IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Baek et al.
U.S. Patent No.: 6,978,346 Attorney Docket No.: 47415.538
Issue Date: December 20, 2005 IPR2015-______
Appl. Serial No.: 09/753,245
Filing Date: December 29, 2000
Title: APPARATUS FOR REDUNDANT INTERCONNECTION BETWEEN MULTIPLE HOSTS AND RAID

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PETITION FOR INTER PARTES REVIEW OF UNITED STATES PATENT NO. 6,978,346 PURSUANT TO 35 U.S.C. §§ 311-319, 37 C.F.R. § 42
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PETITIONERS’ EXHIBITS LIST (January 8, 2015)

VMWARE-1001: U.S. Patent No. 6,978,346 to Baek et al., foreign application priority date 9/19/2000 (“the ’346 patent”);

VMWARE-1002: Excerpts from the Prosecution History of the ’346 Patent;

VMWARE-1003: Expert Declaration of Dr. Robert Horst;

VMWARE-1004: Dr. Robert Horst Curriculum Vitae;


VMWARE-1007: U.S. Patent No. 6,401,170 to Griffith et al., filed on 8/18/1999 (“Griffith”);

VMWARE-1008: U.S. Patent No. 6,578,158 to Deitz et al., filed on 10/28/1999 (“Deitz”);

VMWARE-1009: Affidavit of Mr. Chris Butler, on behalf of Internet Archive;

VMWARE-1010: U.S. Patent No. 6,073,218 to DeKoning et al., filed on 12/23/1996 (“DeKoning”);

VMWARE-1011: Clark, “Designing Storage Area Networks,” 1st Edition, Addison-Wesley Professional (1999);


This petition is substantively identical to the petition submitted in IPR2014-00901 (instituted) and has identical exhibits. Petitioners request that this petition be instituted, but only as to the same ground of unpatentability that was instituted in that proceeding, namely claims 1-9 being obvious under 35 U.S.C. § 103 over Mylex and Hathorn. See Institution Decision of December 11, 2014 (IPR2014-00901). This Petition is accompanied by a Motion for Joinder to that IPR.

I. 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)

The real parties-in-interest are Dell Inc., Hewlett-Packard Company, and NetApp, Inc.

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

Petitioners for Inter Partes Review of U.S. Patent No. 6,978,346

00926; 1-12-cv-01629; 1-12-cv-01625; 1-12-cv-01627; 1-12-cv-01624; 1-12-cv-01628; and 1-12-cv-01626.

The ’346 patent is also the subject of IPR No. IPR2013-00635 (instituted), IPR2014-00152 (not instituted), IPR2014-00901 (instituted) IPR2014-00949 (instituted) and IPR2014-00976 (not instituted). This petition is substantively the same as the ones filed in cases IPR2014-00901 and -00949 and is accompanied by a Motion for Joinder to IPR2014-00901.

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

Petitioners provide the following designation of counsel.

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<thead>
<tr>
<th>Lead Counsel</th>
<th>Back-up Counsel</th>
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<tr>
<td>USPTO Reg. No. 32,271</td>
<td>USPTO Reg. No. 54,214</td>
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</table>
D. Service Information

Please address all correspondence and service to counsel at the addresses provided in Section I(C) of this petition. Petitioners also consent to electronic service by email at david.mccombs.ipr@haynesboone.com, Thomas.kelton.ipr@haynesboone.com, and Russ.emerson.ipr@haynesboone.com.

II. PAYMENT OF FEES UNDER 37 C.F.R. § 42.103

Petitioners authorize the Patent and Trademark Office to charge Deposit Account No. 08-1394 for the fee set forth in 37 C.F.R. § 42.15 (a) for this petition and further authorizes payment for any additional fees to be charged to this Deposit Account.

III. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing Under 37 C.F.R. § 42.104

Petitioners certify that the ’346 Patent is eligible for IPR. Petitioners are not barred or estopped from requesting this review challenging the Challenged Claims on the below-identified grounds. Specifically, this petition is filed within one
month of the decision instituting IPR2014-00901 and is accompanied by a Motion for Joinder under 37 C.F.R. § 42.122(b).

**B. Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested**

Petitioners request an IPR of the Challenged Claims on Ground 1 set forth in the table shown below, and request that each of the Challenged Claims be found unpatentable. An explanation of how these claims are unpatentable under the statutory grounds identified below is provided in the form of a detailed description that indicates where each element can be found in the cited prior art, and the relevance of that prior art. Additional explanation and support for each ground of rejection is set forth in Exhibit VMWARE-1003, the Declaration of Dr. Robert Horst (“Horst Declaration”), referenced throughout this petition.

<table>
<thead>
<tr>
<th>Ground</th>
<th>’346 Patent Claims</th>
<th>Basis for Rejections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground 1</td>
<td>Claims 1-9</td>
<td>Obvious under §103 based on Mylex in view of Hathorn</td>
</tr>
<tr>
<td>Ground 2</td>
<td>Claims 1-9</td>
<td>Obvious under §103 based on Hathorn in view of Mylex</td>
</tr>
<tr>
<td>Ground 3</td>
<td>Claims 1-9</td>
<td>Obvious under §103 based on Deitz or Mylex in view of Griffith or DeKoning</td>
</tr>
</tbody>
</table>

The Hathorn patent (Ex. 1005) issued on 11/12/1996 and thus qualifies as prior art under 35 U.S.C. §§ 102(a) and (b). The Mylex paper (Ex. 1006) was publicly distributed no later than 5/29/1998 and thus qualifies as prior art under 35 U.S.C. §§ 102(a) and (b). Therefore, both Hathorn and Mylex are printed publications that were publicly distributed more than one year before any of the applications to which the ’346 patent claims priority.

The application that issued as the Griffith patent was filed on 8/18/1999, thus Griffith (Ex. 1007) qualifies as prior art under 35 U.S.C. § 102(e). The application that issued as the Deitz patent was filed on 10/28/1999, thus Deitz (Ex. 1008) qualifies as prior art under 35 U.S.C. § 102(e). The application that issued as the DeKoning patent was filed on 12/23/1996, thus DeKoning (Ex. 1010) qualifies as prior art under 35 U.S.C. § 102(e). Therefore, Griffith, Deitz, and DeKoning are patents that issued on respective applications filed before any of the applications to which the ’346 patent claims priority.

1 The Mylex paper was publicly available for download via www.mylex.com.

(See Ex. 1009.)
C. Claim Construction under 37 C.F.R. §§ 42.104(b)(3)

Petitioners submit, for purposes of the IPR only, that the claim terms are presumed to take on their broadest reasonable interpretation in view of the specification of the ’346 patent. 37 C.F.R. § 42.100(b). In particular, Petitioners expressly reserve the right to submit constructions for individual claim terms in the matters now pending in the District of Delaware, under the legal standards applicable in those proceedings which are different than those proposed or adopted in this proceeding, including how a person of ordinary skill in the art would understand the claims in light of relevant intrinsic and extrinsic evidence.

Under the law applicable to construction in IPR proceedings, the following claim terms should be construed applying the broadest reasonable interpretation to be broad enough to encompass the corresponding definition:

<table>
<thead>
<tr>
<th>Claim Term</th>
<th>Broadest Reasonable Interpretation</th>
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<tbody>
<tr>
<td>“RAID”</td>
<td>“redundant array of inexpensive disks”</td>
</tr>
<tr>
<td>“RAID controller/RAID controlling unit”</td>
<td>“a component that controls operation of the RAID”</td>
</tr>
<tr>
<td>“exchange/exchanges information”</td>
<td>“to transmit and receive information reciprocally”</td>
</tr>
<tr>
<td>“connection unit”</td>
<td>“a hub or switch”</td>
</tr>
<tr>
<td>“network interface controller,”</td>
<td>“the part of a RAID controller that allows”</td>
</tr>
</tbody>
</table>
“network controlling unit,” and
“network interface controlling unit”
the RAID controller to communicate with
the ‘connection units’”

1. “RAID” (Claims 1-9)

Under the broadest reasonable interpretation in light of the specification, the
term “RAID” should be construed as “at least a redundant array of independent
disks.” “RAID” is understood by one of ordinary skill as an acronym for
“redundant array of inexpensive disks.” (Ex. 1001 at Abstract; Ex. 1003, ¶¶ 14-16.)

2. “RAID controller/RAID controlling unit” (Claims 1-9)

Under the broadest reasonable interpretation in light of the specification, the
phrases “RAID controller” and “RAID controlling unit” should both be construed
as “a component that controls operation of the RAID.” (Ex. 1003, ¶¶ 14-16.)

3. “exchange/exchanges information” (Claims 1-9)

Under the broadest reasonable interpretation in light of the specification, the
phrases “exchange information” and “exchanges information” should both be
construed to mean “to transmit and receive information reciprocally.” (Ex. 1003,
¶¶ 14-16.)

4. “connection unit” (Claims 1-9)

Under the broadest reasonable interpretation in light of the specification, the
phrase “connection unit” should be construed as “a hub or switch.” (Ex. 1003, ¶¶
14-16.) This construction is supported by the specification, which uses the term
hub to refer to a hub or switch. (Ex. 1001 at 3:13-18.)

5. “network interface controller,” “network controlling unit,”
and “network interface controlling unit” (Claims 1-9)

Under the broadest reasonable interpretation in light of the specification, the
phrases “network interface controller,” “network controlling unit,” and “network
interface controlling unit” should be construed as “the part of a RAID controller
that allows the RAID controller to communicate with the ‘connection units.’” (Ex.
1003, ¶¶ 14-16.)

IV. SUMMARY OF THE ’346 PATENT

A. Brief Description

The ’346 patent relates to a system with “redundant interconnections
between multiple hosts and a RAID.” The system includes two RAID controllers.
Each RAID controller has two network interface controllers (“NICs”). The system
has two hub/switch devices. Fig. 4 illustrates the system described in the ’346
patent:
Figure 4 is a block diagram of a system including RAID 490 and its interconnection to host computers 400-405. (Ex, 1001 at 2:64-3:6.) RAID 490 includes two RAID controllers 460 and 461 and hubs 440 and 441. (Id. at 3:10-18.) Each RAID controller includes a pair of network interface controllers. For example, RAID controller 460 includes network interface controllers 470 and 471, and RAID controller 461 includes network interface controllers 480 and 481. (Id. at 3:11-13.) Each host computer has its own network interface controller (410 to 415), which connects the host computer through the hubs to the network interface controllers (470, 471, 480, 481) of RAID controllers 460 and 461. (Id. at 3:31-35.)

This structure provides a “communication passage between two RAID controllers.” (Id. at 3:64-65.) For example, RAID controller 460 can send data to RAID controller 461 via NIC 470, switch/hub 440, and NIC 480. (Id. at 3:66-4:12.)
This redundant system of RAID controllers and network interface controllers purports to provide a “fault tolerant function.” (Id. at 3:63-66.) A RAID controller “having [an] error occurrence is removed from the network” and a NIC from the other RAID controller “takes over a function” of a NIC on the faulty RAID controller. (Id. at 4:19-25.)

B. Prosecution History

Two amendments were made during prosecution of the application which issued as the ’346 patent. An initial amendment was made following a rejection over US 5,812,754 (hereinafter “Lui”). On February 10, 2005, the examiner issued a Final Office Action rejecting all claims over Lui. In response, Applicant amended claims 1-9 and argued that Lui does not teach “two network interface controlling units included in each RAID controller.” (Ex. 1002 at 48.) Applicant argued that Lui does not teach that “the first network controlling unit exchanges information with the fourth network controlling unit and the second network controlling unit exchanges information with the third network controlling unit.” (Id. at 48-49.)

V. MANNER OF APPLYING CITED PRIOR ART TO EVERY CLAIM FOR WHICH AN IPR IS REQUESTED, THUS ESTABLISHING A REASONABLE LIKELIHOOD THAT AT LEAST ONE CLAIM OF THE ’346 PATENT IS UNPATENTABLE

This petition shows how the references above, alone or in combination with each other and other supporting references, disclose the limitations of the
Challenged Claims and show they are unpatentable. As detailed below, this petition shows a reasonable likelihood that Petitioners will prevail with respect to the Challenged Claims.

A. Brief Description of the References

i. Mylex

Mylex is a whitepaper entitled “Storage Area Networks: Unclogging LANs and Improving Data Accessibility,” authored by Kevin J. Smith of the Mylex Corporation and published on the Mylex Corporation’s public website. Mylex describes the Mylex Fibre Channel product line of external RAID controllers and the use of storage area networks to configure reliable and high-performance pools of storage. (Ex. 1006 at 2.) Mylex discloses SANs (storage area networks) made up of hubs and switches that include redundant connections between multiple hosts and RAID arrays, allowing for host-independent failover. (Id. at 16.) Mylex teaches fault tolerance where NICs on one RAID controller take over the function of NICs on a faulty RAID controller. (Id. at Figs. 17-19; Ex. 1003, ¶¶ 39-41, 140-141). Mylex discloses a direct heartbeat path between controllers for exchanging fault tolerance information. (Ex. 1006 at Fig. 17).

ii. Hathorn

The Hathorn patent, entitled “Remote Data Shadowing Using A Multimode Interface To Dynamically Reconfigure Control Link-Level And Communication Link-Level” and assigned to IBM, is directed to DASDs (direct access storage
devices) and discloses that multiple DASDs can be configured as a RAID. (Ex. 1003, ¶ 44.) Hathorn discloses that if a single DASD fails, then the lost data can be recovered by using the remaining data and error correction procedures. (Ex. 1005 at 2:4-11.)

Hathorn teaches that RAID controllers can communicate either via direct paths between controllers, like in the Mylex reference, or by modifying the NICs to communicate between each other over the existing switch network. (Ex. 1003, ¶¶ 48-55.) Hathorn teaches that the storage controllers can have “dual function link-level facilities … [which allow] the primary and secondary storage controller ports 321, 324, 331, and 334 [to] be dynamically set to communicate either as a channel or control unit link-level facility.” (Ex. 1005 at 8:1-6; 10:41-45.) A “channel link-level facility” allows the storage controller ports on two different RAID controllers to exchange information. (Id. at 5:8-15.)

iii. Deitz

U.S. Patent No. 6,578,158 to Deitz, titled “Method And Apparatus For Providing A RAID Controller Having Transparent Failover And Fallback,” is assigned to IBM. Deitz discloses redundant RAID systems including multiple host computers connected to a plurality of hubs, where 1) one hub is connected to (i) an active RAID controller port on a first RAID controller and (ii) an inactive RAID controller port on a second RAID controller, and 2) a second hub is connected to
(i) an inactive RAID controller port on a first RAID controller and (ii) an active RAID controller port on a second RAID controller. (Ex. 1003, ¶ 224.)

Deitz discloses the transmission of heartbeat signals (also called pings or polls) between RAID controllers through an inter-RAID-controller path (Figure 1) or a storage-side path (Fig. 2, and 6:59-64). (Ex. 1008, at Figs. 1-2; 6:59-63.)

iv. Griffith

The Griffith patent, titled “RAID Systems During Non-Fault And Faulty Conditions On A Fiber Channel Arbitrated Loop SCSI Bus Or Switch Fabric Configuration,” is assigned to Digi-Data Corporation. Griffith discloses a RAID system that uses arbitrated fiber channels or switch fabric to connect multiple host computers and storage array controllers (“SACs”). (Ex. 1007, at Abstract.) Griffith Figure 5 shows an embodiment of an “ACTIVE-ACTIVE redundant RAID system … which incorporates a switch fabric configuration.” (Id. at 4:53-55) Griffith teaches that fault tolerance information can be exchanged either through (i) a direct path between RAID controllers or (ii) by allowing the NICs to exchange information using the existing switch network. (Ex. 1007, at 9:15-21; 8:25-26; 9:37-40; Ex. 1003, ¶¶ 205, 208, 210-214.) For example, see the annotated Griffith Fig. 4 below:
Griffith discloses a redundant RAID system in which the switch fabric connecting the host computers and the controllers “provides redundancy in the case of any single computer or controller failure.” (Ex. 1007, at 2:35-38; 8:63-64.) “[E]ach SAC is designated a primary SAC for an array of storage units, which it normally serves as controller, and as a secondary SAC for another array of storage units.” (Id. at Abstract; Ex. 1003, ¶ 209.)

v. DeKoning

The DeKoning patent, titled “Methods And Apparatus For Coordinating Shared Multiple Raid Controller Access To Common Storage Devices,” is assigned to LSI Logic Corp. DeKoning discloses an “invention [that] provides inter-controller communications … [so that a plurality of RAID controllers]
communicate among themselves to permit continued operations in case of failures.” (Ex. 1010 at 3:15-21.) DeKoning teaches using several communication mediums to exchange between RAID controllers, including using the existing host-side communication bus. (Id. at 4:58-5:10; Ex. 1003, ¶ 206.)

B. Motivation to Combine

One of ordinary skill would have been motivated to apply the respective teachings of Mylex and Hathorn to render obvious claims 1-9 of the ’346 Patent. One of ordinary skill would have been motivated to combine the teachings of Mylex with Hathorn because of the close relationship between Mylex Corporation and IBM, assignee of the Hathorn patent. In September of 1999, IBM acquired Mylex. Storage system designers at IBM in the 2000 timeframe would have been strongly motivated to combine and leverage storage technology from Mylex, and vice versa. Later IBM products were partly based on the technology IBM acquired from Mylex, demonstrating that the motivation to combine these features was real and actually resulted in new products. (Ex. 1003, ¶ 34.)

Mylex and Hathorn also are directed to the same field of endeavor, and both describe similar redundant RAID systems that connect multiple hosts to switches or hubs, which in turn connect to RAID controllers with two or more ports. Both Mylex and Hathorn describe redundancy in terms of sending communications between two or more RAID controllers and/or network interface controller ports.
Both Mylex and Hathorn disclose RAID 1-type systems (disk mirroring/shadowing) (Ex. 1006 at 12; Ex. 1005 at 1:9-12), and disclose using off-the-shelf components for constructing the RAID system, and as such their combination is merely the use of known techniques to achieve predictable results. (Ex. 1006 at 15 (marketing “Mylex controllers”); Ex. 1005 at 6:25-34 (describing an IBM Enterprise Systems/9000 (ES/9000) processor running DFSMS/MVS operating software, IBM 3990 Model 6 storage controllers, and an IBM ESCON Director dynamic switch).) One of ordinary skill would have been motivated to study multiple examples of disk mirroring systems when designing a new RAID system. As a result of their similarity, one of ordinary skill would have been able to apply the fault tolerance teachings of Mylex to the system disclosed by Hathorn, or the modifying NICs to communicate teachings of Hathorn to the system disclosed by Mylex with predictable results. (Ex. 1003, ¶¶ 33-34.)

In addition, one of ordinary skill would have been motivated to apply (i) the Griffith teachings of exchanging fault tolerance information using the existing switch network or (ii) the DeKoning teachings of using a host-side communication bus to allow RAID controllers to exchange information, to the systems described in Mylex or Deitz in order to render every claim in the ’346 patent obvious. Mylex, Deitz, Griffith and DeKoning are in the same field of endeavor. Each describes redundant RAID systems that connect multiple hosts to RAID controllers. While
Griffith only discloses using one switch or hub, and DeKoning discloses using a host-side communication bus, the concept of using multiple switches or hubs in RAID systems was well known at the time of the alleged invention. (See Ex. 1005 at Fig. 3.)

Further, Griffith, DeKoning, Deitz and Mylex describe fault tolerance in terms of sending communications between two or more RAID controllers and/or network interface controlling unit ports. One of ordinary skill would have been motivated to study multiple examples of fault tolerant RAID systems when designing a new RAID system, and Mylex Corporation, IBM (assignee of the Deitz patent) and Digi-Data Corporation (assignee of the Griffith patent) were all RAID providers. One of ordinary skill would have known to look at the teachings of these RAID providers when configuring redundant RAID systems. Furthermore, Mylex, Deitz, and Griffith all describe redundant RAID systems comprised of off-the shelf components, and as such their combination is merely the use of known techniques to achieve predictable results. (Ex. 1006 at 15 (marketing “Mylex controllers”); Ex. 1007 at 5:33-35 (“A preferred SAC is the Z-9100 Ultra-Wide SCSI RAID controller manufactured by Digi-Data Corporation, Jessup, Md.”); Ex. 1008 at 5:33-36 (“controllers 105 can be any suitable fibre channel compatible controller that can be modified to operate according to the present invention, such
as for example the DAC960SF, commercially available from Mylex, Inc., Boulder, Colo.”).

One of ordinary skill also would have been motivated to combine the teachings of Griffith with Mylex controllers because Griffith discloses that its “preferred dual-port disk is the 3.5-Inch Ultrastar2 XP available from IBM” (Ex. 1007 at 8:38-39), and there was a close relationship between IBM and Mylex Corporation. In September of 1999, IBM completed the acquisition of Mylex. Storage system designers in that timeframe using the IBM 3.5-Inch Ultrastar2 XP disclosed in Griffith would have been strongly motivated to combine and leverage the teachings from other IBM and Mylex storage technology.

A. [GROUND 1 and GROUND 2] – The Combination of Mylex and Hathorn Renders Obvious Claims 1-9

Claims 1-9 of the ’346 patent are obvious in light of Mylex in view of the teachings of Hathorn, and/or Hathorn in view of the teachings of Mylex, thereby rendering each of these claims unpatentable under 35 U.S.C. § 103.

Specifically, a person of ordinary skill would understand that the Mylex paper discloses every element of the ’346 patent’s claims 1-9, with the exception of a direct exchange of information between network interface controlling units. Instead, the Mylex paper discloses a direct “heartbeat” communication path between controllers for exchanging information. However, the Hathorn patent teaches that communication paths are expensive, and that this expense can be
reduced by modifying network interface controlling unit ports to use the existing switch network for communications between RAID controllers (instead of using a direct “heartbeat” path). (Ex. 1003, §§ 32, 48-55.) An annotated Mylex Figure 17 is included below showing this combination:

Additionally, a person of ordinary skill would understand that the Hathorn patent discloses every element of the ’346 patent’s claims 1-9, with the possible exception of the fault tolerance functionality recited in the ’346 patent’s claims 4 and 9. However, the Mylex paper teaches fault tolerance as claimed. (Ex. 1003, §§ 40-41.) Hathorn discloses that all NICs can be modified to exchange information using the switch network. (Ex. 1005 at 11:25-43 (“The primary storage controller 325, acting as host with the ports 324 enabled as channel link-level facility, sends an EPC frame to the secondary storage controller 335 … the secondary storage controller 335 processes the EPC frame and returns an acknowledgement (ACK) frame.”); Ex. 1003, §§ 48-55.) As such, with reference
to Hathorn Fig. 3, ports 324B and 334B (2nd and 4th NICs) can be used to
exchange fault tolerance information in a non-faulty state, as claimed. Using the
fault tolerance teachings of Mylex, these ports can execute a function of ports
324A and 334A (1st and 3rd NICs) in a faulty state, as claimed.

Further, with respect to claim element [4b], one of ordinary skill, using the
teachings of Hathorn, would have found it obvious to configure Mylex’s second
and fourth network interface controlling units to exchange fault tolerance
information. For example, with reference to Mylex Fig. 17, using the “reserved”
second and fourth NICs for exchanging fault tolerance information, while neither
controller is faulty, would be a matter of obvious design choice, as this would
allow maximum performance for processing host commands on the active ports.
(Ex. 1003, ¶ 95.) In the event of a fault, using the fault tolerance teachings of
Mylex, the second and fourth network interface controlling units could be
configured to execute a function of the first and third network interface controlling
units when one of the RAID controlling units is faulty. An annotated Mylex
Figure 17 is included below showing this configuration:
i. **Detailed Disclosure**

[1a] **An apparatus for a redundant interconnection between multiple hosts and a RAID, comprising:**

Mylex and Hathorn both disclose redundant interconnections between multiple hosts and a RAID. (Ex. 1003, ¶¶ 56-60.) Mylex discloses redundant connections between servers and storage devices. (Ex. 1006 at Figs. 12, 17; *id.* at 15 (“each controller has redundant paths to host systems and pairs of controllers provide redundant paths to disks”); *id.* at 11, 16.) A server as described by Mylex functions as a host. (*Id.* at 11, 16.) Mylex further discloses a RAID storage device. (*Id.* at 11, 12.)

Hathorn, e.g., at Figure 3, discloses multiple hosts, including primary and secondary hosts 301 and 311, and discloses redundant connections such as 341, 342 and 343, 344, respectively, between the hosts and dynamic switches 305 and 315. (Ex. 1005 at Fig. 3; Ex. 1003, ¶ 142.) In addition, Hathorn Fig. 5 discloses shadowing data across multiple disks to create a remote dual copy, which is a
RAID architecture commonly known as RAID 1. (Ex. 1005 at 8:64-9:51; 12:54-60; Ex. 1003, ¶ 143.)

[1b] a first RAID controlling units and a second RAID controlling unit for processing a requirement of numerous host computers,

Mylex and Hathorn both disclose dual RAID controllers for processing requirements of the numerous host computers. (Ex. 1003, ¶¶ 144-147.) Mylex discloses “Duplex RAID Controllers.” (Ex. 1006 at 11.) Mylex discloses configurations that utilize duplex RAID disk array controllers (DACs) that can be RAID controllers. (Id. at Fig. 17 (illustrating a first and a second RAID controller, where “Controller 0” is a first RAID controller and “Controller 1” is a second RAID controller).) Mylex duplex RAID controllers are used for processing a requirement of host computers. (Id. at 16.)

Hathorn discloses dual RAID controllers for processing requirements of the numerous host computers. Hathorn Fig. 3, for instance, discloses storage controllers 322, 325, 332 and 335. (Ex. 1005 at Fig. 3.) Hathorn discloses that multiple DASDs can be configured as a RAID. (ID. at 2:4-11.) Hathorn further discloses that dual RAID controllers are used for processing a requirement, e.g., a write command, of host computers. (Id. at Fig. 6; 9:52-56; 10:5-14.)

[1c] the first RAID controlling unit including a first network controlling unit and a second network controlling unit, and the second RAID controlling unit including a third network controlling unit and a fourth network controlling unit;
Mylex and Hathorn both disclose a system having first and second controllers, where each of the first and second controllers has a first and second port that can be considered first-fourth network controlling units (e.g., Port 1, Port 2, and two Reserved Ports in Mylex; Ports 324A, 324B, 334A, and 334B in Hathorn). (Ex. 1003, ¶¶ 65 and 149.) Mylex Fig. 17 shows that both “Controller 0” and “Controller 1,” corresponding to the first and second RAID controllers, are configured with two Ports (“Port 1”, “Port 2” and two “Reserved Ports”).

(Ex. 1006 at Fig. 17 (annotated).)

As explained with respect to element [1b], the RAID architecture disclosed by Hathorn includes storage controller 325, which is a first RAID controlling unit, and storage controller 335, which is a second RAID controlling unit. (Ex. 1005 at Fig. 3.) Storage controller 325 has ports 324A through 324D; storage controller 335 has ports 334A through 334D. (Id. at Fig. 3.)
Mylex and Hathorn both disclose a plurality of connection units for connecting the first RAID controlling units and the second RAID controlling unit to the numerous host computers. (Ex. 1006 at 19 (“Ports can be directly attached to SAN servers or indirectly through hubs and switches”); see also id. at 4, 11, 16.)

Mylex Figs. 12, 17, and 20-21 show multiple servers connected to controller ports through a SAN network. (Ex. 1006 at Figs. 12, 17, 20-21). The Mylex figures describe features that can be configured in a single system. (Ex. 1003, ¶ 36.) Mylex discloses that “[s]witches, hubs and routers are interconnect devices that can be employed to construct SAN networks.” (Ex. 1006 at 5.) Mylex also discloses that SAN networks can be created by a plurality of such hubs or switches in a cascade. (Id. at 8; see also id. at Fig. 6.)

Hathorn, e.g., at Fig. 3, discloses dynamic switches 305 and 315, which connect the first and second RAID controlling units 325 and 335 to the numerous host computers 301 and 311. (Ex. 1005 at Fig. 3.)

[1e] wherein the first RAID controlling unit and the second RAID controlling unit directly exchange information with the numerous host computers through the plurality of connecting units,
Mylex and Hathorn both disclose a first RAID controlling unit and second RAID controlling unit directly exchanging information with the numerous host computers through the plurality of connecting units. (Ex. 1003, ¶¶ 73-75, 152-155.) Mylex discloses an exchange of information between hosts and RAID controlling units: “Mylex external RAID array controllers use sophisticated caching algorithms for both read and write operations.” (Ex. 1006 at 20; see also id. at Figs. 12, 17 (disclosing RAID controllers connected to hosts via SAN network connecting units); 16 (“Mylex controllers have dual SAN ports which doubles the bandwidth to controllers and allows redundant paths from other SAN devices to the controllers to increase the resiliency of the SAN topology… The SAN ports can be connected directly to … servers or indirectly through hubs and switches.”).

Hathorn, e.g., at Fig. 3, discloses this element where RAID controllers 325 and 335 are connected to dynamic switches 305 and 315 by communication links 349 and 345. (Ex. 1005 at Fig. 3.) Dynamic switches 305 and 315 are connected to hosts 301 and 311 through communication links 341, 342, 343 and 344. (Id. at Fig. 3.) Hathorn Fig. 6 is a flowchart that further illustrates “CUs” (RAID controlling units) exchange information with hosts, e.g., when executing a host write command to storage. (Id. at Fig. 6.) Hathorn further discloses that “primary host 201 can thus communicate with any secondary storage controller 232, 235, or the secondary host 211 via the dynamic switch 205 or 215. Likewise, the
secondary host can communicate with any primary storage controller 222, 225, or
the primary host 201 via the dynamic switch 205 or 215.” (Id. at 7:28-33.)

[1f] and the first network controlling unit exchanges information with
the fourth network controlling unit, and the second network controlling
unit exchanges information with the third network controlling unit.

Hathorn, and Mylex with Hathorn, disclose this element. (Ex. 1003, ¶¶ 76-
80, 156-158.) Hathorn discloses alternative systems: (i) where dedicated paths
between RAID controllers are used to allow RAID controllers to exchange
information, and (ii) where RAID controller NICs exchange information using the
existing switch network. Hathorn Fig. 2, for example, shows dedicated
communication links 247 and 248 between RAID controllers 222 and 235, as well
as between RAID controllers 225 and 232. (Ex. 1005 at Fig. 2.) Hathorn discloses
that these dedicated paths “present a substantial expense” (id. at 4:17-30) – an
expense which can be avoided by “[modifying] ports on the storage controllers
such that the ports can operate as a … channel link-level facility.” (Id. at Abstract.)
Hathorn Fig. 3 shows NICs are modified to exchange information via the existing
switch network instead of the dedicated paths included in Fig. 2: “primary storage
controller 322, via the same port A 321, can communicate with secondary storage
controller 332 by communication links 350, dynamic switch 305, communication
links 351, dynamic switch 315, and communication links 346, wherein port A 321
acts as a channel link-level facility.” (Id. at 8:3-15, Fig. 2; see also id. at 10:41-52.)
Hathorn Fig. 5 shows one example of this information exchange, where
“[s]tep 512 involves the primary storage controller 325 sending data to be
shadowed to the secondary storage controller 335… At step 512, port 324 (A-B) is
operating in channel link-level facility mode.” (Id. at 9:30-51, Fig. 5.)

Hathorn Fig. 7 further discloses a process for defining peer-to-peer
communications between RAID controllers 325 and 335, in which an information
exchange includes RAID controller 335 responding to EPC frames transmitted by
RAID controller 325. (See id. at Fig. 7; see also, e.g., id. at 11:25-43 (“The primary
storage controller … sends an EPC frame … the secondary storage controller 335
process the EPC frame and returns an acknowledgement (ACK) frame”); 7:25-43.)

Hathorn discloses that any port of a RAID controller (e.g., Fig. 3’s 324A, the
first network controlling unit) can exchange information with any port of another
RAID controller (e.g., Fig. 3’s 334B, the fourth network controlling unit). (Ex.
1003, ¶¶ 79-80.)

Mylex discloses a “heartbeat path” between two RAID controllers
(Controller 0 and 1) used for exchanging fault tolerance information. (See, e.g., Ex.
1006 at Fig. 17.) Mylex discloses that the controllers use this path to provide high
availability and transmit/receive “I’m alive heartbeat messages.” (Id. at 16.)

Figures 17 and 18 disclose reserved NICs on RAID controllers used to take over
the function of a faulty NIC on a different RAID controller. (Id. at Figs. 17, 18.)
[2] The apparatus as recited in claim 1, wherein said respective RAID controlling units are connected to the plurality of individual connecting units.

Mylex and Hathorn both disclose an apparatus wherein said respective RAID controlling units are connected to the plurality of individual connecting units. (Ex. 1003, ¶ 84.) Mylex Figs. 20 and 21 show RAID controllers connected to a hub or switch. Mylex Fig. 6 shows RAID controllers connected to a hub-switch cascade. Mylex Figs. 12 and 17 show RAID controllers connected to a SAN network. Mylex discloses that “[s]witches, hubs and routers are interconnect devices that can be employed to construct SAN networks.” (Ex. 1006 at 5.)

Hathorn discloses a RAID architecture in which multiple RAID controllers are connected to dynamic switches through multiple communication links. Hathorn Fig. 3, for instance, shows RAID controllers 325 and 335 connected to dynamic switches 305 and 315 by communication links 345 and 349. (Ex. 1005 at Fig. 3.)

[3] The apparatus as recited in claim 2, wherein the first network interface controlling unit is coupled to the connecting unit of one side and the second network interface controlling unit is coupled to the connecting unit of another side.

Hathorn and Mylex both disclose this element. (Ex. 1003, ¶¶ 85-86, 162.) Hathorn Fig. 3 shows first and second network interface controlling unit ports are coupled to connecting units of two sides (upper and lower side of Figure 3). An annotated Hathorn Figure 3 is included below:
Fig. 3 discloses a first network interface controlling unit (port 324A) coupled to the dynamic switch 305 on the upper “side” of Fig. 3 by connection link 349. (Id.) The second network interface controlling unit (port 324B) is coupled to the dynamic switch 315 on the lower “side” of Figure 3 by connection link 349, dynamic switch 305, and connection link 351. (Id.)

Mylex, as discussed in claim 2 above, discloses controllers that are connected to hubs and switches for communication with one or more servers, wherein the respective RAID controlling units are connected to individual connecting units. (Ex. 1006 at 16, Figs. 6, 20-21.) As discussed with respect to
element [1d], Mylex discloses a SAN that consists of hubs, switches, and/or a cascade of hubs and switches. (See element [1d], supra.)

Mylex Figure 17 (see above, claim element [1f]) discloses that all network interface controllers are connected to the hubs on the left and right sides of Figure 17. (Ex. 1006 at Fig. 17.) Mylex Figure 12 shows a SAN network, where the first network controlling unit is coupled to one section of the SAN network ports (the Unix system on the left side of the Figure), and the second network controlling unit may be coupled to a different section of the SAN network ports (the NT server on the right side of the Figure):

(Ex. 1006 at Fig. 12 (annotated).)
[4a] The apparatus as recited in claim 3, wherein the first network interface controlling unit and the third network interface controlling unit process the requirement of the numerous host computers;

Mylex and Hathorn both disclose this element. (Ex. 1003, ¶¶ 90, 163-165.)

Mylex discloses a redundant system where the first and third network controlling units are active and process I/O requests of the servers. (Ex. 1006 at 16, 18.) For example, in Mylex Fig. 17, the first network interface controller (Port 1) and the third network interface controller (Port 2) process the requirements of the hosts, while the other two NICs are “reserved” for fault tolerance purposes. (Id. at Fig. 17.)

Hathorn discloses a port of one RAID controller (the first network interface controlling unit) and a port of another RAID controller (the third network interface controlling unit) processing the requirement of the numerous host computers. As explained with respect to claim element [1a], a requirement of a host computer can include a write command to volume B, which the controller mirrors to volume B’. (Ex. 1003, ¶ 143.) As such, e.g., Hathorn’s Fig. 3 discloses that storage controller 322 is configured as attached to DASD 323 (Vol A and B). (Ex. 1005 at Fig. 3.) A write command to this DASD would necessarily be processed by either NIC 324A or B and by the NICs 334A or B (Id.)

Hathorn further discloses that in the case of a fault, storage controller ports on two different RAID controllers can process host requirements. (See, e.g., id. at
2:47-50 (“The secondary or remote location, in addition to providing a back-up data copy, must also have enough system information to take over processing for the primary system should the primary system become disabled.”).

[4b] and the second network interface controlling unit and the fourth network controlling unit are used for communication between the first RAID controlling unit and the second RAID controlling unit when the first and second RAID controlling units are not faulty and the second network interface controlling unit and the fourth network controlling unit are used for executing a function of the first network interface controlling unit and the third network controlling unit when one of the first RAID controlling unit and the second RAID controlling unit is faulty.

Mylex with Hathorn, and Hathorn with Mylex, disclose this element. (Ex. 1003, ¶¶ 91-96, 166-172.) As shown in Figures 17-19, Mylex teaches the claimed fault tolerance function of a storage controller port (i.e. network interface controller) on one RAID controller taking over the identity and function of a storage controller port on a different RAID controller, and vice versa. (Ex. 1006 at Figs. 17-19.) Mylex discloses that the second and fourth network controlling unit ports can be “reserved” for the purposes of fault tolerance. (Ex. 1006 at 18.)

Mylex Figure 19 shows the return process: “When the failed controller is replaced, it is detected by the surviving controller which allows it to restart and returns the failed controller’s port ID’s, and then it starts processing I/O.” (Id.) Mylex discloses a heartbeat direct path between controllers for exchanging fault tolerance information. (Id.) Hathorn teaches that the expense of a direct
communication path between controllers can be avoided by modifying the NICs to exchange communications using the existing switch network. (See claim [1f]; Ex. 1003, ¶ 95.)

Hathorn discloses multiple storage controllers with multiple ports, and multiple paths between the switches and ports, comprising a fault tolerant system. (Ex. 1003, ¶ 166.) Further, Hathorn discloses use of “IBM 3990 storage controller[s]” (Ex. 1005 at 5:59), which are fault tolerant controllers. (See, e.g., Ex. 1003, ¶ 166; Ex. 1012 at 44, Fig. 5.)

[5a] The apparatus as recited in claim 1, wherein said plurality of connecting units have at least three connection ports

Mylex and Hathorn both disclose an apparatus wherein the plurality of connecting units have at least three connection ports. (Ex. 1003, ¶¶ 97-101.) Mylex discloses switches or hubs (e.g., that can be used in the SAN network illustrated in Figure 17) that include at least three connection ports. (Ex. 1006 at Fig. 17; see also element [1d].)

Mylex Fig. 12 illustrates a SAN with at least nine connection ports connecting multiple servers and multiple controllers. (Ex. 1006 at Fig. 12; see also id. at 15.) Mylex Fig. 6 also discloses a cascaded hub-switch system with at least four connection ports on the switch. (Id. at Fig. 6.) Mylex also discloses that an apparatus with hubs and switches can have up to twelve connection ports. (Id. at Figs. 20 and 21.)
Hathorn discloses multiple dynamic switches (e.g., plurality of connecting units) with at least eight connection ports each. Hathorn Fig. 3, for instance, shows dynamic switch 305 connected to eight ports: communication links 341, 342, 349 (two ports), 350 (two ports), and 351 (two ports). (Ex. 1005 at Fig. 3.) Fig. 3 also shows dynamic switch 315 connected to eight ports: communication links 343, 344, 345 (two ports), 346 (two ports), and 351 (two ports). (Id.)

[5b] two of the at least three connection ports is coupled to one of the first network interface controlling unit and the third network controlling unit

Mylex and Hathorn both disclose that two of the at least three connection ports are coupled to one of the first network interface controlling unit and the third network controlling unit. In a switch or a hub, all ports are connected to each SAN device. (Ex. 1003, ¶ 103; Ex. 1010 at 11:25-31.) Mylex discloses this. (Ex. 1006 at 7 (“[i]n a FC-AL, nodes arbitrate to gain access to the loop and then pairs of nodes establish a logical point-to-point connection to exchange data; the other nodes on the loop act as repeaters”).)

Mylex Fig. 12 discloses SAN network connection units, where each port is connected to at least one of the first and third network controlling units. (Ex. 1006 at Figs. 12, 17) Hathorn discloses a RAID architecture in which at least two of the eight connection ports for each switch are coupled to the first and the third network interface controlling units. (Ex. 1005 at Fig. 3.)
[5c] and the rest of the connection ports being provided as a hub equipment connected with the numerous host computers.

Mylex and Hathorn both disclose this element. (Ex. 1003, ¶¶ 104, 177-181.) Because all ports in switches and hubs are connected to every SAN device, Mylex Figs. 6, 12, and 17, e.g., disclose the rest of the connection ports as connected to numerous host computers. (Ex. 1006 at Figs. 6, 12, 17.) Further, as discussed for claim [1d], Mylex discloses that a SAN network can be comprised of hubs, switches, or a cascade of hubs and switches. (See claim [1d], supra.)

Similarly, because each of the ports of a switch or hub has a connection to all of the other ports of a switch, Hathorn, e.g., in Figure 3, discloses the rest of connection ports on dynamic switches 305 and 315 are connected to host computers 301 and 311 by communication links 341, 342, 343 and 344. (Ex. 1003, ¶¶ 176-181.) Further, Mylex discloses that SANs can be comprised of hubs or switches. (Ex. 1006 at 8 (“Hubs and switches are interconnect devices used in Storage Area Networks.”).)

[6a] The apparatus as recited in claim 1, wherein said plurality of connecting units have at least three connection ports

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [5a].

[6b] two of the at least three connection port are coupled to one of the first network interface controlling unit and the third network controlling unit
Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [5b].

[6c] and the rest of the connection ports being provided as a network switch equipment connected with the numerous host computers.

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [5c].

[7a] The apparatus as recited in claim 1, wherein said plurality of connecting units have at least five connection ports,

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [5a]. Mylex discloses an apparatus wherein the plurality of connecting units have at least nine connection ports. (Ex. 1006 at Fig. 12.) Mylex also discloses that an apparatus with hubs and switches can have up to twelve connection ports. (Id. at Figs. 20, 21.)

Hathorn discloses a RAID architecture including dynamic switches that each have at least eight connection ports. (Ex. 1005 at Fig. 3.)

[7b] four of the at least five connection ports is coupled to one of the first network interface controlling unit and the third network controlling unit

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [5b]. (Ex. 1003, ¶ 113.) The nine- or twelve-ported connection units in Mylex have at least five connecting ports coupled to the first and third network controller units. (Ex. 1006 at Fig. 21; see also id. at Figs. 17, 20 and 21.)
Hathorn discloses a RAID architecture in which at least four of the eight connection ports for each switch are coupled to the first and the third network controlling units. (Ex. 1005 at 8:6-14, Fig. 3.)

[7c] and the rest of the connection ports being provided as a switch connected with the numerous host computers.

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [6c].

[8] The apparatus as recited in claim 1, wherein the first network interface controlling unit of the first RAID controlling unit being connected to a first connecting unit, the second network interface controlling unit of said first RAID controlling unit being connected to a second connecting unit, the third network interface controlling unit of the second RAID controlling unit being connected to the second connecting unit, and the fourth network interface controlling unit of the second RAID controlling unit being connected to the first connecting unit.

Mylex and Hathorn both disclose this element. (Ex. 1003, ¶¶ 115-118, 188-190.) Mylex discloses that SANs can be created using switches, hubs, or “cascades,” such that there are two or more switches and/or hubs. (Ex. 1006 at Fig. 6; see also id. at 8.)

Mylex Fig. 17 shows a first controller (the first FL Controller) having two ports (“Port 1” and “Reserved”) and a second controller (the second FL controller) having two ports (“Port 2” and “Reserved”). When the SAN in Fig. 17 is made of more than one hub and/or switch, e.g. as illustrated in Mylex’s Fig. 6, each port is connected to both connecting units. (Ex. 1006 at Figs. 6, 17.)
Hathorn, e.g., at Figure 3, discloses (i) the first network interface controlling unit is connected to a first connecting unit, switch 305, through connection path 349; (ii) the second network interface controlling unit is connected to a second connecting unit, switch 315, through connection path 349, switch 305, and connection path 351; (iii) the third network interface controlling unit is connected to the connecting unit, switch 315, through connection path 345; and (iv) the fourth network interface controlling unit is connected to the first connecting unit, switch 305, through connection path 345, switch 315, and connection path 351. (Ex. 1005 at Fig. 3.)
[9a] An apparatus for a redundant interconnection between multiple host computers and a RAID, the apparatus comprising:

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [1a].

[9b] a plurality of connection units for connecting the host computers and the RAID;

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim element [1d]. (Ex. 1003, ¶ 120.)

[9c] a first and a second RAID controllers, included in the RAID, each of which having a first network interface controller and a second network interface controller for processing requests from the plurality of the host computers connected through the plurality of the connection units,

Mylex and Hathorn both disclose this element for the reasons set forth above with respect to claim elements [1b-c].

[9d] wherein the first network interface controller in the first RAID controller supplies data to the host computers connected through the plurality of connection units and processes information transmitted from the second network interface controller in the second RAID controller,

Hathorn, and Mylex with Hathorn, disclose this element. (Ex. 1003, ¶¶ 127-129, 195.) Mylex discloses first and second RAID controllers, each of which has a first network interface controller for processing requests from the plurality of host computers connected through the plurality of connection units, and a second network interface controller for executing a function of the first network interface controller on an alternate RAID when faulty. (See, e.g., Ex. 1006 at Fig. 17)
Mylex discloses that the RAID controllers exchange fault tolerance information through a direct heartbeat path between controllers. (See, e.g., id. at Fig. 17.)

Hathorn teaches that NICs can be modified to exchange information to avoid expense. (See claim [1f] and below.) Hathorn likewise discloses a RAID architecture in which the first network interface controllers in the first and second RAID controller supply data to the host computers connected through the plurality of connection units. (Ex. 1005 at 7:28-38 (“The primary host 201 can thus communicate with any secondary storage controller 232, 235, or the secondary host 211 via the dynamic switch 205 or 215. Likewise, the secondary host can communicate with any primary storage controller 222, 225, or the primary host 201 via the dynamic switch 205 or 215. Additionally, primary storage controllers 222, 225 can communicate with secondary storage controllers 232, 235, respectively. Thus, the primary host 201 could send data or records for back-up directly to the secondary storage subsystem.”).)

Hathorn also discloses that the NICs can be modified to become channel link-level facilities and exchange information via the existing switch network instead of using an expensive direct communication path between controllers. (See claim [1f]; see also Ex. 1005 at Fig. 3 (showing that storage controller 325
communicates with storage controllers 335 over links 349, 351 and 345 and hubs 305 and 315); Abstract; 8:3-15; Claim 11.)

Hathorn also discloses that when the ports are modified to act in channel link-level facility mode, two RAID controllers, through their respective storage ports, can transmit “an EPC frame” and receive an “acknowledgement (ACK) frame.” (Id. at 11:25-44.)

[9e] wherein the first network interface controller in the second RAID controller supplies data to the host computers connected through the plurality of connection units and processes information transmitted from the second network interface controller in the first RAID controller,

Hathorn, and Mylex with Hathorn, disclose this element, for the reasons discussed with respect to claim [9d].

[9f] wherein the second network interface controller in the first RAID controller is used for fault tolerance by performing functions of the first network interface controller in the second RAID controller when the second RAID controller is faulty, and

Mylex, and Hathorn with Mylex, disclose this element. (Ex. 1003, ¶¶ 133-135.) Mylex describes SANs capable of performing failover and failback operations for fault tolerance. (Ex. 1006 at 16, 11.) The failover system disclosed by Mylex includes a second port of a non-faulty controller performing operations of a port of a faulty controller. (Id. at Figs. 17-19.) “If a controller fails, the surviving controller senses the absence of heartbeats, fails over the ID of the active port on the failed controller to its reserved port, and updates its data structures with
configuration information stored on disk. The failover process is transparent since the nodes still see the same fibre port ID’s on the SAN interconnect.” (Id. at 18.)

As shown above with respect to Claim [4b], Hathorn discloses fault tolerant IBM 3990 RAID controllers. (Ex. 1005 at 5:59; Ex. 1003, ¶ 166; Ex. 1012 at 44, Fig. 5; see also Ex. 1003, ¶ 197.)

[9g] wherein the second network interface controller in the second RAID controller is used for fault tolerance by performing functions of the first network interface controller in the first RAID controller when the first RAID controller is faulty, and

Mylex, and Hathorn with Mylex, disclose this element. The Mylex failover discussion (see, e.g., claim [4b]) applies equally well to failure of either controller. (Ex. 1003, ¶ 137.) In a similar manner, with reference to Mylex Figure 17, when one of the first or second RAID controllers is faulty, one of the second network interface controllers (labeled “Reserved”) will perform the functions of the first network interface controllers in the faulty RAID controller. (Id.) Further, this claim element is disclosed for the reasons set forth above with respect to claim element [9f].

[9h] wherein the first network controlling unit in the first RAID controlling unit exchanges information with the second network controlling unit in the second RAID controlling unit, and the second network controlling unit in the first RAID controlling unit exchanges information with the first network controlling unit in the second RAID controlling unit.
Hathorn, and Mylex with Hathorn, disclose this element for the reasons set forth above with respect to claim element [1f].

B. [GROUND 3] – The Combination of Deitz or Mylex with Griffith or DeKoning Renders Obvious Claims 1-9

Claims 1-9 of the ’346 Patent are obvious in light of the combination of Deitz or Mylex with Griffith or DeKoning, rendering each of these claims unpatentable under 35 U.S.C. § 103. Griffith teaches that (i) RAID controllers can exchange fault tolerance information either by a direct path between controllers or by using the existing switch network, and (ii) a dual-ported RAID controller can act both as a primary controller for its associated disks and a secondary controller for the disks of another RAID controller, in the case of a fault, and vice versa.

DeKoning teaches that RAID controllers can exchange information using several communication mediums, including the host-side communication bus.

Mylex and Deitz both disclose every element of claims 1-9, with the exception that they disclose RAID controllers that communicate via a direct “heartbeat” path. One of ordinary skill would have applied the teachings of Griffith and/or DeKoning to either Mylex and/or Deitz to render obvious all claims of the ’346 patent. An annotated Deitz Figure 2 below shows this combination:
With respect to claim 4(b), in view of Griffith’s teaching that each storage controller can exchange fault tolerance information via their respective NICs, or DeKoning’s teaching that several communication mediums may be used for exchanging RAID controller information, including the host-side network, one of ordinary skill would understand that the second and fourth network interface controlling units disclosed in Deitz can be configured to send failover monitoring communications when the RAID controllers are not faulty, and as shown in Deitz Figure 2, can be configured to execute a function of the first and third network interface controlling units when one of the RAID controlling units is faulty. One of ordinary skill would understand that using the second and fourth “inactive” NICs
for exchanging failover information would be an obvious design choice that would lessen the performance impact on the “active” NICs. (Ex. 1003, ¶ 269.) Further, Griffith, e.g., at Figs. 4 and 5, teaches that switches or hubs can connect to every RAID controller. As such, it would have been obvious to modify the system disclosed in Deitz’s Figure 2 to establish communication paths between the second and fourth NICs. (Id.)

i. Detailed Disclosure

[1a] An apparatus for a redundant interconnection between multiple hosts and a RAID, comprising:

Deitz discloses this element. (Ex. 1003, ¶¶ 232-233.) Deitz discloses multiple host computers and a RAID, stating that “[t]he present invention is directed to a memory system having a number of controllers adapted to transfer data between at least one host computer and a data storage system, such as one or more Redundant Array of Independent Disks (RAID) storage systems.” (Ex. 1008 at 4:44-48; see also id. at 1:30-35.) Deitz also shows redundant interconnections between multiple host computers and a RAID in Figure 2. (Id. at Fig 2.) Deitz discloses redundant connections between the hosts and the RAID, stating that “a pair of the controllers 105 can be configured to operate as dual-active controllers as described above, or as dual-redundant controllers wherein one controller serves as an installed spare for the other, which in normal operation handles all I/O requests from the host computer 110. Preferably, the controllers 105 operate as dual-active
controllers to increase the bandwidth of the memory system 100.” \((Id.\ at\ 5:40-48;\ see\ also\ id.\ at\ 1:30-35;\ 10:22-27.\)"

\[1b\] a first RAID controlling units and a second RAID controlling unit for processing a requirement of numerous host computers,

Deitz discloses first and second RAID controllers for processing a requirement of numerous host computers. (Ex. 1003, ¶¶ 236-237.) For example, see Figure 2 in claim \[1a\] (controllers 105a and 105b).

Deitz discusses multiple RAID controllers for processing information from hosts 110a and 110b and discloses “[a] method and apparatus for controlling a memory system 100 comprising a plurality of controllers 105 connected by a fibre channel arbitrated loop 145 to provide transparent failover and failback mechanisms for failed controllers. The controllers 105 are adapted to transfer data between a data storage system 120 and at least one host computer 100 in response to instructions therefrom.” (Ex. 1008 at Abstract.)

\[1c\] the first RAID controlling unit including a first network controlling unit and a second network controlling unit, and the second RAID controlling unit including a third network controlling unit and a fourth network controlling unit;

Deitz discloses this element. (Ex. 1003, ¶ 242.) Deitz discloses that each of the controllers has a first active port and a second inactive port, stating that, “as shown in FIG. 2, each of the controllers 105 have at least one active port 195a, 195b and one inactive port 200a, 200b. The active ports 195a, 195b receive and
process I/O requests sent by the host computers 110 on the host-side loops 115. The inactive ports 200a, 200b, also known as a failover ports, can process I/O requests only when the active port 195a, 195b on the same host-side loop 115a, 115b, has failed.” (Ex. 1008 at 6:42-49; see also id. at 3:63-66; 5:37-45; Claim 5; Claim 14; Claim 20; Claim 21.) Deitz discloses network interface controllers, i.e., active and failover ports 195a, 195b, 200a and 200b in Fig. 2. (Id. at Fig. 2.)

[1d] a plurality of connection units for connecting the first RAID controlling units and the second RAID controlling unit to the numerous host computers,

Deitz discloses a plurality of hubs for connecting the host computers to the RAID controllers. (See, e.g., Deitz at Fig. 2 (disclosing two hubs: 150a and 150b); see also Ex. 1008 at 5:18-19 (“[t]he host-side loops 115 are made up of several fibre channels 145 and a hub 150a, 150b.”).)

[1e] wherein the first RAID controlling unit and the second RAID controlling unit directly exchange information with the numerous host computers through the plurality of connecting units,

Deitz discloses this element. As shown in the Fig. 2, Deitz discloses that the first and second RAID controllers (105a and 105b) both have ports that are “active” (195a and 195b) in exchanging information with hosts 110a and 110b, through hubs 150a and 150b.

Deitz discloses a data exchange between the host computers and the RAID controllers, stating that “[t]he host-side loops 115 are adapted to enable data and
input/output (I/O) requests from the host computer 110 to be transferred between any port on the loop 115.” (Ex. 1008 at 5:29-32.)

[1f] and the first network controlling unit exchanges information with the fourth network controlling unit, and the second network controlling unit exchanges information with the third network controlling unit.

Deitz with Griffith and/or DeKoning discloses this element. (Ex. 1003, ¶ 253.) Deitz discloses a direct communication path between RAID controllers for exchanging failover information. (See, e.g., Deitz at Fig. 2 (disclosing a direct path 205).)

Deitz discloses that “[t]he signal passed between the controllers 105 to indicate controller failure can be a passive signal, such as for example the lack of a proper response to a polling or pinging scheme in which each controller interrogates the other at regular, frequent intervals to ensure the other controller is operating correctly. Alternatively, the signal can be a dynamic signal transmitted directly from a failed or failing controller 105a, 105b to the surviving controller 105b, 105a instructing it to initiate a failover process or mechanism. Optionally, the communication path 205 is also adapted to enable the controllers 105 to achieve cache coherency in case of controller failure.” (Ex. 1008 at 6:63-7:7; see also id. at 6:54-63; 7:35-39; 9:44-47; Claim 11.)

Deitz teaches that other pathways aside from dedicated communication channels between controllers may enable signals to be passed between controllers,
stating that “[t]he communication path 205 …. can take the form of a dedicated high speed path extending directly between the controllers 105, as shown in FIG. 1, or one of the device-side channels 140a-c (disk channels) which can also serve as the communication path 205, as shown in FIG. 2.” (Ex. 1008 at 6:54-63.)

Griffith discloses that failover communications can be exchanged (i) between RAID controls over a direct communication path, such as disclosed in Deitz, or (ii) by using the existing switch network connecting network interface controlling unit ports. (Ex. 1007 at 9:15-21; Ex. 1003, ¶ 254.)

DeKoning teaches that several communication mediums can be used to exchange information between RAID controllers, including using the existing host-side communication bus. (See, e.g., Ex. 1010 at 4:58-5:10.)

[2] The apparatus as recited in claim 1, wherein said respective RAID controlling units are connected to the plurality of individual connecting units

Deitz discloses RAID controllers connected to the plurality of connection units. (See, e.g., Deitz at Fig. 2 (disclosing RAID controllers 105a and 105b connected to hubs 150a and 150b).)

[3] The apparatus as recited in claim 2, wherein the first network interface controlling unit is coupled to the connecting unit of one side and the second network interface controlling unit is coupled to the connecting unit of another side.

Deitz discloses this element. (Ex. 1003, ¶¶ 259-260.) As shown in Deitz Fig. 2, Deitz discloses active port 195a (first NIC) connected to the hub 150a on
the left side of Figure 2, and failover port 200a (second NIC) connected to the hub 150b on the right side of the Figure. (Ex. 1008 at Fig. 2.)

[4a] The apparatus as recited in claim 3, wherein the first network interface controlling unit and the third network interface controlling unit process the requirement of the numerous host computers;

Deitz discloses this element. As shown in the Deitz Fig. 2, Deitz discloses that the first and third NICs are active for exchanging information with the hosts 110a and 110b. (Ex. 1008 at Fig. 2.)

Deitz states that “as shown in FIG. 2, each of the controllers 105 have at least one active port 195a, 195b and one inactive port 200a, 200b. The active ports 195a, 195b receive and process I/O requests sent by the host computers 110 on the host-side loops 115. The inactive ports 200a, 200b, also known as a failover ports, can process I/O requests only when the active port 195a, 195b on the same host-side loop 115a, 115b, has failed.” (Ex. 1008 at 6:41-49; 7:32-38; 5:22-29.)

[4b] and the second network interface controlling unit and the fourth network controlling unit are used for communication between the first RAID controlling unit and the second RAID controlling unit when the first and second RAID controlling units are not faulty and the second network interface controlling unit and the fourth network controlling unit are used for executing a function of the first network interface controlling unit and the third network controlling unit when one of the first RAID controlling unit and the second RAID controlling unit is faulty.

Deitz with Griffith and/or DeKoning discloses this element. (Ex. 1003, ¶¶ 269-270.) As explained with respect to claim element [1f], supra, Griffith
and/or DeKoning discloses that the network interface controlling units on the
primary and secondary RAID controllers exchange failover information using the
existing switch network, instead of the direct path 205 between controllers
disclosed in Deitz. (Ex. 1003, ¶ 266.)

Deitz also discloses that active ports on a first RAID controller can fail over
to inactive ports on a second RAID controller when the first RAID controller is
faulty, stating that “[t]he signal passed between the controllers 105 to indicate
controller failure can be a passive signal, such as for example the lack of a proper
response to a polling or pinging scheme in which each controller interrogates the
other at regular, frequent intervals to ensure the other controller is operating
correctly. Alternatively, the signal can be a dynamic signal transmitted directly
from a failed or failing controller 105a, 105b to the surviving controller 105b, 105a
instructing it to initiate a failover process or mechanism.” (Ex. 1008 at Fig. 2; 6:54-
7:7; 7:35-39; 9:44-47; Claim 11.)

Deitz also discloses that “[a] failover unit is adapted to enable a surviving
controller to respond to instructions addressed to it and to instructions addressed to
the failed controller…. The failover unit also includes a loop initialization unit,
which is adapted to instruct a surviving controller to assume the identity of the
failed controller and to instruct the surviving controller to respond to instructions
addressed to it and to the failed controller as well as instructions addressed to the surviving controller.” (Ex. 1008 at 3:52-61; 6:63-7:8; 5:41-46.)

Deitz discloses how such operations are performed in failover mode, stating that “[i]n the assuming identity step 240, the failover port 200a, 200b of the surviving controller 105a, 105b, begins accepting and processing I/O requests addressed by the host computers 110a, 110b, to the failed controller 105b, 105a.” (Id. at 7:55-58.)

Griffith, e.g., at Figs. 4 and 5, teaches that switches or hubs can connect to every RAID controller. (Ex. 1007 at Figs. 4 and 5.)

[5a] The apparatus as recited in claim 1, wherein said plurality of connecting units have at least three connection ports.

Deitz discloses this element. As shown in Deitz Fig. 2, hubs 150a and 150b are each connected to hosts 110a and 110b and to controllers 105a and 105b, such that hubs 150a and 150b each have at least four connection ports. (Ex. 1008 at Fig. 2.)

[5b] two of the at least three connection ports is coupled to one of the first network interface controlling unit and the third network controlling unit

Deitz discloses this element. As shown in Deitz Fig. 2, hubs 150a and 150b are connected to ports 195a, 195b, 200a, and 200b (network controlling units) of RAID controllers 105a and 105b, while each port is connected to every other port. (Ex. 1003, ¶ 274; Ex. 1008 at Fig. 2; 5: 7-29).
[5c] and the rest of the connection ports being provided as a hub
equipment connected with the numerous host computers,

Deitz discloses this element. As explained with respect to claim element
[5b], supra, each of the ports of Deitz’s hubs is coupled to each of the other ports
of the hub, and Deitz thus discloses that all of the connection ports on hubs 150a
and 150b (shown in the Deitz Fig. 2) are connected to hosts 110a and 110b. (Ex.
1008 at Fig. 2.)

[6a] The apparatus as recited in claim 1, wherein said plurality of
connecting units have at least three connection ports,

Deitz discloses this element for the same reasons set forth with respect to
claim element [5a], supra.

[6b] two of the at least three connection port are coupled to one of the
first network interface controlling unit and the third network
controlling unit

Deitz discloses this element for the same reasons set forth with respect to
claim element [5b], supra.

[6c] and the rest of the connection ports being provided as a network
switch equipment connected with the numerous host computers

Deitz alone, or with Griffith, discloses this element. (Ex. 1003, ¶ 280.)

Deitz, as explained with respect to claim element [5c], supra, in Fig. 2 shows hubs
150a and 150b, and every port on these hubs is connected to every other port on
the same hubs, and to every SAN device, e.g., the hosts. (Ex. 1008 at Fig. 2.)
Griffith teaches that RAID controlling units, e.g., 105a and 105b in Deitz Fig. 2, can be connected to hosts via hubs or switches. (Ex. 1007 at 8:22-34; Figs. 4, 5.)

[7a] The apparatus as recited in claim 1, wherein said plurality of connecting units have at least five connection ports,

Deitz alone, or with Griffith, discloses this element. (Ex. 1003, ¶¶ 281-282.) As explained with respect to claim element [5a], supra, Deitz Fig. 2 discloses two hubs with four connection ports (collectively 8 connection ports). (Ex. 1008 at Fig. 2.)

Griffith Figs. 4 and 5 teach that hubs or switches with at least twelve connection ports can be used in redundant RAID systems. (Ex. 1007 at Figs. 4, 5.)

[7b] four of the at least five connection ports is coupled to one of the first network interface controlling unit and the third network controlling unit

Deitz alone, or with Griffith, discloses this element. As explained with respect to claim element [5b], supra, all ports on Deitz’s hubs can communicate with all other ports on the hub and, as such, Deitz Fig. 2 discloses hubs with four connections ports connected to one of the first and third NIC. (Ex. 1008 at Fig. 2.)

Griffith Figs. 4 and 5 teach that hubs or switches with at least twelve connection ports can be used in redundant RAID systems. (Ex. 1007 at Figs. 4, 5.)

[7c] and the rest of the connection ports being provided as a switch connected with the numerous host computers

Deitz alone, or with Griffith, discloses this element. (Ex. 1003, ¶ 285.) As explained with respect to claim elements [6c] and [7b], supra, all of the ports of
Deitz’s network hub are coupled to one another. (Ex. 1008 at Fig. 2.) Griffith Figs. 4 and 5 teach that hubs or switches with at least twelve connection ports can be used in redundant RAID systems. (Ex. 1007 at Figs. 4 and 5.)

[8] The apparatus as recited in claim 1, wherein the first network interface controlling unit of the first RAID controlling unit being connected to a first connecting unit, the second network interface controlling unit of said first RAID controlling unit being connected to a second connecting unit, the third network interface controlling unit of the second RAID controlling unit being connected to the second connecting unit, and the fourth network interface controlling unit of the second RAID controlling unit being connected to the first connecting unit.

Deitz discloses this element. Deitz, e.g., at Fig. 2, discloses a port of a first controller and a port of a second controller both connected to one hub, and another port of the first controller and another port of the second controller both connected to another hub. (Ex. 1008 at Fig. 2.) As shown in Deitz Fig. 2, hub 150a is connected to both active port 195a of controller 105a and to failover port 200b of controller 105b, and hub 150b is connected to both failover port 200a and active port 195b. (Id.)

[9a] An apparatus for a redundant interconnection between multiple host computers and a RAID, the apparatus comprising:

Deitz discloses this element for the same reasons set forth with respect to claim element 1[a], supra.

[9b] a plurality of connection units for connecting the host computers and the RAID;
Deitz discloses this element for the same reasons set forth with respect to claim element [1d], supra.

[9c] a first and a second RAID controllers, included in the RAID, each of which having a first network interface controller and a second network interface controller for processing requests from the plurality of the host computers connected through the plurality of the connection units,

Deitz discloses this element for the same reasons set forth with respect to claim elements [1b-c], supra.

[9d] wherein the first network interface controller in the first RAID controller supplies data to the host computers connected through the plurality of connection units and processes information transmitted from the second network interface controller in the second RAID controller,

Deitz with DeKoning and/or Griffith disclose this element. (Ex. 1003, ¶ 296.) Deitz discloses a first port of a first RAID controller supplying data to the hosts through hubs, stating that “as shown in FIG. 2, each of the controllers 105 have at least one active port 195a, 195b and one inactive port 200a, 200b. (Ex. 1008 at Fig. 2.) The active ports 195a, 195b receive and process I/O requests sent by the host computers 110 on the host-side loops 115.” (Id. at 6:42-45; 1:63-66; 3:3-20; 7:52-58; Claim 5.)

As discussed with respect to claim element [1d], supra, ports 195a, 195b, 200a and 200b of controllers 105a and 105b are connected to the hosts through hubs 150a and 150b. (Id. at Fig. 2.) Deitz discloses communication between a
controller port and a host when discussing the use of dual-active mode, stating that “the memory system 100 is then ready to begin regular operations in a dual-active operation step 225 in which the controllers 105 both simultaneously receive and process I/O requests from the host computers 110.” (Id. at 7:31-35; 5:58-61.)

Deitz discloses signals transmitted between RAID controllers for performing failover and failback operations, stating that “[t]he signal passed between the controllers 105 to indicate controller failure can be a passive signal, such as for example the lack of a proper response to a polling or pinging scheme in which each controller interrogates the other at regular, frequent intervals to ensure the other controller is operating correctly. Alternatively, the signal can be a dynamic signal transmitted directly from a failed or failing controller 105a, 105b to the surviving controller 105b, 105a instructing it to initiate a failover process or mechanism. Optionally, the communication path 105 is also adapted to enable the controllers 105 to achieve cache coherency in case of controller failure.” (Id. at 6:63-7:7; 6:54-63; 7:35-39; 8:50-59; 9:7-10; 9:44-47; Claim 11.)

Griffith teaches that storage controller ports can exchange failover information without a direct path between controllers. (See, e.g., claim [1f].) DeKoning teaches that RAID controllers can exchange information using several mediums, including the host-side communication network. (Id.)

[9e] wherein the first network interface controller in the second RAID controller supplies data to the host computers connected through the
plurality of connection units and processes information transmitted from the second network interface controller in the first RAID controller,

Deitz with DeKoning and/or Griffith discloses this element. As explained with respect to claim element [9d], supra, Deitz Fig. 2 discloses that port 195b (first NIC) on second RAID controller 105b is active and used to supply data to the hosts, and the same port 195b is used to process failover communications with inactive port 200a (second NIC) on the first RAID controller 105a. (Ex. 1008 at Fig. 2.)

[9f]wherein the second network interface controller in the first RAID controller is used for fault tolerance by performing functions of the first network interface controller in the second RAID controller when the second RAID controller is faulty, and

Deitz discloses this element. As discussed with respect to claim element [4b], supra, Deitz discloses failover processes that enable a failover port in a remaining RAID controller to perform functions of an active port in a faulty RAID controller. Deitz discloses that “[o]n detection of a controller failure, a failover procedure is performed on the surviving controller 105a, 105b, the failover procedure involves the steps of disabling the failed controller (step 235) and assuming the identity of the failed controller (step 240). In the disabling step 235, the surviving controller 105a, 105b asserts a reset signal, which disables the failed controller 105b, 105a by resetting its local processor 185a, 185b, and the active port 195a, 195b, fibre protocol chip (not shown). Resetting the fibre protocol chip
causes the hub 150a, 150b to automatically bypass the primary port 195a, 195b, on the failed controller 105a, 105b. In the assuming identity step 240, the failover port 200a, 200b of the surviving controller 105a, 105b, begins accepting and processing I/O requests addressed by the host computers 110a, 110b, to the failed controller 105b, 105a.” (Ex. 1008 at 7:44-58; 7:24-31; 7:65-8:1; Claim 10; Claim 14.) Deitz also discloses failover operations with respect to Fig. 2 stating that “[t]he inactive ports 200a, 200b, also known as a failover ports, can process I/O requests only when the active port 195a, 195b on the same host-side loop 115a, 115b, has failed. For example, in case of failure of controller 105a, inactive port 200b on surviving controller 105b assumes the identity of the active port 195a on failed controller 105a and begins accepting and processing I/O requests directed to the failed controller 105a.” (Id. at 6:44-53.)

Deitz Fig. 2 shows that the storage ports “failover inactive” on both RAID controllers being used for fault tolerance by performing functions of the “active” ports on the other RAID controllers when faulty. (Id. at Fig. 2.)

[9g] wherein the second network interface controller in the second RAID controller is used for fault tolerance by performing functions of the first network interface controller in the first RAID controller when the first RAID controller is faulty, and

For the reasons discussed with respect to claim element [9f], supra, Deitz discloses that the second network interface controller in the second RAID controller is used for fault tolerance by performing functions of the first network
interface controller in the first RAID controller when the first RAID controller is faulty.

[9h] wherein the first network controlling unit in the first RAID controlling unit exchanges information with the second network controlling unit in the second RAID controlling unit, and the second network controlling unit in the first RAID controlling unit exchanges information with the first network controlling unit in the second RAID controlling unit.

Deitz with Griffith and/or DeKoning discloses this element for the same reasons set forth with respect to claim element [1f], supra.

VI. CONCLUSION

For the reasons set forth above, Petitioners have established a reasonable likelihood of prevailing with respect to at least one claim of the ‘346 Patent. Indeed, Petitioners have set forth multiple grounds that establish a reasonable likelihood of prevailing with respect to claims 1-9 of the ‘346 Patent. Therefore, Petitioners ask that the Patent Office order an inter partes review trial and then proceed to cancel claims 1-9.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Baek et al.
U.S. Patent No.: 6,978,346 Attorney Docket No.: 47415.538
Issue Date: December 20, 2005 IPR2015-______
Appl. Serial No.: 09/753,245
Filing Date: December 29, 2000
Title: APPARATUS FOR REDUNDANT INTERCONNECTION BETWEEN MULTIPLE HOSTS AND RAID

CERTIFICATE OF SERVICE

The undersigned certifies, in accordance with 37 C.F.R. § 42.205, that service was made on the Patent Owner as detailed below.

Date of service January 8, 2015

Manner of service FEDERAL EXPRESS

Documents served Petition for Inter Partes Review

Petitioners’ Exhibit List

Exhibits VMWARE-1001 through VMWARE-1014

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