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Paper 14
Entered: July 10, 2019

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

RED HAT, INC., DELL INC., DELL TECHNOLOGIES INC.,
EMC CORPORATION, HEWLETT PACKARD ENTERPRISES CO.,
HITACHI VANTARA CORPORATION,
and SUPER MICRO COMPUTER, INC.,
Petitioner,

v.

ELECTRONICS & TELECOMMUNICATIONS RESEARCH INSTITUTE,
Patent Owner.

Case IPR2019-00467
Patent 6,718,436 B2

Before JAMESON LEE, KIMBERLY McGRAW,
and NATHAN A. ENGELS, *Administrative Patent Judges*.

LEE, *Administrative Patent Judge*.

DECISION
Denying Instituting of *Inter Partes* Review
35 U.S.C. § 314 (a)

I. INTRODUCTION

A. Background

On December 19, 2018, Petitioner filed a Petition to institute *inter partes* review of claims 1–14 of U.S. Patent No. 6,718,436 B2 (Ex. 1001, "the '436 patent"). Paper 6 ("Pet."). Patent Owner filed a Preliminary Response.[1] Paper 11 ("Prelim. Resp.").

To institute an *inter partes* review, we must determine that the information presented in the Petition shows "that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." 35 U.S.C. § 314(a). Having considered all submissions of both parties, we determine that Petitioner has not demonstrated a reasonable likelihood that it would prevail in establishing the unpatentability of any of claims 1–14.

Accordingly, the Petition is *denied*, and no *inter partes* review is instituted.

B. Related Matters

The parties identify several civil actions involving alleged infringement of the '436 patent: *Sequoia Tech., LLC v. Dell, Inc.*, No. 1-18-cv-01127-LPS-CJB (D. Del.); *Sequoia Tech., LLC v. Hitachi, Ltd.*, No. 1-18-cv-01129-LPS-CJB (D. Del.); *Sequoia Tech., LLC v. Sun Micro Computer, Inc.*, No. 1-18-cv-01307-LPS-CJB (D. Del.); *Sequoia Tech., LLC v. Hewlett Packard Enter. Co.*, No. 1-18-cv-01128-LPS-CJB (D. Del.). Pet. 3, Paper 7, 2. Patent Owner further identifies an action seeking declarative

[1] Patent Owner did not file a declaration of any technical witness in support of the Preliminary Response.

judgment of non-infringement against the '436 patent: *Red Hat, Inc. v. Sequoia Tech., LLC*, No. 1-18-cv-02027-MN (D. Del.). Paper 7, 2. Petitioner also has filed another petition for *inter partes* review of claims 1–14 of the '436 patent, IPR2019-00465. Paper 7, 1.

C. The '436 Patent

The '436 patent is directed to the managing of a logical volume. Ex. 1001, 3:66–4:40. A logical volume is a virtual disk drive that includes multiple physical disk drives. *Id.* at 1:24–26. The '436 patent explains that logical volume managers implementing software RAID (Redundant Array of Independent Disks) were known. *Id.* at 3:20–22. Such a logical volume manager is an intermediate level block device driver implementing various RAID techniques in software based on the calculating ability of a computer, and treats several physically separated independent disk drives as one disk drive. *Id.* at 3:22–27. According to the '436 patent, conventional logical volume managers have problems in that the metadata is too large to manage in huge storage structures and the processing speed is too slow when modifying the metadata. *Id.* at 3:41–44. Also, according to the '436 patent, the huge size of the metadata in prior art logical volume managers delays system booting time and uses too much memory. *Id.* at 3:44–46.

The '436 patent describes a method for managing a logical volume, said "to support dynamic online resizing and minimizing a size of metadata," including the steps of: a) creating the logical volume by gathering disk partitions in response to a request for creating the logical volume in a physical storage space; b) generating the metadata including information of the logical volume and the disk partitions forming the logical volume and storing the metadata to the disk partitions forming the logical

volume; c) dynamically resizing the logical volume in response to request for resizing, and modifying the metadata on the disk partitions forming the logical volume; and d) calculating and returning a physical address corresponding to a logical address of the logical volume by using mapping information of the metadata containing information of the physical address corresponding to the logical address. *Id.* at 4:7–22.

Figure 1 of the '436 patent is reproduced below:

FIG. 1

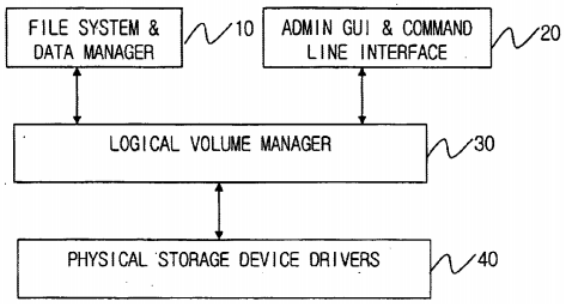

Figure 1 is a diagram of a computer system according to the '436 patent. Ex. 1001, 5:23–24. The computer system includes physical storage device drivers 40 for operating disk drive devices in an operating system. *Id.* at 6:20–22. Logical volume manager 30 is a virtual intermediate level device driver located above a variety of physical device drivers 40, uses services of physical device drivers, and is included in the operating system of the computer. *Id.* at 6:23–26. File system and data manager 10 performs operations on a logical volume serviced by logical volume manager 30. *Id.* at 6:27–29. An administration graphical user interface (admin GUI) and command line interface 20 are tools to perform managing operations on the logical volume by using functions provided by the logical volume manager. *Id.* at 6:29–33.

Figure 2 of the ’436 patent is reproduced below:

FIG. 2

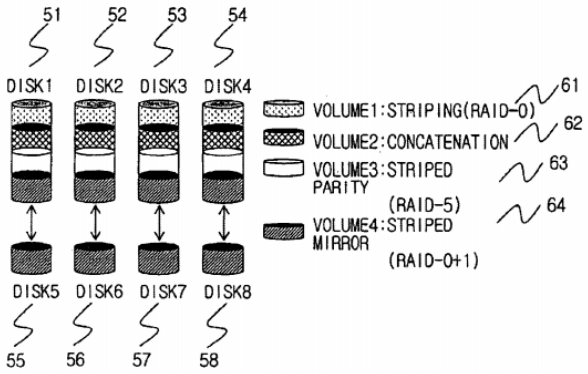

Figure 2 is a view of a logical volume in accordance with a preferred embodiment of the ’436 patent. *Id.* at 5:25–26. It shows possible logical volumes generated by the logical volume manager in an embodiment of eight disk drives. *Id.* at 6:37–39.

Disks 1, 2, 3, and 4 are divided into four partitions and disks 5, 6, 7, and 8 each constitute a single partition. *Id.* at 6:39–41. Disks can be divided into partition(s) using a tool or utility applied by an operating system. *Id.* at 6:41–42. Volume 1 (61) includes the first partition of disks 1, 2, 3, and 4; Volume 2 (62) includes the second partition of disks 1, 2, 3, and 4; Volume 3 (63) includes the third partition of disks 1, 2, 3, and 4; and Volume 4 (64) includes the fourth partition of disks 1, 2, 3, and 4, as well as the whole partitions of disks 5, 6, 7, and 8. *Id.* at 6:44–51.

There can be three virtualizations of storage space in accordance with a preferred embodiment of the ’436 patent. *Id.* at 6:54–56. The first virtualization is a disk partition or physical partition, and it is generated by an operating system’s tool or utility. *Id.* at 6:57–59. The disk partition is a minimum unit of the logical volume; a logical volume includes more than one disk partition; and a logical volume is resized in disk partition units. *Id.*

at 6:59–62. The second virtualization is the logical volume, which is a union of disk partitions and is extensible. *Id.* at 6:64–65. A logical volume is named and provides continuous address space, and it can be resized while the system is operating. *Id.* at 6:66–67. The third virtualization is an extent. *Id.* at 7:1. It is continuous space having the same size and also a minimum unit of space allocation to store information. *Id.* at 7:1–3. The size of an extent is fixed with each logical volume and it is decided at the time of creation of the logical volume. *Id.* at 7:3–5.

The '436 patent describes storing the metadata in a table structure within the physical disk partitions forming a logical volume. *Id.* at 7:13–20. Figure 3 is reproduced below:

FIG. 3

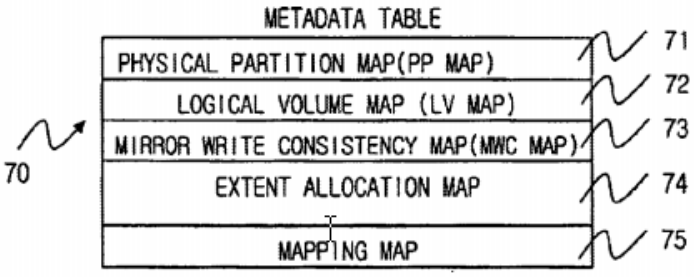

Figure 3 shows metadata table 70 stored in each disk partition constructing one logical volume. *Id.* at 7:18–20. As shown in Figure 3, metadata table 70 stored in the disk partitions includes numerous maps, i.e., a physical partition map, a logical volume map, a mirror write consistency map, an extent allocation map, and a mapping map. *Id.* Figures 4, 5, and 6 are structural diagrams illustrating the physical partition map, logical volume map, and mapping map, and are reproduced below:

FIG. 4

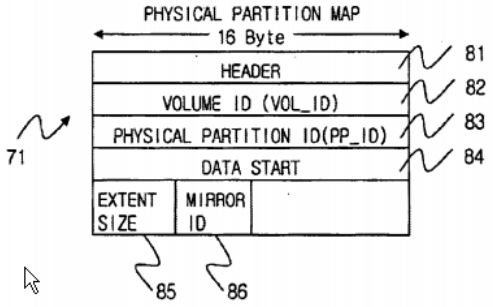

Figure 4 is a structural diagram of a physical partition map in the metadata table within the disk partitions. *Id.* at 5:32–34.

FIG. 5

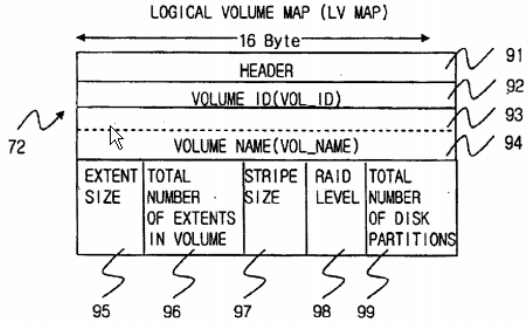

Figure 5 is a structural diagram of a logical volume map in the metadata table within the disk partitions. *Id.* at 5:35–37.

FIG. 6

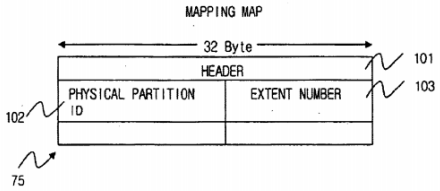

Figure 6 is a structural diagram of a mapping map in the metadata table within the disk partitions. *Id.* at 5:38–40.

Claims 1, 8, and 11 are independent. Claims 1 and 11 are each directed to a "method for managing a logical volume in order to support

dynamic online resizing and minimizing a size of metadata." Ex. 1001, 12:16–18, 14:26–28. Claim 8 is directed to a "computer-readable recording medium storing instructions for executing a method for managing a logical volume in order to support dynamic online resizing and minimizing a size of metadata." *Id.* at 13:29–30. Claim 1 is representative and reproduced below:

> 1. A method for managing a logical volume in order to support dynamic online resizing and minimizing a size of metadata, said method comprising steps of:
>
> a) creating the logical volume by gathering disk partitions in response to a request for creating the logical volume in a physical storage space;
>
> b) generating the metadata including information of the logical volume and the disk partitions forming the logical volume and storing the metadata to the disk partitions forming the logical volume;
>
> c) dynamically resizing the logical volume in response to a request for resizing, and modifying the metadata on the disk partitions forming the logical volume; and
>
> d) calculating and returning a physical address corresponding to a logical address of the logical volume by using mapping information of the metadata containing information of the physical address corresponding to the logical address;
>
> wherein the metadata includes,
>
> a disk partition table containing information of a disk partition into which the metadata is stored;
>
> a logical volume table for maintaining the information of the logical volume by storing duplicated information of the logical volume onto all disk partitions of the logical volume;
>
> an extent allocation table for indicating whether each extent in the disk partition is used or not used; and

> a mapping table for maintaining mapping information for a physical address space corresponding to a logical address space which is a continuous address space equal in size of storage space to an entirety of said logical volume.

Id. at 12:16–48. Claim 8 recites a computer-readable recording medium storing instructions for executing the same method as that recited in claim 1. *Id.* at 13:29–61. Claim 11 is the same as claim 1, except that the four tables within the metadata are more restrictively recited as:

> a disk partition table including the logical volume information to which the disk partition containing the metadata belongs, information for identifying the disk partition, real data start information, an extent size information of the disk partition defined in the logical volume, and mirror checking information;
>
> a logical volume table duplicated and stored in all disk partitions constructing corresponding logical volume including logical volume identifying information corresponding to the logical volume, logical volume name information, extent size information of the logical volume, RAID level information of construction type of the logical volume, and total number of disk partitions constructing the logical volume;
>
> an extent allocation table for representing usage of the extent by using one bit per each extent in the disk partition; and
>
> a mapping table being constructed with a pair of the disk partition identifying information and an extent number corresponding to each extent for mapping a logical address to a physical address, for continuous logical address space of a logical volume.

Id. at 14:45–67.

D. Evidence Relied Upon

Petitioner relies on the following references:[2]

References		Date	Exhibit
Bridge	U.S. Patent No. 6,405,284 B1	June 11, 2002, filed Oct. 23, 1998	Ex. 1005
Williams	EP 0 482 853 A2	Apr. 29, 1992	Ex. 1006
Kodama	U.S. Patent No. 6,542,862 B2	April 1, 2003, filed Mar. 21, 2001	Ex. 1007
Peloquin	U.S. Patent No. 6,574,705 B1	June 3, 2003, filed Nov. 16, 2000	Ex. 1009

Petitioner also relies on the Declarations of Brian A. Berg. (Ex. 1003).

E. The Asserted Ground of Unpatentability

Claims Challenged	Basis	References
1, 2, 4–6 and 8–13	§ 103(a)	Bridge and Williams
1, 2, 4–6 and 8-13	§ 103(a)	Bridge, Williams, and Peloquin
3, 7, and 14	§ 103(a)	Bridge, Williams, and Kodama
3, 7, and 14	§ 103(a)	Bridge, Williams, Peloquin, and Kodama

[2] The ’436 patent issued from U.S. Patent Application 10/005,604, filed December 7, 2001. Ex. 1001, (21), (22). The ’436 patent lists Korean Application 2001-45621 as a foreign priority application, filed July 27, 2001. *Id.* at (30). But Patent Owner has not, in the Preliminary Response, attempted to show entitled to the July 27, 2001 priority date. For purposes of this Decision, December 7, 2001 is the effective filing date of the ’436 patent.

II. ANALYSIS

A. The Law on Obviousness

The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective indicia of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). One seeking to establish obviousness based on more than one reference also must articulate sufficient reasoning with rational underpinnings to combine teachings. *See KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 418 (2007).

B. The Level of Ordinary Skill in the Art

Petitioner asserts that the level of ordinary skill in the art corresponds to "at least an undergraduate degree or equivalent academic or professional training in computer science or computer engineering, or a related field, and two years of industry experience in the field of data storage systems." Pet. 7 (citing Ex. 1003 ¶ 11). Patent Owner has not offered an articulation of the level of ordinary skill in the art. We adopt the level of ordinary skill as articulated by Petitioner, except that we delete the qualifier "at least" to eliminate vagueness as to the appropriate level of education. The qualifier expands the range without an upper bound, i.e., encompassing a Ph.D. Degree and beyond, and thus does not meaningfully indicate the level of ordinary skill in the art.

C. Claim Construction

For petitions filed on or after November 13, 2018, a claim shall be construed using the same claim construction standard that would be used to

construe the claim in a civil action under 35 U.S.C. § 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100(b) (2018). Petitioner filed its Petition on December 19, 2018. Paper 6. Thus, we apply the claim construction standard as set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

Claim terms are generally given their ordinary and customary meaning as would be understood by one with ordinary skill in the art in the context of the specification, the prosecution history, other claims, and even extrinsic evidence including expert and inventor testimony, dictionaries, and learned treatises, although extrinsic evidence is less significant than the intrinsic record. *Phillips*, 415 F.3d at 1312–1317. Usually, the specification is dispositive, and it is the single best guide to the meaning of a disputed term. *Id.* at 1315.

The specification may reveal a special definition given to a claim term by the patentee, or the specification may reveal an intentional disclaimer or disavowal of claim scope by the inventor. *Id.* at 1316. If an inventor acts as his or her own lexicographer, the definition must be set forth in the specification with reasonable clarity, deliberateness, and precision. *Renishaw PLC v. Marposs Societa' per Azioni*, 158 F.3d 1243, 1249 (Fed. Cir. 1998). The disavowal, if any, can be effectuated by language in the specification or the prosecution history. *Poly-America, L.P. v. API Indus., Inc.*, 839 F.3d 1131, 1136 (Fed. Cir. 2016). "In either case, the standard for disavowal is exacting, requiring clear and unequivocal evidence that the claimed invention includes or does not include a particular feature." *Id.*

Only those claim terms that are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Ltd.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011); *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Petitioner proposes a construction for the claims terms "disk partition" and "extent." Pet. 9–11. Patent Owner does not disagree with Petitioner's proposed constructions of "disk partition" and "extent." It is not necessary in this Decision, however, to construe the term "extent."

Petitioner proposes that "disk partition" means "*one of a plurality of disks or portions of a disk that form a logical volume*." Pet. 9. We have reviewed the specification and the prosecution history of record, and have no reason to disagree with Petitioner's construction of "disk partition," with the understanding that "form a logical volume" refers to actual storage space allocated exclusively to a logical volume. The specification of the '436 patent does not indicate any overlap in the disk partitions of separate logical volumes. Petitioner also has not explained how such an overlap could be permitted without creating usage conflicts between logical volumes that would render the data unreliable.

Petitioner's articulation plus our additional clarification is consistent with the specification, particularly the illustration shown in Figure 2 reproduced above. Each of the first quarter of disks 1, 2, 3, and 4 is a disk partition forming logical volume 1. Each of the second quarter of disks 1, 2, 3, and 4 is a disk partition forming logical volume 2. Each of the third quarter of disks 1, 2, 3, and 4 is a disk partition forming logical volume 3.

Each of the fourth quarter of disks 1, 2, 3, and 4 is a disk partition forming logical volume 4. Each of the whole of disks 5, 6, 7, and 8 is a disk partition forming logical volume 4.

D. Alleged Unpatentability of Claims 1, 2, 4–6, and 8–13 as Obvious over Bridge and Williams

1. Bridge (Ex. 1005)

Bridge discloses a system and method for managing storage provided by multiple data storage devices. Ex. 1005, Abstr. According to Bridge, its system and method improves load balancing, reduces or eliminates fragmentation, and makes efficient changes in hardware configuration. *Id.* "I/O load and data are spread relatively evenly across many data storage devices in the system," and "[d]ynamic reorganization can be performed for the data stored on the data storage devices." *Id.*

As background, Bridge describes that a logical volume manager divides a physical disk drive into one or more partitions (also known as extents or subdisks). *Id.* at 1:34–36. Each logical volume is composed of one or more partitions and each partition is typically defined by an offset and length. *Id.* at 1:36–38. "In the simplest case, the disk manager forms a logical volume from a single partition. In more complex cases, the disk manager may form logical volumes by concatenating multiple partitions." *Id.* at 1:47–51. Bridge identifies a fragmentation problem with conventional systems, and a load balancing problem with conventional systems. *Id.* at 1:52–62, 2:8–18. Regarding fragmentation, Bridge explains that because each partition typically has a different length, over time and through data deletions many pieces of free space are created that cannot be reused. *Id.* at 1:52–62. Regarding the load balancing problem, Bridge explains that a

disk drive normally serves one request at a time, that requests received at a busy disk drive are stored in a queue, that if one disk drive is accessed more than other disk drives, the queue for that disk drive gets longer and the wait becomes longer. *Id.* at 2:10–6. Thus, some disk drives get overloaded while others remain idle or lightly loaded. *Id.* at 2:16–17.

In its Summary of the Invention section, Bridge describes:

> A feature of one embodiment of the invention is that *each disk drive is divided into many small fixed size pieces*. Each piece is small compared to the size of the logical volume or disk drive. In the contemplated normal operation of the invention, storage space on a disk drive is allocated and freed in units of the fixed size pieces. Fragmentation is reduced or eliminated because all pieces are of the same size. . . .
>
> Another feature is that *each logical volume is made of pieces from many disk drives*. In an embodiment, there would be pieces from every storage device, but this may not be possible if there are too many devices or if some are full. The pieces of a logical volume are spread out as evenly as is practical so that two pieces on the same disk drive are far apart in the address space of the logical volume. Thus I/O load is spread evenly over all disk drives. The address space of the logical volume can be striped across small groups of pieces to improve the throughput for large I/O operations.

Id. at 3:24–44 (emphasis added).

Figure 1 of Bridge is reproduced below:

Fig. 1

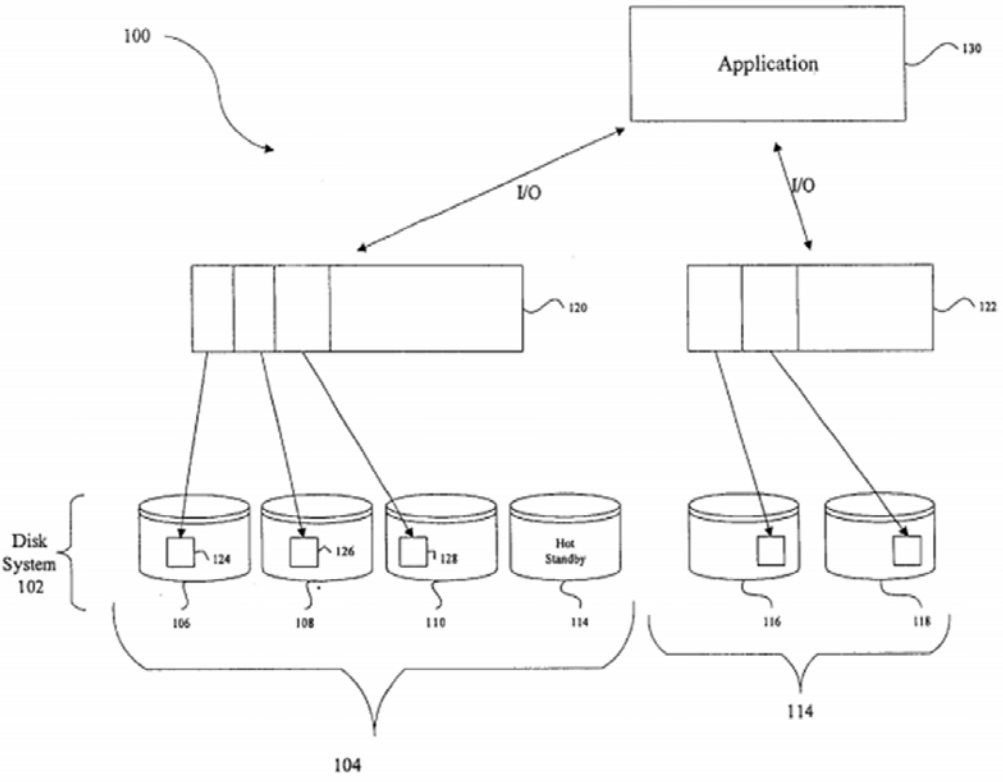

Figure 1 illustrates a storage system according to an embodiment of Bridge. *Id.* at 3:66–67. Bridge describes that in one embodiment "a logical volume is allocated within a single disk group."[3] *Id.* at 6:27–28. Figure 1 illustrates logical volume 120 allocated to disk group 104 having 4 disks and logical volume 122 allocated to disk group 114 having 2 disks. *Id.* at 6:28–32. The data in a volume is stored in data extents, and each data extent is a contiguous section of storage on a named drive. *Id.* at 6:47–49. Bridge describes that the first three such extents of logical volume 120 are data extents 124, 126, and 128 on disk drives 106, 108, and 110, respectively. *Id.*

[3] Bridge describes a "disk group" as "a set of disk drives that have similar characteristics." *Id.* at 5:42–43. A hot standby disk drive is not immediately made available for storage but is used to replace a disk drive that has failed. *Id.* at 5:50–55.

at 6:49–51. Similarly, the first two data extents of logical volume 122 are data extents 116 and 118. *Id.* at Fig. 1. Extents for a logical volume may be located on a single named drive, or may be spread across multiple disk drives. *Id.* at 6:52–53. Bride states that spreading logical volumes over multiple disk drives provides load balancing advantages. *Id.* at 6:54–55. Bridge further states that preferably each data extent for a particular logical volume is of a fixed size. *Id.* at 6:66–67.

Notably, while not shown in Figure 1, according to Bridge, allocated portions of a disk drive can belong to different logical volumes. *Id.* at 6:9–13. Thus, in Bridge, it is the logical volume that is allocated to or assigned to particular disk drives, and not the disk drive or disk drives that are assigned to particular logical volume. Figure 3 of Bridge is reproduced below and shows this overlapping structure.

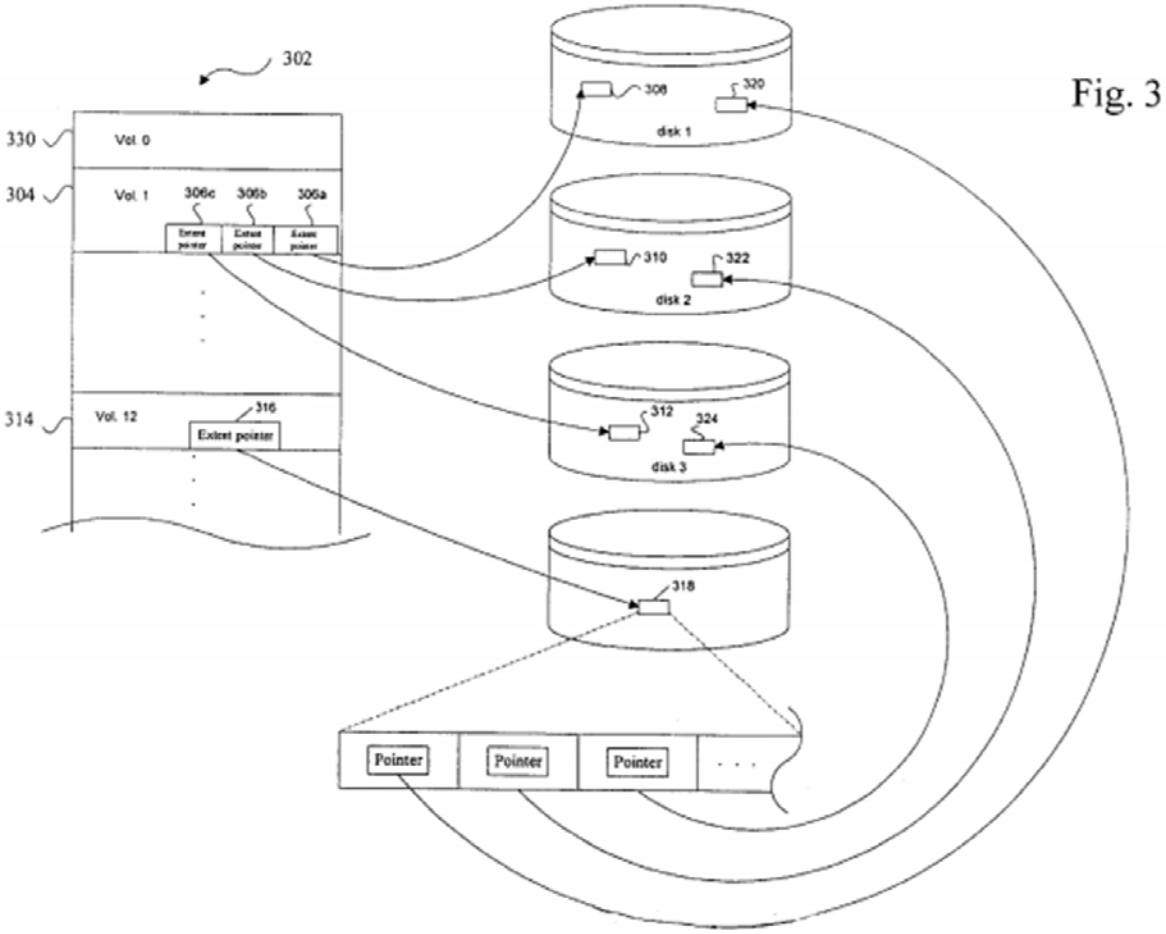

Fig. 3

Figure 3 illustrates logical volume directory entries for each logical volume and what the entries indicate. *Id.* at 4:3–4. As shown in Figure 3, disks 1, 2, and 3 each hold a data extent (308, 310, 312) of logical volume 304, as well as a data extent (322, 322, 324) of logical volume 12. *Id.* at 9:65–10:2.

2. Williams (Ex. 1006)

Williams discloses a volume managing system for computer storage devices. Ex. 1006, Abstr. Multiple physical volumes are within the system as a plurality of data storage devices. *Id.* at 3:43–47. The physical volumes are logically partitioned. *Id.* Abstr. A logical volume is partitioned into one or more logical partitions. *Id.* at 3:48–49. A logical partition comprises one or more physical partitions of actual storage devices, i.e., the physical

volumes that are the actual storage devices. *Id.* at 3:49–51. Figures 14 and 15 of Williams are reproduced below.

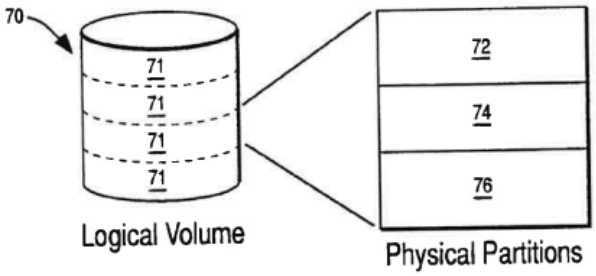

FIG. 14

Figure 14 illustrates the interrelationship between logical volumes, logical partitions, and physical partitions. *Id.* at 7:24–26.

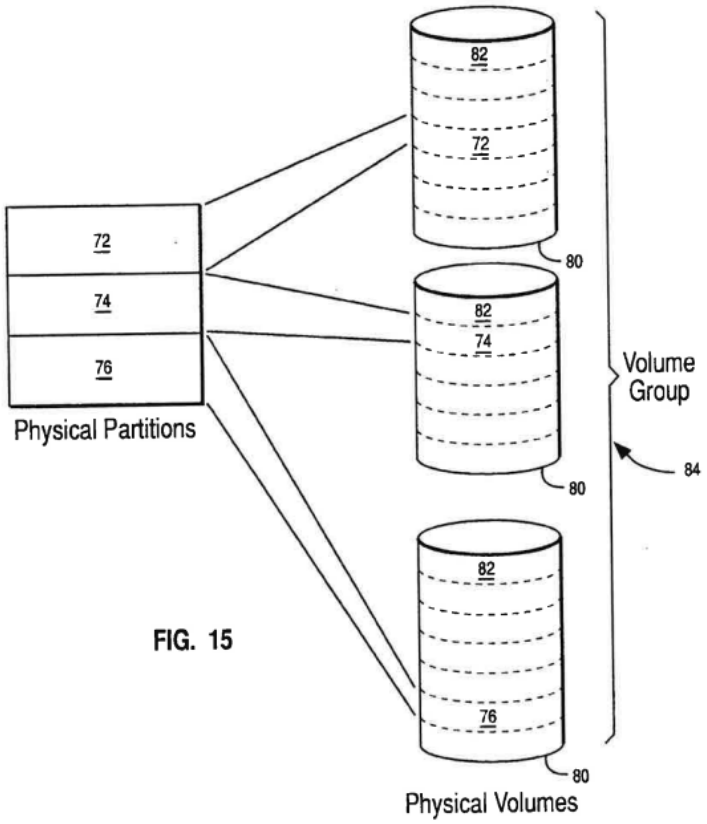

FIG. 15

Figure 15 illustrates the interrelationship between physical partitions, physical volumes, and volume groups. *Id.* at 7:27–29.

As shown in Figure 14, logical volume 70 is a logical disk made up of logical partitions 71. *Id.* at 12:28–31. Each logical partition 71 is comprised of one or more physical partitions, such as physical partitions 72, 74, and 76. *Id.* at 12:31–32. As shown in Figure 15, a physical volume is composed of a plurality of contiguous physical partitions. *Id.* at 4:54–55. A plurality of physical volumes that are grouped together is referred to as a volume group. *Id.* at 4:55–57. Figure 15 shows that physical partitions 72, 74, and 76 are distributed among physical volumes 80 of volume group 84. *Id.* at 7:27–29; *see also id.* at 4:48–57.

As Figures 14 and 15 illustrate, physical volumes 80 encompass the physical partitions that form logical volume 70 (e.g., physical partitions 72, 74, and 76) as well as other physical partitions that do not form logical volume 70. For example, element 82 in Figure 15 is a Volume Group Status Area ("VGSA") that resides in each physical volume 80 and indicates the state of each physical partition in the physical volume. *Id.* at 10:42–45. Further, every physical volume 80 within volume group 84 includes an identical copy of the VGSA. *Id.* at 10:45–47. Williams describes that the VGSA is not contained within any physical partition. *Id.* at 10:47–49.

Although not shown in Figures 14 and 15, each physical volume 80 also includes a Volume Group Data Area ("VGDA"). Ex. 1006, 11:12–13. The metadata within the VGDA indicates the interrelationship between the logical and physical volumes and physical partitions. *Id.* at 11:13-15. Williams describes that the VGDA can be duplicated in each physical volume, and that it is not contained within any physical partition. *Id.* at 11:17–18.

3. Claim 1

For three separate reasons discussed below, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of claim 1 as would have been obvious over Bridge and Williams.

"creating the logical volume by gathering disk partitions"

Claim 1 recites, in pertinent part, "creating the logical volume by gathering disk partitions." Ex. 1001, 12:19–21. Petitioner specifically identifies the "disk drives" of Bridge as the "disk partitions" of claim 1. Pet. 23. Consistent with that is Petitioner's characterizing Bridge's disk drives as being on the same hierarchical level as disk partitions of the '436 patent. Petitioner further identifies Bridge's discussion of pooling together of disk drives as disclosing gathering disk partitions. *Id.* Mr. Berg in his testimony equates Bridge's disk drives to "disk partitions" and Bridge's pooling of disk drives to gathering disk partitions. Ex. 1003 ¶ 4.

Petitioner, however, has not sufficiently established that Bridge's disk drive constitutes a disk partition, and consequently also has not established that pooling together of disk drives constitutes gathering disk partitions. We begin our analysis by restating Petitioner's interpretation of "disk partition," which we have adopted for this decision: "disk partition" means "*one of a plurality of disks or portions of a disk that form a logical volume*."

As discussed above, Bridge's logical volume is formed from individual pieces within one or more disk drives, *not* from whole disk drives themselves. "[E]ach logical volume is made of pieces from many disk drives." Ex. 1005, 1:35–36. That relationship is illustrated in Figure 1 of Bridge, reproduced below. As shown, an entire disk drive does not form a

logical volume. Rather, selected pieces (124, 126, and 128) and (116 and 118) within disk drives are the constituent parts of logical volumes 120 and 122, respectively. Further, the pieces are called data extents, and each data extent is a contiguous section of storage on a disk drive. *Id.* at 6:47–49.

Fig. 1

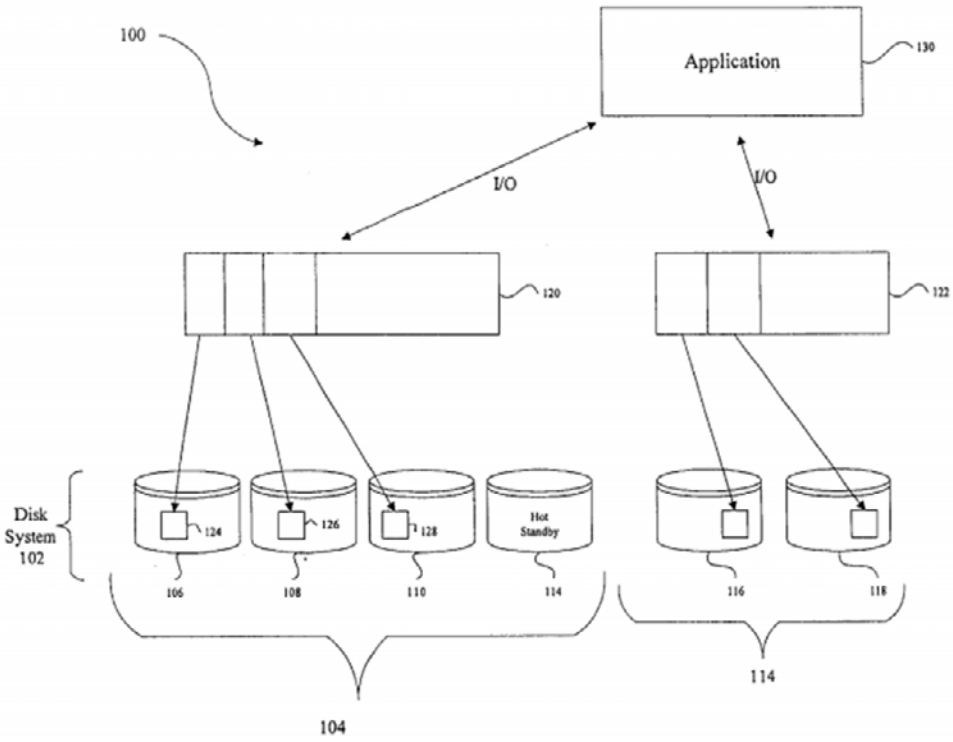

Figure 1 illustrates an embodiment of Bridge. *Id.* at 3:66–67. A disk drive can include extents that are allocated to different logical volumes. That is illustrated in Figure 3 of Bridge, reproduced below:

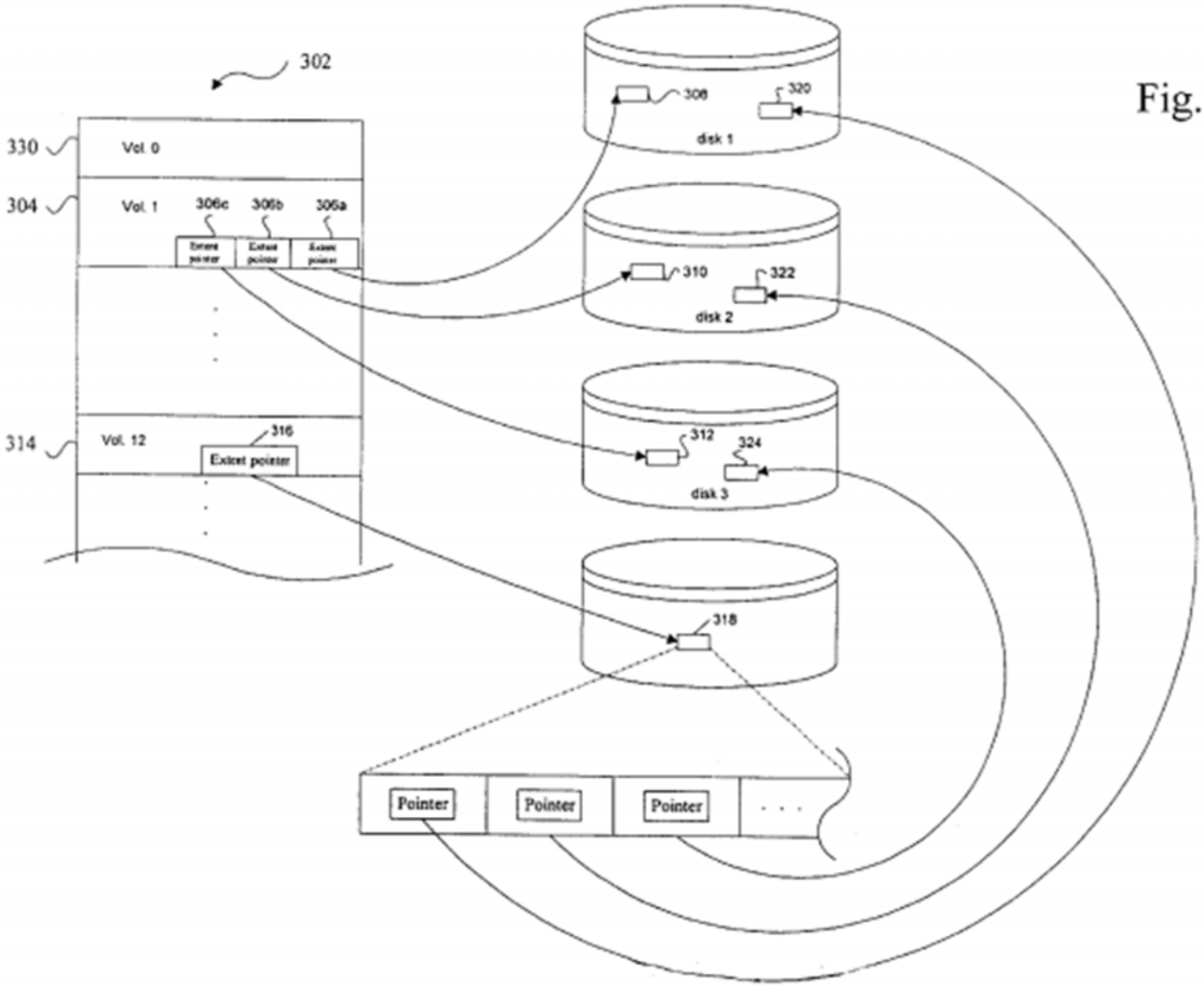

Fig. 3

Figure 3 illustrates logical volume directory entries for each logical volume and what the entries indicate. *Id.* at 4:3–4.

As shown in Figure 3, disks 1, 2, and 3 each hold a data extent (308, 310, 312) of logical volume 304, as well as a data extent (322, 322, 324) of logical volume 12. *Id.* at 9:65–10:2. Thus, the pooling together of disk drives does not gather any "disk partition" which, according to claim construction discussed above, constitutes actual storage space allocated exclusively to a logical volume. In Bridge, the mere identification of whole

disk drives does not set aside or identify any specific actual storage space usable only by a particular logical volume.

Petitioner asserts that in Bridge entire disk drives are gathered and allocated to a logical volume. Pet. 24 (citing Ex. 1005, 16:32–33, 47–64, and Fig. 8). We have read the cited portions of Bridge and find no description of any exclusive allocation of an entire disk drive to any particular logical volume. We further have reviewed Mr. Berg's testimony in Paragraph 50 of his declaration, *cited at* Pet. 24, and we find nothing to indicate that any disk drive or disk group in Bridge is allocated exclusively for use by a particular logical volume.

Petitioner further notes that the '436 patent itself discusses a well-known tool FDISK that divides a disk into partitions and that FDISK is used in Bridge. Pet. 25. Petitioner also explains that FDISK can partition an entire disk to result in a single partition for that disk. *Id.* This argument is misplaced, as it oversimplifies the issue. To satisfy the claim limitation of "creating the logical volume by gathering disk partitions," it is not enough that Bridge discloses formatting a whole disk drive into one usable partition. Instead, because of the construction of "disk partition" discussed above, for Petitioner's argument to be valid, the entire disk drive would have to be allocated for exclusive use by a logical volume. However, as explained above, in Bridge an entire disk drive is shared by multiple logical volumes in that the extents in the disk drive may be allocated to different logical volumes.

For the foregoing reasons, Petitioner has not sufficiently shown that Bridge's disk drives are disk partitions or that Bridge discloses "creating the logical volume by gathering disk partitions."

"dynamically resizing the logical volume in response to a request for resizing"

Claim 1 recites, in pertinent part: "dynamically resizing the logical volume in response to a request for resizing." Ex. 1001, 12:26–27. Petitioner's discussion of this limitation relies solely on Bridge's disclosure. Pet. 29–31. First, Petitioner notes that Bridge performs automatic online disk drive reorganization for the incremental addition or removal of storage capacity, and Petitioner asserts that if a disk drive needs to be removed, its pieces can be migrated to other disk drives. *Id.* at 29. In that regard, Petitioner quotes Bridge's description: "The [data] migration can be performed **dynamically or automatically** once the system recognizes that a hardware change has occurred or will occur to the system configuration, such as the addition or removal of a disk drive." Ex. 1005, 5:7–11, *cited at* Pet. 29 (emphasis added by Petitioner).

As noted by Patent Owner, however, data migration is not the same as resizing a logical volume. Prelim. Resp. 16. We agree. For instance, if a disk drive has been added to increase the size of one or more logical volumes, and then data redistribution is executed to rebalance the load, the data migration would occur *after* the logical volume has been expanded thus causing a data imbalance. Similarly, if a disk drive will be removed to decrease the size of one or more logical volumes, data migration away from the disk drive to be removed would have to occur *prior to* actual removal of the disk drive and consequent down-sizing of the logical volumes using that disk drive. Resizing of a logical volume is related to data migration, but the two are not the same. Petitioner, however, has failed to recognize that distinction.

Even assuming that data migration is the same as resizing a logical volume, which it is not, Petitioner has not sufficiently shown the "in response to a request for resizing" portion of the limitation. Petitioner again refers to the language quoted above: "[t]he migration can be **performed dynamically** or automatically." *Id.* at 29. Petitioner argues: "If the resizing is 'performed dynamically,' this would be in response to a request as the other option is 'automatically,' which is by definition without a request." *Id.* at 29–30 (citing Ex. 1003 ¶ 59). The argument is unpersuasive, as the stated reasoning is unsupported by the disclosure of Bridge.

First, we do not agree that the disjunctive term "or" is always or even just typically used to connect antonyms. Petitioner's rationale incorrectly assumes that that is the case. Second, Petitioner's reasoning applies that misplaced assumption, to the exclusion of any review or analysis of how the term "dynamic" is used in the rest of the disclosure of Bridge. Our reading of Bridge indicates that Bridge uses "dynamically" to mean something akin to "under changing circumstances." For instance, claim 1 of Bridge states "dynamically moving the data in response to a change in the configuration of the storage system to reestablish an even spread of the data . . . ." Ex. 1005, 28:40–42. Bridge also refers to the use of "dynamic" storage devices (Ex. 1005, 26:26–33), and "dynamic storage" is defined as "[a] type of storage in which data is stored and retrieved from a moving data stream," or "[a] type of storage that requires periodic refreshment for retention of data." *IEEE 100: The Authoratative Dictionary of IEEE Standards Terms* 348 (7th ed. 2000) (Ex. 3001). Nothing indicates that "dynamically" means responding to a request.

Petitioner further identifies disclosure in Bridge about a "process for expanding a logical volume." Pet. 30 (citing Ex. 1005, 4:15–16, 16:65–17:38, Fig. 9). However, Petitioner fails to explain why that expansion of a logical volume is performed in response to a request. Similarly, Petitioner further identifies disclosure in Bridge about a "process for shrinking a logical volume." *Id.* (citing Ex. 1005, 20:32–64, Fig. 13). Petitioner also fails to explain why that shrinking of a logical volume is performed in response to a request.

For the foregoing reasons, Petitioner has not sufficiently shown that Bridge discloses "dynamically resizing the logical volume in response to a request for resizing."

"storing the metadata to the disk partitions forming the logical volume"
and
"a logical volume table for maintaining the information of the logical volume by storing duplicated information of the logical volume onto all disk partitions of the logical volume"

Claim 1 recites a step of "storing the metadata to the disk partitions forming the logical volume," and further specifies that the metadata includes "a logical volume table for maintaining the information of the logical volume by storing duplicated information of the logical volume onto all disk partitions of the logical volume." Ex. 1001, 12:24–25, 12:38–41. Petitioner does not rely on Bridge for satisfying the requirements of where to store metadata.[4] Instead, Petitioner relies on Williams for those metadata storage

[4] Bridge discloses that the metadata for a logical volume is stored within a different logical volume. Ex. 1005, 9:40–41, 10:25–26. Petitioner

requirements, i.e., in the disk partitions forming the logical volume, and in all disk partitions of the logical volume. Prelim. Resp. 26–29, 35–38.

According to Petitioner, Bridge discloses metadata in the form of a logical volume directory that contains information regarding the contents of logical volumes. Pet. 35 (citing Ex. 1005, 10:35–36). Also according to Petitioner, Bridge discloses that the logical volume directory containing metadata for logical volumes should be mirrored (duplicated). *Id.* at 20, 35. Further according to Petitioner, Williams discloses that each physical volume contains a VGDA and that metadata is stored within the VGDA of each physical volume. Pet. 36. The VGDA metadata "indicates the interrelationship between the logical and physical volumes and physical partitions." Ex. 1006, 11:12-15.

Petitioner regards Williams's physical volume as a "disk partition" according to the '436 patent. Pet. 19 (citing Ex. 1006, 9:17–19, Ex. 1003 ¶ 35); Pet. 36 (citing Ex. 1006, 11:12–13). Petitioner thus concludes that Williams's teachings regarding having VGDA metadata in each physical volume is disclosure of storing metadata in each disk partition. Pet 36.

Petitioner asserts that it would have been obvious to one with ordinary skill in the art, in light of Williams's disclosure of storing metadata within each "disk partition," to do the same in Bridge, i.e., store Bridge's logical volume directory entries in each "disk partition," and states that that would improve performance and guard against disk drive failures. Pet 37. For reasons discussed below, the argument is unpersuasive.

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acknowledges that in Bridge the metadata for a logical volume is not necessarily stored in each disk partition comprising the logical volume. Pet. 20.

First, just as Bridge's disk drive does not qualify as a "disk partition" as discussed above, Williams's physical volume also does not qualify as a "disk partition." That is because, just like the disk drives do not form logical volumes in Bridge, the physical volumes in Williams also do not form logical volumes. Figure 14 of Williams is reproduced below.

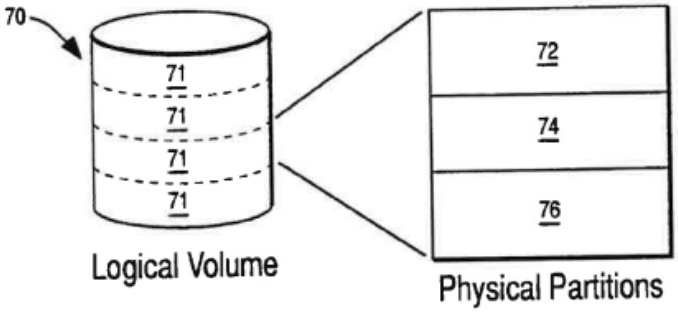

FIG. 14

Figure 14, reproduced above, illustrates the interrelationship between logical volumes and physical partitions. *Id.* at 7:24–26. As shown in Figure 14, each logical volume is comprised of physical partitions, not physical volumes. Although each physical partition of a logical volume, e.g., physical partitions 72, 74, and 76, comes from within a physical volume 80, as shown in Figure 15 reproduced below, each physical volume 80 may contain physical partitions that are allocated to and thus form other logical volumes. Thus, based on a proper construction of "disk partition" discussed above, physical volumes do not form a logical volume and thus a physical volume does not constitute a "disk partition." Consequently, Williams does not disclose, as Petitioner asserts, storing metadata into the disk partitions forming a logical volume, much less all disk partitions of the logical volume.

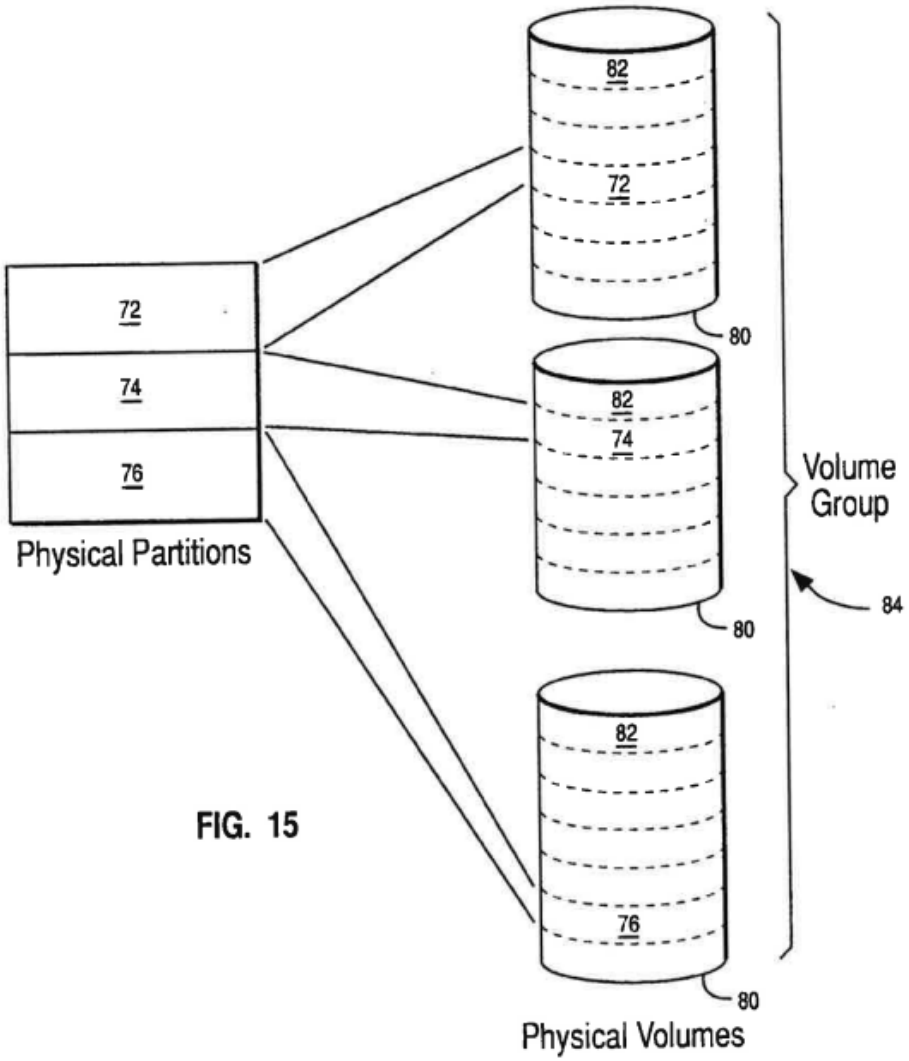

FIG. 15

Figure 15 illustrates the interrelationship between physical partitions, physical volumes, and volume groups. *Id.* at 7:27–29. For instance, it is evident from Figures 14 and 15 above that if metadata is stored into each physical volume in a physical partition just below physical partition 82, then the metadata is not within any physical partition 72, 74, and 76 which form logical partition 71 of logical volume 70.

Patent Owner argues that in Williams, the metadata for a logical volume actually is stored outside of the logical volume. Prelim. Resp. 26. We agree, assuming that there exist disk partitions in Williams that form a

logical volume. Williams discloses that logical volumes are formed from physical partitions. *Id.* (citing Ex. 1006, 5:7–13). However, Williams explicitly describes that the VGDA storing the metadata is not contained in any physical partition. Ex. 1006, 11:17–18. That is consistent with the description in Williams that when a file system is to be installed, "a logical volume is created which includes only the minimum number of physical partitions on the disk required to store the file system." Ex. 1006, 5:7–11. Thus, in Williams the metadata is not contained within any logical volume, and not in any disk partition forming the logical volume.

Petitioner has not sufficiently shown that Williams discloses storing metadata for a logical volume in any disk partition forming the logical volume, or that Williams discloses storing metadata of a logical volume, whether or not duplicated metadata, in all disk partitions forming the logical volume. Consequently, Petitioner's proposed combination of Bridge and Williams does not lead to the subject matter of claim 1, and Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of claim 1 as obvious over Bridge and Williams.

4. Claims 2 and 4–6

Claims 2 and 4–6 each depend directly or indirectly from claim 1. The deficiency of Petitioner's analysis for claim 1, discussed above, applies also to each of claims 2 and 4–6. Petitioner's analysis of claims 2 and 4–6 adds nothing to cure the deficiency discussed above for claim 1. Pet. 44–61. Thus, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 2 and 4–6 as obvious over Bridge and Williams.

5. Claim 8–10

Claim 8 recites a computer-readable recording medium storing instructions for executing a method, and the method is the same as that recited in claim 1. Ex. 1001, 13:29–61. Petitioner's analysis of claim 8 adds nothing to cure the deficiency discussed above in the context of claim 1, which applies to claim 8. Pet. 61–62. Claim 9 depends from claim 8 and claim 10 depends from claim 9. Petitioner's analysis of claims 9 and 10 adds nothing to cure the deficiency discussed above for claim 1, which is also applicable to claim 8. Pet. 44–58, 62–63. Thus, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 8–10 as obvious over Bridge and Williams.

6. Claims 11–13

Claim 11 is independent. As noted above, claim 11 is the same as claim 1, except that the four tables within the metadata are more restrictively recited. The deficiency of Petitioner's analysis for claim 1 also applies to claim 11. Pet, 47–58, 63–64. Petitioner's further discussions for the additional limitations of claim 11 do not cure that deficiency. Claims 12 and 13 each depends from claim 11. Petitioner's analysis of claims 12 and 13 adds nothing to cure the deficiency discussed above for claim 1, which applies to claim 11. Pet. 58–61, 64. Thus, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 11–13 as obvious over Bridge and Williams.

E. Alleged Unpatentability of Claims 1, 2, 4–6, and 8–13 as Obvious over Bridge, Williams, and Peloquin

1. Peloquin (Ex. 1009)

Peloquin discloses a data processing system and a method for storing logical volume information used by a logical volume manager to create and manage a logical volume. Ex. 1009, 1:62–64. The data processing system includes a plurality of storage devices, and a plurality of physical partitions within the plurality of storage devices are specified. *Id.* at 1:64–67. Each of the physical partitions includes a plurality of sectors, and the specified physical partitions are logically combined to create the logical volume. *Id.* at 1:67–2:2. A first plurality of the sectors are reserved in each of the physical partitions for the logical volume information. *Id.* at 2:2–4. The first plurality of sectors are located at the top of each of the physical partitions. *Id.* at 2:4–6. The logical volume information is stored in the first plurality of sectors in each of the physical partitions. *Id.* at 4:6–8.

Figure 3 of Peloquin is reproduced below.

FIG. 3

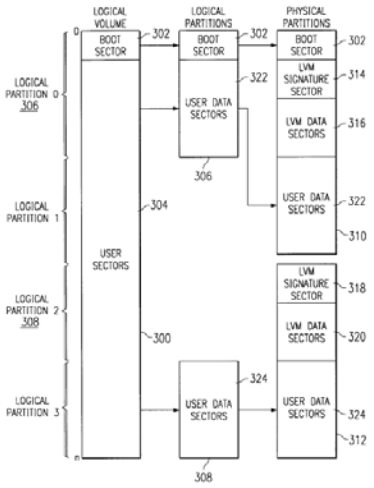

Figure 3 is a block diagram of a logical volume, and the logical partitions and physical partitions that are mapped to the logical volume. *Id.*

at 2:29–32. The logical volume includes a boot sector 302, and user sectors 304. *Id.* at 5:30–32. The sectors are divided into logical partitions, such as 306 and 308. *Id.* at 5:33–34. In turn, each of the logical partitions is mapped to a physical partition that stores the information of the logical partition. *Id.* at 5:33–36. In the specific example of Figure 3, logical partition 306 maps to physical partition 310, and similarly logical partition 308 maps to physical partition 312. *Id.* at 5:36–38.

Logical volume information consisting of LVM signature information and LVM data is stored at the top of each physical partition, in an LVM signature sector 314 and LVM data sectors 316, respectively. *Id.* at 5:41–43. In the embodiment of Figure 3, the logical volume information that is stored in the first physical partition 310 is stored immediately after boot sector 302. *Id.* 5:43–45. However, for all remaining physical partitions, the logical volume information is stored at the very top of the physical partition, as illustrated by physical partition 312. *Id.* at 5:44–47.

2. Claims 1, 8, and 11

In discussing the alleged ground of obviousness of claims 1, 8, and 11 over Bridge and Williams in Sections II.D.3, II.D.5, and II.D.6 above, we identified three deficiencies of Petitioner's analysis. Petitioner's application of Peloquin does not cure any of those three deficiencies.

"*dynamically resizing the logical volume in response to a request for resizing*"

Petitioner's application of Peloquin (Pet. 64–68) does not relate in any way to the limitation of "dynamically resizing the logical volume in response to a request for resizing." Thus, for the same reasons Petitioner's

analysis for claim 1 is deficient based on Bridge and Williams, it also is deficient based on Bridge, Williams, and Peloquin.

"storing the metadata to the disk partitions forming the logical volume"
and
"a logical volume table for maintaining the information of the logical volume by storing duplicated information of the logical volume onto all disk partitions of the logical volume"

Petitioner identifies Peloquin's physical partition as a "disk partition" according to the '436 patent. Pet. 64. According to Petitioner, Peloquin discloses storing metadata of a logical volume within each disk partition of the logical volume. *Id.* at 65. Petitioner then asserts that it would have been obvious to one with ordinary skill in the art to store the metadata of Bridge and Williams in the manner described by Peloquin, i.e., within each disk partition forming the logical volume. Pet. 65–68.

The proposal to modify Williams is misplaced, because in the alleged ground of obviousness based on Bridge and Williams, Williams was relied on simply to modify Bridge. Pet. 37. Modifying Williams, as proposed by Petitioner here, does not fit within Petitioner's theory of obviousness.

Regarding modifying Bridge, Petitioner proposes to store metadata of a logical volume in each disk partition forming the logical volume, in light of the disclosures of Peloquin. However, the proposed manner of combination of Bridge and Peloquin is excessively vague and conclusory. Pet. 65–68. As such, it is insufficient to support an assertion of obviousness.

As discussed above in the context of the combination of Bridge and Williams, what Petitioner identifies in Bridge as disk partitions, i.e., disk drives, do not actually constitute disk partitions. In adding and discussing

Peloquin, Petitioner has not identified, in the alternative, anything else in Bridge as a disk partition. In the ground based on Bridge, Williams, and Peloquin, it is unclear what in Bridge would, in the alternative, constitute the disk partitions. It also is uncertain whether Petitioner is proposing to modify the operations of Bridge such that the disk drives of Bridge would, in the modified Bridge system, constitute disk partitions forming logical volumes. Petitioner has not sufficiently set forth even on a most general level how Bridge would be modified to meet the limitation of storing metadata in the disk partitions and further in all disk partitions forming the logical volume.

Petitioner additionally fails to account for Bridge's disclosure that the metadata for a logical volume is stored in a separate logical volume (Ex. 1005, 9:40–41, 10:25–26). If metadata for a logical volume is stored in a separate logical volume, the metadata necessarily is not stored within the disk partitions forming the logical volume. Teachings both for and against making a modification must be balanced and weighed against each other in an obviousness analysis. *See Winner Int'l Royalty Corp. v. Wang*, 202 F.3d 1340, 1348 (Fed. Cir. 2000) ("the benefits, both lost and gained, should be weighed against one another."). Petitioner has not addressed the diametrically opposite teaching from Bridge.

Accordingly, Petitioner's application of Peloquin does not cure the above-discussed deficiency of its analysis for claim 1 based on Bridge and Williams, with respect to the requirement of storing metadata within disk partitions forming the logical volume and in all disk partitions.

"creating the logical volume by gathering disk partitions"

As noted above, Petitioner identifies Peloquin's physical partition as a "disk partition" according to the '436 patent. Pet. 64. Petitioner asserts that in Peloquin, a plurality of physical partitions are logically combined to create the logical volume. Pet. 64–65. It is unexplained, however, how that translates to gathering disk partitions in Bridge to create the logical volume. As noted above, the proposed manner of combination of Bridge and Peloquin is excessively vague. As discussed above, Petitioner has not even identified valid disk partitions in Bridge, or indicated that the operations of Bridge would be modified to turn its disk drives into disk partitions. Without having adequately identified disk partitions in Bridge, Petitioner has not adequately explained how Bridge, in light of Peloquin, satisfies the limitation of "creating the logical volume by gathering disk partitions."

Accordingly, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 1, 8, and 11 as obvious over Bridge, Williams, and Peloquin.

3. Claims 2 and 4–6

Claims 2 and 4–6 each depend directly or indirectly from claim 1. The deficiency of Petitioner's analysis for claim 1, discussed above, applies also to each of claims 2 and 4–6. Petitioner's analysis of claims 2 and 4–6 adds nothing to cure the deficiency discussed above for claim 1. Pet. 44–61, 67–68. Thus, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 2 and 4–6 as obvious over Bridge, Williams, and Peloquin.

4. Claims 9 and 10

Claim 10 depends from claim 9 and claim 9 depends from claim 8. The deficiency of Petitioner's analysis for claim 8, discussed above, applies to each of claims 9 and 10. Petitioner's analysis of claims 9 and 10 adds nothing to cure the deficiency discussed above for claim 8. Pet. 44–58, 62–63, 67–68. Thus, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 9 and 10 as obvious over Bridge, Williams, and Peloquin.

5. Claims 12 and 13

Claims 12 and 13 each depends from claim 11. The deficiency of Petitioner's analysis for claim 11, discussed above, applies to each of claims 12 and 13. Petitioner's analysis of claims 12 and 13 adds nothing to cure the deficiency discussed above for claim 11. Pet. 58–60, 64, 67–68. Thus, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 12 and 13 as obvious over Bridge, Williams, and Peloquin.

F. Alleged Unpatentability of Claims 3, 7, and 14 as Obvious over Bridge, Williams, and Kodama

Claim 3 depends from claim 1. Claim 7 depends from claim 4. Claim 14 depends from claim 11. Thus, the deficiency of Petitioner's showings based on the combination of Bridge and Williams for claim 1 applies also to claim 3. The deficiency of Petitioner's showings for claim 4 based on Bridge and Williams applies also to claim 7. The deficiency of Petitioner's showings for claim 11 based on Bridge and Williams applies also to claim 14. As applied by Petitioner, Kodama do not relate to or cure the deficiency of Petitioner's analysis with respect to claims 1, 4, and 11 based Bridge and

Williams. Pet. 72–76. Kodama is relied on by Petitioner to meet the additional limitations recited in claims 3, 7, and 14. *Id.*

Accordingly, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 3, 7, and 14 as obvious over Bridge and Williams.

G. Alleged Unpatentability of Claims 3, 7, and 14 as Obvious over Bridge, Williams, Peloquin, and Kodama

Claim 3 depends from claim 1. Claim 7 depends from claim 4. Claim 14 depends from claim 11. Thus, the deficiency of Petitioner's showings based on the combination of Bridge, Williams, and Peloquin for claim 1 applies also to claim 3. The deficiency of Petitioner's showings for claim 4 based on Bridge, Williams, and Peloquin applies also to claim 7. The deficiency of Petitioner's showings for claim 11 based on Bridge, Williams, and Peloquin applies also to claim 14. As applied by Petitioner, Kodama does not relate to or cure the deficiency of Petitioner's analysis with respect to claims 1, 4, and 11 based Bridge, Williams, and Peloquin. Pet. 72–76. Kodama is relied on by Petitioner to meet the additional limitations recited in claims 3, 7, and 14. *Id.*

Accordingly, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any of claims 3, 7, and 14 as obvious over Bridge and Williams.

H. Discretionary Denial of Petition under 35 U.S.C. § 314(a)

Patent Owner asserts that we should exercise discretion under 35 U.S.C. § 314(a) to not institute review in this case, because Petitioner has filed, simultaneously, two petitions for *inter partes* review of the same claims of the '436 patent. Prelim. Resp. 33–35. According to Patent

Owner, "[m]ultiple simultaneous petitions can pose more harassment risks than ones spread out over time as they multiply the patent owner's work and expense in the compressed time frames of IPR proceedings." *Id.* at 34. Patent Owner argues that multiple simultaneously filings amount to paying more to argue more, which is contrary to "the integrity of the patent system, the efficient administration of the Office, and the ability of the Office to timely complete [review] proceedings." *Id.* (citing 35 U.S.C. § 316(b)).

We do not reach the issue of discretionary denial of the Petition, because, as discussed above, Petitioner has not shown a reasonable likelihood that it would prevail in establishing unpatentability of any claim.

III. CONCLUSION

Petitioner has not shown a reasonable likelihood that it would prevail in establishing that at least 1 of the challenged claims 1–14 is unpatentable.

IV. ORDER

It is

ORDERED that the Petition is *denied* and that no *inter partes* review is instituted for any challenged claim on any ground of unpatentability.

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