 Sept 2004 (30.09.2004), figure 1, sections [0038] - [0039], [0060] - [0062], [0074]	1-20
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A	EP 1152570 A2 (AGILENT TECHNOLOGIES, INC.), 7 November 2001 (07.11.2001), abstract	1-20
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<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2007/050930

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 5905868 A (BAGHAI ET AL), 18 May 1999 (18.05.1999), claim 1</p> <p style="text-align: center;">-- -----</p>	1-20

International patent classification (IPC)**H04L 12/26** (2006.01)**H04L 12/24** (2006.01)**Download your patent documents at www.prv.se**

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Cited literature, if any, will be enclosed in paper form.

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Information on patent family members

28/06/2008

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