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(54) Title: SYSTEM TO DELIVER ALERT MESSAGES FROM AT LEAST ONE CRITICAL SERVICE RUNNING ON A MONITORED TARGET SYSTEM TO A WEARABLE DEVICE

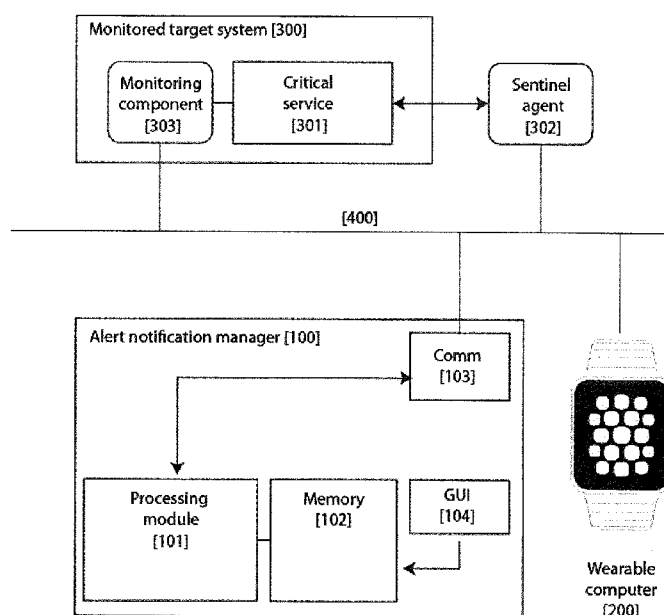


Fig 1

(57) Abstract: System to deliver alert messages from at least one critical service running on a monitored target system to a wearable device, comprising means for : receiving incoming sentinel messages over a communications network from at least one critical service running on said monitored target system, processing said incoming sentinel messages by comparing the received alert message content with predefined alert conditions stored in a memory, communicating an alert message over a communication network to a wearable device in the case that said sentinel message contains an alert event that matches a predefined alert condition stored in said memory, receiving incoming alert messages on said wearable device over said communication network, and converting said alert messages into at least one haptic signal noticeable by the user on said wearable device.

[DESCRIPTION]

System to deliver alert messages from at least one critical service running on a monitored target system to a wearable device.

5

FIELD OF THE INVENTION

The present invention relates to the field of administration of complex computer systems used in hospitals and medical institutions,
10 where business critical processes are executed on computer systems.

BACKGROUND OF THE INVENTION

Many businesses depend on IT (information technology) solutions to
15 support their critical business processes. Especially repetitive tasks and tasks in which large amounts of data are involved can nowadays be handled efficiently by computer systems. The concerned IT-components may be implemented in different ways and in different technical setups. They range from so-called stand-alone
20 configurations which are typically used by a single user at a time, to multi-user client-server setups. In the latter type of configuration, different services or components of the IT-system can be distributed over multiple physical hardware configurations, but will interoperate and be connected to each other via a communication
25 network. In such configurations, different subsystems will operate to provide specialised services for other subsystems or clients. Examples of such services offered by different IT-subsystems are for instance database services, network services, application services, web services, file sharing services, and alike.

30

An example of such a complex integrated system is an ERP system or - in a hospital context- a hospital management system (HIS). In such system, it is not uncommon that the different systems or subsystems which are serving different purposes are interconnected with each
35 other, and where data transfer between different modules of the subsystems is taken care of by dedicated interface components. These dedicated interfaces are actively translating and transporting data

from one subsystem to another, and have been specifically designed to do so. The use of these interfaces solves the problem of interoperability or compatibility of the data transfers between the different subsystems and assures the transport of time critical data
5 between the modules.

Technically, the interfaces may be configured to run as independent processes or programs on dedicated computer systems (or hosts). Such processes are commonly known as interface processes. It is clear
10 that any of these interface processes can cause business critical problems in case of failure.

An example of such a business critical process in a hospital environment is the transfer of scheduling and admission data for a
15 patient who received an internal referral from one department to another department in the hospital. The interface managing the transfer of these data is essential for the admission and scheduling process insofar that failure to perform this transfer in due time may lead to delays in planning and scheduling, making double
20 inquiries of information from the patient, ... A failure can even lead to critical situations affecting the patients treatment and health.

The result of such configurations is that IT systems become very complex chains of interoperating subsystems, in which various
25 components may become essential for proper operation. It is therefore of utmost importance that these business critical processes are implemented in such way that they are operational at all times. Certain strategies for ensuring 24/7 uptime of business critical systems can be implemented using fail-over strategies,
30 redundant configurations and backup techniques described in the art, but do not resolve all issues. Interfaces and critical services may fail after a program crash.

In order for the responsible system administrator to be able to
35 timely intervene in case of a failure of a critical component or service, it is essential that the interfaces and services are permanently monitored.

In the art, various methods are described on how to monitor running computer services or processes, many of them involve the use of so-called sentinel agents, which are active monitoring programs

5 guarding the proper operation of running systems and services. The sentinel agents monitor a set of selected parameters generated by the targeted system or processes to be monitored.

After a successful detection of a critical problem, it is essential
10 that the problem is escalated immediately to the responsible system administrator, and that the relevant alert level is provided to him at that moment, in order to allow him to respond with the appropriate actions.

15 This can be achieved by ensuring that the alert message confidently and quickly is delivered to an interface which is available to the administrator at the time of the alert. The prerequisites for a successful delivery of the message are the following:

- only the critical alerts are delivered to the administrator and
20 that less important ones are filtered out and are not delivered
- critical alert messages should be noticeable for the administrator under all circumstances in order to avoid missed alerts

25 In the art, different solutions to deliver alert messages in a confident way to a user have been described making use of, for instance, handheld communication devices to receive alert notifications by email, sms or other common communication means. The delivered messages may then contain contextual information about the
30 alert providing relevant information to the system administrator about the problem.

The likelihood that the alert signal is noticed by the user upon receipt of the message can be augmented by means of emitting
35 audible, visual or haptic signals by the handheld device. Audible signals will be effective in quiet environments (where the audible signal or ringtone can be easily noticed by the user), whereas

visual signals will be successful in conditions where the device is located within the viewing range of the user. Haptic signals will only be effective when the user is in direct contact with the handheld device (and not when the device is for instance stored in a pocket which is not in contact with the users body).

Another problem encountered with the solutions presented above, is that the augmented alert signal may be very intrusive and disturbing for the administrator or his environment. Imagine a system delivering very loud alert notifications; these may be very disturbing during meetings or other situations.

So, since each of these techniques have their shortcomings, today no good solution exists to ascertain the delivery of critical alert messages to a system administrator under all circumstances, especially under circumstances when loud or intrusive signals are not acceptable.

SUMMARY OF THE INVENTION

The present invention is beneficial in that the aforementioned delivery success rate for delivering alert messages can be drastically augmented. The invention provides for a solution to deliver critical alerts in a reliable, but yet non-disturbing or discrete way to a system administrator who is on guard. The above-described aspects are solved by a system as set out in claim 1. Further advantages and embodiments of the present invention will become apparent from the following description and drawings. Specific examples and preferred embodiments are set out in the dependent claims.

The present invention provides a system to deliver alert messages from at least one monitored target system (running at least one critical service) to a wearable device. The invention consists of 2 components; the alert notification manager and a wearable device.

The alert notification manager is a processor or a software application running on a computer system connected to a communication network. The alert notification manager is configured to perform a number of functions in the system. The alert notification manager 1) receives the (raw) sentinel messages, 2) analyses them to check whether the sentinel message in question carries a critical alert, and eventually 3) escalates the alert by sending an alert message to the wearable device over a network.

The embodiments of the systems and methods described herein may be implemented in hardware or software, or a combination of both. However, preferably, these embodiments are implemented in computer programs executing on programmable computers each comprising at least one module component which comprises at least one processor (e.g. a microprocessor), a data storage system (including volatile and non-volatile memory and/or storage elements), at least one input device, and at least one output device. For example and without limitation, the programmable computers (referred to here as computer systems) may be a personal computer, laptop, personal data assistant, and cellular telephone, smart-phone device, tablet computer, and/or wireless device. Program code is applied to input data to perform the functions described herein and generate output information. The output information is applied to one or more output devices, in known fashion.

Each program is preferably implemented in a high level procedural or object oriented programming and/or scripting language to communicate with a computer system. However, the programs can be implemented in assembly or machine language, if desired. In any case, the language may be a compiled or interpreted language. Each such computer program is preferably stored on a storage media or a device (e.g. ROM or magnetic diskette) readable by a general or special purpose programmable computer, for configuring and operating the computer when the storage media or device is read by the computer to perform the procedures described herein. The subject system may also be considered to be implemented as a computer-readable storage medium, configured with a computer program, where the storage medium so

configured causes a computer to operate in a specific and predefined manner to perform the functions described herein.

A first function of the alert notification manager is to receive
5 incoming sentinel input from a target system which runs a critical service or interface and which is to be monitored. The sentinel input consists of all received sentinel messages. The sentinel messages are sent by sentinel agents (which are monitoring the target system) or by monitoring components foreseen in the target
10 system itself (where the target system then acts as it's own sentinel agent). The sentinel input is being monitored in real time in order to make sure that time critical failures of such a critical service or interface is being detected. The sentinel messages are data messages which are sent over a communication network to which
15 the alert notification manager is also connected. The sentinel messages comprise data about the alert events on the target system, such as the alert level or criticality of the alert, coded information about the event, data about the record which was processed at the moment of the event, ...

20 The sentinel messages are either sent actively by the sentinel agent or the monitoring component of the target system. In another embodiment the sentinel messages are requested by the alert notification manager itself, which on regular intervals queries the
25 (passive) sentinel agents and monitoring components for new status messages.

A second function of the alert notification manager is to analyse the content of the received sentinel messages (i.e. data on the
30 alert events) in real time by comparing the message content against the predefined alert conditions stored in memory of the alert notification manager. Alert events turn into critical alerts when they match any of the predefined alert conditions. The alert conditions are the rules which determine when an analysed message
35 will be interpreted as a critical alert which needs to be escalated to the system administrator. The list of stored alert conditions can be adapted and configured (in order to become predefined) by means

of a GUI which is connected to the memory of the alert notification manager.

The GUI is accessible to the system administrator which allows him
5 to determine the different alert conditions for the escalated alert messages. The GUI may be accessible as a web-enabled service (such as a html-accessible webpage) or through a dedicated interface. The dedicated interface may be available on the host running the alert notification manager itself, or may be available on a different host
10 through a network enabled interface. The GUI even may be accessible from the wearable device itself.

The third function of the alert notification manager is to transmit the alert message to the wearable device. For this purpose, the
15 alert notification manager comprises a communication module which is configured to send a coded alert message to the wearable device. The coded alert message is sent over a communication network, such as the internet, gsm-network, local LAN or Wifi-network or alike. The coded alert message will comprise data about the destination of the
20 message (the wearable device), the criticality level of the alert message, and contextual information about the critical event and its origins (the description of the monitored system).

In this invention, the wearable device is configured to receive and
25 convert said alert messages into at least one haptic signal noticeable by the wearer of the wearable device. The haptic signal may be a vibration signal characterized by a certain vibration sequence or intensity. The differences between the haptic messaging schemes can be used to differentiate between different types of
30 alert messages, or for instance alert levels for the respective alert message.

In a different embodiment, the haptic signal characteristics can be specified for each alert message type. In this case, the haptic
35 signal characteristics are stored in the same memory connected to the alert notification manager for each alert condition.

In again a different embodiment, the alerts messages can be routed to different wearable devices and as such addressing different users under certain circumstances. In this case the specific addressing data are stored in the same memory connected to the alert notification manager for each alert condition.

Additionally, the alert messages can be made time-dependent insofar that the alert messages will only be active during certain periods of time of the day. This option allows the alert messages to be routed differently (to address different users) depending on different times of the day. Similarly, the timing data are stored in the same memory connected to the alert notification manager for each alert condition. All of these configuration parameters are then configurable through above mentioned GUI.

15

Development of wearable computers is accelerating with advances in technologies. Here, wearable computers refer to computers that a user can naturally wear, like clothes, watches, bracelets, glasses, and accessories, and which are in direct contact with the skin of the wearer. Smart-phones or tablet PCs do not have the same essential features as the wearable devices described above, since they are not necessarily always in contact with the user. Additionally, wearable computers may achieve better portability than smartphones or table PCs.

25

In particular, as one kind of wearable computers, a variety of products of a wrist watch, i.e. of a smart watch, through which the user can access a variety of online services, such as, for example, diary, messages, notifications, and stock quotes services, in a wireless manner, has appeared. In the case of the smart watch, the remarkable convenience is that the device is always in physical contact with the wearer of the watch. The wearability of the wearable device ascertains a compelling presence to the user during its use, and ascertains the delivery of a transmitted alert message to the user in a non-intrusive, or non-disturbing way. This effect cannot be achieved by devices which are not wearable in the definition that they are not permanently carried in contact with the

body of the user, such as smartphones. The art describes indeed devices (such as smartphones) which are capable of transmitting haptic signals customized for each type of alert, but the fact that smartphones can be mislaid, can be switched off, or be placed on a
5 table or something cannot ensure that the haptic signal will be transmitted under all circumstances. For a wearable device, the haptic signal will be transmitted to the user under all circumstances.

10 Since the wearable device is in constant contact (or which is present in a compelling way) with the user, it can ensure that critical messages are transferred to a user.

Optionally, the wearable computer could be configured to require
15 that the user acknowledges the signal (for instance by only stopping the repetition of the signals by executing a command on the wearable device, for instance by pressing a button, or an icon on the touch sensitive display). In this case, the wearable computer is fitted with a sensor unit to detect an input signal. This way, it can be
20 ascertained that the message was effectively delivered successfully to the user.

In another embodiment the wearable computer may include a display unit (or screen) to provide additional information at the moment
25 that the alert is delivered to the user. This has the additional advantage that contextual information can be added to the alert message, but this in a way that the display unit (or screen) itself does not attract the attention of the user or people in his direct vicinity. As such, the display of this supplementary contextual
30 information is not accompanied with light flashes or audible signals.

Further advantages and embodiments of the present invention will become apparent from the following description and drawings.

35

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a simplified illustration of a system to deliver time critical alert messages from a monitored target system [300] to a wearable device [200]. The system consists of the 2 main components: the alert notification manager [100] and the wearable device [200],
5 and is configured to monitor the target system [300] which is not part of the system itself, but resides on the same communication network [400] as the system components [100] and [200].

Fig. 2 represents a table containing the different alert
10 configurations for the different monitored target systems [300] stored in the memory [102].

Fig. 3 represents a table containing the different alert configurations for the different monitored target systems [300]
15 stored in the memory [102], comprising data for the different patterns of the haptic signals to be generated by the wearable device.

DETAILED DESCRIPTION OF THE INVENTION

20

In the following detailed description, reference is made in sufficient detail to the above referenced drawing, allowing those skilled in the art to practice the embodiments explained below.

25 The main embodiment of the present invention provides a system to deliver time critical alert messages from at least one monitored target system (which is running at least one critical service) to a wearable device.

30 The monitored target system [300] is a computer system which hosts a critical service, running process or program [301]. It means that the monitored target system [300] is being monitored because of the fact that it provides the necessary computing resources and infrastructure to host or run the critical service [301]. The
35 critical service [301] may be an independent running process or service, or may be a service which is a part of computer application.

The critical running process [301] is assumed to be running under normal operational conditions; when running, this process or program [301] performs its desired functions and is capable of communicating
5 with the monitoring component [303] or the sentinel agent [302].
Under normal operational conditions, the critical running process or program can provide and communicate status information to the monitoring component [303] or the sentinel agent [302], allowing same to analyse the status or condition of said process. This status
10 information may be standard operational or performance parameters of the critical service (for instance: the number of records being processed per unit of time) which can be analysed by the monitoring component [303] or the sentinel agent [302], or may be a status code providing the status directly. In the case that the critical service
15 would be in a failing mode or would not be running (for instance due to a program or system crash); said status information would deviate from the status information available during normal operating conditions, or said status information would not be available at all (for instance when the program halted). These deviations will then
20 be identified as error conditions by the monitoring component [303] or the sentinel agent [302], and be transferred to the alert notification manager [100] as a sentinel message.

The sentinel agent [302] differs from the monitoring component [303]
25 in that the monitoring component is part of the running critical process/program [301], and a sentinel agent [302] is not. In the case of a monitoring component, the critical process is fitted to actively provide status information about its performance by itself through its integrated monitoring component. A sentinel agent [302],
30 on the contrary, is an external program which is implemented and executed as a separate running program or service, which actively monitors a different process (the critical service [301]). A sentinel agent has the advantage that it will continue to respond even in case that the critical process fails or crashes, which in
35 this case can continue to provide sentinel messages about the crashed process.

The alert notification manager [100] communicates via a communication module [103] which is configured to receive sentinel messages from at least one monitoring component [303] or sentinel agent [302]. The communication module [103] transfers the incoming
5 sentinel messages to the processing module [101], which compares the content of the sentinel messages to the alert conditions stored in the memory [102] of the alert notification manager [100]. In the case that the processed sentinel message matches one of the stored alert conditions in the memory, the processing module [101] will
10 construct an alert message which will be sent to the wearable device [200]. The message contains addressing data to be able to be sent over a communications network to the destination device; the wearable computer [200]. The alert message optionally contains information about the alert condition, and optionally supplementary
15 contextual information providing more background about the alert condition.

The alert notification manager is a dedicated component which is installed preferably on the internal communication network of the
20 hospital, in order for it to have communication network access to the monitored target systems [300]. The network is in many cases an ethernet network, a Wi-Fi network, or alike. The communication between the alert notification manager [300] and the wearable computer [200] can be done over any wireless communication
25 technology suitable to reach the wearable computer, such as Wi-Fi, gsm- or cellphone networks, or in some cases even short range wireless communication technologies (near field networks, blue tooth,...)...

30 The alert notification manager [100] can be configured in that the alert configuration can be defined by means of a GUI. An alert configuration is defined by the monitored critical process, the alert condition, optional contextual information and the destination where to sent the alerts to (which may be an individual computer or
35 plural wearable computers at the same time) (see Figure 2). The contextual information may comprise references to the severity or

urgency level of the alert, or in-depth textual info about the alert just messaged to the wearer in a haptic way.

Additionally, the alert notification manager [100] can be configured
5 to deliver alert messages to different destinations during different periods of the day, allowing to send the alert messages only to the system administrator who is on guard at a certain moment.

The alert configurations stored in memory [102] can be edited by the
10 user via a configuration GUI [104] which may be accessible via the communication network (web-interface) via network capable device, or, in another embodiment, via the display interface of the targeted wearable computer [200] itself. The advantage of this approach where the alert configurations are stored in a memory of the system (as
15 opposed to in the wearable device itself) is that this enhances the configurability of the alert characteristics of the stored alert configurations, since they can be managed via the configuration GUI.

The wearable computer [200] of one embodiment of the invention can
20 be a smart watch as disclosed in US Patent 8,854,925. The wearable computer may also be any other wearable computer which is in sufficient direct contact with the skin of the user for haptic signals to be detectable by the wearer at all times (for instance: a vibrating pod or bracelet, implant,...), or whose display is
25 permanently in the field-of-view of the user (such as the "Google glass" (HUD-equipped pair of glasses)). The wearable computer in this invention has to be able to convert received alert messages into haptic signals. These haptic signals are typically vibrations produced by a vibrating element (actuator) built in into the
30 wearable computer which can be triggered by an electronic signal. It is of importance in this invention that the haptic signal is only detectable by the user of the wearable computer itself, in so far that other people in the vicinity of the user would not be disturbed or alerted by the signal delivered to the user. This would have to
35 mean that the haptic signal should not create secondary effects beyond the delivery of the haptic signal itself: a vibrating signal

should not produce audible effects insofar that they could be perceived by other people except for the user himself.

So, the vibrating signals' noise level should not exceed the ambient
5 noise level. For that purpose, the intensity settings of the vibration should be adjustable to match the acoustic environment the user situation is in. A very subtle, low intensity vibration setting should be used during a meeting or when the administrator would have to work in the vicinity of a patient, whereas a higher intensity
10 vibration could be selected when the user is in a loud area (such as the staff restaurant during lunch break). The ambient noise level can be used to adjust the intensity of the haptic signal. The ambient noise level should then be measured by a microphone in the wearable computer, or connected to the wearable computer.

15

The wearable device of this embodiment is thus able to transform the received alert message into a vibration, drawing the wearer's attention only. Other types of haptic signals may be considered as well, such as changes in temperature applied to the skin of the
20 wearer.

The haptic signals can be produced in different patterns and/or intensities noticeable by the user. As such, a certain differentiation can be achieved by delivering a haptic signal for
25 different types of alert messages. The pattern of the haptic signal can be used to uniquely identify a certain incoming alert type, thus providing additional identification information about the alert to the user.

30 Another embodiment of the invention may provide for a smartphone as an intermediary communication device, in which case the smartphone receives the alert messages sent by the alert notification manager. The smartphone then allows filtering on a broader range of alert messages escalated by the alert notification manager to the
35 smartphone. The user then can configure the escalated alert messages to the wearable device on his smartphone, offering a greater

flexibility for the user to define the range of alerts he wants to be notified of.

A further embodiment of the invention may provide that the haptic
5 signals are supplemented with visual display messages (in different
colours of screens, using symbols displayed on the screen, or as
light flashes) to provide further contextual information about the
alert to the extent that the wearable device is able to produce such
signals. The function of these visual display messages is in this
10 case not to transmit the alert or alert message itself to the user,
but rather to supply additional information which can be consulted
after the user has been notified of the alert by means of the haptic
signal or signals.

15 Again in another embodiment, the alert message is accompanied by a
displayed message on the display of the wearable device, requesting
an user interaction to be executed by the user of the wearable
device, serving as the acknowledgement of the receipt of the alert
message by the user. In this case, the wearable device comprises a
20 means to display said acknowledgement request message on its
display, and a means to receive the acknowledgement feedback (such
as by receiving a press on a button on the wearable device, or by a
press on a touch sensitive screen of the wearable device).

■

[CLAIMS]

1. System to deliver alert messages from at least one critical service [301] running on a monitored target system [300] to a
5 wearable device [200], comprising means for:
- receiving incoming sentinel messages over a communications network [400] from at least one critical service [301] running on said monitored target system,
 - processing said incoming sentinel messages by comparing the
10 received alert message content with predefined alert conditions stored in a memory [102] (of the alert notification manager [100]),
 - communicating an alert message over a communication network [400] to a wearable device [200] in the case that said sentinel message contains an alert event that matches a predefined alert condition
15 stored in said memory [102],
 - receiving incoming alert messages on said wearable device [200] over said communication network [400],
 - converting said alert messages into at least one haptic signal noticeable only by the user of said wearable device [200].
- 20
2. System according to Claim 1, wherein the haptic signal associated with a certain alert condition is delivered to the user of said wearable device [200] in a specific pattern, which is predefined and stored in said memory [102] for each alert condition.
- 25
3. System according to Claim 1, wherein the secondary acoustic effects of said haptic signal do not exceed the ambient acoustic level.
- 30
4. System according to Claim 1, wherein the haptic signal is adjusted to the ambient acoustic level of the user preventing the generation of perceivable secondary effects of the haptic signal.
5. System according to any of the previous claims, wherein the alert
35 configurations can be defined and altered by means of a GUI [104].

6. System according to any of the previous claims, wherein the wearable computer [200] communicates with a smart phone as intermediary device to receive the alert messages.

5 7. System according to any of the previous claims, wherein the haptic messages delivered by the wearable computer are supplemented with visual display messages (in different colours of screens, or using symbols) to provide further contextual information about the alert.

10

8. System according to any of the previous claims, wherein the receipt of the alert message by the user has to be acknowledged by performing an action on the wearable device.

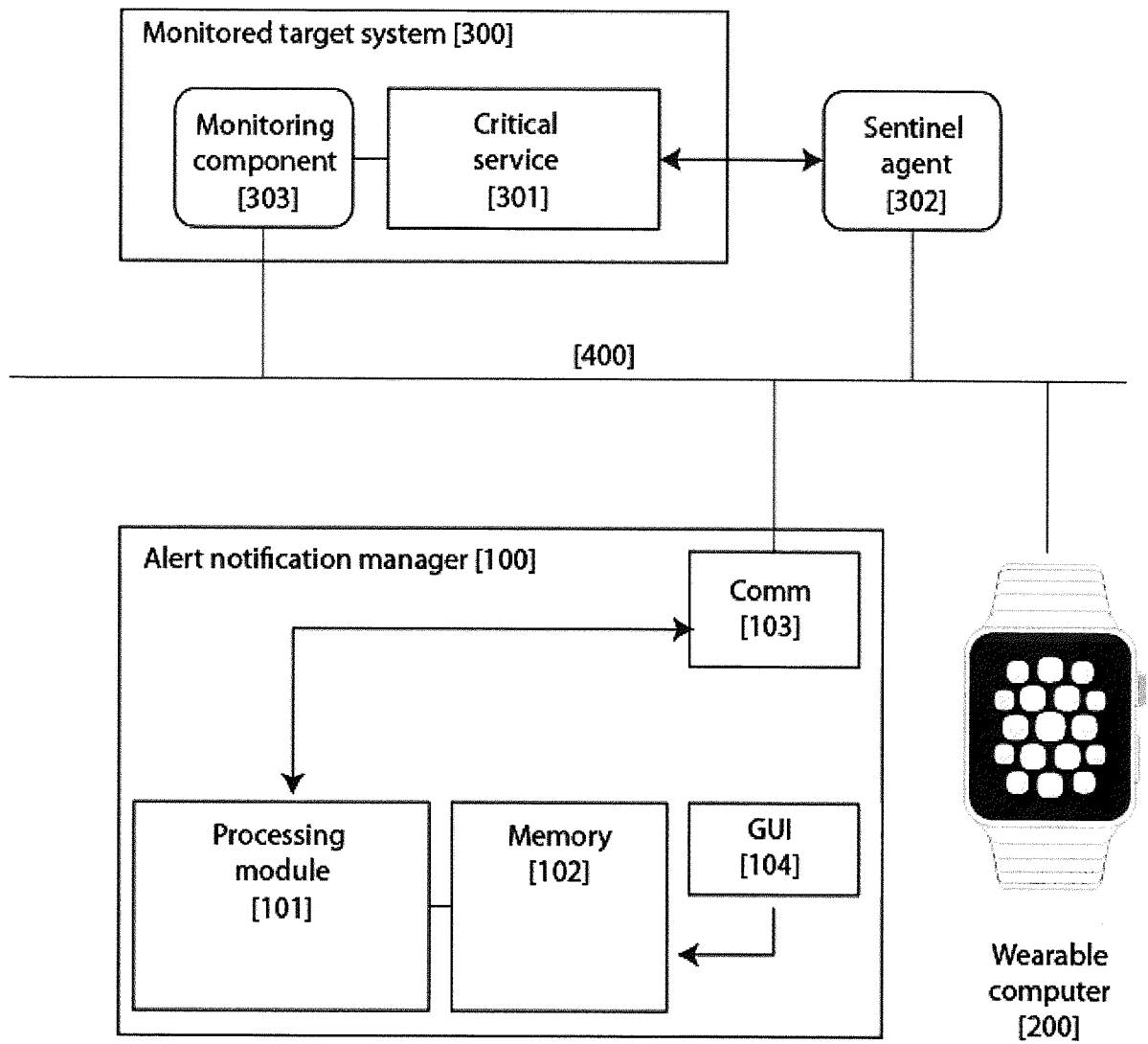


Fig 1

Critical process	Alert condition	Contextual information	Alert to Wearable computer
process 1	process dead is killed (does not run)	urgent!	1
process 2	parameter x1 > 25	x1 = 43	1
process 2	parameter x2 < 1	x2 = 0	1,2
process 3	number of records processed < 1/min	record process rate, last record processed	2

Fig 2

Critical process	Alert condition	Contextual information	Alert to Wearable computer	Type of haptic signal
process 1	process dead is killed (does not run)	urgent!	1	pattern A
process 2	parameter x1 > 25	x1 = 43	1	pattern B
process 2	parameter x2 < 1	x2 = 0	1,2	pattern C
process 3	number of records processed < 1/min	record process rate, last record processed	2	pattern C'

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/079106

A. CLASSIFICATION OF SUBJECT MATTER

INV. G06F11/07
ADD. G05B23/02 H04L12/24 G06Q10/06

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)

G06F G06Q G05B H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/073445 A1 (COMPUTER ASS THINK INC [US]) 19 September 2002 (2002-09-19) abstract page 4, line 16 - page 11, line 25 figures 1-3	1-8
A,P	----- "Tapping With Apple Watch's Haptic Feedback" In: Marc Saltzman: "Apple Watch For Dummies, Chapter I", 20 July 2015 (2015-07-20), For Dummies, XP002753162, the whole document ----- -/--	1-8



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

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PCT/EP2015/079106

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A	WO 2009/024557 A2 (IBM [US]; IBM UK [GB]; OUTLAW MICHAEL PATRICK [US]; SHAOUY WILLIAM PHI) 26 February 2009 (2009-02-26) abstract page 8, line 27 - page 9, line 2 page 10, line 5 - line 24 page 12, line 31 - page 13, line 4 figures 1-4 -----	1-8

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