



US007076568B2

(12) **United States Patent**
Philbrick et al.

(10) **Patent No.:** **US 7,076,568 B2**
(45) **Date of Patent:** ***Jul. 11, 2006**

(54) **DATA COMMUNICATION APPARATUS FOR COMPUTER INTELLIGENT NETWORK INTERFACE CARD WHICH TRANSFERS DATA BETWEEN A NETWORK AND A STORAGE DEVICE ACCORDING DESIGNATED UNIFORM DATAGRAM PROTOCOL SOCKET**

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,366,538	A	12/1982	Johnson et al.	364/200
4,589,063	A	5/1986	Shah et al.	710/8
4,991,133	A	2/1991	Davis et al.	364/900
5,056,058	A	10/1991	Hirata et al.	709/230
5,058,110	A	10/1991	Beach et al.	370/85.6
5,097,442	A	3/1992	Ward et al.	365/78

(Continued)

FOREIGN PATENT DOCUMENTS

WO	WO/98/19412	5/1998
----	-------------	--------

(Continued)

OTHER PUBLICATIONS

Stevens, "TCP/IP Illustrated, vol. 1: The protocols," New York, 1994, pp. 143-168.*

(Continued)

Primary Examiner—Jungwon Chang

(74) Attorney, Agent, or Firm—Mark Lauer; Silicon Edge Law Group LLP

(75) Inventors: **Clive M. Philbrick**, San Jose, CA (US); **Laurence B. Boucher**, Saratoga, CA (US); **Daryl D. Starr**, Milpitas, CA (US)

(73) Assignee: **Alacritech, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 804 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/802,551**

(22) Filed: **Mar. 9, 2001**

(65) **Prior Publication Data**

US 2001/0037406 A1 Nov. 1, 2001

Related U.S. Application Data

(60) Provisional application No. 60/098,296, filed on Aug. 27, 1998, provisional application No. 60/061,809, filed on Oct. 14, 1997.

(51) **Int. Cl.**
G06F 15/16 (2006.01)

(52) **U.S. Cl.** **709/250; 709/230**

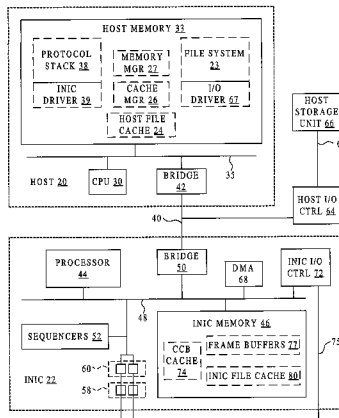
(58) **Field of Classification Search** **709/203, 709/212, 217, 230, 232, 250; 710/5, 22, 710/23, 26, 27; 370/474**

See application file for complete search history.

(57) **ABSTRACT**

An interface device is connected to a host by an I/O bus and provides hardware and processing mechanisms for accelerating data transfers between a network and a storage unit, while controlling the data transfers by the host. The interface device includes hardware circuitry for processing network packet headers, and can use a dedicated fast-path for data transfer between the network and the storage unit, the fast-path set up by the host. The host CPU and protocol stack avoids protocol processing for data transfer over the fast-path, freeing host bus bandwidth, and the data need not cross the I/O bus, freeing I/O bus bandwidth. Realtime audio and video communication can also be provided when the interface device is coupled by an audio/video interface to appropriate communication devices, such as microphone, a speaker, a camera and/or a display.

20 Claims, 24 Drawing Sheets



U.S. PATENT DOCUMENTS

5,163,131 A	11/1992	Row et al.	395/200	6,047,356 A	4/2000	Anderson et al.	711/129
5,212,778 A	5/1993	Dally et al.	395/400	6,049,808 A *	4/2000	Talluri et al.	707/201
5,280,477 A	1/1994	Trapp	370/85.1	6,057,863 A	5/2000	Olarig	345/520
5,289,580 A	2/1994	Latif et al.	395/275	6,061,368 A	5/2000	Hitzelberger	370/537
5,303,344 A	4/1994	Yokoyama et al.	395/275	6,065,096 A	5/2000	Day et al.	711/114
5,412,782 A	5/1995	Hausman et al.	395/250	6,067,569 A	5/2000	Khaki et al.	709/224
5,448,566 A	9/1995	Richter et al.	370/94.1	6,070,200 A	5/2000	Gates et al.	710/20
5,485,579 A	1/1996	Hitz et al.	395/200.12	6,097,734 A *	8/2000	Gotesman et al.	370/474
5,506,966 A	4/1996	Ban	395/250	6,101,555 A	8/2000	Goshey et al.	709/321
5,511,169 A	4/1996	Suda	395/280	6,141,705 A	10/2000	Anand et al.	710/15
5,517,668 A	5/1996	Szwerinski et al.	395/800	6,145,017 A	11/2000	Ghaffari	710/5
5,524,250 A	6/1996	Chesson et al.	395/775	6,157,955 A	12/2000	Narad et al.	709/228
5,548,730 A	8/1996	Young et al.	395/280	6,172,980 B1	1/2001	Flanders et al.	370/401
5,566,170 A	10/1996	Bakke et al.	370/60	6,173,333 B1	1/2001	Jolitz et al.	
5,588,121 A	12/1996	Reddin et al.	395/200.15	6,226,680 B1	5/2001	Boucher et al.	709/230
5,590,328 A	12/1996	Seno et al.	395/675	6,246,683 B1	6/2001	Connery et al.	370/392
5,592,622 A	1/1997	Isfeld et al.	395/200.02	6,247,060 B1	6/2001	Boucher et al.	709/238
5,598,410 A	1/1997	Stone	370/469	6,345,301 B1	2/2002	Burns et al.	709/230
5,619,650 A	4/1997	Bach et al.	395/200.01	6,356,951 B1	3/2002	Gentry, Jr.	709/250
5,629,933 A	5/1997	Delp et al.	370/411	6,385,647 B1 *	5/2002	Willis et al.	709/217
5,634,099 A	5/1997	Andrews et al.	395/200.07	6,389,468 B1	5/2002	Muller et al.	709/226
5,634,127 A	5/1997	Cloud et al.	395/680	6,405,237 B1 *	6/2002	Khalidi et al.	709/203
5,642,482 A	6/1997	Pardillos	395/200.2	6,421,753 B1 *	7/2002	Hoese et al.	710/305
5,664,114 A	9/1997	Krech, Jr. et al.	395/200.64	6,427,169 B1	7/2002	Elzur	709/224
5,671,355 A	9/1997	Collins	395/200.2	6,434,651 B1	8/2002	Gentry, Jr.	710/260
5,678,060 A	10/1997	Yokoyama et al.	709/212	6,449,656 B1	9/2002	Elzur et al.	709/236
5,692,130 A	11/1997	Shobu et al.	395/200.12	6,453,360 B1	9/2002	Muller et al.	709/250
5,699,317 A	12/1997	Sartore et al.	395/230.06	6,470,382 B1 *	10/2002	Wang et al.	709/220
5,701,434 A	12/1997	Nakagawa	395/484	6,470,397 B1 *	10/2002	Shah et al.	709/250
5,701,516 A	12/1997	Cheng et al.	395/842	6,697,868 B1 *	2/2004	Craft et al.	709/230
5,727,142 A	3/1998	Chen	395/181	6,807,581 B1 *	10/2004	Starr et al.	709/250
5,749,095 A	5/1998	Hagersten	711/141	6,941,386 B1 *	9/2005	Craft et al.	709/250
5,751,715 A	5/1998	Chan et al.	370/455	2001/0004354 A1	6/2001	Jolitz	
5,752,078 A	5/1998	Delp et al.	395/827	2001/0025315 A1	9/2001	Jolitz	
5,758,084 A	5/1998	Silverstein et al.	395/200.58				
5,758,089 A	5/1998	Gentry et al.	395/200.64				
5,758,186 A	5/1998	Hamilton et al.	395/831				
5,758,194 A	5/1998	Kuzma	395/886				
5,771,349 A	6/1998	Picazo, Jr. et al.	395/188.01				
5,778,013 A	7/1998	Jedwab	714/807				
5,790,804 A	8/1998	Osborne	395/200.75				
5,794,061 A	8/1998	Hansen et al.	395/800.01				
5,802,258 A	9/1998	Chen	395/182.08				
5,802,580 A	9/1998	McAlpice	711/149				
5,809,328 A	9/1998	Nogales et al.	395/825				
5,812,775 A	9/1998	Van Seeters et al.	395/200.43				
5,815,646 A	9/1998	Purcell et al.	395/163				
5,848,293 A *	12/1998	Gentry	710/5				
5,878,225 A	3/1999	Blumsky et al.	395/200.57				
5,898,713 A	4/1999	Melzer et al.	371/53				
5,909,546 A *	6/1999	Osborne	709/212				
5,913,028 A *	6/1999	Wang et al.	709/203				
5,930,830 A	7/1999	Mendelson et al.	711/171				
5,931,918 A *	8/1999	Row et al.	719/321				
5,935,205 A	8/1999	Murayama et al.	709/216				
5,937,169 A	8/1999	Connery et al.	395/200.8				
5,941,969 A *	8/1999	Ram et al.	710/315				
5,941,972 A	8/1999	Hoese et al.	710/129				
5,950,203 A	9/1999	Stakuis et al.	707/10				
5,991,299 A	11/1999	Radogna et al.	370/392				
5,996,024 A	11/1999	Blumenau	709/301				
6,005,849 A	12/1999	Roach et al.	370/276				
6,009,478 A	12/1999	Panner et al.	710/5				
6,016,513 A	1/2000	Lowe	709/250				
6,021,446 A	2/2000	Gentry, Jr.	709/303				
6,021,507 A	2/2000	Chen	714/2				
6,026,452 A	2/2000	Pitts	710/56				
6,034,963 A	3/2000	Minami et al.	370/401				
6,038,562 A	3/2000	Anjur et al.	707/10				

FOREIGN PATENT DOCUMENTS

WO	WO/98/50852	11/1998
WO	WO/99/04343	1/1999
WO	WO 99/65219	12/1999
WO	WO 00/13091	3/2000
WO	WO 01/04770 A2	1/2001
WO	WO 01/05107 A1	1/2001
WO	WO 01/05116 A2	1/2001
WO	WO 01/05123 A1	1/2001
WO	WO 01/40960 A1	6/2001

OTHER PUBLICATIONS

Schulzrinne et al., RFC 1889, <http://www.ietf.org/rfc/rfc1889.txt?number=1889>, Jan. 1996.*

Search results for socket, www.techdictionary.com, visited Aug. 19, 2004.*

Search results for "protocol stack" from www.techdictionary.com, visited Feb. 17, 2005.*

Search results for "cache" from www.techdictionary.com, visited Feb. 17, 2005.*

Search results for "User Datagram Protocol" from www.techdictionary.com, visited Feb. 17, 2005.*

Internet pages entitled "Hardware Assisted Protocol Processing", (which Eugene Feinber is working on), 1 page, printed Nov. 25, 1998.

Zilog product Brief entitled "Z85C30 CMOS SCC Serial Communication Controller", Zilog Inc., 3 pages, 1997.

Internet pages of Xpoint Technologies www.xpoint.com website, 5 pages, printed Dec. 19, 1997.

Internet pages entitled: Asante and 100BASE-T Fast Ethernet. 7 pages, printed May 27, 1997.

Internet pages entitled: A Guide to the Paragon XP/S-A7

- Richard Stevens, "TCP/IP Illustrated, vol. 1, The Protocols", pp. 325-326 (1994).
- Internet pages entitled: Northridge/Southbridge vs. Intel Hub Architecture, 4 pages, printed Feb. 19, 2001.
- Gigabit Ethernet Technical Brief, Achieving End-to-End Performance. Alteon Networks, Inc., First Edition, Sep. 1996.
- Internet pages directed to Technical Brief on Alteon Ethernet Gigabit NIC technology, www.alteon.com, 14 pages, printed Mar. 15, 1997.
- VIA Technologies, Inc. article entitled "VT8501 Apollo MVP4", pp. i-iv, 1-11, cover and copyright page, revision 1.3, Feb. 1, 2000.
- iReady News Archives article entitled "iReady Rounding Out Management Team with Two Key Executives", <http://www.ireadyco.com/archives/keyexec.html>, 2 pages, printed Nov. 28, 1998.
- "Toshiba Delivers First Chips to Make Consumer Devices Internet-Ready Based on iReady's Design," Press Release Oct. 1998, 3 pages, printed Nov. 28, 1998.
- Internet pages from iReady Products, web site <http://www.ireadyco.com/products.html>, 2 pages, downloaded Nov. 25, 1998.
- iReady News Archives, Toshiba, iReady shipping Internet chip, 1 page, printed Nov. 25, 1998.
- Interprophet article entitled "Technology", <http://www.interprophet.com/technology.html>, 17 pages, printed Mar. 1, 2000.
- iReady Corporation, article entitled "The I-1000 Internet Tuner", 2 pages, date unknown.
- iReady article entitled "About Us Introduction", Internet pages from <http://www.iReadyco.com/about.html>, 3 pages, printed Nov. 25, 1998.
- iReady News Archive article entitled "Revolutionary Approach to Consumer Electronics Internet Connectivity Funded", San Jose, CA, Nov. 20, 1997. 2 pages, printed Nov. 2, 1998.
- iReady News Archive article entitled "Seiko Instruments Inc. (SII) Introduces World's First Internet-Ready Intelligent LCD Modules Based on IReady Technology," Santa Clara, CA and Chiba, Japan, Oct. 26, 1998. 2 pages, printed Nov. 2, 1998.
- NEWSwatch article entitled "iReady internet Tuner to Web Enable Devices", Tuesday, Nov. 5, 1996, printed Nov. 2, 1998.
- EETimes article entitled "Tuner for Toshiba, Toshiba Taps iReady for Internet Tuner", by David Lammers, 2 pages, printed Nov. 2, 1998.
- "Comparison of Novell Netware and TCP/IP Protocol Architectures", by J.S. Carbone, 19 pages, printed Apr. 10, 1998.
- Adaptec article entitled "AEA-7110C-a DuraSAN product", 11 pages, printed Oct. 1, 2001.
- iSCSI HBA article entitled "iSCSI and 2Gigabit fibre Channel Host Bus Adapters from Emulex, QLogic, Adaptec, JNI", 8 pages, printed Oct. 1, 2001.
- U.S. Appl. No. 60/053,240, filed Jul. 18, 1997, Jolitz et al.
- iSCSI HBA article entitled "FCE-3210/6410 32 and 64-bit PCI-to-Fibre Channel HBA", 6 pages, printed Oct. 1, 2001.
- iSCSI HBA article entitled "iSCSI Storage", 6 pages, printed Oct. 1, 2001.
- "Two-Way TCP Traffic Over Rate Controlled Channels: Effects and Analysis", by Kalampoukas et al., IEEE Transactions on Networking, vol. 6, No. 6, Dec. 1998.
- iReady Design", Santa Clara, CA, and Tokyo, Japan, Oct. 14, 1998, printed Nov. 2, 1998.
- U.S. Appl. No. 08/964,304, by Napolitano, et al., entitled "File Array Storage Architecture", filed Nov. 4, 1997.
- "File System Design For An NFS File Server Appliance", Article by D. Hitz, et al., 13 pages.
- Adaptec Press Release article entitled "Adaptec Announces EtherStorage Technology", 2 pages, May 4, 2000, printed Jun. 14, 2000.
- Adaptec article entitled "EtherStorage Frequently Asked Questions", 5 pages, printed Jul. 19, 2000.
- Adaptec article entitled "EtherStorage White Paper", 7 pages, printed Jul. 19, 2000.
- CIBC World Markets article entitled "Computers; Storage", by J. Berlino et al., 9 pages, dated Aug. 7, 2000.
- Merrill Lynch article entitled "Storage Futures", by S. Milunovich, 22 pages, dated May 10, 2000.
- CBS Market Watch article entitled "Montreal Start-Up Battles Data Storage Bottleneck", by S. Taylor, dated Mar. 5, 2000, 2 pages, printed Mar. 7, 2000.
- Internet-draft article entitled "SCSI/TCP (SCSI over TCP)", by J. Satran et al., 38 pages, dated Feb. 2000, printed May 19, 2000.
- Internet pages entitled Technical White Paper-Xpoint's Disk to LAN Acceleration Solution for Windows NT Server, printed Jun. 5, 1997.
- Jato Technologies article entitled Network Accelerator Chip Architecture, twelve-slide presentation, printed Aug. 19, 1998.
- EETimes article entitled Enterprise System Uses Flexible Spec, dated Aug. 10, 1998, printed Nov. 25, 1998.
- Internet pages entitled "Smart Ethernet Network Interface Cards", which Berend Ozceri is developing, printed Nov. 25, 1998.
- Internet pages entitled "Hardware Assisted Protocol Processing", which Eugene Feinberg is working on, printed Nov. 25, 1998.
- Internet pages of Xahti corporation entitled "GigaPower Protocol Processor Product Review," printed Nov. 25, 1999.
- Internet pages entitled "DART: Fast Application Level Networking via Data-Copy Avoidance," by Robert J. Walsh, printed Jun. 3, 1999.
- Internet pages of InterProphet entitled "Frequently Asked Questions", by Lynne Jolitz, printed Jun. 14, 2000.
- Internet pages entitled iReady About Us and iReady Products, printed Nov. 25, 1998.
- Andrew S. Tanenbaum, Computer Networks, Third Edition, 1996, ISBN 0-13-349945-6.
- Form 10-K for Exelan, Inc., for the fiscal year ending Dec. 31, 1987 (10 pages).
- Form 10-K for Exelan, Inc., for the fiscal year ending Dec. 31, 1988 (10 pages).
- Article from Rice University entitled "LRP: A New Network Subsystem Architecture for Server Systems", by Peter Druschel and Gaurav Banga, Rice University, Oct. 1996, 15 pages.
- Internet RFC/STD/FYI/BCP Archives article with heading "RFC2140" entitled "TCP Control Block Interdependence", web address <http://www.faqs.org/rfcs/rfc2140.html>, 9 pages, printed Sep. 20, 2002.
- Stevens, "TCP/IP Illustrated, vol. 1: The Protocols," © 1994, ISBN 0-201-63346-9, p. 229.

Schwaderer et al., IEEE Computer Society Press publication entitled, "XTP in VLSI Protocol Decomposition for ASIC Implementation", from 15th Conference on Local Computer Networks, 5 pages, Sep. 30-Oct. 3, 1990.

Beach, Bob, IEEE Computer Society Press publication entitled, "UltraNet: An Architecture for Gigabit Networking", from 15th Conference on Local Computer Networks, 18 pages, Sep. 30-Oct. 3, 1990.

Chesson et al., IEEE Symposium Record entitled, "The Protocol Engine Chipset", from Hot Chips III, 16 pages, Aug. 26-27, 1991.

Maclean et al., IEEE Global Telecommunications Conference, Globecom '91, presentation entitled, "An Outboard Processor for High Performance Implementation of Transport Layer Protocols", 7 pages, Dec. 2-5, 1991.

Ross et al., IEEE article entitled "FX1000: A high performance single chip Gigabit Ethernet NIC", from Comcon '97 Proceedings, 7 pages, Feb. 23-26, 1997.

Strayer et al., "Ch. 9: The Protocol Engine" from XTP: The Transfer Protocol, 12 pages, Jul. 1992.

Publication entitled "Protocol Engine Handbook", 44 pages, Oct. 1990.

Koufopavlou et al., IEEE Global Telecommunications Conference, Globecom '92, presentation entitled, "Parallel TCP

for High Performance Communication Subsystems", 7 pages, Dec. 6-9, 1992.

Lilienkamp et al., Publication entitled "Proposed Host-Front End Protocol", 56 pages, Dec. 1984.

Intel article entitled "Solving Server Bottlenecks with Intel Server Adapters", Copyright Intel Corporation, 1999, 8 pages.

Thia, Y.H. Publication entitled "High-Speed OSI Protocol Bypass Algorithm with Window Flow Control", *Protocols for High Speed Networks*, pp. 53-68, 1993.

Thia, Y.H. Publication entitled "A Reduced Operational Protocol Engine (ROPE) for a multiple-layer bypass architecture", *Protocols for High Speed Networks*, pp. 224-239, 1995.

WindRiver article entitled "Tornado: For Intelligent Network Acceleration", copyright Wind River Systems, 2001, 2 pages.

WindRiver White Paper entitled "Complete TCP/IP Offload for High-Speed Ethernet Networks", Copyright Wind River Systems, 2002, 7 pages.

* cited by examiner

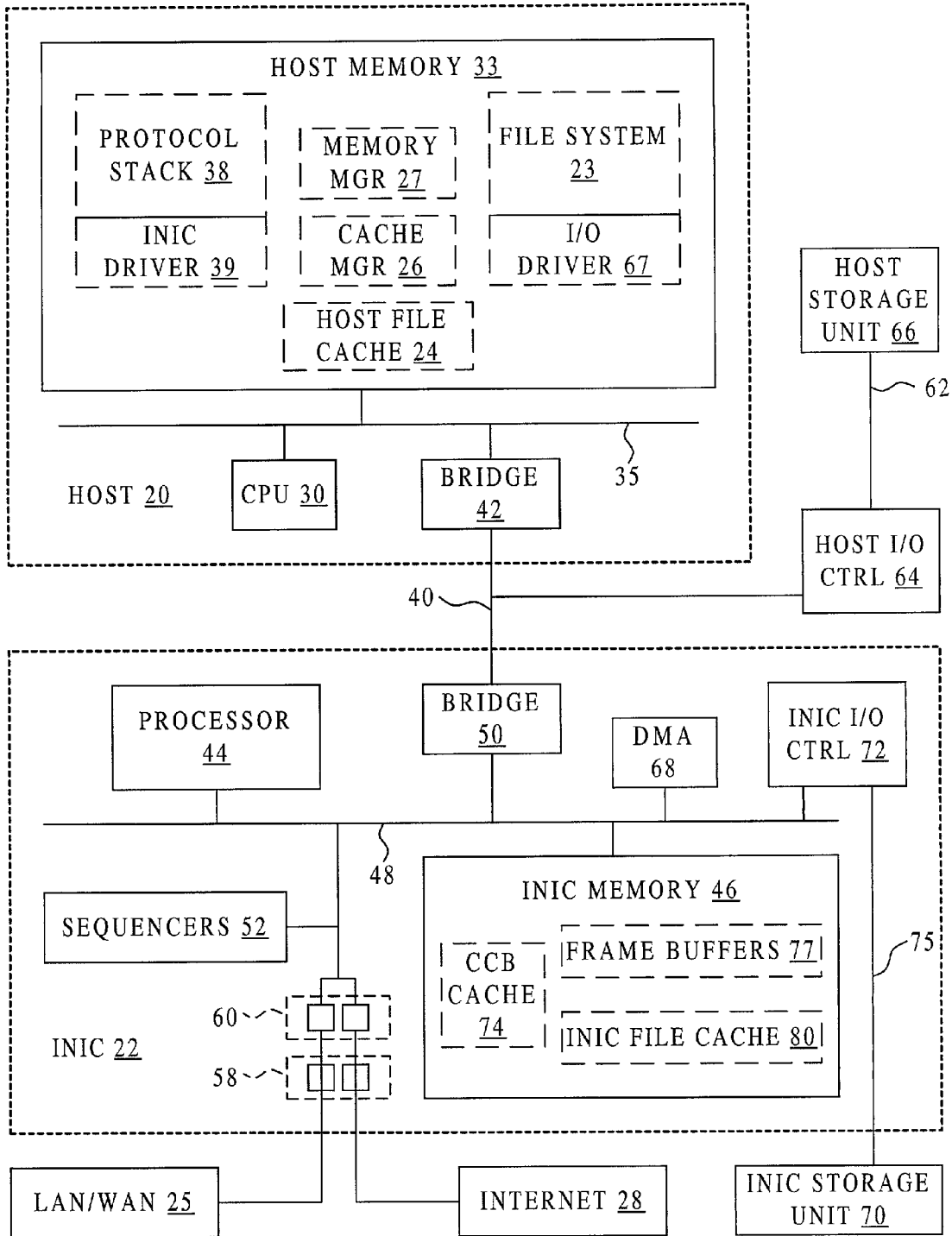


FIG. 1

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.