

FILE HISTORY

US 6,680,904

PATENT: 6,680,904

INVENTORS: KAPLAN MENACHEM

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MAGAL ELI

TITLE: Bi-directional chaining of network access
ports

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6680904



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U.S. UTILITY Patent Application

O.I.P.E.

PATENT DATE

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JAN 20 2004

APPLICATION NO.	CONT/PRIOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
09/472683		375 370	216	2738 2734	HSA, Alper

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TITLE

BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS

PTO-2040
12/99

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)					
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
370	217	370	352	392	395.1	465	
INTERNATIONAL CLASSIFICATION							
G01R	31/08						
H04L	12/66						
	12/28						
H04J	3/16						
☐ Continued on Issue Slip Inside File Jacket							

☐ TERMINAL DISCLAIMER	DRAWINGS Sheets Drwg. 9 Figs. Drwg. 11 Print Fig. 3	CLAIMS ALLOWED Total Claims 26 Print Claim for O.G. 1
☐ The term of this patent subsequent to _____ (date) has been disclaimed.	(Assistant Examiner) _____ (Date) _____	NOTICE OF ALLOWANCE MAILED 9/3/03
☐ The term of this patent shall not extend beyond the expiration date of U.S. Patent. No. _____	<i>Suehotta</i> DUC HO 8-28-03 (Primary Examiner) (Date)	ISSUE FEE m Amount Due 1350 Date Paid 12-1-03
☐ The terminal _____ months of this patent have been disclaimed.	<i>M. Gordon</i> 9/5/03 (Legal Instruments Examiner) (Date)	ISSUE BATCH NUMBER

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ISSUE FEE IN FILE

(FACE)

6,680,904

Bi-directional chaining of network access ports

Transaction History

Date	Transaction Description
12-27-1999	Workflow - Drawings Finished
12-27-1999	Workflow - Drawings Matched with File at Contractor
01-04-2000	Initial Exam Team nn
02-04-2000	Notice Mailed--Application Incomplete--Filing Date Assigned
02-07-2000	Preexamination Location Change
04-14-2000	Application Is Now Complete
04-18-2000	Application Dispatched from OIPE
06-22-2000	Case Docketed to Examiner in GAU
10-06-2000	Case Docketed to Examiner in GAU
05-08-2001	Information Disclosure Statement (IDS) Filed
05-08-2001	Information Disclosure Statement (IDS) Filed
02-12-2002	Case Docketed to Examiner in GAU
03-12-2002	Case Docketed to Examiner in GAU
12-30-2002	Case Docketed to Examiner in GAU
02-03-2003	Non-Final Rejection
02-04-2003	Mail Non-Final Rejection
04-09-2003	Miscellaneous Incoming Letter
05-12-2003	Information Disclosure Statement (IDS) Filed
05-12-2003	Information Disclosure Statement (IDS) Filed
06-18-2003	Response after Non-Final Action
06-18-2003	Request for Extension of Time - Granted
06-27-2003	Date Forwarded to Examiner
09-03-2003	Mail Notice of Allowance
09-03-2003	Notice of Allowance Data Verification Completed
09-03-2003	Case Docketed to Examiner in GAU
09-05-2003	Dispatch to Publications
09-05-2003	Dispatch to Publications
09-08-2003	Receipt into Pubs
09-09-2003	Workflow - File Sent to Contractor
10-13-2003	Receipt into Pubs
12-01-2003	Issue Fee Payment Verified
12-01-2003	Issue Fee Payment Received
12-15-2003	Application Is Considered Ready for Issue
12-17-2003	Receipt into Pubs
12-30-2003	Issue Notification Mailed
01-20-2004	Recordation of Patent Grant Mailed
01-20-2004	Patent Issue Date Used in PTA Calculation
01-27-2012	Applicant Has Filed a Verified Statement of Small Entity Status in Compliance with 37 CFR 1.27
06-13-2016	Change in Power of Attorney (May Include Associate POA)
06-13-2016	Correspondence Address Change
07-11-2016	File Marked Found
07-12-2016	File Marked Found



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INITIALS

CONTENTS

	Date Received (Incl. C. of M.) or Date Mailed	Date Received (Incl. C. of M.) or Date Mailed
1. Application <i>gms</i> papers.		42.
2. <i>HR: JNTIC doc</i>	<i>02/04/00</i>	43.
3. <i>doc & repro charges</i>	<i>07/03/00</i>	44.
4. <i>I.D.S.</i>	<i>5/8/01</i>	45.
2/3/03 <i>Ref (3)</i>	<i>2/4/03</i>	46.
6. <i>Misc Letter</i>	<i>4-9-03</i>	47.
7. <i>I.D.S.</i>	<i>5-12-03</i>	48.
8. <i>EOT(2) Rmdt A</i>	<i>6-18-03</i>	49.
9/03 <i>allowance</i>	<i>9/13/03</i>	50.
10.		51.
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POSITION	INITIALS	ID NO.	DATE
FEE DETERMINATION	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
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FORMALITY REVIEW	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
RESPONSE FORMALITY REVIEW	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

INDEX OF CLAIMS

✓ Rejected N Non-elected
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 (Through numeral)..... Canceled A Appeal
 - Restricted O Objected

Claim	Final	Original	Date
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Claim	Final	Original	Date
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SEARCHED			
Class	Sub.	Date	Exmr.
370	246, 217 352-356 389, 392 395.1 465, 466	1-18-03	DH
340	2-28 2-24		
710	110, 129 131, 132		
712	31, 29		
709	208, 209 225, 229		
375	222		
Updated as above		8-27-03	DH

INTERFERENCE SEARCHED			
Class	Sub.	Date	Exmr.
370	217 352 392 395.1 465	8-28-03	DH

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	Date	Exmr.
Ess	1-18-03	DH

(RIGHT OUTSIDE)

	Type	L #	Hits	Search Text	DBs
1	BRS	L1	216	chain\$4 same access\$4 adj ports	USPAT
2	BRS	L2	2	1 and slave same (ports adj10 lines)	USPAT
3	BRS	L3	10	1 and network adj5 access	USPAT
4	BRS	L4	0	3 and slave	USPAT
5	BRS	L5	0	3 and master	USPAT
6	BRS	L6	1	(daisy adj chain) same slave and second adj master and switch	USPAT
7	BRS	L7	4	dslam and slave same port	USPAT
8	BRS	L8	0	dsl and multi adj3 shelf	USPAT
9	BRS	L9	574	access same master adj10 slave and packet	USPAT
10	BRS	L10	20	9 and second adj master	USPAT
11	BRS	L11	6	709/\$.ccls. and(daisy adj3 chain) same slave	USPAT
12	BRS	L12	3305	709/\$.ccls. and access adj5 network	USPAT
13	BRS	L13	2	12 and slave and second adj master	USPAT
14	BRS	L14	153	slave same (ports adj10 lines) and access	USPAT
15	BRS	L15	24	14 and slave adj10 (ports adj10 lines) and respective	USPAT
16	BRS	L16	0	(slave adj units) same port adj10 subscriber adj3 line	USPAT
17	BRS	L17	142	(slave adj units) same port	USPAT
18	BRS	L18	11	17 and (slave adj units) same port adj10 lines	USPAT
19	BRS	L19	21	dsl and slave same port	USPAT

1-16-03

	Time Stamp	Comments	Error Definition	Errors
17	2003/01/12 16:42			0
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20	2003/01/12 16:46			0
21	2003/01/12 16:51			0



US006680904B1

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

(10) **Patent No.: US 6,680,904 B1**
(45) **Date of Patent: Jan. 20, 2004**

(54) **BI-DIRECTIONAL CHAINING OF
NETWORK ACCESS PORTS**

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Tzur-Igal (IL); **Ron Sdayoor**, Kiryat
(IL); **Eric Paneth**, Givataim (IL); **Eli
Magal**, Tel Aviv (IL)

(73) Assignee: **Orckit Communications Ltd.**, Tel Aviv
(IL)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/472,683**

(22) Filed: **Dec. 27, 1999**

(51) **Int. Cl.**⁷ **G01R 31/08**; H04L 12/66;
H04L 12/28; H04J 3/16

(52) **U.S. Cl.** **370/217**; 370/352; 370/392;
370/395.1; 370/465

(58) **Field of Search** 370/216, 217,
370/352-356, 389, 392, 395.1, 465, 466;
340/2.28, 2.24; 710/110, 129, 131, 132;
712/31, 39; 709/208, 209, 225, 229; 375/222

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,899,582 A * 5/1999 DuLac 386/125
6,181,715 B1 * 1/2001 Phillips et al. 370/493

6,215,863 B1 * 4/2001 Bennett, III et al. 379/221.09
6,219,354 B1 * 4/2001 Fink et al. 370/463
6,317,415 B1 * 11/2001 Darnell et al. 370/230
6,345,051 B1 * 2/2002 Gupta et al. 370/395.2
6,404,861 B1 * 6/2002 Cohen et al. 379/93.01
6,424,657 B1 * 7/2002 Voit et al. 370/412

OTHER PUBLICATIONS

Dave Allen et al, "An "Optimized for ATM" ADSL Access
Architecture using SDP", 7 pages, ADSL Forum 98-221,
Nov. 17th to 20th, 1998, Los Angeles, CA, USA.

"Vortex Chip Set: Introduction", Preliminary Issue 1, 16
pages, Jun. 1999, PMC-Sierra, Inc., BC Canada.

* cited by examiner

Primary Examiner—Duc Ho

(74) *Attorney, Agent, or Firm*—Abelman, Frayne &
Schwab

(57) **ABSTRACT**

Network access apparatus includes first and second master
units, each having a physical interface to a packet-switched
network. A plurality of slave units, each slave unit having
one or more ports to respective subscriber lines, are linked
by a plurality of physical interface lines in one or more daisy
chains, in which the slave units are mutually connected in
series by the physical interface lines therebetween. Each
daisy chain includes at least a first slave unit connected by
one of the physical interface lines to the first master unit and
a last slave unit connected by another of the physical
interface lines to the second master unit.

26 Claims, 9 Drawing Sheets

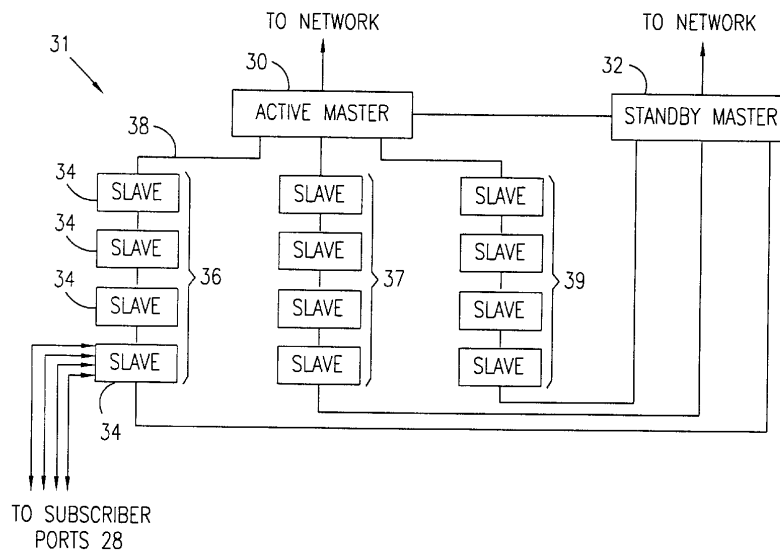


FIG. 1
PRIOR ART

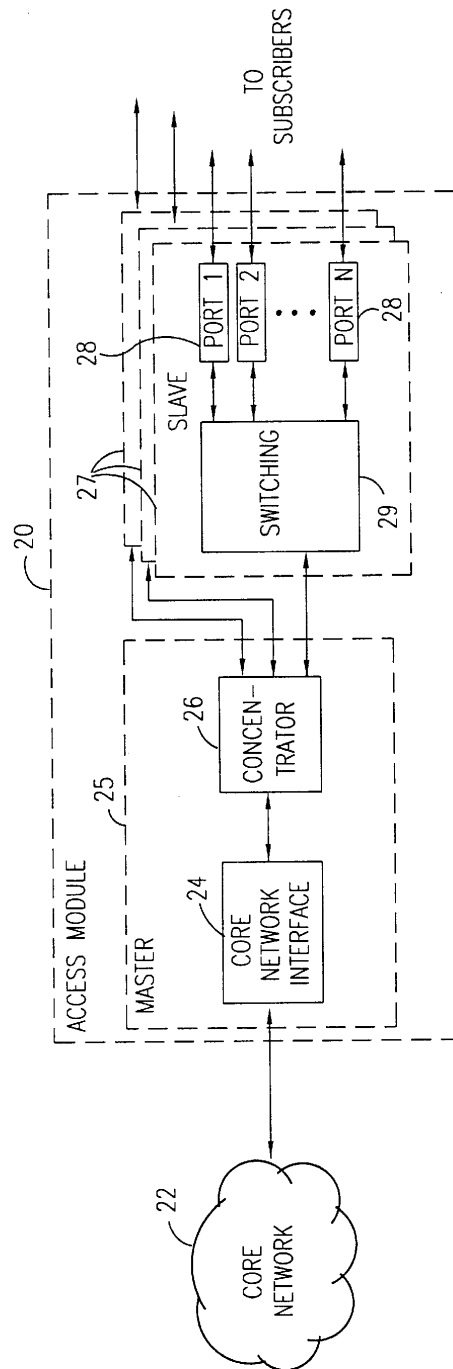


FIG. 2A
PRIOR ART

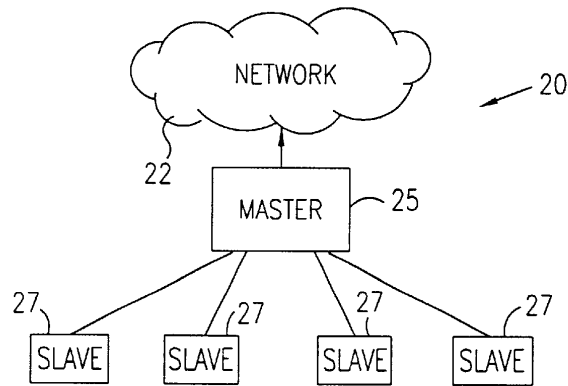


FIG. 2B
PRIOR ART

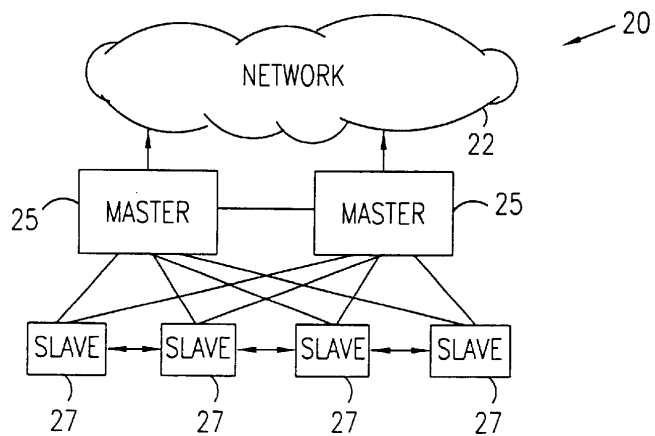


FIG. 3

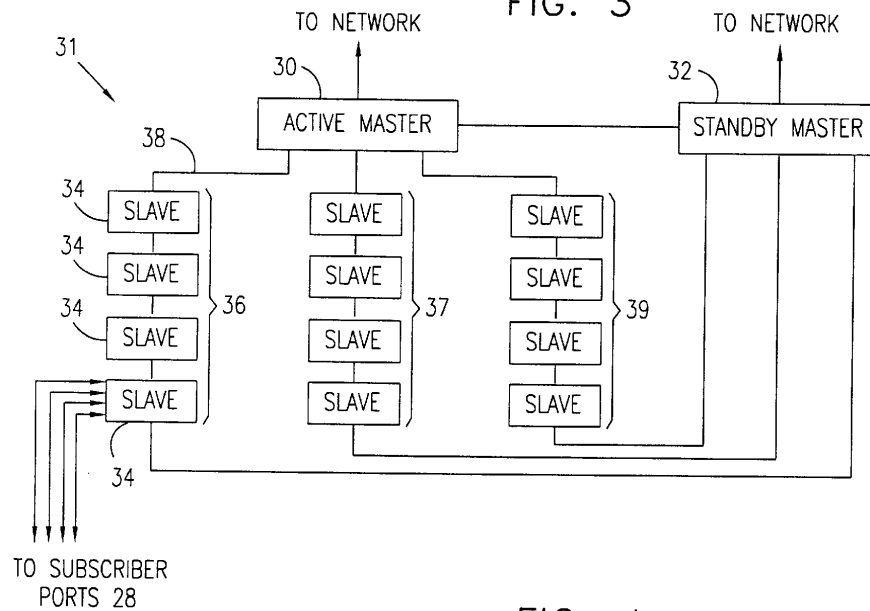


FIG. 4

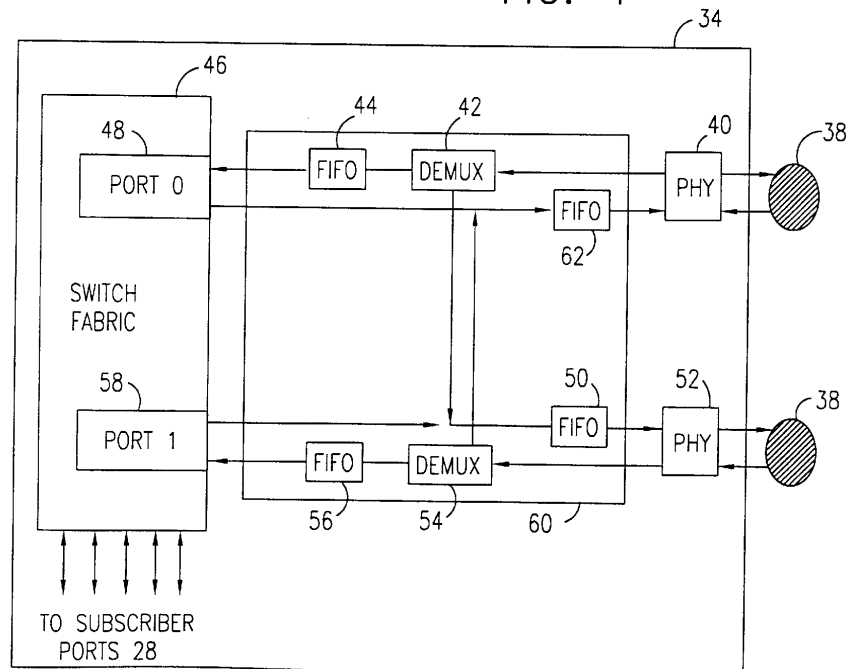


FIG. 5

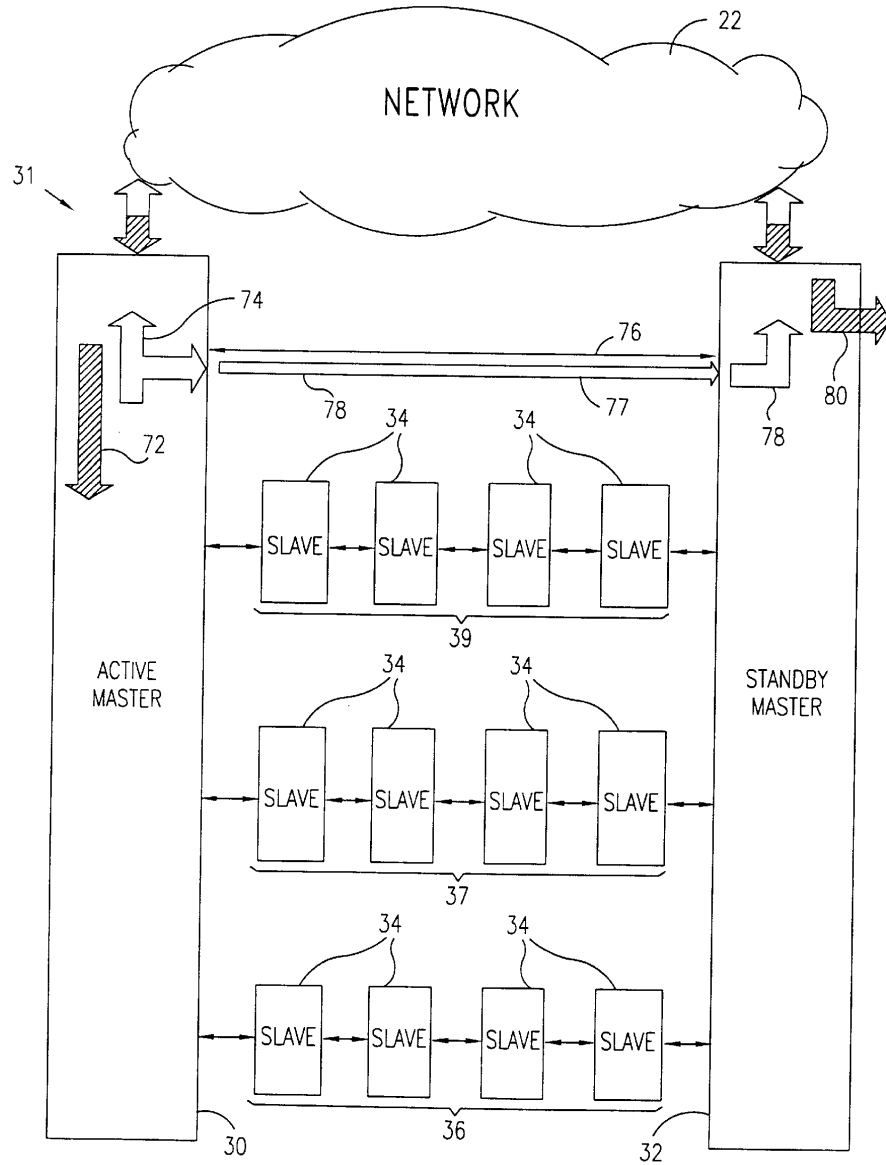


FIG. 7

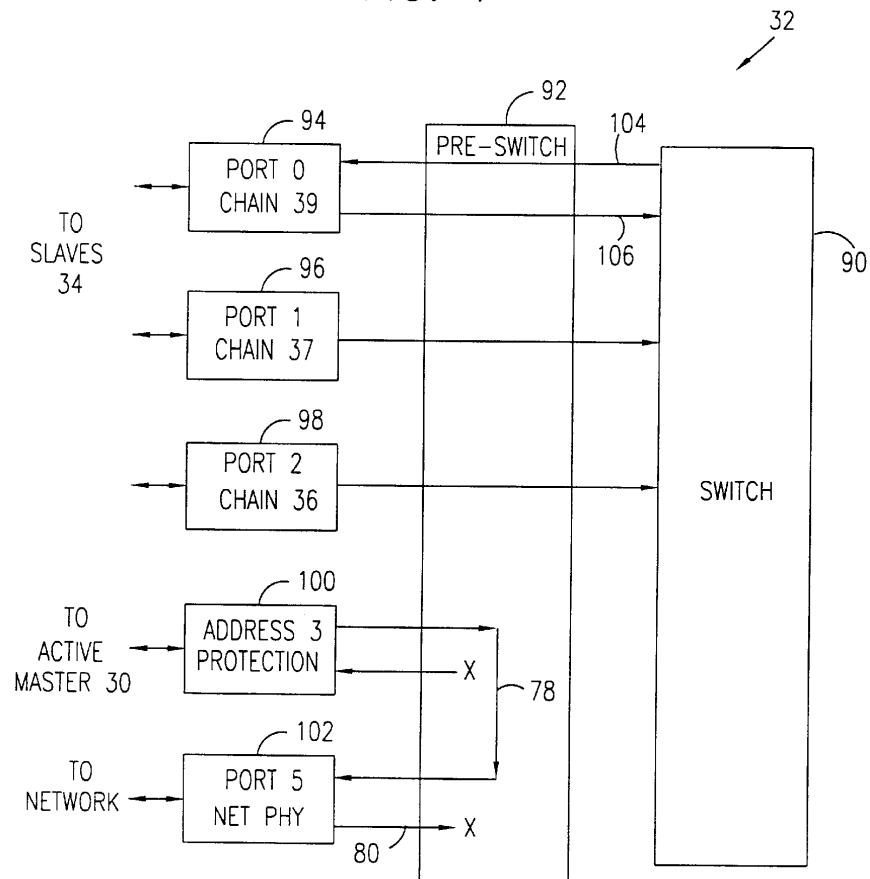


FIG. 8

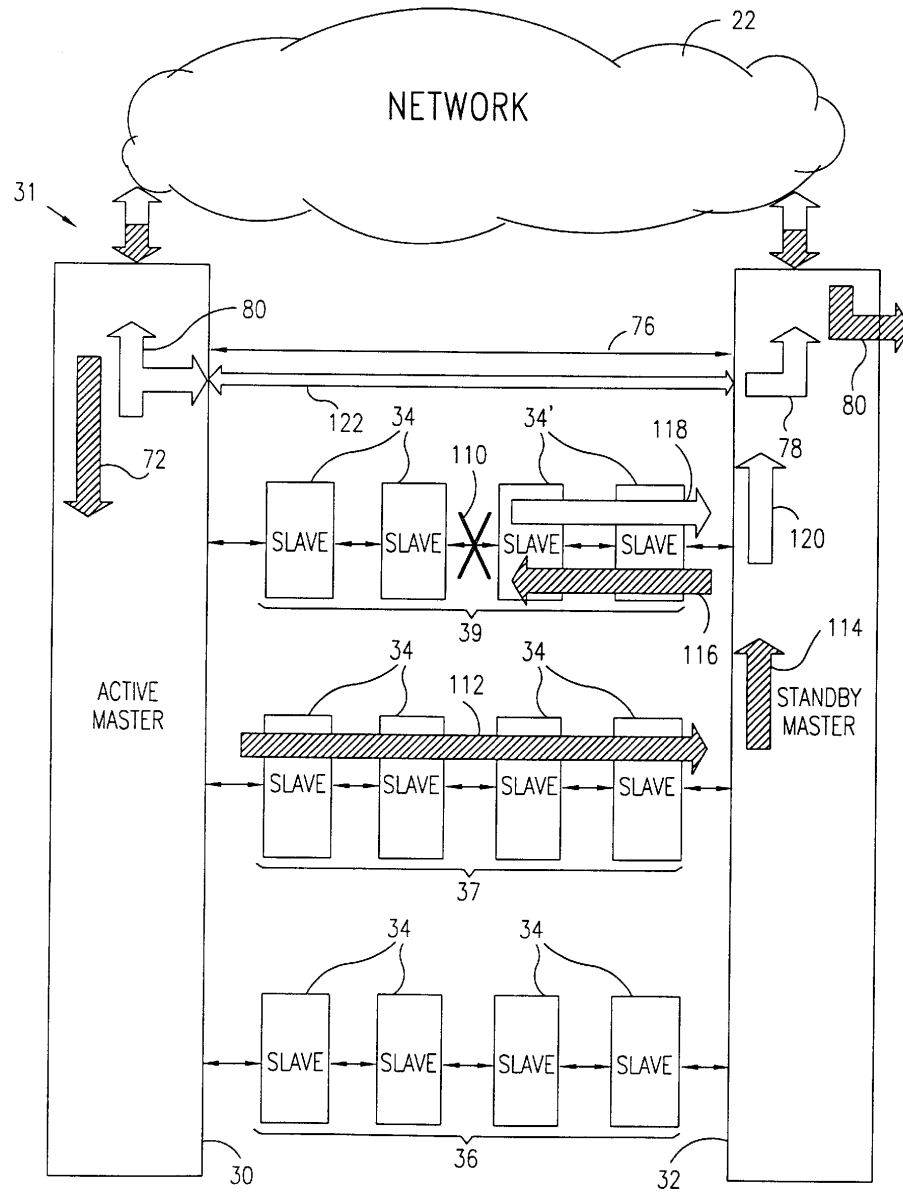


FIG. 9

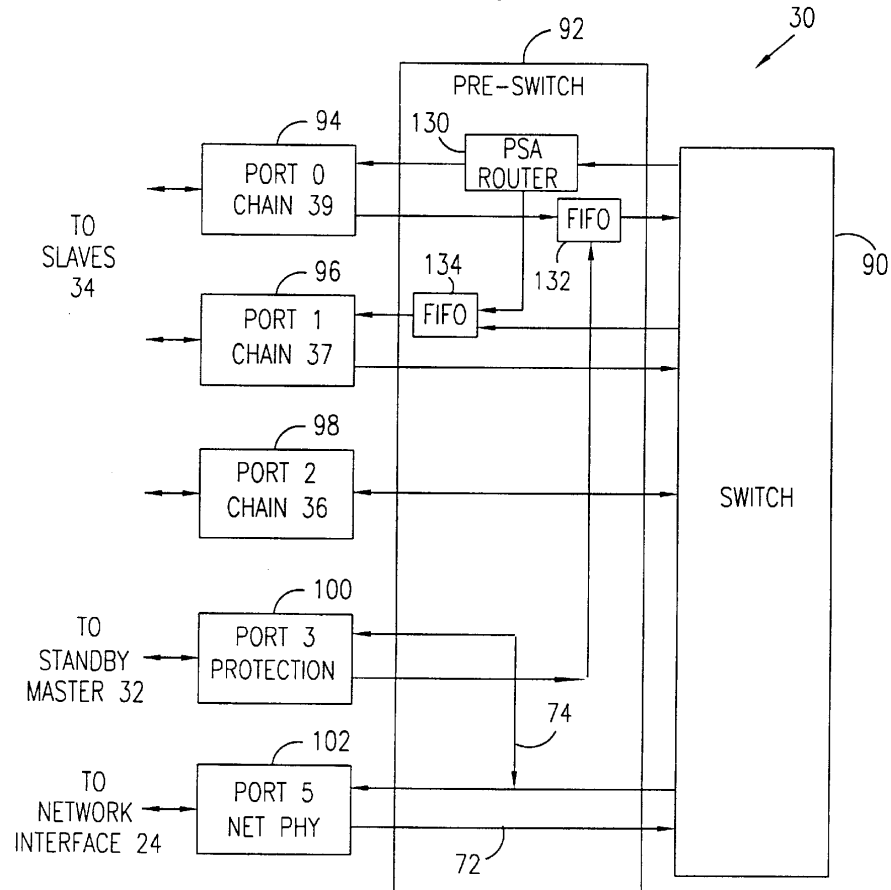
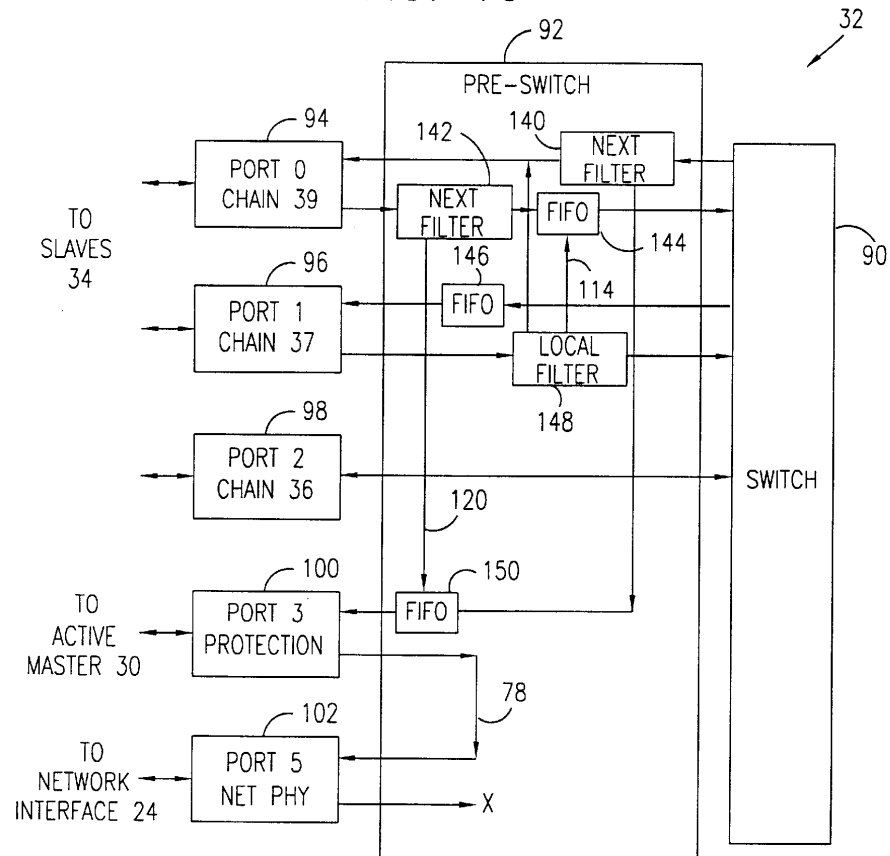


FIG. 10



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**BI-DIRECTIONAL CHAINING OF
NETWORK ACCESS PORTS****FIELD OF THE INVENTION**

The present invention relates generally to high-speed data communication systems, and specifically to digital subscriber line systems.

BACKGROUND OF THE INVENTION

Digital Subscriber Line (DSL) is a modem technology that enables broadband digital data to be transmitted over twisted-pair wire, which is the type of infrastructure that links most home and small business subscribers to their telephone service providers. DSL modems enable users to access digital networks at speeds tens to hundreds of times faster than current analog modems and basic ISDN service. DSL thus opens the most critical bottleneck in local-loop access to high-speed networks, such as Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) networks, without requiring major investments in new infrastructure. A range of DSL standards have been defined, known generically as "xDSL," wherein the various standards have different data rates and other associated features but share common principles of operation.

DSL subscribers are connected to high-speed networks through Digital Subscriber Line Access Multiplexer (DSLAM) systems. Because of the high cost of network bandwidth, a single DSLAM must typically be designed to serve between 100 and 1000 subscribers and to concentrate their traffic through one or a few network trunks. The need to serve such a large and potentially variable number of subscribers in the one DSLAM has led to the development of "multi-shelf" access architectures.

FIG. 1 is a block diagram that schematically illustrates a DSLAM system 20 implementing a multi-shelf architecture, as is known in the art. System 20 comprises a master unit 25 coupled to multiple slave units 27 in a star configuration. Master unit 25 communicates with a core network 22, such as an ATM network. The master unit comprises a core network interface element 24, providing the necessary physical layer (PHY) and data link layer (for example, ATM) functions. A concentrator 26 performs higher-level functions, including VPI/VCI translation for the ATM network, and multiplexes downstream and upstream packets, or cells, among slave units 27. Each slave unit typically comprises a switching core 29, coupled to a plurality of ports 28 serving respective subscriber premises via suitable DSL modems. In the physical implementation of system 20, each such slave unit occupies its own shelf in an electronics rack, and this is the reason for the use of the term "multi-shelf."

FIGS. 2A and 2B are block diagrams that schematically illustrate topologies known in the art for use in multi-shelf access systems, such as that shown in FIG. 1. FIG. 2A shows a simple star configuration. In a redundant star configuration, shown in FIG. 2B, each slave unit is connected to two or more alternative master units, so as to provide protection in case of a failure in one of the master units.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide an improved multi-shelf access architecture.

It is a further object of some aspects of the present invention to provide apparatus and methods for efficient, high-speed transfer of data packets within an access multiplexer system.

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It is still a further object of some aspects of the present invention to improve the robustness and reliability of multi-shelf access systems.

In preferred embodiments of the present invention, a multi-shelf access system comprises two master units ("masters") and a plurality of slave units ("slaves") One of the masters serves as an active master, through which the slaves normally receive data packets from a core network and transmit packets back upstream to the network. The other master is termed a standby master. The slaves are connected in one or more daisy chains between the active and standby masters, and are configured so that both downstream and upstream packets can be transmitted in either direction along each of the chains, i.e., from or to either of the two masters. Thus, if a failure occurs in any one of the slaves or in a link between them, the traffic direction in the chain in which the failure has occurred is simply reversed so as to run through the standby master. Substantially no reprogramming of the slaves is required for this purpose. All of the slaves (except possibly a slave that has failed) continue to provide service to subscribers, typically with only a short interruption until corrective action is completed.

Preferably, the upstream packets are bicast by the active master to both the core network and to the standby master. The standby master also transmits the upstream packets to the core network, in order to protect against faults in the network interface of the active master unit.

In some preferred embodiments of the present invention, each slave comprises a pre-switch, which examines each packet passed down its respective chain to determine whether the packet is destined for any of the ports on that slave. Preferably, every packet passed between the masters and slaves has a pre-switch address. If the packet is addressed to a particular slave, the pre-switch on that slave conveys the packet to a switch or switching fabric of the slave, which routes the packet to the appropriate port. If the packet is a multicast packet with an appropriate pre-switch address, the pre-switch both conveys a copy of the packet to the switch or switching fabric of the slave and passes the packet on down the chain. The pre-switch similarly accepts packets carrying a "next" address, i.e., packets that are sent from one slave to its immediate neighbor for topology detection and diagnostics. Otherwise, the pre-switch rejects the packet and passes it on to the next slave along the chain.

The pre-switch thus reduces the burden on the switching fabric of the slave and ensures that packets are passed down the chain at the full data rate supported by the master-slave interface. Furthermore, in the case of a fault in the slave, the pre-switch simply passes all packets through to the next slave in the chain, so that the effect of the fault is limited as far as possible.

Preferably, the slave pre-switch is bidirectional, i.e., it treats packets passed both up and down the chain in substantially the same manner. The pre-switch thus supports the failure protection mechanism described hereinabove, wherein the traffic direction is reversed in response to a failure in the chain.

There is therefore provided, in accordance with a preferred embodiment of the present invention, network access apparatus, including:

- first and second master units, each including a physical interface to a packet-switched network;
- a plurality of slave units, each slave unit including one or more ports to respective subscriber lines; and
- a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave

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units are mutually connected in series by the physical interface lines therebetween, each daisy chain including at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit.

Preferably, in normal operation, downstream data packets received from the network are passed from the first master unit to each of the daisy chains via the first slave unit in each chain, and upstream data packets received by the slaves in each chain from the subscriber lines are passed via the first slave unit in the chain to the first master unit for transmission over the network. Further preferably, the apparatus includes a protection interface, which couples the second master unit to the first master unit, and over which interface data packets are conveyed between the first and second master units in case of a fault. Most preferably, the first master unit multicasts the upstream data packets that it receives from the slave units to the network and, via the protection interface, to the second master unit, which transmits the upstream data packets to the network.

Preferably, in case of a fault at a location in one of the daisy chains, data flow in a portion of the daisy chain between the location of the fault and the second master unit is reversed, so that the downstream data packets are passed from the second master unit to the slave units in the portion of the daisy chain via the last slave unit in the chain, and the upstream data packets are passed by the last slave unit to the second master unit. Further preferably, the downstream packets for the slave units in the portion of the daisy chain between the location of the fault and the second master unit are conveyed to the second master unit from the first master unit via another one of the daisy chains.

In a preferred embodiment, each of the first and second master units includes:

- a switch, configured to route data packets between the respective physical interface and the one or more daisy chains; and
- a pre-switch, which in the event of a fault at a location in one of the daisy chains, re-routes at least a portion of the data packets exchanged with one or more of the slaves in the daisy chain in which the fault has occurred through another one of the daisy chains. Preferably, the pre-switch re-routes the data packets such that substantially no reconfiguration of the switch is required responsive to the fault.

In a further preferred embodiment, each of the slave units includes:

- a switch fabric including one or more switches, which convey data packets to respective ports on the switch to which the packets are addressed; and
- a pre-switch, which receives the data packets from one of the physical interface lines connected to the slave unit and passes those of the data packets that are addressed to any of the ports on the slave unit to the switch fabric, while passing packets not addressed to any of the ports on the slave unit for output through another of the physical interface lines.

Preferably, each of the slave units is coupled to receive packets transferred thereto from the first and second master units over first and second ones of the physical interface lines, respectively, and the pre-switch passes the packets received through the first and second physical interface line and addressed to any of the ports on the slave unit to respective first and second addresses in the switch fabric. Further preferably, in response to a reversal of a direction of data flow in the daisy chain, the first and second addresses

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are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required.

In a preferred embodiment, the network includes an asynchronous transfer mode (ATM) network. In another preferred embodiment, the network includes an Internet protocol (IP) network.

There is further provided, in accordance with a preferred embodiment of the present invention, in a network access multiplexing system, in which a master unit is connected by a physical interface to a packet-switched network, a slave unit configured to be coupled to the master unit in a daisy chain of such slave units, the slave unit including:

- a plurality of ports, for coupling the slave unit to respective subscriber lines;
- first and second physical interfaces, coupled to exchange packets with preceding and succeeding units, respectively, along the daisy chain;
- a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface; and
- a fabric of one or more switches, which convey the retained packets to the ports, responsive to the address data.

Preferably, the pre-switch is further coupled to receive packets transferred thereto from the second physical interface and to sort the packets in like manner to the packets received through the first physical interface. Most preferably, the retained packets that were received from the first and second physical interfaces and are passed by the pre-switch to the switch fabric are identified by respective first and second port numbers, wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second port numbers are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required in response to the reversal.

Further preferably, when one of the packets received by the pre-switch includes a multicast packet addressed to one or more of the ports on the slave unit, the pre-switch sorts the multicast packet such that one copy of the packet is retained and another copy of the packet is passed to the second physical interface.

Preferably, in the event of a fault in the switch fabric, the pre-switch continues to pass the packets addressed to the succeeding units on to the succeeding units without significant interruption.

There is also provided, in accordance with a preferred embodiment of the present invention, a method for providing access to a network, including:

- coupling first and second master units to interface with the network;
- linking a plurality of slave units, each slave unit including one or more ports to respective subscriber lines, in a daisy chain between the first and second master units; conveying initial downstream data packets, received from the network by one of the master units, along the daisy chain in a first direction, so as to deliver the packets to the ports of the slave units; and
- in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units.

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Preferably, the initial and further downstream packets are received from the network by the first master unit, and conveying the further downstream packets in the second direction includes conveying the further downstream packets from the first master unit to the second master unit, and then conveying the further downstream packets from the second master unit to the daisy chain. Most preferably, conveying the further downstream packets from the first master unit to the second master unit includes linking further slave units in an additional daisy chain between the first and second master units, and conveying the further downstream packets from the first master unit to the second master unit over the additional daisy chain.

Further preferably, the method includes conveying initial upstream data packets, received by the slave units from the subscriber lines, along the daisy chain in the second direction so as to transmit the upstream data packets via the first master unit over the network, and in the event of the fault, conveying further upstream data packets received by one or more of the slave units along the daisy chain in the first direction via the second master unit. Most preferably, the method includes bicast the upstream data packets from the first master unit to the network and to the second master unit, which transmits the bicast upstream data packets over the network.

Preferably, conveying the initial downstream data packets along the daisy chain includes pre-switching the packets at each of the slave units, so that packets not addressed to any of the ports on the slave unit are passed to the next slave unit in the daisy chain, while packets that are addressed to one or more of the ports on the slave unit are passed to a switch fabric that directs the packets to the ports to which they are addressed.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram that schematically illustrates a multi-shelf access system, as is known in the art;

FIGS. 2A and 2B are block diagrams that schematically illustrate multi-shelf system topologies that are known in the art;

FIG. 3 is a block diagram that schematically illustrates the topology of a multi-shelf access system, in accordance with a preferred embodiment of the present invention;

FIG. 4 is a block diagram that schematically illustrates a pre-switch used in a slave unit of a multi-shelf access system, in accordance with a preferred embodiment of the present invention;

FIG. 5 is a block diagram that schematically illustrates data flow in a multi-shelf access system under normal operating conditions, in accordance with a preferred embodiment of the present invention;

FIG. 6 is a block diagram that schematically illustrates details of an active master in the system of FIG. 5, in accordance with a preferred embodiment of the present invention;

FIG. 7 is a block diagram that schematically illustrates details of a standby master in the system of FIG. 5, in accordance with a preferred embodiment of the present invention;

FIG. 8 is a block diagram that schematically illustrates data flow in the system of FIG. 5 under fault conditions, in accordance with a preferred embodiment of the present invention;

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FIG. 9 is a block diagram that schematically illustrates details of the active master in the system of FIG. 5 under the fault conditions of FIG. 8, in accordance with a preferred embodiment of the present invention; and

FIG. 10 is a block diagram that schematically illustrates details of the standby master in the system of FIG. 5 under the fault conditions of FIG. 8, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 3 is a block diagram that schematically illustrates a multi-shelf access system 31, in accordance with a preferred embodiment of the present invention. System 31 is preferably a DSLAM, which provides subscriber access to an ATM network. Alternatively, system 31 may be configured for providing broadband access to substantially any high-speed, packet-switched network, such as an IP network, over substantially any suitable communications infrastructure. Some of the principles embodied in this system may also be applied in core network switching devices.

System 31 comprises two mutually-linked masters 30 and 32, both of which are generally capable of performing the functions of master 25, including interfacing to network 22 and higher-level routing functions, as shown in FIG. 1 and described with reference thereto. A plurality of slaves 34 are connected between masters 30 and 32 by lines 38 in a number of daisy chains 36, 37 and 39. Each slave comprises multiple subscriber ports 28, which link system 31 to respective subscriber locations. Although three chains are shown in FIG. 2, each comprising four slaves 34, it will be appreciated that masters 30 and 32 may also be configured to accommodate greater or smaller numbers of chains and/or slaves. An advantage of the architecture of system 31 is that additional slaves may be added to the chains as needed, without having to change the number of interfaces associated with masters 30 and 32.

Master 30 is termed the active master, because in normal operation of system 31, i.e., in the absence of faults in the system, downstream traffic from the network is routed from master 30 down chains 36, 37 and 39 to the respective slaves 34. Upstream traffic from the slaves is likewise routed up the chains to master 30. Active master 30 bicast upstream packets to the network and to standby master 32. The standby master conveys copies of the upstream packets to the network, as well, as protection against a failure in the network interface of active master 30. In case of a fault in one of chains 36, 37 or 39, as described further hereinbelow, the traffic direction in all or a part of the faulty chain is reversed. Packets are then directed between some of the slaves and standby master 32, rather than directly between the slaves and active master 30. When a serious failure occurs in the active master, all traffic may be directed through the standby master.

FIG. 4 is a block diagram that schematically illustrates details of one of slaves 34, showing particularly a pre-switch 60 in the slave, in accordance with a preferred embodiment of the present invention. This embodiment makes use of a pre-switch addressing scheme to facilitate traffic switching at the shelves. Every packet sent between masters 30 and 32 and slaves 34 has a pre-switch address (PSA), which identifies the packet as either:

1. A packet to/from a distinct slave shelf;
2. A broadcast/multicast packet; or
3. A packet for immediate neighbor (also called "Next" address, because it addresses the next element along a chain).

Pre-switch 60 processes packets according to their respective PSAs, as described further hereinbelow.

A PSA need not be unique over the entire multi-shelf system 31. Uniqueness is required, however, within any single chain 36, 37 or 39. If PSA is not unique at the entire multi-shelf system level, another bit must be allocated to distinguish between ordinary traffic and protection traffic packets. Protection traffic arises, as described hereinbelow, in situations wherein one of the chains delivers traffic for a shelf on another chain in which a fault has occurred.

The PSA is implemented either by appending some extra bits to every packet, or by using part of an already existing packet header. Specifically, for ATM implementation, the GFC portion of the standard ATM cell header is preferably used to accommodate the PSA. GFC is a four-bit field, of which three bits may be used for the PSA, and the remaining bit to indicate protection traffic. Using the GFC for the PSA limits the number of VPIs that can be allocated per slave shelf to 256. This limitation is most often acceptable, as it still allows at least one VPI per user. Alternatively, if more VPIs are required, extra bits may be appended to every cell.

The "Next" (neighbor) address is used for various topology detection and diagnostic procedures. Typically, each shelf sends control packets with the "Next" address, carrying the identity of the sending shelf identity, as well as the identity of the neighbor as received over the link and, optionally, additional information.

Referring back to FIG. 4, downstream data packets from active master 30 on line 38 are received by a first physical layer interface 40 and passed to a first demultiplexer 42 in pre-switch 60. The demultiplexer examines the PSA of the packets and, depending on this examination, takes the following actions:

If the PSA corresponds to this slave 34, a port number (PORT 0) is appended to the packet. This port is identified schematically in FIG. 4 by a block 48 in a switch or switching fabric 46 of the slave. A demultiplexer 42 passes the packet to an input FIFO 44, from which it is conveyed to switching fabric 46, which then routes the packet to the appropriate port 28.

If the packet is a broadcast packet, sent to slave 34, as well as to other slaves, the demultiplexer passes a copy of the packet, with the appropriate port number, to input FIFO 44, and switching fabric 46 routes the packet to the appropriate port, as described above. Another copy of the packet is passed to an output FIFO 50, from which it is sent through a second physical layer interface 52 over line 38 to the next slave in the chain.

If the PSA does correspond to this slave 34, demultiplexer 42 passes the packet to output FIFO 50 and from there through interface 52 and line 38 to the next slave in the chain.

If the packet carries a "Next" neighbor address, the demultiplexer passes the packet to input FIFO 44 and from there to switching fabric 46.

In this manner, pre-switch 60 relieves switching fabric 46 of the need to deal with any packets that are not addressed to ports 28 of the particular slave 34.

Upstream data packets are handled in an analogous fashion. Such packets are received by physical layer interface 52 and are passed to a second demultiplexer 54 in pre-switch 60. In this case, too, the pre-switch examines the packets to determine whether they carry a PSA corresponding to this slave 34. If so, another port number (PORT 1) of the slave is appended to the packet, identified by a block 58. In this case, the packets are passed to an input FIFO 56 and from there are conveyed to switching fabric 46 for routing to the

appropriate port 28. Otherwise, the packets are sent to an output FIFO 62, for transmission upstream via physical layer interface 40.

Packets that are received by slave 34 from ports 28 are passed by switch fabric 46 to output FIFO 62, as appropriate, for transmission back to active master 30. Alternatively, when a fault has occurred, the upstream packets from the ports are passed via FIFO 50 to standby master 32.

Because of the essential symmetry of slave 34 and particularly of pre-switch 60, the reversal in the direction of data flow over line 38 is accomplished without reprogramming look-up tables in switching fabric 46. It is necessary only to swap ports 0 and 1. The swap affects packets both received and transmitted by the slave, but it has no effect on through traffic, which is passed by demultiplexers 42 and 54 to respective output FIFOs 50 and 62 in any case. Should a fault occur in switch fabric 46 or elsewhere in slave 34, so that the slave is unable to transfer packets to or from its ports 28, pre-switch 60 simply passes all packets through to the next slaves (or master) up and down the chain. The effect of the fault is thus limited to the subscribers served by the particular slave, and other subscribers served by system 31 are substantially unaffected.

Although the operation of pre-switch 60 is described herein in the context of system 31, it will be appreciated that the principles embodied in the pre-switch may similarly be applied, mutatis mutandis, in other multi-shelf access architectures. The pre-switching technique is particularly useful when slave shelves are daisy-chained together, even when the chain is not closed as it is in system 31.

FIG. 5 is a block diagram that schematically illustrates details of data packet flow in system 31 under normal, fault-free conditions, in accordance with a preferred embodiment of the present invention. Hatched arrows, such as an arrow 72, represent downstream data flow, while unfilled arrows, such as an arrow 74, represent upstream data flow. Packets received from network 22 are routed by active master 30 down each of chains 36, 37 and 39, as indicated by arrow 72. Standby master 32 normally discards these downstream packets, as indicated by an arrow 80, except when a fault occurs in the active master.

Upstream packets, received by slaves 34 from their respective ports, are passed up the respective chains to active master 30. The active master bcasts these packets, sending them both to network 22 and to standby master 32 over a protection interface 76 between the two masters, as indicated by an arrow 77. The standby master also transmits the upstream packets over network 22, as indicated by an arrow 78. This redundancy in transmission is in accordance with fault protection mechanisms used in high-speed networks known in the art, such as the standard "1+1 APS" (automatic protection switching) technique used in SONET.

FIG. 6 is a block diagram that schematically shows details of active master 30 in normal operation, in accordance with a preferred embodiment of the present invention. Master 30 comprises a main switch 90 and a pre-switch 92. The main switch receives downstream (incoming) packets from the network physical layer interface (NET PHY). The network interface has a switching address 102, corresponding to a switch port no. 5. (For the particular case of ATM switching, this and the other port numbers in the figure preferably correspond to UTOPIA addresses.) The packets are distributed to chains 36, 37 and 39 at respective addresses 98, 96 and 94 (switch ports 2, 1 and 0). Upstream packets are delivered to address 102 for transmission over the network. Pre-switch 92 bcasts these packets, as described hereinabove, to an address 100 (switch port 3) of protection

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interface 76 to standby master 32. Input packets to master 30 from the protection interface are discarded by pre-switch 92. Other than these protection functions, the pre-switch operates as a transparent pass-through, as shown in FIG. 6, as long as no faults have occurred in system 31.

FIG. 7 is a block diagram that schematically shows details of standby master 32, in accordance with a preferred embodiment of the present invention. The standby master is structurally substantially identical to the active master, including main switch 90 and pre-switch 92. In normal operation, as shown in the figure, standby master 32 communicates only with active master 30, and is not expected to receive packets from or convey packets to any of slaves 34. Control traffic between the active and standby masters is preferably conveyed through chain 39, over an upstream path 104 and a downstream path 106 through the chain. Upstream data packets received by the standby master at address 100, over protection interface 76 from active master 30, are conveyed by pre-switch 92 to the network physical layer interface at address 102. The pre-switch passes any traffic from chains 36 and 37 transparently to switch 90, which treats any packets that it receives, except for control packets, as misrouted traffic.

Optionally, active master 30 and standby master 32 include their own local ports (not shown in the figures). In this case, the standby master is preferably treated as an additional slave on one of the chains, typically chain 39, and its ports have the same setup as all of the slave ports. Only the local ports of the active master have a different setup. The ports on the standby master are preferably assigned their own PSA, reducing by one the number of slaves that can be added on chain 39. Data traffic to and from the local ports on the standby master are carried over paths 106 and 104, in addition to the control traffic. Because protection interface 76 is reserved and, preferably, hardware-switched to deal with fault situations, it is undesirable to use this interface for the ordinary data and control traffic between the active and standby masters.

FIG. 8 is a block diagram that schematically illustrates operation of system 31 in the event of a communication fault in chain 39, in accordance with a preferred embodiment of the present invention. The fault is indicated by a mark 110 between two of slaves 34 and 34' in the chain, between which communications have been interrupted. In multi-shelf topologies known in the art, such as those shown in FIGS. 2A–2C, such a fault would result in interruption of service to subscribers served by all of slaves 34' downstream of the fault. In system 31, however, active master 30 recognizes that a fault has occurred, and commands standby master 32 and slaves 34 to take corrective action.

Downstream traffic for slaves 34' is routed by active master 30 through chain 37, as indicated by an arrow 112. Standby master 32 switches this traffic onto chain 39, as shown by arrows 114 and 116, so that the packets reach slaves 34'. The addresses of the two inputs to the pre-switches 60 of slaves 34' are swapped, as described hereinabove (FIG. 4), in order to reverse the direction of traffic flow on this portion of chain 39. Upstream packets returned by slaves 34' are routed back to standby master 32, as shown by an arrow 118. The standby master switches this traffic over protection interface 76 to active master 30, as indicated by arrows 120 and 122. From this point, the upstream traffic is transmitted over network 22 in normal fashion. Traffic to and from slaves 34 on chains 36 and 37 is substantially unaffected. Failures in chains 36 and 37 are handled in similar fashion.

FIG. 9 is a block diagram that schematically illustrates details of the operation of pre-switch 92 in active master 30

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under the fault conditions shown in FIG. 8, in accordance with a preferred embodiment of the present invention. For clarity of illustration, this block diagram and the other illustrations of pre-switch 92 show only the elements of the pre-switch that are of functional importance in handling this particular fault. The illustrated arrangement of these elements, and particularly of FIFO buffers in the pre-switch, has been chosen for simplicity and conceptual clarity, and variations on this arrangement will be apparent to those skilled in the art.

For all incoming traffic destined for chain 39, a PSA router 130 in pre-switch 92 determines whether the packets are addressed to slaves 34, upstream of the fault indicated by mark 110, or slaves 34', downstream of the fault. The PSA re-routes the traffic for slaves downstream of the fault through chain 37, in accordance with the following routing table:

TABLE I

PSA address	Original switch port	New switch port
0	0	0
1	0	0
2	0	1
3	0	1
4	0	0
5	0	0
6	0	1

In this table, PSA numbers 2 and 3 refer to slaves 34', whose traffic is thus routed via a FIFO 134 to address 96 (switch port 1) of chain 37. Broadcast traffic for chain 39 is routed by PSA router 130 to both chains 39 and 37, except for "Next" packets, which are sent only to chain 39.

As noted hereinabove, it is necessary to avoid confusion between downstream traffic to slaves 34', transferred on chain 37 as represented by arrow 112, and ordinary downstream traffic to slaves 34 located on chain 37 itself. For this reason, PSA router 130 preferably sets a bit reserved for this purpose in the packets destined for slaves 34'. In the case of ATM cells, for example, router 130 preferably sets the least significant bit of the GFC field to 1. Standby master 32 changes this bit back to 0 when switching the packets back to chain 39.

In the upstream direction, the traffic from slaves 34' over protection interface 76, represented by arrow 122, is merged with the normal upstream traffic from slaves 34 on chain 39 by a FIFO 132. Switch 90 processes the merged traffic as though it had all come directly from chain 39, and no special processing is required after pre-switch 92.

FIG. 10 is a block diagram that schematically illustrates details of pre-switch 92 in standby master 32 under the fault conditions of FIGS. 8 and 9, in accordance with a preferred embodiment of the present invention. Downstream traffic from chain 37 is examined by a local filter 148 in pre-switch 92 of standby master 32. The filter identifies packets destined for slaves 34', preferably based on the least significant bit of the GFC field in the packets, as noted above, and routes these packets to address 94 (UTOPIA port 0) of chain 39. The local filter changes the least significant bits back to 0. Packets for local ports on the standby master are routed to a FIFO 144, from which they are conveyed to switch 90. Other packets, typically "next" traffic originating from the last slave 34 on chain 37, are passed by filter 148 directly to switch 90.

Traffic arriving at standby master 32 from chain 39 is received by a next filter 142, which separates normal packet

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traffic from "Next" neighbor packets. The filter routes upstream packets, sent by slaves 34', to a FIFO 150. From this FIFO, these packets are conveyed through address 100, via protection interface 76, to active master 30. Upstream traffic from the local ports on the standby master is similarly routed by a next filter 140 to FIFO 150, and from there over the protection interface to the active master. The "Next" packets, however, are routed by filters 140 and 142 directly between the standby master and chain 39.

While FIGS. 8, 9 and 10 illustrate only a case in which a fault has occurred in chain 39, it will be understood that similar techniques may be applied when faults occur in chains 36 and 37. In fact, these latter cases are simpler to deal with, since control traffic between masters 30 and 32 is normally carried only over chain 39. In all cases, the use of pre-switches 92 in the two masters allows such faults to be handled substantially without any reprogramming or reconfiguration of switches 90.

Although preferred embodiments are described hereinabove with reference to DSL access to an ATM network, the principles of the present invention are similarly applicable in providing access to substantially any type of packet-switched network, and over substantially any sort of subscriber interface. The architecture and switching techniques used in system 31 are most advantageous when there is a need for high concentration at the access stage, i.e., for multiplexing of many lines into one or a few trunks. Those skilled in the art, however, will understand that the principles embodied in system 31 may also be applied to multiplexers and switches of other types, even including core network devices.

It will thus be appreciated that the preferred embodiments described above are cited by way of example, and that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove, as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description and which are not disclosed in the prior art.

What is claimed is:

1. Network access apparatus, comprising:
first and second master units, each comprising a physical interface to a packet-switched network;
a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and
a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected one of the physical interface lines to the first master unit, a second slave unit connected to the first slave unit but not to the first or second master unit, and a last slave unit connected by another of the physical interface lines to the second master unit.
2. Apparatus according to claim 1, wherein the network comprises an asynchronous transfer mode (ATM) network.
3. Apparatus according to claim 1, wherein the network comprises an Internet protocol (IP) network.
4. Network access apparatus, comprising:
first and second master units, each comprising a physical interface to a packet-switched network;
a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and
a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave

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units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit,

wherein in normal operation, downstream data packets received from the network are passed from the first master unit to each of the daisy chains via the first slave unit in each chain, and upstream data packets received by the slaves in each chain from the subscriber lines are passed via the first slave unit in the chain to the first master unit for transmission over the network.

5. Apparatus according to claim 4, and comprising a protection interface, which couples the second master unit to the first master unit, and over which interface data packets are conveyed between the first and second master units in case of a fault.

6. Apparatus according to claim 5, wherein the first master unit bcasts the upstream data packets that it receives from the slave units to the network and, via the protection interface, to the second master unit, which transmits the upstream data packets to the network.

7. Apparatus according to claim 4, wherein in case of a fault at a location in one of the daisy chains, data flow in a portion of the daisy chain between the location of the fault and the second master unit is reversed, so that the downstream data packets are passed from the second master unit to the slave units in the portion of the daisy chain via the last slave unit in the chain, and the upstream data packets are passed by the last slave unit to the second master unit.

8. Apparatus according to claim 7, wherein the downstream packets for the slave units in the portion of the daisy chain between the location of the fault and the second master unit are conveyed to the second master unit from the first master unit via another one of the daisy chains.

9. Network access apparatus, comprising:

- first and second master units, each comprising a physical interface to a packet-switched network;
- a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and
- a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit,

wherein each of the first and second master units comprises:

- a switch, configured to route data packets between the respective physical interface and the one or more daisy chains; and
- a pre-switch, which in the event of a fault at a location in one of the daisy chains, re-routes at least a portion of the data packets exchanged with one or more of the slaves in the daisy chain in which the fault has occurred through another one of the daisy chains.

10. Apparatus according to claim 9, wherein the pre-switch re-routes the data packets such that substantially no reconfiguration of the switch is required responsive to the fault.

11. Network access apparatus, comprising:

- first and second master units, each comprising a physical interface to a packet-switched network;

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a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and

a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit,

wherein each of the slave units comprises:

a switch fabric comprising one or more switches, which convey data packets to respective ports on the switch to which the packets are addressed; and

a pre-switch, which receives the data packets from one of the physical interface lines connected to the slave unit and passes those of the data packets that are addressed to any of the ports on the slave unit to the switch fabric, while passing packets not addressed to any of the ports on the slave unit for output through another of the physical interface lines.

12. Apparatus according to claim 11, wherein each of the slave units is coupled to receive packets transferred thereto from the first and second master units over first and second ones of the physical interface lines, respectively, and wherein the pre-switch passes the packets received through the first and second physical interface line and addressed to any of the ports on the slave unit to respective first and second addresses in the switch fabric.

13. Apparatus according to claim 12, wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second addresses are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required.

14. In a network access multiplexing system, in which a master unit is connected by a physical interface to a packet-switched network, a slave unit configured to be coupled to the master unit in a daisy chain of such slave units, the slave unit comprising:

a plurality of ports, for coupling the slave unit to respective subscriber lines;

first and second physical interfaces, coupled to exchange packets with preceding and succeeding units, respectively, along the daisy chain;

a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface; and

a fabric of one or more switches, which convey the retained packets to the ports, responsive to the address data.

15. The slave unit according to claim 14, wherein the pre-switch is further coupled to receive packets transferred thereto from the second physical interface and to sort the packets in like manner to the packets received through the first physical interface.

16. The slave unit according to claim 15, wherein the retained packets that were received from the first and second physical interfaces and are passed by the pre-switch to the switch fabric are identified by respective first and second port numbers, and wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second port numbers are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required in response to the reversal.

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17. The slave unit according to claim 14, wherein when one of the packets received by the pre-switch comprises a multicast packet addressed to one or more of the ports on the slave unit, the pre-switch sorts the multicast packet such that one copy of the packet is retained and another copy of the packet is passed to the second physical interface.

18. The slave unit according to claim 14, wherein in the event of a fault in the switch fabric, the pre-switch continues to pass the packets addressed to the succeeding units on to the succeeding units without significant interruption.

19. A method for providing access to a network, comprising:

coupling first and second master units to interface with the network;

linking a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines, in a daisy chain between the first and second master units;

conveying initial downstream data packets, received from the network by one of the master units, along the daisy chain in a first direction, so as to deliver the packets to the ports of the slave units; and

in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units.

20. A method according to claim 19, wherein the initial and further downstream packets are received from the network by the first master unit, and wherein conveying the further downstream packets in the second direction comprises conveying the further downstream packets from the first master unit to the second master unit, and then conveying the further downstream packets from the second master unit to the daisy chain.

21. A method according to claim 20, wherein conveying the further downstream packets from the first master unit to the second master unit comprises linking further slave units in an additional daisy chain between the first and second master units, and conveying the further downstream packets from the first master unit to the second master unit over the additional daisy chain.

22. A method according to claim 19, and comprising conveying initial upstream data packets, received by the slave units from the subscriber lines, along the daisy chain in the second direction so as to transmit the upstream data packets via the first master unit over the network, and in the event of the fault, conveying further upstream data packets received by one or more of the slave units along the daisy chain in the first direction via the second master unit.

23. A method according to claim 22, and comprising multicasting the upstream data packets from the first master unit to the network and to the second master unit, which transmits the multicast upstream data packets over the network.

24. A method according to claim 19, wherein conveying the initial downstream data packets along the daisy chain comprises pre-switching the packets at each of the slave units, so that packets not addressed to any of the ports on the slave unit are passed to the next slave unit in the daisy chain, while packets that are addressed to one or more of the ports on the slave unit are passed to a switch fabric that directs the packets to the ports to which they are addressed.

25. A method according to claim 19, wherein the network comprises an asynchronous transfer mode (ATM) network.

26. A method according to claim 19, wherein the network comprises an Internet protocol (IP) network.

* * * * *



Bib Data Sheet


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UTILITY PATENT APPLICATION TRANSMITTAL	
Attorney Docket No.	204,344
First Inventor or Application Identifier	Menachem KAPLAN
Title	BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS
Express Mail Label No.	EJ620992788US

(Only for new nonprovisional applications under 37 CFR 1.53(b))

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents. 1. ☒ Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original, and a duplicate for fee processing) 2. ☒ Specification [Total Pages 31] (preferred arrangement set forth below) - Descriptive title of the invention - Cross References to Related Applications - Statement Regarding Fed sponsored R & D - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure 3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 9] 4. Oath or Declaration —unsigned [Total Pages 2] a. ☐ Newly executed (original or copy) b. ☐ Copy from a prior application (37 C.F.R. § 1.63(d)) (for continuation/divisional with Box 17 completed) (Note Box 5 below) i. ☐ DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b). 5. ☐ Incorporation By Reference (useable if Box 4b is checked) The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein. 6. ☐ Microfiche Computer Program (Appendix) 7. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. ☐ Computer Readable Copy b. ☐ Paper Copy (identical to computer copy) c. ☐ Statement verifying identity of above copies	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
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ACCOMPANYING APPLICATION PARTS	
8. ☐ Assignment Papers (cover sheet & document(s))	
9. ☐ 37 C.F.R. §3.73(b) Statement (when there is an assignee) ☒ Power of Attorney	
10. ☐ English Translation Document (if applicable)	
11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations	
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Prior application information: Examiner _____ Group / Art Unit: _____

18. CORRESPONDENCE ADDRESS

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TOTAL AMOUNT OF PAYMENT (\$ 868.00

Complete if Known

Application Number
 Filing Date
 First Named Inventor Menachem KAPLAN
 Examiner Name
 Group / Art Unit
 Attorney Docket No. 204,344

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity	Small Entity	Fee Code	Fee Code	Fee Description	Fee Paid
101	790	201	395	Utility filing fee	760.00
106	330	208	185	Design filing fee	
107	540	207	270	Plant filing fee	
108	790	208	395	Reissue filing fee	
114	150	214	75	Provisional filing fee	
SUBTOTAL (1)					(\$ 760.00)

2. EXTRA CLAIM FEES

Total Claims	Extra Claims	Fee from below	Fee Paid
26	-20 = 6	X 18 =	108.00
Independent Claims	-3 =	X	
Multiple Dependent			

**or number previously paid, if greater; For Reissues, see below

Large Entity	Small Entity	Fee Code	Fee Code	Fee Description	Fee Paid
103	22	203	11	Claims in excess of 20	
102	82	202	41	Independent claims in excess of 3	
104	270	204	135	Multiple dependent claim, if not paid	
109	82	209	41	** Reissue independent claims over original patent	
110	22	210	11	** Reissue claims in excess of 20 and over original patent	
SUBTOTAL (2)					(\$ 108.00)

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity	Small Entity	Fee Code	Fee Code	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
118	400	218	200	Extension for reply within second month	
117	950	217	475	Extension for reply within third month	
118	1,510	218	755	Extension for reply within fourth month	
128	2,080	228	1,030	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,320	241	660	Petition to revive - unintentional	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	870	244	335	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
128	240	128	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
148	790	248	395	Filing a submission after final rejection (37 CFR 1.129(a))	
149	790	249	395	For each additional invention to be examined (37 CFR 1.129(b))	
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Other fee (specify)					

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BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS**FIELD OF THE INVENTION**

The present invention relates generally to high-speed data communication systems, and specifically to digital subscriber line systems.

BACKGROUND OF THE INVENTION

Digital Subscriber Line (DSL) is a modem technology that enables broadband digital data to be transmitted over twisted-pair wire, which is the type of infrastructure that links most home and small business subscribers to their telephone service providers. DSL modems enable users to access digital networks at speeds tens to hundreds of times faster than current analog modems and basic ISDN service. DSL thus opens the most critical bottleneck in local-loop access to high-speed networks, such as Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) networks, without requiring major investments in new infrastructure. A range of DSL standards have been defined, known generically as "xDSL," wherein the various standards have different data rates and other associated features but share common principles of operation.

DSL subscribers are connected to high-speed networks through Digital Subscriber Line Access Multiplexer (DSLAM) systems. Because of the high cost of network bandwidth, a single DSLAM must typically be designed to serve between 100 and 1000 subscribers and to concentrate their traffic through one or a few network trunks. The need to serve such a large and potentially variable number of subscribers in the one DSLAM has led to the development of "multi-shelf" access architectures.

Fig. 1 is a block diagram that schematically illustrates a DSLAM system 20 implementing a multi-shelf

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architecture, as is known in the art. System 20 comprises a master unit 25 coupled to multiple slave units 27 in a star configuration. Master unit 25 communicates with a core network 22, such as an ATM network. The master unit comprises a core network interface element 24, providing the necessary physical layer (PHY) and data link layer (for example, ATM) functions. A concentrator 26 performs higher-level functions, including VPI/VCI translation for the ATM network, and multiplexes downstream and upstream packets, or cells, among slave units 27. Each slave unit typically comprises a switching core 29, coupled to a plurality of ports 28 serving respective subscriber premises via suitable DSL modems. In the physical implementation of system 20, each such slave unit occupies its own shelf in an electronics rack, and this is the reason for the use of the term "multi-shelf."

Figs. 2A and 2B are block diagrams that schematically illustrate topologies known in the art for use in multi-shelf access systems, such as that shown in Fig. 1. Fig. 2A shows a simple star configuration. In a redundant star configuration, shown in Fig. 2B, each slave unit is connected to two or more alternative master units, so as to provide protection in case of a failure in one of the master units.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide an improved multi-shelf access architecture.

It is a further object of some aspects of the present invention to provide apparatus and methods for efficient, high-speed transfer of data packets within an access multiplexer system.

It is still a further object of some aspects of the present invention to improve the robustness and reliability of multi-shelf access systems.

In preferred embodiments of the present invention, a multi-shelf access system comprises two master units ("masters") and a plurality of slave units ("slaves"). One of the masters serves as an active master, through which the slaves normally receive data packets from a core network and transmit packets back upstream to the network. The other master is termed a standby master. The slaves are connected in one or more daisy chains between the active and standby masters, and are configured so that both downstream and upstream packets can be transmitted in either direction along each of the chains, i.e., from or to either of the two masters. Thus, if a failure occurs in any one of the slaves or in a link between them, the traffic direction in the chain in which the failure has occurred is simply reversed so as to run through the standby master. Substantially no reprogramming of the slaves is required for this purpose. All of the slaves (except possibly a slave that has failed) continue to provide service to subscribers, typically with only a short interruption until corrective action is completed.

Preferably, the upstream packets are bicast by the active master to both the core network and to the standby

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master. The standby master also transmits the upstream packets to the core network, in order to protect against faults in the network interface of the active master unit.

In some preferred embodiments of the present invention, each slave comprises a pre-switch, which examines each packet passed down its respective chain to determine whether the packet is destined for any of the ports on that slave. Preferably, every packet passed between the masters and slaves has a pre-switch address. If the packet is addressed to a particular slave, the pre-switch on that slave conveys the packet to a switch or switching fabric of the slave, which routes the packet to the appropriate port. If the packet is a multicast packet with an appropriate pre-switch address, the pre-switch both conveys a copy of the packet to the switch or switching fabric of the slave and passes the packet on down the chain. The pre-switch similarly accepts packets carrying a "next" address, i.e., packets that are sent from one slave to its immediate neighbor for topology detection and diagnostics. Otherwise, the pre-switch rejects the packet and passes it on to the next slave along the chain.

The pre-switch thus reduces the burden on the switching fabric of the slave and ensures that packets are passed down the chain at the full data rate supported by the master-slave interface. Furthermore, in the case of a fault in the slave, the pre-switch simply passes all packets through to the next slave in the chain, so that the effect of the fault is limited as far as possible.

Preferably, the slave pre-switch is bidirectional, i.e., it treats packets passed both up and down the chain in substantially the same manner. The pre-switch thus supports the failure protection mechanism described

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hereinabove, wherein the traffic direction is reversed in response to a failure in the chain.

There is therefore provided, in accordance with a preferred embodiment of the present invention, network access apparatus, including:

first and second master units, each including a physical interface to a packet-switched network;

a plurality of slave units, each slave unit including one or more ports to respective subscriber lines; and

a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain including at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit.

Preferably, in normal operation, downstream data packets received from the network are passed from the first master unit to each of the daisy chains via the first slave unit in each chain, and upstream data packets received by the slaves in each chain from the subscriber lines are passed via the first slave unit in the chain to the first master unit for transmission over the network. Further preferably, the apparatus includes a protection interface, which couples the second master unit to the first master unit, and over which interface data packets are conveyed between the first and second master units in case of a fault. Most preferably, the first master unit multicasts the upstream data packets that it receives from the slave units to the network and, via the protection interface, to the second master unit, which transmits the upstream data packets to the network.

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Preferably, in case of a fault at a location in one of the daisy chains, data flow in a portion of the daisy chain between the location of the fault and the second master unit is reversed, so that the downstream data packets are passed from the second master unit to the slave units in the portion of the daisy chain via the last slave unit in the chain, and the upstream data packets are passed by the last slave unit to the second master unit. Further preferably, the downstream packets for the slave units in the portion of the daisy chain between the location of the fault and the second master unit are conveyed to the second master unit from the first master unit via another one of the daisy chains.

In a preferred embodiment, each of the first and second master units includes:

- a switch, configured to route data packets between the respective physical interface and the one or more daisy chains; and

- a pre-switch, which in the event of a fault at a location in one of the daisy chains, re-routes at least a portion of the data packets exchanged with one or more of the slaves in the daisy chain in which the fault has occurred through another one of the daisy chains. Preferably, the pre-switch re-routes the data packets such that substantially no reconfiguration of the switch is required responsive to the fault.

In a further preferred embodiment, each of the slave units includes:

- a switch fabric including one or more switches, which convey data packets to respective ports on the switch to which the packets are addressed; and

- a pre-switch, which receives the data packets from one of the physical interface lines connected to the slave unit and passes those of the data packets that are

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addressed to any of the ports on the slave unit to the switch fabric, while passing packets not addressed to any of the ports on the slave unit for output through another of the physical interface lines.

Preferably, each of the slave units is coupled to receive packets transferred thereto from the first and second master units over first and second ones of the physical interface lines, respectively, and the pre-switch passes the packets received through the first and second physical interface line and addressed to any of the ports on the slave unit to respective first and second addresses in the switch fabric. Further preferably, in response to a reversal of a direction of data flow in the daisy chain, the first and second addresses are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required.

In a preferred embodiment, the network includes an asynchronous transfer mode (ATM) network. In another preferred embodiment, the network includes an Internet protocol (IP) network.

There is further provided, in accordance with a preferred embodiment of the present invention, in a network access multiplexing system, in which a master unit is connected by a physical interface to a packet-switched network, a slave unit configured to be coupled to the master unit in a daisy chain of such slave units, the slave unit including:

- a plurality of ports, for coupling the slave unit to respective subscriber lines;

- first and second physical interfaces, coupled to exchange packets with preceding and succeeding units, respectively, along the daisy chain;

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a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface; and

a fabric of one or more switches, which convey the retained packets to the ports, responsive to the address data.

Preferably, the pre-switch is further coupled to receive packets transferred thereto from the second physical interface and to sort the packets in like manner to the packets received through the first physical interface. Most preferably, the retained packets that were received from the first and second physical interfaces and are passed by the pre-switch to the switch fabric are identified by respective first and second port numbers, wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second port numbers are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required in response to the reversal.

Further preferably, when one of the packets received by the pre-switch includes a multicast packet addressed to one or more of the ports on the slave unit, the pre-switch sorts the multicast packet such that one copy of the packet is retained and another copy of the packet is passed to the second physical interface.

Preferably, in the event of a fault in the switch fabric, the pre-switch continues to pass the packets addressed to the succeeding units on to the succeeding units without significant interruption.

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There is also provided, in accordance with a preferred embodiment of the present invention, a method for providing access to a network, including:

coupling first and second master units to interface with the network;

linking a plurality of slave units, each slave unit including one or more ports to respective subscriber lines, in a daisy chain between the first and second master units;

conveying initial downstream data packets, received from the network by one of the master units, along the daisy chain in a first direction, so as to deliver the packets to the ports of the slave units; and

in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units.

Preferably, the initial and further downstream packets are received from the network by the first master unit, and conveying the further downstream packets in the second direction includes conveying the further downstream packets from the first master unit to the second master unit, and then conveying the further downstream packets from the second master unit to the daisy chain. Most preferably, conveying the further downstream packets from the first master unit to the second master unit includes linking further slave units in an additional daisy chain between the first and second master units, and conveying the further downstream packets from the first master unit to the second master unit over the additional daisy chain.

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Further preferably, the method includes conveying initial upstream data packets, received by the slave units from the subscriber lines, along the daisy chain in the second direction so as to transmit the upstream data packets via the first master unit over the network, and in the event of the fault, conveying further upstream data packets received by one or more of the slave units along the daisy chain in the first direction via the second master unit. Most preferably, the method includes bicasting the upstream data packets from the first master unit to the network and to the second master unit, which transmits the bicast upstream data packets over the network.

Preferably, conveying the initial downstream data packets along the daisy chain includes pre-switching the packets at each of the slave units, so that packets not addressed to any of the ports on the slave unit are passed to the next slave unit in the daisy chain, while packets that are addressed to one or more of the ports on the slave unit are passed to a switch fabric that directs the packets to the ports to which they are addressed.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram that schematically illustrates a multi-shelf access system, as is known in the art;

Figs. 2A and 2B are block diagrams that schematically illustrate multi-shelf system topologies that are known in the art;

Fig. 3 is a block diagram that schematically illustrates the topology of a multi-shelf access system,

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in accordance with a preferred embodiment of the present invention;

Fig. 4 is a block diagram that schematically illustrates a pre-switch used in a slave unit of a multi-shelf access system, in accordance with a preferred embodiment of the present invention;

Fig. 5 is a block diagram that schematically illustrates data flow in a multi-shelf access system under normal operating conditions, in accordance with a preferred embodiment of the present invention;

Fig. 6 is a block diagram that schematically illustrates details of an active master in the system of Fig. 5, in accordance with a preferred embodiment of the present invention;

Fig. 7 is a block diagram that schematically illustrates details of a standby master in the system of Fig. 5, in accordance with a preferred embodiment of the present invention;

Fig. 8 is a block diagram that schematically illustrates data flow in the system of Fig. 5 under fault conditions, in accordance with a preferred embodiment of the present invention;

Fig. 9 is a block diagram that schematically illustrates details of the active master in the system of Fig. 5, under the fault conditions of Fig. 8, in accordance with a preferred embodiment of the present invention; and

Fig. 10 is a block diagram that schematically illustrates details of the standby master in the system of Fig. 5 under the fault conditions of Fig. 8, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 3 is a block diagram that schematically illustrates a multi-shelf access system 31, in accordance with a preferred embodiment of the present invention. System 31 is preferably a DSLAM, which provides subscriber access to an ATM network. Alternatively, system 31 may be configured for providing broadband access to substantially any high-speed, packet-switched network, such as an IP network, over substantially any suitable communications infrastructure. Some of the principles embodied in this system may also be applied in core network switching devices.

System 31 comprises two mutually-linked masters 30 and 32, both of which are generally capable of performing the functions of master 25, including interfacing to network 22 and higher-level routing functions, as shown in Fig. 1 and described with reference thereto. A plurality of slaves 34 are connected between masters 30 and 32 by lines 38 in a number of daisy chains 36, 37 and 39. Each slave comprises multiple subscriber ports 28, which link system 31 to respective subscriber locations. Although three chains are shown in Fig. 2, each comprising four slaves 34, it will be appreciated that masters 30 and 32 may also be configured to accommodate greater or smaller numbers of chains and/or slaves. An advantage of the architecture of system 31 is that additional slaves may be added to the chains as needed, without having to change the number of interfaces associated with masters 30 and 32.

Master 30 is termed the active master, because in normal operation of system 31, i.e., in the absence of faults in the system, downstream traffic from the network is routed from master 30 down chains 36, 37 and 39 to the respective slaves 34. Upstream traffic from the slaves

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is likewise routed up the chains to master 30. Active master 30 bicast upstream packets to the network and to standby master 32. The standby master conveys copies of the upstream packets to the network, as well, as protection against a failure in the network interface of active master 30. In case of a fault in one of chains 36, 37 or 39, as described further hereinbelow, the traffic direction in all or a part of the faulty chain is reversed. Packets are then directed between some of the slaves and standby master 32, rather than directly between the slaves and active master 30. When a serious failure occurs in the active master, all traffic may be directed through the standby master.

Fig. 4 is a block diagram that schematically illustrates details of one of slaves 34, showing particularly a pre-switch 60 in the slave, in accordance with a preferred embodiment of the present invention. This embodiment makes use of a pre-switch addressing scheme to facilitate traffic switching at the shelves. Every packet sent between masters 30 and 32 and slaves 34 has a pre-switch address (PSA), which identifies the packet as either:

1. A packet to/from a distinct slave shelf;
2. A broadcast/multicast packet; or
3. A packet for immediate neighbor (also called "Next" address, because it addresses the next element along a chain).

Pre-switch 60 processes packets according to their respective PSAs, as described further hereinbelow.

A PSA need not be unique over the entire multi-shelf system 31. Uniqueness is required, however, within any single chain 36, 37 or 39. If PSA is not unique at the entire multi-shelf system level, another bit must be allocated to distinguish between ordinary traffic and

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protection traffic packets. Protection traffic arises, as described hereinbelow, in situations wherein one of the chains delivers traffic for a shelf on another chain in which a fault has occurred.

The PSA is implemented either by appending some extra bits to every packet, or by using part of an already existing packet header. Specifically, for ATM implementation, the GFC portion of the standard ATM cell header is preferably used to accommodate the PSA. GFC is a four-bit field, of which three bits may be used for the PSA, and the remaining bit to indicate protection traffic. Using the GFC for the PSA limits the number of VPIs that can be allocated per slave shelf to 256. This limitation is most often acceptable, as it still allows at least one VPI per user. Alternatively, if more VPIs are required, extra bits may be appended to every cell.

The "Next" (neighbor) address is used for various topology detection and diagnostic procedures. Typically, each shelf sends control packets with the "Next" address, carrying the identity of the sending shelf identity, as well as the identity of the neighbor as received over the link and, optionally, additional information.

Referring back to Fig. 4, downstream data packets from active master 30 on line 38 are received by a first physical layer interface 40 and passed to a first demultiplexer 42 in pre-switch 60. The demultiplexer examines the PSA of the packets and, depending on this examination, takes the following actions:

- If the PSA corresponds to this slave 34, a port number (PORT 0) is appended to the packet. This port is identified schematically in Fig. 4 by a block 48 in a switch or switching fabric 46 of the slave. A demultiplexer 42 passes the packet to an input FIFO 44, from which it is conveyed to

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switching fabric 46, which then routes the packet to the appropriate port 28.

- If the packet is a broadcast packet, sent to slave 34, as well as to other slaves, the demultiplexer passes a copy of the packet, with the appropriate port number, to input FIFO 44, and switching fabric 46 routes the packet to the appropriate port, as described above. Another copy of the packet is passed to an output FIFO 50, from which it is sent through a second physical layer interface 52 over line 38 to the next slave in the chain.
- If the PSA does correspond to this slave 34, demultiplexer 42 passes the packet to output FIFO 50 and from there through interface 52 and line 38 to the next slave in the chain.
- If the packet carries a "Next" neighbor address, the demultiplexer passes the packet to input FIFO 44 and from there to switching fabric 46.

In this manner, pre-switch 60 relieves switching fabric 46 of the need to deal with any packets that are not addressed to ports 28 of the particular slave 34.

Upstream data packets are handled in an analogous fashion. Such packets are received by physical layer interface 52 and are passed to a second demultiplexer 54 in pre-switch 60. In this case, too, the pre-switch examines the packets to determine whether they carry a PSA corresponding to this slave 34. If so, another port number (PORT 1) of the slave is appended to the packet, identified by a block 58. In this case, the packets are passed to an input FIFO 56 and from there are conveyed to switching fabric 46 for routing to the appropriate port 28. Otherwise, the packets are sent to an output FIFO

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62, for transmission upstream via physical layer interface 40.

Packets that are received by slave 34 from ports 28 are passed by switch fabric 46 to output FIFO 62, as appropriate, for transmission back to active master 30. Alternatively, when a fault has occurred, the upstream packets from the ports are passed via FIFO 50 to standby master 32.

Because of the essential symmetry of slave 34 and particularly of pre-switch 60, the reversal in the direction of data flow over line 38 is accomplished without reprogramming look-up tables in switching fabric 46. It is necessary only to swap ports 0 and 1. The swap affects packets both received and transmitted by the slave, but it has no effect on through traffic, which is passed by demultiplexers 42 and 54 to respective output FIFOs 50 and 62 in any case. Should a fault occur in switch fabric 46 or elsewhere in slave 34, so that the slave is unable to transfer packets to or from its ports 28, pre-switch 60 simply passes all packets through to the next slaves (or master) up and down the chain. The effect of the fault is thus limited to the subscribers served by the particular slave, and other subscribers served by system 31 are substantially unaffected.

Although the operation of pre-switch 60 is described herein in the context of system 31, it will be appreciated that the principles embodied in the pre-switch may similarly be applied, *mutatis mutandis*, in other multi-shelf access architectures. The pre-switching technique is particularly useful when slave shelves are daisy-chained together, even when the chain is not closed as it is in system 31.

Fig. 5 is a block diagram that schematically illustrates details of data packet flow in system 31

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under normal, fault-free conditions, in accordance with a preferred embodiment of the present invention. Hatched arrows, such as an arrow 72, represent downstream data flow, while unfilled arrows, such as an arrow 74, represent upstream data flow. Packets received from network 22 are routed by active master 30 down each of chains 36, 37 and 39, as indicated by arrow 72. Standby master 32 normally discards these downstream packets, as indicated by an arrow 80, except when a fault occurs in the active master.

Upstream packets, received by slaves 34 from their respective ports, are passed up the respective chains to active master 30. The active master bicast these packets, sending them both to network 22 and to standby master 32 over a protection interface 76 between the two masters, as indicated by an arrow 77. The standby master also transmits the upstream packets over network 22, as indicated by an arrow 78. This redundancy in transmission is in accordance with fault protection mechanisms used in high-speed networks known in the art, such as the standard "1+1 APS" (automatic protection switching) technique used in SONET.

Fig. 6 is a block diagram that schematically shows details of active master 30 in normal operation, in accordance with a preferred embodiment of the present invention. Master 30 comprises a main switch 90 and a pre-switch 92. The main switch receives downstream (incoming) packets from the network physical layer interface (NET PHY). The network interface has a switching address 102, corresponding to a switch port no. 5. (For the particular case of ATM switching, this and the other port numbers in the figure preferably correspond to UTOPIA addresses.) The packets are distributed to chains 36, 37 and 39 at respective

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addresses 98, 96 and 94 (switch ports 2, 1 and 0). Upstream packets are delivered to address 102 for transmission over the network. Pre-switch 92 bicast these packets, as described hereinabove, to an address 100 (switch port 3) of protection interface 76 to standby master 32. Input packets to master 30 from the protection interface are discarded by pre-switch 92. Other than these protection functions, the pre-switch operates as a transparent pass-through, as shown in Fig. 6, as long as no faults have occurred in system 31.

Fig. 7 is a block diagram that schematically shows details of standby master 32, in accordance with a preferred embodiment of the present invention. The standby master is structurally substantially identical to the active master, including main switch 90 and pre-switch 92. In normal operation, as shown in the figure, standby master 32 communicates only with active master 30, and is not expected to receive packets from or convey packets to any of slaves 34. Control traffic between the active and standby masters is preferably conveyed through chain 39, over an upstream path 104 and a downstream path 106 through the chain. Upstream data packets received by the standby master at address 100, over protection interface 76 from active master 30, are conveyed by pre-switch 92 to the network physical layer interface at address 102. The pre-switch passes any traffic from chains 36 and 37 transparently to switch 90, which treats any packets that it receives, except for control packets, as misrouted traffic.

Optionally, active master 30 and standby master 32 include their own local ports (not shown in the figures). In this case, the standby master is preferably treated as an additional slave on one of the chains, typically chain 39, and its ports have the same setup as all of the slave

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ports. Only the local ports of the active master have a different setup. The ports on the standby master are preferably assigned their own PSA, reducing by one the number of slaves that can be added on chain 39. Data traffic to and from the local ports on the standby master are carried over paths 106 and 104, in addition to the control traffic. Because protection interface 76 is reserved and, preferably, hardware-switched to deal with fault situations, it is undesirable to use this interface for the ordinary data and control traffic between the active and standby masters.

Fig. 8 is a block diagram that schematically illustrates operation of system 31 in the event of a communication fault in chain 39, in accordance with a preferred embodiment of the present invention. The fault is indicated by a mark 110 between two of slaves 34 and 34' in the chain, between which communications have been interrupted. In multi-shelf topologies known in the art, such as those shown in Figs. 2A-2C, such a fault would result in interruption of service to subscribers served by all of slaves 34' downstream of the fault. In system 31, however, active master 30 recognizes that a fault has occurred, and commands standby master 32 and slaves 34 to take corrective action.

Downstream traffic for slaves 34' is routed by active master 30 through chain 37, as indicated by an arrow 112. Standby master 32 switches this traffic onto chain 39, as shown by arrows 114 and 116, so that the packets reach slaves 34'. The addresses of the two inputs to the pre-switches 60 of slaves 34' are swapped, as described hereinabove (Fig. 4), in order to reverse the direction of traffic flow on this portion of chain 39. Upstream packets returned by slaves 34' are routed back to standby master 32, as shown by an arrow 118. The

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standby master switches this traffic over protection interface 76 to active master 30, as indicated by arrows 120 and 122. From this point, the upstream traffic is transmitted over network 22 in normal fashion. Traffic to and from slaves 34 on chains 36 and 37 is substantially unaffected. Failures in chains 36 and 37 are handled in similar fashion.

Fig. 9 is a block diagram that schematically illustrates details of the operation of pre-switch 92 in active master 30 under the fault conditions shown in Fig. 8, in accordance with a preferred embodiment of the present invention. For clarity of illustration, this block diagram and the other illustrations of pre-switch 92 show only the elements of the pre-switch that are of functional importance in handling this particular fault. The illustrated arrangement of these elements, and particularly of FIFO buffers in the pre-switch, has been chosen for simplicity and conceptual clarity, and variations on this arrangement will be apparent to those skilled in the art.

For all incoming traffic destined for chain 39, a PSA router 130 in pre-switch 92 determines whether the packets are addressed to slaves 34, upstream of the fault indicated by mark 110, or slaves 34', downstream of the fault. The PSA re-routes the traffic for slaves downstream of the fault through chain 37, in accordance with the following routing table:

TABLE I

PSA address	Original switch port	New switch port
0	0	0
1	0	0
2	0	1

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3	0	1
4	0	0
5	0	0
6	0	1

In this table, PSA numbers 2 and 3 refer to slaves 34', whose traffic is thus routed via a FIFO 134 to address 96 (switch port 1) of chain 37. Broadcast traffic for chain 39 is routed by PSA router 130 to both chains 39 and 37, except for "Next" packets, which are sent only to chain 39.

As noted hereinabove, it is necessary to avoid confusion between downstream traffic to slaves 34', transferred on chain 37 as represented by arrow 112, and ordinary downstream traffic to slaves 34 located on chain 37 itself. For this reason, PSA router 130 preferably sets a bit reserved for this purpose in the packets destined for slaves 34'. In the case of ATM cells, for example, router 130 preferably sets the least significant bit of the GFC field to 1. Standby master 32 changes this bit back to 0 when switching the packets back to chain 39.

In the upstream direction, the traffic from slaves 34' over protection interface 76, represented by arrow 122, is merged with the normal upstream traffic from slaves 34 on chain 39 by a FIFO 132. Switch 90 processes the merged traffic as though it had all come directly from chain 39, and no special processing is required after pre-switch 92.

Fig. 10 is a block diagram that schematically illustrates details of pre-switch 92 in standby master 32 under the fault conditions of Figs. 8 and 9, in accordance with a preferred embodiment of the present invention. Downstream traffic from chain 37 is examined

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by a local filter 148 in pre-switch 92 of standby master 32. The filter identifies packets destined for slaves 34', preferably based on the least significant bit of the GFC field in the packets, as noted above, and routes these packets to address 94 (UTOPIA port 0) of chain 39. The local filter changes the least significant bits back to 0. Packets for local ports on the standby master are routed to a FIFO 144, from which they are conveyed to switch 90. Other packets, typically "next" traffic originating from the last slave 34 on chain 37, are passed by filter 148 directly to switch 90.

Traffic arriving at standby master 32 from chain 39 is received by a next filter 142, which separates normal packet traffic from "Next" neighbor packets. The filter routes upstream packets, sent by slaves 34', to a FIFO 150. From this FIFO, these packets are conveyed through address 100, via protection interface 76, to active master 30. Upstream traffic from the local ports on the standby master is similarly routed by a next filter 140 to FIFO 150, and from there over the protection interface to the active master. The "Next" packets, however, are routed by filters 140 and 142 directly between the standby master and chain 39.

While Figs. 8, 9 and 10 illustrate only a case in which a fault has occurred in chain 39, it will be understood that similar techniques may be applied when faults occur in chains 36 and 37. In fact, these latter cases are simpler to deal with, since control traffic between masters 30 and 32 is normally carried only over chain 39. In all cases, the use of pre-switches 92 in the two masters allows such faults to be handled substantially without any reprogramming or reconfiguration of switches 90.

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Although preferred embodiments are described hereinabove with reference to DSL access to an ATM network, the principles of the present invention are similarly applicable in providing access to substantially any type of packet-switched network, and over substantially any sort of subscriber interface. The architecture and switching techniques used in system 31 are most advantageous when there is a need for high concentration at the access stage, i.e., for multiplexing of many lines into one or a few trunks. Those skilled in the art, however, will understand that the principles embodied in system 31 may also be applied to multiplexers and switches of other types, even including core network devices.

It will thus be appreciated that the preferred embodiments described above are cited by way of example, and that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove, as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description and which are not disclosed in the prior art.

What is claimed is:

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CLAIMS

1. Network access apparatus, comprising:
first and second master units, each comprising a physical interface to a packet-switched network;
a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and
a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit.
2. Apparatus according to claim 1, wherein in normal operation, downstream data packets received from the network are passed from the first master unit to each of the daisy chains via the first slave unit in each chain, and upstream data packets received by the slaves in each chain from the subscriber lines are passed via the first slave unit in the chain to the first master unit for transmission over the network.
3. Apparatus according to claim 2, and comprising a protection interface, which couples the second master unit to the first master unit, and over which interface data packets are conveyed between the first and second master units in case of a fault.
4. Apparatus according to claim 3, wherein the first master unit multicasts the upstream data packets that it receives from the slave units to the network and, via the protection interface, to the second master unit, which transmits the upstream data packets to the network.

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5. Apparatus according to claim 2, wherein in case of a fault at a location in one of the daisy chains, data flow in a portion of the daisy chain between the location of the fault and the second master unit is reversed, so that the downstream data packets are passed from the second master unit to the slave units in the portion of the daisy chain via the last slave unit in the chain, and the upstream data packets are passed by the last slave unit to the second master unit.

6. Apparatus according to claim 5, wherein the downstream packets for the slave units in the portion of the daisy chain between the location of the fault and the second master unit are conveyed to the second master unit from the first master unit via another one of the daisy chains.

7. Apparatus according to claim 1, wherein each of the first and second master units comprises:

a switch, configured to route data packets between the respective physical interface and the one or more daisy chains; and

a pre-switch, which in the event of a fault at a location in one of the daisy chains, re-routes at least a portion of the data packets exchanged with one or more of the slaves in the daisy chain in which the fault has occurred through another one of the daisy chains.

8. Apparatus according to claim 7, wherein the pre-switch re-routes the data packets such that substantially no reconfiguration of the switch is required responsive to the fault.

9. Apparatus according to claim 1, wherein each of the slave units comprises:

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a switch fabric comprising one or more switches, which convey data packets to respective ports on the switch to which the packets are addressed; and

a pre-switch, which receives the data packets from one of the physical interface lines connected to the slave unit and passes those of the data packets that are addressed to any of the ports on the slave unit to the switch fabric, while passing packets not addressed to any of the ports on the slave unit for output through another of the physical interface lines.

10. Apparatus according to claim 9, wherein each of the slave units is coupled to receive packets transferred thereto from the first and second master units over first and second ones of the physical interface lines, respectively, and wherein the pre-switch passes the packets received through the first and second physical interface line and addressed to any of the ports on the slave unit to respective first and second addresses in the switch fabric.

11. Apparatus according to claim 10, wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second addresses are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required.

12. Apparatus according to claim 1, wherein the network comprises an asynchronous transfer mode (ATM) network.

13. Apparatus according to claim 1, wherein the network comprises an Internet protocol (IP) network.

~~14.~~ In a network access multiplexing system, in which a master unit is connected by a physical interface to a packet-switched network, a slave unit configured to be

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coupled to the master unit in a daisy chain of such slave units, the slave unit comprising:

a plurality of ports, for coupling the slave unit to respective subscriber lines;

first and second physical interfaces, coupled to exchange packets with preceding and succeeding units, respectively, along the daisy chain;

a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface; and

a fabric of one or more switches, which convey the retained packets to the ports, responsive to the address data.

15. Apparatus according to claim 14, wherein the pre-switch is further coupled to receive packets transferred thereto from the second physical interface and to sort the packets in like manner to the packets received through the first physical interface.

16. Apparatus according to claim 15, wherein the retained packets that were received from the first and second physical interfaces and are passed by the pre-switch to the switch fabric are identified by respective first and second port numbers, and wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second port numbers are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required in response to the reversal.

17. Apparatus according to claim 14, wherein when one of the packets received by the pre-switch comprises a

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multicast packet addressed to one or more of the ports on the slave unit, the pre-switch sorts the multicast packet such that one copy of the packet is retained and another copy of the packet is passed to the second physical interface.

18. Apparatus according to claim 14, wherein in the event of a fault in the switch fabric, the pre-switch continues to pass the packets addressed to the succeeding units on to the succeeding units without significant interruption.

19. A method for providing access to a network, comprising:

coupling first and second master units to interface with the network;

linking a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines, in a daisy chain between the first and second master units;

conveying initial downstream data packets, received from the network by one of the master units, along the daisy chain in a first direction, so as to deliver the packets to the ports of the slave units; and

in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units.

20. A method according to claim 19, wherein the initial and further downstream packets are received from the network by the first master unit, and wherein conveying the further downstream packets in the second direction comprises conveying the further downstream packets from

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the first master unit to the second master unit, and then conveying the further downstream packets from the second master unit to the daisy chain.

21. A method according to claim 20, wherein conveying the further downstream packets from the first master unit to the second master unit comprises linking further slave units in an additional daisy chain between the first and second master units, and conveying the further downstream packets from the first master unit to the second master unit over the additional daisy chain.

22. A method according to claim 19, and comprising conveying initial upstream data packets, received by the slave units from the subscriber lines, along the daisy chain in the second direction so as to transmit the upstream data packets via the first master unit over the network, and in the event of the fault, conveying further upstream data packets received by one or more of the slave units along the daisy chain in the first direction via the second master unit.

23. A method according to claim 22, and comprising multicasting the upstream data packets from the first master unit to the network and to the second master unit, which transmits the multicast upstream data packets over the network.

24. A method according to claim 19, wherein conveying the initial downstream data packets along the daisy chain comprises pre-switching the packets at each of the slave units, so that packets not addressed to any of the ports on the slave unit are passed to the next slave unit in the daisy chain, while packets that are addressed to one or more of the ports on the slave unit are passed to a switch fabric that directs the packets to the ports to which they are addressed.

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25. A method according to claim 19, wherein the network comprises an asynchronous transfer mode (ATM) network.

26. A method according to claim 19, wherein the network comprises an Internet protocol (IP) network.

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ABSTRACT

Network access apparatus includes first and second master units, each having a physical interface to a packet-switched network. A plurality of slave units, each slave unit having one or more ports to respective subscriber lines, are linked by a plurality of physical interface lines in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween. Each daisy chain includes at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit.

DATE: 03-26-2003

FIG. 1
PRIOR ART

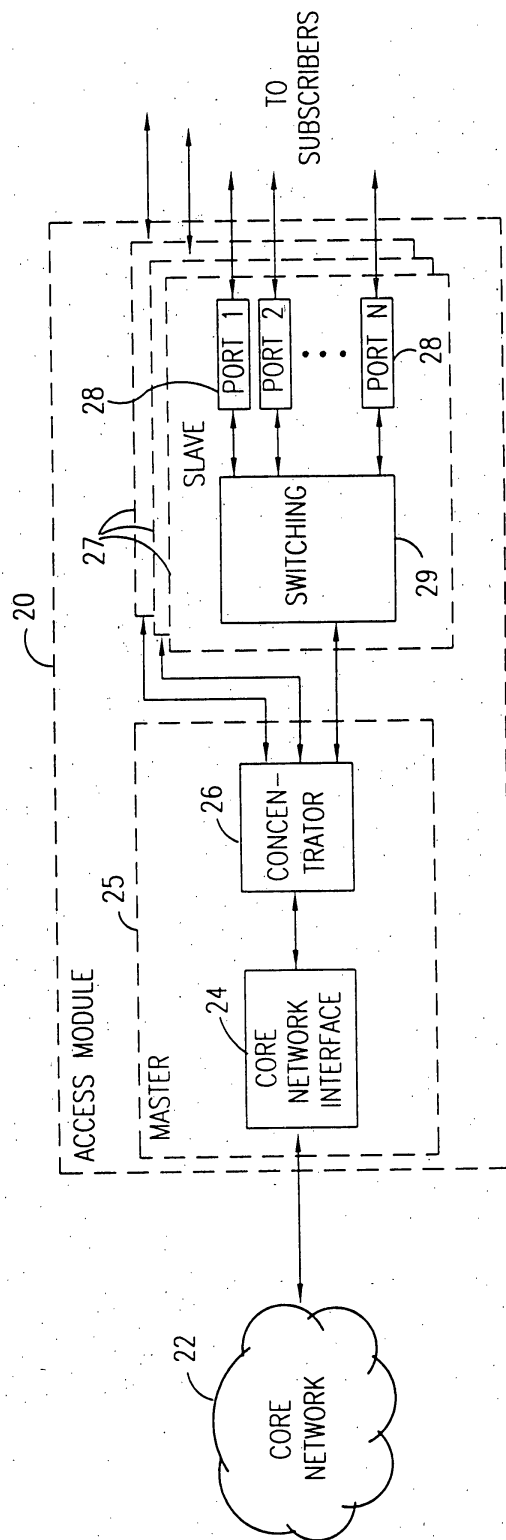


FIG. 2A
PRIOR ART

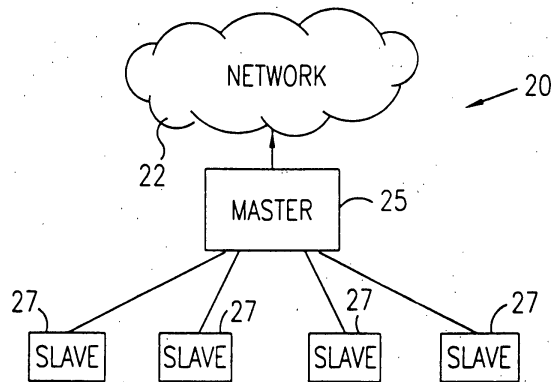


FIG. 2B
PRIOR ART

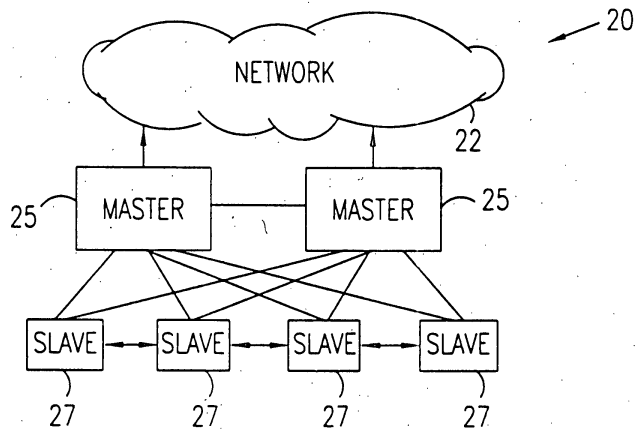


FIG. 3

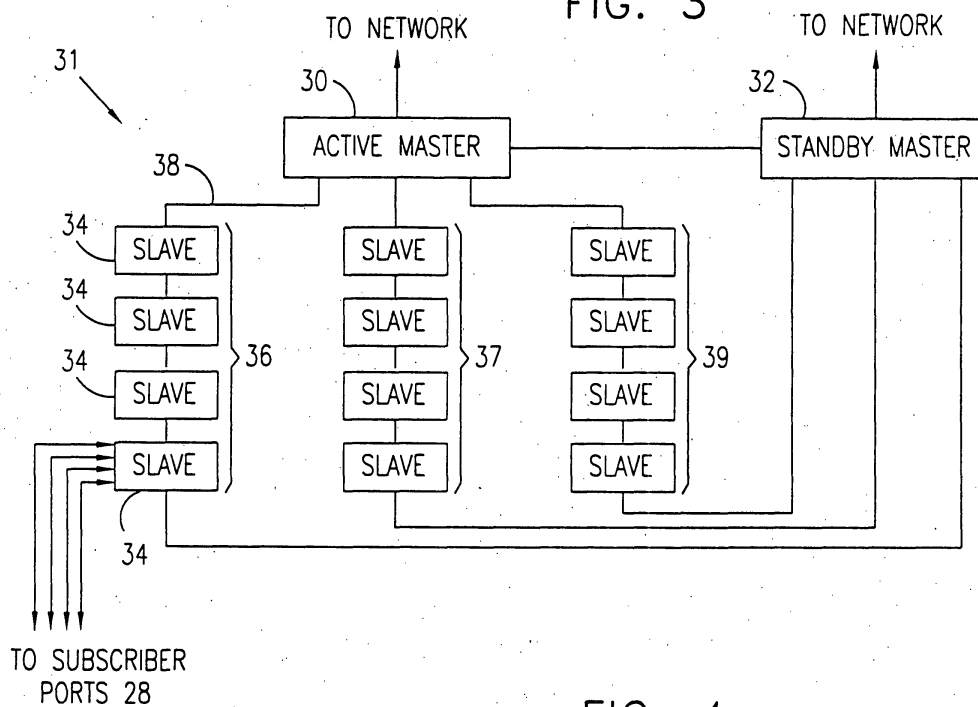


FIG. 4

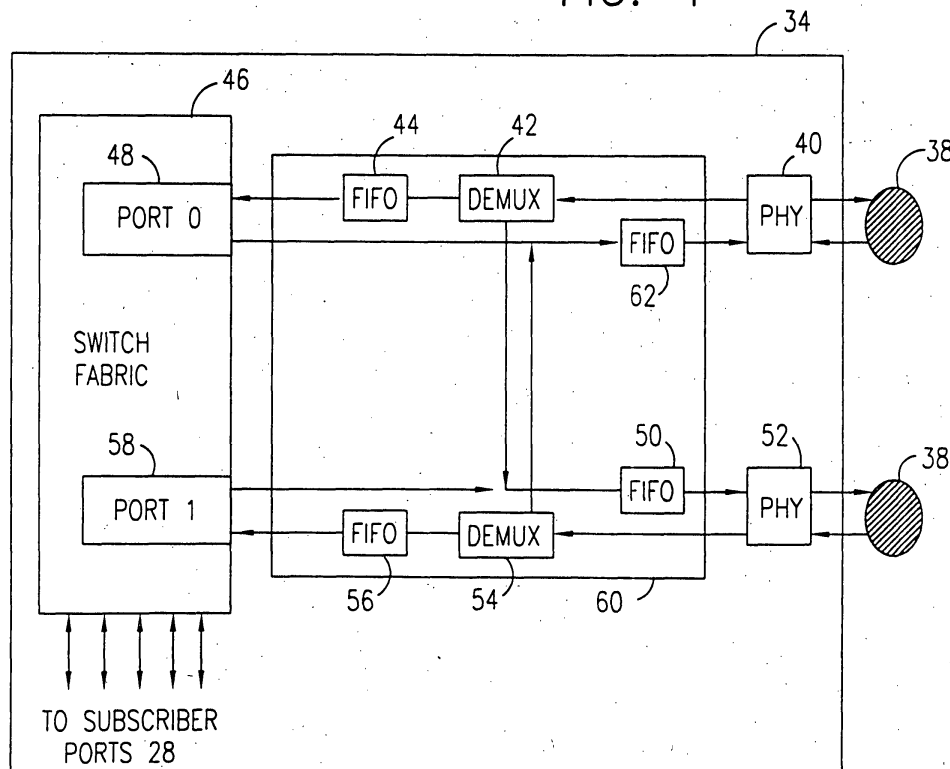


FIG. 5

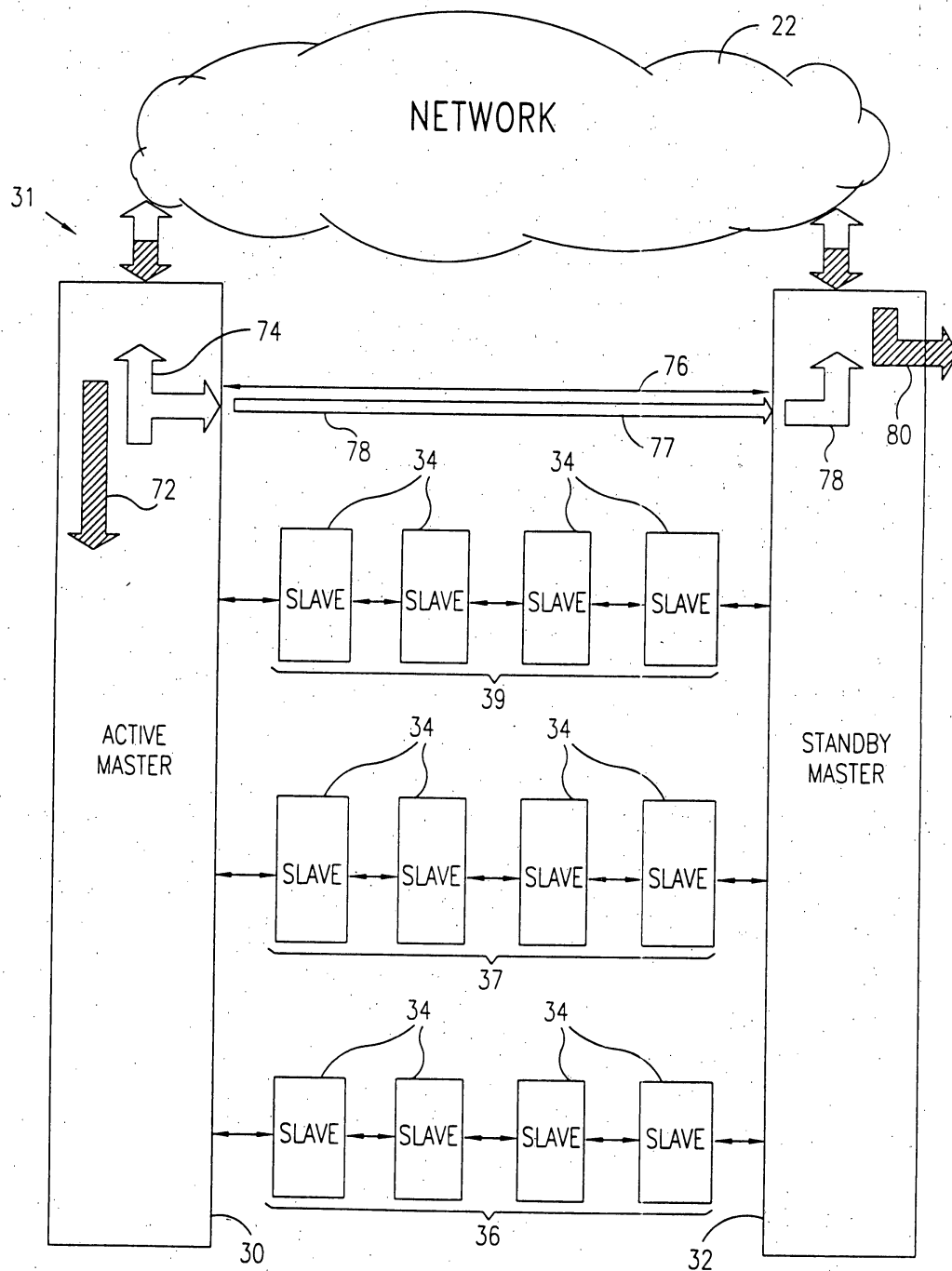


FIG. 6

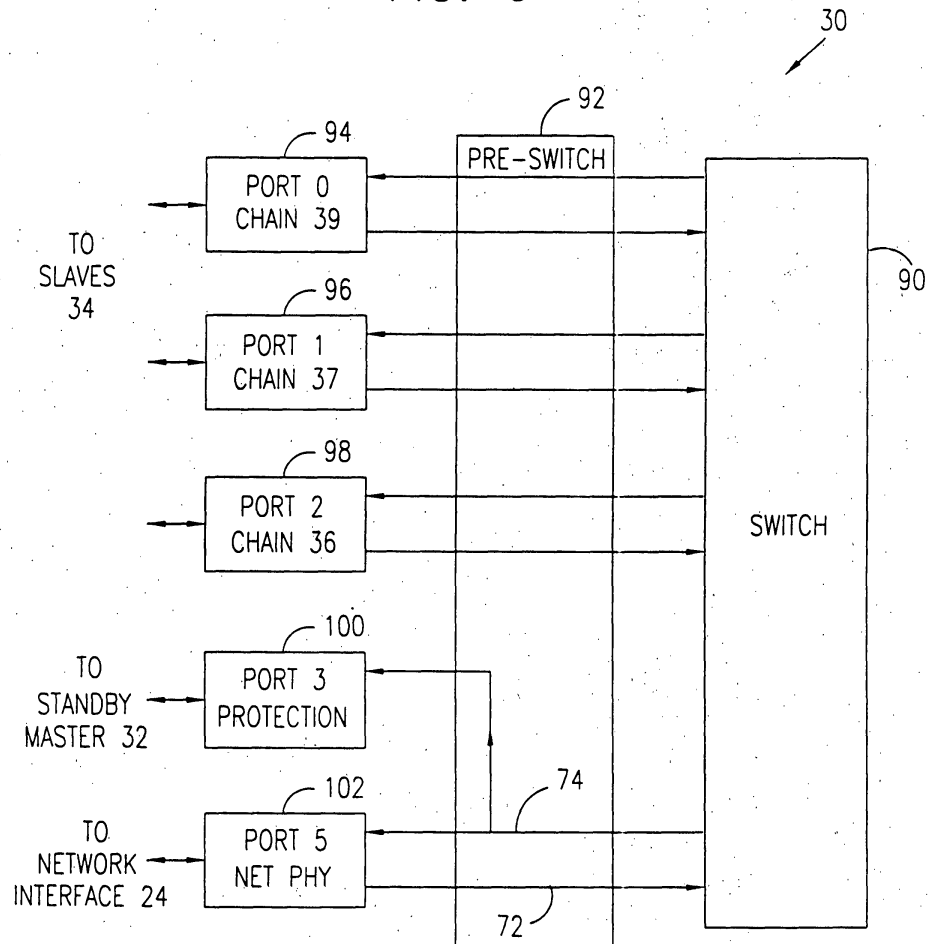


FIG. 7

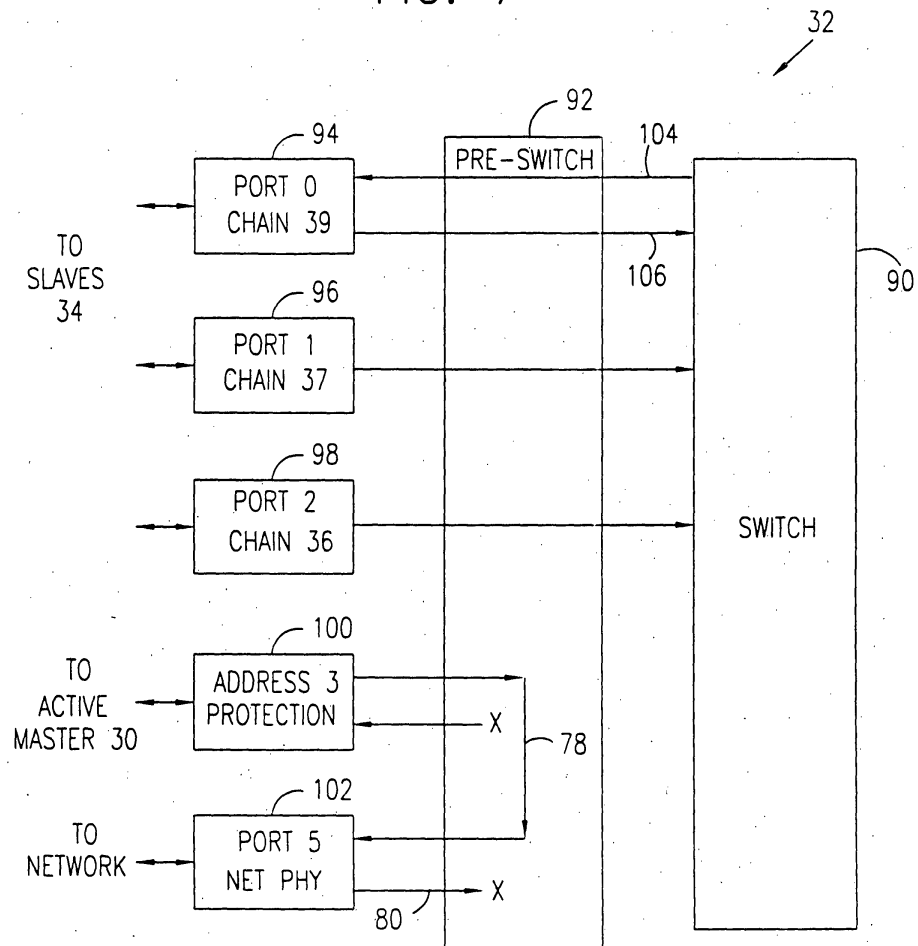


FIG. 8

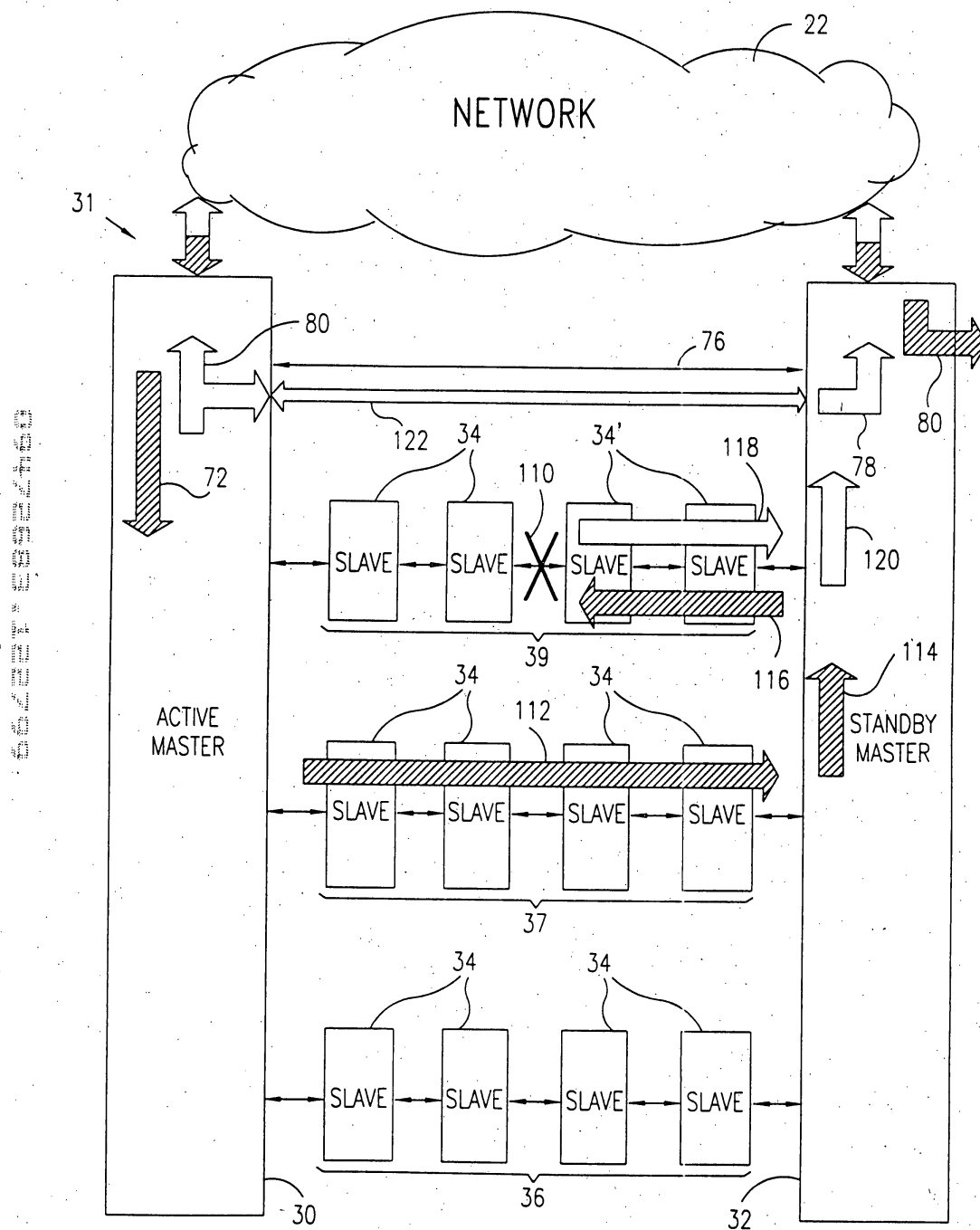
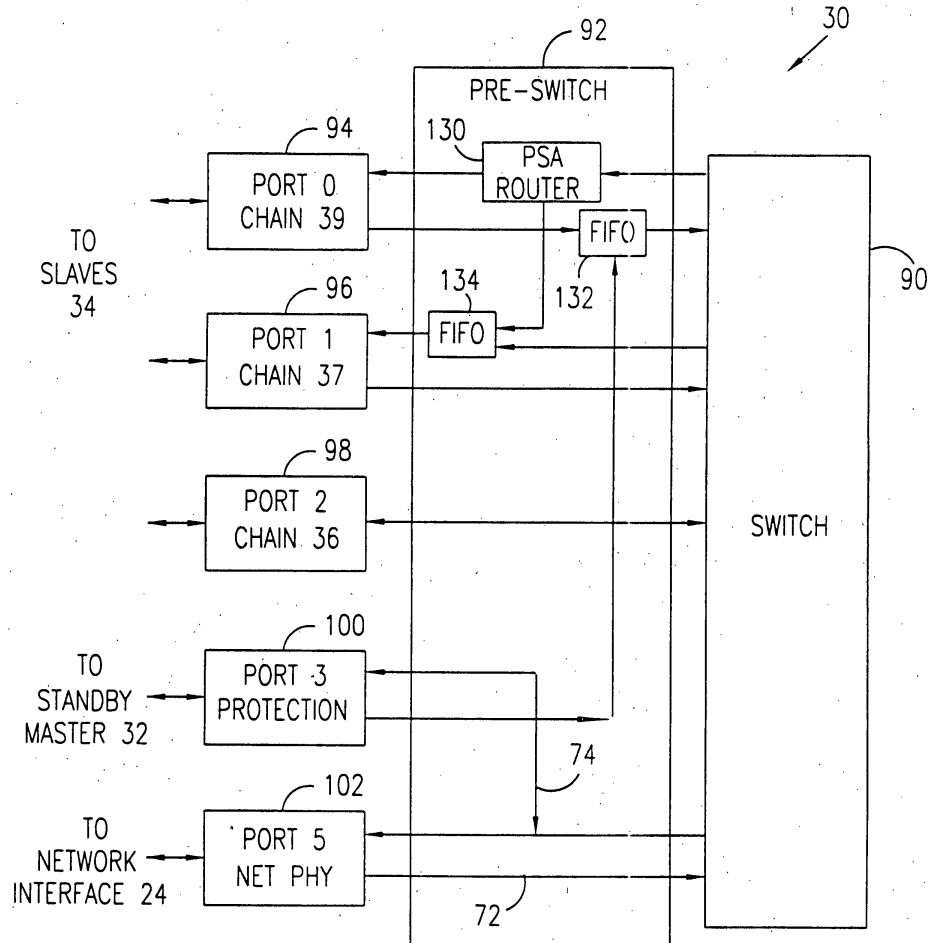
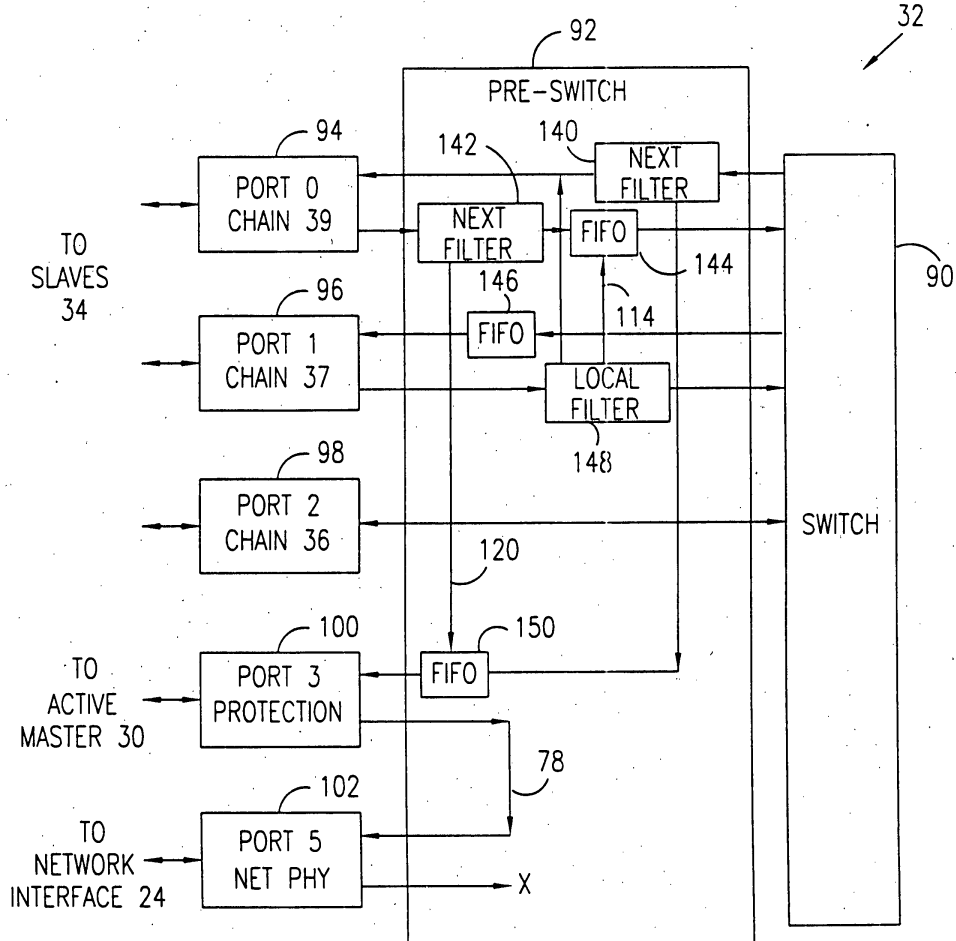


FIG. 9



32



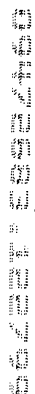
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FIG. 2A
PRIOR ART

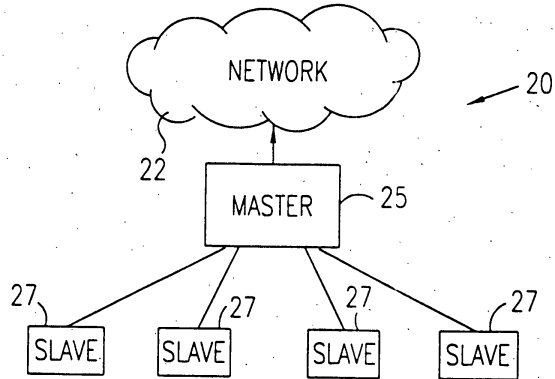


FIG. 2B
PRIOR ART

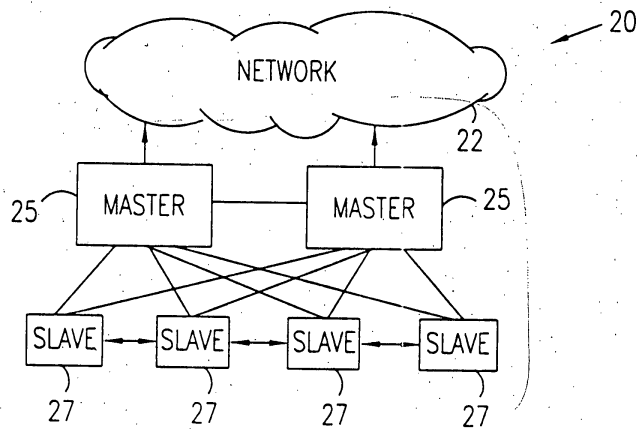


FIG. 3

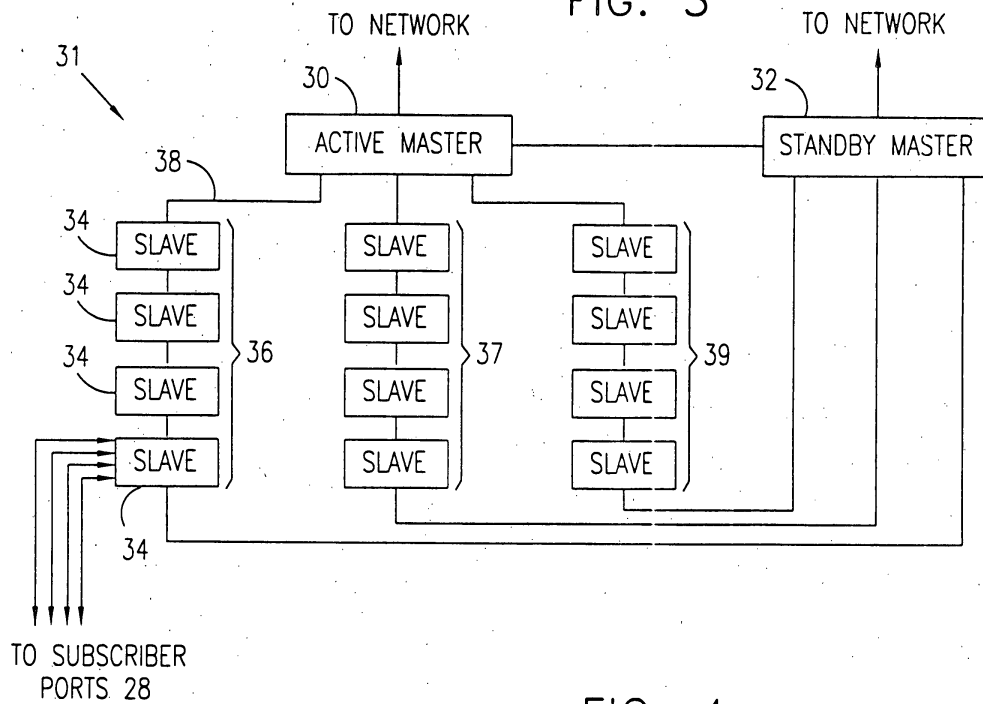


FIG. 4

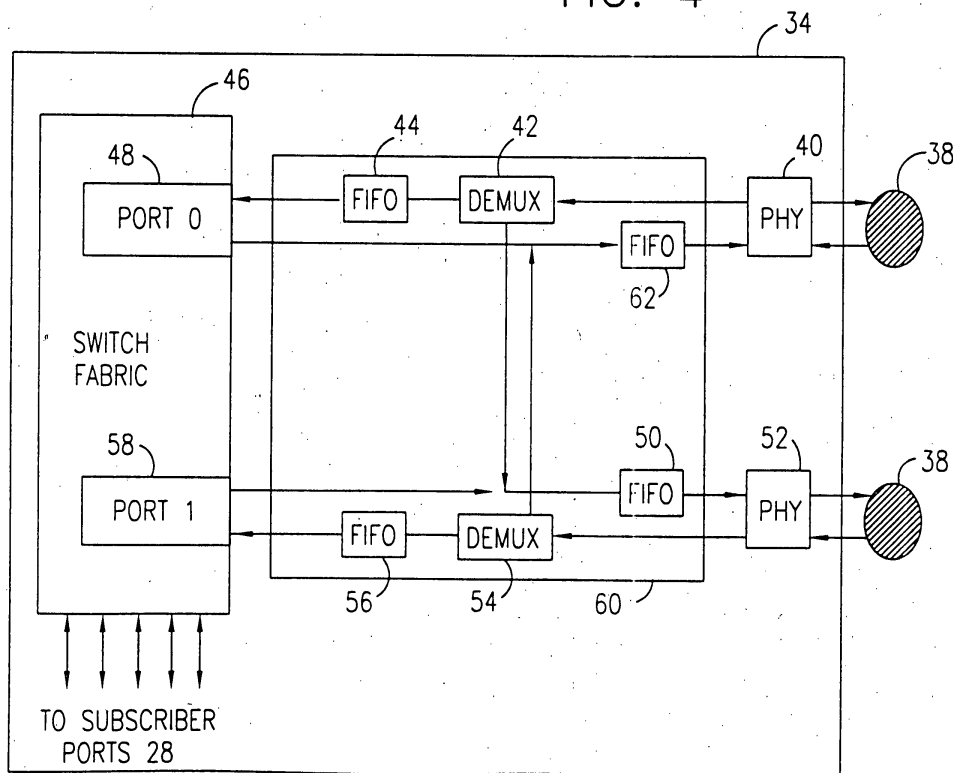


FIG. 5

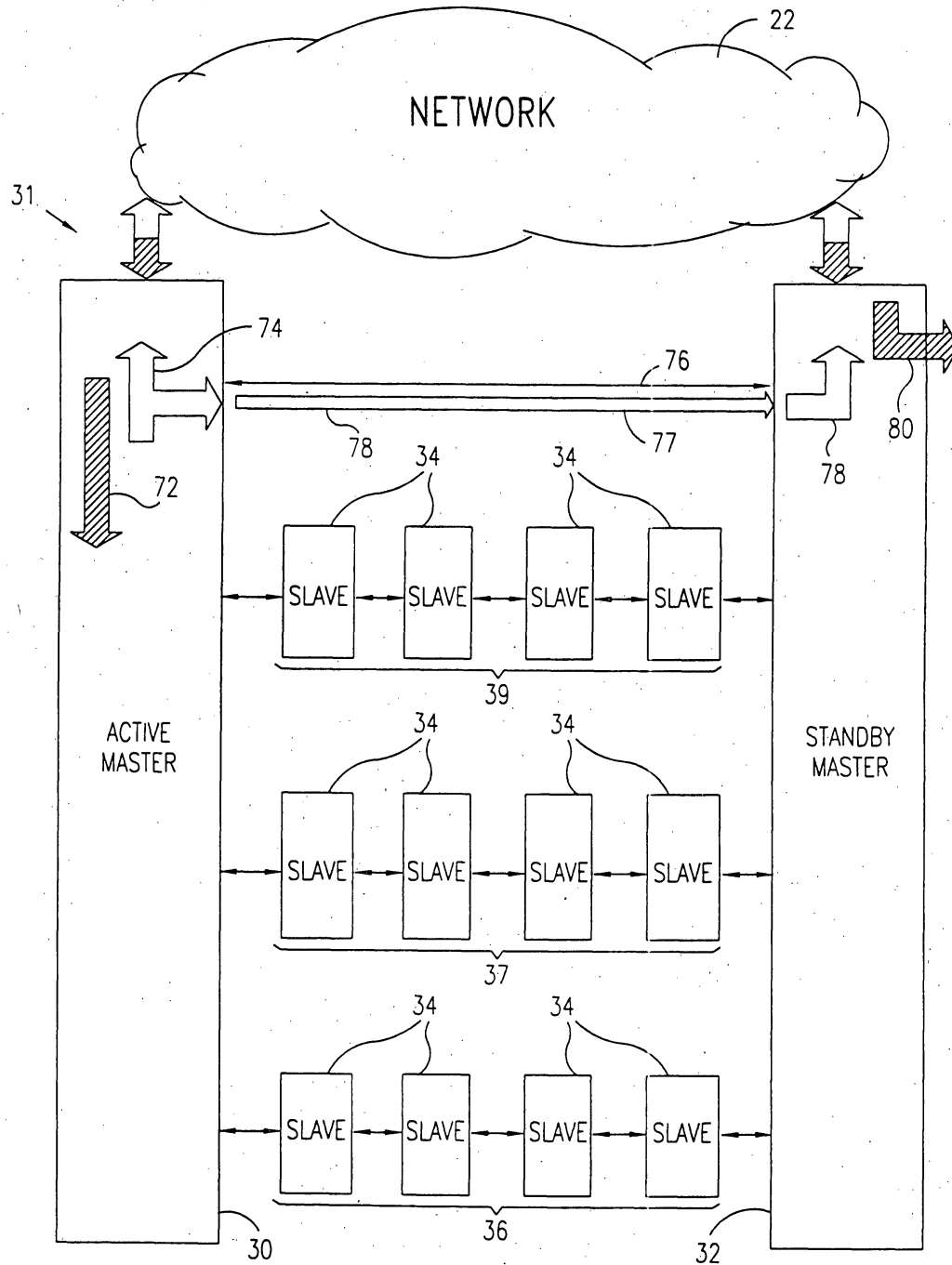


FIG. 6

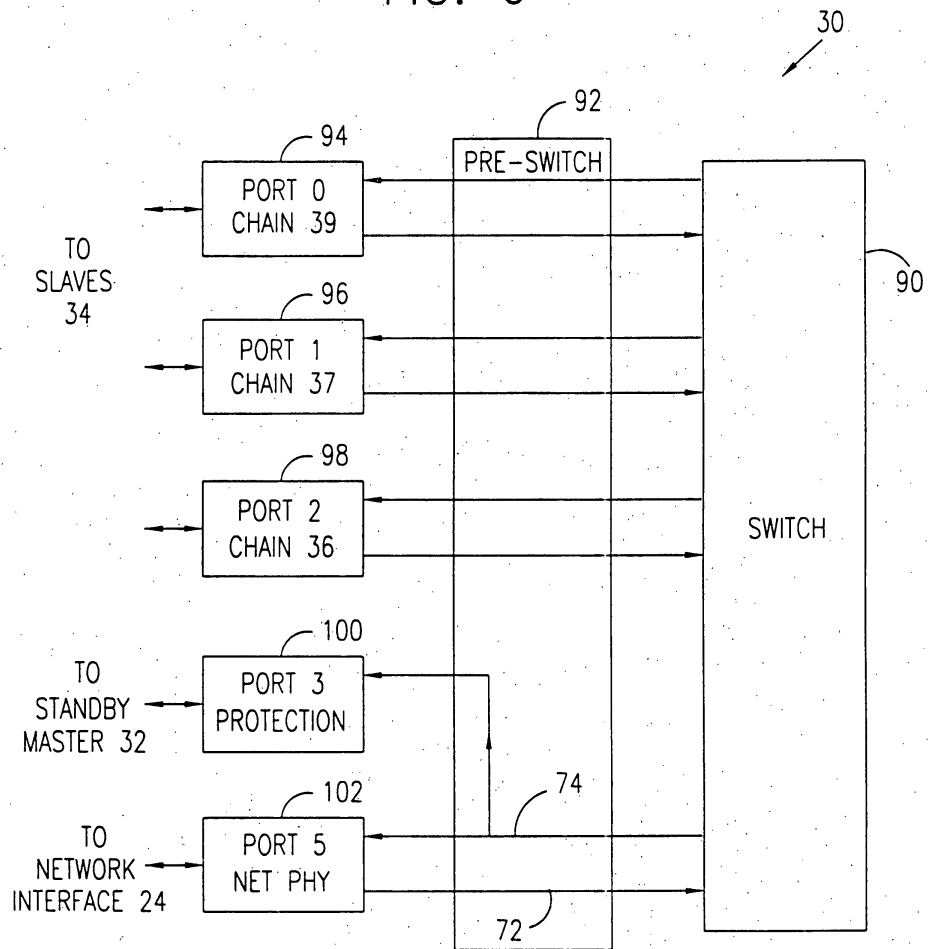


FIG. 7

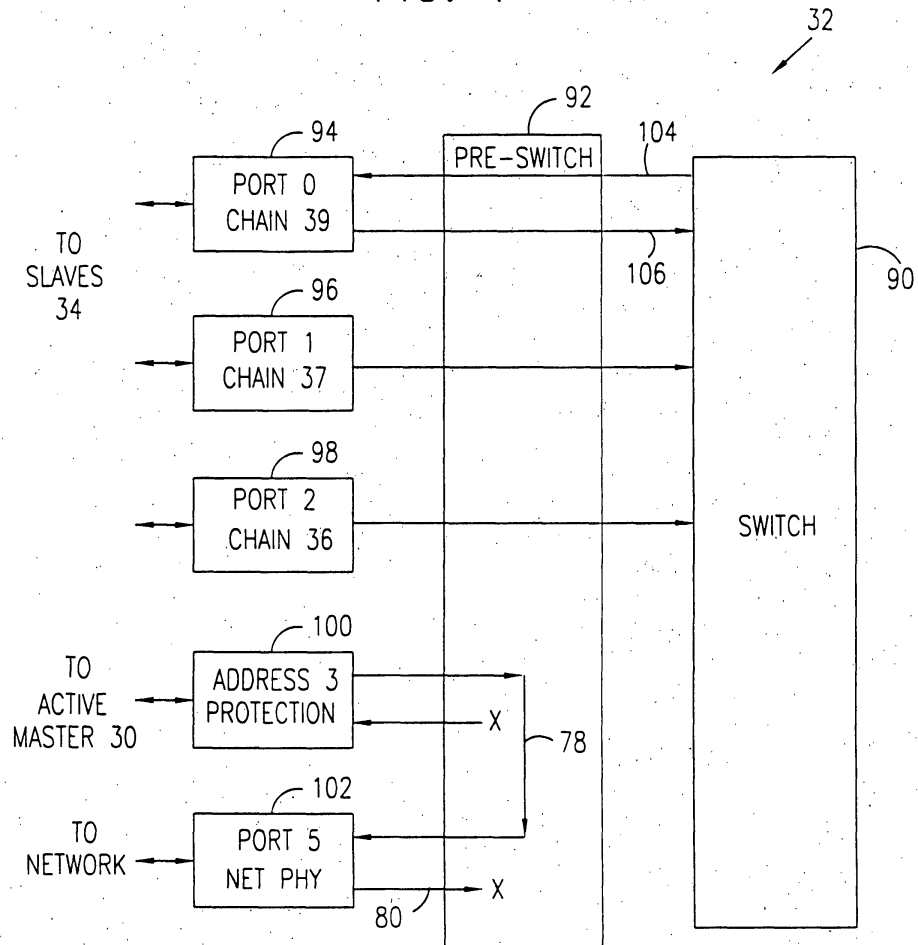


FIG. 8

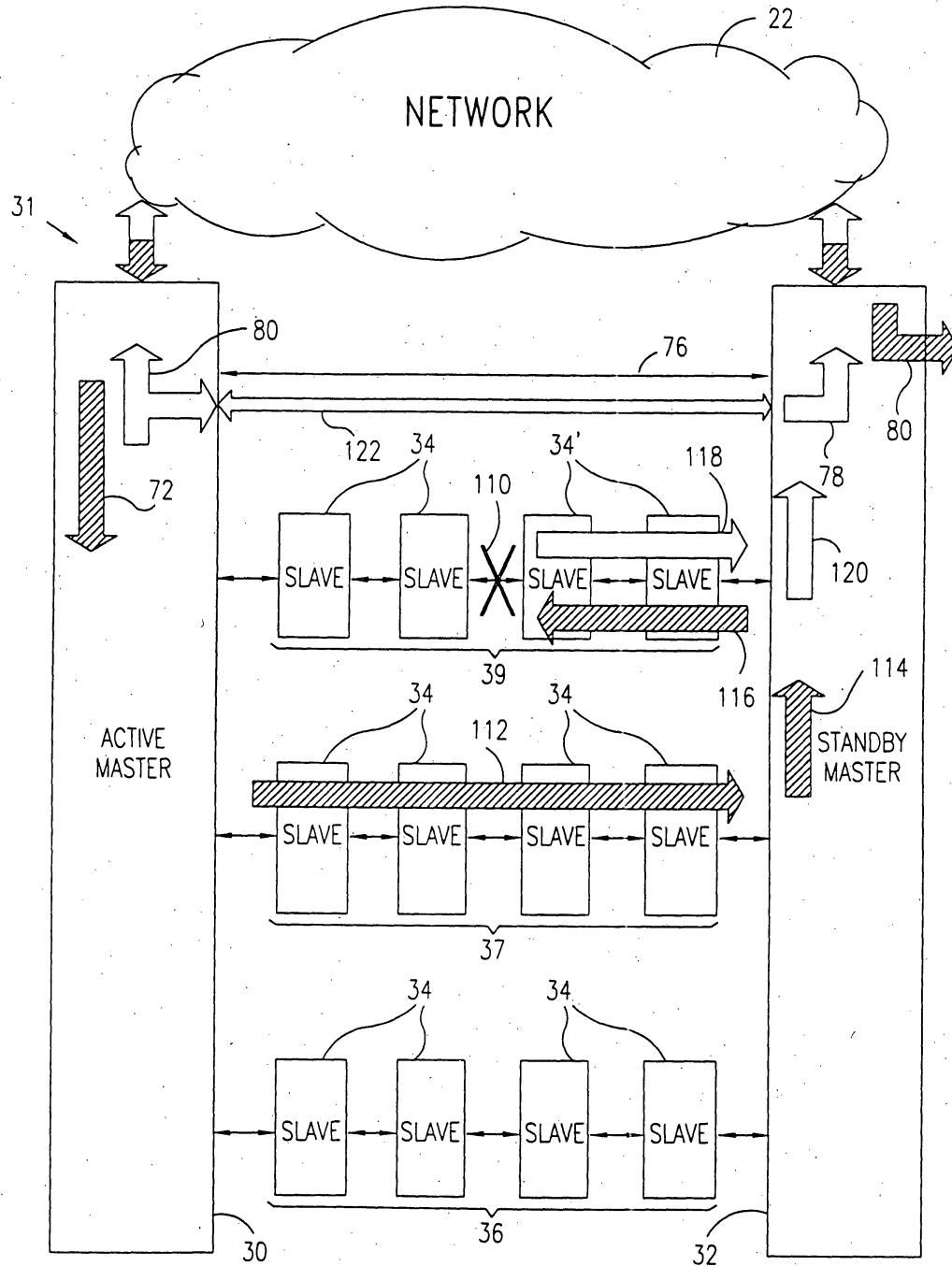


FIG. 9

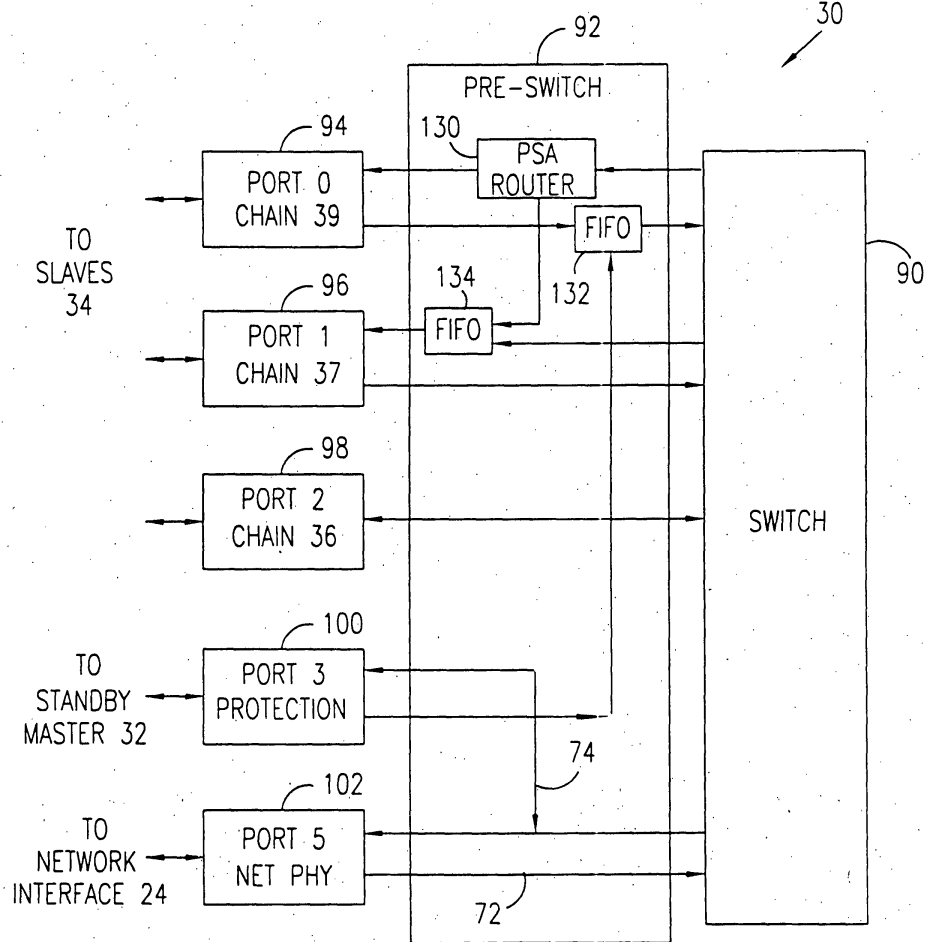
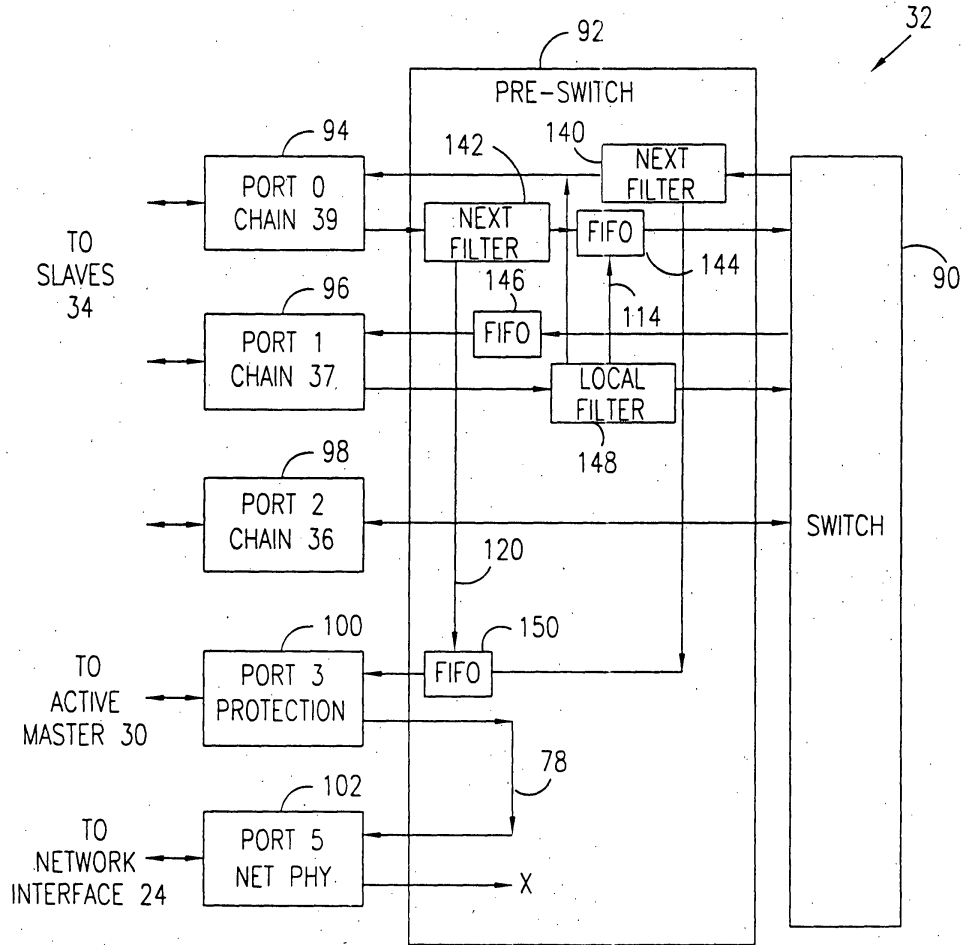


FIG. 10



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FIG. 1
PRIOR ART

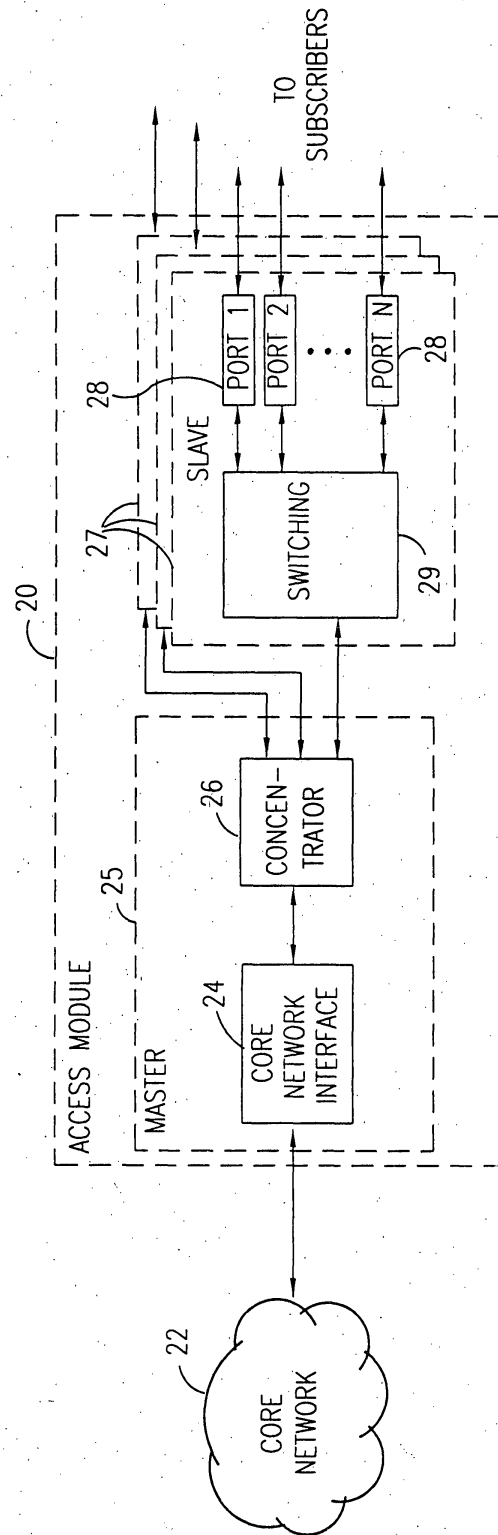


fig 11

FIG. 2A
PRIOR ART

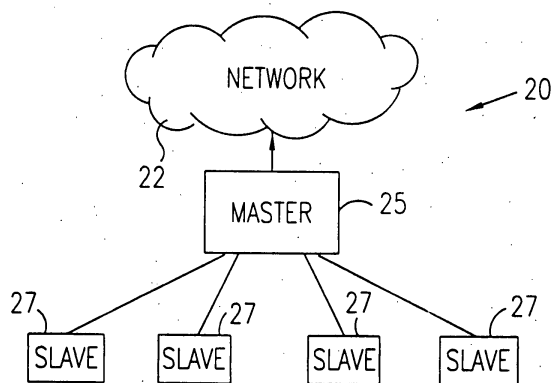


FIG. 2B
PRIOR ART

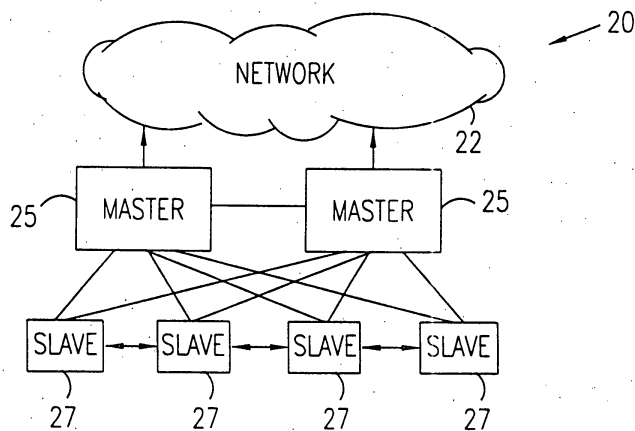


FIG. 3

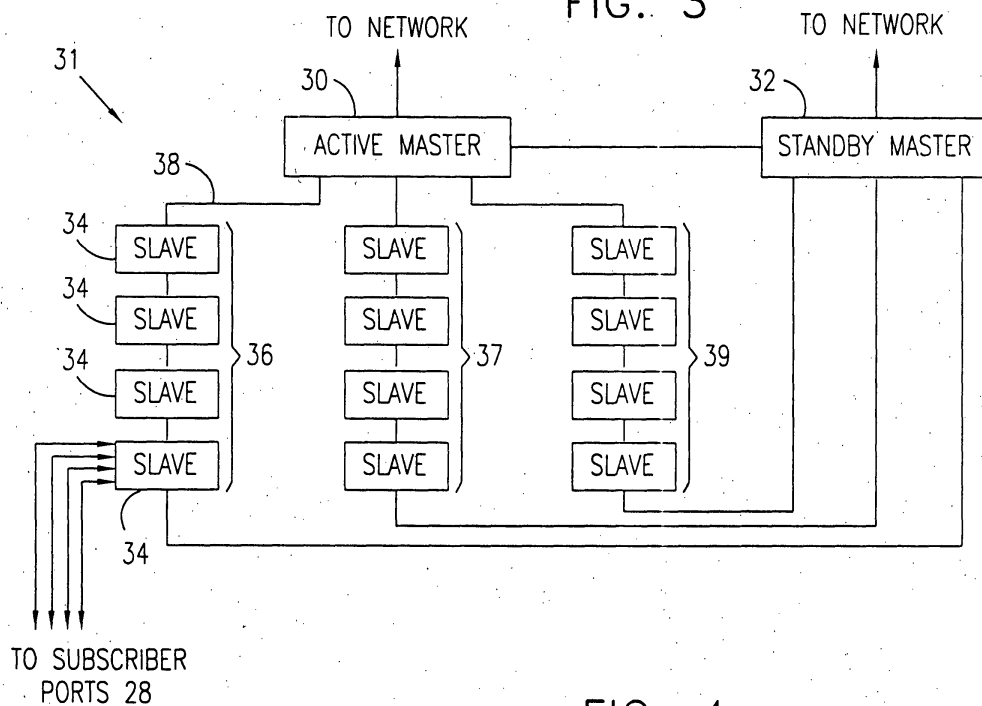


FIG. 4

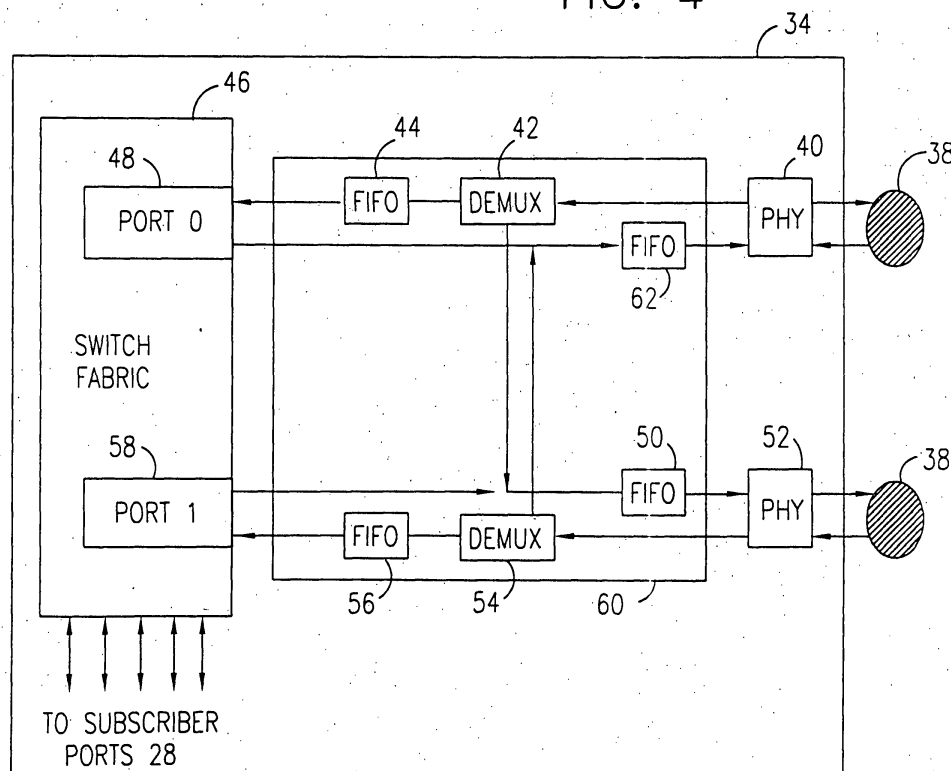


FIG. 5

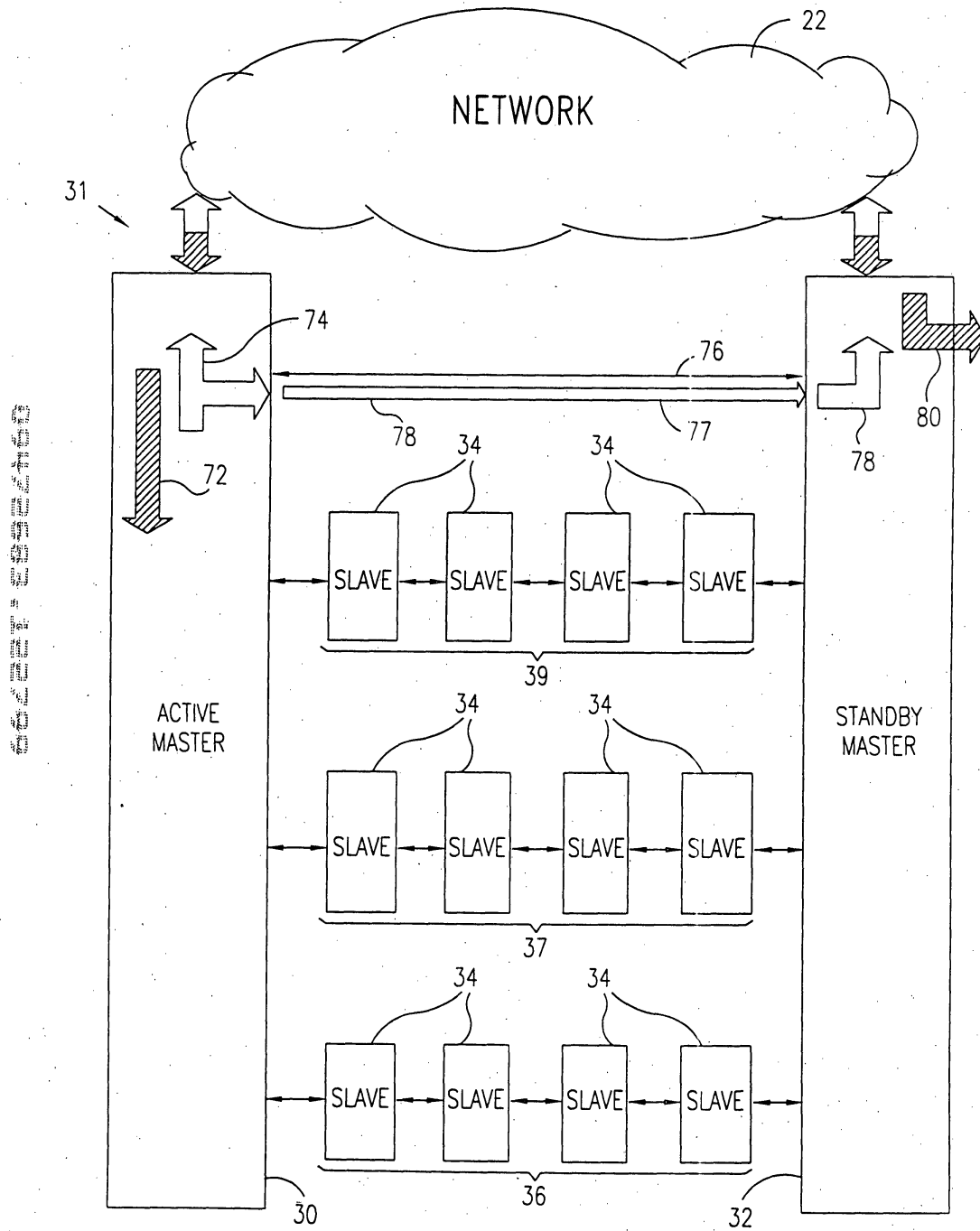


FIG. 6

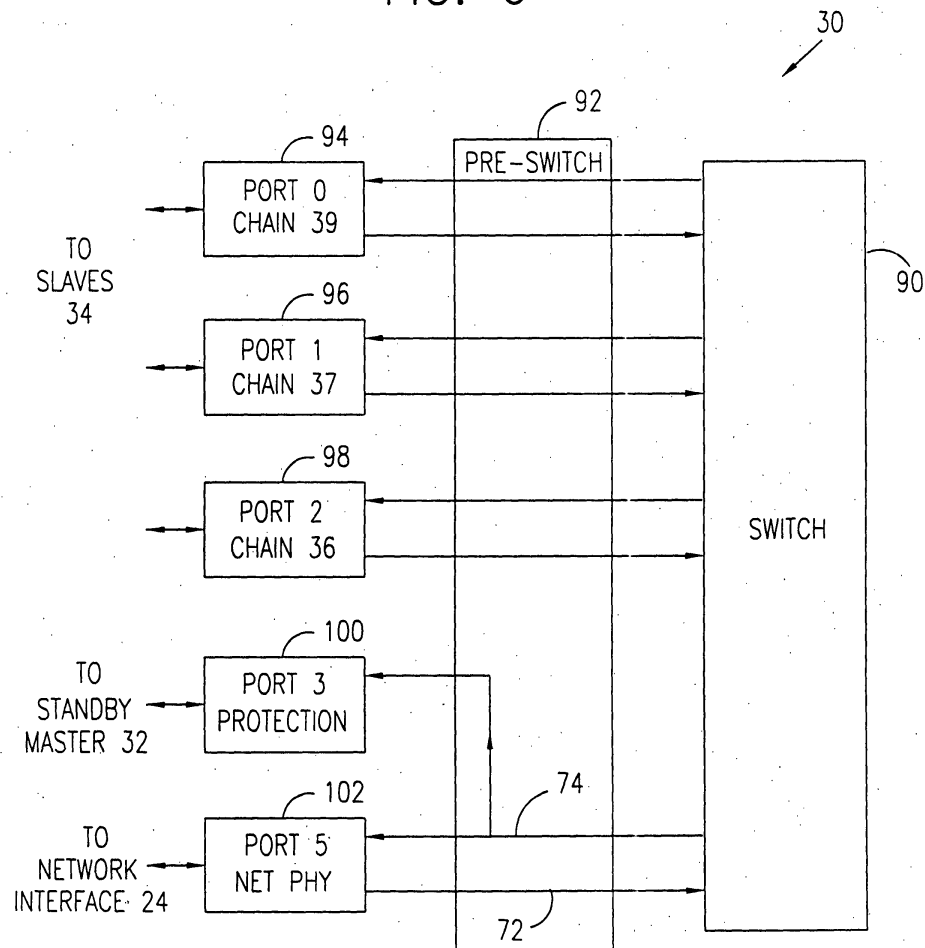


FIG. 7

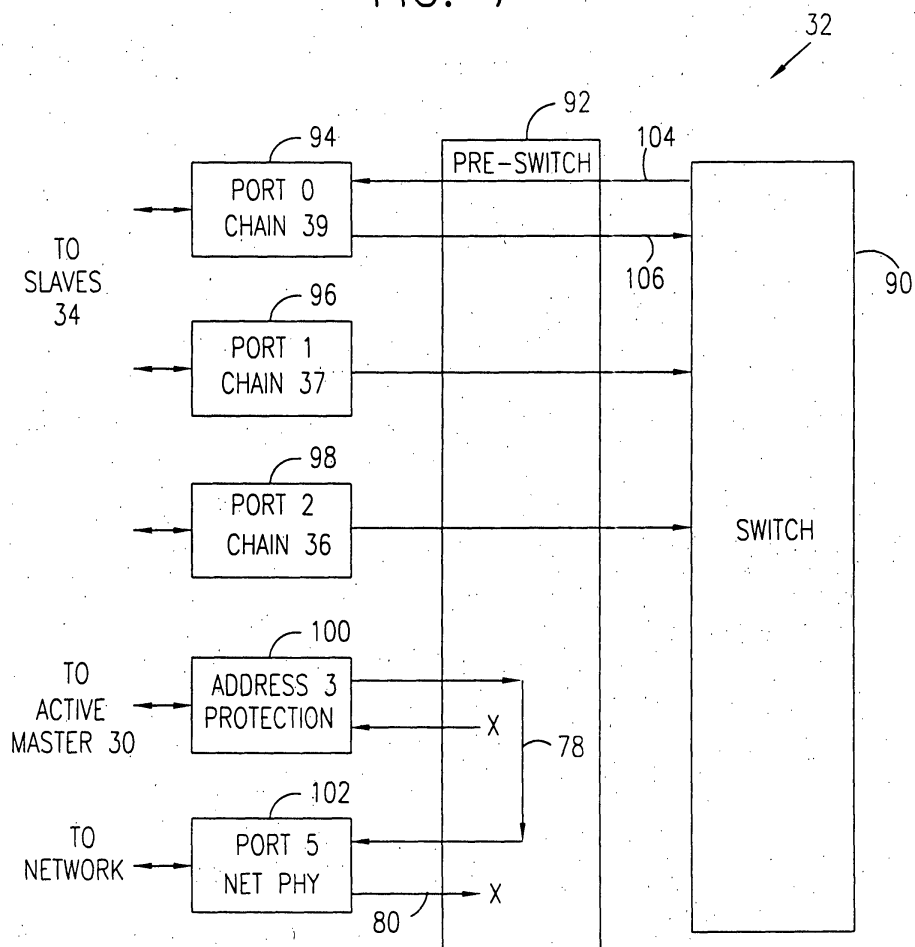


FIG. 8

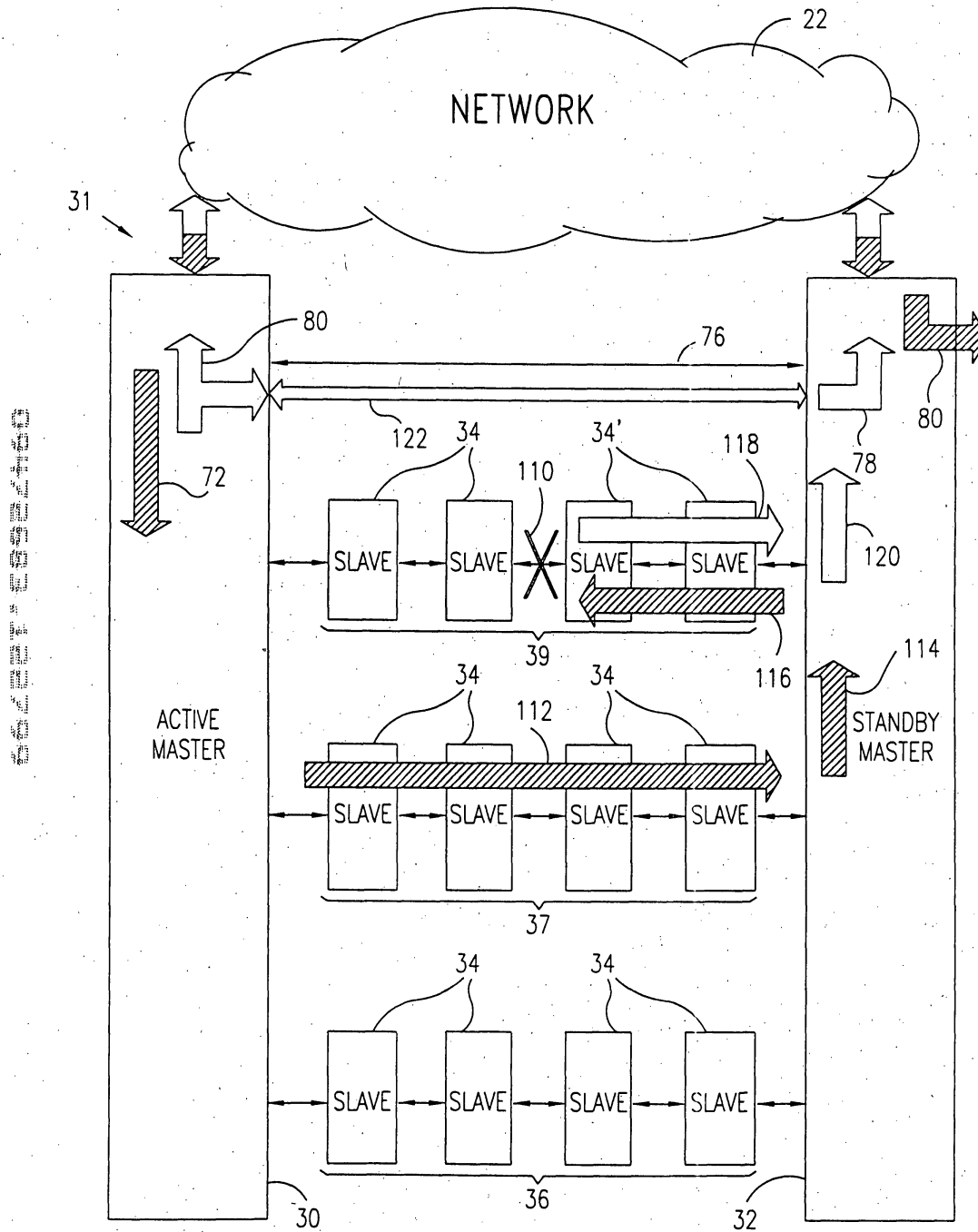


FIG. 9

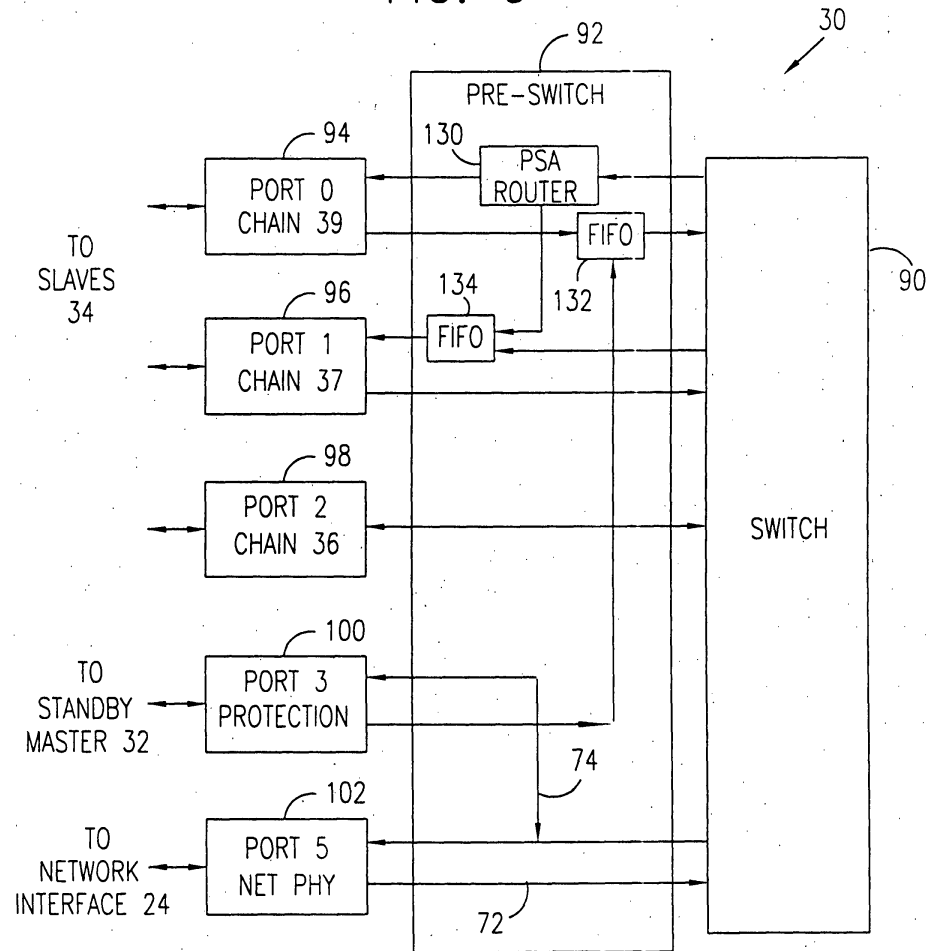
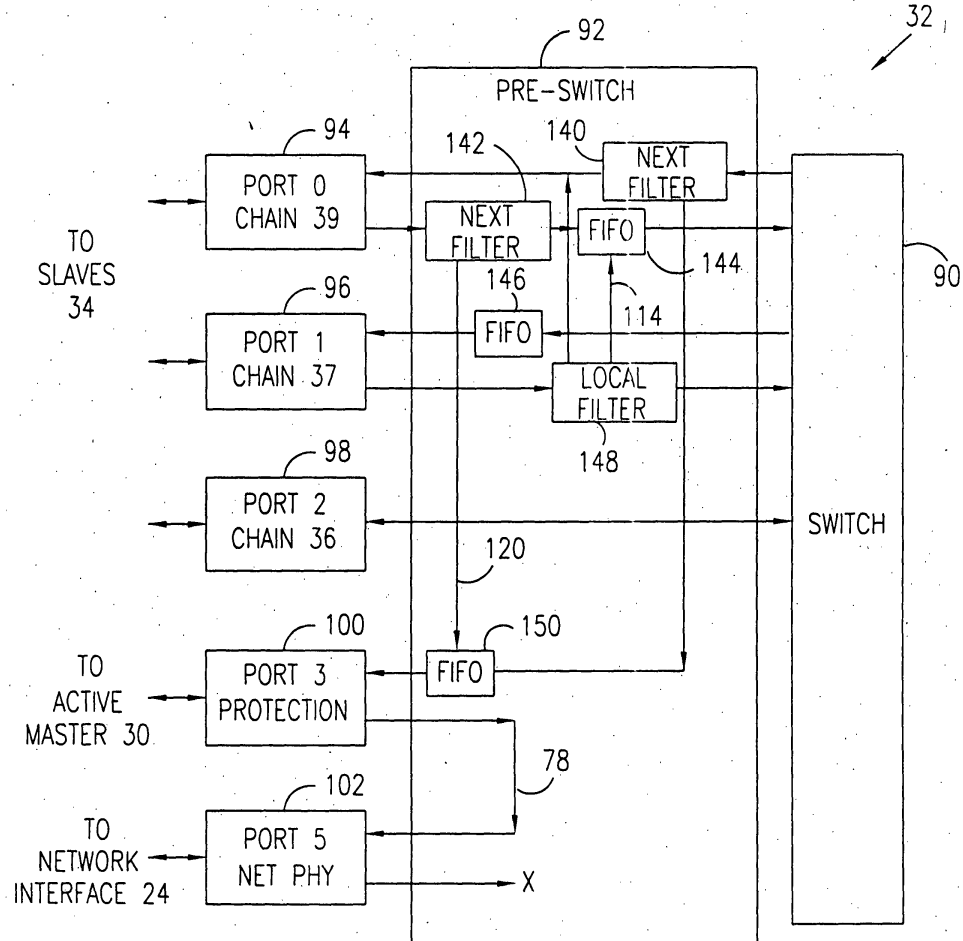


FIG. 10



UNITED STATES

PATENT APPLICATION DECLARATION AND POWER OF ATTORNEY - ORIGINAL APPLICATION	ATTORNEY'S DOCKET NO. 204,344
--	----------------------------------

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name:
I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention entitled

(1) TITLE OF
INVENTION

(1) BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS

the specification of which

(2) CHECK
APPROPRIATE
BOX

(2) ☒ is attached hereto.
☐ was filed on _____ as Application No. _____
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.
I acknowledge my duty to disclose information of which I am aware which is material to the patentability of this application under 37 CFR 1.56(a): the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application; and as to applications for patents or inventor's certificate on the invention filed in any country foreign to the United States prior to this application by me or my legal representatives or assigns.

(3) CHECK
APPROPRIATE
BOX

(3) ☒ no such applications have been filed, or
☐ such applications have been filed as follows:

(4) COMPLETE
DATA INDICATED
IF APPLICABLE

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED WITHIN 12 MONTHS PRIOR TO THIS APPLICATION				
Country	Application Number	Date of Filing (day, month, year)	Date of Issue (day, month, year)	Priority Claimed Under 35 USC 119
(4)				☐ Yes ☐ No
				☐ Yes ☐ No
ALL FOREIGN APPLICATIONS, IF ANY, FILED MORE THAN 12 MONTHS PRIOR TO THIS APPLICATION				
(4)				

I hereby claim the benefit under Title 35, United States Code § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112. I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(5) COMPLETE
DATA INDICATED
IF APPLICABLE

(5) _____
(Application Ser. No.) (Filing date) (Status: patented, pending, abandoned)

(5) _____
(Application Ser. No.) (Filing date) (Status: patented, pending, abandoned)

Power of Attorney: As a _____ed inventor, I hereby appoint the following attorney _____ and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Jeffrey A. Schwab, Registration Number 24,490
Stewart J. Fried, Registration Number 20,694
Jay S. Cinamon, Registration Number 24,156
Dennis A. Mason, Registration Number 19,571

Michael I. Markowitz, Registration Number 30,659
Thomas E. Spath, Registration Number 25,928
Joseph J. Catanzaro, Registration Number 25,837
Anthony Coppola, Registration Number 41,493

Send Correspondence To:
Abelman, Frayne & Schwab
150 East 42nd Street
New York, New York 10017-5612

Direct Telephone Calls To:
Jeffrey A. Schwab, Stewart J. Fried, Jay S. Cinamon,
Dennis A. Mason, Michael I. Markowitz,
Thomas E. Spath, Joseph J. Catanzaro
or Anthony Coppola at (212) 949-9022

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(6) DETAILS
REQUIRED
FOR EACH
INVENTOR

Full Name of Sole or First Inventor Menachem KAPLAN	Inventor's Signature	Date
Residence 3a Hadar Street, Petach Tikva 49327, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Second Joint Inventor, If Any David ZELIG	Inventor's Signature	Date
Residence 25 Hana Senesh Street, Givataim 53541, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Third Joint Inventor, If Any Roy KINAMON	Inventor's Signature	Date
Residence 19 Hazohar Street, Tel Aviv 62507	Citizenship Israel	
Post Office Address same as above		
Full Name of Fourth Joint Inventor, If Any Eli ALONI	Inventor's Signature	Date
Residence 28 Agamit Street, Tzur-Igal 44862, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Fifth Joint Inventor, If Any Ron SDAYOOR	Inventor's Signature	Date
Residence 1/22 Bar Yehuda Street, Kiryat Ono 55404, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Sixth Joint Inventor, If Any Eric PANETH	Inventor's Signature	Date
Residence 39 Shimon Ben Zvi Street, Givataim 53631, Israel	Citizenship Israel	
Post Office Address same as above		

Power of Attorney: As a named inventor, I hereby appoint the following attorney and/or agent(s) to prosecute this application and transact all business with the Patent and Trademark Office connected therewith:

Jeffrey A. Schwab, Registration Number 24,490
 Stewart J. Fried, Registration Number 20,694
 Jay S. Cinamon, Registration Number 24,156
 Dennis A. Mason, Registration Number 19,571

Michael I. Markowitz, Registration Number 30,659
 Thomas E. Spath, Registration Number 25,928
 Joseph J. Catanzaro, Registration Number 25,837
 Anthony Coppola, Registration Number 41,493

Send Correspondence To:
 Abelman, Frayne & Schwab
 150 East 42nd Street
 New York, New York 10017-5612

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 Dennis A. Mason, Michael I. Markowitz,
 Thomas E. Spath, Joseph J. Catanzaro
 or Anthony Coppola at (212) 949-9022

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(6) DETAILS
 REQUIRED
 FOR EACH
 INVENTOR

Full Name of Sole or First Inventor Eli MAGAL	Inventor's Signature	Date
Residence 7 Shmaryahu Levin Street, Tel Aviv 64357, Israel	Citizenship Isarel	
Post Office Address same as above		
Full Name of Second Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Third Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Fourth Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Fifth Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Sixth Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		

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UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

2

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO./TITLE
09/472,683	12/27/99	KAPLAN	204,344

0232/0204

ABELMAN FRAYNE & SCHWAB
150 EAST 42ND STREET
NEW YORK NY 10017-5617

2734

DATE MAILED:

02/04/10

NOTICE TO FILE MISSING PARTS OF APPLICATION
Filing Date Granted

An Application Number and Filing Date have been assigned to this application. The items indicated below, however, are missing. Applicant is given TWO MONTHS FROM THE DATE OF THIS NOTICE within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a). If any of items 1 or 3 through 5 are indicated as missing, the SURCHARGE set forth in 37 CFR 1.16(e) of ☐ \$65.00 for a small entity in compliance with 37 CFR 1.27, or ☒ \$130.00 for a non-small entity, must also be timely submitted in reply to this NOTICE to avoid abandonment.

If all required items on this form are filed within the period set above, the total amount owed by applicant as a
☐ small entity (statement filed) ☒ non-small entity is \$ 130.00.

☐ 1. The statutory basic filing fee is:

- ☐ missing.
☐ insufficient.

Applicant must submit \$_____ to complete the basic filing fee and/or file a small entity statement claiming such status (37 CFR 1.27).

☐ 2. The following additional claims fees are due:

\$_____ for _____ total claims over 20.

\$_____ for _____ independent claims over 3.

\$_____ for multiple dependent claim surcharge.

Applicant must either submit the additional claim fees or cancel additional claims for which fees are due.

☒ 3. The oath or declaration:

- ☒ is missing or unsigned.
☐ does not cover the newly submitted items.

An oath or declaration in compliance with 37 CFR 1.63, including residence information and identifying the application by the above Application Number and Filing Date is required.

☐ 4. The signature(s) to the oath or declaration is/are by a person other than inventor or person qualified under 37 CFR 1.42, 1.43 or 1.47.

A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.

☐ 5. The signature of the following joint inventor(s) is missing from the oath or declaration:

An oath or declaration in compliance with 37 CFR 1.63 listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.

☐ 6. A \$50.00 processing fee is required since your check was returned without payment (37 CFR 1.21(m)).

☐ 7. Your filing receipt was mailed in error because your check was returned without payment.

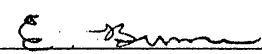
☐ 8. The application was filed in a language other than English.

Applicant must file a verified English translation of the application, the \$130.00 set forth in 37 CFR 1.17(k), unless previously submitted, and a statement that the translation is accurate (37 CFR 1.52(d)).

☐ 9. OTHER: _____

Direct the reply and any questions about this notice to "Attention: Box Missing Parts."

A copy of this notice MUST be returned with the reply.


Customer Service Center
Initial Patent Examination Division (703) 308-1202

Lawrence E. Abelman
Jeffrey A. Schwab
Victor M. Tannenbaum
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Howard R. Jaeger

Gabriel M. Frayne (1929 - 2000)



BELMAN, FRAYNE & SCHWA

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Wayne J. Gu***
Anthony A. Coppola
Michael J. Schwab
Jeanine M. Mitchell
Marcella Ballard
Jennifer R. Waitman
Lori B. Cohen
Laura J. Winston
Stephen J. Quigley

Dennis A. Mason
U.S. Patent Agent

*Member PA Bar Only
**Member NJ Bar Only
***Member MD Bar Only

April 3, 2000

Assistant Commissioner for Patents
Washington, D.C. 20231

Attention: Box Missing Parts

Re: Inventor: Menachem Kaplan, et al.
Ser. No: 09/472,683
For: BI-DIRECTIONAL CHAINING
OF NETWORK ACCESS PARTS
Docket: 204,344

Sir:

In response to the Notice of Missing Parts of February 4, 2000, attached are the Declaration and Power of Attorney, check in the amount of \$130 to cover filing fee and Return Postcard Receipt. A copy of the Notice of Missing Parts is also attached.

Respectfully submitted,

ABELMAN, FRAYNE & SCHWAB

Jay S. Cinamon
Jay S. Cinamon
Reg. No. 24,156

"EXPRESS MAIL" label no: EK 051 382 428 US

Date of Deposit: 03 APR 2000
This is to certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231.



UNITED STATES

PATENT APPLICATION DECLARATION AND POWER OF ATTORNEY - ORIGINAL APPLICATION	ATTORNEY'S DOCKET NO. 204,344
--	----------------------------------

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name:
I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention entitled

(1) **BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS**

(1) TITLE OF INVENTION

the specification of which

(2) CHECK APPROPRIATE BOX

(2) ☐ is attached hereto.
☒ was filed on December 27, 1999 as Application No. 09/472,683
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge my duty to disclose information of which I am aware which is material to the patentability of this application under 37 CFR 1.56(a): the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application; and as to applications for patents or inventor's certificate on the invention filed in any country foreign to the United States prior to this application by me or my legal representatives or assigns.

(3) CHECK APPROPRIATE BOX

(3) ☒ no such applications have been filed, or
☐ such applications have been filed as follows:

(4) COMPLETE DATA INDICATED IF APPLICABLE

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED WITHIN 12 MONTHS PRIOR TO THIS APPLICATION				
Country	Application Number	Date of Filing (day, month, year)	Date of Issue (day, month, year)	Priority Claimed Under 35 USC 119
(4)				☐ Yes ☐ No
				☐ Yes ☐ No
ALL FOREIGN APPLICATIONS, IF ANY, FILED MORE THAN 12 MONTHS PRIOR TO THIS APPLICATION				
(4)				

I hereby claim the benefit under Title 35, United States Code § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112. I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

(5) COMPLETE DATA INDICATED IF APPLICABLE

(5) _____
(Application Ser. No.) (Filing date) (Status: patented, pending, abandoned)

(5) _____
(Application Ser. No.) (Filing date) (Status: patented, pending, abandoned)

BEST COPY

Power of Attorney: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Jeffrey A. Schwab, Registration Number 24,490
 Stewart J. Fried, Registration Number 20,694
 Jay S. Cinamon, Registration Number 24,136
 Dennis A. Mason, Registration Number 19,571

Michael I. Markowitz, Registration Number 30,659
 Thomas E. Spah, Registration Number 25,928
 Joseph J. Caranzaro, Registration Number 25,337
 Anthony Coppola, Registration Number 41,493

Send Correspondence To:
 Abelman, Frayne & Schwab
 150 East 42nd Street
 New York, New York 10017-5612

Direct Telephone Calls To:
 Jeffrey A. Schwab, Stewart J. Fried, Jay S. Cinamon,
 Dennis A. Mason, Michael I. Markowitz,
 Thomas E. Spah, Joseph J. Caranzaro
 or Anthony Coppola at (212) 949-9022

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statement may jeopardize the validity of the application or any patent issued thereon.

1) DETAILS
 REQUIRED
 OF EACH
 INVENTOR

Full Name of Sole or First Inventor Menachem KAPLAN	Inventor's Signature <i>[Signature]</i>	Date 25/3/2000
Residence 3a Ha'azar Street, Petach Tikva 49327, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Second Joint Inventor, If Any David ZELIG	Inventor's Signature <i>[Signature]</i>	Date 24/3/00
Residence 25 Hana Senesh Street, Givataim 53541, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Third Joint Inventor, If Any ROV KINAMON	Inventor's Signature <i>[Signature]</i>	Date 29/3/00
Residence 19 Hazohar Street, Tel Aviv 62507	Citizenship Israel	
Post Office Address same as above		
Full Name of Fourth Joint Inventor, If Any Eli ALONI	Inventor's Signature <i>[Signature]</i>	Date 27/3/00
Residence 28 Aqamit Street, Tzur-Isal 44862, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Fifth Joint Inventor, If Any Ron SCAYOOR	Inventor's Signature <i>[Signature]</i>	Date 27.3.00
Residence 1/22 Bar Yehuda Street, Kiryat Ono 55404, Israel	Citizenship Israel	
Post Office Address same as above		
Full Name of Sixth Joint Inventor, If Any ERIC PANETE	Inventor's Signature <i>[Signature]</i>	Date 27/3/2000
Residence 39 Shimon Ben Zvi Street, Givataim 53631, Israel	Citizenship Israel	
Post Office Address same as above		

Power of Attorney: I, the undersigned inventor, hereby appoint the following attorney(s) or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Jeffrey A. Schwab, Registration Number 24,490
Stewart J. Fried, Registration Number 20,694
Jay S. Cinamon, Registration Number 24,156
Dennis A. Mason, Registration Number 19,571

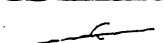
Michael I. Markowitz, Registration Number 30,659
Thomas E. Spahn, Registration Number 25,923
Joseph J. Caranzano, Registration Number 25,837
Anthony Coppola, Registration Number 41,493

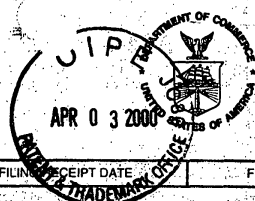
Send Correspondence To:
Abelman, Frayne & Schwab
150 East 42nd Street
New York, New York 10017-5612

Direct Telephone Calls To:
Jeffrey A. Schwab, Stewart J. Fried, Jay S. Cinamon,
Dennis A. Mason, Michael I. Markowitz,
Thomas E. Spahn, Joseph J. Caranzano
or Anthony Coppola at (212) 949-9022

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(6) DETAILS
REQUIRED
FOR EACH
INVENTOR

Full Name of Sole or First Inventor	Inventor's Signature	Date
Eli MAGAL		2/3/00
Residence	Citizenship	
7 Shmaryahu Levin Street, Tel Aviv 64357, Israel	Israel	
Post Office Address		
same as above		
Full Name of Second Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Third Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Fourth Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Fifth Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		
Full Name of Sixth Joint Inventor, If Any	Inventor's Signature	Date
Residence	Citizenship	
Post Office Address		



UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NUMBER	FILING RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO./TITLE
09/472,683	12/27/99	KAPLAN	204,344

ABELMAN FRAYNE & SCHWAB
150 EAST 42ND STREET
NEW YORK NY 10017-5612

0232/0204

DATE MAILED:

02/04/00

NOTICE TO FILE MISSING PARTS OF APPLICATION
Filing Date Granted

An Application Number and Filing Date have been assigned to this application. The items indicated below, however, are missing. Applicant is given TWO MONTHS FROM THE DATE OF THIS NOTICE within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a). If any of items 1 or 3 through 5 are indicated as missing, the SURCHARGE set forth in 37 CFR 1.16(e) of \$65.00 for a small entity in compliance with 37 CFR 1.27, or \$130.00 for a non-small entity, must also be timely submitted in reply to this NOTICE to avoid abandonment.

If all required items on this form are filed within the period set above, the total amount owed by applicant as a ☐ small entity (statement filed) ☒ non-small entity is \$ 130

- ☐ 1. The statutory basic filing fee is:
- ☐ missing.
 - ☐ insufficient.
- Applicant must submit \$ _____ to complete the basic filing fee and/or file a small entity statement claiming such status (37 CFR 1.27).
- ☐ 2. The following additional claims fees are due:
- \$ _____ for _____ total claims over 20.
 - \$ _____ for _____ independent claims over 3.
 - \$ _____ for multiple dependent claim surcharge.
- Applicant must either submit the additional claim fees or cancel additional claims for which fees are due.
- ☒ 3. The oath or declaration:
- ☒ is missing or unsigned.
 - ☐ does not cover the newly submitted items.
- An oath or declaration in compliance with 37 CFR 1.63, including residence information and identifying the application by the above Application Number and Filing Date is required.
- ☐ 4. The signature(s) to the oath or declaration is/are by a person other than inventor or person qualified under 37 CFR 1.42, 1.43 or 1.47.
- A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- ☐ 5. The signature of the following joint inventor(s) is missing from the oath or declaration:
- An oath or declaration in compliance with 37 CFR 1.63 listing the names of all inventors and signed by the omitted inventor(s), identifying this application by the above Application Number and Filing Date, is required.
- ☐ 6. A \$50.00 processing fee is required since your check was returned without payment (37 CFR 1.21(m)).
- ☐ 7. Your filing receipt was mailed in error because your check was returned without payment.
- ☐ 8. The application was filed in a language other than English.
- Applicant must file a verified English translation of the application, the \$130.00 set forth in 37 CFR 1.17(k), unless previously submitted, and a statement that the translation is accurate (37 CFR 1.52(d)).
- ☐ 9. OTHER:

Direct the reply and any questions about this notice to "Attention: Box Missing Parts."

A copy of this notice MUST be returned with the reply.

Customer Service Center
Initial Patent Examination Division (703) 308-1202

04/06/2000 CV0111
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15-09-01

01P-2734
2634L
5/16/01
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Technology Center 2600

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Menachem KAPLAN et al.

Serial No.: 09/472,683

Filed: December 27, 1999

For: BI-DIRECTIONAL CHAINING OF
NETWORK ACCESS PORTS

) Art Unit: 2734
)
) Examiner: N/A
) Washington, D.C.
) May 8, 2001
)
) Docket No.: 204,344

INFORMATION DISCLOSURE STATEMENT [IDS]

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. 1.97, 1.98, and it is requested that the information set forth in this statement and in the listed documents be considered during the pendency of the above-identified application, and any other application relying on the filing date of the above-identified application or cross-referencing it as a related application.

[X] 1. This IDS should be considered, in accordance with 37 C.F.R. 1.97, as it is filed:

(Check one of the boxes A-D)

☐ A. within three months of the filing date of the above-identified national application or within three months of the entry into the national stage of the above-identified international application.

[X] B. before the mailing date of a first office action on the merits.

☐ C. after (A) and (B) above, but before final rejection or allowance, and Applicants have made the necessary certification (box "i" below) or paid the necessary fee (box "ii" below).

(check one of the boxes "i" and "ii" below:)

☐ i. Counsel certifies that, upon information and belief, each item of information listed herein was either (a) cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS; or (b) was not cited in a communication from a foreign patent office in a counterpart foreign application and, to the knowledge of undersigned after making reasonable inquiry, was not known to any individual designated in 1.56(c) more than three months prior to the filing of this IDS.

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☐ ii. A check for the fee set forth in 1.17(p), presently believed to be \$230, is enclosed (check no. _____).

☐ D. after (A), (B) and (C) above, but before payment of the issue fee: Applicant petitions under 37 C.F.R. 1.97(d) for the consideration of this IDS. A check for the fee set forth in §1.17(i), presently believed to be \$130 is enclosed (check no. _____). Counsel certifies that, upon information and belief, each item of information listed herein was either (i) cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the IDS; or (ii) was not cited in a communication from a foreign patent office in a counterpart foreign application and, to the knowledge of the undersigned after making reasonable inquiry, was not known to any individual designated in 1.56(c) more than three months prior to the filing of this IDS.

☒ 2. In accordance with 37 C.F.R. 1.98, this IDS includes a list (e.g., form PTO-1449) of all patents, publications, or other information submitted for consideration by the office, either incorporated into this IDS or as an attachment hereto. A copy of each document listed is attached, except as explained below.

(check boxes A and/or B and fill in blanks, if appropriate.)

☐ A. Document(s) _____ is (are) deemed substantially cumulative to document(s) _____, and; in accordance with 1.98(c), only a copy of each of the latter documents is enclosed.

☐ B. Certain documents were previously cited by or submitted to the Office in the following prior application(s), which are relied upon under 35 U.S.C. 120:

[insert serial numbers and filing dates of prior applications]

Applicant identifies these documents by attaching hereto copies of the forms PTO-892 and PTO-1449 from the files of the prior application(s) or a fresh PTO-1449 listing these documents, and request that they be considered and made of record in accordance with 1.98(d). Per 37 CFR 1.98(d), copies of these documents need not be filed in this application.

☐ 3. Document(s) _____ is(are) not in the English language. In accordance with 1.98(c), Applicant states:

☐ An English translation of each document (or of the pertinent portions thereof), or a copy of each corresponding English-language patent or application, or English-language abstract (or claim) is enclosed.

☐ A concise explanation of the relevance of document(s) _____ is found in the attached search report (see reply to Comment 68 in the preamble to the final rules; 1135 OG 13 at 20).

☐ A concise explanation of the relevance of document(s) _____ is set forth as follows:

[Insert concise explanation of relevance]

☐ A concise explanation of the relevance of document(s) _____ can be found on page(s) _____ of the specification.

☐ A concise explanation of document(s) _____ can be found on the attached sheet.

4. No explanation of relevance is necessary for documents in the English language (see reply to Comments 67 and 68 in the preamble to the final rules; 1135 OG 13 at 20).

☐ 5. Other information being provided for the examiner's consideration follows:

A _____ dated _____, which issued during the prosecution of Applicant's Patent Application No. _____, which corresponds to the present application.

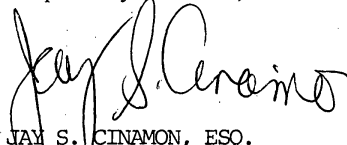
6. In accordance with 37 C.F.R. 1.97(g) and (h), the filing of this IDS should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56 (b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant reserves the right to prove that the date of publication is in fact different.

CROSS REFERENCE UNDER 37 C.F.R. §1.78 TO RELATED APPLICATIONS

Pursuant to 37 C.F.R. § 1.78, Applicant notes that the above-identified patent application may be related to the following U.S. Patent Applications:

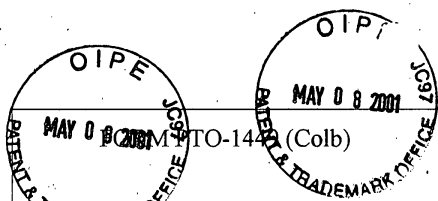
(1) U.S. Patent Application Serial No. 09/443,157, entitled SWITCH WITH SERIAL OUTPUT LINKS AND MULTI-DIMENSIONAL SCHEDULING, filed November 18, 1999.

Respectfully submitted,



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Date: May 8, 2001

Page 1 of 1

TO-144 (Colb) LIST OF PATENTS AND PUBLICATIONS FOR APPLICANTS' INFORMATION STATEMENT	ATTY DOCKET NO. 204,344 APPLICANT Menachem KAPLAN et al. FILING DATE December 27, 1999	SERIAL NUMBER 204,344 RECEIVED MAY 15 2001 #4 Technology Center 2600 GROUP ART UNIT 2734 2665
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U.S. PATENT DOCUMENTS

Examiner's Initials		DOCUMENT NO.	DATE	NAME	CLASS	SUB	FILING DATE
	AA						
	AB						
	AC						
	AD						
	AE						
	AF						

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUB	TRANS- LATION
	AG						
	AH						
	AI						

OTHER ART (Including Author, Bills, Pertinent Pages, Etc.)

DH	AJ	Dave Allan et al, "An "Optimized for ATM" ADSL Access Architecture using SDP", 7 pages, ADSL Forum 98-221, November 17 th to 20 th , 1998, Los Angeles, CA, USA.
DH	AK	"VORTEX CHIP SET: Introduction", Preliminary Issue 1, 16 pages, June 1999, PMC-Sierra, Inc., BC Canada.
	AL	
EXAMINER: Duc Ho		DATE CONSIDERED: 1-23-03
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.		

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U.S. Patent Application Serial No. 09/443,157, filed November 18, 1999



SWITCH WITH SERIAL OUTPUT LINKS AND MULTI-DIMENSIONAL
SCHEDULING

FIELD OF THE INVENTION

The present invention relates generally to high-speed data communication systems, and specifically to digital subscriber line systems.

BACKGROUND OF THE INVENTION

Digital Subscriber Line (DSL) is a modem technology that enables broadband digital data to be transmitted over twisted-pair wire, which is the type of infrastructure that links most home and small business subscribers to their telephone service providers. DSL modems enable users to access digital networks at speeds tens to hundreds of times faster than current analog modems and basic ISDN service. DSL thus opens the most critical bottleneck in local-loop access to high-speed networks, such as Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) networks, without requiring major investments in new infrastructure. A range of DSL standards have been defined, known generically as "xDSL," wherein the various standards have different data rates and other associated features but share common principles of operation.

DSL subscribers are connected to high-speed networks through Digital Subscriber Line Access Multiplexer (DSLAM) systems. The DSLAM is built around a concentrator, which multiplexes the traffic carried by a large number of DSL subscriber modems, or ports, through a common link to the network backbone. The concentrator should ensure that all of the subscribers have continuous access to the full bandwidth for which they have contracted. Ideally, the DSLAM system should be designed so that it can economically serve an initial, limited subscriber base, and still be capable of growing in

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capacity as the number of subscribers and their bandwidth demands increase over time.

Typically, the ports of the DSLAM are connected by a common bus to the concentrator. Alternatively, the ports are connected by point-to-point links to the concentrator either in a star or serial configuration. For example, PMC-Sierra, Inc., of Burnaby, British Columbia, offers a product known as the Vortex Chip Set, which allows serial point-to-point connection of multiple ports to a DSLAM concentrator. The Vortex Chip Set is described in a Preliminary Release, issued June, 1999, by PMC-Sierra, which document is incorporated herein by reference.

SUMMARY OF THE INVENTION

It is an object of some aspects of the present invention to provide improved methods and apparatus for multiplexed network access by multiple subscribers.

It is a further object of some aspects of the present invention to provide a multiplexer architecture that facilitates expansion of the number of subscribers who can be served by a common multiplexer system.

It is yet a further object of some aspects of the present invention to provide methods for scheduling transmission of data through a common trunk so that all of the subscribers served by the trunk receive their fair share of the available bandwidth.

In preferred embodiments of the present invention, a multiplex access system serves a plurality of network users, who are coupled thereby to access a high-speed packet-switched network through a multiplexer, or concentrator. The multiplexer concentrates traffic between the users and the network over a common trunk. The users communicate with the concentrator via subscriber lines, connected to respective ports of the multiplexer system. Preferably, the ports comprise Digital Subscriber Line (DSL) modems. The ports are linked to the concentrator in series, most preferably in a loop configuration.

In some preferred embodiments of the present invention, the ports are linked by a "daisy chain" of mutual point-to-point connections. A first port in the chain is linked by point-to-point connections to the concentrator and to a second port. The second port is in turn linked to a third port, and so forth. The last port in the chain is linked back to the concentrator. Data packets received over the network are passed from the concentrator to the first port and thence from one port to the next in the chain. When a packet addressed to a particular user reaches the appropriate port, the packet

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is sent out through the respective subscriber line. Similarly, packets received from a user at one of the ports are passed along the chain until they reach the concentrator, which sends them out over the network.

Daisy-chaining the ports in a loop of this sort differs from multiplexer systems known in the art, in which the ports are typically arranged in a star configuration around the multiplexer, or else on a bus. Whereas the star configuration is limited to a predetermined number of ports that are provided by the concentrator, the daisy-chain configuration allows the number of ports to be scaled up arbitrarily in response to increases in system speed, component density and numbers of subscribers. Unlike bus configurations, daisy-chaining of the ports does not require complex, high-speed bus arbitration logic. Daisy chaining also enables groups of ports to be serviced in locations remote from the concentrator, using only a single duplex line for an entire group.

In some preferred embodiments of the present invention, the concentrator manages the transmission of packets of different priorities between the network and the plurality of subscribers using a multi-dimensional scheduling method. The method takes into account two or more sets of criteria, or dimensions, in queuing the packets and determining the order in which they are to be transmitted. Preferably, one of the sets of criteria is based upon priorities assigned to different service types, such as voice or electronic mail. Another set of criteria is preferably based upon ensuring that communications resources are allocated fairly among the subscribers or, alternatively or additionally, take into account differing levels of service for which different users have contracted with a network operator. The concentrator statistically multiplexes the packets to and

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from the ports while balancing the various dimensions one against another.

This multi-dimensional scheduling enables each type of service to be maintained at a predetermined quality level, based on its respective priority, and to ensure that all subscribers receive their fair share of the available bandwidth, even when a total packet demand rate exceeds the capacity of the trunk. By contrast, systems known in the art, using "one-dimensional" scheduling, are incapable of ensuring that criteria of prioritization and fairness are simultaneously observed at all times. It will be appreciated that while preferred embodiments of the present invention are described with reference to a particular series configuration of subscriber ports linked to a concentrator, the principles of multi-dimensional scheduling may similarly be applied to multiplexing systems of other types.

There is therefore provided, in accordance with a preferred embodiment of the present invention, multiplexing apparatus for providing network access to multiple subscribers, including:

- a multiplexer, which communicates with a network so as to receive a downstream data packet therefrom destined for a selected one of the subscribers; and

- a plurality of ports arranged in a serial chain and linked to respective subscriber lines serving the subscribers, the ports including:

- a first port, coupled to receive the data packet from the multiplexer; and

- one or more subsequent ports, coupled so that each subsequent port receives the data packet in turn from a preceding one of the ports in the chain, such that the data packet is passed along the serial chain until it reaches the port coupled to the subscriber line serving the selected one of the subscribers, which port passes the packet to the subscriber.

Preferably, each of the ports includes a modem, most preferably, a Digital Subscriber Line modem, for communicating over the subscriber line. In a preferred embodiment, the network includes an Asynchronous Transfer Mode network.

In another preferred embodiment, the network operates in accordance with the Internet Protocol.

Preferably, the plurality of ports includes a last port in the chain, which is coupled to pass data packets to the multiplexer, wherein when an upstream data packet is received from one of the subscribers by one of the ports, the upstream packet is passed from port to port in turn along the serial chain until it reaches the multiplexer, which conveys the packet over the network.

In a preferred embodiment, the plurality of ports are located at a site remote from the multiplexer, and wherein the first port is coupled to the multiplexer by a serial link between the multiplexer and the remote site. Optionally, the serial link passes through a circuit-switched network.

Preferably, the multiplexer appends a routing tag to the packet, responsive to which the ports determine whether to convey the packet over the respective subscriber lines.

Further preferably, the multiplexer receives and queues a plurality of packets of different types, for different ones of the subscribers, and conveys the packets in an order corresponding to a priority order of the different types while serving the different ones of the subscribers in a round robin.

There is also provided, in accordance with a preferred embodiment of the present invention, a method for providing network access to multiple subscribers, including:

receiving from a network a downstream data packet destined for a selected one of the subscribers;

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passing the packet along a serial chain of ports linked to respective subscriber lines serving the subscribers, such that the packet is passed from port to port until it reaches the port coupled to the subscriber line that serves the selected one of the subscribers; and conveying the packet over the subscriber line to the subscriber.

There is additionally provided, in accordance with a preferred embodiment of the present invention, a method for scheduling transmission for multiple subscribers of data packets of a plurality of different types over a common trunk, wherein the subscribers belong to a defined subscriber order, and the types of packets belong to a defined type order, the method including:

arranging the packets in one or more queues;

selecting from one of the queues a packet of a first type in the type order to convey over the trunk for a first subscriber in the subscriber order;

seeking in the one or more queues a further packet of the first type to convey over the trunk for a second subscriber, subsequent to the first subscriber in the subscriber order; and

if no further packet of the first type is found, conveying over the trunk for the second subscriber a packet of a second type, subsequent to the first type in the type order.

Preferably, the type order includes an order of priorities, and wherein arranging the packets in the one or more queues includes arranging packets in order of priority.

Preferably, arranging the packets in the one or more queues includes assigning to each of the subscribers a respective maximum queue size, and discarding data packets from the queues when the respective queue sizes are exceeded. Most preferably, assigning the respective maximum queue size includes assigning a queue size to

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each of the subscribers responsive to a respective level of network service provided to each of the subscribers. Further preferably, assigning the queue size to each of the subscribers includes assigning queue sizes dependent on data rates respectively guaranteed to the subscribers.

Preferably, seeking in the one or more queues the further packet of the first type includes conveying substantially all of the packets of the first type in all of the queues before conveying the packet of the second type. Preferably, conveying for the second subscriber the packet of the second type includes conveying a packet of the second type for the subscriber next in the subscriber order after the subscriber for whom the last one of the packets of the first type was conveyed. Most preferably, conveying the packet of the second type includes conveying substantially all of the packets of the second type in all of the queues, and the method includes conveying a packet of a third type, subsequent to the second type in the type order, for the subscriber next in the subscriber order after the subscriber for whom the last one of the packets of the second type was conveyed.

There is additionally provided, in accordance with a preferred embodiment of the present invention, apparatus for scheduling transmission for multiple subscribers of data packets of a plurality of different types over a common trunk, wherein the subscribers belong to a defined subscriber order, and the types of packets belong to a defined type order, the apparatus including:

- a plurality of queues; and

- a multiplexer, which arranges the packets in the queues, and which selects from one of the queues a packet of a first type in the type order to convey over the trunk for a first subscriber in the subscriber order, and which seeks in the one or more queues a further packet of the first type to convey over the trunk for a second

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subscriber, subsequent to the first subscriber in the subscriber order,

wherein if no further packet of the first type is found, the multiplexer conveys over the trunk for the second subscriber a packet of a second type, subsequent to the first type in the type order.

The present invention will be more fully understood from the following detailed description of the preferred embodiments thereof, taken together with the drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram that schematically illustrates a multiplexing system, for coupling multiple subscribers to a communications network, in accordance with a preferred embodiment of the present invention;

Fig. 2 is a block diagram that schematically illustrates a concentrator in the system of Fig. 1, in accordance with a preferred embodiment of the present invention;

Fig. 3 is a block diagram that schematically illustrates the structure of a data packet conveyed in the system of Fig. 1, in accordance with a preferred embodiment of the present invention;

Fig. 4 is a block diagram that schematically illustrates the multiplexing system of Fig. 1 in an alternative configuration, in accordance with a preferred embodiment of the present invention;

Fig. 5 is a block diagram that schematically shows a detail of a multiplexing system, useful in understanding a method for multi-dimensional scheduling of transmission of packets in the system, in accordance with a preferred embodiment of the present invention; and

Figs. 6A and 6B are flow charts that schematically illustrate methods for multi-dimensional scheduling, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1 is a schematic block diagram illustrating a multiplex system 20, which provides access to a network 22 for a plurality of subscribers 24, in accordance with a preferred embodiment of the present invention. Preferably, system 20 comprises a DSLAM system, as described generally in the Background of the Invention. Network 22 is shown as comprising an ATM network, but may alternatively comprise substantially any other type of packet-switched network, such as an IP network.

System 20 comprises a network interface 26, preferably a Utopia interface, as is known in the art, which conveys data packets between network 22 and a concentrator 28. Typically, interface 26 comprises a physical layer (PHY) and data link layer (ATM) interface, communicating with the network core, and also performs virtual path/virtual circuit identifier (VPI/VCI) translation and other higher-layer functions. These elements are well known in the ATM art. Concentrator 28 comprises a multiplexer, which couples a plurality of ports 30, serving subscribers 24, to network interface 26. Ports 30, which preferably comprise suitable DSL modems, as are known in the art, are mounted on line cards 36, which are typically inserted in slots of a common backplane (not shown) for convenience of construction and service. The ports are marked "Port 1," "Port 2," etc., in the figure. Each port may be on its own line card, in its own backplane slot, or alternatively, several ports may share a common card and slot, as shown in Fig. 1. Although for simplicity only one line card 36 is shown in detail in the figure, system 20 typically comprises a plurality of such line cards, each having its own connection to concentrator 28 and serving multiple ports.

Ports 30 are arranged in series in a "daisy chain" 38, wherein each port is connected to the next one in the

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chain by a point-to-point data line 32 and, optionally, a clock line 34. Alternatively, the clock is provided to all of the line cards in parallel through the backplane. Whenever concentrator 28 receives a packet destined for one of ports 30 in chain 38, the packet is passed over line 32 to Port 1. If the packet is not destined for the subscriber 24 served by Port 1, labeled Subscriber 1 in the figure, the packet is passed on to Port 2, and so on down the line. Similarly, when one of ports 30 receives a packet from the respective subscriber 24 for transmission over network 22, it is passed down the chain of ports until it reaches concentrator 28. Preferably, lines 32 are driven by concentrator 28 at a high clock rate, most preferably at least 12-16 Mbs, so that there is sufficient bandwidth for substantially all downstream and upstream traffic without loss of packets. At this rate, delay introduced by the daisy-chain configuration is insignificant.

Although for the sake of simplicity, only four ports 30 are shown in Fig. 1, a typical daisy chain will include up to 8 ports, with concentrator 28 serving up to 64 such daisy chains in parallel. The daisy chain may include all of the ports on a given line card 36, or alternatively a single card may include a number of different daisy chains. Additionally or alternatively, a daisy chain may include ports residing on two or more different cards, since only a simple serial connection is needed from one port to the next in the chain. A further advantage of the daisy-chain approach is that as component density and speed increases, and it becomes possible to produce line cards 36 that incorporate greater numbers of ports on a single card, the additional ports may simply be added into the daisy chain. The capacity of system 20 can thus be scaled up without necessarily replacing concentrator 28 or the backplane on which line cards 36 reside.

Fig. 2 is a block diagram that schematically illustrates details of concentrator 28, in accordance with a preferred embodiment of the present invention. Cells are received from network interface 26 in an input FIFO (first-in-first-out) input buffer 39. A downstream processor 40, preferably a reduced instruction set computer (RISC) device, reads the headers of the incoming cells to determine to which port or ports 30 they should be routed and, preferably, to add an appropriate routing tag to each cell (or packet), as described further hereinbelow. The cells are stored in a SDRAM buffer 44, to be transmitted to the appropriate ports according to a transmission priority scheme, which is likewise described hereinbelow.

Cells to be transmitted to ports 30 on line cards 36 are read into an output RAM 41 and from there to one of a plurality of two-cell FIFO output buffers 42. Each such FIFO is associated with a respective one of daisy chains 38 on the line cards. The chains in Fig. 2 are numbered for convenience CHAIN 0, CHAIN 1, ..., CHAIN N.

Cells returning from the daisy-chained ports are received in respective FIFO input buffers 43, and from there are conveyed to an input RAM 45 and to SDRAM buffer 44. An upstream RISC processor 46 removes the internal routing tag and generates an appropriate header to be attached to each cell for transmission through the ATM network. These cells are queued and then sent out through an output FIFO buffer 47 over network interface 26.

Fig. 3 is a schematic block diagram illustrating a packet 51 conveyed by concentrator 28 over daisy chain 38, in accordance with a preferred embodiment of the present invention. An original cell 52 (or packet) is received from network interface 26 and is identified by the concentrator as being destined for one of ports 30 on the particular daisy chain in question. The concentrator

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preferably adds an internal routing tag 53, typically a header, to the cell, in order to indicate for which of the ports on the daisy chain the packet is destined. Alternatively, a portion of original cell 52, typically a 4-bit field known as the GFC in ATM access systems, is set aside for routing and is then reset to a default value when the routing information has been used and is no longer needed. The information in the routing tag is preferably read by the concentrator from a suitable routing table stored in memory.

Routing tag 53 includes a port address 49, which indicates which port 30 is to take the packet. For each port along daisy chain 38, if port address 49 does not match the port number, packet 51 is passed on to the next port in the chain. For upstream packets sent from subscribers 24, port address 49 indicates concentrator 28 (or contains a null address, since such packets will reach the concentrator in any event). A given physical port 30 may include two or more channels, associated with different subscribers on a single line or different types of service provided to a given subscriber. For such cases, an optional logical port field 48 identifies the applicable channel of the physical port indicated by address 49. One or more additional fields 50 are preferably reserved for other information, for example, to flag multicast packets. Thus, when one of ports 30 receives a suitably-flagged multicast packet with port address 49 matching that port, it both sends a copy of the packet to the corresponding subscriber 24 and passes the packet on to the next port in the chain.

If port address 49 assigned by concentrator 28 does not match any of ports 30, or equivalently, if a null address is assigned, packet 51 will loop through all of chain 38 and return to the concentrator. This feature enables testing connectivity of the chain without the necessity of interrupting user traffic.

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Fig. 4 is a block diagram that schematically shows multiplexing system 20 in an alternative configuration, in accordance with a preferred embodiment of the present invention. In order to maintain the transmission speeds and quality of service prescribed by xDSL standards, the modems associated with ports 30 must be within a certain maximum distance (expressed in terms of the required run of copper-wire cable) from the premises of subscribers 24. On the other hand, the elements of system 20 are costly, and it is uneconomic to deploy the entire system in an area in which there are relatively few subscribers to serve. Therefore, the configuration of Fig. 4 offers the possibility of remote transmission convergence (TC) extension, whereby one or more extension elements 54, functionally similar to line cards 36, are located remote from system 20 and provide network access to subscribers 24 in the remote area.

Extension element 54 comprises ports 30, arranged in a daisy chain, like the ports on line card 36 in Fig. 1. Element 54 is connected to concentrator 28 by a duplex point-to-point line, such as a T1, E1 or other high-speed line, through an existing network 55, so that the concentrator interacts with the remote extension element in essentially the same manner as with the local line card. Preferably, network 55 comprises a circuit-switched network, such as a public switched telephone network (PSTN), which typically uses time-division-multiplexing (TDM), rather than packet switching as in network 22. Alternatively, the connection between element 54 and system 20 may be made through the infrastructure of a cable entertainment network, or any other suitable infrastructure that may be available. This sort of remote TC extension is possible because of the serial, daisy-chain connection between concentrator 28 and ports 30. Only the single duplex line is needed between the concentrator and the multiple ports, by

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contrast with systems known in the art, which require either a separate concentrator at the remote location or a remote bus extension.

Fig. 5 is a block diagram that schematically illustrates a detail of a multiplexing system 60, useful in understanding a method for multi-dimensional scheduling of transmission of packets in the system, in accordance with a preferred embodiment of the present invention. In the example shown in Fig. 5, the scheduling method is applied to a link between concentrator 28 and a unit with multiple ports, such as extension element 54. The principles of the method described hereinbelow, however, are applicable to a wide range of situations in which data packets must be routed to multiple recipients and/or from multiple sources over a common trunk of limited capacity. The trunk is preferably a serial trunk, as in system 20, but may also comprise a parallel link, such as a multi-line bus, as well as a wireless connection.

System 60 includes a number m of different clients, each typically corresponding to one of ports 30 (Fig. 1 or 3). Each client i contracts for a range of n_i different services j , such as voice, video, Internet browsing, electronic mail, etc. Each such service is assigned a priority level and is characterized by a peak data rate $Z_{i,j}$ and a sustained rate over time $S_{i,j}$. All of the packets directed to the m clients are conveyed over the common trunk between concentrator 28 and element 54, which has a maximum data capacity of X . Each subscriber is assured a minimum average bandwidth of Y_i for which he or she has contracted. Bursts of data above the average are handled by queuing when necessary. As long as excess bandwidth is available at any given time, the client may even be allowed to exceed Y_i , but there is no guarantee of bandwidth above this minimum.

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Problems in system 60, such as loss of data and violation of client contracts, will arise when the data rate demand exceeds the maximum capacity of the trunk, i.e., when:

$$\sum_{i=1}^m \sum_{j=1}^{ni} Z_{i,j} > X \quad (1)$$

Such problems must be resolved by the use of statistical multiplexing, so that the maximum trunk capacity is not exceeded. In other words, the situation expressed by equation (1) must be handled by appropriate prioritization and scheduling of data packets when possible. the available capacity must be distributed fairly among the subscribers, preferably in accordance with the assigned priority levels of the data to be conveyed and subject to the constraint (at least at times when the total demand is in excess of the trunk capacity) that for each subscriber i :

$$\sum_{j=1}^{ni} S_{i,j} \leq Y_i \quad (2)$$

Although as noted above, violations of equation (1) can be handled by appropriate buffering and statistic multiplexing, when the sustained rate exceeds the trunk capacity, i.e., when

$$\sum_{i=1}^m \sum_{j=1}^{ni} S_{i,j} > X \quad (3)$$

over a period of time, packets must be dropped from the data streams of subscribers who exceed their contract rates, as given by equation (2). Preferably, elimination of excess packets is accomplished using methods of early

packet discard (EPD) and partial packet discard (PPD), as are known in the art.

Fig. 6A is a flow chart that schematically illustrates a method for queuing data packets for transmission over a common trunk, such as that shown in Fig. 5, in accordance with a preferred embodiment of the present invention. In order to meet the criterion of equation (2), each subscriber i is assigned a maximum permitted queue size, which is determined for each service type as a function of the subscriber's contractual minimum average bandwidth Y_i and the peak and sustained rates for the particular service type i, j . Methods for determining permitted queue sizes and allocating buffer memory accordingly are well known in the art.

Thus, as shown in Fig. 6A, when a data packet arrives at concentrator 28, it is sorted and queued according to the priority of its service type j and the identity of the subscriber i to whom it belongs. When the total data rate is at or near the maximum trunk capacity, and the contractual bandwidth is exceeded, the subscriber's queue will fill beyond the maximum permitted size. In this case, any packets overflowing the queue are discarded, as noted above, in order to ensure that the queues of other subscribers, who have stayed within their respective limits, are not damaged.

Fig. 6B is a flow chart that schematically illustrates a method for transmitting data, following queuing of the data using the method of Fig. 6A, in accordance with a preferred embodiment of the present invention. Packets are sent in order of their priorities, while subscribers (or users) are served in a round robin, to ensure that all of them receive their fair shares of the available bandwidth.

The process of selecting the user to be served begins each time a new packet is to be sent over the

common trunk, subject to the constraint of the trunk bandwidth on the total rate of packets that can be sent. Typically, subject to this bandwidth constraint, the process is triggered whenever a buffer (such as FIFO 42 or 43 in Fig. 2) on one of the lines served by the concentrator becomes empty. An interrupt is then generated (to the appropriate RISC processor 40 or 46, in the example of Fig. 2), which initiates the selection process.

The selection is preferably based on a three-dimensional table, which is updated at each cycle of the selection process. The columns of the table correspond to the users, while the rows correspond to the different levels of service priority. For each user and priority level, the table includes two binary entries, or layers (creating the third dimension of the table):

- Eligibility of each of the users to send or receive data. A value of 1 indicates that the user is eligible for service at this cycle, based on the service bandwidth allocated to the user, for example, which may vary from one user to another.
- Queue status for each client at each priority level. A value of 1 in this case indicates that there is a packet waiting to be sent in the corresponding queue.

A logical "AND" operation is applied to the two table levels in order to generate, at each cycle of the process, a two-dimensional table of binary values, indicating the users and priority levels to be served. Table I below, shows an example of such a table generated for eight users at four priority levels:

TABLE I

Priority	User							
	1	2	3	4	5	6	7	8
1	1	0	0	0	0	1	0	0
2	0	1	0	1	1	0	0	0
3	1	0	0	0	0	1	1	1
4	0	1	0	0	0	0	1	0

Concentrator 28 uses this table to determine from which of the queues to take the packet that is to be sent in the current cycle. To make the determination, the two-dimensional table is opened out into a one-dimensional sequence, starting from the least-recently served user at the highest priority. For the example in Table I, assuming that user 4 was served in the preceding cycle, the sequence begins with user 5 at priority 1, as shown in Table II below:

TABLE II

User	5	6	7	8	1	2	3	4	5	6	7	8	1	2
Priority	1	1	1	1	1	1	1	1	2	2	2	2	2	2
Value	0	1	0	0	1	0	0	0	1	0	0	0	0	1

3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4
2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4
0	1	0	1	1	1	1	0	0	0	0	0	1	0	0	1	0	0

The concentrator needs only to find the first non-zero entry in this sequence in order to select the user and priority of the queue from which the next packet is to be selected. In this case, it will be the first-priority queue of user 6. On the other hand, if all of the first eight entries in the sequence of Table II were 0, the selection process would go on to the next priority

level (starting from the ninth entry - user 5 at priority 2). This process continues until it is determined that all of the queues of all of the eligible users are empty, down to the most-recently served user at the last priority.

The result of this scheme is that a packet of a given priority in one of the queues will always be sent before any lower-priority packet. When two subscribers are waiting for transmission of queued packets at the same priority level, the least-recently-served subscriber will always be served next. This arrangement may result, however, in subscribers with low-priority service waiting excessive periods for transmission due to heavy high-priority traffic. To overcome this problem, other transmission criteria may be added. For example, a packet in a low-priority queue that has not been serviced within a given period of time may be automatically upgraded to a higher-priority queue.

Although preferred embodiments are described hereinabove with reference to DSL technology and systems and to particular packet-switched networks and access devices, it will be appreciated that the principles of the present invention may be applied generally in other fields of network access technology and, with appropriate modifications, in network core switching devices, as well. It will be understood that the preferred embodiments described above are cited by way of example, and that the present invention is not limited to what has been particularly shown and described hereinabove. Rather, the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove, as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description and which are not disclosed in the prior art.

CLAIMS

1. Multiplexing apparatus for providing network access to multiple subscribers, comprising:

a multiplexer, which communicates with a network so as to receive a downstream data packet therefrom destined for a selected one of the subscribers; and

a plurality of ports arranged in a serial chain and linked to respective subscriber lines serving the subscribers, the ports comprising:

a first port, coupled to receive the data packet from the multiplexer; and

one or more subsequent ports, coupled so that each subsequent port receives the data packet in turn from a preceding one of the ports in the chain, such that the data packet is passed along the serial chain until it reaches the port coupled to the subscriber line serving the selected one of the subscribers, which port passes the packet to the subscriber.

2. Apparatus according to claim 1, wherein each of the ports comprises a modem for communicating over the subscriber line.

3. Apparatus according to claim 2, wherein the modem comprises a Digital Subscriber Line modem.

4. Apparatus according to claim 1, wherein the network comprises an Asynchronous Transfer Mode network.

5. Apparatus according to claim 1, wherein the network operates in accordance with the Internet Protocol.

6. Apparatus according to claim 1, wherein the plurality of ports comprises a last port in the chain, which is coupled to pass data packets to the multiplexer.

7. Apparatus according to claim 6, wherein when an upstream data packet is received from one of the subscribers by one of the ports, the upstream packet is passed from port to port in turn along the serial chain

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until it reaches the multiplexer, which conveys the packet over the network.

8. Apparatus according to claim 1, wherein the plurality of ports are located at a site remote from the multiplexer, and wherein the first port is coupled to the multiplexer by a serial link between the multiplexer and the remote site.

9. Apparatus according to claim 8, wherein the serial link passes through a circuit-switched network.

10. Apparatus according to claim 1, wherein the multiplexer appends a routing tag to the packet, responsive to which the ports determine whether to convey the packet over the respective subscriber lines.

11. Apparatus according to claim 1, wherein the multiplexer receives and queues a plurality of packets of different types, for different ones of the subscribers, and conveys the packets in an order corresponding to a priority order of the different types while serving the different ones of the subscribers in a round robin.

12. A method for providing network access to multiple subscribers, comprising:

receiving from a network a downstream data packet destined for a selected one of the subscribers;

passing the packet along a serial chain of ports linked to respective subscriber lines serving the subscribers, such that the packet is passed from port to port until it reaches the port coupled to the subscriber line that serves the selected one of the subscribers; and

conveying the packet over the subscriber line to the subscriber.

13. A method according to claim 12, wherein conveying the packet to the subscriber comprises passing the packet over a Digital Subscriber Line.

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14. A method according to claim 12, wherein the network comprises an Asynchronous Transfer Mode network.

15. A method according to claim 12, wherein the network operates in accordance with the Internet Protocol.

16. A method according to claim 12, and comprising:
receiving at one of the ports an upstream data packet from one of the subscribers;
passing the upstream packet from port to port to a final port in the serial chain; and
conveying the packet from the final port over the network.

17. A method according to claim 12, wherein passing the packet along the serial chain comprises appending a routing tag to the packet, responsive to which the ports determine whether to convey the packet over the respective subscriber lines.

18. A method according to claim 12, wherein receiving the downstream data packet comprises queuing a plurality of packets of different types, for different ones of the subscribers, and wherein passing the packet along the serial chain comprises passing the packets in an order corresponding to a priority order of the different types while serving the different ones of the subscribers in a round robin.

19. A method for scheduling transmission for multiple subscribers of data packets of a plurality of different types over a common trunk, wherein the subscribers belong to a defined subscriber order, and the types of packets belong to a defined type order, the method comprising:

arranging the packets in one or more queues;
selecting from one of the queues a packet of a first type in the type order to convey over the trunk for a first subscriber in the subscriber order;

seeking in the one or more queues a further packet of the first type to convey over the trunk for a second

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subscriber, subsequent to the first subscriber in the subscriber order; and

if no further packet of the first type is found, conveying over the trunk for the second subscriber a packet of a second type, subsequent to the first type in the type order.

20. A method according to claim 19, wherein the type order comprises an order of priorities, and wherein arranging the packets in the one or more queues comprises arranging packets in order of priority.

21. A method according to claim 19, wherein arranging the packets in the one or more queues comprises assigning to each of the subscribers a respective maximum queue size, and discarding data packets from the queues when the respective queue sizes are exceeded.

22. A method according to claim 21, wherein assigning the respective maximum queue size comprises assigning a queue size to each of the subscribers responsive to a respective level of network service provided to each of the subscribers.

23. A method according to claim 22, wherein assigning the queue size to each of the subscribers comprises assigning queue sizes dependent on data rates respectively guaranteed to the subscribers.

24. A method according to claim 19, wherein seeking in the one or more queues the further packet of the first type comprises conveying substantially all of the packets of the first type in all of the queues before conveying the packet of the second type.

25. A method according to claim 24, wherein conveying for the second subscriber the packet of the second type comprises conveying a packet of the second type for the subscriber next in the subscriber order after the

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subscriber for whom the last one of the packets of the first type was conveyed.

26. A method according to claim 25, wherein conveying the packet of the second type comprises conveying substantially all of the packets of the second type in all of the queues, and comprising conveying a packet of a third type, subsequent to the second type in the type order, for the subscriber next in the subscriber order after the subscriber for whom the last one of the packets of the second type was conveyed.

27. Apparatus for scheduling transmission for multiple subscribers of data packets of a plurality of different types over a common trunk, wherein the subscribers belong to a defined subscriber order, and the types of packets belong to a defined type order, the apparatus comprising:

a plurality of queues; and

a multiplexer, which arranges the packets in the queues, and which selects from one of the queues a packet of a first type in the type order to convey over the trunk for a first subscriber in the subscriber order, and which seeks in the one or more queues a further packet of the first type to convey over the trunk for a second subscriber, subsequent to the first subscriber in the subscriber order,

wherein if no further packet of the first type is found, the multiplexer conveys over the trunk for the second subscriber a packet of a second type, subsequent to the first type in the type order.

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ABSTRACT

Multiplexing apparatus for providing network access to multiple subscribers includes a multiplexer, which communicates with a network so as to receive a downstream data packet therefrom destined for a selected one of the subscribers, and a plurality of ports arranged in a serial chain and linked to respective subscriber lines serving the subscribers. The ports include a first port, coupled to receive the data packet from the multiplexer, and one or more subsequent ports, coupled so that each subsequent port receives the data packet in turn from a preceding one of the ports in the chain. The data packet is passed along the serial chain until it reaches the port coupled to the subscriber line serving the selected one of the subscribers, which port passes the packet to the subscriber.

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Title: An "Optimized for ATM" ADSL Access Architecture using SDP

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Abstract:

SDP, the Simple Device Protocol, enables a new type of pure ATM access architecture. This paper outlines such an architecture and describes the key benefits. Inherent in this architecture is a number of solutions to outstanding ATM/ADSL issues.

Notice:

This contribution has been prepared to assist the ADSL Forum. It is offered to the Forum as a basis for discussion and is not a binding proposal on the author(s), parent companies or any other company. The requirements are subject to change after further study. The author reserves the right to add, to amend or withdraw the statements contained herein.

1. Introduction

This contribution is the 1998 version of the "ruthlessly simplified DSLAM" first discussed in [1].

The rationale for minimizing footprint, and power consumption has not diminished with time. In fact given the current regulatory environment, the attributes of central office frugality is desirable to an even larger potential customer base. The co-location cage is the CLEC version of the remote cabinet in terms of physical deployment constraints.

What has also changed since 1996 is the understanding that the access node needs to be fully featured in both the ATM sense and in the ADSL sense. Full ATM/ADSL functionality needs to be provided while providing deployment flexibility.

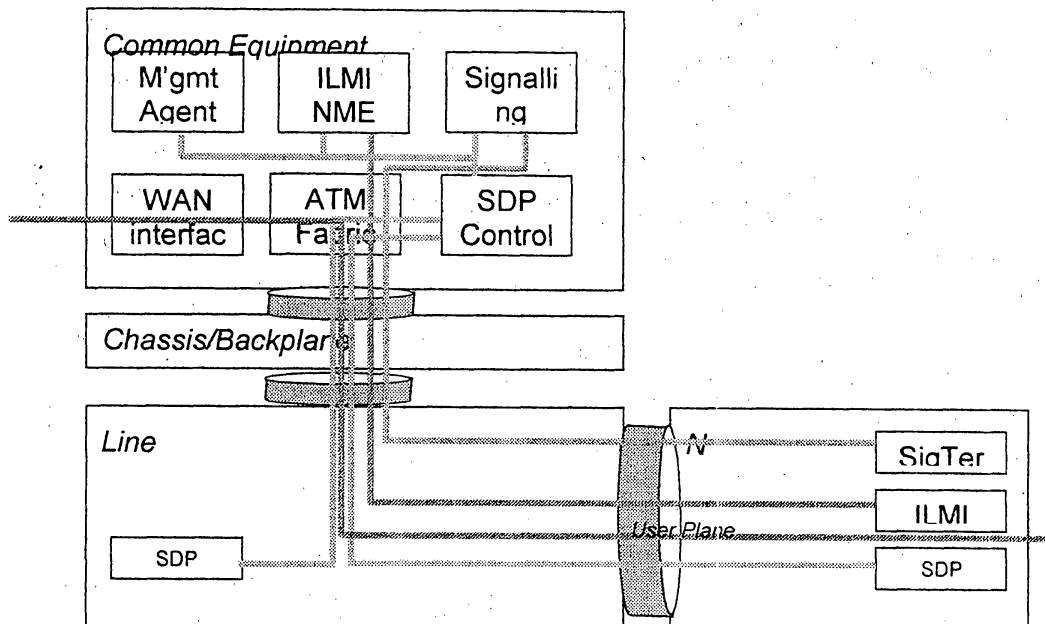
This contribution proposes exclusive use of the ATM layer for control/configuration and management of the ATM/ADSL layers. The key notion is the minimization and simplification of internal interfaces and DSL interfaces such that high degrees of integration and density can be achieved.

2.0 the Simplified DSLAM

The key attribute of the simplified DSLAM is that ATM is used for all control and configuration functions. Specifically, SDP is recommended for ATM/ADSL control/configuration functions and management information gathering functions between the common equipment and the ATUs.

This has several useful properties, the most notable of which is that only one interface is required between the common equipment and the ATU-C/ATU-Rs. Further, this interface is distance insensitive such that subtending line card drawers can be remotely located from the common equipment. This opens up numerous possibilities in "distributed DSLAM" architectures to meet both regulatory and physical plant engineering requirements.

This is a significant benefit. Non ATM solutions require multiple interfaces on the backplane and significant complexity to be deployed both on the line card and in the ATU-R. This additional complexity translates into reduced density, which has significant drawbacks when the deployment scenario has real physical constraints such as a remote or a "co-lo" cage.



As a case study, let's contrast implementing SDP[2] vs. the recommendations in G.997.1 (G.ploam) [3]. We will adopt the architecture that the ADSL system consists of common equipment (WAN interface, SNMP TR-006[4] compliant agent, multiplexing function etc.), ATU-C line cards connected to the common equipment via a backplane, and the ATU-Rs.

The G.ploam Implementation

G.997.1 recommends the use of SNMPv1 over the clear channel EOC between the ATU-C and the ATU-R to perform physical layer management of the ATU-R. There are several DSLAM implementation possibilities, each of which has substantial disadvantages:

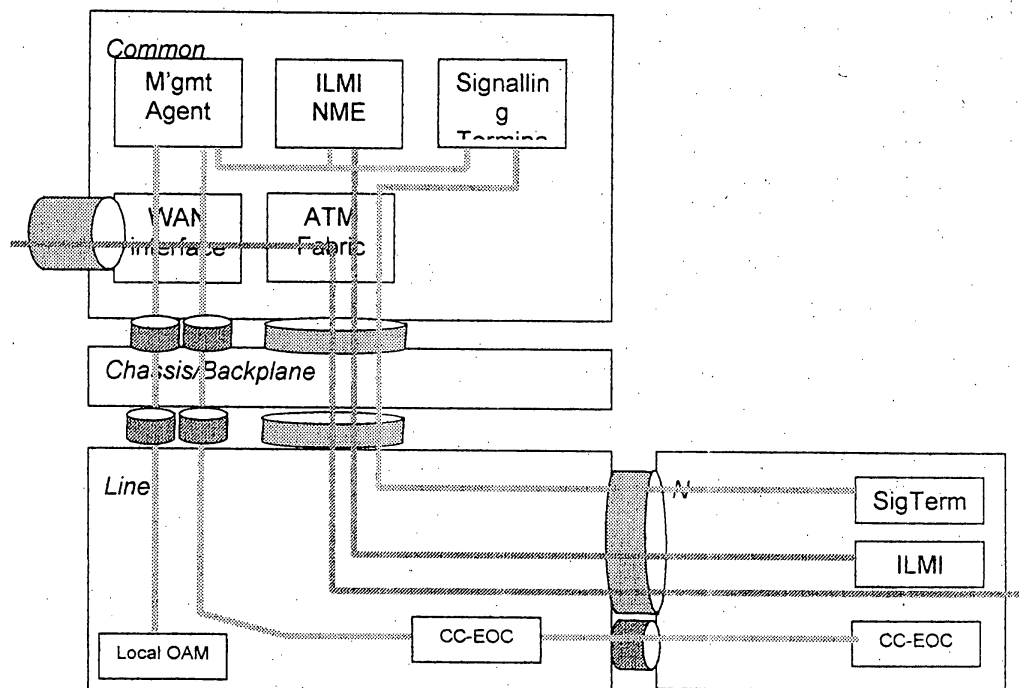
Option 1: The clear channel EOC is implemented on the common equipment and merely relayed by the ATU-C. This may or may not share a common physical interface with the ATU-C to common equipment path.

- If it does not share the interface, then two separate backplane interfaces are required in addition to the ATM interface. This burdens the backplane with TWO additional interfaces and associated transceivers (hence additional power dissipation) as well as two additional sets of physical contacts reducing reliability.

- If it does share the interface, then de-multiplexing is required as well as complexity in protocol handling as the error recovery for SNMP is end-to-end, and the ATU-C would be obligated to correctly replicate errors.

Further, most designers when obliged to implement SNMP for ATU-R phy layer management, may also want to simplify the design and implement SNMP in the ATU-C as well

Option 2: The clear channel EOC is generated at the ATU-C and the ATU-C presents a consolidated ATU-C/R view over a single physical interface to the common equipment. In this scenario, the ATU-C is burdened with implementing not only SNMP (and potentially the associated security provisions), but requires a repository for ATU-R information prior to presenting the consolidated view to the common equipment. Again, most designers when obliged to implement SNMP in the ATU-C to communicate with the ATU-R, will also choose to implement it as the ATU-C to common equipment interface as well. A separate physical interface between the ATU-C and the common equipment is still required.



In essence, we could find ourselves implementing SNMP on the line card in all circumstances as well as providing a separate physical path (with associated electronics). Even assuming multiple ports on a single card, significant complexity is required. Numerous sources will point out that SNMP is relatively trivial in implementation and

resource consumption. We would contend that it is still an order of magnitude more complex than what is required for physical layer OAM and ATM/ADSL configuration and control, and provision of SNMPv3 security features adds significantly more complexity.

The SDP Implementation

SDP uses ATM cells over well known VPI/VCIs to directly communicate with the ATU-C and ATU-Rs. The SDP control function is implemented on the common equipment and is coupled to the common SNMP agent, signalling termination and ATM layer management functions. In this scenario, the ATM connectivity across the backplane is re-used for control and configuration of both the ATU-Cs and ATU-Rs.

As SDP messages fit into a single cell, the ATU-C and ATU-R merely need to filter the cell streams to obtain cells destined to the local VPI/VCI termination. The messages are already delineated on cell boundaries, so additional delineation of the traffic via software is not required. The data that can be obtained is delineated on virtual register boundaries, so the rare information token that overflows a single transaction can still be reliably obtained.

3.0 Other Considerations

3.1 Reliability

The reliability of the common equipment to ATU-R path is an issue. Carriage over different paths in the DSL link may have different characteristics that must be considered. The key requirement is that the optimized for ATM architecture SDP based control mechanisms are no more vulnerable to interruptions in connectivity than any other mechanisms that could be employed.

Currently, all data transport across the DSL link (AOC, EOC, bearer channels etc.) is equally vulnerable to induced communication errors and has the same error detection and recovery mechanisms¹. The ATM layer does potentially have a longer recovery time from errors if the error caused a loss of cell delineation (time to re-synchronize on 'n' correct HECs) however this can be considered to be inconsequential in proportion to the required data rates and latency requirements for control information. It is hard to envision transmission errors that pathologically interfered with cell delineation while permitting other paths (EOC, AOC etc.) to work.

The reliability of the path between the common equipment and the ATU-C is similarly an issue, but as this is entirely new equipment, this can be adequately engineered.

¹ The reader is referred to the reference models in [6] section 4 in which it can be seen that the combined bearer channel, EOC/AOC payload is CRC'd, FEC'd and interleaved together.

The conclusion is that using SDP in place of any other DSL communication path will not cause a reduction in reliability.

3.2 Security

The SDP path between the common equipment and the ATU-R has the following security attributes:

- 1) It depends on physical connectivity for mutual authentication.
- 2) It does not naturally traverse any unknown parties. It is carried on a unique virtual connection local to the ADSL subsystem.
- 3) Only via physical interdiction of the SDP path, can either the device or the controller be impersonated or may the traffic be altered.
- 4) Only a limited set of functions can be performed by the SDP controller. This is scoped by the interface the device presents to the controller.
- 5) The SDP controlled device may only originate trap messages. Traffic originated by the device is only parasitic of bandwidth between the controller and the device (minimal impact on other customers). Traffic originated by the device may attempt a form of denial of service attack by causing excessive SNMP traps from the common equipment to the local EMS. A filtering function is required at the common equipment.

The conclusion is that for a third party to interfere with the service, physical interdiction is required (to which all systems are vulnerable, regardless of the technology). Once this has occurred, the SDP path is probably the least vulnerable ATM path in that it is scoped to being within the ADSL subsystem and has severely scoped functionality.

A malicious customer may connect equipment to the network and attempt to manipulate the SDP trap mechanism to perform denial of service, but for reasonable implementations, they may only interfere with their own service. The combination of scoped reach into the network or the premises via the SDP path, and the severely scoped functionality is adequate security (especially when compared to attempting to manipulate signalling, and other higher order service functions).

The possible attacks that SDP is vulnerable to may only be prevented via the incorporation of cryptographic techniques for strong authentication and non-repudiation. The complexity of such techniques is significantly out of proportion to the value of what is being protected.

4.0 Conclusion

The SDP implementation shares the ATM service transport connectivity required between the ATUs and the common equipment, this has numerous advantages:

- sharing the message delineation mechanisms common to the ATM service transport.
- minimizes the functionality required to be implemented in the ATUs by pushing the complexity into the common equipment and not replicating it in each system component.
- via the use of WAN capable transport (ATM), the common equipment may be located remotely from the ATU-Cs expanding the deployment options for ADSL equipment.
- the management link is in-band. This is much simpler to use the same transmit/receive procedure for all purposes, especially for G.LITE. This is according to the ATM architecture when the management is always in-band, using a separate VC.

eliminate the need to terminate the ATU-R's management protocol in the ATU-C simply for sending it through the EOC. The ATU-R's management protocol will pass through the ATU-C without any interference. This functional decoupling opens up numerous possibilities as to how DSLAMs may evolve.

An SDP capable architecture promises to be significantly more capable than competing proposals and should be pursued by the ADSL Forum.

5. Recommendation

The ADSL Forum should promote SDP as a mechanism for physical layer configuration and control of ATU-Cs and ATU-Rs.

6. References

- [1] Allan, David "Topics in DSLAM architecture", ADSL Forum Contribution 96-130, December 1996
- [2] Wilhelm et.al. "The Simple Device Protocol", ADSL Forum Contribution 98-158, September 1998
- [3] Johansson, A "G.997.1", ADSL Forum Contribution 98-205, November 1998
- [4] "ATM Mode Working Text for TR-002 Version 2", ADSL Forum working document WT-021
- [5] "SNMP based ADSL Line MIB", ADSL Forum Technical Report, TR-006, March 1998
- [6] "T1.413 Issue 2 Draft Standard", Committee T1-Telecommunications, Working Group T1E1.4, September 1998

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VORTEX CHIP SET
INTRODUCTION

VORTEX CHIP SET

**S/UNI-TM
DUPLICATE**
PM7350

**S/UNI-TM
VORTEX**
PM7351

**S/UNI-TM
APEX**
PM7326

**S/UNI-TM
ATLAS**
PM7324

INTRODUCTION

PRELIMINARY

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ISSUE 1

PMC-990712



PMC-Sierra, Inc.

**VORTEX CHIP SET
INTRODUCTION**

REVISION HISTORY

Issue No.	Issue Date	Details of Change
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1 PURPOSE AND SCOPE OF THIS DOCUMENT

PMC-Sierra has introduced the Industry's first standard product chip set designed from the ground up to satisfy requirements of the newest and fastest growing network access applications:

- Digital Subscriber Line Access Multiplexers -- DSLAMs.
- Third-generation digital wireless base-stations and base-station controllers.
- Multi-service access multiplexers.

This paper discusses how and why PMC-Sierra implemented a system level solution to satisfy the unique requirements of this marketplace. We first analyze the requirements driving Digital Subscriber Line Access Multiplexer (DSLAM) market and describe how the features of the VORTEX chip set meet these requirements. We then expand the discussion to include third generation CDMA wireless equipment (hereafter called 3G Wireless) and multi-service access platforms capable of supporting ATM, frame, and TDM interfaces.

2 VORTEX CHIP SET OVERVIEW

The VORTEX chip set is optimized for use in carrier grade, full-featured access equipment delivering high speed Internet and voice services to end customers. As shown in the following table, its feature set has been carefully crafted to minimize the entire life cycle cost of access platforms targeted to mass market service deployment.

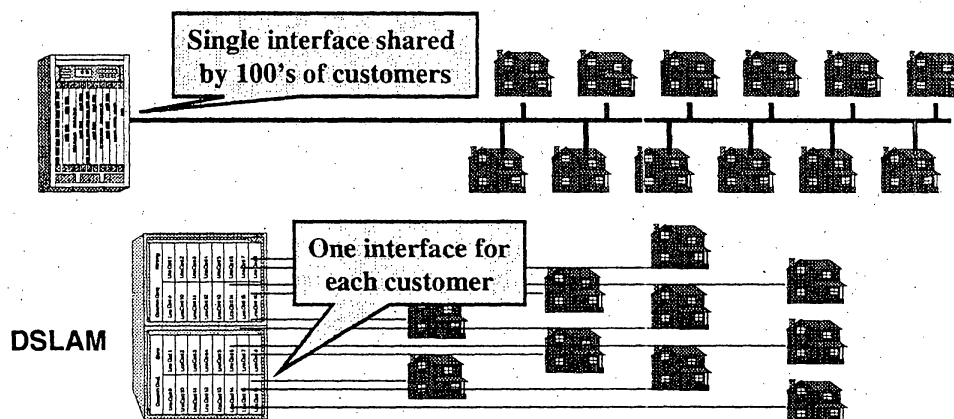
VORTEX chip set Feature	Impact on equipment life cycle
Centralized switching and traffic management for 2048 subscriber lines, eliminating the need for expensive and complex traffic management functions on the line card.	System hardware and software design is greatly simplified, thereby reducing development costs and speeding time to market.
Reduced system software complexity by eliminating the need for software intelligence on the line cards.	Future in-field upgrades of software and hardware will not impact the line cards (which are the most numerous cards in the system). This extends the system's lifetime and reduces ongoing maintenance costs.
Class of Service (CoS) differentiated traffic buffering and scheduling is implemented on each of the 2048 lines, and on the WAN up-link. Traffic shaping is implemented on the WAN up-link ports.	Service providers can offer differentiated services to address specific needs of distinct market segments. CoS processing is handled centrally, thereby ensuring fairness across all customers regardless of system size.
Low Voltage Differential Signal (LVDS) serial interconnect between the DSLAM subscriber line cards and the centralized switch card. In an architecture based on a parallel bus backplane the entire backplane can be taken out of service by a failure on one line card. With the serial point-to-point backplane implemented by the VORTEX chip set, failures on one line card do not impact other line cards.	Designing for fault tolerance is greatly simplified, reducing development costs and improving time to market. In-field operating costs are lowered due to improved reliability and simplified servicing that results from line card independence.
LVDS operates over the backplane or between shelves on twisted pair cabling, and is "hot-swap" capable. The physical location of the line card — whether it is on the same or a different shelf from the switching card — is hidden from the traffic management device.	This architecture directly scales to large, multi-shelf systems without increasing the cost or complexity of the traffic management hardware and software. In-field expansion from single to multi-shelf configurations is directly supported with no impact on the system software.
Optional 1:1 redundancy of the common equipment.	Directly supports "carrier grade" reliability, greatly simplifying system design and reducing time to market. In-field upgrades from unprotected to 1:1 protected systems can be done without taking equipment out of service.

3 TAKING XDSL SERVICES TO THE MASS MARKET

Access services based on ADSL, SDSL, HDSL, and G.Lite have moved rapidly from trial to deployment. The current focus of many of these service offerings is the business customer, with deployment for residential customers to follow. However, to be successful in the higher volume, lower margin residential access services the service provider must be supported by network equipment capable of competitive mass market deployment.

In the residential market the main competition in the broadband Internet access market are cable modems. Where it is available, Internet access delivered over the cable television plant has often been priced lower -- sometimes significantly lower -- than xDSL based services. Price is almost always a significant factor in the mass market, and the shared nature of the cable plant reduces the electronic equipment dedicated to each customer. As shown in Figure 1, the cable head end equipment is fully shared across all subscribers, while the DSLAM must provide a dedicated line interface for each customer.

Figure 1 - Cable Modem Infrastructure compared to xDSL Infrastructure



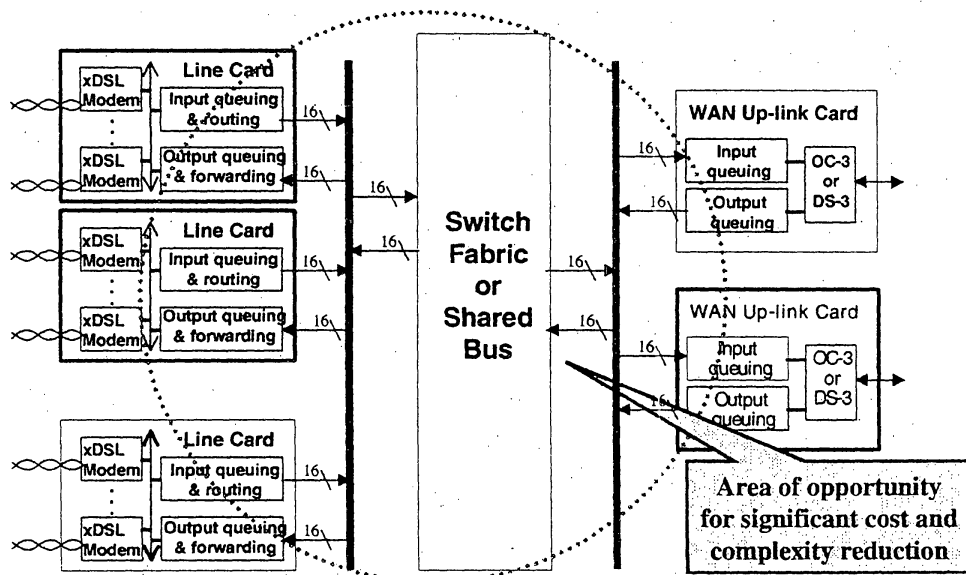
The shared cable can create traffic bottlenecks as high-speed services grow in popularity. This is often cited as a key technical advantage of xDSL based services, but the reduced complexity at the head-end does create a cost advantage for cable modems in terms of the amount of electronics needed. However, this competitive advantage of cable modem based services is neutralized when the per-customer cost of the DSLAM is significantly reduced by deploying fully optimized DSLAM platforms.

Current DSLAM solutions such as shown in Figure 2 typically employ distributed traffic management and control functions that span the line cards and the central switch -- the same architecture used to implement traditional ATM access multiplexers and switches.

Traditional ATM core equipment is designed for a relatively small number of high-speed ports and does not take advantage of the different traffic characteristics exhibited by lower speed xDSL ports versus higher speed optical ports.

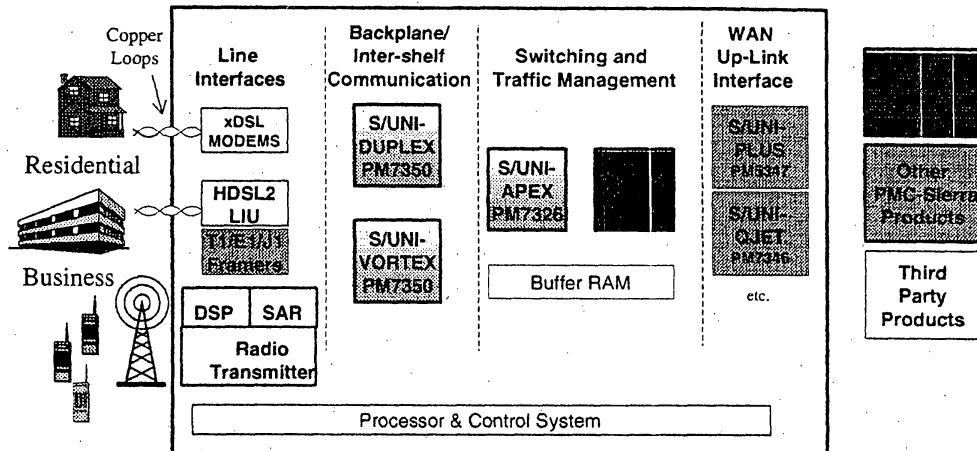
Since currently available traffic management devices typically support 32 ports, the traditional approach works well for implementing line cards with a few high speed ports (DS-3s and OC-3s). However, this approach is not optimal for terminating the numerous relatively low speed interfaces provided by xDSL, T1, E1, and HDSL2 interfaces.

Figure 2 - Typical ATM Switch or Shared Bus DSLAM



Attempts to incrementally improve the traditional architecture, such as by placing more modems on each line card, tend not to scale well and often run into physical and thermal limits. To properly address system level complexity it is necessary to implement system level solutions. As shown in Figure 3 the VORTEX chip set is the first in the world to provide the system-scale integration needed to fully address these requirements.

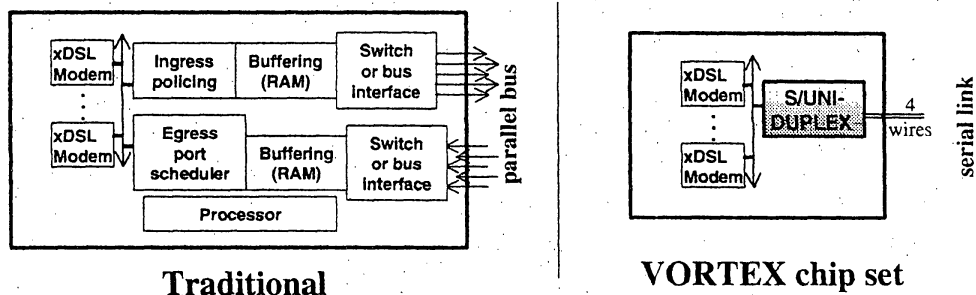
Figure 3 - The Access Multiplexer Silicon Map



Current DSLAM solutions typically employ widely distributed traffic management, switching, buffering, and control functions that span the line interface cards and the network interface card. The cards that interface to the customer's access line are the most numerous and hence cost sensitive card in the system. By applying system level integration across a family of devices the VORTEX chip set eliminates the need for traffic management, buffering and control functions on the line cards.

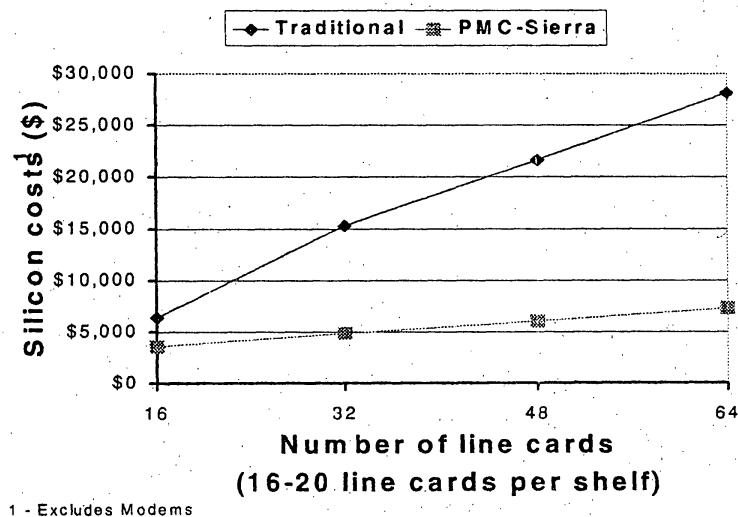
As shown in Figure 4, this reduces the line card's complexity and cost while increasing the card's reliability. The traditional interfaces to a shared bus or centralized switch fabric, typically via a parallel bus interface, are replaced by a simple serial interface, with built in protection switching capability. The traditional complex traffic management required on the card -- including packet discard, congestion control, policing, QoS support, etc. -- is centralized in a common card where its costs can be spread across the maximum number of paying customers! This also eliminates complex traffic management software from the line card, making the line card's processor optional.

Figure 4 - Line Card Complexity Comparison



As modem technology matures the cost of ADSL, G.Lite, and other xDSL modems is decreasing rapidly. By remaining independent of any modem technology, equipment based on the VORTEX chip set can take full advantage of these cost reductions. Also, as modem costs decline the cost of the rest of the devices become an increasingly larger fraction of the equipment cost. As shown in the graph in Figure 5, as access equipment moves to mass market scale it becomes increasingly important to have selected the right system architecture.

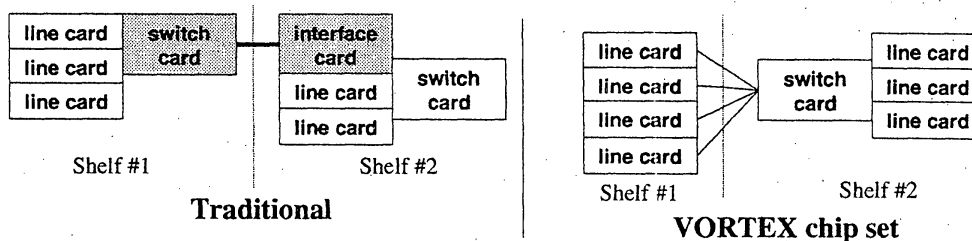
Figure 5 - DSLAM System Silicon Cost



The cost savings shown are derived from two main sources:

- The cost of each line card is reduced significantly as discussed previously,
- and as shown in Figure 6, traditional architectures use multiple stages of switching to tie together multiple shelves. This becomes complex and costly, especially when redundancy is used to improve fault tolerance.

Figure 6 - Multi-shelf Architecture Comparison



In the traditional architecture each shelf requires its own dedicated switch, plus an interface card on the main shelf. In this architecture maintaining fairness and QoS across all interfaces is difficult. There is also an increase in cross-switch transit delay due to the multiple switching stages -- potentially degrading voice service quality. Software complexity is high, increasing development costs and greatly increasing the risk of programming errors.

In the VORTEX chip set architecture serial point to point connections are used between the line cards and the switching card. Switching and traffic management functionality is not impacted by the physical location of the line card because to the switch card a multi-shelf configuration appears simply to be a single, very large shelf!

Software development costs and ongoing maintenance can be a significant portion of the platforms life-cycle costs. Since the VORTEX chip set eliminates the need for "intelligent" line interface cards there is a dramatic reduction in software complexity, as show by the table in Figure 7. Here we see that as the DSLAM grows the traditional architecture experiences a large increase in the number of "intelligent" elements that will require programming and software updates. An architecture based on a more centralized traffic management function, such as implemented by the VORTEX chip set, experiences very little growth in complexity even as the DSLAM grows to many racks of equipment.

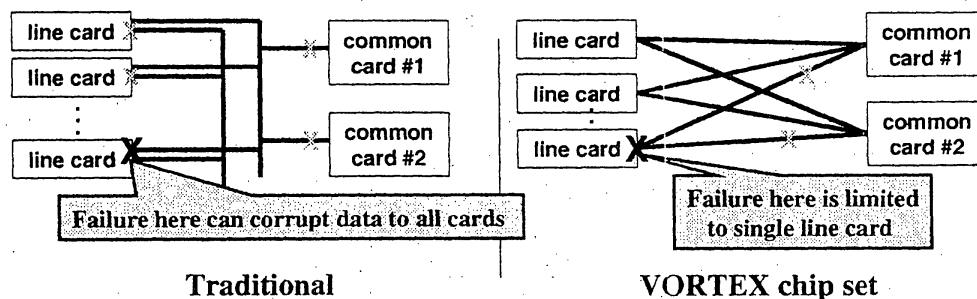
Figure 7 - Access Equipment Software Complexity

# shelves	# line cards	Traditional Architecture Complexity	VORTEX Chip Set Complexity
1	16	17	1
2	32	34	1
3	48	51	1
4	64	68	1
5	80	85	2
6	96	102	2
7	112	119	2
8	128	136	2
9	144	153	3
10	160	170	3
11	176	187	3
12	192	204	3
13	208	221	4
14	224	238	4
15	240	255	4
16	256	272	4

A key requirement that a mass market capable DSLAM must fulfil is "Carrier Grade" reliability and fault tolerance. As shown in Figure 8, with the traditional architecture the shared parallel bus allows a mechanical or device failure to corrupt all traffic on the bus. As well, the high component count on the line cards reduces reliability and software complexity is high, greatly increasing the risk of programming errors.

With the VORTEX chip set architecture the S/UNI-DUPLEX and S/UNI-VORTEX implement a high-speed point-to-point serial LVDS backplane. Communication links are not shared, so failure on one line card cannot corrupt traffic to the other line cards. Direct support for duplicated common cards ensures no single failure can disable a large number of subscribers.

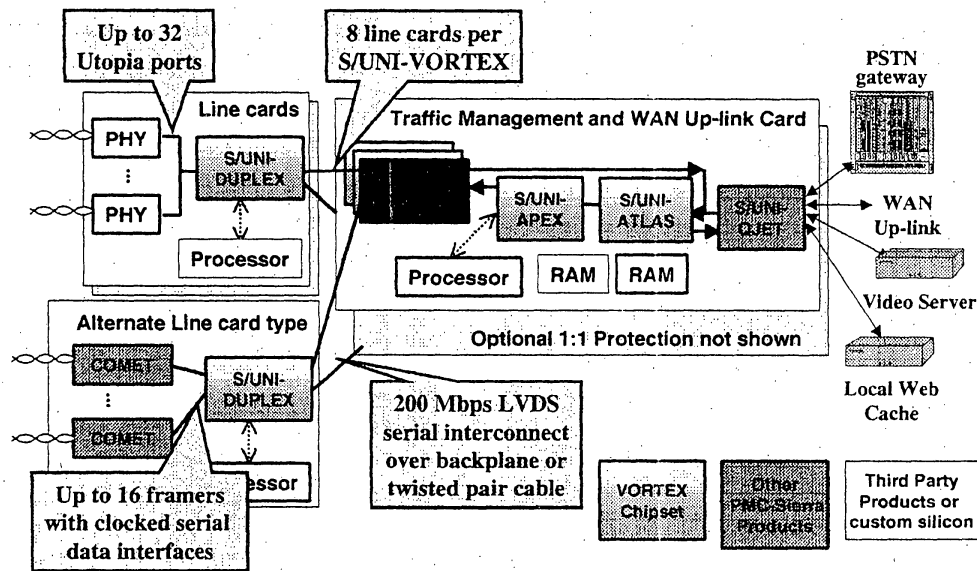
Figure 8 - Fault Tolerance Comparison



4 EXAMPLE APPLICATIONS OF THE VORTEX CHIP SET

4.1 ATM DSLAM

Figure 9 - VORTEX Chip Set Based ATM DSLAM



In an ATM DSLAM the S/UNI-VORTEX and S/UNI-DUPLEX devices work together to create an interconnect architecture in which up to 2048 modems, framers, or PHY devices are connected to working and protection common cards. Interconnect between line cards and the common card is point-to-point 4-wire serial LVDS running at 200 Mbit/s. S/UNI-VORTEX and S/UNI-DUPLEX are mixed signal devices and require no external analog components. They connect directly to backplane traces or up to 10 meters of inter-shelf twisted pair cabling in multi-shelf architectures.

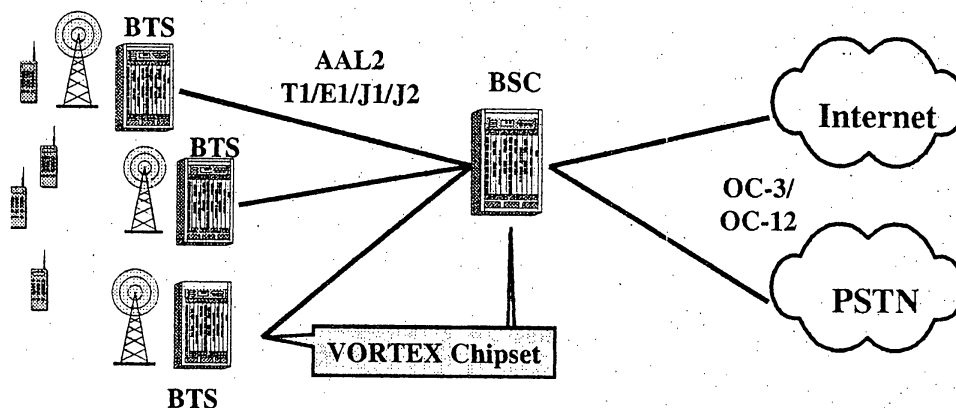
The S/UNI-ATLAS handles ingress and egress policing, address lookup/translation (i.e. switch tag generation), statistics gathering, I.610 FM & PM OAM.

The S/UNI-APEX provides per VC queuing, scheduling, and switching functions for up to 2K logical PHYs on the line side and up to four physical high-speed PHYs on the WAN side. The S/UNI-APEX provides QoS parameter configuration with EPD/PPD processing for up to 64K connections.

4.2 3G Wireless

Figure 10 shows a typical network configuration for 3G wireless systems. These next generation wireless networks are being specified with ATM and AAL2 between the Base Station Controller (BSC) and the Base Transceiver Station (BTS). The links between BTS and BSC are typically multiple T1/E1/J1/J2 (often with Inverse Multiplexing over ATM or IMA). The links may also be STS-1 or OC-3, although the bandwidth actually used will normally be significantly less than 155 Mbit/s.

Figure 10 - 3rd Generation Wireless Network



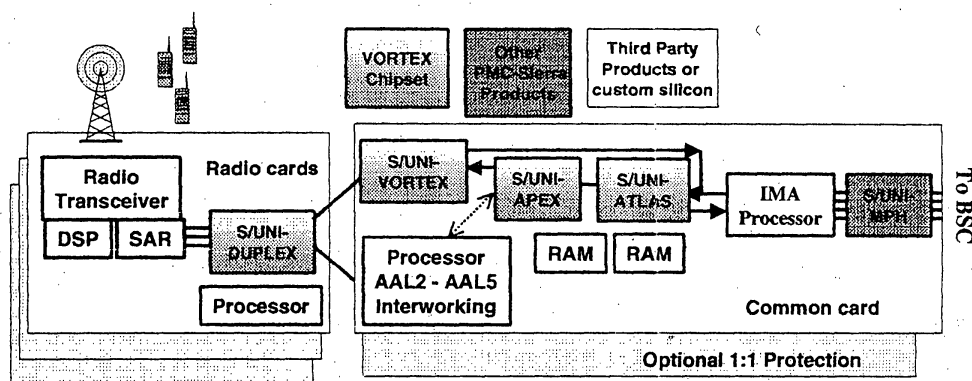
An example configuration for a BTS is shown in Figure 11. This architecture takes advantage of the serial backplane, protection switching (for large base stations), policing, traffic management, and VC switching capabilities of the VORTEX chip set. It also takes advantage of the 32-bit wide, 66 MHz, burst transfer capable microprocessor port on the S/UNI-APEX in order to attach a processor capable of performing AAL2 to AAL5 mapping.¹

In the downstream (to the radio) direction the AAL2 processor accepts AAL2 cells from the up-link and splits them into individual AAL5 cell streams per radio channel. Each cell stream is treated as a separate VC by the S/UNI-APEX and is routed to the appropriate radio card and channel by the S/UNI-VORTEX and S/UNI-DUPLEX. In the upstream direction (to the up-link) the AAL2 processor accepts individual voice cell streams multiplexed up from the radio cards (one voice stream per VC). The AAL2 processor combines the individual streams into the multiplexed AAL2 stream that is sent over the up-link.

¹ There are other ways in which the AAL2 to AAL5 processing could be done, including placing an interworking device in-line between the IMA processor and the S/UNI-APEX.

Data and signaling traffic need not be routed through the AAL2 processor if it is encapsulated in AAL5 cells, for example. The traffic management and CoS capabilities of the S/UNI-APEX are used to ensure minimal delay of the voice traffic, priority treatment of signaling channels, and CoS aware buffering and congestion management of bursty data traffic.

Figure 11 - Radio Base Transceiver Station



The Downstream traffic flow has several potential paths:

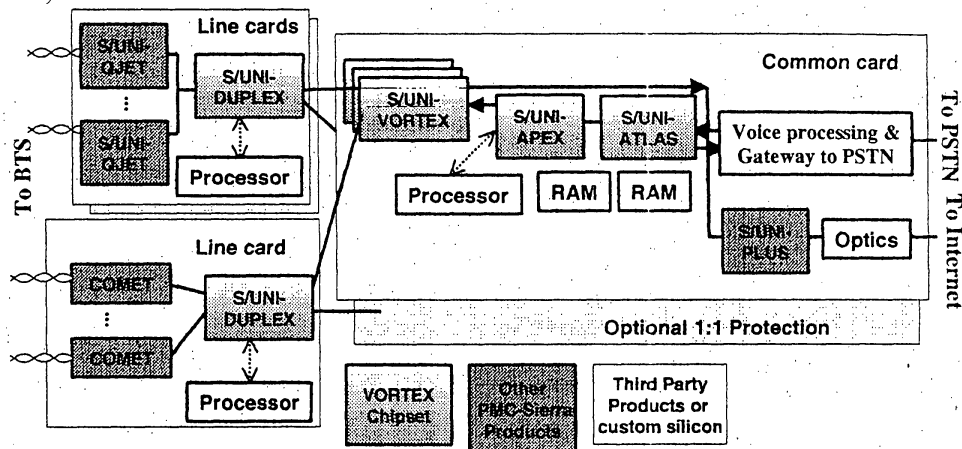
Voice: MPH-IMA-Atlas-Apex-AAL2/5-Apex-Vortex-Duplex-SAR-DSP-Radio
Data: MPH-IMA-Atlas-Apex-Vortex-Duplex-SAR-Radio
Signaling: MPH-IMA-Atlas-Apex-Common Microprocessor, or
MPH-IMA-Atlas-Apex-Vortex-Duplex-Radio Microprocessor, or
Common Microprocessor-Apex-Vortex-Duplex-Radio Microprocessor

The Upstream traffic flow has similar options:

Voice: Radio-DSP-SAR-Duplex-Vortex-Apex-AAL2/5-Apex-Atlas-IMA-MPH
Data: Radio-SAR-Duplex-Vortex-Apex-Atlas-IMA-MPH
Signaling: Common Microprocessor- Apex-Atlas-IMA-MPH, or
Radio Microprocessor- Duplex-Vortex-Atlas-Apex-Atlas-IMA-MPH, or
Common Microprocessor- Duplex-Vortex-Atlas-Apex-Microprocessor

As shown in Figure 12 the portion of the Radio Base Station Controller (BSC) that terminates the ATM traffic from the Base Transceiver Stations (BTS) can be built much like a DSLAM. For voice traffic the key function of the "front end" of the BSC is to terminate many lines and switch the traffic to and from the voice processors. For data traffic, the front end switches traffic directly to the network interface.

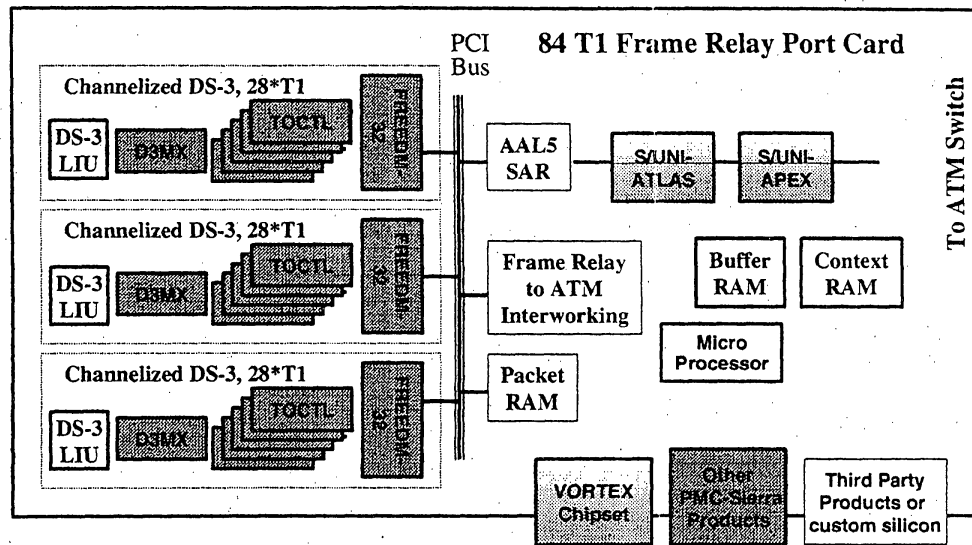
Figure 12 - Radio Base Station Controller



4.3 Multi-service Access Switches

Figure 13 provides an example of a "frame at the edge, cells in the core" architecture that takes advantage of the packet contiguous switching capabilities of the S/UNI-APEX. A SAR is used to convert from frames to cells, but the SAR's reassembly functionality is greatly simplified because all cells arrive at the SARs in packet contiguous order, meaning, packet reassembly does not have to span multiple packet streams.

Figure 13 - High Density Frame Relay Port Card



5 CONCLUSION

The VORTEX chip set fully addresses the data path requirements for the exploding markets of wireline and wireless network access. The key requirements of these markets are:

- efficient processing of voice and data traffic from hundreds or even thousands of lines or channels,
- full featured quality of service differentiation on every port,
- built in fault tolerance and protection switching of common components,
- simplified software architecture, and
- support for simple in-field upgrades.

There is a single phrase that summarizes PMC-Sierra's goal in developing the VORTEX chip set:

**A mass market architecture for mass market deployment of
3G wireless and high speed access services**

PRELIMINARY
ISSUE 1
PMC-990712



VORTEX CHIP SET
INTRODUCTION

NOTES

PRELIMINARY

ISSUE 1

PMC-990712



PMC-Sierra, Inc.

**VORTEX CHIP SET
INTRODUCTION**

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PM-990712 (P1) Issue date: June 1999

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/472,683	12/27/1999	MENACHEM KAPLAN	204.344	9079

7590 02/04/2003
ABELMAN FRAYNE & SCHWAB
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NEW YORK, NY 100175612

EXAMINER

HO, DUC CHI

ART UNIT

PAPER NUMBER

2665

DATE MAILED: 02/04/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.		Applicant(s)	
	09/472,683		KAPLAN ET AL.	
	Examiner		Art Unit	
	Duc C Ho		2665	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on 27 December 1999.

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) 1-26 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☒ Claim(s) 14 and 19-26 is/are allowed.

6) ☒ Claim(s) 1, 12 and 13 is/are rejected.

7) ☒ Claim(s) 2-11 and 15-18 is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some * c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892) 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>4</u> .	4) ☐ Interview Summary (PTO-413) Paper No(s). _____ 5) ☐ Notice of Informal Patent Application (PTO-152) 6) ☐ Other:
---	---

DETAILED ACTION

Claim Objections

1. Claims 15-18 are objected to because of the following informalities: The preamble of the independent claim 14 discloses a network access multiplexing system. Therefore, the word "Apparatus" as appeared in the preamble of claims 15-18 should be replaced by the word "system" in order to be consistent with the term used in the independent claim.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102(e) that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –
(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

3. The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

4. Claims 1, 12 are rejected under 35 U.S.C. 102(e) as being anticipated by the admitted prior art of the instant application in figures 1, and its block diagram in figure 2B.

Regarding claim 1, figure 2B of the admitted prior art of the instant application is block diagrams that schematically illustrate topologies known in the art for use in multi-shelf access systems, such as that shown in fig. 1, page 2, lines 18-25, wherein the core network 22 is an ATM network (packet-switched network), page 2, lines 1-4.

first and second master units (first and second master units 25-fig. 2B) , each comprising a physical interface to a packet-switched network (As shown, each master unit 25 connected to the ATM network 22, therefore, each master unit 25 inherently includes a physical interface to the network 22);

a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines (The admitted prior art in figure 1 of the instant application discloses a DSLAM system 20 implementing a multi-shelf architecture. The DSLAM 20 has a plurality of slave units 27, and each slave unit comprises a plurality of ports to respective subscriber premises via suitable DSL modems, page 2, lines 11-14);

a plurality of physical interface lines, which link the slave units in one or more daisy chains (the bi-directional arrows which links the slave units 27-fig. 2B in daisy chain constitute a plurality of physical interface lines), in which the slave units are mutually connected in series by the physical interface lines therebetween (as shown, the slave units 27-fig. 2B are mutually connected in series by the physical interface lines), each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit (the shown daisy chain having the first slave unit 27-fig. 2B connected to the first master unit via a physical interface

line, and the last slave unit 27-fig. 2B connected to the second master unit via another physical interface line).

Regarding claim 12, the network 22-fig. 2B is an Asynchronous Transfer Mode network, page 2, column 1-5.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103© and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

7. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over the admitted prior art of the instant application in figures 1, and 2B as applied to claim 1

above, and further in view of Phillips et al. (US 6,181,715), hereinafter referred to as Phillips.

Regarding claim 13, the admitted prior art of the instant application in figures 1, and 2B disclose all claimed limitations, except *the network comprises an Internet Protocol (IP) network*.

Phillips discloses a method and system for emulated telephony over DSL. Referring to figure 1, a DSLAM 54 connected to the packet network 20 (IP network, column 4, lines 3-5) includes a transmission unit 56 and an adaptation layer 58, serving a plurality of remote terminals 60, 62, and 64 with a corresponding DSL 61, 62, and 65 respectively, column 5, lines 3-13.

It would have been obvious to one of ordinary skill in the art, at the time invention was made, to employ a DSLAM unit connecting to an IP network as taught by Phillips into the system of the admitted prior art in figures 1, and 2B of the instant application in order to reduce the cost requiring major investment in new infrastructure since DSL opens the most critical bottleneck in local-loop access to high-speed network such as ATM and IP networks.

Allowable Subject Matter

8. Claims 14, and 19-26 are allowed.
9. Claims 15-18 would be allowable if rewritten or amended to overcome the objection(s) set forth in this Office action.

10. Claims 2-11 are objected to as being dependent upon a rejected base claim, but would be allowable if written in independent form including all of the limitations of the base claim and any intervening claims.

Reason for Allowance

11. Regarding claim 14, the prior art fails to teach or suggest in a network access multiplexing system comprises a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface, in combination with other limitations.

Regarding claims 19-26, the prior art fails to teach or suggest a method for providing access to a network, comprises a step in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units, in combination with other limitations, as specified in claim 19.

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Fink et al. (US 6,219,354); Voit et al. (US 6,424,657) are cited to show bi-directional chaining of network access ports, which is considered pertinent to the claimed invention.

Application/Control Number: 09/472,683
Art Unit: 2665

Page 7

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Duc Ho whose telephone number is (703) 305-1332. The examiner can normally be reached on Monday through Friday from 7:00 am to 3:30 pm.

If attempt to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Huy Vu, can be reached on (703) 308-6602.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 305-4750

14. Any response to this action should be mailed to:

Commissioner of Patents and Trademarks

Washington, D.C. 20231

or faxed to:

(703) 872-9314

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive,
Arlington, VA, Sixth Floor (Receptionist).

Patent Examiner



Duc Ho

1-23-03

Notice of References Cited	Application/Control No. 09/472,683	Applicant(s)/Patent Under Reexamination KAPLAN ET AL.	
	Examiner Duc C Ho	Art Unit 2665	Page 1 of 1

U.S. PATENT DOCUMENTS

*	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
A	US-6,181,715	01-2001	Phillips et al.	370/493
B	US-6,424,657	07-2002	Voit et al.	370/412
C	US-6,219,354	04-2001	Fink et al.	370/463
D	US-			
E	US-			
F	US-			
G	US-			
H	US-			
I	US-			
J	US-			
K	US-			
L	US-			
M	US-			

FOREIGN PATENT DOCUMENTS

	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
N					
O					
P					
Q					
R					
S					
T					

NON-PATENT DOCUMENTS

	Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
U	
V	
W	
X	

Copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
in MM-YYYY format are publication dates. Classifications may be US or foreign.



05-14-03

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7
S-19-0:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:

Menachem KAPLAN, et al.

Serial No.: 09/472,683

Filed: December 27, 1999

For: BI-DIRECTIONAL CHAINING OF
NETWORK ACCESS PORTS

) Art Unit: 2665
)
) Examiner: Duc C Ho
)
) Washington, D.C.
)
) May 12, 2003
)
) Docket No.: 204,344

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INFORMATION DISCLOSURE STATEMENT [IDS]

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. 1.97, 1.98, and it is requested that the information set forth in this statement and in the listed documents be considered during the pendency of the above-identified application, and any other application relying on the filing date of the above-identified application or cross-referencing it as a related application.

☒ 1. This IDS should be considered, in accordance with 37 C.F.R. 1.97, as it is filed:

(Check one of the boxes A-D)

☐ A. within three months of the filing date of the above-identified national application or within three months of the entry into the national stage of the above-identified international application.

☐ B. before the mailing date of a first office action on the merits.

☒ C. after (A) and (B) above, but before final rejection or allowance, and Applicants have made the necessary certification (box "i" below) or paid the necessary fee (box "ii" below).

(check one of the boxes "i" and "ii" below:)

☐ i. Counsel certifies that, upon information and belief, each item of information listed herein was either (a) cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS; or (b) was not cited in a communication from a foreign patent office in a counterpart foreign application and, to the knowledge of undersigned after making reasonable inquiry, was not known to any individual designated in 1.56(c) more than three months prior to the filing of this IDS.

05/15/2003 CNGUYEN 00000016 09472683

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180.00 OP

☒ ii. A check for the fee set forth in 1.17(p), presently believed to be \$180 is enclosed (check no. 14705).

☐ D. after (A), (B) and (C) above, but before payment of the issue fee: Applicant petitions under 37 C.F.R. 1.97(d) for the consideration of this IDS. A check for the fee set forth in §1.17(i), presently believed to be \$130 is enclosed (check no. _____). Counsel certifies that, upon information and belief, each item of information listed herein was either (i) cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the IDS; or (ii) was not cited in a communication from a foreign patent office in a counterpart foreign application and, to the knowledge of the undersigned after making reasonable inquiry, was not known to any individual designated in 1.56(c) more than three months prior to the filing of this IDS.

☒ 2. In accordance with 37 C.F.R. 1.98, this IDS includes a list (e.g., form PTO-1449) of all patents, publications, or other information submitted for consideration by the office, either incorporated into this IDS or as an attachment hereto. A copy of each document listed is attached, except as explained below.

(check boxes A and/or B and fill in blanks, if appropriate.)

☐ A. Document(s) _____ is (are) deemed substantially cumulative to document(s) _____, and, in accordance with 1.98(c), only a copy of each of the latter documents is enclosed.

☐ B. Certain documents were previously cited by or submitted to the Office in the following prior application(s), which are relied upon under 35 U.S.C. 120:

[insert serial numbers and filing dates of prior applications]

Applicant identifies these documents by attaching hereto copies of the forms PTO-892 and PTO-1449 from the files of the prior application(s) or a fresh PTO-1449 listing these documents, and request that they be considered and made of record in accordance with 1.98(d). Per 37 CFR 1.98(d), copies of these documents need not be filed in this application.

☐ 3. Document(s) _____ is(are) not in the English language. In accordance with 1.98(c), Applicant states:

☐ An English translation of each document (or of the pertinent portions thereof), or a copy of each corresponding English-language patent or application, or English-language abstract (or claim) is enclosed.

☐ A concise explanation of the relevance of document(s) _____ is found in the attached search report (see reply to Comment 68 in the preamble to the final rules; 1135 OG 13 at 20).

☐ A concise explanation of the relevance of document(s) _____ is set forth as follows:
[Insert concise explanation of relevance]

☐ A concise explanation of the relevance of document(s) _____ can be found on page(s) _____ of the specification.

☐ A concise explanation of document(s) _____ can be found on the attached sheet.

4. No explanation of relevance is necessary for documents in the English language (see reply to Comments 67 and 68 in the preamble to the final rules; 1135 OG 13 at 20).

[X] 5. Other information being provided for the examiner's consideration follows:

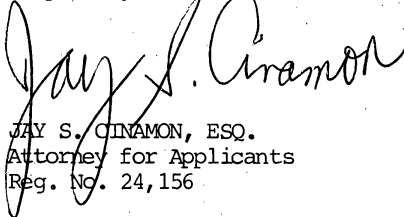
An Official Action dated February 3, 2003, which issued during the prosecution of Applicant's U.S. Patent Application No.: 09/443,157.

6. In accordance with 37 C.F.R. 1.97(g) and (h), the filing of this IDS should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56 (b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant reserves the right to prove that the date of publication is in fact different.

CROSS REFERENCE UNDER 37 C.F.R. §1.78 TO RELATED APPLICATIONS

Pursuant to 37 C.F.R. § 1.78, Applicant notes that the above-identified patent application may be related to the following U.S. Patent Applications:

Respectfully submitted,


JAY S. CINAMON, ESQ.
Attorney for Applicants
Reg. No. 24,156

ABELMAN, FRAYNE & SCHWAB
150 East 42nd Street
New York, New York 10017
(212) 949-9022
(212) 949-9190

Date: May 12, 2003

Page 1 of 1

FORM PTO-1449 (Colb)	ATTY DOCKET NO. 204,344-09/472,683	SERIAL NUMBER 09/472,683
LIST OF PATENTS AND TRADEMARK PUBLICATIONS FOR APPLICANTS' INFORMATION STATEMENT	APPLICANT Menachem KAPLAN, et al.	EXAMINER Duc C Ho
	FILING DATE December 27, 1999	GROUP ART UNIT 2665

U.S. PATENT DOCUMENTS

Examiner's Initials		DOCUMENT NO.	DATE	NAME	CLASS	SUB	FILING DATE
	AA	6,215,863	Apr. 2001	Bennett, III et al.			
	AB	6,345,051	Feb. 2002	Gupta, et al.			
	AC	5,899,582	May 1999	DuLac			
	AD	6,317,415	Nov. 2001	Darnell, et al.			
	AE	6,404,861	Jun. 2002	Cohen, et al.			
	AF						
	AG						
	AH						

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MAY 16 2003
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FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	CLASS	SUB	TRANSLATION
	AI						
	AJ						
	AK						

OTHER ART (Including Author, Bills, Pertinent Pages, Etc.)

AL	
AM	
EXAMINER:	DATE CONSIDERED:
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	



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06-20-03

Docket No.: 204,344

2665
8A
6-27-03
NY

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Application of : KAPLAN et al.

Serial No.: 09/472,683 : Group Art Unit: 2665

Filed : December 27, 1999 : Examiner: Duc Chi Ho

For : BI-DIRECTIONAL CHAINING OF NETWORK ACCESS
PORTS

June 18, 2003

AMENDMENT

Honorable Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

RECEIVED

JUN 24 2003

Technology Center 2600

STATEMENT OF FILING BY EXPRESS MAIL 37 C.F.R. §1.10

This correspondence is being deposited with the United States Postal Service on June 18, 2003 in an envelope as "Express Mail Post Office to Addressee" Mailing Label No. ET 537 599 921 US addressed to the Honorable Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

06/27/2003 MGDORDN 00000001 010035 09472683
01 FC:1201 252.00 DA

06/23/2003 MBERHE 00000003 09472683
01 FC:1252 410.00 DP

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PETITION PURSUANT TO 37 CFR 1.136(a)

We request the response term be extended 2 months from February 4, 2003 to July 4, 2003. We enclose the requisite fee of \$410.00 for a Large Entity. Charge any deficiency or other fees to Deposit Account No. 01-0035.

Jay S. Cinamon

Jay S. Cinamon

(Typed or printed name of person mailing paper or fee)

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INTRODUCTORY COMMENTS

Sir:

In response to an Official Action dated February 4, 2003, kindly amend this application as follows.

AMENDMENTS TO THE CLAIMS

1. (Currently amended) Network access apparatus, comprising:

first and second master units, each comprising a physical interface to a packet-switched network;

a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and

A1 a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected one of the physical interface lines to the first master unit, a second slave unit connected to the first slave unit but not to the first or second master unit, and a last slave unit connected by another of the physical interface lines to the second master unit.

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2. (Currently amended) ~~Apparatus according to claim 1~~
Network access apparatus, comprising:

first and second master units, each comprising a physical interface to a packet-switched network;

a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and

a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit

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and a last slave unit connected by another of the physical interface lines to the second master unit,

wherein in normal operation, downstream data packets received from the network are passed from the first master unit to each of the daisy chains via the first slave unit in each chain, and upstream data packets received by the slaves in each chain from the subscriber lines are passed via the first slave unit in the chain to the first master unit for transmission over the network.

5. (Original) Apparatus according to claim 4 and comprising a protection interface, which couples the second master unit to the first master unit, and over which interface data packets are conveyed between the first and second master units in case of a fault.

6. (Original) Apparatus according to claim 5, wherein the first master unit bicast the upstream data packets that it receives from the slave units to the network and, via the protection interface, to the second master unit, which transmits the upstream data packets to the network.

7. (Original) Apparatus according to claim 4, wherein in case of a fault at a location in one of the daisy chains, data flow in a portion of the daisy chain between the location of the fault and the second master unit is reversed, so that the downstream data packets are passed from the second master unit to the slave units in the portion of the daisy chain via the last slave unit in the chain, and the upstream data packets are passed by the last slave unit to the second master unit.

8. (Original) Apparatus according to claim 5, wherein the downstream packets for the slave units in the portion of the daisy chain between the location of the fault and

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the second master unit are conveyed to the second master unit from the first master unit via another one of the daisy chains.

9. ~~(Currently amended) Apparatus according to claim 1~~
Network access apparatus, comprising:

first and second master units, each comprising a physical interface to a packet-switched network;

a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines; and

a plurality of physical interface lines, which link the slave units in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween, each daisy chain comprising at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit,

wherein each of the first and second master units comprises:

a switch, configured to route data packets between the respective physical interface and the one or more daisy chains; and

a pre-switch, which in the event of a fault at a location in one of the daisy chains, re-routes at least a portion of the data packets exchanged with one or more of the slaves in the daisy chain in which the fault has occurred through another one of the daisy chains.

10. (Original) Apparatus according to claim 9, wherein the pre-switch re-routes the data packets such that substantially no reconfiguration of the switch is required responsive to the fault.

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11. (Currently amended) ~~Apparatus according to claim 1~~
Network access apparatus, comprising:

first and second master units, each comprising a
physical interface to a packet-switched network;

a plurality of slave units, each slave unit
comprising one or more ports to respective subscriber
lines; and

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a plurality of physical interface lines, which link
the slave units in one or more daisy chains, in which the
slave units are mutually connected in series by the
physical interface lines therebetween, each daisy chain
comprising at least a first slave unit connected by one
of the physical interface lines to the first master unit
and a last slave unit connected by another of the
physical interface lines to the second master unit,

wherein each of the slave units comprises:

a switch fabric comprising one or more switches,
which convey data packets to respective ports on the
switch to which the packets are addressed; and

a pre-switch, which receives the data packets from
one of the physical interface lines connected to the
slave unit and passes those of the data packets that are
addressed to any of the ports on the slave unit to the
switch fabric, while passing packets not addressed to any
of the ports on the slave unit for output through another
of the physical interface lines.

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10. (Original) Apparatus according to claim 8, 11
each of the slave units is coupled to receive packets
transferred thereto from the first and second master
units over first and second ones of the physical
interface lines, respectively, and wherein the pre-switch
passes the packets received through the first and second

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physical interface line and addressed to any of the ports on the slave unit to respective first and second addresses in the switch fabric.

¹³ 11. (Original) Apparatus according to claim ¹²10, wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second addresses are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required.

² 12. (Original) Apparatus according to claim 1, wherein the network comprises an asynchronous transfer mode (ATM) network.

³ 13. (Original) Apparatus according to claim 1, wherein the network comprises an Internet protocol (IP) network.

AI 14. (Original) In a network access multiplexing system, in which a master unit is connected by a physical interface to a packet-switched network, a slave unit configured to be coupled to the master unit in a daisy chain of such slave units, the slave unit comprising:

a plurality of ports, for coupling the slave unit to respective subscriber lines;

first and second physical interfaces, coupled to exchange packets with preceding and succeeding units, respectively, along the daisy chain;

a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface; and

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a fabric of one or more switches, which convey the retained packets to the ports, responsive to the address data.

15. (Currently amended) ~~Apparatus~~ The slave unit according to claim 14, wherein the pre-switch is further coupled to receive packets transferred thereto from the second physical interface and to sort the packets in like manner to the packets received through the first physical interface.

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16. (Currently amended) ~~Apparatus~~ The slave unit according to claim 15, wherein the retained packets that were received from the first and second physical interfaces and are passed by the pre-switch to the switch fabric are identified by respective first and second port numbers, and wherein in response to a reversal of a direction of data flow in the daisy chain, the first and second port numbers are swapped in the pre-switch, so that substantially no reconfiguration of the switch fabric is required in response to the reversal.

17. (Currently amended) ~~Apparatus~~ The slave unit according to claim 14, wherein when one of the packets received by the pre-switch comprises a multicast packet addressed to one or more of the ports on the slave unit, the pre-switch sorts the multicast packet such that one copy of the packet is retained and another copy of the packet is passed to the second physical interface.

18. (Currently amended) ~~Apparatus~~ The slave unit according to claim 14, wherein in the event of a fault in the switch fabric, the pre-switch continues to pass the packets addressed to the succeeding units on to the succeeding units without significant interruption.

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19. (Original) A method for providing access to a network, comprising:

coupling first and second master units to interface with the network;

linking a plurality of slave units, each slave unit comprising one or more ports to respective subscriber lines, in a daisy chain between the first and second master units;

conveying initial downstream data packets, received from the network by one of the master units, along the daisy chain in a first direction, so as to deliver the packets to the ports of the slave units; and

in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units.

20. (Original) A method according to claim 19, wherein the initial and further downstream packets are received from the network by the first master unit, and wherein conveying the further downstream packets in the second direction comprises conveying the further downstream packets from the first master unit to the second master unit, and then conveying the further downstream packets from the second master unit to the daisy chain.

21. (Original) A method according to claim 20, wherein conveying the further downstream packets from the first master unit to the second master unit comprises linking further slave units in an additional daisy chain between the first and second master units, and conveying the

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further downstream packets from the first master unit to the second master unit over the additional daisy chain.

22. (Original) A method according to claim 19, and comprising conveying initial upstream data packets, received by the slave units from the subscriber lines, along the daisy chain in the second direction so as to transmit the upstream data packets via the first master unit over the network, and in the event of the fault, conveying further upstream data packets received by one or more of the slave units along the daisy chain in the first direction via the second master unit.

23. (Original) A method according to claim 22, and comprising bicasting the upstream data packets from the first master unit to the network and to the second master unit, which transmits the bicast upstream data packets over the network.

AH 24. (Original) A method according to claim 19, wherein conveying the initial downstream data packets along the daisy chain comprises pre-switching the packets at each of the slave units, so that packets not addressed to any of the ports on the slave unit are passed to the next slave unit in the daisy chain, while packets that are addressed to one or more of the ports on the slave unit are passed to a switch fabric that directs the packets to the ports to which they are addressed.

25. (Original) A method according to claim 19, wherein the network comprises an asynchronous transfer mode (ATM) network.

26. (Original) A method according to claim 19, wherein the network comprises an Internet protocol (IP) network.

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REMARKS

This application contains claims 1-26. Claims 14 and 19-26 are allowed. Claims 1, 2, 7, 9 and 15-18 have been amended. No new matter has been added. Reconsideration is respectfully requested.

Claims 15-18 were objected to for use of the term apparatus, which is inconsistent with the terminology used in claim 14, from which these claims depend. The Examiner suggested that this term be replaced with the word "system." In fact, claim 14 is drawn to a slave unit in a network access multiplexing system. Applicant has therefore amended claims 15-18 to read, "The slave unit according to claim 14...."

Claims 1 and 12 were rejected under 35 U.S.C. 102(e) over the admitted prior art in Fig. 2B of the present patent application. Applicant has amended claim 1 in order to clarify the distinction of the present invention over Fig. 2B. The amended claim recites that each daisy chain includes a second slave unit connected to the first slave unit but not to the first or second master unit. This limitation is absent from the cited art. Therefore, claim 1 as amended is believed to be patentable, as is claim 12, which depends from claim 1.

Claim 13 was rejected under 35 U.S.C. 103(a) over the admitted prior art in Fig. 2B, in view of Phillips et al. (U.S. Patent 6,181,715). In view of the patentability of amended claim 1, from which claim 13 depends, claim 13 is believed to be patentable, as well.

Claims 2-11 were objected to for depending from rejected claim 1, but were held to recite allowable subject matter. Applicant has therefore amended claims

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2, 7 and 9 to stand as independent claims, incorporating the limitations of claim 1, from which they formerly depended. Claims 3-6 depend from claim 2; claim 8 depends from claim 7; and claims 10-11 depend from claim 9. Therefore, all of claims 2-11 are now believed to be in condition for allowance.

Applicant believes the amendments and remarks presented hereinabove to be fully responsive to all of the grounds of rejection and objections raised by the examiner. In view of these amendments and remarks, applicant respectfully submits that all of the claims in the present application are in order for allowance. Notice to this effect is hereby requested.

Respectfully submitted,


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Notice of Allowability	Application No.	Applicant(s)	
	09/472,683	KAPLAN ET AL.	
	Examiner	Art Unit	
	Duc C Ho	2665	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendment filed 6-18-03.
2. ☒ The allowed claim(s) is/are 1, 12, 13, 2-11, and 14-26 which have been renumbered 1-26, respectively.
3. ☒ The drawings filed on 27 December 1999 are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
 - (a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
8. ☐ CORRECTED DRAWINGS must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No. _____.
 - (b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the Examiner.
 - (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet.

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1 ☐ Notice of References Cited (PTO-892) 3 ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5 ☐ Information Disclosure Statements (PTO-1449), Paper No. _____ 7 ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material	2 ☐ Notice of Informal Patent Application (PTO-152) 4 ☐ Interview Summary (PTO-413), Paper No. _____ 6 ☐ Examiner's Amendment/Comment 8 ☒ Examiner's Statement of Reasons for Allowance 9 ☐ Other
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DETAILED ACTION

Reason for allowance

1. The following is an examiner's statement of reasons for allowance:

Regarding claims 1, 12, and 13, the prior arts fail to teach or fairly suggest a network access apparatus, which comprises first and second master units, and a second slave unit connected to the first slave unit but not to the first or second master unit, in combination with other limitations, as specified in the independent claim 1.

Regarding claims 2-6, the prior arts fail to teach or fairly suggest a network access apparatus, which comprises first and second master units, each comprising a physical interface to a packet-switched network, wherein in normal operation, downstream data packets received from the network are passed from the first master unit to each of the daisy chains via the first slave unit in the chain, and upstream data packets received by the slaves in each chain from the subscriber lines are passed via the first slave unit in the chain to the first master unit for transmission over the network, in combination with other limitations, as specified in the independent claim 2.

Regarding claims 7-8, the prior arts fail to teach or fairly suggest a network access apparatus, which comprises first and second master units, wherein each of the first and the second master unit comprises a pre-switch, which in the event of a fault at a location in one of the daisy chains, re-routes at least a portion of the data packets exchanged with one or more of the slaves in the daisy chain in which the fault has occurred through another one of the daisy chains, in combination with other limitations, as specified in the independent claim 7.

Regarding claims 9-11, the prior arts fail to teach or fairly suggest a network access apparatus, which comprises a plurality of slave units, wherein each of the slave unit comprises a pre-switch, which receives the data packets from one of the physical interface lines connected to

the slave unit and passes those of the data packets that are addressed to any of the ports on the slave unit to the switch fabric, while passing packets not addressed to any of the ports on the slave unit for output through another of the physical interface lines, in combination with other limitations, as specified in the independent claim 9.

Regarding claims 14-18, the prior art fails to teach or suggest in a network access multiplexing system comprises a pre-switch, coupled to receive packets from the first physical interface and responsive to address data carried by the packets, to sort the packets such that packets addressed to the slave unit are retained, and packets addressed to the succeeding units are passed to the second physical interface, in combination with other limitations, as specified in claim 14.

Regarding claims 19-26, the prior art fails to teach or suggest a method for providing access to a network, comprises a step in the event of a fault in the daisy chain, conveying further downstream data packets, received from the network by one of the master units, along the daisy chain in a second direction, opposite to the first direction, so as to deliver the further packets to the ports of at least some of the slave units, in combination with other limitations, as specified in claim 19.

2. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Duc Ho whose telephone number is (703) 305-1332. The examiner can normally be reached on Monday through Friday from 7:00 am to 3:30 pm.

If attempt to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Huy Vu, can be reached on (703) 308-6602.

Application/Control Number: 09/472,683
Art Unit: 2665

Page 4

Any inquiry of a general nature or relating to the status of this application or proceeding
should be directed to the Group receptionist whose telephone number is (703) 305-4700

Patent Examiner



Duc Ho

08-28-03

Notice of References Cited

Application/Control No.

09/472,683

Applicant(s)/Patent Under
Reexamination
KAPLAN ET AL.

Examiner

Duc C Ho

Art Unit

2665

Page 1 of 1

U.S. PATENT DOCUMENTS

	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
A	US-6,181,715	01-2001	Phillips et al.	370/493
B	US-6,424,657	07-2002	Voit et al.	370/412
C	US-6,219,354	04-2001	Fink et al.	370/463
D	US-			
E	US-			
F	US-			
G	US-			
H	US-			
I	US-			
J	US-			
K	US-			
L	US-			
M	US-			

FOREIGN PATENT DOCUMENTS

	Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
N					
O					
P					
Q					
R					
S					
T					

NON-PATENT DOCUMENTS

Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)

U

Z

V

This reference is not being furnished with this Office action. (See MPEP § 707.03(a).)
MM-YYYY format are publication dates. Classifications may be US or foreign.

and Trademark Office
(Rev. 31-2001)

Notice of References Cited

Part of Paper No. 8

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NOTICE OF ALLOWANCE AND FEE(S) DUE

7590 09/03/2003
ABELMAN FRAYNE & SCHWAB
150 EAST 42ND STREET
NEW YORK, NY 10017-5612

EXAMINER

HO, DUC CHI

ART UNIT

CLASS-SUBCLASS

2665

370-217000

DATE MAILED: 09/03/2003

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/472,683	12/27/1999	MENACHEM KAPLAN	204.344	9079

TITLE OF INVENTION: BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1300	\$0	\$1300	12/03/2003

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. **PROSECUTION ON THE MERITS IS CLOSED.** THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN **THREE MONTHS** FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. **THIS STATUTORY PERIOD CANNOT BE EXTENDED.** SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

☐ Applicant claims SMALL ENTITY status.
See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
Alexandria, Virginia 22313-1450
or Fax (703) 746-4000

INSTRUCTIONS: This form should be used for transmitting the **ISSUE FEE** and **PUBLICATION FEE** (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)
7590 09/03/2003

ABELMAN FRAYNE & SCHWAB
150 EAST 42ND STREET
NEW YORK, NY 10017-5612

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Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/472,683	12/27/1999	MENACHEM KAPLAN	204.344	9079

TITLE OF INVENTION: BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1300	\$0	\$1300	12/03/2003

EXAMINER	ART UNIT	CLASS-SUBCLASS
HO, DUC CHI	2665	370-217000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached. ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.	2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 1 _____ 2 _____ 3 _____
--	---

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE _____ (B) RESIDENCE: (CITY and STATE OR COUNTRY) _____

Please check the appropriate assignee category or categories (will not be printed on the patent); ☐ individual ☐ corporation or other private group entity ☐ government

4a. The following fee(s) are enclosed: ☐ Issue Fee ☐ Publication Fee ☐ Advance Order - # of Copies _____	4b. Payment of Fee(s): ☐ A check in the amount of the fee(s) is enclosed. ☐ Payment by credit card. Form PTO-2038 is attached. ☐ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).
---	---

Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) _____	(Date) _____
------------------------------	--------------

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Alexandria, Virginia 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.** SEND TO: Commissioner for Patents, Alexandria, Virginia 22313-1450.

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/472,683	12/27/1999	MENACHEM KAPLAN	204.344	9079
7590 09/03/2003				
ABELMAN FRAYNE & SCHWAB 150 EAST 42ND STREET NEW YORK, NY 10017-5612			EXAMINER HO, DUC CHI	
			ART UNIT	PAPER NUMBER
			2665	

DATE MAILED: 09/03/2003

Determination of Patent Term Extension under 35 U.S.C. 154 (b)
(application filed after June 7, 1995 but prior to May 29, 2000)

The Patent Term Extension is 0 day(s). Any patent to issue from the above-identified application will include an indication of the 0 day extension on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Extension is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (703) 305-1383. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/472,683	12/27/1999	MENACHEM KAPLAN	204.344	9079
7590 09/03/2003				
ABELMAN FRAYNE & SCHWAB 150 EAST 42ND STREET NEW YORK, NY 10017-5612				
EXAMINER				
HO, DUC CHI				
ART UNIT		PAPER NUMBER		
2665				

DATE MAILED: 09/03/2003

Notice of Fee Increase on October 1, 2003

If a reply to a "Notice of Allowance and Fee(s) Due" is filed in the Office on or after October 1, 2003, then the amount due will be higher than that set forth in the "Notice of Allowance and Fee(s) Due" since there will be an increase in fees effective on October 1, 2003. See Revision of Patent Fees for Fiscal Year 2004; Final Rule, 68 Fed. Reg. 41532, 41533, 41534 (July 14, 2003).

The current fee schedule is accessible from (<http://www.uspto.gov/main/howtofees.htm>).

If the fee paid is the amount shown on the "Notice of Allowance and Fee(s) Due" but not the correct amount in view of the fee increase, a "Notice of Pay Balance of Issue Fee" will be mailed to applicant. In order to avoid processing delays associated with mailing of a "Notice of Pay Balance of Issue Fee," if the response to the Notice of Allowance is to be filed on or after October 1, 2003 (or mailed with a certificate of mailing on or after October 1, 2003), the issue fee paid should be the fee that is required at the time the fee is paid. If the issue fee was previously paid, and the response to the "Notice of Allowance and Fee(s) Due" includes a request to apply a previously-paid issue fee to the issue fee now due, then the difference between the issue fee amount at the time the response is filed and the previously-paid issue fee should be paid. See Manual of Patent Examining Procedure, Section 1308.01 (Eighth Edition, August 2001).

Effective October 1, 2003, 37 CFR 1.18 is amended by revising paragraphs (a) through (c) to read as set forth below.

Section 1.18 Patent post allowance (including issue) fees.

(a) Issue fee for issuing each original or reissue patent, except a design or plant patent:

By a small entity (Sec. 1.27(a))..... \$665.00

By other than a small entity..... \$1,330.00

(b) Issue fee for issuing a design patent:

By a small entity (Sec. 1.27(a))..... \$240.00

By other than a small entity..... \$480.00

(c) Issue fee for issuing a plant patent:

By a small entity (Sec. 1.27(a))..... \$320.00

By other than a small entity..... \$640.00

Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.



ABEY MAN, FRAYNE & SCHWAB

Attorneys at Law
150 East 42nd Street
New York, New York 10017-5612

Telephone: (212) 949-9022
Facsimile: (212) 949-9190

Cable: LAWABEL New York
Telex: 661108 and 276592
e-mail@lawabel.com

BOX ISSUE FEE

December 1, 2003

Hon. Assistant Commissioner of Patents
Alexandria, VA 22313-1450

Sir/Madam:

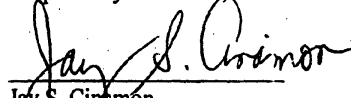
We enclose our check in payment of the issue fee on the following application.

APPLICANT: Kaplan, Menachem CASE: 204,344
SERIAL NO.: 09/472,683 FILED: December 27, 1999
TITLE: BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS
ASSIGNED TO: Orckit Communications Ltd.
ALLOWED: September 3, 2003 with 26 claims
ISSUE FEE DUE: December 3, 2003 AMOUNT: \$ 1330.00
PRIORITY: [X] None
SMALL ENTITY STATUS: NO

We await the receipt of the issue notification and the Letters Patent Document.

JSC:ma

Respectfully submitted,


Jay S. Cinnamon
Reg. No. 24,156

Enclosed Check No. 15604

BEST COPY



PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** Mail Stop ISSUE FEE
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 Alexandria, Virginia 22313-1450
 or **Fax** (703) 746-4000

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CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)
 7590 09/03/2003

ABELMAN FRAYNE & SCHWAB
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 NEW YORK, NY 10017-5612

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
 I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for delivery by first class mail addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO, on the date indicated below.

Jay S. Chamon Reg. No. 24,156 (Expositor's name)
 Jay S. Chamon (Signature)
 December 1, 2003 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/472,683	12/27/1999	MENACHEM KAPLAN	204.344	9079

TITLE OF INVENTION: BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS 12/05/2003 AWONDAF2 00000048 09472683

2/05/2003 AWONDAF2 00000066 010035 09472683

01 FC:1501

1330.00 OP

1 FC:8001 6.00 DA

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1300	\$0	\$1300	12/03/2003

EXAMINER	ART UNIT	CLASS-SUBCLASS
HQ, DUC CHI	2665	370-217000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Abelman, Frayne
 2 & Schwab
 3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY AND STATE OR COUNTRY)

ORCKIT COMMUNICATIONS LTD.

Tel Aviv Israel

Please check the appropriate assignee category or categories (will not be printed on the patent); ☐ individual ☐ corporation or other private group entity ☐ government

4a. The following fee(s) are enclosed:

☒ Issue Fee
☐ Publication Fee
☒ Advance Order - # of Copies 2 (two)

4b. Payment of Fee(s):

☒ check in the amount of the fee(s) is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized by check the required fee(s), or credit any overpayment, to Deposit Account Number 01-0035 (enclose an extra copy of this form).

Director for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

Authorized Signature (Date)
 Jay S. Chamon December 1, 2003

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant, a registered attorney or agent, or the assignee or other party in interest (as shown by the records of the United States Patent and Trademark Office).

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Alexandria, Virginia 22313-1450.

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Date of Deposit: December 1, 2003

This correspondence is being

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Postal Service "Express Mail Post

Office to Addressee" service under

37 CFR § 1.10 on the date indicated

above and addressed to:

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

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PTOL-85 (Rev. 08/03) Approved for use through 04/30/2004.

OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

File History Content Report

The following content is missing from the original file history record obtained from the United States Patent and Trademark Office. No additional information is available.

Document Date - 2004-01-20

Document Title - USPTO Grant

File History Content Report

The following content is missing from the original file history record obtained from the United States Patent and Trademark Office. No additional information is available.

Document Date - 2012-01-27

Document Title - Applicant Communication Re: Verified Statement of Small Entity Status in Compliance with 37 CFR 1.27

Electronic Acknowledgement Receipt	
EFS ID:	25972064
Application Number:	09472683
International Application Number:	
Confirmation Number:	9079
Title of Invention:	BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS
First Named Inventor/Applicant Name:	MENACHEM KAPLAN
Correspondence Address:	ABELMAN FRAYNE & SCHWAB - 150 EAST 42ND STREET - NEW YORK NY 10017-5612 US 212 949-9022 -
Filer:	Yehuda Binder
Filer Authorized By:	
Attorney Docket Number:	204.344
Receipt Date:	06-JUN-2016
Filing Date:	27-DEC-1999
Time Stamp:	02:53:07
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
File Listing:	

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	Signed-POA.pdf	137789	no	2
			03199d6fc2535ea8201418fc7d2606b12fcefb97		
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73	SIGNED-sb0096-61.pdf	137786	no	2
			2c8428f80e2e0ca9d8dabc276f7afdee44440108		
Warnings:					
Information:					
Total Files Size (in bytes):			275575		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☒ Practitioners associated with the Customer Number: 131926

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

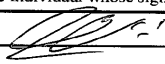
☒ The address associated with Customer Number: 131926

OR

☐ Firm or Individual Name			
Address			
City	State	Zip	
Country			
Telephone	Email		

Assignee Name and Address:

Orckit IP, LLC
874 Walker Road, Suite C, Dover, Delaware, USA**A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.**

SIGNATURE: The individual whose signature and title is supplied below is authorized to act on behalf of the assignee			
Signature		Date	June 5, 2016
Name	Yehuda Binder	Telephone	+972-54-4444577
Title	CEO and Owner of Orckit IP LLC		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: MENACHEM KAPLAN et al

Application No./Patent No.: 09/472,683

Filed/Issue Date: 12-27-1999

Titled: BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS

ORCKIT IP, LLC

, a Limited Liability Company

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;
 2. ☐ an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or
 3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)
- the patent application/patent identified above, by virtue of either:

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy therefore is attached.

OR

B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: ORCKIT COMMUNICATION LTD To: ORCKIT IP, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 038541, Frame 0984, or for which a copy thereof is attached.

2. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Yehuda Binder/

Signature

Yehuda Binder

Printed or Typed Name

ORCKIT IP, LLC
DE LLC # 5886551
831 Beacon St. # 307
Newton, MA 02459-1840

June 5, 2016

Date

CEO and Owner of Orckit IP LLC

Title

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/472,683	12/27/1999	MENACHEM KAPLAN	

131926
May Patents Ltd. c/o Dorit Shem-Tov
P.O.B 7230
Ramat-Gan, 5217102
ISRAEL

CONFIRMATION NO. 9079
POA ACCEPTANCE LETTER



Date Mailed: 06/13/2016

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/06/2016.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/mtturner myles/



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/472,683	12/27/1999	MENACHEM KAPLAN	

ABELMAN FRAYNE & SCHWAB
150 EAST 42ND STREET
NEW YORK, NY 10017-5612

CONFIRMATION NO. 9079
POWER OF ATTORNEY NOTICE



CC000000083617089

Date Mailed: 06/13/2016

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/06/2016.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/rmtturner myles/

File History Content Report

The following content is missing from the original file history record obtained from the United States Patent and Trademark Office. No additional information is available.

Document Date - 2016-06-13

Document Title - USPTO Communication Re: Change of Address

AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
---	---

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.);

DOCKET NO. 2:22-cv-276	DATE FILED 7/22/2022	U.S. DISTRICT COURT Eastern District of Texas
PLAINTIFF Orckit Corporation		DEFENDANT Cisco Systems, Inc.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 6,680,904	1/20/2004	Orckit Corporation
2 7,545,740	6/9/2009	Orckit Corporation
3 8,830,821	9/9/2014	Orckit Corporation
4 10,652,111	5/12/2020	Orckit Corporation
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT		
CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

PATENT APPLICATION FEE DETERMINATION RECORD Effective November 10, 1998					Application or Docket Number	
CLAIMS AS FILED - PART I (Column 1) (Column 2)						
FOR	NUMBER FILED	NUMBER EXTRA				
BASIC FEE						
TOTAL CLAIMS	26 minus 20 =	6				
INDEPENDENT CLAIMS	3 minus 3 =					
MULTIPLE DEPENDENT CLAIM PRESENT						
* If the difference in column 1 is less than zero, enter "0" in column 2						
CLAIMS AS AMENDED - PART II (Column 1) (Column 2) (Column 3)						
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA			
	Total	* 26 Minus ** 26 =				
	Independent	* 6 Minus *** 3 =	3			
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA			
	Total	* Minus ** =				
	Independent	* Minus *** =				
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					
AMENDMENT C	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA			
	Total	* Minus ** =				
	Independent	* Minus *** =				
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM					
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20." *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3." The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.						

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
	380.00	OR		760.00
X\$ 9=		OR	X\$18=	108
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL		OR	TOTAL	868

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	252
+130=		OR	+260=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	252

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X\$ 9=		OR	X\$18=	
X39=		OR	X78=	
+130=		OR	+260=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

Derwent Innovation

Derwent Innovation Patent Export, 2022-09-20 00:35:54 +0000

Search results for: PNS=(US6680904);

Collections searched: DWPI; ARIPO grant; Argentina UM; Argentina app; Armenia grant; Australia UM; Australia app; Australia grant; Austria UM; Austria app; Austria grant; Belarus UM; Belarus grant; Belgium app; Belgium grant; Brazil UM; Brazil app; Brazil grant; Bulgaria UM; Bulgaria app; Bulgaria grant; Canada app; Canada grant; China, Mainland UM; China, Mainland app; China, Mainland grant; Colombia app; Costa Rica UM; Costa Rica app; Croatia UM; Croatia app; Croatia grant; Cuba app; Cuba grant; Czech Republic UM; Czech Republic app; Czech Republic grant; Czechoslovakia grant; Denmark UM; Denmark app; Denmark grant; Estonia UM; Estonia app; Estonia grant; Eurasian (EAPO) grant; Europe (EP) app; Europe (EP) grant; Finland app; Finland grant; France app; France grant; Georgia grant; German Democratic Republic app; German Democratic Republic grant; Germany UM; Germany app; Germany grant; Greece app; Greece grant; Gulf Cooperation Council grant; Hong Kong UM; Hong Kong app; Hong Kong grant; Hungary grant; Iceland grant; India app; India grant; Indonesia UM; Indonesia app; Ireland UM; Ireland app; Ireland grant; Israel grant; Italy grant; Italy grant; Italy grant; Italy grant; Japan UM; Japan app; Japan grant; Korea UM; Korea app; Korea grant; Latvia grant; Lithuania grant; Luxembourg app; Luxembourg grant; Malaysia app; Malaysia grant; Mexico app; Mexico grant; Moldova UM; Moldova grant; Monaco grant; Mongolia UM; Mongolia grant; Morocco app; Morocco grant; Netherlands app; Netherlands grant; New Zealand grant; Norway app; Norway grant; OAPI grant; PCT (WO) app; Philippines UM; Philippines app; Philippines grant; Poland UM; Poland grant; Portugal UM; Portugal app; Portugal grant; Romania UM; Romania app; Romania granted; Russia UM; Russia app; Russia grant; Serbia UM; Serbia app; Serbia grant; Singapore app; Singapore grant; Slovakia UM; Slovakia app; Slovakia grant; Slovenia UM; Slovenia grant; South Africa app; Spain UM; Spain app; Spain grant; Sweden app; Sweden grant; Switzerland app; Switzerland grant; Taiwan UM; Taiwan app; Taiwan grant; Thailand UM; Thailand app; Thailand grant; Tunisia app; Turkey UM; Turkey app; Turkey grant; UK app; UK grant; USSR grant; Ukraine UM; Ukraine grant; United States app; United States grant; Uruguay app; Vietnam UM; Vietnam app; Vietnam grant; Other

Table of Contents

1. US6680904B1 Bi-directional chaining of network access ports
-

Family 1/1**1 record(s) per family****Record 1/1** US6680904B1 Bi-directional chaining of network access ports**Title:** Bi-directional chaining of network access ports**Title - DWPI:** Network access apparatus for digital subscriber line system, has daisy chain with top and bottom slaves connected to active master and standby master by different physical interface lines**Priority Number:** US1999472683A**Priority Date:** 1999-12-27**Application Number:** US1999472683A**Application Date:** 1999-12-27**Publication Date:** 2004-01-20**IPC Class Table:**

IPC	Section	Class	Subclass	Class Group	Subgroup
H04L001256	H	H04	H04L	H04L0012	H04L001256
H04Q001104	H	H04	H04Q	H04Q0011	H04Q001104

IPC Class Table - DWPI:

IPC - DWPI	Section - DWPI	Class - DWPI	Subclass - DWPI	Class Group - DWPI	Subgroup - DWPI
G01R003108 (IPC 1-7)	G	G01	G01R	G01R0031	G01R003108 (IPC 1-7)
H04Q001104 (IPC 1-7)	H	H04	H04Q	H04Q0011	H04Q001104 (IPC 1-7)
H04J000316 (IPC 1-7)	H	H04	H04J	H04J0003	H04J000316 (IPC 1-7)
H04L001228 (IPC 1-7)	H	H04	H04L	H04L0012	H04L001228 (IPC 1-7)
H04L001256 (IPC 1-7)	H	H04	H04L	H04L0012	H04L001256 (IPC 1-7)
H04L001266 (IPC 1-7)	H	H04	H04L	H04L0012	H04L001266 (IPC 1-7)

Assignee/Applicant: Orckit Communications Ltd., Tel Aviv, IL

JP F Terms:

JP FI Codes:

Assignee - Original: Orckit Communications Ltd.

Any CPC Table:

Type	Invention	Additional	Version	Office
Current	H04L 49/3081	H04L 2012/5603	20130101	EP; US
Current	H04L 12/56	H04L 2012/5614	20130101	EP; US
Current	H04Q 11/0478	H04L 2012/5627	20130101	EP; US
Original	H04L 49/3081	H04L 2012/5603	20130101	US
Original	H04L 12/56	H04L 2012/5614	20130101	US
Original	H04Q 11/0478	H04L 2012/5627	20130101	US

ECLA: H04L004930J | H04L001256 | H04Q001104S2

Abstract:

Network access apparatus includes first and second master units, each having a physical interface to a packet-switched network. A plurality of slave units, each slave unit having one or more ports to respective subscriber lines, are linked by a plurality of physical interface lines in one or more daisy chains, in which the slave units are mutually connected in series by the physical interface lines therebetween. Each daisy chain includes at least a first slave unit connected by one of the physical interface lines to the first master unit and a last slave unit connected by another of the physical interface lines to the second master unit.

Language of Publication: EN

INPADOC Legal Status Table:

Gazette Date	Code	INPADOC Legal Status Impact
2022-07-19	AS	-
Description: ASSIGNMENT ORCKIT IP, LLC, MASSACHUSETTS ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNOR:NAHUM COMMUNICATION N.T.B LTD.; REEL/FRAME:060544/0799 2022-06-15		
2022-07-18	AS	-
Description: ASSIGNMENT NAHUM COMMUNICATION N.T.B. LTD., ISRAEL ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNOR:ORCKIT IP, LLC; REEL/FRAME:060539/0804 2021-12-31		
2019-01-13	AS	-

Description: ASSIGNMENT ORCKIT IP, LLC, MASSACHUSETTS ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNOR:BLACKBIRD TECH LLC; REEL/FRAME:048067/0604 2019-01-09		
2018-05-03	AS	-
Description: ASSIGNMENT BLACKBIRD TECH LLC, MASSACHUSETTS ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNOR:ORCKIT IP, LLC; REEL/FRAME:045708/0435 2018-04-26		
2016-05-11	AS	-
Description: ASSIGNMENT ORCKIT IP, LLC, DELAWARE ASSIGNMENT OF ASSIGNORS INTEREST; ASSIGNORS:ORCKIT COMMUNICATION LTD.; ORCKIT-CORRIGENT LTD.; CORRIGENT SYSTEMS LTD.; REEL/FRAME:038541/0984 2016-04-25		
2016-01-13	SULP	+
Description: SURCHARGE FOR LATE PAYMENT FEE PAYMENT YEAR 11		
2016-01-13	FPAY	+
Description: FEE PAYMENT FEE PAYMENT YEAR 12		
2015-08-28	REMI	-
Description: MAINTENANCE FEE REMINDER MAILED		
2013-07-26	AS	-
Description: ASSIGNMENT ORCKIT COMMUNICATIONS LTD., ISRAEL RELEASE BY SECURED PARTY; ASSIGNOR:HUDSON BAY IP OPPORTUNITIES MASTER FUND LP; REEL/FRAME:030885/0117 2013-07-23		
2013-03-18	AS	-
Description: ASSIGNMENT HUDSON BAY IP OPPORTUNITIES MASTER FUND, LP, NEW Y SECURITY AGREEMENT; ASSIGNOR:ORCKIT COMMUNICATIONS LTD.; REEL/FRAME:030034/0366 2013-03-18		
2012-01-20	SULP	+
Description: SURCHARGE FOR LATE PAYMENT FEE PAYMENT YEAR 7		
2012-01-20	FPAY	+
Description: FEE PAYMENT FEE PAYMENT YEAR 8		
2011-08-29	REMI	-
Description: MAINTENANCE FEE REMINDER MAILED		

2007-07-18	FPAY	+
Description: FEE PAYMENT FEE PAYMENT YEAR 4		
2003-12-30	STCF	-
Description: INFORMATION ON STATUS: PATENT GRANT PATENTED CASE		

Post-Issuance (US):

Reassignment (US) Table:

Assignee	Assignor	Date Signed	Reel/Frame	Date
ORCKIT IP LLC, WEST NEWBURY, MA, US	NAHUM COMMUNICATION N.T.B LTD.	2022-06-15	060544/0799	2022-07-19
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: RICHARD A. BAKER, JR. 291 MAIN STREET WEST NEWBURY, MA 01985				
NAHUM COMMUNICATION N.T.B. LTD., RAMAT GAN, IL	ORCKIT IP, LLC	2021-12-31	060539/0804	2022-07-18
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: RICHARD A. BAKER, JR. 291 MAIN STREET WEST NEWBURY, MA 01985				
ORCKIT IP LLC, NEWTON, MA, US	BLACKBIRD TECH LLC	2019-01-09	048067/0604	2019-01-13
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: MAY PATENTS LTD. C/O DORIT SHEM-TOV P.O.B 7230 RAMAT-GAN, 5217102 ISRAEL				
BLACKBIRD TECH LLC, BOSTON, MA, US	ORCKIT IP, LLC	2018-04-26	045708/0435	2018-05-03
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				
Corresponent: BLACKBIRD TECH LLC ONE BOSTON PLACE, SUITE 2600 BOSTON, MA 02108				
ORCKIT IP LLC, DOVER, DE, US	ORCKIT COMMUNICATION LTD.	2016-04-25	038541/0984	2016-05-11
	ORCKIT-CORRIGENT LTD.	2016-04-25	-	-
	CORRIGENT SYSTEMS LTD.	2016-04-25	-	-
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).				

Corresponent: MAY PATENTS LTD. C/O DORIT SHEM-TOV P.O.B 7230 RAMAT-GAN, 5217102 ISRAEL				
ORCKIT COMMUNICATIONS LTD.,TEL AVIV,IL	HUDSON BAY IP OPPORTUNITIES MASTER FUND LP	2013-07-23	030885/0117	2013-07-26
Conveyance: RELEASE BY SECURED PARTY (SEE DOCUMENT FOR DETAILS).				
Corresponent: SHEEHAN PHINNEY BASS + GREEN PA 1000 ELM STREET, 17TH FLOOR PO BOX 3701 MANCHESTER, NH 03105				
HUDSON BAY IP OPPORTUNITIES MASTER FUND LP,NEW YORK,NY,US	ORCKIT COMMUNICATIONS LTD.	2013-03-18	030034/0366	2013-03-18
Conveyance: SECURITY AGREEMENT				
Corresponent: SHEEHAN PHINNEY BASS + GREEN PA 1000 ELM STREET, 17TH FLOOR PO BOX 3701 MANCHESTER, NH 03105				

Maintenance Status (US):

Litigation (US): 2022-07-22 2022 Orckit Corporation Cisco Systems, Inc. E.D. Texas

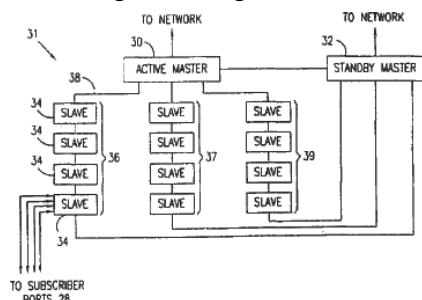
2:22cv00276

Opposition (EP):

License (EP):

EPO Procedural Status:

Front Page Drawing:



Priority Number - DWPI: US1999472683A

Priority Date - DWPI: 1999-12-27

Assignee - Current US: ORCKIT IP LLC



United States Patent and Trademark Office

Office of the Commissioner for Patents

BI-DIRECTIONAL CHAINING OF NETWORK ACCESS PORTS

PATENT # 6680904 APPLICATION # 09472683 FILING DATE 12/27/1999 ISSUE DATE 01/20/2004

Payment Window Status

WINDOW 11.5 Year		STATUS Closed		FEES Paid		No maintenance fees are due.
Window	First Day to Pay	Surcharge Starts	Last Day to Pay	Status	Fees	
3.5 Year	01/20/2007	07/21/2007	01/22/2008	Closed	Paid	
7.5 Year	01/20/2011	07/21/2011	01/20/2012	Closed	Paid	
11.5 Year	01/20/2015	07/21/2015	01/20/2016	Closed	Paid	

Patent Holder Information

Customer # 287

Entity Status SMALL

Phone Number 00352/499841

Address DENNEMEYER & CO. LUXEMBOURG
P.O. BOX 1502
L - 1015
LUXEMBOURG,
LUXEMBOURG