

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Collins et al.

U.S. Patent No.: 7,120,832

Attorney Docket No.: 39898-0052IP1

Issue Date: October 10, 2006

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Filing Date: September 27, 2001

Title: STORAGE DEVICE PERFORMANCE MONITOR

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 7,120,832 PURSUANT TO 35 U.S.C. §§ 311-319, 37 C.F.R. § 42**

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LIST OF EXHIBITS

FEDEX-1001	U.S. Patent No. 7,120,832 to Collins et al. (“the ’832 patent”)
FEDEX-1002	Excerpts from the Prosecution History of the ’832 patent
FEDEX-1003	Declaration of Dr. Nenad Medvidovic
FEDEX-1004	U.S. Patent No. 5,287,363 to Wolf et al. (“Wolf”)
FEDEX-1005	U.S. Patent No. 5,584,018 to Kamiyama (“Kamiyama”)
FEDEX-1006	U.S. Patent No. 5,881,311 to Woods (“Woods”)
FEDEX-1007	Excerpts of Cant, “Writing Windows WDM Device Drivers,” (1999)
FEDEX-1008	Excerpts of Nutt, “Operating Systems A Modern Perspective,” Second Edition (2000)
FEDEX-1009	Excerpts of McKusick et al., “The Design and Implementation of the 4.4 BSD Operating System,” (1996)
FEDEX-1010	Excerpts of Que Corporation’s “Using MS-DOS 6, Special Edition,” (1993)
FEDEX-1011	Excerpts of Custer, “Inside the Windows NT File System,” (1994)
FEDEX-1012	Rosenblum et al., “The Design and Implementation of a Log-Structured File System,” ACM Transactions on Computer Systems, Vol. 10, No. 1, February 1992, Pages 26-52
FEDEX-1013	Excerpts of Powers et al., “AS/400 Disk Storage Topics and Tools,” (April 2000)
FEDEX-1014	U.S. Patent Application Publication No. 2003/0046270 to Leung et al.

FEDEX-1015	U.S. Patent No. 6,408,406 (“Parris”)
FEDEX-1016	Complaint, <i>Valtrus Innovations Ltd. et al. v. FedEx Corp. et al.</i> , Case No. 2:25-cv-00516 (E.D. Tex. May 9, 2025)

LISTING OF CHALLENGED CLAIMS

Claim 1	
1[p]	A method for monitoring performance of a storage device, comprising:
1[a]	intercepting communications between a computer system and said storage device;
1[b]	analyzing said intercepted communications relative to a threshold value for the performance of said storage device; and
1[c]	responding to a decline in the performance of said storage device based on said analyzed intercepted communications by automatically reallocating at least some data on said storage device to enhance continued operation of the storage device.
Claim 2	
2	A method as in claim 1, further comprising measuring access time for said storage device.
Claim 3	
3	A method as in claim 2, further comprising correcting said measured access time for system overhead.
Claim 4	
4	A method as in claim 1, wherein intercepting said communications comprises intercepting an error reported by said storage device.
Claim 5	
5	A method as in claim 1, further comprising determining an access location on said storage device and an access frequency for data stored thereon, based on said intercepted communications.

Claim 6	
6	A method as in claim 1, further comprising determining an access location on said storage device and an access duration for data stored thereon, based on said intercepted communications.
Claim 7	
7	A method as in claim 1, further comprising logging said communications over time.
Claim 8	
8	A method as in claim 7, wherein analyzing said communications comprises deriving said threshold value based on said logged communications.
Claim 9	
9	A method as in claim 1, wherein responding to said declining performance of said storage device further comprises automatically backing-up data stored on said storage device.
Claim 10	
10	A method as in claim 1, wherein reallocating at least some data on said storage device is based on usage patterns of said data.
Claim 11	
11	A method as in claim 1, wherein responding to said declining performance of said storage device further comprises defragmenting at least a portion of said storage device.
Claim 12	
12[p]	An apparatus for monitoring performance of a storage device, comprising:
12[a]	computer readable storage media;

12[b]	computer readable program code stored on said computer readable storage media, comprising:
12[c]	a) program code for intercepting communications between a computer system and said storage device;
12[d]	b) program code for analyzing said communications, wherein said communications are compared to a predicted decline in performance of said storage device; and
12[e]	c) program code for responding to a decline in the performance of said storage device by backing up at least some data on said storage device prior to said predicted failure of said storage device to enhance continued operation of said storage device.
Claim 13	
13	An apparatus as in claim 12, wherein said program code for intercepting said communications comprises program code for intercepting an error reported by said storage device.
Claim 14	
14	An apparatus as in claim 12, further comprising program code for measuring access time for said storage device, and wherein said communications comprises at least said access time.
Claim 15	
15	An apparatus as in claim 14, further comprising: a) program code for determining system overhead; and b) program code for correcting said access time for said system overhead.
Claim 16	
16	An apparatus as in claim 12, wherein said program code for responding to said decline in the performance of said storage device further comprises defragmenting at least a portion of said storage device based on said communications.

Claim 17	
17[a]	An apparatus as in claim 12, further comprising: a communications log;
17[b]	program code for logging said communications over time in said communications log; and
17[c]	program code for determining the decline in performance of said storage device based at least in part on said logged communications.
Claim 18	
18	An apparatus as in claim 12, further comprising program code for deriving a threshold value for the performance of said storage device, wherein said program code for responding to said decline in the performance of said storage device responds when the performance of said storage device satisfies said threshold value thereof.
Claim 19	
19	An apparatus as in claim 12, wherein said program code for responding further comprises program code for reallocating data to another sector of said storage device.
Claim 20	
20	An apparatus as in claim 19, wherein said program code for reallocating reallocates at least some data on said storage device based on usage patterns of said at least some data.
Claim 21	
21	An apparatus as in claim 12, further comprising a graphical user interface for reporting the performance of said storage device to a user.
Claim 22	
22[p]	An apparatus for monitoring performance of a storage device, comprising:

22[a]	means for evaluating communications between a computer system and said storage device to determine the performance of said storage device based at least in part on intercepted communications with said storage device;
22[b]	and means for enhancing the performance of said storage device by reallocating at least some data on the storage device.
Claim 23	
23	An apparatus as in claim 22, further comprising means for intercepting communications with said storage device.
Claim 24	
24[p]	An apparatus as in claim 22,
24[a]	further comprising means for measuring time to access said storage device,
24[b]	wherein said measured access time is evaluated to determine the performance of said storage device.
Claim 25	
25[p]	A method for monitoring performance of a storage device, comprising:
25[a]	intercepting communications between a computer system and said storage device;
25[b]	analyzing said intercepted communications; and
25[c]	reallocating at least some of said data on said storage device to enhance the performance of said storage device based on said analyzed communications.
Claim 26	
26	A method as in claim 25, wherein intercepting said communications comprises determining access location, access frequency, and access duration for said data on said storage device.

FedEx Corporation and FedEx Office and Print Services, Inc. petition for *Inter Partes* Review of claims 1-26 (“Challenged Claims”) of U.S. Patent No. 7,120,832.

I. REQUIREMENTS FOR IPR

A. Standing

Petitioners certify that the ’832 patent is available for IPR and that Petitioners are not barred or estopped from requesting IPR.

B. Challenge and Relief Requested

Petitioners request IPR of the Challenged Claims on the grounds listed below. Petitioners submit that the cited prior art references are themselves sufficient to establish unpatentability pursuant to the analysis in §III. The §III analysis further cites to the declaration from Dr. Medvidovic (FEDEX-1003) for complementary support, corroboration, and explanation.

Ground	Claims	Basis
1	1-4, 7-10, 12-25	§103: Wolf
2	5-6, 10, 26	§103: Wolf and Kamiyama
3	9, 11-21	§103: Wolf and Woods

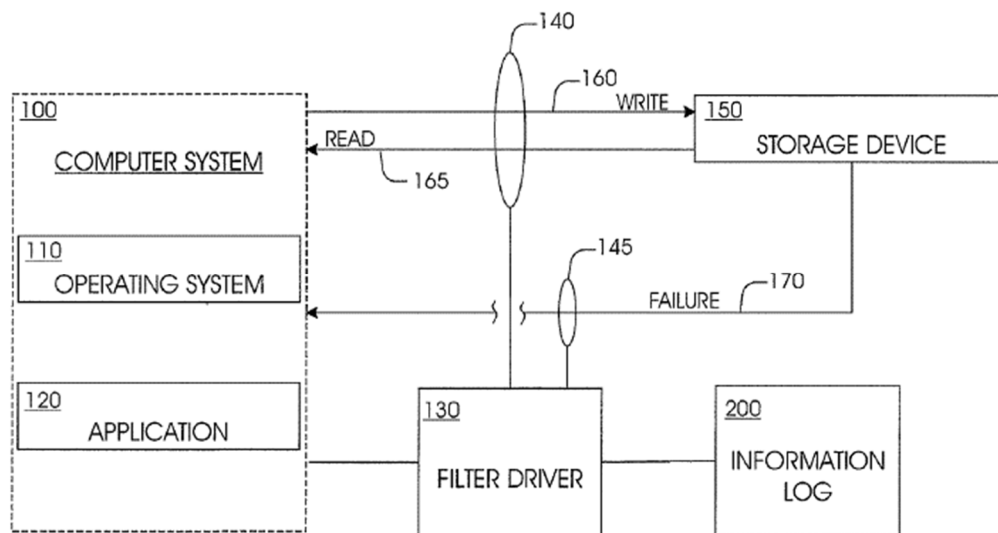
As shown below, each reference pre-dates the ’832 patent’s filing date (September 27, 2001; “Critical Date”) by more than a year.

Reference	Date	Prior Art At Least Under
Wolf	2/15/1994 (issued)	§102(b)
Kamiyama	12/10/1996 (issued)	§102(b)
Woods	3/9/1999 (issued)	§102(b)

II. THE '832 PATENT

A. Brief Description

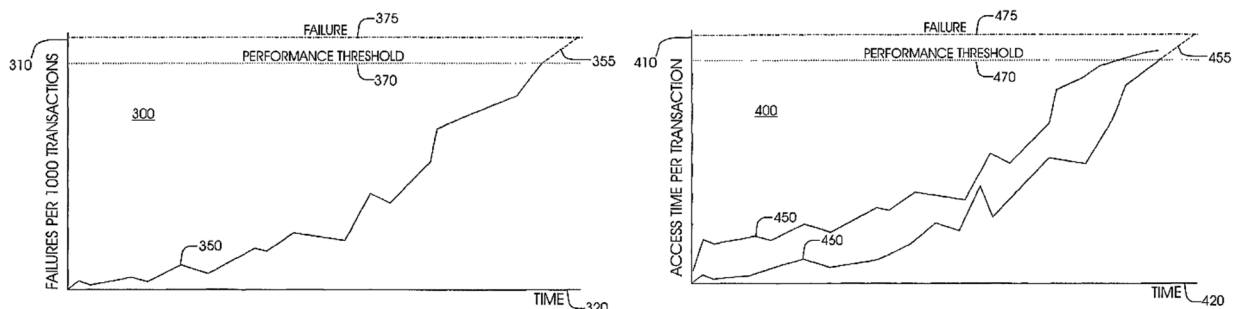
The '832 patent describes a storage device performance monitor for use with computer systems. FEDEX-1001, 1:6-9. Figure 1 (below) is a diagram including a computer system 100 including an operating system 110. *Id.*, 3:39-44. The diagram also shows a storage device 150 and a filter driver 130 “for intercepting 140 communications (e.g., write commands 160, read commands 165) between the computer system 100 (e.g., the operating system 110, an application 120) and the storage device 150” and intercepting “145 errors or failures 170 reported by the storage device 150 to the computer system 100.” *Id.*, 3:44-53. The information from the intercepted communications, and other information related thereto, may be stored in an information log 200 for analysis. *Id.*, 3:53-58; FEDEX-1003, ¶38.



FEDEX-1001, Figure 1

The functionality for intercepting communications is “embodied in firmware and/or software...stored in computer readable storage media and executed, for example, by the computer system 100.” FEDEX-1001, 3:59-4:3; FEDEX-1003, ¶39.

The intercepted communications may be compared to a known or predicted failure of the storage device 150. FEDEX-1001, 6:3-15. The failure may be known based on past performance of comparable storage devices or predicted based on statistical analysis of the logged information. *Id.* A performance threshold may be determined based on the known or predicted failure, and when the analysis of the intercepted communications indicates that the performance of the storage device 150 is approximately at the performance threshold, a response may be initiated to prevent, or reduce the risk of, loss of the data. *Id.*, 6:16-36. For example, as shown in Figure 3 (below, left), the performance threshold may be “‘seventy-five failures per thousand transactions’, based on the predicted failure of ‘one-hundred failures per thousand transactions’.” *Id.* As another example, shown in Figure 4 (below, right), the performance threshold may be “an access time of 2.5 ms, based on the predicted failure of an access time of 3.0 ms.” *Id.*, 8:8-30; FEDEX-1003, ¶40.



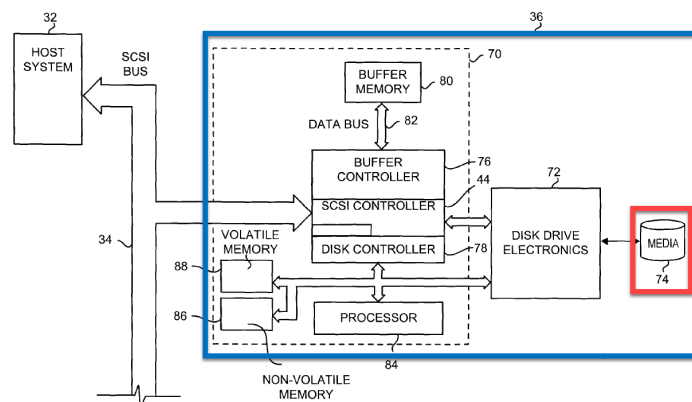
FEDEX-1001, Figures 3-4. A preemptive/preventative response may include alerting the user that the storage device 150 is about to fail, so that the user may replace it, or automatically backing-up or reallocating data on the storage device 150 to an alternate storage device. *Id.*, 6:25-36, 8:30-37. Such a response may also include reallocating all or some of the data on a storage device to another portion of the same storage device. *Id.*, 10:45-49; FEDEX-1003, ¶41.

B. Prosecution History

Application Serial No. 09/966,953, which issued as the '832 patent, was filed on September 27, 2001. FEDEX-1001, cover page (21) (22). During prosecution, the applicant amended its claims multiple times in various attempts to distinguish the cited art. For example, the applicant amended independent claims 1 and 24 (now issued claim 22) to recite the feature of responding to a decline in performance “by automatically reallocating at least some data on said storage device” and independent claim 13 (now issued claim 12) to recite responding to a decline in performance “by backing up at least some data on said storage device.” FEDEX-1002, 66, 68. In another office action response, the applicant further amended independent claims 1 and 13 (now issued claim 12) to recite automatically reallocating “to enhance continued operation of the storage device” and independent claim 24 (now issued claim 22) to recite “enhancing the performance” by reallocating. FEDEX-1002, 231, 233, 236. As explained in §III.A, these added

features are squarely taught by the prior art Wolf reference, which is §102(b) prior art and has never been considered by the Patent Office.

In attempting to distinguish U.S. Patent No. 6,408,406 (“Parris”), the applicant argued Parris’s disclosure of “historical performance parameters includ[ing] running logs of both recoverable and non-recoverable errors encountered during the operation of the disk drive targets” failed to disclose “intercepting communications between a computer system and a storage device.” FEDEX-1002, 239 (original emphasis); *see also id.* at 281 (making same arguments in an appeal brief). Parris taught that “[d]uring operation of disk drive 36, historical performance parameters are continuously logged to the reserved area of the media 74,” including parameters such as “a grown defect list, a read error counter log, a write error counter log, a verify error counter log, and other disk performance attributes.” FEDEX-1015, 5:33-38. As shown below in Figure 2 of Parris, the media 74 (red) is a part of the storage device (*e.g.*, disk drive 36, blue). *Id.*, Figure 2. In response to the applicant’s arguments, the examiner allowed the claims. FEDEX-1002, 317-323.



Although the applicant argued that merely logging information on a storage device does not teach “intercepting communications between a computer system and a storage device,” Patent Owner is now asserting infringement theories that say the opposite. Specifically, Patent Owner contends in co-pending litigation that “populating data into a memtable” on a storage device is enough to satisfy the “intercepting communications” limitation. *See, e.g.*, FEDEX-1015, ¶87.

C. Level of Ordinary Skill

A person of ordinary skill in the art relating to the subject matter of the ’832 patent would have had (1) at least a master’s degree in computer science, computer engineering, or a related field, and (2) at least two years of professional experience involving the study and/or development of operating systems, filesystems, and/or storage devices. FEDEX-1003, ¶¶42-43. Additional education could substitute for professional experience, and professional experience for education. *Id.*

D. Claim Construction

The analysis below in §III proves the Challenged Claims obvious under any interpretation reasonably advanced according to the *Phillips* standard. Moreover, consistent with the requirements of 37 C.F.R. §42.104(b)(3), this Petition identifies the “specific portions of the specification” that describe structures corresponding to the recited function of each §112, ¶6 element of the ’832 patent’s claims 22-24. Nevertheless, Petitioners submit that the Board need not resolve any express

constructions. *See Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). Should any subsequent discussion of claim interpretation arise here or in the parallel district court proceeding, Petitioners reserve the right to address any construction advanced by Patent Owner, the Board, or the District Court.

III. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. GROUND 1—Wolf renders obvious claims 1-4, 7-10, and 12-25

1. Wolf

Wolf describes a “[m]ethod and apparatus for use in a computer having peripheral data storage, to monitor data transfers to detect defective or marginally defective storage areas.” FEDEX-1004, Abstract, 1:15-23, 3:22-36, 3:54-59.¹ Wolf’s Figure 3 illustrates “software components,” including “resident” components and “transient” components. *Id.*, 6:29-56. The resident components are part of a “device driver,” which “appears to the operating system as a low-level program which functions as an interface between the operating system and a peripheral device” (*e.g.*, a storage device). *Id.*, 9:57-62; *see also id.*, 7:28-37, 16:21-24, 16:49-55; FEDEX-1003, ¶45.

¹ General descriptions provided for this and other references (and combinations thereof) are incorporated into each subsection and mapping of the claims that includes citations to these references.

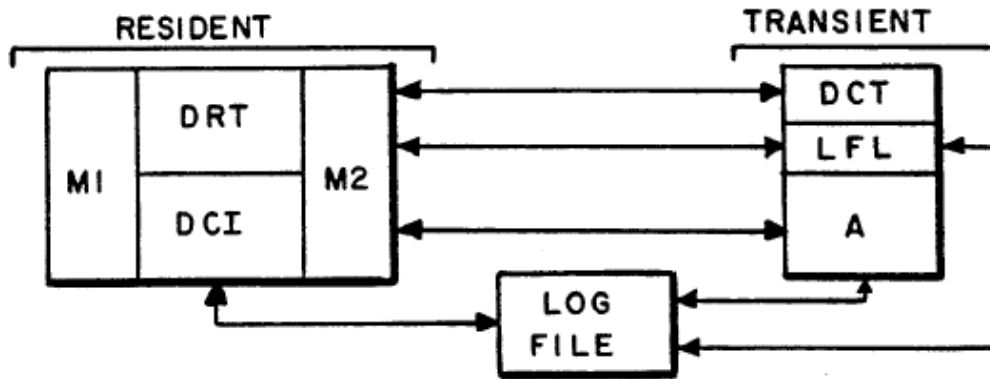


FIG. 3

FEDEX-1004, Figure 3

In Wolf, “the resident components...monitor disk reads.” FEDEX-1004, 6:57-58. For, example, the disk-read timer (DRT) measures “the time duration of data transfer during disk read operations.” FEDEX-1004, 6:58-65, 7:53-13:34. As another example, the disk-call interceptor (DCI) “gather[s] information indicative of disk data read problems and [] log[s] that information onto the log file.” *Id.*, 6:65-67. The disk-call interceptor is aptly named, as it intercepts calls made by the operating system to a disk by being “functionally place[d]...in the operating system’s disk call chain so that the disk-call interceptor is invoked for each disk operation.” *Id.*, 7:38-42. As part of intercepting calls between the operating system and storage device, the DCI gathers “data transfer time measurements from the disk-read timer and information from the status returned by the disk low level interface routine.” *Id.*, 6:68-7:2. Using the logged information, the DCI “detects data transfers that took an excessive amount of time which would indicate that the data was not

successfully read on a first attempt, and one or more retries at reading the data was conducted by the disk controller and/or the operating system's low-level interface to the disk." *Id.*, 6:65-7:11, 15:51-16:14, 17:56-20:50; FEDEX-1003, ¶46.

Within the transient components, Wolf describes an analysis program (denoted "A" in Figure 3 above), which "take[s] the events recorded by the disk-call interceptor on the log file, build[s] and maintain[s] a history of such events sorted by disk unit areas, such as sectors, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective." FEDEX-1004, 7:12-25, 16:56-17:55. The remedial measures "include moving to a good area the data, which was stored in an area accessible to the analysis program by the disk-call interceptor, as described above, and marking the bad or marginally defective area in the disk's list of such areas." *Id.*, 7:21-25; FEDEX-1003, ¶47.

2. Claim Element Analysis

(a) Claims 1 and 25

1[p]. A method for monitoring performance of a storage device, comprising:

25[p]. A method for monitoring performance of a storage device, comprising:

Wolf discloses a "[m]ethod and apparatus for use in a computer having peripheral data storage, to monitor data transfers to detect defective or marginally defective storage areas." FEDEX-1004, Abstract, 1:15-23, 3:22-36, 3:54-59. Wolf's

Figure 1 illustrates the “hardware environment” including a computer 100, a memory with ROM 106 and RAM 108, and hard disk 104 that communicate through bus 102. *Id.*, 4:66-5:66. Wolf explains that “[i]nstructions directing...a computer to perform useful work are contained in computer programs...stored in a ‘external’ medium such as on the hard disk 104, or internally in a read-only memory (ROM) 106” and “loaded into the random access memory (RAM) 108” and “executed by the central processing unit (CPU).” *Id.*, 4:60-5:30. One such embodiment “includes a computer program operating on a personal computer.” *Id.*; FEDEX-1003, ¶48.

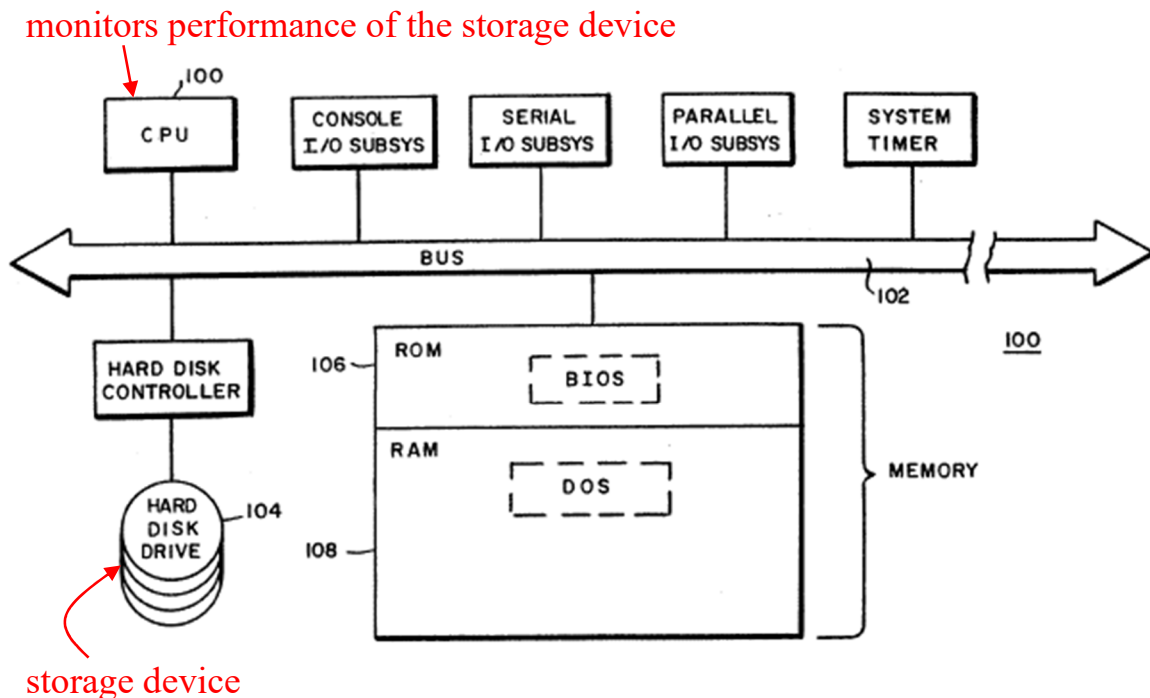


FIG. 1

FEDEX-1004, Figure 1²

² Annotations and color added to figures unless otherwise noted.

As explained in §III.A.1, Wolf monitors the performance of a storage device through its “resident” (*e.g.*, its disk-read timer (“DRT”) and disk-call interceptor (“DCI”)) and “transient” (*e.g.*, its “analysis program”) software components. For example, Wolf’s DRT measures “the time duration of data transfer during disk read operations.” FEDEX-1004, 6:58-65, 7:53-13:34. Also, Wolf’s DCI “gather[s] information indicative of disk data read problems and [] log[s] that information onto the log file.” *Id.*, 6:65-67. From this logged information, the analysis program “take[s] the events recorded by the disk-call interceptor on the log file, build[s] and maintain[s] a history of such events sorted by disk unit areas, such as sectors, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective.” *Id.*, 7:12-25, 16:56-17:55. Accordingly, Wolf’s CPU executes the above-discussed software components to monitor disk reads, detect data transfers that took an excessive amount of time, and log disk status information and access time measurements (**monitor performance of the storage device**). *Id.*, 4:60-5:30, 6:57-58, 6:65-7:11, 15:51-16:14, 17:56-20:50; FEDEX-1003, ¶49 (citing FEDEX-1013, 83-84; FEDEX-1014, [0124]), ¶99.

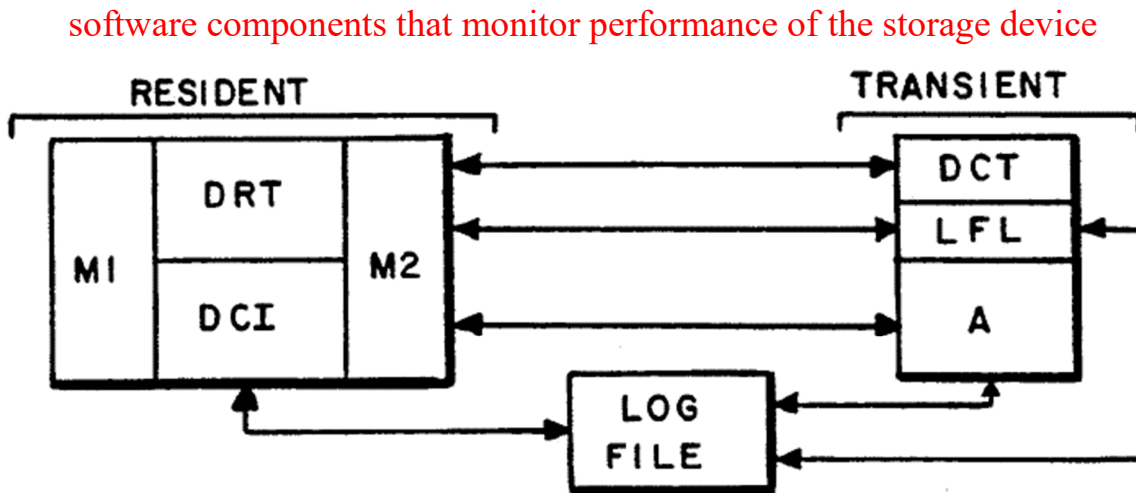


FIG. 3

FEDEX-1004, Figure 3

1[a]. intercepting communications between a computer system and said storage device;

25[a]. intercepting communications between a computer system and said storage device;

Wolf discloses that monitoring of data retrieval from the peripheral storage medium occurs “concurrently with the normal operation of the computer” and is “transparent to normal operations of the computer system and does not interfere with normal computer operations.” FEDEX-1004, 3:22-39. In Wolf, the disk-call interceptor (DCI) is placed “in the operating system’s disk call chain so that the disk-call interceptor is invoked for each disk operation” “in order to distinguish disk read operations from other disk operations before they start” and “to obtain the status information concerning the disk-read operations which is available at their conclusion or abortion.” *Id.*, 7:38-49, 18:26-56. The DCI traps “all the operating

system's disk calls" and "whenever the operating system makes a disk operation call intended for the low-level disk interface routine, it will actually be calling the disk-call interceptor." *Id.*, 14:1-8, 15:24-27. "When called, the disk-call interceptor will perform certain disk call processing and thereafter will execute the call that the operating system tried to make, to the low-level disk interface routine, via the appropriated operating system vector passed to it by the disk-call trapper. Program control will be returned to the disk call interceptor when the disk operation is completed. The disk call interceptor will then make some checks and log reportable events...and return program control to the operating system along with the disk status it received from the disk interface routine." *Id.*, 15:28-38; FEDEX-1003, ¶50.

Wolf's Figure 9 (below) illustrates an exemplary program control and status flow where the disk call interceptor (DCI) is placed in the disk call chain to **intercept communications** between a program (*e.g.*, program 60) running under the operating system (*e.g.*, DOS, comprising DOS Services 64 and DOS Disk Service 68) executed by the CPU (**computer system**) and the hard disk (**storage device**). *Id.*, 5:22-27, 18:57-20:23, 21:31-44. By placing the DCI in a position suitable for intercepting communications to the storage device, it is able to "gather information indicative of disk data read problems," such as "data transfer time measurements" and status information, and "log that information onto the log file." FEDEX-1004, 6:65-7:2; FEDEX-1003, ¶51.

intercepts communications between a computer system and storage device

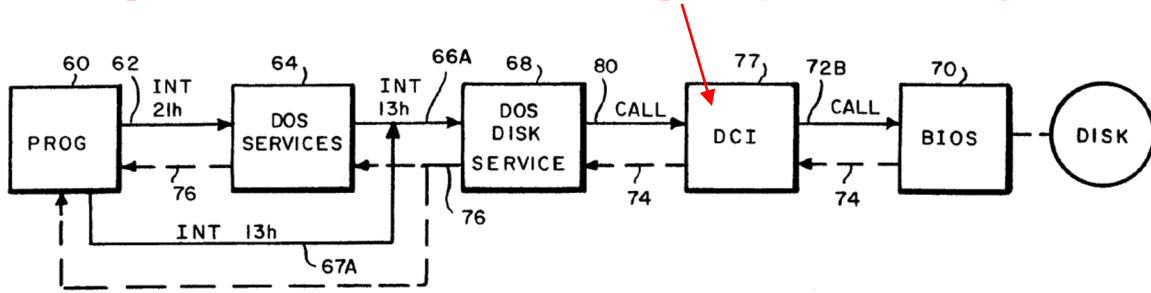


FIG. 9

FEDEX-1004, Figure 9

Moreover, the DCI interfaces with the disk-read timer (“DRT”) across shared memory blocks to measure the “the actual data transfer time.” FEDEX-1004, 12:20-28; *see also id.*, 6:58-61 (“A primary function of the disk-read timer is to measure the time duration of data transfer during disk read operations.”). Wolf teaches intercepting communications to the storage device through its “resident” software components (*e.g.*, the DCI and DRT), and measuring the access time for the calls issued from a computer system to the storage device. *Id.*, Figure 3. Wolf’s functionality closely aligns with the embodiment described in the ’832 patent, which explains that “[i]ntercepting the communications may comprise measuring access time for the storage device.” FEDEX-1001, 2:55-58; *see also id.*, Figure 2 (illustrating measured access time, derived from intercepted communications, as a form of intercepted communications), Figure 7 (same). Thus, the access time measured by the DRT, which is derived from communications between the computer

system and storage device intercepted by the DCI, also constitutes an **intercepted communication**. FEDEX-1003, ¶52, ¶100.

1[b]. analyzing said intercepted communications relative to a threshold value for the performance of said storage device; and
25[b]. analyzing said intercepted communications; and

Multiple aspects of Wolf’s description independently disclose and/or render obvious the feature of **analyzing said intercepted communications relative to a threshold value for the performance of said storage device**. FEDEX-1003, ¶53.

First Aspect—Disk-Call Interceptor and Disk-Read Timer

Wolf discloses that the disk-call interceptor (DCI) gathers “information indicative of disk data read problems,” including “the data transfer time measurements from the disk-read timer [(DRT)],” and from the time measurements, “detects data transfers that took an excessive amount of time which would indicate that the data was not successfully read on a first attempt, and one or more retries at reading the data was conducted by the disk controller and/or the operating system’s low-level interface to the disk.” FEDEX-1004, 6:65-7:11, 15:51-16:14, 17:56-20:50. As Wolf explains in detail, the DCI intercepts “a call for a disk read operation” and interfaces with the DRT across shared memory blocks to determine the “the actual data transfer time.” *Id.*, 12:20-28. The DCI further **analyzes the intercepted communications** to determine whether an error condition has occurred by comparing the time information against a table of acceptable times (**relative to a**

threshold value for the performance of said storage device). *Id.*, 20:24-41, 21:38-43, 24:1-11, 24:22-27, 25:19-24, 27:47-56, 28:10-15; FEDEX-1003, ¶54. Wolf explains the table of acceptable times may be created “at setup time...by performing several series of successive reads” of a number of sectors in the storage device “and logging in the table the average times for each of these read operations.” FEDEX-1004, 20:28-33. “Thus, when the operating system issues a call for a read operation containing one of those numbers of sectors stored in the table, a simple comparison can determine if a reasonable time has been taken for the read.” *Id.*; *see also id.*, 20:37-41 (“no more than one standard deviation greater than the mean, or no more than fifty-percent greater than the mean”), 21:31-44.

Second Aspect—Analysis Program

Wolf also discloses that an analysis program may “analyze[] the historical data [in the log file] to determine whether there are any areas of the storage medium that are unable to store data with integrity or are tending to lose the ability to store data with integrity.” FEDEX-1004, 3:40-46. In addition to timing information, the log file also includes “other loggable information concerning read problems” that the DCI accesses by intercepting “status information in raw form.” *Id.*, 18:7-39, 18:57-20:23. Thus, because the log file contains information gleaned from communications intercepted by the DCI, a POSITA would have understood Wolf to

disclose (and/or found obvious from Wolf's disclosure) that the analysis program **analyzes the intercepted communications**. FEDEX, 1003, ¶55.

According to Wolf, the analysis program "take[s] the events recorded by the disk-call interceptor on the log file, build[s] and maintain[s] a history of such events sorted by disk unit areas, such as sectors, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective." FEDEX-1004, 7:12-21; *see also id.*, 16:56-17:55 (describing operation of analysis program); FEDEX, 1003, ¶55. "The analysis program determines on the basis of the historical data whether any disk areas are defective to the point where they should be designated to the operating system as unusable, and the data relocated." *Id.*, 17:4-7, 20:42-50; FEDEX, 1003, ¶56.

For example, if there is "a single recurrence of the error on retesting the location wherein the error occurred previously," "the location at which the error occurred is identified to the operating system as bad." FEDEX-1004, 17:15-29. Here, a POSITA would have understood Wolf to disclose (and/or found obvious from Wolf's disclosure) that the analysis program utilizes a "single recurrence" as the error **threshold value for the performance of the storage device**. FEDEX, 1003, ¶56. Additionally, Wolf explains that a "criterion for confirming an error is

based on the published specifications for hard disk drives used in personal computers, readily available through vendor literature” (another **threshold value for the performance of the storage device**). FEDEX-1004, 17:20-23; FEDEX-1003, ¶56. As yet another example, Wolf describes how the analysis program checks “the history for that location...to determine if the error is part of a pattern of intermittent errors.” FEDEX-1004, 17:29-38. Here, a POSITA would have understood Wolf to disclose (and/or found obvious from Wolf’s disclosure) that the analysis program utilizes the emergence or existence of a “pattern” as the error **threshold value for the performance of the storage value**. FEDEX, 1003, ¶57, ¶101.

1[c]. responding to a decline in the performance of said storage device based on said analyzed intercepted communications by automatically reallocating at least some data on said storage device to enhance continued operation of the storage device.

25[c]. reallocating at least some of said data on said storage device to enhance the performance of said storage device based on said analyzed communications.

Wolf discloses that if “any areas are determined to be bad or to be marginally bad as a result of the analysis performed” (**responding to a decline in the performance of said storage device based on said analyzed intercepted communications**) the data stored in these areas of the storage device are relocated to other areas of the storage device (**by automatically reallocating at least some data on said storage device**). FEDEX-1004, 3:47-53. For example, the analysis program “take[s] the events recorded by the disk-call interceptor on the log file,

build[s] and maintain[s] a history of such events sorted by disk unit areas, such as sectors, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective.” FEDEX-1004, 7:12-21; 17:58-18:6 (explaining the disk-call interceptor (DCI) “temporarily relocates data recovered from a location which caused a log entry to a location which is known to the analysis program”). “Remedial action can include moving to a good area the data, which was stored in an area accessible to the analysis program by the disk-call interceptor, as described above, and marking the bad or marginally defective area in the disk’s list of such areas.” *Id.*, 7:21-25; *see also id.*, 17:26-34 (describing relocating data from a “bad” to a “good location,” when recurring errors are detected). “Thus, if necessary, data recovered from a faulty sector may be relocated to a safe location.” *Id.*, 17:1-3, 17:23-26; FEDEX-1003, ¶58.

As would have been known or obvious to a POSITA, relocating data from one sector to another (e.g., by the DCI and/or the analysis program) is a straightforward way of **reallocating the data**. FEDEX-1003, ¶59 (citing FEDEX-1009, 293-294, 271; FEDEX-1011, 6-7, 24; FEDEX-1010, 3). Notably, Wolf’s approach of moving data from one sector to another is how the ’832 patent describes **reallocation** in its preferred embodiments. FEDEX-1001, 2:65-3:10 (explaining the “response” of

“reallocat[ing] the storage device” includes a scenario where “the data stored thereon [is] moved prior to a failure”); 9:47-10:23, 10:45-47 (“reallocating all or some of the data to another portion of the storage device [] (e.g., to another sector”).

Additionally, a POSITA would have understood Wolf to disclose (and found obvious) that automatically relocating data to a safe location **enhances continued operation of the storage device**. FEDEX-1004, 6:65-7:11, 15:51-16:14, 17:23-34, 17:56-20:50, 21:31-44; FEDEX-1003, ¶60. For example, Wolf makes clear the above-discussed procedures are performed “concurrently with the normal operation of the computer” (**continued operation of the storage device**). FEDEX-1004, 3:22-39; *see also id.*, 1:59-61. Moreover, Wolf discloses (or renders obvious) the notion of **enhancing** performance by explaining that data relocation is a “remedial action” responsive to one or more error indicators. *Id.*, Abstract, 1:15-23, 7:12-25. Claim 12 of the '832 patent confirms preserving data by moving it to an area with greater storage integrity, as taught by Wolf, enhances the operation of the device. FEDEX-1001, claim 12 (“program code for responding to a decline in the performance of said storage device by **backing up at least some data on said storage device** prior to said predicted failure of said storage device **to enhance continued operation of said storage device**”) (emphasis added). Indeed, it would have been known or obvious to a POSITA that Wolf’s remedial data relocation measures **enhance continued operation of the storage device** because data moved to a safe or “good”

location is more likely to be read successfully on the first attempt, or at all, and accessed within a shorter time than data left at a known “bad” location. FEDEX-1003, ¶60, ¶102.

(b) Claim 2

2. A method as in claim 1, further comprising measuring access time for said storage device.

Wolf’s disk-read timer (DRT) measures “the time duration of data transfer during disk read operations” (**measuring access time for the storage device**). FEDEX-1004, 6:58-65; *see also id.*, 7:53-13:34 (describing the operation of the DRT); FEDEX-1003, ¶61. The DRT “measures the duration of data transfers by counting system timer ticks.” FEDEX-1004, 9:17-18. The disk-call interceptor (DCI) gathers “information indicative of disk data read problems” including “the data transfer time measurements from the disk-read timer,” and from the time measurements, “detects data transfers that took an excessive amount of time which would indicate that the data was not successfully read on a first attempt, and one or more retries at reading the data was conducted by the disk controller and/or the operating system’s low-level interface to the disk.” *Id.*, 6:65-7:11, 15:51-16:14, 17:56-20:50.

Wolf also teaches **measuring access time** for the storage device at “setup time... by performing several series of successive reads” of a number of sectors in the storage device. FEDEX-1004, 20:28-33; FEDEX-1003, ¶62.

(c) Claim 3

3. A method as in claim 2, further comprising correcting said measured access time for system overhead.

Wolf explains “there is great advantage in being able to measure the time duration of data retrieval operations which occur while the computer is performing its usual functions and being able to accurately distinguish seek and rotational latency times from actual read times.” FEDEX-1004, 2:52-57. To that end, Wolf discloses that the DCI eliminates “seek and rotational latency time...from the elapsed time of the read operation” (**corrects the measured access time for system overhead**). *Id.*, 12:46-68, 2:35-61; FEDEX-1003, ¶63. The adjusted time “more accurately reflects the actual data transfer time” and eliminates “any seek and rotational latency time preceding the actual transfer of the data.” FEDEX-1004, 12:46-68.

Wolf also teaches accounting for “controller overhead” by “retesting” (*i.e.*, remeasuring) access times when creating the table of acceptable times for a number of sectors in the storage device. FEDEX-1004, 20:42-50. A POSITA would

understand that such “retesting” also constitutes **correcting said measured access time for system overhead**. FEDEX-1003, ¶64.

(d) Claim 4

4. A method as in claim 1, wherein intercepting said communications comprises intercepting an error reported by said storage device.

Wolf’s disk-call interceptor (DCI) obtains “other loggable information concerning read problems...in status information return[ed] by the disk interface routine at the end of the read operation. For example, if erroneous data read from the disk can be corrected by the disk controller using an error correction code (ECC), the fact that the data has been so corrected is typically provided in the end-of operation status information” (**intercepting an error reported by the storage device**). FEDEX-1004, 18:7-39, 6:65-7:11, 19:41-20:23. In order to collect this information, Wolf teaches positioning the DCI in an “advanced” position closer to the storage device, as illustrated in Figure 9. FEDEX-1004, 19:67-20:15, Figure 9. By positioning the DCI closer to the storage device, the DCI can obtain “the additional and very significant information contained in the raw status information,” such as an indication of whether erroneous data has been corrected by the disk controller with an ECC. *Id.*, 18:7-39, 6:65-7:11, 19:41-20:23; FEDEX-1003, ¶65.

(e) **Claim 7**

7. A method as in claim 1, further comprising logging said communications over time.

Wolf teaches that, at setup time, a table of acceptable times may be created “by performing several series of successive reads” of a number of sectors in the storage device (**said communications**) “and **logging** in the table the average times for each of these read operations.” FEDEX-1004, 20:28-33. In order to compute the average times, a POSITA would understand that, in addition to logging the average times, each of the successive reads (and their access times) would also be **logged**. FEDEX-1003, ¶66. Also, because there are “several series of successive reads,” it would have been known (or obvious) to a POSITA that these communications are being **logged over time**. *Id.*; FEDEX-1004, 20:28-33.

Additionally, as explained for claim 1, as Wolf’s system operates, Wolf’s disk-call interceptor (DCI) gathers measured access times and status information (**said communications**) between a CPU (**computer system**) and storage device that are intercepted, analyzed, and form a basis for reallocating data. For example, Wolf’s DCI “gather[s] information indicative of disk data read problems,” such as “data transfer time measurements” and status information, and “log[s] that information onto the log file” (**logging over time**). FEDEX-1004, 6:65-7:2; *see also id.*, 7:3-11, 15:51-16:14, 17:56-20:50; FEDEX-1003, ¶67.

(f) Claim 8

8. A method as in claim 7, wherein analyzing said communications comprises deriving said threshold value based on said logged communications.

As explained with respect to claim 7, Wolf teaches creating a table of acceptable times (**threshold value**). FEDEX-1004, 20:24-41. The table is created “by performing several series of successive reads” of a number of sectors in the storage device (**said communications**) “and **logging** in the table the average times for each of these read operations.” *Id.*, 20:28-33. Thus, Wolf teaches analyzing the successive reads by computing the average times of the successive reads for each sector, and that the acceptable times are derived based on the successive reads (**deriving said threshold value based on said logged communications**). *Id.*, 20:24-41; FEDEX-1003, ¶68.

(g) Claim 9

9. A method as in claim 1, wherein responding to said declining performance of said storage device further comprises automatically backing-up data stored on said storage device.

As discussed above in 1[c]/25[c], Wolf discloses responding to a failure mode, an unknown defective area, or an area that has become marginally defective (**declining performance**) of the storage device based on the analyzed intercepted communications by automatically reallocating at least some data on the storage device to enhance the performance and continued operation of the storage device. FEDEX-1004, 3:47-53, 6:65-7:25, 15:51-16:14, 16:56-20:50, 21:31-44. Wolf also

discloses that “the historical pattern of errors may be analyzed by an expert system which is part of the analysis program. The expert system determines whether the current pattern of errors indicates a potential catastrophic failure of the disk drive. For example, significant numbers of errors near the inner radius of the storage surface may indicate a fault in the read/write system, while significant numbers of errors near the outer radius of the storage surface may indicate imminent spindle bearing failure. Failures in these systems would be catastrophic, if they occurred with no warning. However, they are problems which generally cannot be fixed by the computer owner or user. Therefore, a warning is issued to the user, so that appropriate action may be taken, **such as backing up the entire hard disk** and taking the machine to a repair facility, where the hard disk might be replaced.” FEDEX-1004, 17:39-55 (emphasis added). A POSITA would have found it obvious to implement Wolf’s system to **automatically** back up data in response to a potential catastrophic failure. FEDEX-1003, ¶69. The POSITA would have known that operating systems like Wolf’s MS DOS (4:54-59) included backup programs that could be called automatically. *Id.* (citing FEDEX-1010, 16-17, 19; EX1011, 5-6, 25). And the POSITA would have appreciated that automating the process reduces the risk of unrecoverable data loss by eliminating the possibility of user error or negligence in failing to manually create a backup. *Id.*

(h) Claim 10

10. A method as in claim 1, wherein reallocating at least some data on said storage device is based on usage patterns of said data.

Wolf discloses that the disk-call interceptor (DCI) gathers “information indicative of disk data read problems” including “the data transfer time measurements from the disk-read timer,” and from the time measurements, “detects data transfers that took an excessive amount of time which would indicate that the data was not successfully read on a first attempt, and one or more retries at reading the data was conducted by the disk controller and/or the operating system’s low-level interface to the disk.” FEDEX-1004, 6:65-7:11, 15:51-16:14 17:56-20:50. Wolf discloses that the DCI determines from the raw time information of the disk read operation whether an error condition has occurred by comparing the raw time information with a table of acceptable times. *Id.*, 20:24-41, 21:38-43, 24:1-11, 24:22-27, 25:19-24, 27:47-56, 28:10-15. Wolf explains the table of acceptable times may be created “at setup time...by performing several series of successive reads” of a number of sectors in the storage device (**usage patterns of said data**) “and logging in the table the average times for each of these read operations.” FEDEX-1004, 20:28-33. “Thus, when the operating system issues a call for a read operation containing one of those numbers of sectors stored in the table, a simple comparison can determine if a reasonable time has been taken for the read.” *Id.*; 21:31-44. If an

error is detected, “[r]emedial action can include moving to a good area the data **[reallocating at least some data]**, which was stored in an area accessible to the analysis program by the disk-call interceptor, as described above, and marking the bad or marginally defective area in the disk’s list of such areas.” *Id.*, 7:21-25; *see also id.*, 17:26-34 (describing relocating data from a “bad” to a “good location,” when recurring errors are detected); FEDEX-1003, ¶70.

Moreover, as explained for 1[b] and 1[c], Wolf’s “analysis program determines on the basis of the historical data” (**usage patterns of said data**) “whether any disk areas are defective to the point where they should be designated to the operating system as unusable, and the data relocated” (**reallocating at least some data**). FEDEX-1004, 17:4-7, 3:40-53, 7:12-25; FEDEX-1003, ¶71.

(i) Claim 12

12[p]. An apparatus for monitoring performance of a storage device, comprising:

Supra 1[p]. FEDEX-1003, ¶72.³

12[a]. computer readable storage media;

Supra 1[p]. FEDEX-1003, ¶73.

³ Beauregard claims are typically treated as method claims. *E.g.*, *Digital-Vending Services Intern., LLC v. University of Phoenix, Inc.*, 672 F.3d 1270, 1275 n.1 (Fed. Cir. 2012).

12[b]. computer readable program code stored on said computer readable storage media, comprising:

Supra 1[p]. FEDEX-1003, ¶74.

12[c]. a) program code for intercepting communications between a computer system and said storage device;

Supra 1[p], 1[a]. FEDEX-1003, ¶75.

12[d]. b) program code for analyzing said communications, wherein said communications are compared to a predicted decline in performance of said storage device; and

As detailed above in 1[b]/25[b], Wolf discloses that the disk-call interceptor (DCI) gathers “information indicative of disk data read problems” including “the data transfer time measurements from the disk-read timer,” and from the time measurements, “detects data transfers that took an excessive amount of time which would indicate that the data was not successfully read on a first attempt, and one or more retries at reading the data was conducted by the disk controller and/or the operating system’s low-level interface to the disk.” FEDEX-1004, 6:65-7:11, 15:51-16:14, 17:56-20:50. Wolf discloses that the DCI determines from the raw time information of the disk read operation whether an error condition has occurred **(analyzing said communications)** by comparing the raw time information with a table of acceptable times **(a predicted decline in performance)**. *Id.*, 20:24-41, 21:38-43, 24:1-11, 24:22-27, 25:19-24, 27:47-56, 28:10-15; FEDEX-1003, ¶76. “Thus, when the operating system issues a call for a read operation containing one

of those numbers of sectors stored in the table, a simple comparison can determine if a reasonable time has been taken for the read.” FEDEX-1004, 20:33-37; *see also id.*, 21:31-44.

Also, as explained for 1[b]/25[b], Wolf’s analysis program detects “any new errors [that] have occurred since the analysis program was last run, and a “procedure to confirm” them (**analyzing said communications**). FEDEX-1004, 17:15-38. For example, Wolf teaches a “criterion for confirming an error is based on the published specifications for hard disk drives used in personal computers, readily available through vendor literature” (another **predicted decline in performance**). FEDEX-1004, 17:20-23; FEDEX-1003, ¶77.

12[e]. c) program code for responding to a decline in the performance of said storage device by backing up at least some data on said storage device prior to said predicted failure of said storage device to enhance continued operation of said storage device.

Supra claim 9. FEDEX-1003, ¶78.

(j) Claim 13

13. An apparatus as in claim 12, wherein said program code for intercepting said communications comprises program code for intercepting an error reported by said storage device.

Supra claim 4. FEDEX-1003, ¶79.

(k) Claim 14

14. An apparatus as in claim 12, further comprising program code for measuring access time for said storage device, and wherein said communications comprises at least said access time.

Supra claim 2. FEDEX-1003, ¶80.

(l) Claim 15

15. An apparatus as in claim 14, further comprising: a) program code for determining system overhead; and b) program code for correcting said access time for said system overhead.

Supra claim 3. FEDEX-1003, ¶81.

(m) Claim 16

16. An apparatus as in claim 12, wherein said program code for responding to said decline in the performance of said storage device further comprises defragmenting at least a portion of said storage device based on said communications.

Supra claim 11. FEDEX-1003, ¶82.

(n) Claim 17

17[a]. An apparatus as in claim 12, further comprising: a communications log;

Supra claim 7. FEDEX-1003, ¶83.

17[b]. program code for logging said communications over time in said communications log; and

Supra claim 7. FEDEX-1003, ¶84.

17[c]. program code for determining the decline in performance of said storage device based at least in part on said logged communications.

Supra 1[b]/25[b] and 12[d]. FEDEX-1003, ¶85.

(o) Claim 18

18. An apparatus as in claim 12, further comprising program code for deriving a threshold value for the performance of said storage device, wherein said program code for responding to said decline in the performance of said storage device responds when the performance of said storage device satisfies said threshold value thereof.

Supra 1[b]/25[b], 1[c]/25[c], and claim 8. FEDEX-1003, ¶86.

(p) Claim 19

19. An apparatus as in claim 12, wherein said program code for responding further comprises program code for reallocating data to another sector of said storage device.

As discussed above in 1[c]/25[c], Wolf discloses that if “any areas are determined to be bad or to be marginally bad as a result of the analysis performed” the data stored in these areas are relocated to other areas. FEDEX-1004, 3:47-53. Specifically, the analysis program “take[s] the events recorded by the disk-call interceptor on the log file, build[s] and maintain[s] a history of such events sorted by **disk unit areas, such as sectors**, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective.” FEDEX-1004, 7:12-25, 16:56-17:55. “Remedial action can include moving to a good area the data, which was stored in an area accessible to the analysis program by the disk-call interceptor, as described above, and marking the bad or marginally

defective area in the disk's list of such areas.” *Id.* “Thus, if necessary, **data recovered from a faulty sector may be relocated to a safe location.**” *Id.*, 17:1-3, 17:23-26. Wolf's claims make it clear that the data is reallocated to another sector of the same storage device. *See, e.g., Id.*, claim 8 (“means for relocating any data stored in said indicated defective locations **to other locations on the data storage device** which are not defective”). A POSITA would have understood or found it obvious that Wolf's analysis program (**program code**) reallocates data from a faulty sector to another safe sector of the storage device. FEDEX-1003, ¶87.

(q) Claim 20

20. An apparatus as in claim 19, wherein said program code for reallocating reallocates at least some data on said storage device based on usage patterns of said at least some data.

Supra claim 10. FEDEX-1003, ¶88.

(r) Claim 21

21. An apparatus as in claim 12, further comprising a graphical user interface for reporting the performance of said storage device to a user.

Wolf discloses “a warning is issued to the user, so that appropriate action may be taken, such as backing up the entire hard disk and taking the machine to a repair facility, where the hard disk might be replaced.” FEDEX-1004, 17:39-55. A POSITA would have understood that the issued warning would have been presented to a user through a graphical user interface. FEDEX-1003, ¶89. Additionally, a POSITA would have found it obvious to include a **user interface** in Wolf's system

for issuing the warning (**reporting the performance**) to the user so that the user may take appropriate action, as was well known at the time of the '832 patent. *Id.*

(s) **Claim 22**

22[p]. An apparatus for monitoring performance of a storage device, comprising:

Supra 1[p]. FEDEX-1003, ¶90.

22[a]. means for evaluating communications between a computer system and said storage device to determine the performance of said storage device based at least in part on intercepted communications with said storage device; and

As discussed, Wolf teaches or renders obvious the claimed function of this element. *Supra* 1[a]-1[b]. As for the corresponding structure, the '832 patent's specification describes a general purpose computer executing software and/or firmware that carries out an algorithm for at least one of:

- Comparing intercepted communications to a known or predicted failure of the storage device,
- Deriving a performance threshold,
- Comparing intercepted communications to the performance threshold, and
- Determining and analyzing an access location and at least one of an access frequency or access duration for at least some data on the storage device.

FEDEX-1001, 3:59-4:3, 5:34-37, 6:3-36, 7:5-13, 8:8-37, 10:38-41, 10:62-64, Figure 7, Figure 8; FEDEX-1003, ¶91.

Like the '832 patent, Wolf explains that the disclosed storage device monitoring techniques can be implemented as “a computer program operating on a personal computer.” FEDEX-1004, 4:60-5:21 (explaining that the computer programs “are loaded into the random access memory” and “executed by the central processing unit”); *see also id.*, 5:22-37. Such computer programs include the disk-call interceptor (DCI), the disk-read timer (DRT), and the analysis program discussed above at 1[a]-1[b]. *Id.*, 6:26-56; FEDEX-1003, ¶92.

Moreover, as discussed at 1[b], Wolf teaches the same kind of algorithm described in the '832 patent in terms of comparing intercepted communications to a known or predicted failure of the storage device. FEDEX-1003, ¶93. For example, Wolf discloses that “when the operating system issues a call for a read operation containing one of those numbers of sectors stored in the table, a simple comparison can determine if a reasonable time has been taken for the read.” FEDEX-1004, 20:28-33; *see also id.*, 20:37-41 (defining a “reasonable time,” for example, as “no more than one standard deviation greater than the mean, or no more than fifty-percent greater than the mean”), 21:31-44.

Additionally, as discussed at 1[b] and claim 8, Wolf teaches the same kind of algorithm described in the '832 patent in terms of deriving a performance threshold and comparing intercepted communications to the performance threshold. FEDEX-1003, ¶94. For example, Wolf discloses deriving a table of acceptable times

(performance thresholds) from “several series of successive reads” of a number of sectors in the storage device “and logging in the table the average times for each of these read operations.” FEDEX-1004, 20:28-33. Subsequently, the above-referenced “simple comparison” is performed based on the performance threshold values populated in the table of acceptable times. *Id.*, 20:24-41.

22[b]. means for enhancing the performance of said storage device by reallocating at least some data on the storage device.

As discussed, Wolf teaches or renders obvious the claimed function of this element. *Supra* 1[c]. As for the corresponding structure, the '832 patent's specification describes a general purpose computer executing software and/or firmware capable of causing “the data stored [on the storage device to] be moved prior to a failure.” FEDEX-1001, 2:65-3:9. Because moving data from one place to another is a basic computer function, the corresponding structure is nothing more than a general purpose processor. *In re Katz Interactive Call Processing Patent Litigation*, 639 F.3d 1303, 1316 (Fed. Cir. 2011) (a patent need not disclose anything beyond “the general purpose processor” for basic functions like “processing,” “receiving,” and “storing” data); FEDEX-1003, ¶95. As discussed at 22[a], Wolf discloses a conventional computer with a CPU that executes program instructions to perform the disclosed storage device monitoring techniques. *Id.*

(t) Claim 23

23. An apparatus as in claim 22, further comprising means for intercepting communications with said storage device.

As discussed, Wolf teaches or renders obvious the claimed function of this claim. *Supra* 1[a]. As for the corresponding structure, the '832 patent's specification describes a "filter driver," which, as the '832 patent concedes, is a well-known type of driver software component. FEDEX-1001, 4:4-16, Figure 1; *see also* FEDEX-1003, ¶96 (citing FEDEX-1007, 3-4, 6; FEDEX-1008, 5 ("A filter driver can be inserted between a device driver and an intermediate driver, between an intermediate driver and a file system driver, or between the file system driver and the I/O Manager API to perform any kind of function that might be desired.")). The analysis at 1[a] establishes that Wolf discloses a disk-call interceptor (DCI) that interacts and shares memory blocks with a disk-read timer (DRT) to intercept communications. *Id.* A POSITA would have understood (or would have found obvious) that Wolf's device driver comprising the DCI and DRT is substantially equivalent to a filter driver. *Id.*

(u) Claim 24

24[p]-24[a]. An apparatus as in claim 22, further comprising means for measuring time to access said storage device,

As discussed, Wolf teaches or renders obvious the claimed function of this claim. *Supra* 1[a], claim 2. As for the corresponding structure, the '832 patent's specification describes a "filter driver," which, as the '832 patent concedes, is a well-

known type of driver software component, and a “timer.” FEDEX-1001, 4:4-16, 6:62-67, 7:66-8:1, 10:25-35, Figure 1, Figure 7; *see also* FEDEX-1003, ¶97 (citing FEDEX-1007, 3-4, 6; FEDEX-1008, 5). The analysis at 1[a] and claim 2, establishes that Wolf discloses a disk-call interceptor (DCI) that interacts and shares memory blocks with a disk-read timer (DRT) to intercept communications and measure access times. *Id.* It would have been apparent or obvious to a POSITA that Wolf’s device driver, comprising the DCI and DRT, provides a timer and is substantially equivalent to a filter driver. *Id.*

24[b]. wherein said measured access time is evaluated to determine the performance of said storage device.

Supra 1[a]-1[b], claim 2. FEDEX-1003, ¶98.

B. GROUND 2—Wolf in view of Kamiyama renders obvious claims 5-6, 10, and 26

1. Kamiyama

Kamiyama discloses calculating “access frequencies” of data stored on disks to distinguish “between frequently accessed data and rarely accessed data” for data relocation. FEDEX-1005, 2:52-56, 4:15-30, 5:3-11, 7:44-52, 8:54-63. In Kamiyama, “[m]anagement of data such as access frequency data is performed by using a data management table shown in, e.g., FIG.8.” *Id.*, 7:19-43. The data management table includes a label, “access frequency,” as illustrated in Figure 8 (below) and discussed throughout Kamiyama. When “a data read command is received,” “the data is read

out from the corresponding medium” from the location indicated in the data management table, and “the access frequency associated with the readout data in the management table is updated.” *Id.*, 8:8-17; FEDEX-1003, ¶103.

Notably, Kamiyama uses the term “access frequency” more broadly than the ’832 patent’s claims. In Kamiyama, “access frequency” encompasses multiple distinct metrics, including “the number of times of access per unit time” (the claimed **access frequency**) and “the time differen[ce] between the latest access time point and the current time point” (the claimed **access duration**), which may be considered in analyzing whether to reallocate data. FEDEX-1005, 7:19-25, Figure 8; FEDEX-1003, ¶104.

TOTAL DATA COUNT					
TOTAL DATA BYTE COUNT					
DATA ID	DATA SIZE	ACCESS FREQUENCY	CHANGE FLAG		STORAGE MEDIUM (LOCATION)
		21		22	23

F I G. 8

FEDEX-1005, Figure 8

2. Combination of Wolf and Kamiyama

As discussed above for 1[a]/25[a], Wolf's disk-call interceptor (DCI) is placed "in the operating system's disk call chain so that the disk-call interceptor is invoked for each disk operation" "to obtain the status information concerning the disk-read operations." FEDEX-1004, 7:38-49, 18:26-56. As discussed above in 1[b]/25[b], Wolf discloses that the DCI gathers "data transfer time measurements" from the intercepted communications. *Id.*, 6:65-7:11, 15:51-16:14, 17:56-20:50. Wolf also discloses that the analysis program "analyzes the historical data to determine whether there are any areas of the storage medium that are unable to store data with integrity or are tending to lose the ability to store data with integrity." *Id.*, 3:40-46. Specifically, the analysis program "take[s] the events recorded by the disk-call interceptor on the log file, build[s] and maintain[s] a history of such events sorted by disk unit areas, such as sectors, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective." *Id.*, 7:12-25, 16:56-17:55. "The analysis program determines on the basis of the historical data whether any disk areas are defective to the point where they should be designated to the operating system as unusable, and the data relocated." *Id.*, 17:4-7, 20:42-50. Based on Wolf's disclosure, a POSITA would have understood that

Wolf determines the disk unit area, *e.g.*, sector and the data transfer time based on the intercepted events. FEDEX-1003, ¶105.

A POSITA would have found it obvious to implement Wolf's system to also determine the access frequency and access duration of data in the sector based on intercepted data read commands and relocate the data based on the access frequency and/or access duration, as suggested by Kamiyama. FEDEX-1005, 2:52-56, 4:15-30, 5:3-11, 7:10-12, 7:19-52, 8:8-17, 8:54-63, Figure 8; FEDEX-1003, ¶105. Doing so merely combines known prior art elements according to known methods to yield predictable results. FEDEX-1003, ¶112. In addition, this combination would have been obvious because it applies a known technique (Kamiyama's determinations of access frequency and access duration of data and relocation of data based on access frequency and access duration) to a known device (Wolf's system) that is ready for improvement, to yield predictable results, especially since Kamiyama's functionalities were designed precisely for the purpose of analyzing and improving accesses to a storage medium. *Id.* Multiple independent reasons would have motivated a POSITA to implement Wolf based on Kamiyama's suggestions. FEDEX-1003, ¶106.

First, Wolf's teachings and suggestions pertain to relocating data based on analyses of historical data relating to intercepted data read commands. FEDEX-1004, 3:40-46, 6:65-7:25, 7:38-49, 15:51-16:14, 16:56-20:50. A POSITA of

“ordinary creativity” therefore would have been motivated to incorporate Kamiyama’s functionalities (*e.g.*, determining access frequency and access duration and relocating data accordingly) into Wolf’s system that relocates data based on an analysis of historical data relating to intercepted data read events to attain expected benefits. FEDEX-1003, ¶107; *KSR Int’l Co. v. Teleflex, Inc.*, 550 U.S. 398, 405 (2007) (“If a person of ordinary skill in the art can implement a predictable variation, and would see the benefit of doing so, § 103 likely bars its patentability.”); *see also id.*, 418, 421.

For example, Wolf makes clear its intent to provide a system for determining “on the basis of the historical data” whether any data needs to be “relocated.” FEDEX-1004, 17:4-7, 20:42-50. Additionally, Wolf explains that analyzing historical data is beneficial in that it indicates “the occurrence of any difficulty in retrieving data.” FEDEX-1004, 1:15-20. Wolf thus broadly describes the notion of analyzing historical data, which a POSITA would have understood to implicate a wide variety of historical data useful for determining whether data stored on the storage device needs to be relocated. FEDEX-1003, ¶108 (citing FEDEX-1009, 324-325; FEDEX-1012, 2, 8; FEDEX-1013, 119-121). For example, a POSITA would have understood that both access frequency and access duration for a given set of data are useful metrics in evaluating the performance degradation of the portion of a storage device storing said data. *Id.* Therefore, a POSITA would have been

motivated to incorporate determinations of access frequency and access duration to more fulsomely evaluate how close a sector of a storage device is to failure. *Id.* Thus, Wolf's suggestion of analyzing historical data would have prompted a POSITA to pursue references, like Kamiyama, that also analyze historical data in the form of access frequency and access duration to determine whether to relocate data. *Id.*; FEDEX-1005, 2:52-56, 4:15-30, 5:3-11, 7:10-12, 7:19-52, 8:8-17, 8:54-63, Fig. 8.

Second, a POSITA would have pursued integration of Kamiyama's teachings with Wolf to obtain the added functionality of relocating data based on access frequency and access duration, and its concomitant advantages. FEDEX-1003, ¶109. As detailed by Kamiyama, "it is desirable that data, mainly frequently accessed data, be distributed and stored in the respective media, and the access frequencies of the respective media be equalized. Therefore, new data need to be stored on the basis of equalization of stored data amounts. In addition, when the access frequencies of some of the respective media unevenly increase as time elapse, migration of data needs to be performed to equalize the access frequencies." FEDEX-1005, 4:52-61. Based on Kamiyama's teachings to "equalize the access frequencies," a POSITA would have been motivated to implement Wolf to further reallocate data across sectors of the storage device based on access frequency and access duration to evenly distribute wear across the storage media. FEDEX-1003, ¶109.

Third, a POSITA also would have been motivated to implement Wolf's storage medium as "a disk array for parallel processing to achieve high performance" with storage media that "can be simultaneously accessed" based on Kamiyama's teachings. FEDEX-1005, 1:39-45, 3:64-67. Kamiyama explains that in "performing parallel processing with respect to a plurality of media, the total access time can be shortened by performing distributed storage of frequently accessed data in a plurality of media, instead of performing centralized storage of the frequently accessed data in one medium to cause centralization of access thereto. As frequently accessed data increases in amount, the effect of this parallel processing improves." *Id.*, 4:39-46. Kamiyama further explains that "the frequently accessed data are distributed and stored in the respective media to prevent centralization of access to one medium." *Id.*, 7:10-12; FEDEX-1003, ¶¶110-111.

Fourth, a POSITA would have understood that implementing Kamiyama's teachings discussed above in Wolf's system would have yielded a predictable result from combining known prior art elements according to known methods. FEDEX-1003, ¶112; *KSR*, 550 U.S. at 416. Wolf and Kamiyama describe similar systems that provide similar functionality for a similar purpose. FEDEX-1003, ¶112. The proposed combination of implementing Kamiyama's access frequency and access duration analyses, and data relocation based on such metrics, with Wolf's system does not change the key aspects of either reference. *Id.* The crux of the combination

simply involves adding functionality to Wolf's system based on access frequency and access duration. *Id.* The respective teachings would work in combination just as they did apart. *Id.* And it would have been well within the POSITA's skill level skill to implement such a combination. *Id.* For these same reasons, a POSITA would have had a reasonable expectation of success in achieving the Wolf-Kamiyama combination. *Id.*

3. Claim Element Analysis

(a) Claim 5

5. A method as in claim 1, further comprising determining an access location on said storage device and an access frequency for data stored thereon, based on said intercepted communications.

As discussed above in §III.B.2, Wolf determines the disk unit area, e.g., sector **(an access location on said storage device)** and the data transfer time based on the intercepted events **(intercepted communications)**. *See, e.g.*, FEDEX-1004, 6:65-7:25, 15:51-16:14, 16:56-20:50. A POSITA would have found it obvious to implement Wolf's system to also determine access frequency, as suggested by Kamiyama. FEDEX-1003, ¶113.

Kamiyama discloses calculating "access frequencies" of data stored on disks (e.g., "the number of times of access per unit time") **(determining an access frequency for data stored thereon)** to distinguish "between frequently accessed data and rarely accessed data" for data relocation. FEDEX-1005, 2:52-56, 4:15-30,

5:3-11, 7:19-25, 7:44-52, 8:54-63. In Kamiyama, “[m]anagement of data such as access frequency data is performed by using a data management table shown in, e.g., FIG. 8.” *Id.*, 7:19-43. When “a data read command is received,” “the data is read out from the corresponding medium” from the location indicated in the data management table, and “the access frequency associated with the readout data in the management table is updated.” *Id.*, 8:8-17. As shown in Figure 8 below, Kamiyama’s management table stores access frequency and access location for received data read commands. FEDEX-1003, ¶114.

TOTAL DATA COUNT		access frequency	access location			
TOTAL DATA BYTE COUNT						
DATA ID	DATA SIZE	ACCESS FREQUENCY	CHANGE FLAG			STORAGE MEDIUM (LOCATION)
		21		22		23

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FEDEX-1005, Figure 8

As discussed above in §III.B.2, a POSITA would have found it obvious to modify Wolf based on Kamiyama's teachings to provide a system that determines the disk unit area, *e.g.*, sector (**an access location on said storage device**) and an **access frequency** for the data based on intercepted data read commands (**intercepted communications**). FEDEX-1003, ¶115.

(b) Claim 6

6. A method as in claim 1, further comprising determining an access location on said storage device and an access duration for data stored thereon, based on said intercepted communications.

As discussed above in 1[a]/25[a], Wolf's disk-call interceptor (DCI) is placed "in the operating system's disk call chain so that the disk-call interceptor is invoked for each disk operation" "to obtain the status information concerning the disk-read operations." FEDEX-1004, 6:57-7:11, 7:38-49, 18:26-56. Wolf also teaches that the DCI gathers "data transfer time measurements" from the intercepted communications. *Id.*, 6:65-7:11, 15:51-16:14, 17:56-20:50. Wolf's analysis program "take[s] the events recorded by the disk-call interceptor on the log bile, build[s] and maintain[s] a history of such events sorted by disk unit areas, such as sectors, appl[ies] certain algorithms to the historical data, take[s] remedial measures and/or communicate[s] with a computer operator whenever application of the algorithms to the historical data indicates a failure mode, an unknown defective area or an area that has become marginally defective." *Id.*, 7:12-25, 16:56-17:55, 17:4-7, 20:42-50.

Thus, Wolf determines the disk unit area, *e.g.*, sector (**an access location on said storage device**) and the data transfer time based on the intercepted events (**intercepted communications**). FEDEX-1003, ¶116. While Wolf does not explicitly describe determining an access duration and access frequency, a POSITA would have found it obvious to implement Wolf's system to also determine access duration and access frequency, as suggested by Kamiyama. *Id.*

Kamiyama teaches determining, in a "data management table," one of a number of metrics (collectively labeled "access frequency"). FEDEX-1005, 7:19-25, Figure 8. As discussed, this label is broader than the claimed "access frequency," and in fact encompasses multiple distinct metrics, including "the number of times of access per unit time" (**access frequency**) and "the time different between the latest access time point and the current time point" (**access duration**), which may be considered in analyzing whether to reallocate data. *Id.*, 7:19-25, Figure 8; FEDEX-1003, ¶117. It would have been obvious to a POSITA in view of Kamiyama, that both access frequency and access duration could be determined in assessing whether to reallocate data. *Id.* For example, Kamiyama describes reallocating data according to the metrics described above. *See, e.g.*, FEDEX-1005, 4:39-46, 7:10-12.

As discussed above in §III.B.2, a POSITA would have found it obvious to modify Wolf based on Kamiyama's teachings to provide a system that determines the disk unit area, *e.g.*, sector (**an access location on said storage device**) and an

access duration and an **access frequency** for the data based on intercepted data read commands (**intercepted communications**). FEDEX-1003, ¶118.

(c) **Claim 10**

10. A method as in claim 1, wherein reallocating at least some data on said storage device is based on usage patterns of said data.

As discussed above in §III.B.2 and for claim 10 in Ground 1, Wolf’s “analysis program determines on the basis of the historical data whether any disk areas are defective to the point where they should be designated to the operating system as unusable, and the data relocated.” FEDEX-1004, 17:4-7, 20:42-50. As discussed above in §III.B.2 and for claim 5, a POSITA would have found it obvious to modify Wolf based on Kamiyama’s teachings to provide a system that determines the access frequency (**usage patterns**) for the data based on intercepted data read commands (**intercepted communications**). FEDEX-1003, ¶119.

Kamiyama further discloses that “the frequently accessed data are distributed and stored in the respective media to prevent centralization of access.” FEDEX-1005, 7:10-12. As discussed above in §III.B.2, a POSITA would have found it obvious to modify Wolf based on Kamiyama’s teachings to determine access frequency (**usage patterns**) of data in the sector based on intercepted data read commands and relocate the data based on the access frequency (**reallocating data on the storage device based on usage patterns of the data**), as suggested by

Kamiyama. *Id.*, 2:52-56, 4:15-30, 5:3-11, 7:10-12, 7:19-52, 8:8-17, 8:54-63, Figure 8; FEDEX-1003, ¶120.

(d) Claim 26

26. A method as in claim 25, wherein intercepting said communications comprises determining access location, access frequency, and access duration for said data on said storage device.

Supra claim 6. FEDEX-1003, ¶121.

C. GROUND 3—Wolf in view of Woods renders obvious claims 9 and 11-21

1. Woods

Woods relates to “data storage management.” FEDEX-1006, 2:7-15. Woods teaches managing storage through the use of a processing element 301 which integrates “backup” and “hierarchical storage management” functionality, among others. *Id.*, 7:14-57, Figure 3. Woods teaches that “[e]xisting hierarchical storage management and live data backup systems must intrusively take over part of the operating system to allow them to intercept the data file storage and data file archival requests from the application programs.” *Id.*, 6:30-63, Figure 2A (showing prior art hierarchical storage management software 201 and backup software 202 interposed between application programs 101-103 and operating system 105). Its invention overcomes the prior art’s deficiencies by intercepting communications to the storage device using the processing element 301, which is situated closer to the storage device. *Id.*, 6:30-63, 7:14-57; FEDEX-1003, ¶122. For example, Woods teaches that

the “block based data storage subsystem 300,” illustrated in Figure 3 as comprising the processing element 301, “simply replaces the disk drives 111-113 attached to the computer system 100 in a transparent manner with the multitude of data storage devices 310-319,” and “[t]he processing element 301 is interconnected via bus 302 with a plurality of device interface electronics elements 303-305, each of which serves to interface a plurality of the data storage devices.” FEDEX-1006, 7:21-38.⁴

Woods describes an “allocation algorithm” associated with “an array of virtual devices,” also referred to as a “layer.” FEDEX-1006, 13:5-16. “The allocation algorithm is used to allocate storage locations when performing migration. Depending on the type of virtual devices and the location of the virtual device in the storage hierarchy, several allocation algorithms are possible. Another consideration in the allocation algorithm is the number of fragments in the layer. As data is demigrated from a layer, it leaves unused storage locations. These locations must be tracked to know how much physical storage space is actually used.” *Id.*, 13:27-36.

⁴ This explanation in Woods is similar to Wolf’s teaching to position its disk-call interceptor in an “advanced” position closer to the storage device (*e.g.*, as illustrated in Figure 9). By doing so, its “monitoring and logging is transparent to normal operations of the computer system and does not interfere with normal computer operations.” FEDEX-1004, 3:37-39, 19:67-20:23, Figure 9; FEDEX-1003, ¶122.

“The algorithms associated with virtual devices track the number of reads, writes, access sizes and how often an access had to wait for a physical device to be free to get access to the data. These statistics indicate the efficiency of the virtual device. If the statistics indicate that the algorithms are not working, this can be flagged as a performance hindering condition.” *Id.*, 14:26-32, 13:52-60. Thus, like Wolf, Woods monitors the performance of a storage device. FEDEX-1003, ¶123.

The algorithms Woods describes include an “Intra Layer Defragmentation” algorithm “to free more data storage locations in the layer.” FEDEX-1006, 18:32-38, 18:46-53. The algorithm runs “whenever the low watermark for available segments is hit on one of the data storage layers and idle time exists.” *Id.* at 18:33-36. Woods explains that “[f]ragmentation occurs whenever data is demigrated to cache 406 and then not migrated back to the same data storage location in the originating layer. This leaves the old location unused and leaves a gap in the sequence of segments.” *Id.*, 18:39-43. “The number of used segments is tracked and the distance between the tail pointer is also readily calculated. In a layer with no fragments, the number of used segments and the distance between the head and the tail pointers add up to the total number of segments on the layer. The difference between the used and the head and tail calculation identify the number of fragments in this layer. If the number of fragments exceed a certain percentage, a defragmentation operation is in order.” *Id.*, 18:53-61. Woods discloses an exemplary

method for defragmentation where data in a present layer with excessive fragments is migrated to the next layer. *Id.*, 18:39-19:39, Figure 14; FEDEX-1003, ¶124.

The algorithms also include “data backup” algorithms performed “as a scheduled event.” FEDEX-1006, 19:39-20:44. “For a full backup process, this process backs up every valid segment in the data storage subsystem. If the backup process is an incremental backup, then only the changed blocks, not previously backed up are processed.” *Id.*, 19:55-58; FEDEX-1003, ¶125.

2. Combination of Wolf and Woods

As discussed above in 1[c]/25[c], Wolf discloses responding to a failure mode, an unknown defective area, or an area that has become marginally defective (a decline in the performance) of the storage device based on the analyzed intercepted communications by automatically reallocating at least some data on the storage device to enhance the performance and continued operation of the storage device. FEDEX-1004, 3:47-53, 6:65-7:25, 15:51-16:14, 16:56-20:50, 21:31-44; FEDEX-1003, ¶126. Wolf also discloses that “the historical pattern of errors may be analyzed by an expert system which is part of the analysis program. The expert system determines whether the current pattern of errors indicates a potential catastrophic failure of the disk drive. For example, significant numbers of errors near the inner radius of the storage surface may indicate a fault in the read/write system, while significant numbers of errors near the outer radius of the storage surface may indicate

imminent spindle bearing failure. Failures in these systems would be catastrophic, if they occurred with no warning. However, they are problems which generally cannot be fixed by the computer owner or user. Therefore, a warning is issued to the user, so that appropriate action may be taken, **such as backing up the entire hard disk** and taking the machine to a repair facility, where the hard disk might be replaced.” FEDEX-1004, 17:39-55 (emphasis added).

Although Wolf does not explicitly disclose automatically backing-up the drive, a POSITA would have found it obvious to implement Wolf’s system to automatically back-up data, as suggested by Woods, in response to a potential failure. FEDEX-1006, 19:39-20:44; FEDEX-1003, ¶127. Further, a POSITA would have found it obvious to implement Wolf’s system to monitor fragmentation and perform a defragmentation operation to reallocate some of the data on the storage device in response to a decline in efficiency and performance of the storage device, as suggested by Woods. FEDEX-1006, 14:26-32, 13:52-60, 18:32-61; FEDEX-1003, ¶127. This combines the prior art elements according to known methods to yield the predictable results taught by Wolf and Woods. FEDEX-1003, ¶132. In addition, this would have been obvious because it applies a known technique (Woods’ automatic data backup and defragmentation operation) to a known device (Wolf’s system) that is ready for improvement, to yield predictable results, especially since Woods’ functionalities were designed precisely for the purpose of

improving efficiency and performance of a storage medium. *Id.*; FEDEX-1006, 14:26-32, 13:52-60. Multiple independent reasons would have motivated a POSITA to implement Wolf based on Woods' suggestions. FEDEX-1003, ¶128.

First, Wolf's teachings and suggestions pertain to responding to a failure mode, an unknown defective area, or an area that has become marginally defective (a decline in the performance) of the storage device by automatically reallocating data. FEDEX-1004, 3:47-53, 6:65-7:25, 15:51-16:14, 16:56-20:50, 21:31-44. Wolf also teaches a user responding to a potential failure of the disk drive based on a warning issued to the user by backing up the disk drive. *Id.*, 17:39-55. A POSITA of "ordinary creativity" therefore would have been motivated to pursue the predictable upgrade of incorporating Woods' functionalities (*e.g.*, automatically backing up and defragmenting data in response to a decline in efficiency and performance of the storage device) with Wolf's system that relocates data in response to a decline in the performance or potential failure, in order to attain expected benefits. FEDEX-1003, ¶129 (citing FEDEX-1009, 310; FEDEX-1010, 26); *KSR*, 550 U.S. at 405 ("If a person of ordinary skill in the art can implement a predictable variation, and would see the benefit of doing so, § 103 likely bars its patentability."), 418, 421.

For example, Wolf makes clear its intent is to provide a system for responding to a decline in the performance or potential failure of the storage device. FEDEX-1004, 3:47-53, 6:65-7:25, 15:51-16:14, 16:56-20:50, 21:31-44. Additionally, Wolf

explains “[f]ailures in these systems would be catastrophic, if they occurred with no warning.” *Id.*, 17:39-55. Wolf thus broadly describes the importance of responding to a decline in the performance or potential failure of the storage device. FEDEX-1003, ¶130. Wolf’s suggestion of responding to a decline in the performance or potential failure of the storage device would have prompted a POSITA to pursue references, like Woods, that also respond to a decline in efficiency and performance of the storage device. *Id.*; FEDEX-1006, 14:26-32, 13:52-60, 18:32-61.

Second, a POSITA would have pursued integration of Woods’ teachings with Wolf to obtain the added defragmentation functionality and its concomitant advantages. FEDEX-1003, ¶131. As detailed by Woods, “[f]ragmentation occurs whenever data is demigrated to cache 406 and then not migrated back to the same data storage location in the originating layer. This leaves the old location unused and leaves a gap in the sequence of segments.” FEDEX-1006, 18:39-43. Woods’ algorithms include an “Intra Layer Defragmentation” algorithm “to free more data storage locations in the layer.” *Id.*, 18:32-38, 18:46-53. “The algorithms associated with virtual devices track the number of reads, writes, access sizes and how often an access had to wait for a physical device to be free to get access to the data. These statistics indicate the efficiency of the virtual device. If the statistics indicate that the algorithms are not working, this can be flagged as a performance hindering condition.” *Id.*, 14:26-32, 13:52-60. Based on Woods’ teachings, a POSITA would

have been motivated to implement Wolf to monitor fragmentation, and perform a defragmentation operation to reallocate some of the data on the storage device in response to a decline in efficiency and performance of the storage device and to free more data storage locations. *Id.*, 14:26-32, 13:52-60, 18:32-61; FEDEX-1003, ¶131.

Third, a POSITA would have understood that implementing Woods' teachings discussed above in Wolf's system would have yielded a predictable result from combining known prior art elements according to known methods. FEDEX-1003, ¶132; *KSR*, 550 U.S. at 416. Wolf and Woods describe similar systems that provide similar functionality for a similar purpose. FEDEX-1003, ¶132. The proposed combination of implementing Woods' automatic data back up and defragmentation with Wolf's system does not change the key aspects of either reference. *Id.* The crux of the combination simply involves adding functionality to respond to a decline in efficiency and performance of the storage device and to free more data storage locations. *Id.* The respective teachings would work in combination just as they did apart. *Id.* And it would have been well within the POSITA's skill level skill to implement such a combination. *Id.* For these reasons, a POSITA would have had a reasonable expectation of success in achieving the Wolf-Woods combination. *Id.*

3. Claim Element Analysis

(a) Claim 9

9. A method as in claim 1, wherein responding to said declining performance of said storage device further comprises automatically backing-up data stored on said storage device.

As explained for claim 9 in Ground 1, Wolf teaches a user responding to a warning regarding a potential failure of the disk drive by backing up its data, but does not explicitly disclose automatically backing-up the drive. FEDEX-1004, 17:39-55. A POSITA would have found it obvious to implement Wolf's system to **automatically back-up data**, as suggested by Woods, in response to a potential failure (**decline in performance**). FEDEX-1006, 19:39-20:44; FEDEX-1003, ¶133. For example, Woods teaches performing an "incremental backup" of "changed blocks" (*e.g.*, blocks changed through a defragmentation operation in response to crossing a performance threshold). FEDEX-1006, 18:32-19:38, 19:39-58.

(b) Claim 11

11. A method as in claim 1, wherein responding to said declining performance of said storage device further comprises defragmenting at least a portion of said storage device.

As discussed above in §III.C.2, a POSITA would have found it obvious to implement Wolf's system to perform a **defragmentation** operation to reallocate some of the data on the storage device in response to a **decline in efficiency and**

performance of the storage device, as suggested by Woods. FEDEX-1006, 14:26-32, 13:52-60, 18:32-19:38; FEDEX-1003, ¶134.

(c) Claim 12

12[p]. An apparatus for monitoring performance of a storage device, comprising:

Supra 1[p]. FEDEX-1003, ¶135.

12[a]. computer readable storage media;

Supra 1[p]. FEDEX-1003, ¶136.

12[b]. computer readable program code stored on said computer readable storage media, comprising:

Supra 1[p]. FEDEX-1003, ¶137.

12[c]. a) program code for intercepting communications between a computer system and said storage device;

Supra 1[p], 1[a]. FEDEX-1003, ¶138.

12[d]. b) program code for analyzing said communications, wherein said communications are compared to a predicted decline in performance of said storage device; and

Supra Ground 1, 12[d]. FEDEX-1003, ¶139.

12[e]. c) program code for responding to a decline in the performance of said storage device by backing up at least some data on said storage device prior to said predicted failure of said storage device to enhance continued operation of said storage device.

Supra §III.C.2 and Ground 3, claim 9. FEDEX-1003, ¶140.

(d) Claim 13

13. An apparatus as in claim 12, wherein said program code for intercepting said communications comprises program code for intercepting an error reported by said storage device.

Supra claim 4. FEDEX-1003, ¶141.

(e) Claim 14

14. An apparatus as in claim 12, further comprising program code for measuring access time for said storage device, and wherein said communications comprises at least said access time.

Supra claim 2. FEDEX-1003, ¶142.

(f) Claim 15

15. An apparatus as in claim 14, further comprising: a) program code for determining system overhead; and b) program code for correcting said access time for said system overhead.

Supra claim 3. FEDEX-1003, ¶143.

(g) Claim 16

16. An apparatus as in claim 12, wherein said program code for responding to said decline in the performance of said storage device further comprises defragmenting at least a portion of said storage device based on said communications.

Supra claim 11. FEDEX-1003, ¶144.

(h) Claim 17

17[a]. An apparatus as in claim 12, further comprising: a communications log;

Supra claim 7. FEDEX-1003, ¶145.

17[b]. program code for logging said communications over time in said communications log; and

Supra claim 7. FEDEX-1003, ¶146.

17[c]. program code for determining the decline in performance of said storage device based at least in part on said logged communications.

Supra 1[b]/25[b] and 12[d]. FEDEX-1003, ¶147.

(i) Claim 18

18. An apparatus as in claim 12, further comprising program code for deriving a threshold value for the performance of said storage device, wherein said program code for responding to said decline in the performance of said storage device responds when the performance of said storage device satisfies said threshold value thereof.

Supra 1[b]/25[b], 1[c]/25[c], and claim 8. FEDEX-1003, ¶148.

(j) Claim 19

19. An apparatus as in claim 12, wherein said program code for responding further comprises program code for reallocating data to another sector of said storage device.

Supra Ground 1, claim 19. FEDEX-1003, ¶149.

(k) Claim 20

20. An apparatus as in claim 19, wherein said program code for reallocating reallocates at least some data on said storage device based on usage patterns of said at least some data.

Supra Ground 1, claim 10. FEDEX-1003, ¶150.

(I) Claim 21

21. An apparatus as in claim 12, further comprising a graphical user interface for reporting the performance of said storage device to a user.

Wolf discloses “a warning is issued to the user, so that appropriate action may be taken, such as backing up the entire hard disk and taking the machine to a repair facility, where the hard disk might be replaced.” FEDEX-1004, 17:39-55. A POSITA would have understood that the issued warning would have been presented to a user through a graphical user interface. FEDEX-1003, ¶151. Additionally, a POSITA would have found it obvious to include a **user interface** in Wolf’s system for issuing the warning (**reporting the performance**) to the user so that the user may take appropriate action, as was well known at the time of the ’832 patent. *Id.*

For example, Woods describes a data management system that includes a “user interface.” FEDEX-1006, 9:36-39, 10:4-7, 10:65-11:3, 11:61-64, Figure 6 (user interface 616). Woods discloses that “the user has the option of selecting a host ID” and that the CPU “obtains data from the user indicative of the cost/performance weighting information” and “determined the present capacity on a layer basis and has created the set of recommendations for the user, which information is displayed to the user.” *Id.*, 20:49-51, 20:67-21:2, 23:1-4, 23:22-25. Woods further discloses “a routine is called to interface to the user to determine how to deal with unrecoverable blocks.” *Id.*, 23:61-62. Woods illustrates a networked data management system

including display devices for displaying the user interface. *Id.*, Figure 5; FEDEX-1003, ¶152.

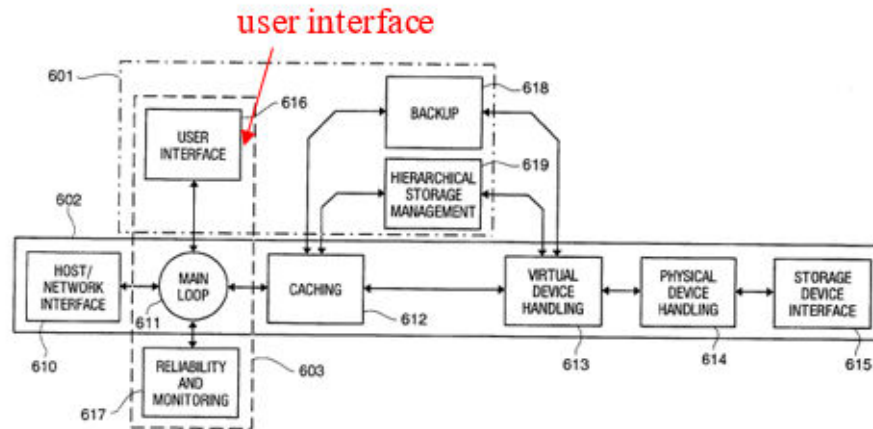


FIG. 6

FEDEX-1006, Figure 6

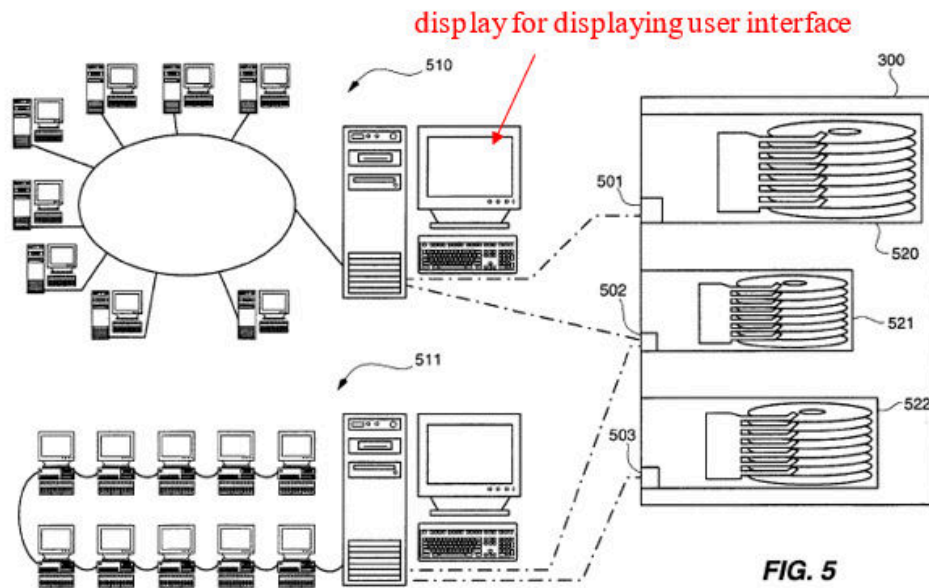


FIG. 5

FEDEX-1006, Figure 5

Further, a POSITA would have found it obvious to implement the Wolf-Woods' user interface as a graphical user interface to provide an intuitive and user-friendly interface for the user to interact with the computer system. FEDEX-1003, ¶153.

IV. PAYMENT OF FEES – 37 C.F.R. §42.103

Petitioners authorize the Patent and Trademark Office to charge any fees to Deposit Account No. 06-1050.

V. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Petitioners, FedEx Corporation and FedEx Office and Print Services, Inc., are the real parties-in-interest. Additionally, even though Petitioners do not believe that these additional entities are real parties-in-interest, Petitioners further identify Federal Express Corporation and FedEx Dataworks in the interest of completeness.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

Petitioners are not aware of any disclaimers, reexamination certificates, or petitions for *inter partes* review for the '832 patent. The '832 patent is the subject of the following civil actions: *Valtrus Innovations Ltd. et al v. FedEx Corporation et al*, 2-25-cv-00516 (EDTX), filed May 9, 2025; *Valtrus Innovations Ltd. et al v. NetApp, Inc.*, 2-25-cv-00517 (EDTX), filed May 9, 2025; *NetApp, Inc. v. Valtrus Innovations Ltd. et al*, 1-25-cv-06138 (SDNY), filed July 25, 2025; *Valtrus*

Innovations Ltd. et al v. The Home Depot, Inc. et al, 2-25-cv-00081 (EDTX), filed January 27, 2025; *Valtrus Innovations Ltd. et al v. Lenovo Group Limited et al*, 2-25-cv-00080 (EDTX), filed January 27, 2025.

C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Lead Counsel	Backup Counsel
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D. Service Information

Please address correspondence/service to the above-listed address. Petitioners consent to email service at IPR39898-0052IP1@fr.com.

Respectfully submitted,

Dated August 29, 2025

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Attorneys for Petitioners

CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 12,996 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated August 29, 2025

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on August 29, 2025, a complete and entire copy of this Petition for *Inter Partes* Review, Power of Attorney, and all supporting exhibits were provided via Priority Express Mail, to the Patent Owner, by serving the correspondence address of record as follows:

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