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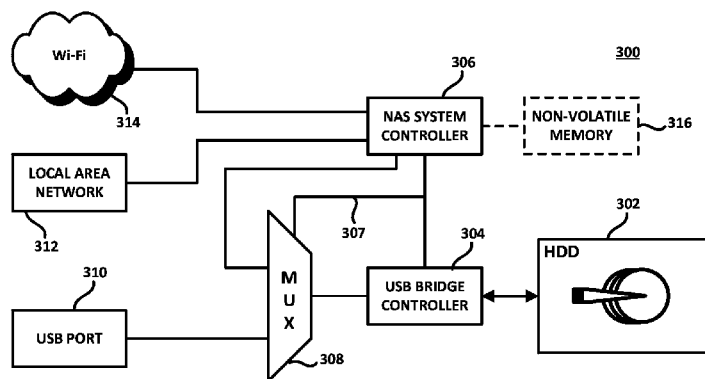
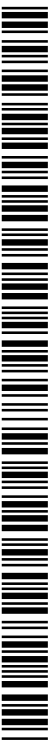


FIG. 3

(57) Abstract: A data storage device may comprise data storage comprising a first logical unit configured to store user data and a second logical unit configured to store an operating system. A first interface may be configured to couple to a host and a second interface may be configured to couple to a network. In a first mode, the data storage device may be configured to expose the first logical unit to the host and render the second logical unit inaccessible and, in a second mode, the data storage device may be configured to allow access to both the first and the second logical units. The first mode may comprise a direct attached storage (DAS) mode and the second mode may comprise a network attached storage (NAS) mode.



WO 2014/190202 A1

## METHODS AND DEVICES FOR BOOTING A NETWORK ATTACHED STORAGE WITH TWO LOGICAL UNITS

### BACKGROUND

**[0001]** Typically, external disk drive products are either configured as Direct Attached Storage (DAS) or Network Attached Storage (NAS) drives. DAS drives can only be used with one computer at a time and are connected using a Universal Serial Bus (USB), Thunderbolt, 1394, eSATA, or other type of cable. NAS drives have an Ethernet or wireless LAN (Wi-Fi) interface and can be accessed by multiple computers simultaneously.

**[0002]** DAS devices are generally simpler in design than NAS drives, in that DAS drives need only allow the host (e.g., a PC) to read/write data sectors on its hard disk drive (HDD); they do not parse the file system that the host creates and do not manage the user's files. Because DAS drives operate at the sector level, hosts can create any number of partitions and file systems on the drive. A NAS drive, in contrast, is essentially a small server: it can run a mainstream operating system (OS) such as a customized version of Linux or Microsoft Windows, for example, and provides file sharing services and other features. NAS devices manage their HDDs the same way a full-featured personal computer (PC) or server does, as they partition their drive(s) according to their requirements and do not allow the user to create arbitrary partitions.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0003]** Fig. 1 is a block diagram of a USB device.

**[0004]** Fig. 2 is a block diagram of a NAS device.

**[0005]** Fig. 3 is a block diagram of a device selectively configurable as a DAS device or as a NAS device, according to one embodiment.

**[0006]** Fig. 4 is a block diagram of a memory storage comprising two logical units, according to one embodiment.

**[0007]** Fig. 5 is a flowchart of a method of operating a data storage device that comprises a first interface configured to couple to a host and a second interface configured to couple to a network, according to one embodiment.

## DETAILED DESCRIPTION

DEFINITIONS

**[0008]** DAS: Direct Attached Storage; e.g., an external, bus-connected (e.g., via Universal Serial Bus (USB), Thunderbolt or the like) storage system. DAS refers to a digital storage system directly attached to a server or workstation, without an intervening storage network. The acronym DAS is mainly used to differentiate non-networked storage from Storage Area Network (SAN) and NAS. A DAS may comprise a data storage device (for example enclosures holding a number of hard disk drives) connected directly to a computer through a host bus adapter (HBA), without a network device (such as a hub, switch, or router) therebetween. The main protocols used for DAS connections are ATA, SATA, eSATA, SCSI, SAS and USB, Firewire (IEEE 1394).

**[0009]** NAS: Network Attached Storage; e.g., an external network-connected (e.g., via Ethernet, Wi-Fi interface or the like) storage system. A NAS not only operates as a file server, but is specialized for this task either by its hardware, software, or combinations thereof. NAS devices usually do not have a keyboard or display, and are controlled and configured over the network, often using a browser.

**[0010]** LBA: Logical Block Address. The location of a data sector on a hard disk drive.

**[0011]** Logical Unit: An endpoint within a device that processes commands sent by the host (e.g., a PC.) A device may have multiple logical units with different characteristics and features; e.g., a disk drive and a CD-ROM.

NAS

**[0012]** NAS devices are gaining in popularity as a convenient method of sharing files among multiple computers. Potential benefits of NAS devices, as compared to file servers, include faster data access, easier administration, and simple configuration. NAS systems are networked appliances which may comprise one or more data storage devices (e.g., HDDs, SSDs, hybrid drives, or the like), sometimes arranged into logical, redundant storage containers or a Redundant Array of Inexpensive Disks (RAID). NAS can remove the responsibility of file serving from other servers on the network. NAS devices may provide access to files using

network file sharing protocols such as NFS, Server Message Block/Common Internet File System (SMB/CIFS), or AFP.

**[0013]** A full-featured OS is not needed on a NAS device, which may comprise a stripped-down OS. For example, FreeNAS, an open source NAS solution designed for commodity PC hardware, may be implemented as a stripped-down version of FreeBSD. NAS systems may comprise one or more data storage devices, which may be arranged into logical, redundant storage containers or RAID. NAS may use file-based protocols such as NFS (popular on UNIX systems), SMB/CIF (used with MS Windows systems), AFP (used with Apple Macintosh computers), or NCP (used with OES and Novell NetWare). NAS devices need not limit clients to a single protocol.

#### NAS vs. DAS

**[0014]** A DAS device may be coupled to a server, laptop, desktop or the like and may not necessarily be networked. For example, the DAS device may serve as supplementary storage for a stand-alone computer or may serve as supplementary storage for a networked file server. In contrast, NAS devices are designed as an easy and self-contained solution for sharing files over a network. Both DAS and NAS may be configured to increase availability of data by using RAID or clustering. When both are present on a network, a NAS device may exhibit somewhat better performance than a DAS device, as the NAS device can be tuned precisely for file serving, which is less likely to happen on a server (to which the DAS is coupled) or general purpose computer that is responsible for other processing. Both NAS and DAS device may comprise cache memory, which may positively affect performance. When comparing use of NAS with use of local (non-networked) DAS, the performance of NAS may depend primarily on the speed of and congestion on the network.

**[0015]** NAS devices are generally not as customizable in terms of hardware (CPU, memory, storage components) or software (extensions, plug-ins, additional protocols) as a general-purpose server supplied with DAS. A typical DAS drive, such as an external USB disk drive, allows the user to freely partition the drive. The host to which the drive is coupled assumes complete control of the drive's

partitions and file systems. Conversely, a typical NAS drive is the sole manager of its drive partitions. NAS drives may comprise one or more partitions to store the NAS operating system and one large partition for the user's data. NAS drives allow networked hosts to read/write files in the user's data partition but do not allow the user to re-partition the disk.

**[0016]** One embodiment selectively configures a disk drive to operate in a first mode as a DAS device or in a second mode as a NAS device. According to one embodiment, the disk drive may be configured to comprise at least two logical units, at least one of which may be configured to store the NAS operating system and optionally other NAS related software, with the remaining one or ones being configured to store user data. When the drive is configured to operate in a first mode (e.g., DAS mode), only the logical unit or units configured to store user data may be exposed to the host. In the second mode (e.g., NAS mode), the one or more logical units storing the NAS OS may be exposed to NAS system controller, as may be the logical unit or units configured to store user data. The NAS system controller may then boot from the logical unit(s) storing the NAS OS (or from some other location storing the NAS OS), thereby enabling the drive to configure itself as a NAS and to provide NAS functionality.

**[0017]** Fig. 1 is a block diagram of a USB storage device. As shown therein, a HDD 102 is coupled to a USB bridge controller 104 and communicates via a UBS port 106. Fig. 2 is a block diagram of a NAS device. As shown therein, HDD 102 is coupled to USB bridge controller 104, which is coupled to a NAS system controller 202, which may interface with a Local Area Network (LAN) 204 and a wireless connection (e.g., Wi-Fi) 206.

**[0018]** According to one embodiment, a combination of a DAS and NAS device may be configured to enable a host computer to create any partition (as is the case with DAS drives) while also managing the file systems, to enable it operate as a file server (as do NAS drives). Accordingly, one embodiment enables the NAS operating system to manage the partitions per its requirements, while also allowing the user to freely partition the drive. Such may be accomplished, according to one embodiment, by a drive that is alternately usable as both DAS and NAS. According to one embodiment, when such a drive is coupled to a host (e.g., plugged

into a PC using a USB cable), the drive may be configured to operate in a first, e.g., DAS mode. Conversely, when such a drive is coupled to a cabled Ethernet connection or accesses a wireless LAN (e.g., Wi-Fi), then the drive may be configured to operate in a second, e.g., NAS mode. When so configured as a NAS device, the disk drive may be configured to store the user's data as well as the NAS operating system (e.g., Linux), software, and the like. According to one embodiment, that portion (e.g., range of LBAs or partition) of the drive storing the NAS OS and its various drivers and other software may be configured so as to not be exposed to the host or user as storage that is accessible, lest the host or user make changes thereto that could break or impair the NAS functionality of the drive.

**[0019]** Fig. 3 is a block diagram of a device 300 that is selectively configurable as a DAS device or as a NAS device, according to one embodiment. As shown therein, a HDD 302 (which may comprise rotating and/or fixed storage media) may be coupled to a bridge controller 304, via a, for example, ATA, SATA, eSATA, SCSI or SAS connection. The bridge controller 304 may be configured to communicate with a port 310 that may be configured according to, for example, the USB protocol. According to one embodiment, the HDD 302 may be solely coupled to the bridge controller 304. The bridge controller 304 may comprise, for example, an 8-bit or 32-bit microcontroller. A NAS system controller 306 may be coupled to the bridge controller 304 and may access the HDD 302 through the bridge controller 304. The NAS system controller 306 may comprise, for example, a System on Controller (SoC) comprising an, e.g., 32-bit microprocessor, together with other ancillary systems, such as dynamic random access memory (DRAM), a memory manager and/or other peripheral controllers. A multiplexor (mux) 308 may be configured to couple the bridge controller 304 to either the NAS system controller (SoC) 306 or a first interface, such as interface port 310 configured according to a first communication protocol such as, for example, USB. The NAS SoC 306 and the bridge controller 304 may be configured to coordinate the control of the mux 308 as shown at 307 and determine whether the device is to be configured and operate as a DAS or as a NAS. Other control circuitry may, according to one embodiment, be interposed between the bridge controller 304 and the NAS system controller 306 for the purpose of, for example, generating the control signal 307 to the mux 308. The

NAS system controller 306 and the bridge controller 304, according to one embodiment, may be included in a single integrated circuit or assembly.

**[0020]** According to one embodiment, when a connection to the drive's USB interface port(s) 310 is detected, such as when interface port 310 is coupled to a host (e.g., plugged into a PC) and processing data access commands for the host, the mux 308 may be controlled such that the device 300 is configured in a first mode in which the bridge controller 304 is connected to the USB port 310. In this configuration, the NAS controller 306 may be inactive or at least decoupled from the data path. According to one embodiment, when a connection to the drive's USB interface port(s) 310 is not detected, such as when the USB interface port 310 is not plugged in to a host or is being used solely to charge the HDD's internal rechargeable batteries, then the mux 308 may be controlled, according to one embodiment, so that the device is configured in a second mode in which the NAS system controller 306 accesses and boots from the HDD 302. In this configuration, the HDD 302 may be configured to store and serve up files in NAS mode, as requested from devices coupled to the LAN 312 and/or to the Wi-Fi 314. Alternatively, according to one embodiment, a non-volatile memory 316 may be coupled to the NAS system controller 306. Such a non-volatile memory 316 may be configured to store the NAS OS. In this case, when the USB interface port 310 is not plugged in to a host or is being used solely to charge the HDD's internal rechargeable batteries, the NAS system controller 306 may access the non-volatile memory 316 and boot its OS from the copy thereof stored in the non-volatile memory 316. In this configuration, the NAS system controller 306 may boot its OS from the non-volatile memory 316 at power-up and may remain booted (and thus immediately available for file serving duties) at all times. According to one embodiment, the HDD 302 may comprise a plurality of disk drives, which may be in a RAID configuration.

**[0021]** One embodiment addresses the manner in which the user's data and NAS operating system is organized on the mass storage device, in the case in which the NAS OS is stored on the HDD 302. According to one embodiment, the HDD may be logically divided into two areas; namely, a first (e.g., large) portion for the user's data files, and a second (e.g., smaller) area for the NAS operating system and software, as shown in Fig. 4. As shown therein, reference

numeral 400 represents the usable storage space on a mass storage device such as a HDD. According to one embodiment, the user area 402, configured to store the user's data, may span from LBA 0 to LBA n and may represent a first logical unit. The portion of the mass storage device reserved for the NAS' OS and other NAS-related software may span, for example, from LBA n+1 to LBA max, where max corresponds to the highest numbered available LBA, and the span from LBA n+1 to LBA max may represent a second logical unit. According to one embodiment, when the drive is operating in DAS mode, the bridge controller 304 may expose only the first logical unit 402 to the host and use, from LBA 0 to LBA n. The second logical unit, from LBA n+1 to LBA max, is not exposed to the host or user when the drive is operating in DAS mode and is thus effectively hidden while the HDD is configured in DAS mode. According to a one embodiment, the two portions of the HDD 302 need not be configured as physically distinct logical units, but may use overlapping "virtual" logical units. For example, in DAS mode, the HDD may be configured to report that its size spans from LBA 0 to LBA n, i.e., not reporting to the host even the existence of the LBAs ranging from LBA n+1 to LBA max. In NAS mode, the HDD may be configured to report that its size spans from LBA0 to LBA max, thereby enabling the NAS system controller 306 access to the entire range of LBAs, including that portion thereof spanning from LBA n+1 to LBA max, from which the NAS system controller 306 may boot its OS, if the NAS OS is indeed stored within that LBA range.

**[0022]** In the case in which HDD 302 is configured with two logical units, when the drive is configured to operate in NAS mode; that is, when the mux 308 couples the bridge controller 304 to the NAS system controller 306, the USB bridge may expose both the first logical unit 402 and the second logical unit 404. This enables the NAS system controller 306 to, according to one embodiment, boot up from the NAS OS stored on the second logical unit 404 on the HDD 302 and to carry out NAS-specific functionality. Indeed, exposing the first logical unit enables access to the user-data area, i.e., LBA 0 to n. Exposing the second logical unit enables access to the NAS operating system area, i.e., LBA n+1 to LBA max. The NAS system controller 306 may be configured, according to one embodiment, to boot from the second logical unit 404 and to allow networked hosts (not shown) to

access the user's data on the first logical unit 402, from either the LAN 312 (e.g., an Ethernet connection) or through Wi-Fi 314.

**[0023]** Since, according to one embodiment, the HDD's capacity may be presented as two different logical units by the bridge controller 304, each logical unit, according to one embodiment, may be partitioned independently. Indeed, the disk's first logical unit 402 may be freely partitioned when the HDD is coupled to a host such as a PC in DAS mode, and the second logical unit 404 storing the NAS OS may be partitioned as needed for and by the NAS system controller 306.

**[0024]** The NAS system controller 306, according to one embodiment, may be configured to boot from the second logical unit 404, which may store the NAS OS files. Once the NAS operating system is loaded, it may operate in the same or a similar manner as the OS in any other NAS device, in that it may be configured to mount the file system(s) on the first logical unit 402 and to allow access to the mounted file system by networked hosts.

**[0025]** Fig. 5 is a flowchart of a method of operating a data storage device that comprises a first interface configured to couple to a host and a second interface configured to couple to a network, according to one embodiment. As shown therein, Block B51 calls for configuring a data storage device to comprise a first logical unit and a second logical unit, and Block B52 calls for storing a (e.g., NAS) operating system in the second logical unit of the data storage device. Thereafter, the data storage device may be configured in a first mode as shown at Block B54 or in a second mode, as shown at B55. Block B54, as shown in Fig. 5, calls for configuring the data storage device in the first mode, in which only the first logical unit is exposed to the host, to enable storage of data therein. As also shown in B54, the first mode configures the data storage device such that the second logical unit is not exposed to the host and is, therefore, inaccessible to the host. As shown at B55, the data storage device, in the second mode, may be configured to enable access to both the first and the second logical units.

**[0026]** While certain embodiments of the disclosure have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the disclosure. Indeed, the novel methods, devices and systems described herein may be embodied in a variety of other forms.

Furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit of the disclosure. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the disclosure. For example, those skilled in the art will appreciate that in various embodiments, the actual physical and logical structures may differ from those shown in the figures. Depending on the embodiment, certain steps described in the example above may be removed, others may be added. Also, the features and attributes of the specific embodiments disclosed above may be combined in different ways to form additional embodiments, all of which fall within the scope of the present disclosure. Although the present disclosure provides certain preferred embodiments and applications, other embodiments that are apparent to those of ordinary skill in the art, including embodiments which do not provide all of the features and advantages set forth herein, are also within the scope of this disclosure. Accordingly, the scope of the present disclosure is intended to be defined only by reference to the appended claims.

## WHAT IS CLAIMED IS:

1. A data storage device, comprising:  
data storage comprising a first logical unit configured to store user data and a second logical unit configured to store an operating system;  
a first interface configured to couple to a host; and  
a second interface configured to couple to a network,  
wherein, in a first mode, the data storage device is configured to expose the first logical unit to the host and render the second logical unit inaccessible and, in a second mode, the data storage device is configured to allow access to both the first and the second logical units.
2. The data storage device of claim 1, wherein the first mode is enabled when a connection to the first interface is detected.
3. The data storage device of claim 1, wherein the second mode is enabled when a connection to the first interface is not detected.
4. The data storage device of claim 1, wherein the data storage comprises a plurality of disks.
5. The data storage of claim 4, wherein the plurality of disks are in a Redundant Array of Inexpensive Disks (RAID) configuration.
6. The data storage device of claim 1, wherein the second mode is enabled when a connection to the first interface is detected
7. The data storage device of claim 1, wherein the first mode comprises a direct attached storage (DAS) mode.
8. The data storage device of claim 1, wherein the second mode comprises a network attached storage (NAS) mode.
9. The data storage device of claim 1 wherein, in the second mode, the data storage device is further configured to boot the operating system stored in the second logical unit.
10. The data storage device of claim 1, wherein the first logical unit spans a first predetermined range of logical block addresses (LBAs) and wherein the second logical unit spans a second predetermined range of LBAs that does not overlap with the first predetermined range of LBAs.

11. The data storage device of claim 1, further comprising a first controller and a second controller wherein the second controller is only active when the data storage device operates in the second mode.

12. The data storage device of claim 11, wherein the second controller is coupled to the second interface.

13. The data storage device of claim 12, wherein the first controller is selectively configured to be coupled to one of the first interface and the second controller.

14. The data storage device of claim 11, further comprising a multiplexer coupled to the first interface and to the second controller, the multiplexer being configured to couple the first interface to the first controller when the data storage device operates in the first mode and to couple the second controller to the first controller when the data storage device operates in the second mode.

15. The data storage device of claim 1, wherein the second interface is configured to selectively couple to a wired network connection and to a wireless network connection.

16. A method of operating a data storage device that comprises a first interface configured to couple to a host and a second interface configured to couple to a network, the method comprising:

configuring data storage of the data storage device to comprise a first logical unit and a second logical unit;

storing an operating system in the second logical unit; and

configuring the data storage device to operate in one of a first mode and a second mode wherein, in the first mode, only the first logical unit is exposed to the host to enable storage of user data therein and the second logical unit is inaccessible and wherein in the second mode, the data storage device is configured to allow access to both the first and the second logical units.

17. The method of claim 16, further comprising detecting a connection on the first interface and configuring the data storage device to operate in the first mode when the connection is detected on the first interface and configuring the data storage device to operate in the second mode when the connection is not detected on the first interface.

18. The method of claim 16, further comprising detecting a connection on the first interface and configuring the data storage device to operate in the second mode when the connection is detected on the first interface.

19. The method of claim 16, wherein the first mode comprises a direct attached storage (DAS) mode.

20. The method of claim 16, wherein the second mode comprises a network attached storage (NAS) mode.

21. The method of claim 17, further comprising booting the operating system stored in the second logical unit when the connection is not detected on the first interface.

22. The method of claim 16, data storage device of claim 1, wherein the data storage comprises a plurality of disks.

23. The method of claim 22, wherein the plurality of disks are in a Redundant Array of Inexpensive Disks (RAID) configuration.

24. The method of claim 16, wherein configuring comprises defining the first logical unit to span a first predetermined range of logical block addresses (LBAs) and defining the second logical unit to span a second predetermined range of LBAs that does not overlap with the first predetermined range of LBAs.

25. The method of claim 16, wherein the data storage device comprises a first controller and a second controller and wherein the method further comprises configuring the second controller to process data access commands only when the data storage device operates in the second mode.

26. The method of claim 25, wherein the second controller is coupled to the second interface and wherein the first controller is selectively configured to be coupled to one of the first interface and the second controller.

27. The method of claim 25, further comprising:

coupling the first interface to the first controller when the data storage device operates in the first mode, and

coupling the second controller to the first controller when the data storage device operates in the second mode.

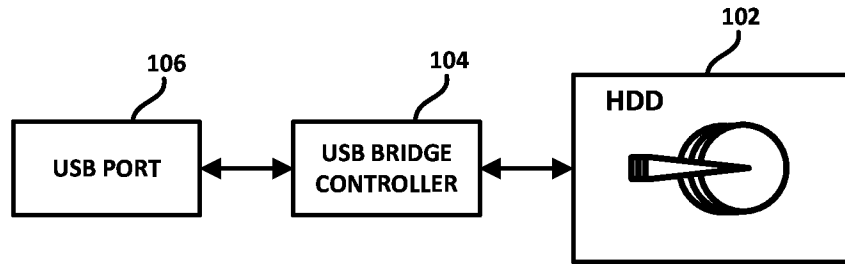
28. The method of claim 16, wherein the second interface is configured to selectively couple to a wired network connection and to a wireless network

connection.

29. A data storage device, comprising:  
a first interface configured to couple to a host;  
a second interface configured to couple to a network;  
a first controller coupled to the first interface and operative to configure the data storage device as a network attached storage (NAS);  
a second controller selectably coupled to one of the first interface and the first controller and operative to configure the data storage device as a direct attached storage (DAS) device; and  
a switch controlled by the second controller, the switch being configured to selectively couple the second controller to one of the first interface and the first controller.

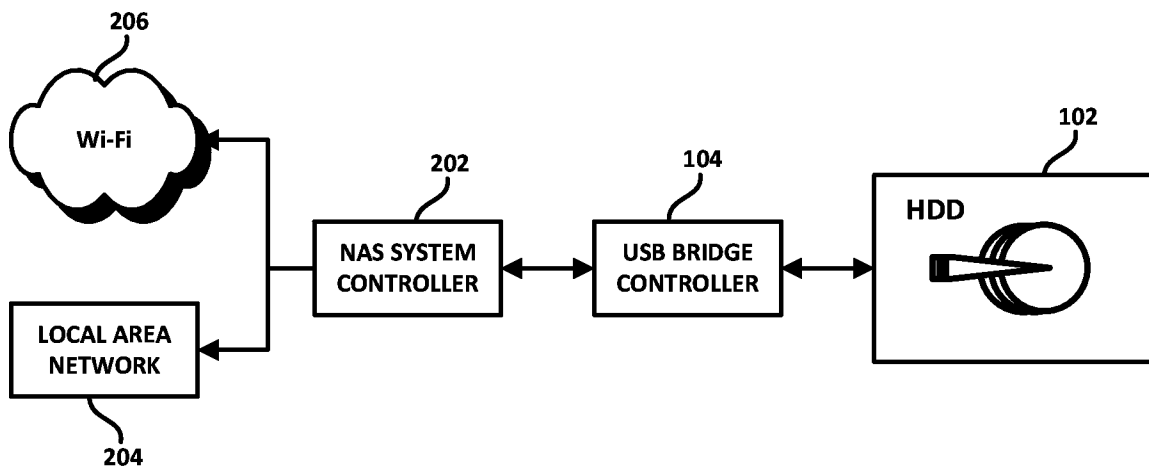
30. The data storage device of claim 29, wherein the switch comprises a multiplexer.

31. The data storage device of claim 29, further comprising data storage comprising a first logical unit configured to store user data and a second logical unit configured to store an operating system.



*FIG. 1*

*(Prior Art)*



*FIG. 2*

*(Prior Art)*

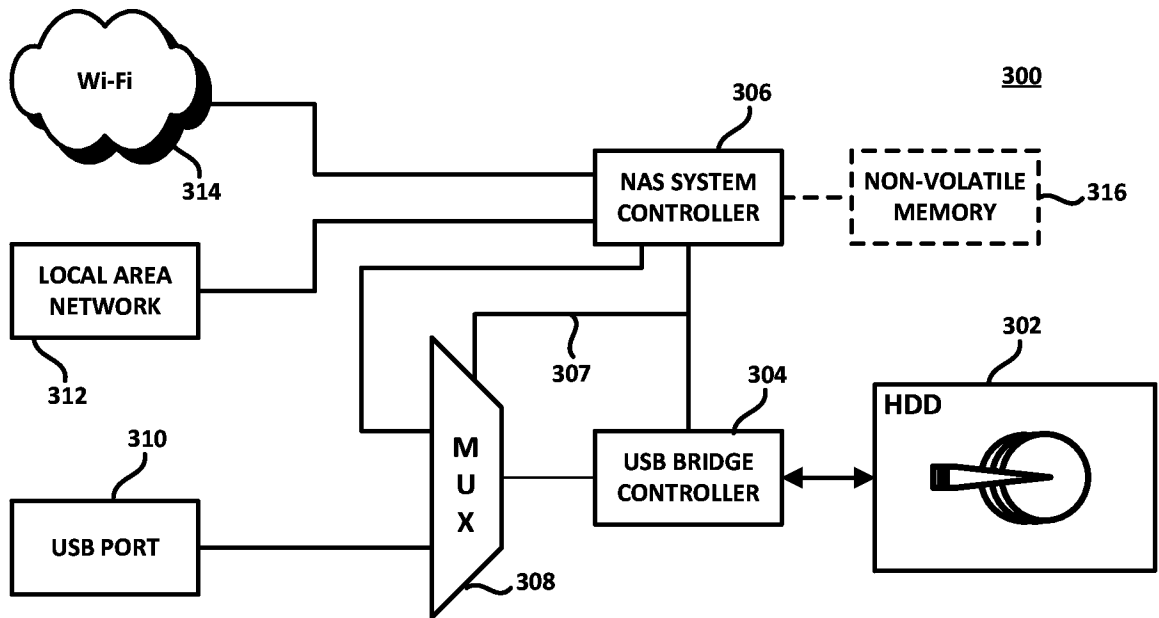


FIG. 3

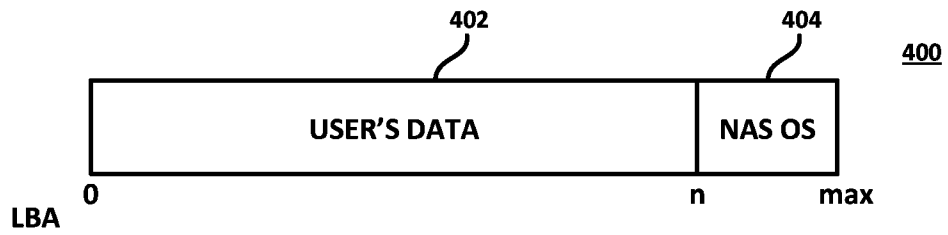
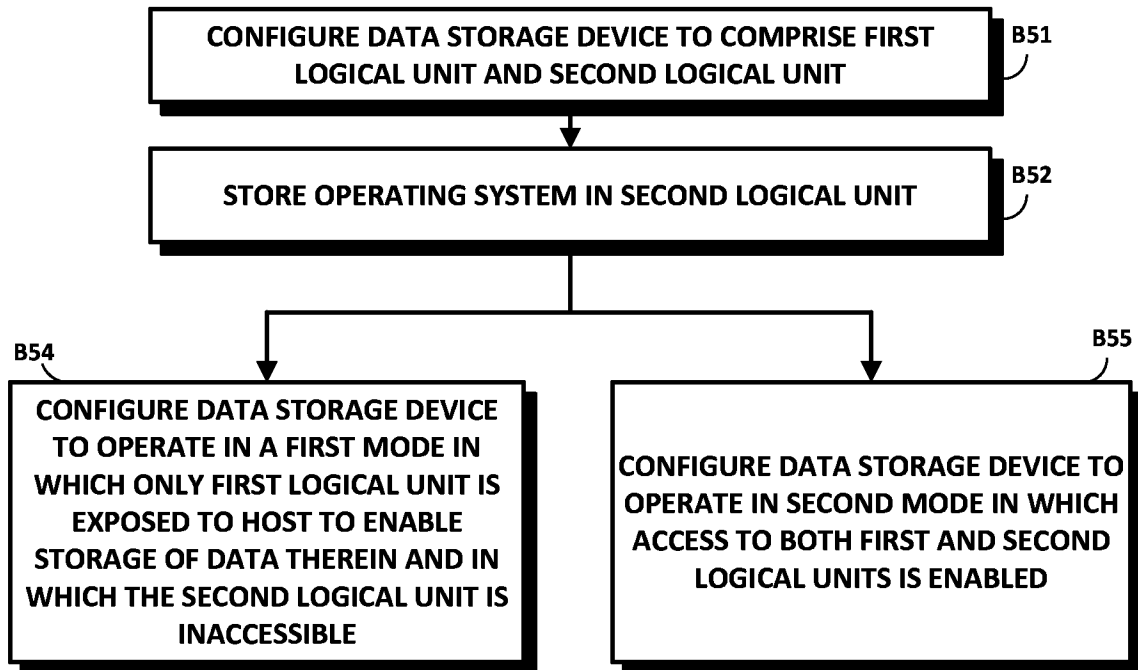


FIG. 4

3/3

*FIG. 5*

**A. CLASSIFICATION OF SUBJECT MATTER****G06F 13/14(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)

**G06F 13/14; G06F 15/16; G06F 15/00; G06F 3/00; G06F 13/38; G06F 12/00; G06F 9/06; G11C 29/00**

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

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: DAS, NAS, RAID, OS, access mode, and similar terms.

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011-0138116 A1 (GREG J. LIPINSKI et al.) 09 June 2011 See paragraphs [0016]-[0019] and [0022]; and figures 1-2.	29-30
Y		1-28, 31
Y	US 2008-0052507 A1 (DAVID Q. CHOW et al.) 28 February 2008 See paragraphs [0028]-[0030] and [0043]; and figures 5 and 7B.	1-28, 31
A	US 2006-0053270 A1 (LOREN S. DUNN et al.) 09 March 2006 See paragraphs [0018]-[0023] and figure 3.	1-31
A	US 2007-0100933 A1 (IAN ROBERT DAVIES et al.) 03 May 2007 See paragraphs [0038]-[0048] and figures 1-3.	1-31
A	US 2009-0228748 A1 (STEVEN G. HAGEROTT et al.) 10 September 2009 See paragraphs [0024]-[0029] and figure 1.	1-31

 Further documents are listed in the continuation of Box C. See patent family annex.

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0138116 A1	09/06/2011	CN 102203743 A	28/09/2011
		EP 2340491 A1	06/07/2011
		WO 2010-047713 A1	29/04/2010
US 2008-0052507 A1	28/02/2008	CN 100487678 C	13/05/2009
		CN 100501702 C	17/06/2009
		CN 101097551 A	02/01/2008
		CN 101097551 B	02/01/2008
		CN 101118783 A	06/02/2008
		CN 101118783 B	06/02/2008
		CN 101122865 A	13/02/2008
		CN 101122865 B	14/07/2010
		CN 101122865 B	13/02/2008
		CN 101122887 A	13/02/2008
		CN 101122887 B	13/02/2008
		CN 101398764 A	01/04/2009
		CN 101398785 A	01/04/2009
		CN 101399075 A	01/04/2009
		CN 101399076 A	01/04/2009
		CN 101403997 A	08/04/2009
		CN 101409111 A	15/04/2009
		CN 101425324 A	06/05/2009
		CN 101630375 A	20/01/2010
		CN 101644995 A	10/02/2010
		CN 101644995 B	28/12/2011
		CN 101727976 A	09/06/2010
		CN 101727976 B	19/09/2012
		CN 101923512 A	22/12/2010
		CN 101923512 B	20/03/2013
		CN 102469715 A	23/05/2012
		JP 03274433 B2	15/04/2002
		JP 03338417 B2	28/10/2002
		JP 2001-005945 A	12/01/2001
		JP 2001-118046 A	27/04/2001
		TW 200813713 A	16/03/2008
		TW 200842887 A	01/11/2008
		TW 200915080 A	01/04/2009
TW 200917017 A	16/04/2009		
TW 200917256 A	16/04/2009		
TW 200926394 A	16/06/2009		
TW 201005652 A	01/02/2010		
TW 1351599 B	01/11/2011		
TW 1351605 B	01/11/2011		
US 06547130 B1	15/04/2003		
US 06854984 B1	15/02/2005		
US 06874044 B1	29/03/2005		
US 07004794 B2	28/02/2006		
US 07021971 B2	04/04/2006		
US 07035110 B1	25/04/2006		

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 07044802 B2	16/05/2006
		US 07069369 B2	27/06/2006
		US 07073010 B2	04/07/2006
		US 07082056 B2	25/07/2006
		US 07094074 B2	22/08/2006
		US 07095617 B1	22/08/2006
		US 07103684 B2	05/09/2006
		US 07103765 B2	05/09/2006
		US 07104848 B1	12/09/2006
		US 07108560 B1	19/09/2006
		US 07125287 B1	24/10/2006
		US 07130958 B2	31/10/2006
		US 07174628 B1	13/02/2007
		US 07182646 B1	27/02/2007
		US 07186147 B1	06/03/2007
		US 07243185 B2	10/07/2007
		US 07249978 B1	31/07/2007
		US 07257714 B1	14/08/2007
		US 07259967 B2	21/08/2007
		US 07264992 B2	04/09/2007
		US 07269004 B1	11/09/2007
		US 07296345 B1	20/11/2007
		US 07297024 B2	20/11/2007
		US 07299316 B2	20/11/2007
		US 07301776 B1	27/11/2007
		US 07318117 B2	08/01/2008
		US 07333364 B2	19/02/2008
		US 07347736 B2	25/03/2008
		US 07365985 B1	29/04/2008
		US 07383362 B2	03/06/2008
		US 07394661 B2	01/07/2008
		US 07407393 B2	05/08/2008
		US 07420803 B2	02/09/2008
		US 07427217 B2	23/09/2008
		US 07428605 B2	23/09/2008
		US 07438562 B2	21/10/2008
		US 07440286 B2	21/10/2008
		US 07440287 B1	21/10/2008
		US 07447037 B2	04/11/2008
		US 07457897 B1	25/11/2008
		US 07466556 B2	16/12/2008
		US 07467290 B2	16/12/2008
		US 07471556 B2	30/12/2008
		US 07475174 B2	06/01/2009
		US 07476105 B2	13/01/2009
		US 07479039 B2	20/01/2009
		US 07483329 B2	27/01/2009
		US 07507119 B2	24/03/2009
		US 07517252 B2	14/04/2009
		US 07524198 B2	28/04/2009

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 07535088 B2	19/05/2009
		US 07535719 B2	19/05/2009
		US 07544073 B2	09/06/2009
		US 07547218 B2	16/06/2009
		US 07552251 B2	23/06/2009
		US 07576990 B2	18/08/2009
		US 07606111 B2	20/10/2009
		US 07609523 B1	27/10/2009
		US 07610438 B2	27/10/2009
		US 07620769 B2	17/11/2009
		US 07628622 B2	08/12/2009
		US 07631195 B1	08/12/2009
		US 07643334 B1	05/01/2010
		US 07649742 B2	19/01/2010
		US 07649743 B2	19/01/2010
		US 07657692 B2	02/02/2010
		US 07660938 B1	09/02/2010
		US 07660941 B2	09/02/2010
		US 07664902 B1	16/02/2010
		US 07673080 B1	02/03/2010
		US 07676640 B2	09/03/2010
		US 07680977 B2	16/03/2010
		US 07690030 B1	30/03/2010
		US 07690031 B2	30/03/2010
		US 07702831 B2	20/04/2010
		US 07702984 B1	20/04/2010
		US 07707321 B2	27/04/2010
		US 07707354 B2	27/04/2010
		US 07708570 B2	04/05/2010
		US 07740493 B2	22/06/2010
		US 07744387 B2	29/06/2010
		US 07761653 B2	20/07/2010
		US 07768785 B2	03/08/2010
		US 07768789 B2	03/08/2010
		US 07769944 B2	03/08/2010
		US 07771215 B1	10/08/2010
		US 07788553 B2	31/08/2010
		US 07789680 B2	07/09/2010
		US 07795714 B2	14/09/2010
		US 07802155 B2	21/09/2010
		US 07804163 B2	28/09/2010
		US 07806705 B2	05/10/2010
		US 07809862 B2	05/10/2010
		US 07814337 B2	12/10/2010
		US 07818492 B2	19/10/2010
		US 07827348 B2	02/11/2010
		US 07830666 B2	09/11/2010
		US 07836236 B2	16/11/2010
		US 07844763 B2	30/11/2010
		US 07849242 B2	07/12/2010

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 07850082 B1	14/12/2010
		US 07850468 B2	14/12/2010
		US 07855099 B2	21/12/2010
		US 07861312 B2	28/12/2010
		US 07865630 B2	04/01/2011
		US 07865809 B1	04/01/2011
		US 07866562 B2	11/01/2011
		US 07869218 B2	11/01/2011
		US 07869219 B2	11/01/2011
		US 07872871 B2	18/01/2011
		US 07872873 B2	18/01/2011
		US 07873837 B1	18/01/2011
		US 07873885 B1	18/01/2011
		US 07874067 B1	25/01/2011
		US 07877542 B2	25/01/2011
		US 07878852 B2	01/02/2011
		US 07886108 B2	08/02/2011
		US 07889544 B2	15/02/2011
		US 07890846 B2	15/02/2011
		US 07930531 B2	19/04/2011
		US 07934037 B2	26/04/2011
		US 07934074 B2	26/04/2011
		US 07941916 B1	17/05/2011
		US 07944702 B2	17/05/2011
		US 07944703 B2	17/05/2011
		US 07953931 B2	31/05/2011
		US 07962836 B1	14/06/2011
		US 07965546 B2	21/06/2011
		US 07966429 B2	21/06/2011
		US 07966462 B2	21/06/2011
		US 07984303 B1	19/07/2011
		US 07987006 B2	26/07/2011
		US 08014130 B1	06/09/2011
		US 08015348 B2	06/09/2011
		US 08021166 B1	20/09/2011
		US 08037234 B2	11/10/2011
		US 08043099 B1	25/10/2011
		US 08060670 B2	15/11/2011
		US 08073985 B1	06/12/2011
		US 08078794 B2	13/12/2011
		US 08095971 B2	10/01/2012
		US 08102658 B2	24/01/2012
		US 08102662 B2	24/01/2012
		US 08108590 B2	31/01/2012
		US 08112574 B2	07/02/2012
		US 08116083 B2	14/02/2012
		US 08141240 B2	27/03/2012
		US 08166221 B2	24/04/2012
		US 08171204 B2	01/05/2012
		US 08180931 B2	15/05/2012

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 08200862 B2	12/06/2012
		US 08241047 B2	14/08/2012
		US 08254134 B2	28/08/2012
		US 08262416 B2	11/09/2012
		US 08266367 B2	11/09/2012
		US 08296467 B2	23/10/2012
		US 08341332 B2	25/12/2012
		US 08452912 B2	28/05/2013
		US 0RE40115 E1	26/02/2008
		US 2003-061474 A1	27/03/2003
		US 2004-236980 A1	25/11/2004
		US 2005-055481 A1	10/03/2005
		US 2005-059273 A1	17/03/2005
		US 2005-059301 A1	17/03/2005
		US 2005-070138 A1	31/03/2005
		US 2005-085129 A1	21/04/2005
		US 2005-085133 A1	21/04/2005
		US 2005-114587 A1	26/05/2005
		US 2005-120146 A1	02/06/2005
		US 2005-120157 A1	02/06/2005
		US 2005-120163 A1	02/06/2005
		US 2005-127735 A1	16/06/2005
		US 2005-138288 A1	23/06/2005
		US 2005-156333 A1	21/07/2005
		US 2005-160213 A1	21/07/2005
		US 2005-160218 A1	21/07/2005
		US 2005-164532 A1	28/07/2005
		US 2005-181645 A1	18/08/2005
		US 2005-182881 A1	18/08/2005
		US 2005-193161 A1	01/09/2005
		US 2005-193162 A1	01/09/2005
		US 2005-197017 A1	08/09/2005
		US 2005-201148 A1	15/09/2005
		US 2005-204187 A1	15/09/2005
		US 2005-223158 A1	06/10/2005
		US 2006-002096 A1	05/01/2006
		US 2006-030080 A1	09/02/2006
		US 2006-067054 A1	30/03/2006
		US 2006-075395 A1	06/04/2006
		US 2006-161725 A1	20/07/2006
		US 2006-286865 A1	21/12/2006
		US 2006-294272 A1	28/12/2006
		US 2007-076387 A1	05/04/2007
		US 2007-079043 A1	05/04/2007
		US 2007-118688 A1	24/05/2007
		US 2007-130414 A1	07/06/2007
		US 2007-130436 A1	07/06/2007
		US 2007-143509 A1	21/06/2007
		US 2007-147157 A1	28/06/2007
		US 2007-150963 A1	28/06/2007

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2007-156587 A1	05/07/2007
		US 2007-168614 A1	19/07/2007
		US 2007-178769 A1	02/08/2007
		US 2007-180264 A1	02/08/2007
		US 2007-183209 A1	09/08/2007
		US 2007-184685 A1	09/08/2007
		US 2007-184719 A1	09/08/2007
		US 2007-197101 A1	23/08/2007
		US 2007-198856 A1	23/08/2007
		US 2007-201274 A1	30/08/2007
		US 2007-204128 A1	30/08/2007
		US 2007-204206 A1	30/08/2007
		US 2007-233955 A1	04/10/2007
		US 2007-250564 A1	25/10/2007
		US 2007-255891 A1	01/11/2007
		US 2007-262155 A1	15/11/2007
		US 2007-268754 A1	22/11/2007
		US 2007-274032 A1	29/11/2007
		US 2007-276987 A1	29/11/2007
		US 2007-276988 A1	29/11/2007
		US 2007-283428 A1	06/12/2007
		US 2007-292009 A1	20/12/2007
		US 2007-293088 A1	20/12/2007
		US 2007-300028 A1	27/12/2007
		US 2007-300029 A1	27/12/2007
		US 2007-300030 A1	27/12/2007
		US 2008-003882 A1	03/01/2008
		US 2008-003883 A1	03/01/2008
		US 2008-005471 A1	03/01/2008
US 2006-0053270 A1	09/03/2006	CN 100498705 C	10/06/2009
		DE 102005037855 A1	30/03/2006
		GB 0518334 D0	19/10/2005
		GB 2418043 A	15/03/2006
		JP 2006-079628 A	23/03/2006
		US 07430661 B2	30/09/2008
US 2007-0100933 A1	03/05/2007	CA 2618080 A1	04/01/2007
		CN 101218571 A	09/07/2008
		CN 101218571 B	11/07/2012
		EP 1902373 A2	26/03/2008
		EP 1902373 B1	22/02/2012
		JP 2005-505056 A	17/02/2005
		JP 2005-507116 A	10/03/2005
		JP 2005-507118 A	10/03/2005
		JP 2008-544421 A	04/12/2008
		US 06839788 B2	04/01/2005
		US 07062591 B2	13/06/2006
		US 07143227 B2	28/11/2006
		US 07146448 B2	05/12/2006

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2014/039232**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 07278054 B2	02/10/2007
		US 07278054 WD	02/10/2007
		US 07315911 B2	01/01/2008
		US 07320083 B2	15/01/2008
		US 07330999 B2	12/02/2008
		US 07334064 B2	19/02/2008
		US 07340555 B2	04/03/2008
		US 07380163 B2	27/05/2008
		US 07401254 B2	15/07/2008
		US 07437493 B2	14/10/2008
		US 07437604 B2	14/10/2008
		US 07464205 B2	09/12/2008
		US 07464214 B2	09/12/2008
		US 07536495 B2	19/05/2009
		US 07543096 B2	02/06/2009
		US 07558897 B2	07/07/2009
		US 07565566 B2	21/07/2009
		US 07627780 B2	01/12/2009
		US 07661014 B2	09/02/2010
		US 07676600 B2	09/03/2010
		US 08185777 B2	22/05/2012
		US 2003-0065733 A1	03/04/2003
		US 2003-0065836 A1	03/04/2003
		US 2003-0065841 A1	03/04/2003
		US 2004-0177126 A1	09/09/2004
		US 2005-0010709 A1	13/01/2005
		US 2005-0010715 A1	13/01/2005
		US 2005-0010838 A1	13/01/2005
		US 2005-0021605 A1	27/01/2005
		US 2005-0021606 A1	27/01/2005
		US 2005-0027751 A1	03/02/2005
		US 2005-0102549 A1	12/05/2005
		US 2005-0102557 A1	12/05/2005
		US 2005-0207105 A1	22/09/2005
		US 2005-0246568 A1	03/11/2005
		US 2006-0106982 A1	18/05/2006
		US 2006-0161707 A1	20/07/2006
		US 2006-0161709 A1	20/07/2006
		US 2006-0277347 A1	07/12/2006
		US 2006-0282701 A1	14/12/2006
		US 2007-0100964 A1	03/05/2007
		US 2007-0168476 A1	19/07/2007
		US 2010-0049822 A1	25/02/2010
		US 2010-0064169 A1	11/03/2010
		WO 2003-030006 A1	10/04/2003
		WO 2003-036484 A1	01/05/2003
		WO 2003-036493 A1	01/05/2003
		WO 2004-074996 A2	02/09/2004
		WO 2004-074996 A3	29/12/2004
		WO 2004-095304 A1	04/11/2004