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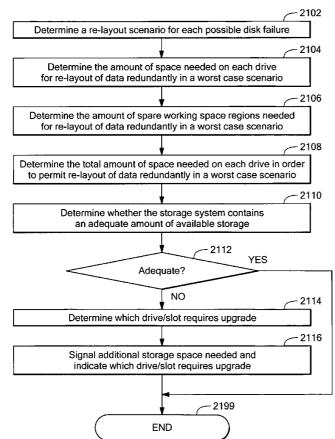
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[Continued on next page]

(54) Title: DYNAMICALLY EXPANDABLE AND CONTRACTIBLE FAULT-TOLERANT STORAGE SYSTEM WITH VIRTUAL HOT SPARE



(57) Abstract: A dynamically expandable and contractible fault-tolerant storage system employs a virtual hot spare that is created from unused storage capacity across a plurality of storage devices. This unused storage capacity is available if and when a storage device fails for storage of data recovered from the remaining storage device(s). On an ongoing basis, the storage system may determine the amount of unused storage capacity that would be required for the vitual hot spare (e,g., based on the number of storage devices, the capacities of the various storage devices, the amount of data stored, and the manner in which the data is stored) and generate a signal if additional storage capacity is needed for a virtual hot spare.

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A. CLASSII INV.	FICATION OF SUBJECT MATTER G06F11/10								
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C. DOCUME	ENTS CONSIDERED TO BE RELEVANT								
Category*	Citation of document, with indication, where appropriate, of the rele	evant passages	Relevant to claim No.						
X	EP 0 726 521 A (HEWLETT-PACKARD Column 14 August 1996 (1996-08-14) abstract column 2, line 4 - line 28 column 4, line 45 - last line column 7, line 32 - column 8, line column 12, line 36 - column 15, line 15, line 16 - column 16, line 16 - column 17, line 18	e 8	1-28						
X Furti	her documents are listed in the continuation of Box C.	X See patent family annex.							
filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another 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 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. "8" document member of the same patent family Date of mailing of the international search report							
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C(Continua	tion). DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WILKES J ET AL: "THE HP AUTORAID HIERARCHICAL STORAGE SYSTE," OPERATING SYSTEMS REVIEW, ACM, NEW YORK, NY, US, vol. 29, no. 5, December 1995 (1995-12), pages 96-108, XP000584820 ISSN: 0163-5980 abstract page 97, right-hand column, line 10 - page 98, left-hand column, line 15 page 101, right-hand column, line 5 - line 47	1-28
X	US 5 479 653 A (JONES ET AL) 26 December 1995 (1995-12-26)	1-3, 15-17
Α	abstract	4-14, 18-28
	figure 4 column 2, line 53 - line 7 column 6, line 12 - column 7, line 52	
A	"VIRTUAL HOT SPARE DISK UNITS" IBM TECHNICAL DISCLOSURE BULLETIN, IBM CORP. NEW YORK, US, vol. 37, no. 9, 1 September 1994 (1994-09-01), pages 5-8, XP000473311 ISSN: 0018-8689 the whole document	1-28

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte I application No
PCT/US2005/039795

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
EP 0726521	A	14-08-1996	DE DE JP JP US	69532030 D1 69532030 T2 3753259 B2 8221876 A 5666512 A	04-12-2003 17-06-2004 08-03-2006 30-08-1996 09-09-1997
US 5479653	A	26-12-1995	NONE		