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Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: NETWORK INTERFACE

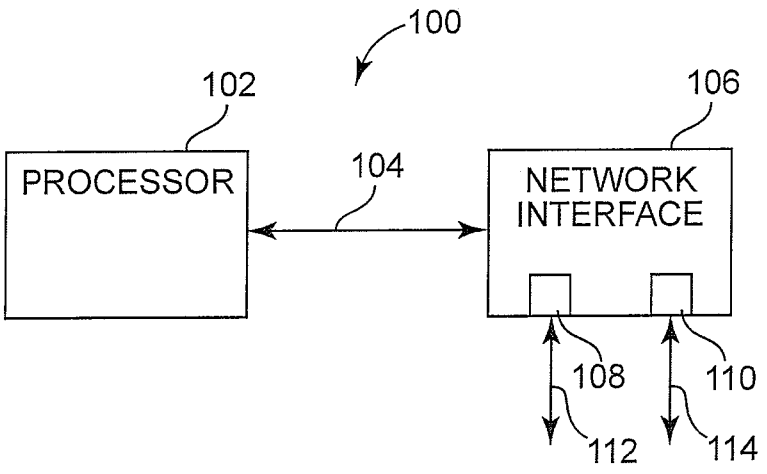

Fig. 1

(57) Abstract: A network interface includes a first port configured for communicatively coupling to a first interface for selectively passing communication signals between the first interface and a processor communicatively coupled to the network interface; a second port configured for communicatively coupling to a second interface for selectively passing communication signals between the second interface and the processor; and a controller configured to, independently of the processor, switch communications from between the first interface and the processor to between the second interface and the processor in response to detecting a failure of communications through the first port.

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NETWORK INTERFACE

Background

Typically, failover and/or redundancy in a network environment in which there are multiple network interfaces involves an operating system and/or a network interface driver running on a computer system. The operating system and/or the network interface driver typically routes communications through a selected interface via a network interface by addressing a selected port of a selected network interface. The operating system and/or the network interface driver may monitor the communications to detect any loss of communications through the selected interface. If the operating system and/or network interface driver detects a loss of communications through the selected interface, the operating system and/or network interface driver may reroute the communications through another interface by addressing another port of a network interface. The monitoring and rerouting of communications by the operating system and/or the network interface driver consumes valuable system resources of the computer system.

Brief Description of the Drawings

Figure 1 is a block diagram illustrating one embodiment of an automatic failover and/or redundancy system for a network.

Figure 2 is a block diagram illustrating one embodiment of a network interface.

Figure 3 is a flow diagram illustrating one embodiment of a method for performing automatic failover and/or redundancy in a network.

Figure 4 is a block diagram illustrating one embodiment of a system including automatic failover and/or redundancy.

Detailed Description

In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

It is to be understood that the features of the various exemplary embodiments described herein may be combined with each other, unless specifically noted otherwise.

Figure 1 is a block diagram illustrating one embodiment of an automatic failover and/or redundancy system 100 for a network. System 100 includes a processor 102 and a network interface 106. In one embodiment, network interface 106 includes a first port 108 and a second port 110. Processor 102 is communicatively coupled to network interface 106 through communication link 104. Network interface 106 is communicatively coupled to a first interface 112 through first port 108. In one embodiment, first interface 112 is an Ethernet interface and first port 108 is an Ethernet port. Network interface 106 is communicatively coupled to a second interface 114 through second port 110. In one embodiment, second interface 114 is an Ethernet interface and second port 110 is an Ethernet port. Network interface 106 provides automatic failover and/or redundancy for communications with processor 102. In response to network interface 106 detecting a failure of communications through one of first interface 112 and second interface 114, network interface 106 automatically

reroutes communications through the other of first interface 112 and second interface 114 independently of processor 102.

In one embodiment, processor 102 is part of a server, a personal computer (PC), or another suitable device configured for transmitting and/or receiving communications through a network. In one embodiment, communication link 104 is a peripheral component interconnect (PCI) bus, a PCI express bus, a sideband interface, a universal serial bus (USB), or another suitable communication link. In one embodiment, network interface 106 is a network card, a network adaptor, a network interface controller (NIC), a network interface card, a local area network (LAN) adaptor, a USB hub, or another suitable network interface. In one embodiment, first port 108 of network interface 106 is assigned a first address and second port 110 of network interface 110 is assigned a second address.

Processor 102 selectively transmits and receives communications through first interface 112 by addressing first port 108 of network interface 106. Processor 102 selectively transmits and receives communications through second interface 114 by addressing second port 110 of network interface 106. In one embodiment, just one of first port 108 and second port 110 is active at a time. Therefore, processor 102 transmits and receives communications through one of first interface 112 and second interface 114 at a time via the active port.

Network interface 106 monitors the communications with processor 102 via the active port. In response to network interface 106 detecting a loss of communications through the active port, network interface 106 automatically switches the routing of communications through the other port independently of processor 102. For example, if processor 102 is communicating with first interface 112 through first port 108, network interface 106 monitors the communications through first port 108 to detect a failure of communications. In response to network interface 106 detecting a failure of communications through first port 108, network interface 106 automatically reroutes the communications to second interface 114 through second port 110 independently of processor 102.

In one embodiment, network interface 106 automatically reroutes the communications by reassigning the first address of first port 108 to second port 110 by switching the first address of first port 108 with the second address of second port 110. Therefore, processor 102 continues to address the same port of network interface 106; however, the communications are automatically rerouted through second port 110 rather than first port 108. Processor 102 is not involved with the rerouting of the communications nor aware of the rerouting of the communications performed by network controller 106. In one embodiment, network interface 106 transmits a message to processor 102 after rerouting the communications to inform processor 102 of the rerouting.

In one embodiment, network interface 106 detects a failure of communications by detecting a loss of link or a loss of the electrical connection between first port 108 and first interface 112 or between second port 110 and second interface 114. In another embodiment, network interface 106 detects a failure of communications by detecting a loss of valid internet protocol (IP) packets for a set period. In another embodiment, network interface 106 detects a failure of communications by periodically attempting to perform a ping or another suitable test to a known 'echo' server. If a response is not received in response to the ping or test, network interface 106 detects a failure of communications. In another embodiment, network interface 106 detects a failure of communications by detecting a failure of a link layer discovery protocol (LLDP). In another embodiment, network interface 106 detects a failure of communications by detecting a preset number of collisions for a set period. In other embodiments, network interface 106 detects a failure of communications using other suitable techniques.

Figure 2 is a block diagram illustrating one embodiment of a network interface 120. In one embodiment, network interface 120 provides network interface 106 previously described and illustrated with reference to Figure 1. Network interface 120 includes a controller 122, a memory 124, and a suitable number of ports 126a-126(n). Controller 122 includes a microprocessor, microcontroller, or other suitable logic circuitry for controlling network interface 120. Memory 124 includes a non-volatile memory, such as a read only memory

(ROM), an electrically erasable and programmable read only memory (EEPROM), a flash memory, or another suitable memory. In one embodiment, memory 124 stores firmware executed by controller 122 to control network interface 120.

Each port 126a-126(n) of network interface 120 is configured for selectively communicating with an interface communicatively coupled to each port. In one embodiment, each port 126a-126(n) is assigned a unique address that is stored in memory 124. Controller 122 monitors communications through an active port 126a-126(n). In response to detecting a failure of communications though an active port 126a-126(n), controller 122 automatically switches the unique address of the active port experiencing the loss of communications with the unique address of another port. Thereafter, the communications are automatically rerouted through the other port without the knowledge or control of the device communicating through network interface 120.

For example in one embodiment, network interface 120 is assigned a unique media access control (MAC) address and each port 126a-126(n) is assigned a unique media-independent interface (MII) or reduced media-independent interface (RMII) address. The addresses are stored in memory 124. In response to controller 122 detecting a loss of communications through an active one of ports 126a-126(n), controller 122 automatically switches the MII or RMII address of the port experiencing the loss of communications with the MII or RMII address of another port. The switchover is transparent to any external device routing communications through network device 120 since the MAC address remains the same. In addition, in one embodiment, virtual local area network (VLAN) tagging is also maintained.

Figure 3 is a flow diagram illustrating one embodiment of a method 140 for performing automatic failover and/or redundancy in a network. At 142, communications with a processor are routed through a network interface to a first interface. At 144, the communications through the first interface are monitored to detect or check for a failure of the communications. At 146, if there is no failure of communications through the first interface, the communications

with the processor are continued to be routed through the first interface via the network interface at 142. If at 146 there is a failure of communications through the first interface, then at 148 the network interface, independently of the processor, switches the routing of the communications with the processor to a second interface. In one embodiment, the network interface notifies the processor of the switch in routing at 150. In other embodiments, the network interface does not notify the processor and the processor remains unaware of the switch in routing.

Figure 4 is a block diagram illustrating one embodiment of a system 200 including automatic failover and/or redundancy. System 200 includes a server 202, a network 218, and one or more clients 222. Server 202 includes a management processor 204, a network interface 208, and other suitable components (not shown) such as a main processor, memory, additional network interfaces, etc. Network interface 208 includes a first port 210 and a second port 212. Management processor 204 is communicatively coupled to network interface 208 through communication link 206. First port 210 communicatively couples network interface 208 to network 218 through first interface 214. Second port 212 communicatively couples network interface 208 to network 218 through second interface 216. Network 218 is communicatively coupled to one or more clients 222 through communication link 220. Network 218 includes any suitable number of interconnected switches, hubs, bridges, repeaters, routers, and/or other suitable network devices.

In one embodiment, server 202 is configured for being remotely managed by a client 222 via management processor 204. Management processor 204 is communicatively coupled to a client 222 through network interface 208 and network 218. Network interface 208 is configured for automatically rerouting communications with management processor 204 through one of first interface 214 and second interface 216 in response to detecting a failure of communications through the other of first interface 214 and second interface 216. In this way, communications between management processor 204 and a client 222 are maintained seamlessly by network interface 208 independently of management processor 204.

The failure of communications could be due to a failure within network interface 208 itself, such as a failure of first port 210 or second port 212. The failure of communications could also be due to a failure of first interface 214 or second interface 216, such as a broken cable. The failure of communications could also be due to a failure within network 218, such as a failed switch, hub, bridge, repeater, router, cable, etc. In any case, network interface 208 provides automatic failover and/or redundancy by detecting the failure of communications and by rerouting the communications in response to detecting the failure.

Embodiments provide a network interface for providing automatic failover and/or redundancy. Embodiments of the network interface transparently maintain communications between devices communicatively coupled through the network interface independently of the communicating devices. Automatic failover and/or redundancy is provided by embodiments of the network interface without consuming system resources of the devices communicating through the network interface.

Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. This application is intended to cover any adaptations or variations of the specific embodiments discussed herein. Therefore, it is intended that this invention be limited only by the claims and the equivalents thereof.

What is Claimed is:

CLAIMS

1. A network interface comprising:

a first port configured for communicatively coupling to a first interface for selectively passing communication signals between the first interface and a processor communicatively coupled to the network interface;

a second port configured for communicatively coupling to a second interface for selectively passing communication signals between the second interface and the processor; and

a controller configured to, independently of the processor, switch communications from between the first interface and the processor to between the second interface and the processor in response to detecting a failure of communications through the first port.

2. The network interface of claim 1, wherein the processor addresses the first port with a first address and the second port with a second address, and

wherein the controller is configured to switch the first address and the second address in response to detecting a failure of communications through the first port.

3. The network interface of claim 1 or 2, wherein the controller is configured to detect a failure of communications through the first port by one of detecting a loss of link, detecting a loss of valid packets for a set period, detecting a preset number of collisions for a set period, detecting a failure of a link layer discovery protocol, and detecting a failure to perform a ping.

4. The network interface of claim 1, 2, or 3, wherein the first port comprises a first Ethernet port and wherein the second port comprises a second Ethernet port.

5. The network interface of claim 1, 2, 3, or 4, wherein the processor comprises a management processor for remotely managing a server.

6. A network interface comprising:

means for communicatively coupling a processor to a first interface for selectively passing communication signals between the processor and the first interface;

means for communicatively coupling the processor to a second interface for selectively passing communication signals between the processor and the second interface; and

means for, independently of the processor, switching communications from between the processor and the first interface to between the processor and the second interface in response to detecting a failure of communications through the means for communicatively coupling the processor to the first interface.

7. The network interface of claim 6, wherein the first interface comprises a first Ethernet interface and wherein the second interface comprises a second Ethernet interface.

8. The network interface of claim 6, further comprising:

means for communicatively coupling the processor to a third interface for selectively passing communication signals between the processor and the third interface.

9. The network interface of claim 6, wherein the network interface comprises one of a network card, a network adaptor, a network interface controller, a network interface card, a local area network adaptor, and a universal serial bus hub.

10. The network interface of claim 6, further comprising:

means for informing the processor of the switch in communications to the second interface.

11. A method for passing communication signals through a network, the method comprising:

communicatively coupling a processor to a first interface to pass communication signals between the processor and the first interface based on an address provided by the processor;

detecting a failure of communications between the processor and the first interface independently of the processor; and

communicatively coupling the processor to a second interface independently of the processor to pass communication signals between the processor and the second interface in response to detecting the failure.

12. The method of claim 11, wherein detecting the failure comprises one of detecting a loss of link, detecting a loss of valid packets for a set period, detecting a preset number of collisions for a set period, detecting a failure of a link layer discovery protocol, and detecting a failure to perform a ping.

13. The method of claim 11 or 12, further comprising:

informing the processor of the failure of communications between the processor and the first interface.

14. The method of claim 11, 12, or 13, wherein communicatively coupling the processor to the first interface comprises communicatively coupling the processor to the first interface based on a media access control (MAC) address, and

wherein communicatively coupling the processor to the second interface comprises communicatively coupling the processor to the second interface without changing the MAC address.

15. The method of claim 14, wherein communicatively coupling the processor to the second interface comprises communicatively coupling the processor to the second interface by switching a first address of the first interface with a second address of the second interface.

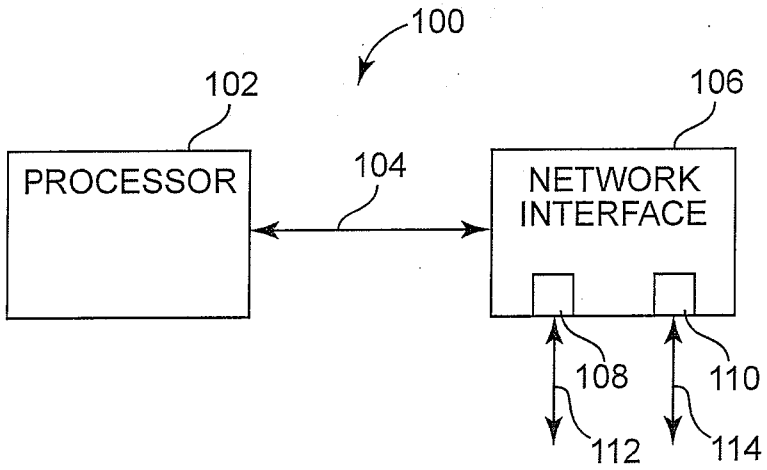
100
102
106
PROCESSOR
104
NETWORK INTERFACE
108
110
112
114

Fig. 1

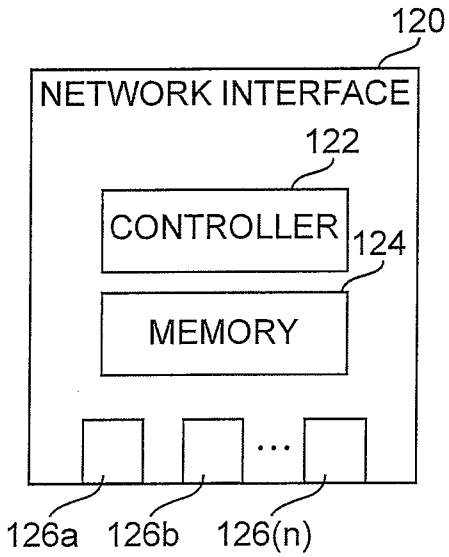
120
NETWORK INTERFACE
122
CONTROLLER
124
MEMORY
126a
126b
126(n)

Fig. 2

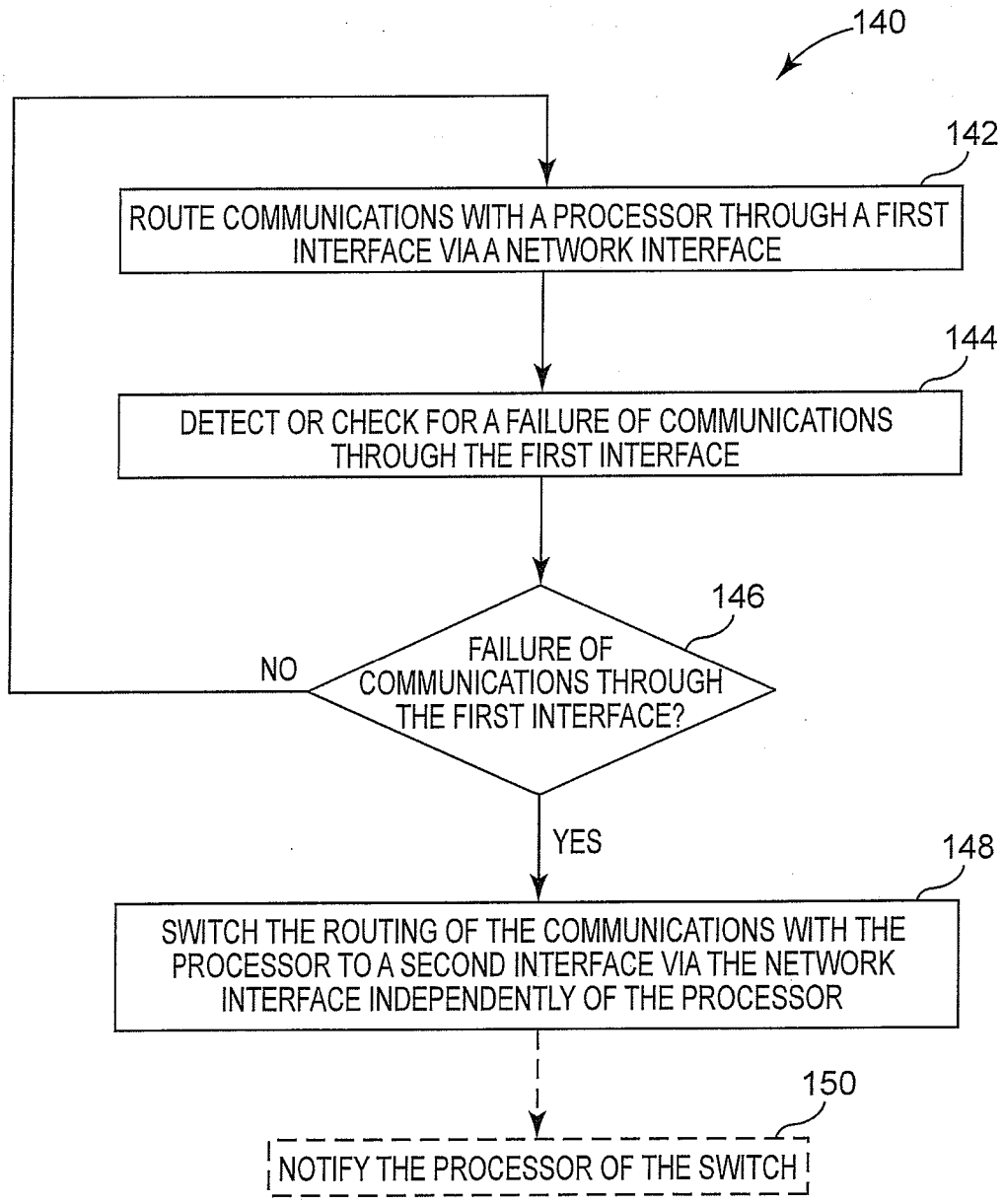
140
142
ROUTE COMMUNICATIONS WITH A PROCESSOR THROUGH A FIRST INTERFACE VIA A NETWORK INTERFACE
144
DETECT OR CHECK FOR A FAILURE OF COMMUNICATIONS THROUGH THE FIRST INTERFACE
146
FAILURE OF COMMUNICATIONS THROUGH THE FIRST INTERFACE?
NO
YES
148
SWITCH THE ROUTING OF THE COMMUNICATIONS WITH THE PROCESSOR TO A SECOND INTERFACE VIA THE NETWORK INTERFACE INDEPENDENTLY OF THE PROCESSOR
150
NOTIFY THE PROCESSOR OF THE SWITCH

Fig. 3

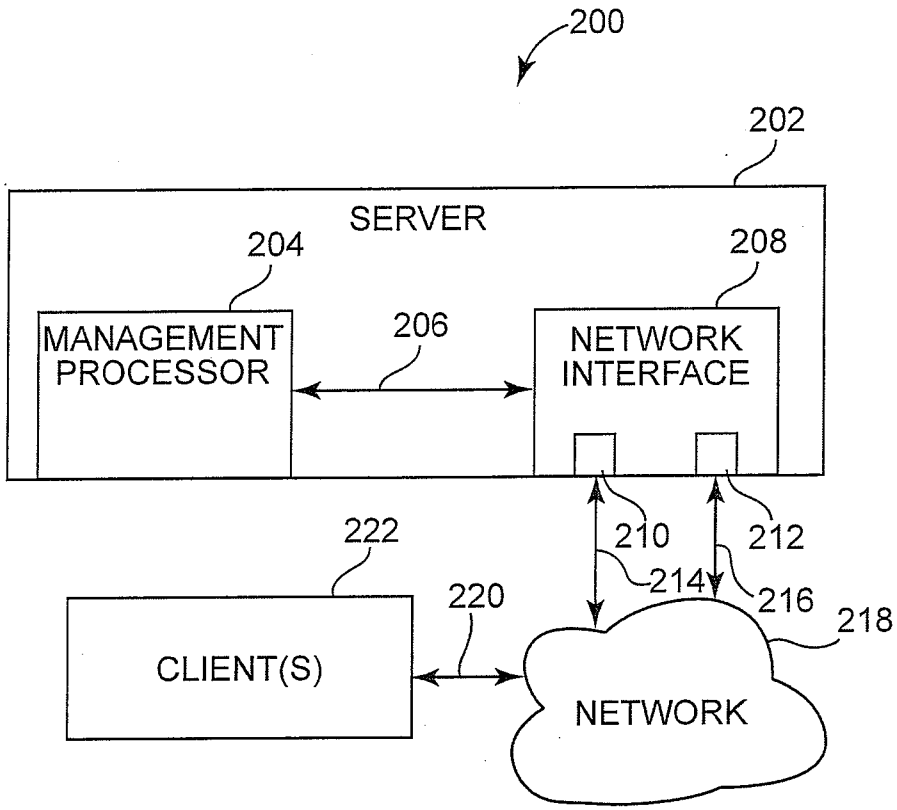
200
202
SERVER
204
208
MANAGEMENT PROCESSOR
206
NETWORK INTERFACE
210
212
214
216
218
222
220
CLIENT(S)
NETWORK

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/041941

A. CLASSIFICATION OF SUBJECT MATTER

H04L 12/28(2006.01)i, H04L 12/56(2006.01)i

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: G06F, H04B, H04L, H04W

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

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and applications for Utility models since 1975

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

eKOMPASS (KIPO internal), IEEE xplore

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007-0159960 A1 (TIMOTHY JERRY SCHIMKE et al.) 12 July 2007 See the abstract, figs. 1A, 2, and paragraphs [0018]-[0026].	1-3, 6-13
Y	US 2008-0263255 A1 (STEPHEN L. BLINICK et al.) 23 October 2008 See the abstract, figs. 1-6, and paragraphs [0060]-[0075].	1-3, 6-13
Y	US 2008-0215910 A1 (CYNTHIA GABRIEL et al.) 4 September 2008 See the abstract, figs. 3A, 3B, and paragraphs [0029]-[0042].	1-3, 6-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 JANUARY 2010 (14.01.2010)	**15 JANUARY 2010 (15.01.2010)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer JUN, Young Sang Telephone No. 82-42-481-5653

Form PCT/ISA/210 (second sheet) (July 2008)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/041941

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 15
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claim 15 is unclear because it refers to claim 14 which does not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 4, 5, 14
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2009/041941

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007-159960 A1	12.07.2007	None	
US 2008-0263255 A1	23.10.2008	US 2008-0263391 A1	23.10.2008
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		WO 2007-022238 A3	16.08.2007