



CONVERGED NETWORKING PATENT PORTFOLIO

AN ACQUISITION OPPORTUNITY



CONVERGED NETWORKING PATENT PORTFOLIO

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SECTION 1



CONVERGED NETWORKING PATENT PORTFOLIO

OVERVIEW OF THE OPPORTUNITY

EXECUTIVE SUMMARY

IPinvestments Group has been engaged by Orckit Communications Ltd. (“Orckit”) to broker the sale of the Orckit-Corrigent Converged Networking patents (the “Patent Portfolio”). The Patent Portfolio enables the complete distribution and management of data as well as the devices that make converged networks possible. This expansive Patent Portfolio covers critical elements of multi-service carrier networking solutions including SONET/SDH and ring-based gigabit Ethernet in the core and distribution layers. Additionally, the Patent Portfolio reads on features present through the entire telecommunications world from millions of popular SOHO routers, Ethernet chipsets, and embedded real-time systems in general. Whether next-generation SONET/SDH, all-optical and/or Ethernet-based media take the lead in the future, Orckit’s Patent Portfolio provides the necessary features to all candidates for next-generation networks. The Patent Portfolio is further summarized below.

- 59 issued U.S. patents.
- Numerous pending U.S. patent applications / international patents assets.
- Over 250 forward references as of September 28, 2010.
- File histories for all assets are available.
- Many patents were pursued due to Orckit’s participation in standard-setting bodies, including the Institute of Electrical and Electronics Engineers (“IEEE”) and the Internet Engineering Task Force (“IETF”). Specifically, Orckit participated in the development of IEEE 802.17 (Resilient Packet Rings). To date, no specific patents are known to have been committed to be available for licensing.

Patent Portfolio

No.	Patent No.	Title	Assignee	Serial No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	6,218,872	Line driver with output impedance synthesis	Orckit Communications Ltd.	09/470,777	12/23/99	12/23/99	04/17/01	10
2	6,483,903	Splitterless Ethernet DSL on subscriber loops	Orckit Communications Ltd.	09/346,416	07/01/99	07/01/99	11/19/02	13
3	6,680,904	Bi-directional chaining of network access ports	None – Orckit Communications	09/472,683	12/27/99	12/27/99	01/20/04	23
4	6,687,224	Bandwidth sharing method	Orckit Communications Ltd.	09/514,745	02/28/00	02/28/00	02/03/04	3
5	6,731,607	Network interface auto-configuration in an access multiplexing system	Orckit Communications Ltd.	09/629,664	08/01/00	08/01/00	05/04/04	5
6	6,785,232	Rate control in transmission of packet data over an ATM network	Orckit Communications Ltd.	09/723,206	11/27/00	11/27/00	08/31/04	9



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No.	Patent No.	Title	Assignee	Serial No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
7	6,813,343	Method and apparatus for filtering asymmetric digital subscriber line (ADSL) signals	Orckit Communications Ltd.	09/310,518	05/12/99	05/12/99	11/02/04	11
8	6,822,943	Network access multiplexer with protocol address translation	Orckit Communications Ltd.	09/708,841	11/08/00	11/08/00	11/23/04	8
9	6,822,944	Management interface for a network access multiplexing system	Orckit Communications Ltd.	09/708,845	11/08/00	11/08/00	11/23/04	6
10	6,834,038	Protection against master unit failure in remote network access multiplexing	Orckit Communications Ltd.	09/637,757	08/11/00	08/11/00	12/21/04	25
11	6,876,669	Packet Fragmentation with Nested Interruptions	Corrigent Systems Ltd.	09/756,553	01/08/01	01/08/01	04/05/05	9
12	6,891,855	Dynamic Packet Fragmentation	Corrigent Systems Ltd.	09/756,554	07/27/00	01/08/01	05/10/05	12
13	6,892,329	Selective Protection for Ring Topologies	Corrigent Systems Ltd.	09/969,839	04/02/01	10/03/01	05/10/05	6
14	6,894,983	Automatic implementation of network configuration changes	Orckit Communications Ltd.	09/637,300	08/11/00	08/11/00	05/17/05	3
15	6,917,986	Fast Failure Protection Using Redundant Network Edge Ports	Corrigent Systems Ltd.	10/036,518	01/07/02	01/07/02	07/12/05	3
16	6,952,397	Communication in a Bidirectional Ring Network with Single-Direction Receiving	Corrigent Systems Ltd.	09/876,414	06/07/01	06/07/01	10/04/05	11
17	6,956,944	Method and apparatus for compensating for an echo signal component in telecommunication systems	Orckit Communications Ltd.	09/460,891	12/14/99	12/14/99	10/18/05	4
18	6,957,369	Hidden Failure Detection	Corrigent Systems Ltd.	10/156,851	05/30/02	05/30/02	10/18/05	0
19	6,963,537	Resource Reservation in a Ring Network	Corrigent Systems Ltd.	09/794,898	07/27/00	02/26/01	11/08/05	2
20	6,973,049	Auto-Configuration of Network Interfaces in a Bidirectional Ring Network	Corrigent Systems Ltd.	09/978,642	10/16/01	10/16/01	12/06/05	0
21	7,032,135	Equipment Protection Using a Partial Star Architecture	Corrigent Systems Ltd.	10/211,065	08/02/02	08/02/02	04/18/06	2
22	7,035,279	Flow Allocation in a Ring Topology	Corrigent Systems Ltd.	09/756,946	01/09/01	01/09/01	04/25/06	9
23	7,054,264	Interconnect and Gateway Protection in Bidirectional Ring Networks	Corrigent Systems Ltd.	09/910,790	07/24/01	07/24/01	05/30/06	5
24	7,061,859	Fast Protection in Ring Topologies	Corrigent Systems Ltd.	09/941,723	08/30/01	08/30/01	06/13/06	1
25	7,069,546	Generic Framework for Embedded Software Development	Corrigent Systems Ltd.	10/005,030	12/03/01	12/03/01	06/27/06	1
26	7,113,485	Latency Evaluation in a Ring Network	Corrigent Systems Ltd.	09/947,183	09/04/01	09/04/01	09/26/06	3
27	7,127,523	Spanning Tree Protocol Traffic in a Transparent LAN	Corrigent Systems Ltd.	10/057,332	07/27/01	01/25/02	10/24/06	11
28	7,133,415	Sonet Circuit Emulation with VT Compression	Corrigent Systems Ltd.	09/978,342	07/10/01	10/17/01	11/07/06	5
29	7,142,516	Performance Monitoring of High Speed Communications Networks	Corrigent Systems Ltd.	10/128,459	04/24/02	04/24/02	11/28/06	2
30	7,145,878	Avoiding Overlapping Segments in Transparent LAN Services on Ring-Based Networks	Corrigent Systems Ltd.	10/054,845	07/27/01	01/25/02	12/05/06	4
31	7,154,899	Protecting the Filtering Database in Virtual Bridges	Corrigent Systems Ltd.	10/061,721	02/01/02	02/01/02	12/26/06	2
32	7,158,721	Performance Monitoring of Multiple Channels in an Automatic Protection Switched Network	Corrigent Systems Ltd.	10/082,771	02/25/02	02/25/02	01/02/07	1
33	7,280,560	Differentiated Services with Multiple Tagging Levels	Corrigent Systems Ltd.	10/128,454	04/24/02	04/24/02	10/09/07	2



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No.	Patent No.	Title	Assignee	Serial No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
34	7,283,465	Hierarchical Virtual Private LAN Service Protection Scheme	Corrigent Systems Ltd.	10/337,382	01/07/03	01/07/03	10/16/07	9
35	7,283,478	Traffic Engineering in Bi-Directional Ring Networks	Corrigent Systems Ltd.	10/211,066	11/28/01	08/02/02	10/16/07	4
36	7,330,431	Multipoint to Multipoint Communication Over Ring Topologies	Corrigent Systems Ltd.	10/933,572	09/03/04	09/03/04	02/12/08	0
37	7,336,605	Bandwidth Allocation for Link Aggregation	Corrigent Systems Ltd.	10/436,516	05/13/03	05/13/03	02/26/08	5
38	7,339,929	Virtual Private LAN Service Using a Multicast Protocol	Corrigent Systems Ltd.	10/226,525	08/23/02	08/23/02	03/04/08	13
39	7,386,010	Multiprotocol Media Conversion	Corrigent Systems Ltd.	10/461,807	06/13/03	06/13/03	06/10/08	12
40	7,418,000	Automated Weight Calculation for Packet Networks	Corrigent Systems Ltd.	10/861,272	06/03/04	06/03/04	08/26/08	0
41	7,420,922	Ring Network With Variable Rate	Corrigent Systems Ltd.	10/387,657	03/12/03	03/12/03	09/02/08	2
42	7,463,580	Resource Sharing Among Network Tunnels	Corrigent Systems Ltd.	11/305,486	12/15/05	12/15/05	12/09/08	0
43	7,478,382	Synchronized Ring Software Download	Corrigent Systems Ltd.	10/951,575	09/27/04	09/27/04	01/13/09	1
44	7,483,399	Signaling MPLS Over RPR Rings	Corrigent Systems Ltd.	10/369,953	06/05/02	02/20/03	01/27/09	1
45	7,515,536	Transparent Transport of Fibre Channel Traffic Over Packet-Switched Networks	Corrigent Systems Ltd.	11/479,595	07/11/05	06/29/06	04/07/09	0
46	7,515,605	Efficient Transport of TDM Services Over Packet Networks	Corrigent Systems Ltd.	10/396,008	03/24/03	03/24/03	04/07/09	1
47	7,545,740	Two-Way Link Aggregation	Corrigent Systems Ltd.	11/279,045	04/07/06	04/07/06	06/09/09	1
48	7,551,599	Layer-3 Network Routing With RPR Layer-2 Visibility	Corrigent Systems Ltd.	10/812,321	03/29/04	03/29/04	06/23/09	0
49	7,593,400	MAC Address Learning in a Distributed Bridge	Corrigent Systems Ltd.	11/419,444	05/19/06	05/19/06	09/22/09	1
50	7,596,088	Route Selection With Bandwidth Sharing Optimization Over Rings	Corrigent Systems Ltd.	11/339,148	01/24/06	01/24/06	09/29/09	0
51	7,626,930	Hash-Based Multi-Homing	Corrigent Systems Ltd.	11/778,286	11/13/06	11/13/06	12/01/09	1
52	7,660,234	Fault-tolerant medium access control (MAC) address assignment in network elements	Corrigent Systems Ltd.	11/534,556	09/22/06	09/22/06	02/09/10	0
53	7,660,303	Point-to-Multipoint Functionality in a Bridged Network	Corrigent Systems Ltd.	11/508,599	08/22/06	08/22/06	02/09/10	0
54	7,697,525	Forwarding Multicast Traffic Over Link Aggregation Ports	Corrigent Systems Ltd.	11/644,773	12/21/06	12/21/06	04/13/10	0
55	7,697,532	Frame Concatenation With Drop Precedence Assignment	Corrigent Systems Ltd.	11/704,615	02/08/07	02/08/07	04/13/10	0
56	7,697,552	MAC Address Scalability in Interconnected Rings	Corrigent Systems Ltd.	11/764,764	11/06/06	06/18/07	04/13/10	0
57	7,768,928	Connectivity Fault Management (CFM) in Networks With Link Aggregation Group Connections	Corrigent Systems Ltd.	11/483,650	07/11/06	07/11/06	08/03/10	0
58	7,773,508	Protecting the Filtering Database in Virtual Bridges	Corrigent Systems Ltd.	11/595,635	02/01/02	11/09/06	08/10/10	0
59	7,808,931	High Capacity Ring Communication Network	Corrigent Systems Ltd.	11/367,231	03/02/06	03/02/06	10/05/10	0
60	N/A	Motion Vector Coding and Decoding in Interlaced Frame Coded Pictures	N/A	10/933,882	09/07/03	09/02/04	N/A	N/A
61	N/A	Tunnel Provisioning With Link Aggregation	N/A	11/123,801	05/06/05	05/06/05	N/A	N/A
62	N/A	Interface Between a Synchronous Network and High-Speed Ethernet	N/A	11/279,710	04/13/06	04/13/06	N/A	N/A
63	N/A	VPLS Failure Protection in Ring Networks	N/A	11/335,770	01/18/06	01/18/06	N/A	N/A
64	N/A	RPR Representation in OSPF-TE	N/A	11/383,869	05/17/06	05/17/06	N/A	N/A



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No.	Patent No.	Title	Assignee	Serial No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
65	N/A	Prevention of Frame Duplication in Interconnected Ring Networks	N/A	12/044,158	03/08/07	03/07/08	N/A	N/A
66	N/A	VPLS Remote Failure Indication	N/A	12/093,824	11/07/06	07/22/08	N/A	N/A
67	N/A	Device Method and System for Providing a Media Stream	N/A	12/143,944	10/16/07	06/23/08	N/A	N/A
68	N/A	Efficient Full Mesh Load Testing of Network Elements	N/A	12/261,072	10/30/08	10/30/08	N/A	N/A
69	N/A	Ring Network Aggregate Rates	N/A	12/348,361	01/05/09	01/05/09	N/A	N/A
70	N/A	High-Speed Processing of Multicast Content Requests	N/A	12/369,011	02/11/09	02/11/09	N/A	N/A
71	N/A	Unicast Streaming of Multicast Content	N/A	12/628,247	12/03/08	12/01/09	N/A	N/A
72	N/A	Hierarchical Virtual Private LAN Service Protection Scheme	N/A	11/745,303	01/07/03	05/07/07	N/A	N/A
73	N/A	Efficient Transport of TDM Services Over Packet Networks	N/A	12/404,444	03/24/03	03/16/09	N/A	N/A

OVERVIEW OF ORCKIT COMMUNICATIONS, LTD.

Based in Tel-Aviv, Israel, Orckit Communications Ltd. (Nasdaq:ORCT) - <http://www.orckit.com>, together with its subsidiaries, designs, develops, manufactures, and markets telecommunication transport equipment capable of supporting the growing capacity demands for high bandwidth video services, including HDTV, Internet Protocol television (“IPTV”), video on demand (“VOD”), interactive television (together known also as “video services”), as well as other types of data services and voice services, whether transmitted over wireline or cellular networks, in metropolitan networks. Orckit target customers are telecommunications service providers active in metropolitan areas, with a focus on incumbent local exchange carriers.

SECTION 2



CONVERGED NETWORKING PATENT PORTFOLIO

OVERVIEW OF THE PATENT PORTFOLIO

OVERVIEW

Orckit's innovative Patent Portfolio (or "Technology") enables the complete distribution and management of data as well as the devices that make converged next-generation networks possible. This expansive Patent Portfolio covers critical elements of multi-service carrier networking solutions including SONET/SDH and ring-based gigabit Ethernet in the core and distribution layers. Additionally, the Patent Portfolio enables features present through the entire telecommunications world from millions of popular SOHO routers, Ethernet router chipsets, DSL deployments and embedded real-time systems in general. Whether next-generation SONET/SDH, all-optical and/or Ethernet-based media take the lead in the future, Orckit's Patent Portfolio provides necessary features to all candidates for next-generation networks from end-to-end, thus enabling both the provider and consumer of converged services.

A particular strength of Orckit's patented Technology and its deep relevance to a large number of companies operating in different fields is demonstrated by over 250 forward references to patents of this portfolio; moreover, this total consists of only references from allowed US patents. Many of Orckit's innovations enjoy international protection as well.

Finally, virtually all of Orckit's wealth of innovations benefit from actual reduction to practice and are used by millions of users around the world. This is a rare opportunity to enjoy a true end-to-end networking technology portfolio that touches on both the present and future of converged networks.



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SYNOPSIS OF PATENT PORTFOLIO SECTIONS

PACKET RING NETWORKS

The innovators at Orckit recognized early on the impact of less distinction between typical ring-oriented cores and access/distribution edge networks typical in the 80's and 90's. Orckit's innovation in the field of ring-topology networks is accentuated by its participation in the important IEEE 802.17 Resilient Packet Ring ("RPR") standard setting activity in early stages. Many of Orckit's patent filings predate not only the proposal of the IEEE RPR standard but even the foundation of the IEEE working group that would later draft said standard(s). As part of the Metro Ethernet movement, actual protection times of these rings at less than 50ms have been demonstrated, showing the Patent Portfolio enables the reliability and performance needed for tomorrow.

Existing optical ring networks using time-division multiplexing (e.g. SONET/SDH) are robust and widely deployed in networks scaling from metropolitan to transoceanic dense wavelength-division multiplexing ("DWDM") networks. They carry the vast majority of telephony, computer data and even financial transactions at high speeds and offer reliability that has made them the workhorse of telecommunications around the world. Unfortunately, these networks are often inefficient and expensive in comparison with packet-based networks typified by Internet protocol ("IP") and Ethernet technologies. Next-generation networks demand the reliability of SONET but with the flexibility of Ethernet or TCP-IP packet-oriented transport. The ubiquity of ring topology packet networks is even more evident as the differentiation between a consumer edge device and core network elements dissipate.

Orckit has been a pioneer in adapting these robust ring-based networking techniques to carry packet-oriented data, including many features that have been adopted into the wide-spread IEEE 802.17 standard. In particular, these Technologies relate to the required capability to wrap a flow of traffic back and restore service after a failure, or steer a flow away from a failed node on the



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network. Although Orckit's Technology enables and improves a myriad of elements related to RPR networks, a few highlights of this rich Patent Portfolio include:

- o Critical steering and wrapping of traffic flows around counter-rotating packet rings where a failed node triggers a node upstream to redirect or re-route packets to avoid a service outage. **These two actions are vital elements of RPR networking as outlined in IEEE 802.17.**
- o Rapid fail-over of network ports between access and edge (e.g. distribution layer) switches while avoiding looping and the need for a Media Access Channel ("MAC") address to age out of tables. This takes the time for a MAC failover from as much as 5 minutes to less than one second. Error messaging and application to layer-2 based connectivity such as VLAN's is explicitly claimed.
- o Auto-sensing of flow direction for packet ring network elements including advertisement packets used to self-configure network elements in a counter-rotating packet ring. Control packets of this kind are explicitly enabled in the context of the RPR standard.
- o Rapid response to multiple breaks, allowing nodes to wrap and steer flows through remaining network segments of the ring. Unlike other ring technologies, Orckit's Technology uses both rings for transmitting data when possible, thus eliminating the unused idle protection ring.
- o Layer-3 routing over RPR while retaining visibility of encapsulated layer-2 traffic information, enabling virtual tunnels and other bridging operations in the context of label switching routers.
- o Both dedicated hardware (e.g. ASIC) and software based routing is provided.
- o **Finally, Orckit's ring-based packet network technology is explicitly NOT constrained to optical networks.** Copper-based physical media, wireless network segments and optical connections can all be accommodated.



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The Packet Ring Network's Patent Portfolio is summarized below.

No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	6,892,329	Selective Protection for Ring Topologies	09/969,839	04/02/01	10/03/01	05/10/05	6
2	6,917,986	Fast Failure Protection Using Redundant Network Edge Ports	10/036,518	01/07/02	01/07/02	07/12/05	3
3	6,952,397	Communication in a Bidirectional Ring Network with Single-Direction Receiving	09/876,414	06/07/01	06/07/01	10/04/05	11
4	6,963,537	Resource Reservation in a Ring Network	09/794,898	07/27/00	02/26/01	11/08/05	2
5	6,973,049	Auto-Configuration of Network Interfaces in a Bidirectional Ring Network	09/978,642	10/16/01	10/16/01	12/06/05	0
6	7,035,279	Flow Allocation in a Ring Topology	09/756,946	01/09/01	01/09/01	04/25/06	9
7	7,054,264	Interconnect and Gateway Protection in Bidirectional Ring Networks	09/910,790	07/24/01	07/24/01	05/30/06	5
8	7,061,859	Fast Protection in Ring Topologies	09/941,723	08/30/01	08/30/01	06/13/06	1
9	7,113,485	Latency Evaluation in a Ring Network	09/947,183	09/04/01	09/04/01	09/26/06	3
10	7,420,922	Ring Network With Variable Rate	10/387,657	03/12/03	03/12/03	09/02/08	2
11	7,483,399	Signaling MPLS Over RPR Rings	10/369,953	06/05/02	02/20/03	01/27/09	1
12	7,551,599	Layer-3 Network Routing With RPR Layer-2 Visibility	10/812,321	03/29/04	03/29/04	06/23/09	0
13	7,596,088	Route Selection With Bandwidth Sharing Optimization Over Rings	11/339,148	01/24/06	01/24/06	09/29/09	0
14	7,697,552	MAC Address Scalability in Interconnected Rings	11/764,764	11/06/06	06/18/07	04/13/10	0
15	7,808,931	High Capacity Ring Communication Network	11/367,231	03/02/06	03/02/06	10/05/10	0
16	N/A	Interface Between a Synchronous Network and High-Speed Ethernet	11/279,710	04/13/06	04/13/06	N/A	N/A
17	N/A	VPLS Failure Protection in Ring Networks	11/335,770	01/18/06	01/18/06	N/A	N/A
18	N/A	RPR Representation in OSPF-TE	11/383,869	05/17/06	05/17/06	N/A	N/A
19	N/A	Prevention of Frame Duplication	12/044,158	03/08/07	03/07/08	N/A	N/A



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No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
		in Interconnected Ring Networks					
20	N/A	Ring Network Aggregate Rates	12/348,361	01/05/09	01/05/09	N/A	N/A

In a world where ring no longer just means SONET, Orckit's inventions are have-to-have elements of next-generation networks, particularly in robust packet-oriented implementations.

NETWORK CONFIGURATIONS AND MANAGEMENT

Another important and valuable area of Orckit's wealth of technical excellence relates to methods and devices for delivering fault-tolerant and well-managed network infrastructures. Additionally, several techniques necessary in migrating from circuit-switched SONET/SDH to packet-oriented infrastructures are provided. Orckit's technical capabilities have allowed innovation from Ethernet link aggregation groups ("LAG")'s to migration paths necessary for legacy TDM technology and extending even to new methods of tagging and prioritizing traffic on converged networks.

This section demonstrates the breadth of Orckit's expertise and inventive skill particularly, with a breadth of technologies that are highlighted below:

- o TDM technologies continue to play key roles in networks of many different scales, but are challenging to integrate with packet-oriented transport. An adaptive encapsulation of TDM signals sensitive to the degree of synchronicity required combined with the ability to strip idle data from the incoming TDM stream before packet-wise encapsulation allows for savings in packet-side bandwidth while also guaranteeing quality of transport to the time-dependent input signal.
- o Using idle lines of communication, or at a lower level, idle traces on a backplane, Orckit has developed a method to use those lines to provide loop-back testing between a master and secondary module. This enables self-testing without impacting active lines carrying



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communications, and with other elements of Orckit's Patent Portfolio relating to intelligent handling of fail-over from active to idle lines. For maintenance purposes, channels can allow diagnostic testing without outages or loss of capacity. Further, the technology is not restricted re: protocols and backplane systems.

- o Selective encapsulation of SONET/SDH data streams for transport over packet networks that eliminate idle virtual tributaries/sections of the SONET data stream, allowing sub-rate payloads to be packetized and transported without waste on the packet network. This allows a smooth transition from circuit-switched to packet-oriented core networks while guaranteeing the reliability that made SONET/SDH so popular.
- o Measuring and allocating bandwidth across an end-to-end network with several different topologies (e.g., blending rings with star or mesh networks) is particularly daunting and absolutely necessary to guarantee service levels. By measuring true point-to-point available resources across mixed topology networks, a true quality-of-service ("QoS") is possible on both a per-service type and point-to-point basis.
- o Several methods used in Ethernet LAG's that can be responsive to bi-directional link aggregation with couple of traffic flows responsive on a MAC, TCP port or IP basis.
- o Multi-level tagging of packets over a committed information rate ("CIR") with the ability to throttle traffic based on several different excess information rate ("EIR") levels and tagging to allow label switch routing to make decisions based on the combination of service type and the degree of excess information rate usage.

The Network Configurations and Management Patent Portfolio is summarized below.

No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	6,957,369	Hidden Failure Detection	10/156,851	05/30/02	05/30/02	10/18/05	0
2	7,032,135	Equipment Protection Using a Partial Star Architecture	10/211,065	08/02/02	08/02/02	04/18/06	2
3	7,133,415	Sonet Circuit Emulation with VT Compression	09/978,342	07/10/01	10/17/01	11/07/06	5
4	7,142,516	Performance Monitoring of High Speed Communications Networks	10/128,459	04/24/02	04/24/02	11/28/06	2
5	7,158,721	Performance Monitoring of Multiple Channels in an	10/082,771	02/25/02	02/25/02	01/02/07	1



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No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
		Automatic Protection Switched Network					
6	7,280,560	Differentiated Services with Multiple Tagging Levels	10/128,454	04/24/02	04/24/02	10/09/07	2
7	7,283,465	Hierarchical Virtual Private LAN Service Protection Scheme	10/337,382	01/07/03	01/07/03	10/16/07	9
8	7,283,478	Traffic Engineering in Bi-Directional Ring Networks	10/211,066	11/28/01	08/02/02	10/16/07	4
9	7,330,431	Multipoint to Multipoint Communication Over Ring Topologies	10/933,572	09/03/04	09/03/04	02/12/08	0
10	7,336,605	Bandwidth Allocation for Link Aggregation	10/436,516	05/13/03	05/13/03	02/26/08	5
11	7,418,000	Automated Weight Calculation for Packet Networks	10/861,272	06/03/04	06/03/04	08/26/08	0
12	7,515,605	Efficient Transport of TDM Services Over Packet Networks	10/396,008	03/24/03	03/24/03	04/07/09	1
13	7,545,740	Two-Way Link Aggregation	11/279,045	04/07/06	04/07/06	06/09/09	1
14	7,626,930	Hash-Based Multi-Homing	11/778,286	11/13/06	11/13/06	12/01/09	1
15	7,660,234	Fault-tolerant medium access control (MAC) address assignment in network elements	11/534,556	09/22/06	09/22/06	02/09/10	0
16	7,697,525	Forwarding Multicast Traffic Over Link Aggregation Ports	11/644,773	12/21/06	12/21/06	04/13/10	0
17	7,697,532	Frame Concatenation With Drop Precedence Assignment	11/704,615	02/08/07	02/08/07	04/13/10	0
18	7,768,928	Connectivity Fault Management (CFM) in Networks With Link Aggregation Group Connections	11/483,650	07/11/06	07/11/06	08/03/10	0
19	N/A	Interface Between a Synchronous Network and High-Speed Ethernet	11/279,710	04/13/06	04/13/06	N/A	N/A
20	N/A	Device Method and System for Providing a Media Stream	12/143,944	10/16/07	06/23/08	N/A	N/A
21	N/A	Efficient Full Mesh Load Testing of Network Elements	12/261,072	10/30/08	10/30/08	N/A	N/A
22	N/A	High-Speed Processing of Multicast Content Requests	12/369,011	02/11/09	02/11/09	N/A	N/A
23	N/A	Unicast Streaming of Multicast Content	12/628,247	12/03/08	12/01/09	N/A	N/A
24	N/A	Efficient Transport of TDM Services Over Packet Networks	12/404,444	03/24/03	03/16/09	N/A	N/A



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EMBEDDED SYSTEM DESIGN AND MANAGEMENT

Although a vital part of the design and continued support of network equipment, the development of embedded software and firmware for complex devices is a common need across industries varying from set-top boxes to supercomputers. Additionally, the order of operations in updating multiple images of embedded software is also key, and a network of devices that are updated incorrectly may simply cease to function at all. Recognizing this ubiquitous problem, Orckit has created a suite of technology that allows both generation and precisely synchronized deployment of these most critical of software rollouts, especially in rings of interconnected devices.

Although Orckit invented these technologies to be used in networking, they are truly universal in the scope of communication-aware electronic devices with embedded software. Some highlights of this innovative technology include:

- o Rapid development of device-controlling software in embedded systems by a unified, transparent structure to handle application-driver interfaces. A single generic application programming interface (“API”) is used to interface with system management programs, eliminating the re-development time when common functions are used in different hardware modules. These functions include:
 - Alarm handlers triggering responses to failing modules
 - Performance handlers that ensure hardware modules are optimally used
 - Maintenance and self test handlers, such as power-on test routines
 - Configuration data and process handlers that set up a module for use based on information acquired from the over-arching system management program
- o Synchronized update of interface software in a redundant ring so that the redundant pathway is used while the other interface is being updated with new software. Software updates can thus be applied “hot” even to device firmware or driver code such as in a line card.



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The Embedded System Design and Management Patent Portfolio is summarized below.

No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	7,069,546	Generic Framework for Embedded Software Development	10/005,030	12/03/01	12/03/01	06/27/06	1
2	7,478,382	Synchronized Ring Software Download	10/951,575	09/27/04	09/27/04	01/13/09	1

ROUTING AND BRIDGING: FIBER CHANNEL, VIRTUAL LANS AND TUNNELS

One significant advantage of converged networks is that the physical connection is less obvious to the end-user. Instead, physical distances between different offices, devices or facilities give way to virtualization of resources, software and services. Several important technologies are needed to deliver this next-generation network experience. Virtual private LAN services (“VPLS”) allow geographically distant sites to share a common Ethernet broadcast domain over ‘pseudo-wires’ or routing and bridging techniques that emulate a physical Ethernet connection over an arbitrary distance. For example, in retail businesses, it is not uncommon to see as many as 5,000 different locations connected in this manner to headquarters for inventory and transaction processing, or company wide telephony. Additionally, these Ethernet-based services are inexpensive and easy to deploy.

The performance needed in routing such vast amounts of traffic require fast label switch routers (“LSR’s”) that use special tags to move different types of traffic through a complex network, often made of rings of connected nodes for reliability such as those enabled by Orckit’s Packet Ring Network Technology.

A few highlights of Orckit’s innovation in this area include:

- o Label switched routers and transparent LAN services are vulnerable to denial of service (“DOS”) attacks that flood the network and destroy paths for valid traffic. By controlling



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the rate and setting a budget for learning new tags and routing instructions, it is possible for the LSR to continue to learn routes without being overwhelmed during these disruptive attacks.

- o Providing a transparent VPLS service between label switch routers allowing IEEE 802.1D-type bridging along the same data tunnels that would be used for user traffic, thus eliminating the need for a separate control channel. A special spanning tree protocol tag is provided and removal of unwanted loops in the core is automatically performed.
- o Use of multicasting to broadcast a data frame (e.g., layer 2 Ethernet) over a VPLS, targeting broadcasts at lower levels without generating unneeded layer-3 routing by individually routing each broadcast through a tunnel(s). Broadcasting at low layers over a VPN is thus explicitly enabled as well.
- o Unique hubs that provide multiple types of layer 2 protocol conversion between TDM, serial interfaces, Ethernet and Cisco™ HDLC where the intermediate transport protocol can be different from the ingress and egress protocol. These hubs provide tremendous design flexibility in transporting normally incompatible voice and data network protocols across an arbitrary intermediate network.
- o Fiber channel (“FC”) is used to connect storage area network (“SAN”) devices and enjoys significant deployment in data centers that perform critical operations. Orckit has developed a method and device capable of tunneling these storage-oriented communications (e.g., between a computer and a disk array) over a packet-switched network without requiring intermediate termination of FC words or trust relationships. The use of MPLS is explicitly enabled as a means to route this tunneled storage-oriented traffic, and unnecessary idle signals are suppressed saving bandwidth as well.
- o Active control of spanning trees, the vital organizational data that makes virtual LAN’s possible, including active control and pruning of them to control overlapping segments on transparent LANs. This technology is especially powerful in complex redundant ring topologies where overlaps can occur quickly if not remedied by these techniques.

The Routing and Bridging: Fiber Channel, Virtual LANS and Tunnels Patent Portfolio is summarized below.



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No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	7,127,523	Spanning Tree Protocol Traffic in a Transparent LAN	10/057,332	09/04/01	01/25/02	10/24/06	11
2	7,145,878	Avoiding Overlapping Segments in Transparent LAN Services on Ring-Based Networks	10/054,845	07/27/01	01/25/02	12/05/06	4
3	7,154,899	Protecting the Filtering Database in Virtual Bridges	10/061,721	02/01/02	02/01/02	12/26/06	2
4	7,283,465	Hierarchical Virtual Private LAN Service Protection Scheme	10/337,382	01/07/03	01/07/03	10/16/07	9
5	7,339,929	Virtual Private LAN Service Using a Multicast Protocol	10/226,525	08/23/02	08/23/02	03/04/08	13
6	7,386,010	Multiprotocol Media Conversion	10/461,807	06/13/03	06/13/03	06/10/08	12
7	7,463,580	Resource Sharing Among Network Tunnels	11/305,486	12/15/05	12/15/05	12/09/08	0
8	7,515,536	Transparent Transport of Fibre Channel Traffic Over Packet-Switched Networks	11/479,595	07/11/05	06/29/06	04/07/09	0
9	7,593,400	MAC Address Learning in a Distributed Bridge	11/419,444	05/19/06	05/19/06	09/22/09	1
10	7,660,303	Point-to-Multipoint Functionality in a Bridged Network	11/508,599	08/22/06	08/22/06	02/09/10	0
11	7,773,508	Protecting the Filtering Database in Virtual Bridges	11/595,635	02/01/02	11/09/06	08/10/10	0
12	N/A	Tunnel Provisioning With Link Aggregation	11/123,801	05/06/05	05/06/05	N/A	N/A
13	N/A	VPLS Remote Failure Indication	12/093,824	11/07/06	07/22/08	N/A	N/A
14	N/A	Hierarchical Virtual Private LAN Service Protection Scheme	11/745,303	05/07/07	05/07/07	N/A	N/A

INTELLIGENT PACKET FRAGMENTATION

Different types of network connections each have their own maximum unit of data they can transmit at one time. When a node on a network tries to transmit a packet of data that is larger than the path can physically carry at once, that packet is fragmented into pieces for later re-assembly on the other side of the conversation. Unfortunately, simply using one fragment size does not yield good QoS in converged networks. Therefore, an adaptive fragmentation technique is needed that is sensitive to both the priority and demands of a given service. Each service type



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may have different needs; in the case of voice over IP (“VoIP”), jitter is caused by fragmentation and network congestion can render telephony services and online games practically unusable.

Fortunately, this patented Technology provides for powerful intelligent packet fragmentation on the full range of product scales from core to home networks. Some highlights of this Technology include:

- o Fragmenting packets of different services and priorities so that higher priority fragments can be transmitted first and with size and speed sensitive to the service they carry. Many different levels of prioritization are available, and these prioritized fragments can travel over any number of different physical links regardless of how logical connections might be formed.
- o TCP/IP fragmentation is explicitly enabled by this intelligent fragmentation technology.
- o Fragment size is dynamic and adaptive, and the size limit can be set based on the classification and/or a configured priority for a given traffic flow. Thus, VoIP can be handled with a higher level of dispatch than a file download if desired. Dynamic packet fragmentation is useful especially in gaming and VoIP-oriented SOHO routers.
- o Jitter control in the adaptive fragmentation and transmission is enabled, again a great boon to combined service networks providing VoIP along side other uses.
- o Both software-based and hardware (e.g. embedded chipset level) implementations are provided. This is of particular interest in consumer-oriented (e.g. SOHO-type) routers.

The Intelligent Packet Fragmentation Patent Portfolio is summarized below.

No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	6,876,669	Packet Fragmentation with Nested Interruptions	09/756,553	01/08/01	01/08/01	04/05/05	9
2	6,891,855	Dynamic Packet Fragmentation	09/756,554	07/27/00	01/08/01	05/10/05	12



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DSLAM AND DSL PROVIDER-SIDE

Orckit's Patent Portfolio also relates to DSLAMs and other provider-side DSL technologies that can be based on ATM, IP or Frame Relay especially as built into the popular multi-shelf form factor. Further, these systems can be deployed in star, chain and ring topologies, featuring QoS improvements that enable the differentiation of service classes. In addition, the system is capable of Operation, Administration and Maintenance ("OAM"), enabling the carrier to remotely detect and localize failures on the backbone network service level, as well as verifying the Service Level Agreement using the system's comprehensive Performance Monitoring feature. The Patent Portfolio is capable of supporting a variety of DSL flavors, including G.lite, full-rate G.dmt, ADSL, SDSL and VDSL.

Orckit's Portfolio offers numerous benefits to the design, delivery and management of server-side DSL, including the following:

- o Improved multi-shelf access architecture
- o Efficient, high-speed transfer of data packets within an access multiplexer system
- o Improved robustness and reliability of multi-shelf access systems
- o Network access system that automatically configures itself upon start-up or replacement of components
- o Enables a connection to be made automatically, preferably an in-band connection, between the network access system and a management station upon start-up of the system or replacement of components
- o Reduces the need for service personnel on the site of the network access system to reprogram configuration settings of the system after a failure or component replacement
- o Improved management network for a high-speed network access multiplexing system, and particularly for a multi-shelf access system
- o An IP management network for a multi-shelf access system that uses a minimal number of IP addresses
- o Provides a network access multiplexing system that is easy to configure and maintain



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- o Improved multiplexed network access by remote subscribers
- o Protection of remote subscribers against equipment failure, including failures associated with a network interface at a main site
- o Provides improved network information management, particularly in the context of ATM interface management
- o Provides methods of network interface management that are suited for use in accessing multiplexing systems that serve large numbers of clients
- o Manages bandwidth by preventing numerous users from collectively exceeding a common data-link device bandwidth use threshold by using simple metrics and using a straightforward evaluation, decision and action function

Data Control - Network Traffic Control (ATM)

In electronic digital data transmission systems, the network protocol ATM encodes data traffic into small fixed-sized cells to transport real-time video and audio as well as image files, text and email. ATM remains widely deployed, and is used as a multiplexing service in DSL networks. Orckit's innovative approach to managing traffic includes improved network traffic control and an improved way of implementing the Generic Cell Rate Algorithm ("GCRA").

The DSLAM and DSL Provider-Side Patent Portfolio is summarized below.

No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	6,680,904	Bi-directional chaining of network access ports	09/472,683	12/27/99	12/27/99	01/20/04	23
2	6,687,224	Bandwidth sharing method	09/514,745	02/28/00	02/28/00	02/03/04	3
3	6,731,607	Network interface auto-configuration in an access multiplexing system	09/629,664	08/01/00	08/01/00	05/04/04	5
4	6,785,232	Rate control in transmission of packet data over an ATM network	09/723,206	11/27/00	11/27/00	08/31/04	9
5	6,822,943	Network access multiplexer with protocol address translation	09/708,841	11/08/00	11/08/00	11/23/04	8
6	6,822,944	Management interface for a network access multiplexing	09/708,845	11/08/00	11/08/00	11/23/04	6



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No.	Patent No.	Title	App. No.	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
		system					
7	6,834,038	Protection against master unit failure in remote network access multiplexing	09/637,757	08/11/00	08/11/00	12/21/04	25
8	6,894,983	Automatic implementation of network configuration changes	09/637,300	08/11/00	08/11/00	05/17/05	3

DSL CUSTOMER-PREMISE EQUIPMENT

Orckit's Patent Portfolio also relates to modems primarily used for Internet access, telecommuting and corporate applications such as remote local area network access that are used on customer premises. The Patent Portfolio provides numerous benefits for xDSL modems including increased accessibility and performance.

ADSL service can be provided to customer premises without the use of a splitter by installing a microfilter directly into any phone jack. However, the customer may not install filters on all phone jacks. As such, the Patent Portfolio improves the performance of splitterless ADSL systems and provides a filtering technique that avoids interference caused by a telephone changing between on-hook and off-hook states, among other performance improvements. A few highlights of this Patent Portfolio include:

- o A filtering technique for ADSL signals that avoids interference caused by a telephone instrument changing between on-hook and off-hook states.
- o A splitterless system for providing 10 MB/sec half/full duplex Ethernet quality data communications via a subscriber loop, wherein the quality of the data transmission is not significantly affected by the simultaneous use of voice/data devices, including POTs, ISDN, telephone and facsimile machines, on the same line. Specifically, the data transmission is not significantly affected either by voice data or by switching of an analog voice device.



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- o Ethernet quality data communications along subscriber loops and is independent of the distance of the subscriber from the telephone company, thereby to overcome problems of known art caused specifically by the necessity of high speed transmission of data over long distances.
- o A system that forms area networks based on existing loops in residential-type areas, whether the network nodes are individual dwellings, or high density Multi Dwelling Units (“MDUs”), such as apartment buildings or hotels.
- o A line driver for data transceivers that, among other things, reduces power consumption, eliminates the output series resistor, and has a well-defined, predetermined output impedance. This configuration of the line driver circuit enables the impedance of the balancing network to be synthesized conveniently, as a function of the turns ratio of the transformer, so as to couple the modem to the line with enhanced efficiency, relative to other methods. The balancing network impedance is most preferably set to be equal to the turns ratio times an impedance of the transmission line.
- o A system for compensating for transmission echo by using a balanced hybrid coupling circuit and a method of using the hybrid in a full duplex modem when receiving a signal from another communications device over a communications channel such as a common telephone line.

Additionally, Orckit patented technologies that are applicable to VDSL or VHDSL (Very High Bitrate DSL). VDSL is a DSL technology providing faster data transmission over a single flat untwisted or twisted pair of copper wires.

The DSL Customer-Premise Equipment Patent Portfolio is summarized below.

No.	Patent No.	Title	App. Number	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
1	6,218,872	Line driver with output impedance synthesis	09/470,777	12/23/99	12/23/99	04/17/01	10
2	6,483,903	Splitterless Ethernet DSL on subscriber loops	09/346,416	07/01/99	07/01/99	11/19/02	13



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No.	Patent No.	Title	App. Number	Priority Date	Filing Date	Issue Date	No. of Fwd. Ref.
3	6,813,343	Method and apparatus for filtering asymmetric digital subscriber line (ADSL) signals	09/310,518	05/12/99	05/12/99	11/02/04	11
4	6,956,944	Method and apparatus for compensating for an echo signal component in telecommunication systems	09/460,891	12/14/99	12/14/99	10/18/05	4

SECTION 3



CONVERGED NETWORKING PATENT PORTFOLIO

OVERVIEW OF THE MARKET OPPORTUNITY

OVERVIEW OF THE MARKET OPPORTUNITY

Orckit's Patent Portfolio enables the complete distribution and management of data as well as the devices that make converged networks possible. Therefore, the market opportunity for this Technology is considerable. The following section will highlight the following three (3) broad categories: ❶ Service Providers, ❷ Network Equipment, and ❸ Customer Premise Equipment ("CPE").

SERVICE PROVIDERS

Global fixed broadband service revenue totaled \$170 billion by the end of 2009, with year-on-year growth of 14 percent. DSL remains the largest broadband revenue generator with 62 percent of total global broadband service revenue.¹ In the United States, broadband competition in each region is generally limited to one DSL and one cable operator. The DSL segment is dominated by AT&T and Verizon, which account for around 80% of DSL subscribers, while cable broadband is less concentrated with Comcast and Time Warner accounting for around 62% of cable broadband.²

Tier 1 service providers AT&T and Verizon may continue to hold the top spots on Vertical System Group's Ethernet Leaderboard, but it's hard not to notice the gains competitive providers and cable made in the first half of this year in the U.S. Ethernet market.

"There was a kind of surge of competitive service providers and cable MSOs gaining Ethernet share in the first half of this year," said Rosemary Cochran, Principal of Vertical Systems Group in an interview with



¹ Article titled *Fixed broadband revenue to top \$184 billion* dated June 10, 2010 - <http://www.networkworld.com/news/2010/061010-fixed-broadband-revenue-to-top.html>

² Article titled *USA Broadband Market – Analysis Statistics and Forecast* dated April 2008 - <http://www.researchandmarkets.com/reports/303858/>



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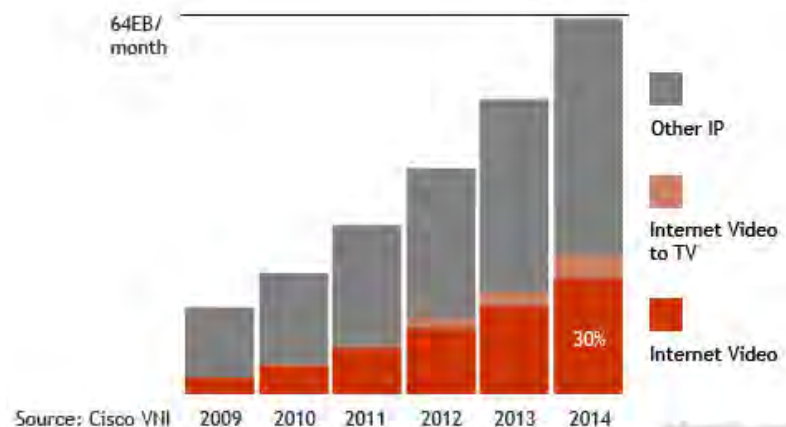
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FierceTelecom. “There's a broadening of the market rather than the incumbents not gaining share it's that there's a lot more players.”

Overall, VSG's Mid-2010 U.S. Business Ethernet Services Leaderboard, which ranks every player in port share order, remained relatively unchanged from its year-end report in 2009. In the new report the ranking of the U.S., every carrier on the Leaderboard holds four percent or more of the Ethernet market based on retail port installations.

No less aggressive were the cable MSOs. In particular, Comcast, Cox and Time Warner Cable all saw continued gains in the Ethernet market in the past half of this year.³

Global internet protocol traffic will increase by four times from 2009 to 2014. Cisco forecasts that the biggest single component of that will be internet video, overtaking peer-to-peer file sharing as the biggest single usage of bandwidth by the end of 2010. The combination of all forms of video will continue to exceed 90% of all global consumer internet traffic and by 2014 nearly half of it will be high-definition video.⁴



³ Article titled *CLECs, cable expand U.S. Ethernet market port share* dated August 17, 2010 - <http://www.fiercetelecom.com/story/clecs-cable-expand-u-s-ethernet-market-port-share/2010-08-17#ixzz0yyD45mSc>

⁴ Article titled *Internet Video Traffic to Increase Massively* dated June 2, 2010 - <http://informatv.com/news/2010/06/02/internetvideotraffic/>



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According to a recent report titled “Global Fixed and Mobile Broadband Outlook”, the U.S. generated more than \$32 billion in broadband revenues in 2008. The report suggests that the U.S. will generate the most broadband revenues in 2013 at more than \$40 billion. The U.S. currently has over 78.5 million fixed broadband connections, with that number forecasted to reach 101 million by 2013.⁵

NETWORK EQUIPMENT

Worldwide telecom spending is on pace to total close to \$2 trillion in 2010, a 5.1% increase from 2009. Between 2010 and 2014, the mobile device share of the telecom market is expected to increase from 11% to 14%, while the service share drops from 80% to 77% and the infrastructure share remains stable at 9% of the total market.⁶

“Service provider investment in carrier Ethernet is growing faster than overall telecom capital expenditures, so it is one of the areas that defied the economic downturn. Globally, service providers invested \$21.6 billion in carrier Ethernet products in 2009, and will increase spending over at least the next five years, for good reason. Carrier Ethernet technologies and products are a permanent, ingrained, inseparable, and growing part of service provider networks, manifested in access, aggregation, core, metro, and long haul. Carrier Ethernet products are used in nearly every part of service provider networks: for customer access, mobile backhaul, mobile core, broadband, broadband backhaul, and optical transport,” notes Michael Howard, Infonetics Research’s principal analyst for carrier and data center networks.

⁵ Article titled *US Tops Broadband Revenues Chart* dated January 2, 2009 - http://www.lightreading.com/document.asp?doc_id=169812

⁶ <http://mmadan.wordpress.com/2010/04/14/gartners-2010-it-spend-forecast/>



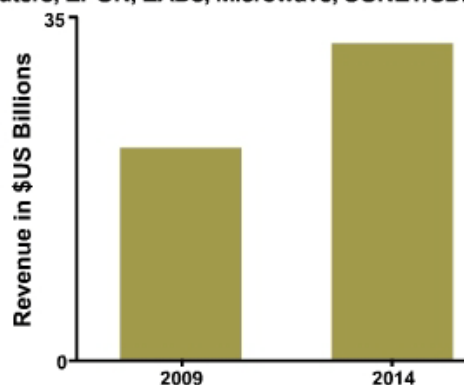
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CARRIER ETHERNET EQUIPMENT MARKET HIGHLIGHTS

- Infonetics Research forecasts carrier Ethernet equipment revenue to grow to over \$32 billion in 2014
- The market is driven primarily by the move to IP next-generation network transformation projects and growing traffic (particularly video traffic) from consumer, business, and mobile backhaul networks
- The largest segments of the carrier Ethernet equipment market are routers, carrier Ethernet switches (“CES”), and optical gear
- Ethernet microwave is the fastest growing segment of the market, based on its use for mobile backhaul
- Revenue from specialized Ethernet access devices (“EADs”), which are typically not routers or switches, but designed with demarcation and OAM functions to deliver E-LINE and E-LAN services, is expected to more than triple from 2009 to 2014
- Cisco continues to be the worldwide revenue market share leader in the carrier Ethernet switch, Ethernet IP core router, and Ethernet IP edge router markets⁷

Worldwide Carrier Ethernet Equipment Revenue
(CES/Routers, EPON, EADs, Microwave, SONET/SDH/WDM, VDSL)



© Infonetics Research, *Carrier Ethernet Equipment Biannual Market Size, Share, and Forecasts*, April 2010

⁷ Article titled *Carrier Ethernet market is booming* dated May 4, 2010 - <http://www.infonetics.com/pr/2010/2h09-carrier-ethernet-Market-Highlights.asp>



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- **The Ethernet virtual private line (“EVPL”) and virtual private LAN service (“VPLS”) markets witnessed a greater uptake of switched Ethernet services in 2009 and are expected to grow until 2014.**
 - “The market was largely limited to point-to-point or E-Line circuits and metro access being wholesaled,” says Frost & Sullivan’s Roopa Shree. “Carriers now have EVPL and VPLS included in their wholesale offering, along with EPL representing the largest market opportunity.”⁸
- **The Global Metro Ethernet market is projected to reach \$19.5 billion by the year 2015.**
 - Increasing bandwidth requirements, growth in MAN terminations in buildings, and growing need to minimize expenditures and improve service revenues are expected to drive demand for Metro Ethernet, globally. Metro Ethernet technology has become an integral element of today's telecommunications industry. Metro Ethernet, with its sophisticated carrier-class features, has significantly transformed the telecom industry and has enabled the industry to provide numerous services to vast areas at a lower cost. The technology extends flexibility to be positioned as a point-to-point connectivity or Internet access in a cost-efficient manner. Several carriers are increasingly deploying large-scale Metro Ethernet networks not only for the delivery of the triple play services, but also for delivery of Ethernet private lines, virtual private lines, and Ethernet virtual private LAN services.⁹

⁸ Article titled *Frost & Sullivan: U.S. wholesale Carrier Ethernet services a \$1.5 billion market in 2014* dated June 10, 2010 - <http://www.lightwaveonline.com/business/news/Frost--Sullivan-US-wholesale-Carrier-Ethernet-services-a-15-billion-market-in-2014-96081459.html>

⁹ Article titled *Global Metro Ethernet Market to Reach \$19.5 Billion by 2015, According to New Report by Global Industry Analysts, Inc.* dated March 23, 2010 - <http://newsguide.us/index.php?path=/technology/networking/Global-Metro-Ethernet-Market-to-Reach-19-5-Billion-by-2015-According-to-New-Report-by-Global-Industry-Analysts-Inc/>



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SONET / SDH

The U.S. Data Transport Services Market earned revenues of over \$33.0 billion in 2009 and estimates \$40.0 billion in 2014, according to Frost & Sullivan.¹⁰

- **The multi-billion dollar U.S. data transport services market represents huge revenue potential for communication service providers, growing at a compound annual growth rate of 4.6 percent. The launch of EVPL service by most leading carriers is expected to enhance market potential for wholesale E-Line services. Multiprotocol label switching (“MPLS”) and Ethernet services are expected to ramp up market revenues. The year-on-year growth rates for these services are pegged at 10-12% for MPLS and 20-30% for Ethernet.**
- Private line (DS1/DS3) and synchronous optical networking “(SONET)” services are likely to command a major share of data transport revenues in the near future. Private line services, particularly DS1 and SONET services, have maintained a modest, but steady inflow of revenues, largely owing to stable demand from wireless service providers on the wholesale front, and the reluctance of end users to move to Ethernet unless their bandwidth needs exceed 6 Mbps on the enterprise/business front.
- “Large carriers are seeing a surge in demand for high bandwidth transport services – especially MPLS VPN for multipoint-to multipoint connectivity for large distributed enterprises,” says Roopa Shree “Also, large carriers are showing increased interest in integrating Telepresence type of solutions with MPLS, which obviously makes sense for large enterprises.”
- **Particularly in the past couple of years, the impact of mobile backhaul on the Sonet/SDH equipment market has been huge. Conservatively, we estimate more than 60 percent of multiservice Sonet/SDH equipment revenue in 2009 was derived**

¹⁰ Article titled *Demand for Private Line and SONET Services Sustain Growth for the U.S. Data Transport Services Market, Finds Frost & Sullivan* dated June 2, 2010 - <http://www.frost.com/prod/servlet/press-release.pag?docid=203116943>



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from mobile backhaul. That percentage amounts to \$3.4 billion spent on multiservice Sonet/SDH for mobile backhaul in 2009.¹¹

- Sonet/SDH equipment has played a key role in mobile backhaul for many years, supporting 2G voice and early 3G services. The role of Sonet/SDH in wireless networks is analogous to its role in wireline networks, in which Sonet/SDH equipment aggregates traffic from multiple TDM-based equipment (T1/E1 lines) and feeds it over optical fibers into the metro core. In the case of mobile backhaul, those T1/E1 lines are attached to cell towers.
- Packet-optical transport systems (“P-OTS”) in mobile backhaul applications is a relatively new class of equipment combines traditional Sonet/SDH functionality with high-capacity Ethernet switching and WDM transport to provide scalability for network traffic growth while bridging the gap between TDM networks and Ethernet/IP networks. *Heavy Reading* divides the optical opportunity for packet backhaul into three network segments: access, edge/aggregation, and metro core. The access network will be dominated by lower-capacity access P-OTS equipment that sits at the cell tower and feeds traffic into aggregation sites. We see midrange-capacity P-OTS sitting at edge/aggregation sites, collecting traffic from cell sites. The excerpt below shows *Heavy Reading's* global forecast for P-OTS for mobile backhaul applications, broken out by network segment:

Global P-OTS Revenue for Mobile Backhaul by Segment

	2009	2010	2011	2012	2013	2014	CAGR 2009-2014
Access	\$152.8M	\$270.7M	\$469.4M	\$581.1M	\$547.2M	\$509.4M	27.2%
Share%	58.2%	58.2%	56.2%	51.2%	44.0%	35.0%	
Aggregation	\$107.3M	\$181.2M	\$329.4M	\$474.0M	\$565.8M	\$754.3M	47.7%
Share%	40.9%	39.0%	39.4%	41.8%	45.5%	51.8%	
Metro Core	\$2.5M	\$13.0M	\$36.7M	\$79.8M	\$130.1M	\$192.0M	138.0%
Share%	1.0%	2.8%	4.4%	7.0%	10.5%	13.2%	
Total	\$262.7M	\$464.9M	\$835.4M	\$1,134.9M	\$1,243.2M	\$1,455.8M	40.8%
Growth%		77.0%	79.7%	35.8%	9.5%	17.1%	

Source: Heavy Reading

¹¹ Market research report titled *The Future of Packet-Optical Transport for Mobile Backhaul* - http://www.heavyreading.com/details.asp?sku_id=2540&skuitem_itemid=1257



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According to a new report from research firm In-Stat, mobile carriers are going to spend nearly \$117 billion by 2014 (up 41 percent from 2009 spend of \$83 billion) on “last mile backhaul (including line leasing, new equipment-spending, and spectrum acquisitions.”¹²

Router Market

“Right now [October 2009], you have a \$10 billion market for routers, and half of it is an installed base with the majority of them needing a refresh,” said Wenceslao Lada, Vice President of Worldwide Channels for Cisco’s Borderless Networks Architecture.¹³

- The major application that Cisco is looking to support with the new routers is video. The new routers series includes hardware and quality-of-service enhancements aimed at improving the video experience, said Cisco’s Shashi Kiran. There is no question that video is becoming more and more ubiquitous in business settings, following the lead of the consumer space. By 2012, analysts predict that 90 percent of consumer Internet traffic will be video, for example.¹⁴

The top two vendors in the service provider router space, Cisco and Juniper, together went from owning 69% of the worldwide router market in 2008 to 59% in 2009, while Alcatel-Lucent, Huawei, and others gained share. Interestingly, smaller player Tellabs pushed past Ericsson in 2009, putting them in the top five for the first time. Tellabs had an especially strong year based on their focus on the mobile sector. All six of the top router vendors posted strong double-digit revenue increases in the fourth quarter, and we expect modest growth in the router segment to continue in 2010 as carriers carry out fixed-mobile convergence strategies for their router networks.

- While the combined market was buoyed in the fourth quarter, it was not enough to offset losses for the year, bringing the overall market down 12% from 2008 to 2009, to \$11.1 billion.

¹² <http://gigaom.com/2010/09/16/lte-to-boost-demand-for-mobile-bandwidth-network-gear/>

¹³ Article titled *Cisco Overhauls Router Family, Touts \$10 Billion Market* dated October 20, 2009 - <http://www.channelinsider.com/c/a/Cisco/Cisco-Overhauls-Router-Family-Touts-10-Billion-Market-229605/>

¹⁴ *Ibid*



CONVERGED NETWORKING PATENT PORTFOLIO

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- Worldwide revenue from service provider IP edge routers, IP core routers, carrier Ethernet switches, and multiservice ATM switches jumped 17% in 4Q09, led by strong IP edge router sales.¹⁵

IP core and edge router revenue in North America was the hero of the second quarter, up 15% sequentially and up 39% from this time last year, as operators put spending back on priority to handle more traffic, especially video over broadband and data and photos over mobile networks.

- Between the first to second quarters of 2010, combined worldwide revenue from service provider IP edge routers, IP core routers, carrier Ethernet switches, and multiservice ATM switches increased 5%, to \$3.1 billion.
- Revenues of the top 7 carrier router vendors—Alcatel-Lucent, Cisco, Fujitsu, Huawei, Juniper, Tellabs, and ZTE—are up in the double-digit percentages year-over-year, from 2Q09 to 2Q10.**¹⁶

CUSTOMER PREMISE EQUIPMENT

Communications industry market research firm Infonetics Research released its fourth quarter (4Q09) Broadband CPE and Subscribers market forecast report, which tracks DSL and cable broadband customer-premise equipment and subscribers, voice CPE, residential gateways, and voice terminal adapters.

- “Now that many major cable operators worldwide are aggressively putting into place the infrastructure to support wideband and DOCSIS 3.0 services, we are now seeing more consistent quarterly shipments of wideband customer-premise equipment. It started with modems earlier in 2009 and now includes both gateways and embedded

¹⁵ Article titled *Together, Cisco and Juniper lost 10% of the worldwide router market in 2009* dated February 19, 2010 - <http://www.networkworld.com/community/node/57754?t51hb>

¹⁶ Article titled *North America drives growth in carrier router and switch market in 2Q10* dated August 27, 2010 - <http://www.ethernetacademy.net/index.php/carrier-ethernet-industry-news/industry-voices/North-America-drives-growth-in-carrier-router-and-switch-market-in-2Q10.html>

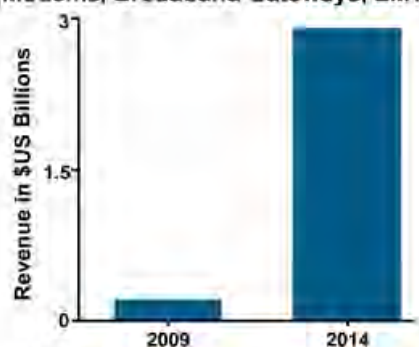


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multimedia terminal adapters (EMTAs). Though the numbers remain small relative to standard cable CPE, we expect wideband cable devices to ramp up quickly in North America, EMEA, and Asia Pacific, nearing \$3 billion worldwide by 2014,” predicts Jeff Heynen, directing analyst for broadband and video at Infonetics Research.

**Wideband Cable CPE Worldwide Revenue Forecast
(Modems, Broadband Gateways, EMTAs)**



© Infonetics Research, *Broadband CPE and Subscribers Quarterly Market Share, Size, and Forecasts*, Mar. 2010

Additional broadband CPE market highlights:

- Worldwide revenue from broadband CPE grew 10% in 4Q09 from 3Q09 to \$1.1 billion¹⁷
- Quarterly growth was driven by 3 main factors:
 - Operators flushed their year-end CPE and broadband budgets
 - Consumers upgraded to new devices over the holidays
 - Chinese operators continued spending on ADSL CPE to support higher speeds as part of their fiber-to-the-building (FTTB) rollouts¹⁸
- For the full 2009 year, the worldwide broadband CPE market totaled \$4.2 billion, down 8% from 2008¹⁹

¹⁷ Article titled *DSL, cable broadband CPE market up 10%; strong growth expected for wideband devices* dated March 16, 2010 - <http://www.infonetics.com/pr/2010/4Q09-Broadband-CPE-Market-Highlights.asp>

¹⁸ *Ibid*

¹⁹ *Ibid*



CONVERGED NETWORKING PATENT PORTFOLIO

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- Technicolor (Thomson) regained the lead from Huawei for overall broadband CPE revenue in 4Q09, and held onto the #1 spot for the year as well, followed by Motorola and Huawei, who are in a very tight race for second.²⁰
- Research firm IDC says that only a third of U.S. homes have a home network. That leaves room for growth. Kaplan says home networking potentially could be a much larger business than video.²¹
- **Sales of routers are flat. Last year, 11.4 million units worth \$735 million were sold. IDC predicts sales of 11.5 million units this year.**²²
- Growth in the market for core home networking products has been slowing in recent years; however, the network connected media device market segment continues to show strong growth. The result, according to a new study from ABI Research, is that total revenues for network connected devices will rise from about \$74 billion this year to over \$94 billion in 2010.
 - o “Network connected media devices such as game consoles, TVs, and set-top boxes offer an opportunity for ‘core networking’ companies to reorient themselves away from a declining market,” says senior analyst Jason Blackwell. “Home network device vendors such as Linksys by Cisco and Netgear, as well as networking silicon vendors such as Broadcom are targeting these growing product categories aimed at home entertainment networking and connecting consumer electronics devices to the network.”²³

²⁰ *Ibid*

²¹ Article titled *Cisco aims to make Wi-Fi easy with its first router for homes* dated April 1, 2010 - http://www.usatoday.com/tech/news/2010-03-31-cisco31_ST_N.htm

²² *Ibid*

²³ Article titled *Media Networking Shines Brightly in \$74 Billion Home Networking Market* dated April 6, 2009 - [http://www.abiresearch.com/press/1405-Media+Networking+Shines+Brightly+in+\\$74+Billion+Home+Networking+Market](http://www.abiresearch.com/press/1405-Media+Networking+Shines+Brightly+in+$74+Billion+Home+Networking+Market)

SECTION 4



US006218872B1

(12) **United States Patent**
Koren

(10) **Patent No.:** **US 6,218,872 B1**
(45) **Date of Patent:** **Apr. 17, 2001**

(54) **LINE DRIVER WITH OUTPUT IMPEDANCE SYNTHESIS**

5,579,336 * 11/1996 Fitzgerald et al. 375/219
5,838,722 * 11/1998 Consi 375/219

(75) Inventor: **Victor Koren**, Rishon le Zion (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.: **09/470,777**

(22) Filed: **Dec. 23, 1999**

(51) Int. Cl.⁷ **H03K 1/00**

(52) U.S. Cl. **327/108; 327/110**

(58) Field of Search 375/219, 220;
327/108, 109, 110, 304, 560-563, 105

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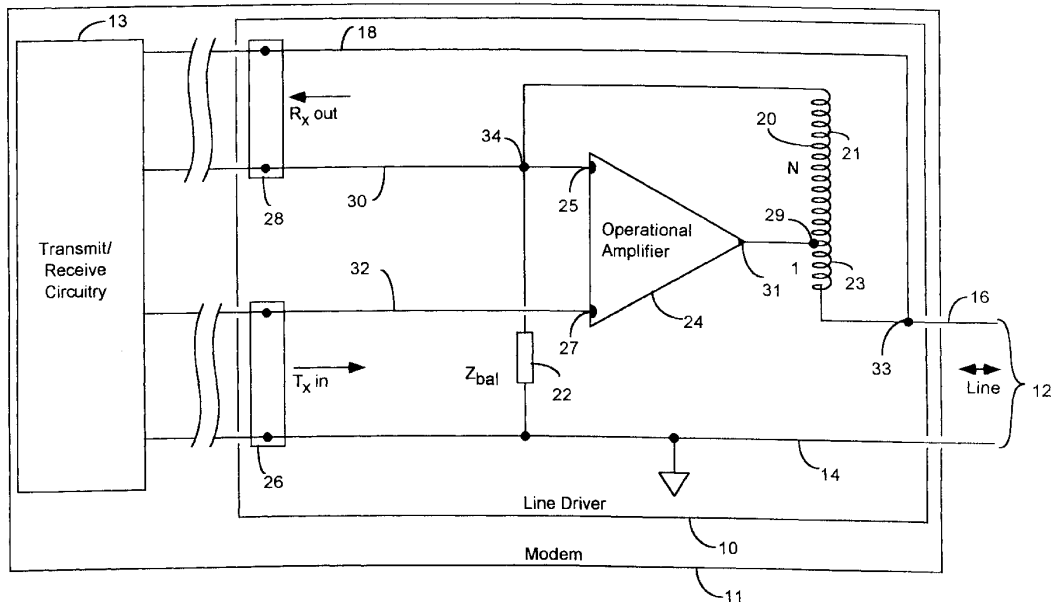
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Primary Examiner—Toan Tran

(57) **ABSTRACT**

A line driver for coupling a data transceiver to a line having a load impedance, having a transformer with a primary coil and a secondary coil with a turns ratio of N:1 therebetween. The line driver includes a shunt impedance set to a value equal to a predetermined function of N and of the load impedance, coupled between one end of the primary coil and ground. The line driver also includes a differential amplifier, having a first input coupled to be driven by a transmit circuit of the transceiver, and having an output coupled to drive the line through the secondary of the transformer, and having a second input shunted to ground through the shunt impedance and coupled to receive feedback from the output through the primary coil of the transformer.

11 Claims, 6 Drawing Sheets





US006483903B1

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

(10) **Patent No.:** **US 6,483,903 B1**
(45) **Date of Patent:** **Nov. 19, 2002**

(54) **SPLITTERLESS ETHERNET DSL ON
SUBSCRIBER LOOPS**

(75) Inventors: **Jacob Itay**, Rishon Lezion (IL); **Shaul
Ozeri**, Tel Aviv (IL)

(73) Assignee: **Orkit 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.: **09/346,416**

(22) Filed: **Jul. 1, 1999**

(51) **Int. Cl.**⁷ **H04M 11/00**

(52) **U.S. Cl.** **379/93.01**; 379/93.05;
379/399.01

(58) **Field of Search** 379/93.01, 93.05,
379/106.09, 93.09, 394, 398, 399.01, 413.01,
413.02, 413.04, 100.15–100.16, 219; 375/222,
219; 709/311

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Primary Examiner—Curtis Kuntz

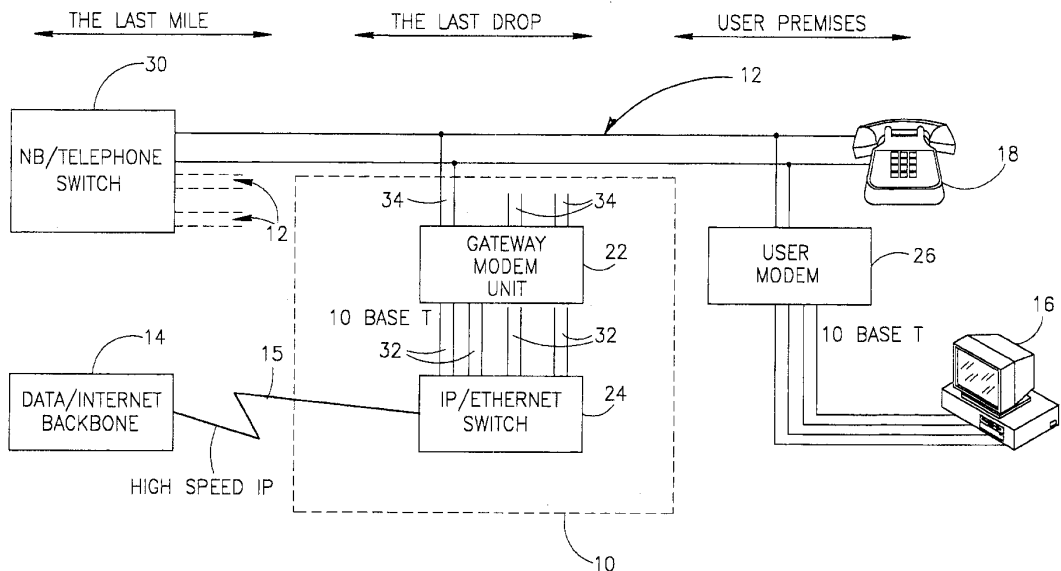
Assistant Examiner—George Eng

(74) *Attorney, Agent, or Firm*—Roberts, Abokhair &
Mardula, LLC

(57) **ABSTRACT**

A splitterless system provides along a subscriber loop, full Ethernet wire speed data transmission between a data source and an Ethernet standard end device. The system includes a gateway modem device connected to a data source, and arranged in splitterless contact with a subscriber loop extending between a Punch Down Block (PDB), and an Ethernet standard end device; and a user modem device connected between the Ethernet standard end device and the subscriber loop so as to define with the gateway modem device a subscriber loop segment, wherein the gateway modem device and the user modem device are operative to communicate along the loop segment in different predetermined, first and second frequency spectra, for uplinking and downlinking, respectively, thus to facilitate therealong full Ethernet wire speed data transmission the-along.

16 Claims, 8 Drawing Sheets





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**
- (75) Inventors: **Menachem Kaplan**, Petach Tikva (IL); **David Zelig**, Givataim (IL); **Roy Kinamon**, Tel Aviv (IL); **Eli Aloni**, 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**

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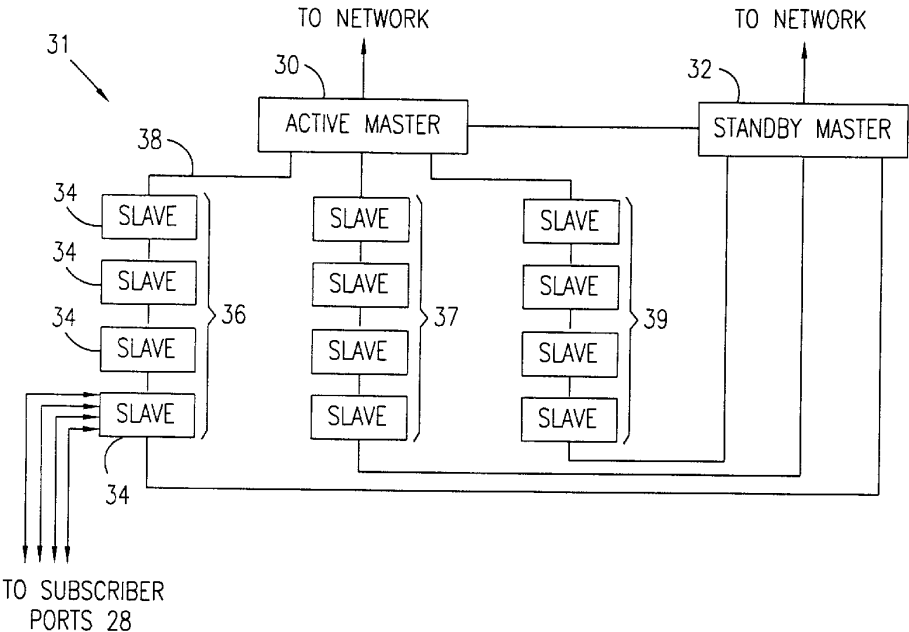
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Primary Examiner—Duc Ho
(74) Attorney, Agent, or Firm—Abelman, Frayne & Schwab

(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





US006687224B1

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

(10) **Patent No.:** **US 6,687,224 B1**
(45) **Date of Patent:** **Feb. 3, 2004**

(54) **BANDWIDTH SHARING METHOD**

(75) Inventors: **Dan Ater**, Kfar Warburg (IL); **Meir Deutsch**, Tel Aviv (IL); **Shmuel Iliaich**, Bat-Yam (IL)
(73) Assignee: **Orkit 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.: **09/514,745**
(22) Filed: **Feb. 28, 2000**
(51) Int. Cl.⁷ **H04L 12/26**
(52) U.S. Cl. **370/230; 370/420; 709/229**
(58) Field of Search 370/229, 230, 370/232, 233, 234, 235, 236, 236.1, 236.2, 235.1, 395.2, 395.21, 395.4, 395.41, 401, 420; 709/229, 233, 235

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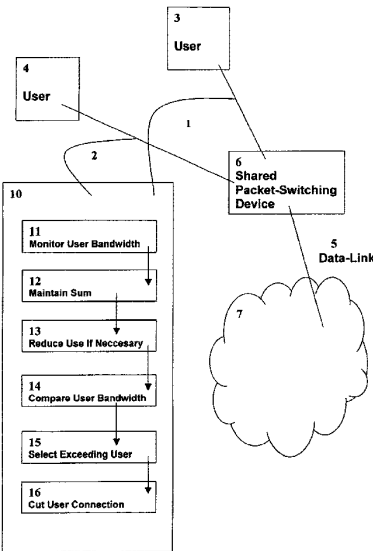
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Primary Examiner—Hassan Kizou
Assistant Examiner—Dmitry Levitan
(74) Attorney, Agent, or Firm—Roberts Abokhair & Mardula, LLC

(57) **ABSTRACT**

A bandwidth sharing method for use on respective interstitial connections between on one side a plurality of users and on the other side a common data-link having a shared packet switching device, the method including performing the steps of:
monitoring data-link directed bandwidth from each user; maintaining a current sum of the monitored bandwidth; and whenever the current sum exceeds a predetermined data-link bandwidth threshold, reducing current collective data-link directed bandwidth by for substantially each user, comparing the respective user's data-link directed bandwidth with a predetermined data-link bandwidth threshold for the respective user; using an allocation function, selecting at least one user who is exceeding his predetermined data-link bandwidth threshold, and for a predetermined time interval, cutting the connection between each selected at least one user and the shared switching device, so as to restore a current sum of the monitored bandwidth to be not greater than the predetermined data-link bandwidth threshold.

14 Claims, 12 Drawing Sheets





US006731607B1

(12) **United States Patent**
Mantin

(10) **Patent No.:** **US 6,731,607 B1**
(45) **Date of Patent:** **May 4, 2004**

(54) **NETWORK INTERFACE AUTO-
CONFIGURATION IN AN ACCESS
MULTIPLEXING SYSTEM**

(75) **Inventor:** **Sharon Mantin**, 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 809 days.

(21) **Appl. No.:** **09/629,664**

(22) **Filed:** **Aug. 1, 2000**

(51) **Int. Cl.**⁷ **H04L 12/28**

(52) **U.S. Cl.** **370/254; 710/104**

(58) **Field of Search** 370/216–254,
370/389, 400.2, 430, 419, 431, 462, 463,
532, 535; 375/222; 709/223–5, 100; 710/100–104;
711/100, 147–155, 162, 163; 714/2, 13

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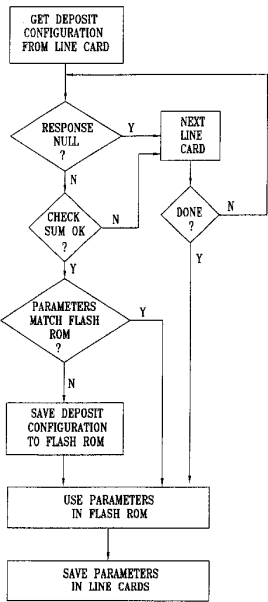
Primary Examiner—David Vincent

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

Multiplexing apparatus for providing access to a high-speed
network over a plurality of subscriber lines. One or more
line cards include ports to the subscriber lines, at least one
of the line cards including a volatile memory for storing
backup configuration parameters of the apparatus. A switch-
ing unit includes a non-volatile memory, adapted to store
operating configuration parameters. A controller in the
switching unit is operative to receive the backup configura-
tion parameters stored in the volatile memory and to
update the operating configuration parameters in the non-
volatile memory responsive to the backup configuration
parameters. The switching unit also includes a communica-
tion interface, over which it is coupled to communicate
with the network in accordance with the operating configura-
tion parameters so as to link the ports of the line cards to the
network.

20 Claims, 5 Drawing Sheets





US006785232B1

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

(10) **Patent No.:** **US 6,785,232 B1**
(45) **Date of Patent:** **Aug. 31, 2004**

(54) **RATE CONTROL IN TRANSMISSION OF
PACKET DATA OVER AN ATM NETWORK**

(75) Inventors: **Yoav Kotser**, Givataim (IL); **Omer
Goldfisher**, Givataim (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 815 days.

(21) Appl. No.: **09/723,206**

(22) Filed: **Nov. 27, 2000**

(51) Int. Cl.⁷ **H04L 12/00**

(52) U.S. Cl. **370/230.1; 370/235.1;
370/395.1; 709/228**

(58) Field of Search 370/229, 230,
370/203.1, 231, 232, 233, 234, 235, 235.1,
236, 395.1, 395.2, 395.21; 709/227, 228,
230, 231, 233, 235

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Primary Examiner—Hassan Kizou

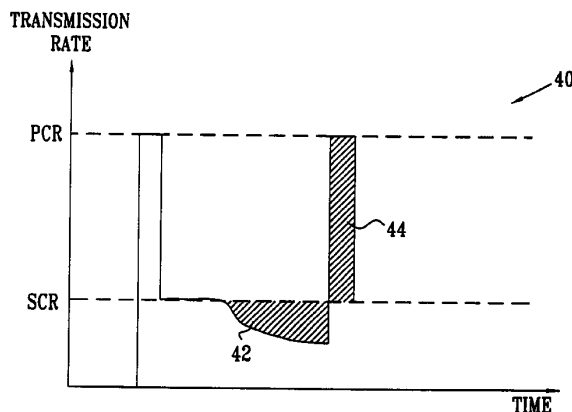
Assistant Examiner—D L Levitan

(74) Attorney, Agent, or Firm—Darby & Darby

(57) **ABSTRACT**

A method for controlling data transmission over a network includes receiving a succession of data packets from a packet input at a potentially variable input rate, each packet in the succession potentially having a respective, non-uniform packet size. For each of the packets in the succession, the respective packet size is compared to a transmission credit allocated to the input. If the allocated credit is sufficient, compared to the respective packet size, the packet is transmitted over the network at a peak transmission rate predetermined by the network. If the allocated credit is insufficient, compared to the respective size, at least a portion of the packet is transmitted over the network at a rate no greater than a sustainable transmission rate predetermined by the network, which sustainable transmission rate is less than the peak transmission rate.

26 Claims, 4 Drawing Sheets





US006813343B1

(12) **United States Patent**
Vitenberg

(10) **Patent No.:** **US 6,813,343 B1**
(45) **Date of Patent:** **Nov. 2, 2004**

(54) **METHOD AND APPARATUS FOR
FILTERING ASYMMETRIC DIGITAL
SUBSCRIBER LINE (ADSL) SIGNALS**

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6,181,777 B1 1/2001 Kiko 379/32.04

(75) Inventor: **Roman Vitenberg**, Holon (IL)

* cited by examiner

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

Primary Examiner—Minsun Oh Harvey

Assistant Examiner—Daniel Swerdlow

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

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

A method and apparatus for selectively filtering signals on a digital subscriber line (DSL) so as to prevent interference resulting from a telephone instrument switching between its on-hook and off-hook states. One embodiment of the invention utilizes an off-hook detector controlling a variable attenuator element. Another embodiment of the invention uses a switch in parallel with a resistive element to implement the variable attenuator element. Yet another embodiment has an inductive element with a saturable core for providing attenuation to compensate for inconsistencies that result from the changing hookswitch status of a telephone instrument.

(21) Appl. No.: **09/310,518**

(22) Filed: **May 12, 1999**

(51) **Int. Cl.**⁷ **H04M 11/06**

(52) **U.S. Cl.** **379/93.05; 379/377; 379/387.01**

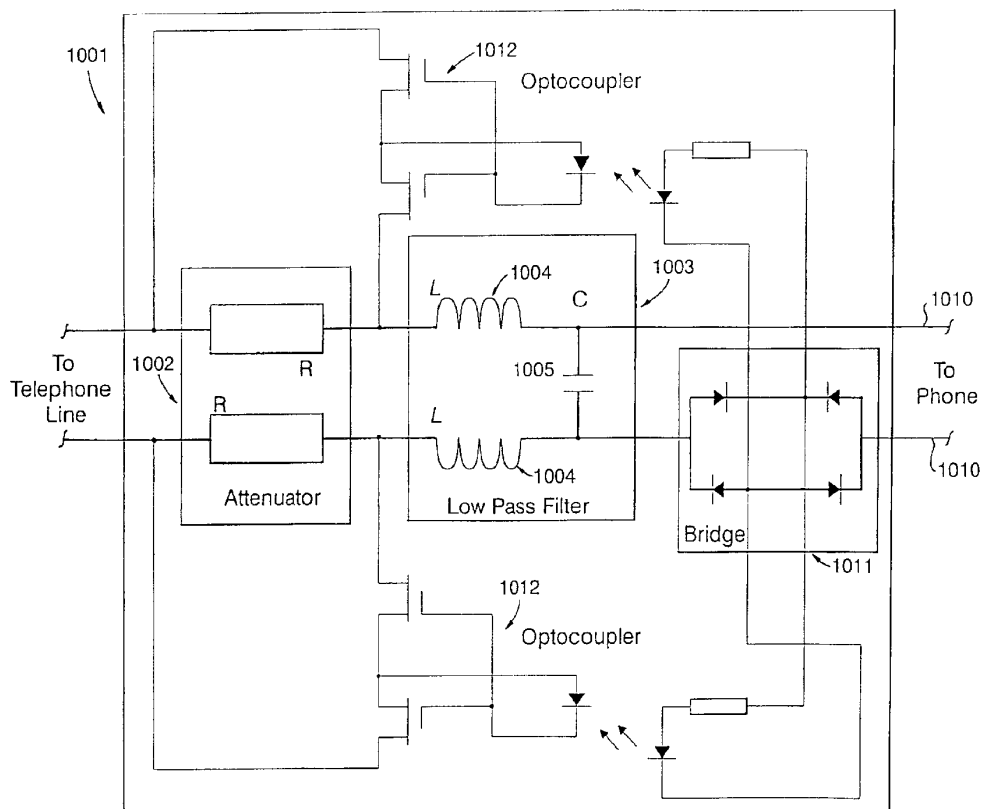
(58) **Field of Search** **379/93.05, 93.06, 379/93.07, 177**

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6 Claims, 10 Drawing Sheets





US006822943B1

(12) **United States Patent**
Mantin

(10) **Patent No.:** **US 6,822,943 B1**
(45) **Date of Patent:** ***Nov. 23, 2004**

(54) **NETWORK ACCESS MULTIPLEXER WITH
PROTOCOL ADDRESS TRANSLATION**

(75) Inventor: **Sharon Mantin**, 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 780 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **09/708,841**

(22) Filed: **Nov. 8, 2000**

(51) **Int. Cl.**⁷ **H04L 12/28**

(52) **U.S. Cl.** **370/254; 370/395.52; 709/221**

(58) **Field of Search** 370/395.1, 395.5,
370/395.52, 465, 475, 352-356, 401, 254,
351, 463; 709/220, 221, 222; 375/222

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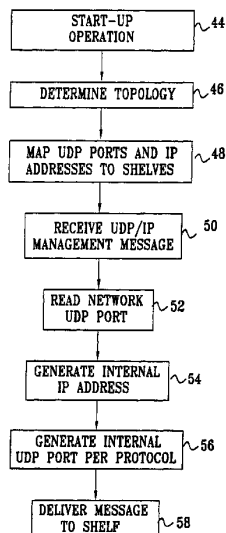
Primary Examiner—Ajit Patel

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

Communication access apparatus includes a master shelf, including a master switching unit linked to communicate with a high-speed network, and a plurality of slave shelves arranged in a given system topology with respect to the master shelf. Each of the slave shelves includes ports configured to serve network subscribers, and further includes a slave switching unit, coupled to communicate with the master switching unit and to multiplex among the ports so as to provide the subscribers with access to the high-speed network, and to receive from the master shelf management messages that are addressed to an internal network-layer address that is determined uniquely for each of the slave shelves based on the topology. A management station is coupled to convey the management messages to the master shelf over a management network in which at least some of the slave shelves share a common external network-layer address by mapping the internal network-layer address of each of the shelves to a respective transport-layer address.

31 Claims, 2 Drawing Sheets





US006822944B1

(12) **United States Patent**
Mantin

(10) **Patent No.:** **US 6,822,944 B1**
(45) **Date of Patent:** **Nov. 23, 2004**

(54) **MANAGEMENT INTERFACE FOR A NETWORK ACCESS MULTIPLEXING SYSTEM**

(75) Inventor: **Sharon Mantin**, Tel Aviv (IL)

(73) Assignee: **Orkit 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 777 days.

(21) Appl. No.: **09/708,845**

(22) Filed: **Nov. 8, 2000**

(51) Int. Cl.⁷ **H04L 12/28**

(52) U.S. Cl. **370/254; 370/395.52; 709/221**

(58) Field of Search 370/395.1, 395.5, 370/395.52, 465, 475, 352, 356, 401, 254, 351, 463; 709/220, 221, 222

(56) **References Cited**

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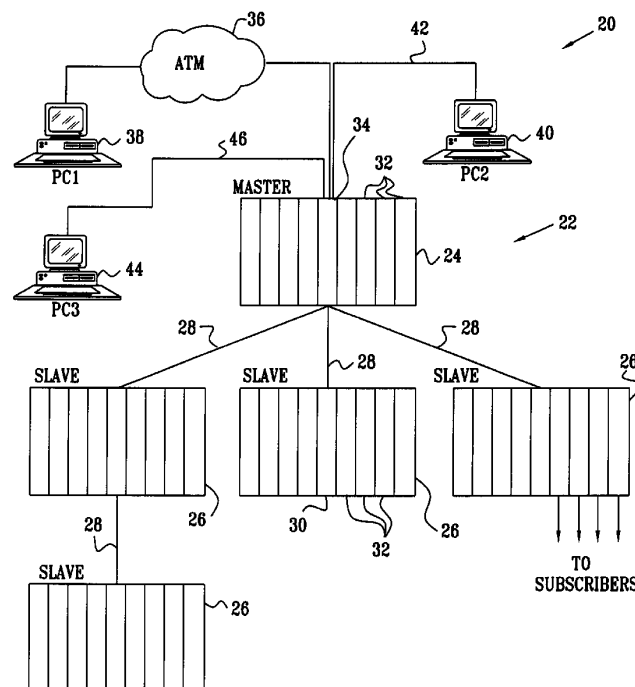
Primary Examiner—Ajit Patel

(74) Attorney, Agent, or Firm—Darby & Darby

(57) **ABSTRACT**

Communication access apparatus includes a master shelf, including a master switching unit linked to communicate with a high-speed network, and a plurality of slave shelves. Each slave shelf includes ports that serve network subscribers, and further includes a slave switching unit, coupled to communicate with the master switching unit and to multiplex among the ports so as to provide the subscribers with access to the high-speed network. A management station is coupled to communicate with the master shelf and the plurality of slave shelves over a management network in which all of the slave shelves are on a single subnet.

36 Claims, 3 Drawing Sheets





US006834038B1

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

(10) **Patent No.:** **US 6,834,038 B1**
(45) **Date of Patent:** **Dec. 21, 2004**

(54) **PROTECTION AGAINST MASTER UNIT FAILURE IN REMOTE NETWORK ACCESS MULTIPLEXING**

(75) Inventors: **David Zelig**, Givatayim (IL); **Eli Aloni**, Zur Yigal (IL); **Ron Sdayor**, Kiryat Ono (IL); **Menahem Kaplan**, Petah-Tikva (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 882 days.

(21) Appl. No.: **09/637,757**

(22) Filed: **Aug. 11, 2000**

(51) **Int. Cl.**⁷ **G06F 11/00**

(52) **U.S. Cl.** **370/217; 370/221; 714/2**

(58) **Field of Search** 370/216–228,
370/535–542, 395.1, 463, 465, 351–356,
432, 389–392; 714/1–2

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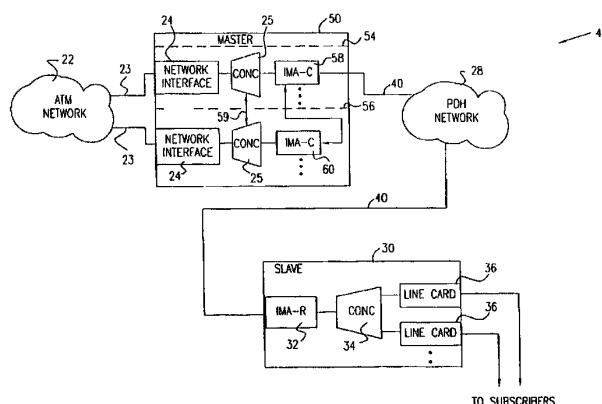
Primary Examiner—Steven Nguyen

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

Network access apparatus includes a slave unit, including a plurality of subscriber ports adapted to be linked to respective subscriber lines, and a multiplexer for multiplexing among the ports. A master sub-system, is connected to at least one trunk line of a first public network, in a location remote from the slave unit. The master sub-system includes a first master unit, adapted to communicate with the slave unit via an assigned link through a second public network, so as to provide users of the subscriber lines with access to the first public network through the at least one trunk line. The master sub-system also includes a second master unit, coupled through the first master unit to communicate with the slave unit via the assigned link, so as to provide the users with access to the first public network through the at least one trunk line in the event of a failure associated with the first master unit.

25 Claims, 3 Drawing Sheets





US00687669B2

(12) **United States Patent**
Shalom

(10) **Patent No.:** **US 6,876,669 B2**
(45) **Date of Patent:** **Apr. 5, 2005**

(54) **PACKET FRAGMENTATION WITH NESTED INTERRUPTIONS**

(75) Inventor: **Rafi Shalom, Ramat Gan (IL)**

(73) Assignee: **Corrigent Systems 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 794 days.

(21) Appl. No.: **09/756,553**

(22) Filed: **Jan. 8, 2001**

(65) **Prior Publication Data**

US 2002/0131425 A1 Sep. 19, 2002

(51) Int. Cl.⁷ **H04J 3/16**

(52) U.S. Cl. **370/468; 370/473; 370/474**

(58) Field of Search **370/352, 433, 370/434, 435, 465, 466, 468, 394, 473, 474**

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Primary Examiner—Chau Nguyen

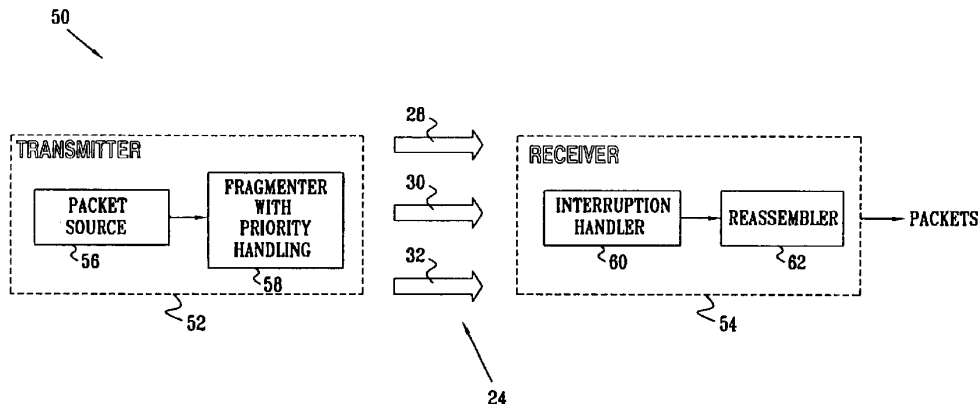
Assistant Examiner—Christine Ng

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

A method for transmitting data over a channel includes receiving a first datagram for transmission at a first priority, and receiving a second datagram for transmission at a second priority, higher than the first priority, before the transmission of the first datagram is completed. The first datagram is divided into a plurality of fragments, including a first fragment and a last fragment. The fragments of the first datagram are transmitted over the channel, beginning with the first fragment. At least a fragment of the second datagram is transmitted over the channel before transmitting the last fragment of the first datagram.

27 Claims, 3 Drawing Sheets





US006891855B2

(12) **United States Patent**
Bruckman

(10) **Patent No.:** **US 6,891,855 B2**
(45) **Date of Patent:** **May 10, 2005**

(54) **DYNAMIC PACKET FRAGMENTATION**

(75) Inventor: **Leon Bruckman, Petah Tikva (IL)**

(73) Assignee: **Corrigent Systems, 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 833 days.

(21) Appl. No.: **09/756,554**

(22) Filed: **Jan. 8, 2001**

(65) **Prior Publication Data**

US 2002/0051466 A1 May 2, 2002

Related U.S. Application Data

(60) Provisional application No. 60/221,039, filed on Jul. 27, 2000.

(51) **Int. Cl.⁷** **H04J 3/24**

(52) **U.S. Cl.** **370/468; 370/474**

(58) **Field of Search** 370/465, 466, 370/468, 473, 474, 476

(56) **References Cited**

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Primary Examiner—Chau Nguyen

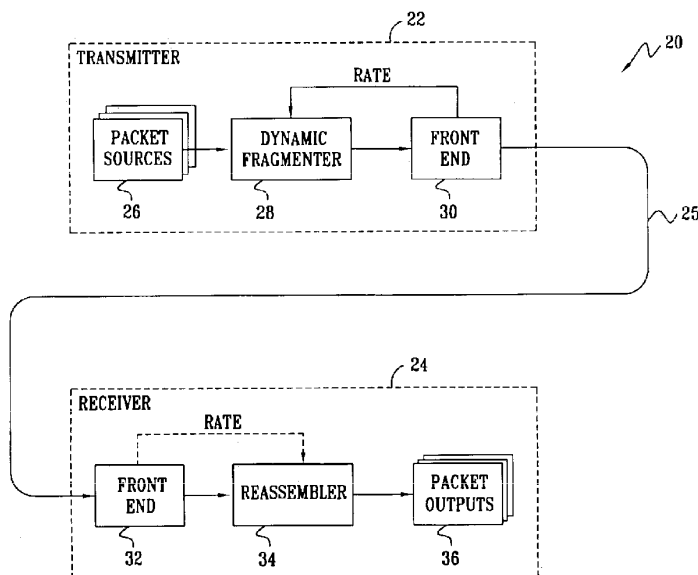
Assistant Examiner—Christine Ng

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

A method and apparatus for transmitting data over a channel having a variable transmission rate. A transmitter determines the rate of transmission of the data over the channel and receives a datagram for transmission over the channel at the determined rate of transmission. The transmitter divides the datagram into fragments of a size no greater than a size limit that is set for the datagram responsive to the determined rate of transmission and transmits the fragments over the channel.

18 Claims, 2 Drawing Sheets





US006892329B2

(12) **United States Patent**
Bruckman

(10) **Patent No.:** **US 6,892,329 B2**
(45) **Date of Patent:** **May 10, 2005**

(54) **SELECTIVE PROTECTION FOR RING TOPOLOGIES**

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(75) Inventor: **Leon Bruckman**, Petach Tikva (IL)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **Corrigent Systems Ltd.**, Tel Aviv (IL)

EP 1 052 808 11/2000
WO WO 00/74318 12/2000

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 496 days.

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(22) Filed: **Oct. 3, 2001**

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(65) **Prior Publication Data**

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US 2002/0144190 A1 Oct. 3, 2002

Related U.S. Application Data

Primary Examiner—Robert Beausoliel

Assistant Examiner—Joseph D Manoskey

(74) *Attorney, Agent, or Firm*—Ladas & Parry LLP

(60) Provisional application No. 60/281,232, filed on Apr. 2, 2001.

(57) **ABSTRACT**

(51) **Int. Cl.**⁷ **G06F 11/16**

A method for fault protection in a bidirectional ring network includes transmitting first and second flows of packets around the bidirectional ring network while defining the first flow as a wrapping flow and the second flow as a non-wrapping flow. Upon detection by a node in the network that a segment of the network proximal to the node has failed, the packets in the first flow are wrapped at the node between clockwise and counterclockwise directions on the network so as to avoid the failed segment, while the packets in the second flow are not wrapped.

(52) **U.S. Cl.** **714/43**; 714/4; 714/717;
709/251; 370/224

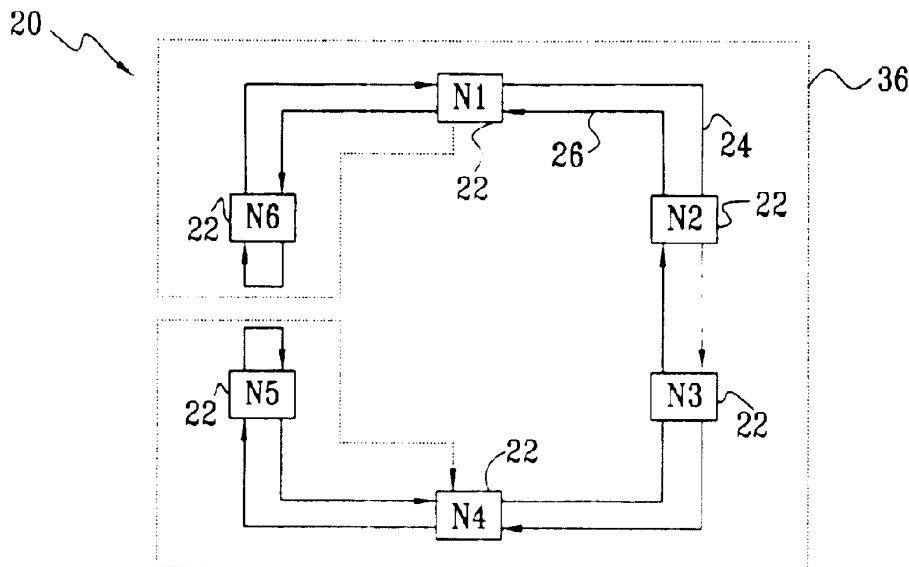
(58) **Field of Search** 714/4, 43, 717;
709/251; 370/222, 223, 224

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24 Claims, 3 Drawing Sheets





US006894983B1

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

(10) **Patent No.:** **US 6,894,983 B1**
(45) **Date of Patent:** **May 17, 2005**

(54) **AUTOMATIC IMPLEMENTATION OF
NETWORK CONFIGURATION CHANGES**

(75) Inventors: **Yaron Lederman**, Ramat-Gan (IL);
Galit Volpert, Petach-Tikva (IL)

(73) Assignee: **Orckit Communicatioins 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 857 days.

(21) Appl. No.: **09/637,300**

(22) Filed: **Aug. 11, 2000**

(51) Int. Cl.⁷ **H04L 12/26**; H04L 12/28;
G06F 15/173

(52) U.S. Cl. **370/252**; 370/254; 370/395.1;
709/223

(58) Field of Search 370/351-356,
370/252, 401-402, 463-465, 257, 254,
395.1, 397, 399; 709/223-230, 221; 379/90.01,
93.01

(56) **References Cited**

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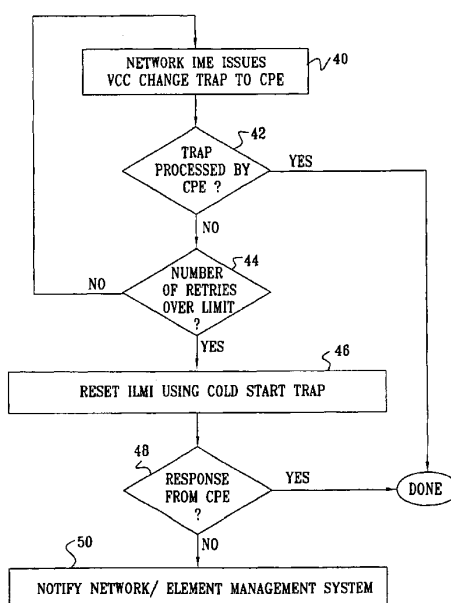
Primary Examiner—Steven Nguyen

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

A method for network management includes sending a trap message from a network end switch to client premises equipment (CPE) over a network connection therebetween, informing the CPE of a change in a network management information base (MIB) of the end switch. A request from the CPE to the end switch, subsequent to the trap message, to read information from the MIB, and the information is provided from the end switch to the CPE responsive to the request. The change is determined to have been implemented by the CPE based on the request to read the information. There is thus no need for the CPE to poll the processor for further trap messages.

19 Claims, 3 Drawing Sheets





US006917986B2

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

(10) **Patent No.:** **US 6,917,986 B2**
(45) **Date of Patent:** **Jul. 12, 2005**

(54) **FAST FAILURE PROTECTION USING
REDUNDANT NETWORK EDGE PORTS**

6,680,906 B1 1/2004 Nguyen

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(75) Inventors: **Gal Mor**, Rishon le Zion (IL); **Shmuel
Ilan**, Ra'anana (IL)

(73) Assignee: **Corrigent Systems 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 734 days.

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Primary Examiner—William A. Cuchlinski, Jr.

Assistant Examiner—Thanh T. Nguyen

(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye P.C.

(21) Appl. No.: **10/036,518**

(22) Filed: **Jan. 7, 2002**

(65) **Prior Publication Data**

US 2003/0208618 A1 Nov. 6, 2003

(51) **Int. Cl.**⁷ **G06F 15/173**

(52) **U.S. Cl.** **709/238**; 709/208; 709/226;
709/209; 709/239; 707/104.1; 370/396;
370/252; 370/352; 370/389

(58) **Field of Search** 709/238, 239,
709/208, 209, 226; 707/104.1; 370/396,
252, 352, 389

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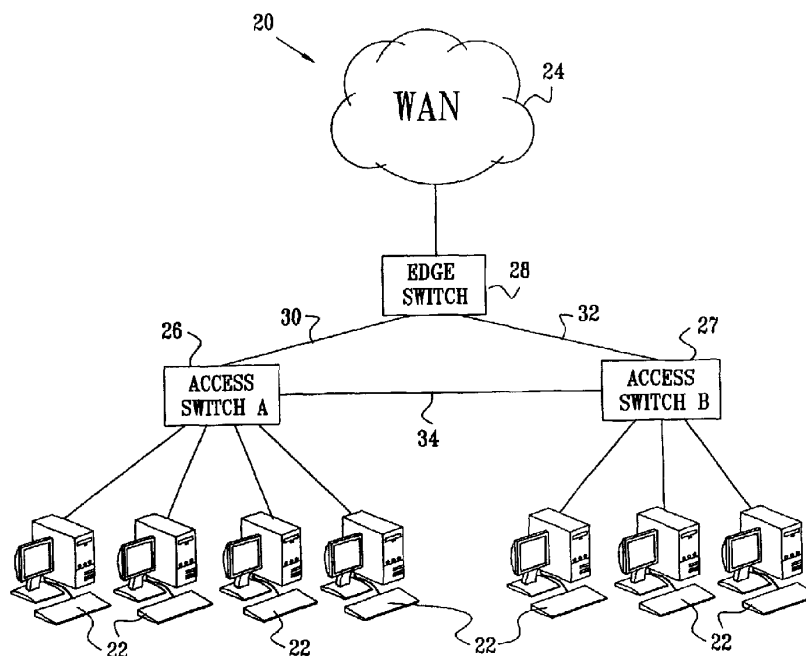
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5,925,137 A 7/1999 Okanoué et al.
6,246,667 B1 6/2001 Ballintine et al.

(57) **ABSTRACT**

A method for fast protection in a fault-tolerant network
includes coupling an edge switch in a network to one or
more access switches via at least first and second redundant
links, respectively connected to first and second ports of the
edge switch. The first port is placed in an active state, while
the second port is placed in a blocking state, so that
communication traffic is conveyed over the first link, and
each of the switches builds a respective database for use in
forwarding the traffic. Responsive to a failure associated
with the first link, the second port is placed in the active state
and the first port is placed in the blocking state. Dummy
traffic is then sent from the edge switch over the second link
to the one or more access switches, so as to cause each of the
one or more access switches to modify its respective data-
base responsive to the second port being in the active state.

24 Claims, 4 Drawing Sheets





US006952397B2

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

(10) **Patent No.:** **US 6,952,397 B2**
(45) **Date of Patent:** **Oct. 4, 2005**

(54) **COMMUNICATION IN A BIDIRECTIONAL RING NETWORK WITH SINGLE-DIRECTION RECEIVING**

(75) Inventors: **Gal Mor**, Rishon-Lezion (IL); **Leon Bruckman**, Petach Tikva (IL); **David Zelig**, Givataim (IL)

(73) Assignee: **Corrigent Systems 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 876 days.

(21) Appl. No.: **09/876,414**

(22) Filed: **Jun. 7, 2001**

(65) **Prior Publication Data**

US 2002/0186667 A1 Dec. 12, 2002

(51) **Int. Cl.**⁷ **H04J 3/14**

(52) **U.S. Cl.** **370/223; 370/258**

(58) **Field of Search** 370/223, 221, 370/222, 224, 452, 453, 238, 227; 398/59; 714/4

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Primary Examiner—Hassan Kizou

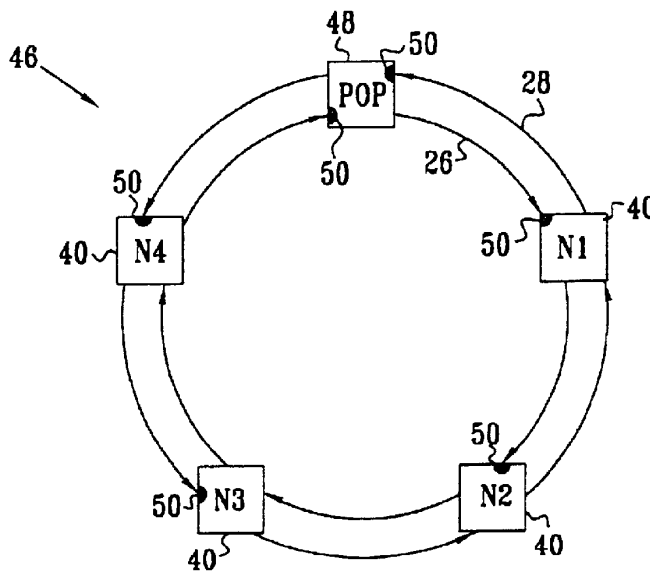
Assistant Examiner—Albert T. Chou

(74) *Attorney, Agent, or Firm*—Weingarten, Schurgin, Gagnebin & Lebovici LLP

(57) **ABSTRACT**

A communication network includes a communication medium and a plurality of communication nodes, mutually coupled by the communication medium so as to form a ring, over which each of the nodes is configured to transmit traffic to the other nodes in both clockwise and counterclockwise directions around the ring. At least one of the nodes is configured to receive the traffic in only one of the directions at any given time.

19 Claims, 4 Drawing Sheets





US006957369B2

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

(10) **Patent No.:** **US 6,957,369 B2**
(45) **Date of Patent:** **Oct. 18, 2005**

(54) **HIDDEN FAILURE DETECTION**

(75) Inventors: **Leon Bruckman**, Petah Tikva (IL);
Shmuel Ilan, Ramat-Gan (IL)

(73) Assignee: **Corrigent Systems 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 415 days.

(21) Appl. No.: **10/156,851**

(22) Filed: **May 30, 2002**

(65) **Prior Publication Data**

US 2003/0226072 A1 Dec. 4, 2003

(51) **Int. Cl.**⁷ **G01R 31/28**

(52) **U.S. Cl.** **714/716**

(58) **Field of Search** 714/724, 726,
714/727, 712, 715, 716, 717; 370/249

(56) **References Cited**

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Primary Examiner—Albert Decady

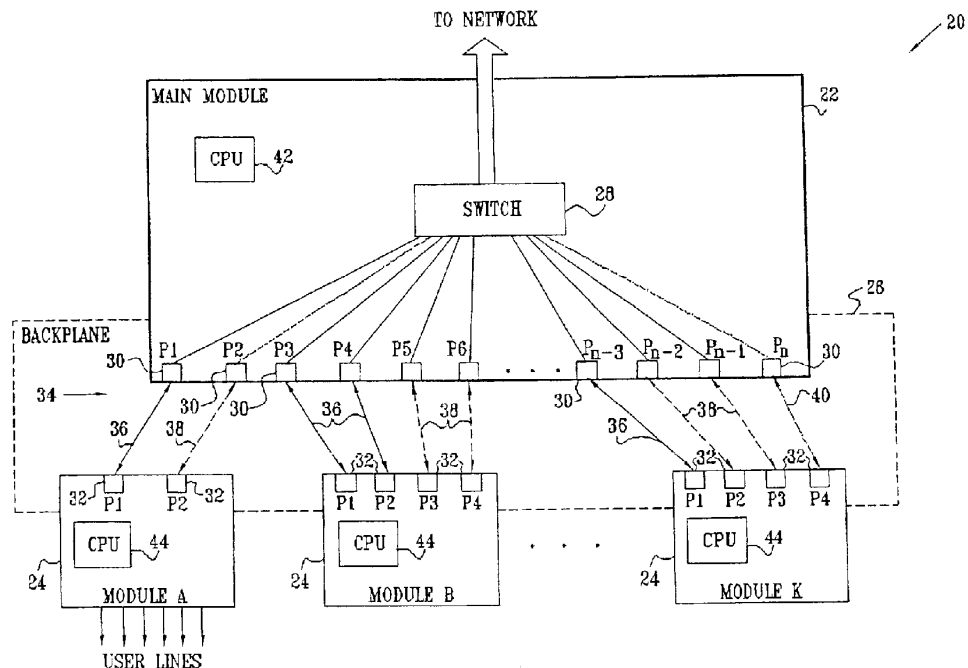
Assistant Examiner—James C Kerveros

(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

(57) **ABSTRACT**

A method for self-testing of an electronic system that includes a main module and subsidiary modules, which are connected to the main module by data lines, at least some of which may be idle. One of the idle lines is selected to serve as an aid line, and the subsidiary module to which the aid line is connected is instructed to loop back traffic reaching the subsidiary module via the aid line. Another idle line is selected for testing, and a switch in the main module is configured to link the aid line and the line under test. The subsidiary module to which the line under test is connected transmits test traffic over the idle line to the main module. If the test traffic does not return to the subsidiary module within a predetermined period of time, a failure is reported.

26 Claims, 2 Drawing Sheets





US006963537B2

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

(10) **Patent No.:** **US 6,963,537 B2**
(45) **Date of Patent:** **Nov. 8, 2005**

(54) **RESOURCE RESERVATION IN A RING NETWORK**

(75) Inventors: **Gal Mor**, Rishon Lezion (IL); **Ron Grinfeld**, Ramat Gan (IL)

(73) Assignee: **Corrigent Systems 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 767 days.

(21) Appl. No.: **09/794,898**

(22) Filed: **Feb. 26, 2001**

(65) **Prior Publication Data**

US 2002/0018481 A1 Feb. 14, 2002

Related U.S. Application Data

(60) Provisional application No. 60/222,698, filed on Aug. 2, 2000, and provisional application No. 60/221,037, filed on Jul. 27, 2000.

(51) **Int. Cl.**⁷ **H04L 12/26**

(52) **U.S. Cl.** **370/232**

(58) **Field of Search** 370/254, 258, 370/255, 351, 400-406, 221-228, 230-235, 236, 237-238.1, 395.21, 395.37-395.41

(56) **References Cited**

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Primary Examiner—Chi Pham

Assistant Examiner—Thai Hoang

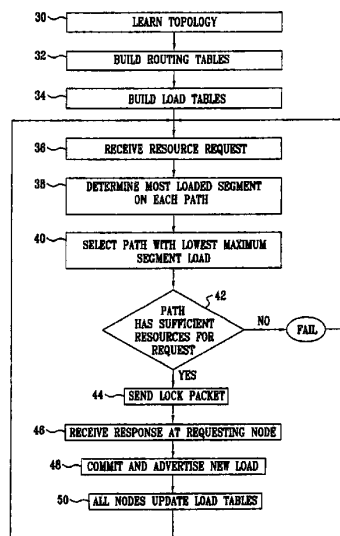
(74) *Attorney, Agent, or Firm*—Darby & Darby

(57)

ABSTRACT

A method for routing a data flow from a source node to a destination node among a plurality of nodes mutually linked in a ring by segments of a communication network, configured so that the data flow can traverse the ring in either of first and second, mutually-opposing directions of communication. The method includes maintaining at each of the nodes a record of respective levels of use of a network resource on the segments in the ring for both the first and second directions of communication. Responsive to the respective levels of use, one of the directions is selected at the source node, in which to route the data flow to the destination node. A notification is sent from the source node to the other nodes in the ring of an additional allocation of the resource required by the source node in order to convey the data flow to the destination node in the selected direction on the segments in the ring. The record of the levels of use of the resource at each of the nodes is updated, responsive to the notification from the source node.

22 Claims, 2 Drawing Sheets





US006973049B2

(12) **United States Patent**
Mor

(10) **Patent No.:** **US 6,973,049 B2**
(45) **Date of Patent:** **Dec. 6, 2005**

(54) **AUTO-CONFIGURATION OF NETWORK INTERFACES IN A BIDIRECTIONAL RING NETWORK**

(75) Inventor: **Gal Mor**, Rishon Lezion (IL)

(73) Assignee: **Corrigent Systems 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 955 days.

(21) Appl. No.: **09/978,642**

(22) Filed: **Oct. 16, 2001**

(65) **Prior Publication Data**

US 2003/0072259 A1 Apr. 17, 2003

(51) **Int. Cl.**⁷ **H04L 12/42**

(52) **U.S. Cl.** **370/258; 370/254**

(58) **Field of Search** 370/254, 255, 370/258, 248

(56) **References Cited**

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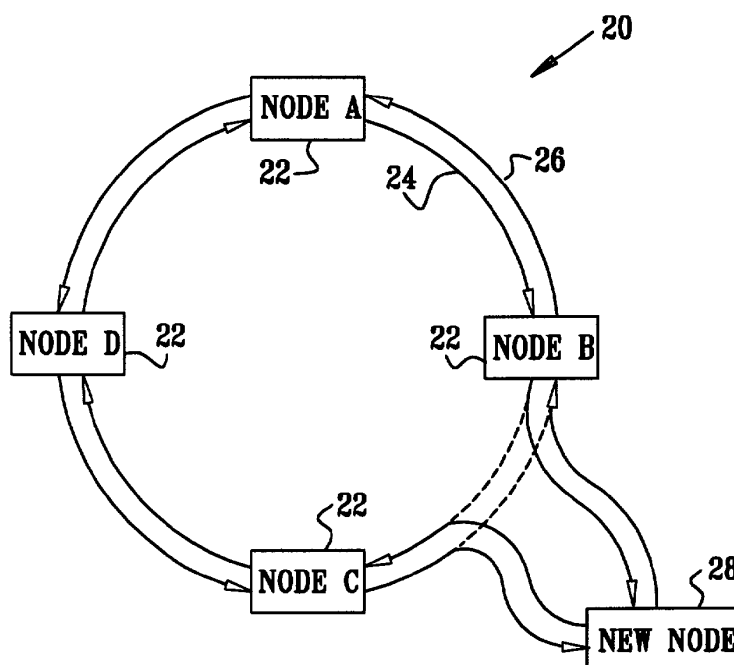
Primary Examiner—Min Jung

(74) *Attorney, Agent, or Firm*—Ladas and Parry LLP

(57) **ABSTRACT**

A method for configuration of a node inserted into a bidirectional ring network includes, responsive to traffic on first and second rings of the network, determining at the node that one of the first and second rings carries the traffic in a clockwise direction around the network, while the other of the rings carries the traffic in a counterclockwise direction. The node then sends and receives advertisement packets through its network interfaces over the respective rings, advertising the determined directions of the traffic carried by the rings. Responsive to the advertisement packets received at the node, the configuration of the node is completed so that the traffic can be sent to and from the node on the first and second rings in the determined directions.

34 Claims, 4 Drawing Sheets





US007032135B2

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

(10) **Patent No.:** **US 7,032,135 B2**
(45) **Date of Patent:** **Apr. 18, 2006**

(54) **EQUIPMENT PROTECTION USING A
PARTIAL STAR ARCHITECTURE**

(75) Inventors: **Rafi Harel**, Beit Hashmonai (IL); **Leon
Bruckman**, Petah Tikva (IL); **Gal Mor**,
Herzlia (IL)

(73) Assignee: **Corrigent Systems 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 558 days.

(21) Appl. No.: **10/211,065**

(22) Filed: **Aug. 2, 2002**

(65) **Prior Publication Data**

US 2004/0078620 A1 Apr. 22, 2004

(51) **Int. Cl.**
G06F 11/00 (2006.01)

(52) **U.S. Cl.** **714/43**; 714/4; 398/61;
370/425; 709/252

(58) **Field of Classification Search** 398/63,
398/61, 43, 4; 714/43, 4, 63, 61; 370/425,
370/419; 709/252

See application file for complete search history.

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Primary Examiner—Robert Beausoliel

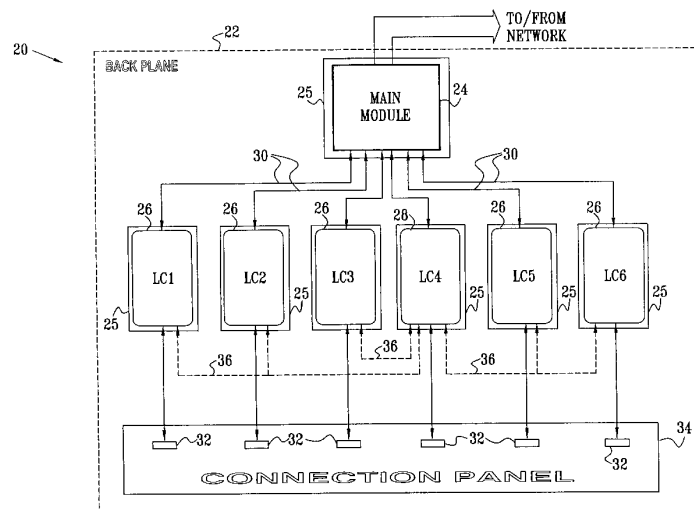
Assistant Examiner—Christopher McCarthy

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

Communication apparatus includes a plurality of interface
cards, including a central interface card and spoke interface
cards, which are adapted to link communication lines to a
network. A protection bus includes multiple spoke connec-
tions that link the central interface card to the spoke inter-
face cards in a partial star configuration, such that on at least one
of the spoke connections there are two of the spoke interface
cards connected together to the central interface card.

17 Claims, 6 Drawing Sheets





US007035279B2

(12) **United States Patent**
Bruckman

(10) **Patent No.:** **US 7,035,279 B2**
(45) **Date of Patent:** **Apr. 25, 2006**

(54) **FLOW ALLOCATION IN A RING TOPOLOGY**

(75) Inventor: **Leon Bruckman**, Petach Tikva (IL)

(73) Assignee: **Corrigent Systems 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 756 days.

(21) Appl. No.: **09/756,946**

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

(65) **Prior Publication Data**

US 2002/0118700 A1 Aug. 29, 2002

(51) **Int. Cl.**
H04L 12/43 (2006.01)

(52) **U.S. Cl.** **370/460**; 370/395.21; 370/395.41; 370/406; 709/225; 709/226; 709/232; 709/238

(58) **Field of Classification Search** 370/389, 370/395.21, 395.41, 395.42, 406, 439, 460
See application file for complete search history.

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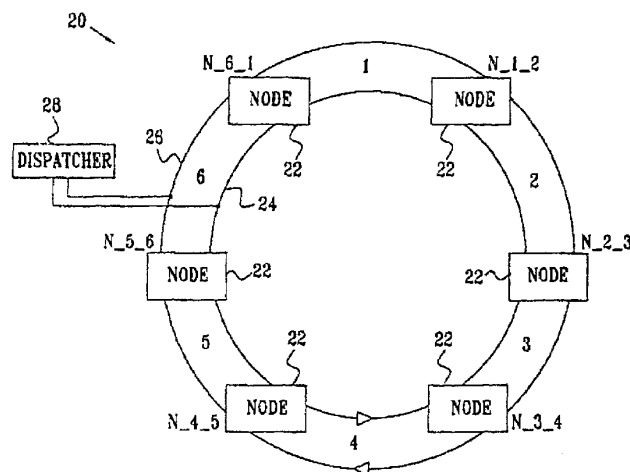
Assistant Examiner—Tri H. Phan

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

In a communication network that includes a plurality of nodes interconnected by links, a method for routing a data flow includes receiving a request to allocate one or more resources in the network so as to carry the data flow between first and second ones of the nodes over one of a plurality of paths therebetween, each such path including a respective sequence of the links. For the links included in each of the paths, respective levels of use of the requested resources due to communications in process over the network are determined. The path that is to carry the data flow is selected responsive to the determined levels of use of the requested resources on the links included in each of the paths.

18 Claims, 6 Drawing Sheets





(12) **United States Patent**
Mor

(10) **Patent No.:** **US 7,054,264 B2**
(45) **Date of Patent:** **May 30, 2006**

(54) **INTERCONNECT AND GATEWAY
PROTECTION IN BIDIRECTIONAL RING
NETWORKS**

(75) Inventor: **Gal Mor**, Rishon-Lezion (IL)

(73) Assignee: **Corrigent Systems 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 1008 days.

(21) Appl. No.: **09/910,790**

(22) Filed: **Jul. 24, 2001**

(65) **Prior Publication Data**

US 2003/0021226 A1 Jan. 30, 2003

(51) **Int. Cl.**

G01R 31/08 (2006.01)

G06F 11/00 (2006.01)

H04J 1/16 (2006.01)

H04J 3/14 (2006.01)

H04L 12/26 (2006.01)

(52) **U.S. Cl.** **370/223; 370/222; 398/1; 398/2; 398/3; 398/4; 398/59; 714/717; 714/799; 714/47; 714/4; 714/2**

(58) **Field of Classification Search** **370/223, 370/222, 254, 403, 227, 258, 225, 216, 217, 370/218, 219, 220, 221, 249, 228, 241, 248, 370/252, 401, 402, 404, 405, 406, 408, 257, 370/229, 465, 224, 452, 453, 238; 714/47, 714/4, 2, 13, 48, 56, 799, 717; 709/238, 709/239; 398/59, 60, 1, 2, 3, 4, 5, 6, 9, 10, 398/17**

See application file for complete search history.

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Primary Examiner—Wellington Chin

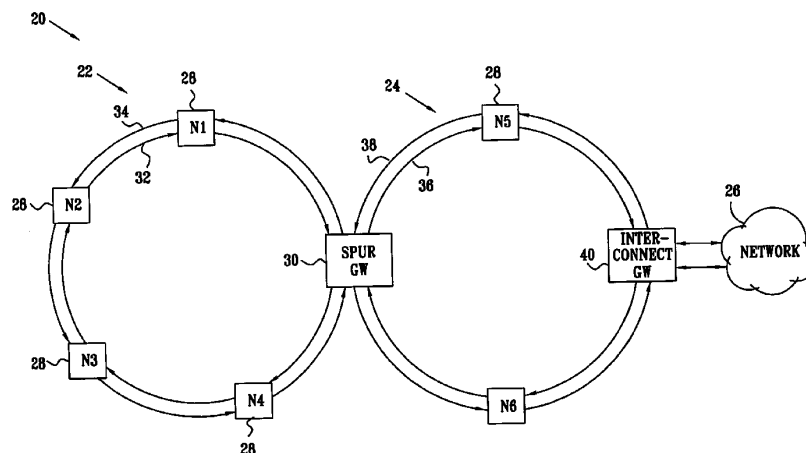
Assistant Examiner—Jamal A. Fox

(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye P.C.

(57) **ABSTRACT**

A communication device for interconnection of first and second networks, of which at least the first network is a bidirectional ring network, includes first and second interconnect modules, each such module adapted to receive outgoing data traffic on the first network at a data rate not substantially greater than a predetermined maximum rate for one of the ring directions, and to convey the outgoing data traffic to the second network. When a fault occurs in one of the first and second modules, the other module is reconfigured to receive substantially all of the outgoing data traffic and to convey the outgoing data traffic to the second network regardless of whether the outgoing data traffic is transmitted on the first network in the clockwise or in the counterclockwise direction.

24 Claims, 4 Drawing Sheets





US007061859B2

(12) **United States Patent**
Barsheshet

(10) **Patent No.:** **US 7,061,859 B2**
(45) **Date of Patent:** **Jun. 13, 2006**

(54) **FAST PROTECTION IN RING TOPOLOGIES**

(75) Inventor: **Yossi Barsheshet**, Givatayim (IL)

(73) Assignee: **Corrigent Systems 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 766 days.

(21) Appl. No.: **09/941,723**

(22) Filed: **Aug. 30, 2001**

(65) **Prior Publication Data**

US 2003/0043738 A1 Mar. 6, 2003

(51) **Int. Cl.**

H04L 12/26 (2006.01)

(52) **U.S. Cl.** **370/225; 370/217;**

(58) **Field of Classification Search** 370/217,
370/221, 222, 223, 216, 218, 224, 241, 250,
370/408, 424, 527, 528, 529, 225, 227, 228
See application file for complete search history.

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Primary Examiner—Kwang Bin Yao

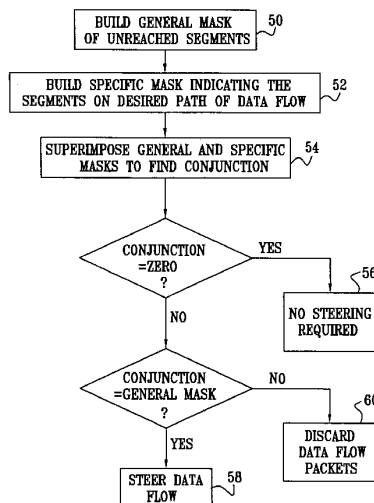
(74) Attorney, Agent, or Firm—Nixon & Vanderhye P.C.

(57)

ABSTRACT

In a bidirectional ring network, in which nodes are mutually connected by network segments, a method of fault protection includes constructing a general mask indicating which of the segments can be reached. For a given data flow to be conveyed through the network from a source node to a destination node, a specific mask is constructed indicating the segments on a desired path of the flow. The general and specific masks are superimposed in order to determine a disposition of the flow.

12 Claims, 3 Drawing Sheets





US007069546B2

(12) **United States Patent**
Tsarfati

(10) **Patent No.:** **US 7,069,546 B2**
(45) **Date of Patent:** **Jun. 27, 2006**

(54) **GENERIC FRAMEWORK FOR EMBEDDED SOFTWARE DEVELOPMENT**

(75) Inventor: **Yoram Tsarfati**, Bet Hanania (IL)

(73) Assignee: **Corrigent Systems 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 637 days.

(21) Appl. No.: **10/005,030**

(22) Filed: **Dec. 3, 2001**

(65) **Prior Publication Data**

US 2003/0105886 A1 Jun. 5, 2003

(51) **Int. Cl.**
G06F 9/45 (2006.01)

(52) **U.S. Cl.** **717/149**; 717/150; 719/318; 719/328

(58) **Field of Classification Search** 717/149–161, 717/140, 100–109, 143, 110, 172; 713/1; 719/328, 318; 709/223, 318; 714/57, 49; 345/765; 385/16; 707/10; 370/254; 379/201.01; 718/318, 328

See application file for complete search history.

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Primary Examiner—Wei Zhen

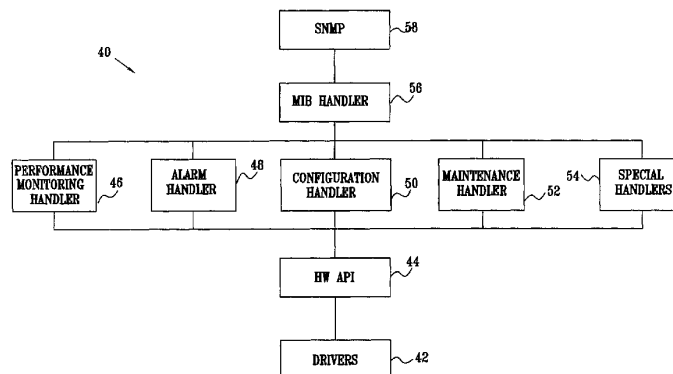
Assistant Examiner—Satish S. Rampuria

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

(57) **ABSTRACT**

A method for producing embedded software includes providing one or more generic application handler programs, each such program comprising computer program code for performing generic application functions common to multiple types of hardware modules used in a communication system. Specific application handler code is generated to associate the generic application functions with specific functions of a device driver for at least one of the types of the hardware modules. The generic application handler programs are compiled together with the specific application handler code to produce machine-readable code to be executed by an embedded processor in the at least one of the types of the hardware modules.

45 Claims, 7 Drawing Sheets





US007113485B2

(12) **United States Patent**
Bruckman

(10) **Patent No.:** **US 7,113,485 B2**
(45) **Date of Patent:** **Sep. 26, 2006**

(54) **LATENCY EVALUATION IN A RING NETWORK**

(75) Inventor: **Leon Bruckman**, Petah Tiqva (IL)

(73) Assignee: **Corrigent Systems 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 1038 days.

(21) Appl. No.: **09/947,183**

(22) Filed: **Sep. 4, 2001**

(65) **Prior Publication Data**

US 2003/0048754 A1 Mar. 13, 2003

(51) **Int. Cl.**
G01R 31/08 (2006.01)

(52) **U.S. Cl.** **370/252; 370/516**

(58) **Field of Classification Search** **370/252, 370/403, 406, 222**

See application file for complete search history.

(56) **References Cited**

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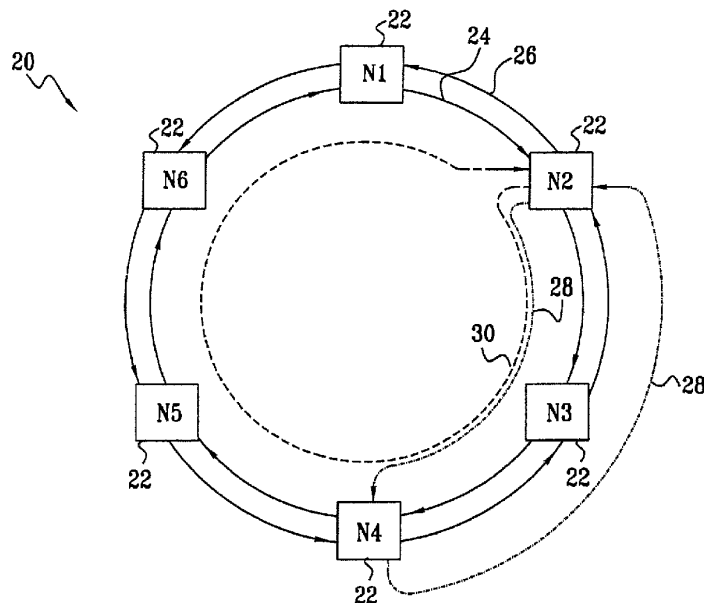
Primary Examiner—Brian Nguyen

(74) Attorney, Agent, or Firm—Darby & Darby

(57) **ABSTRACT**

A method for measuring latency in a bi-directional ring network includes transmitting a latency measurement packet from an originating node to a peer node and noting a time of receipt of the packet at the peer node. The packet is then transmitted back to the originating node in the opposite direction, while recording in the packet an indication of a peer node difference between a time of transmission of the packet from the peer node to the originating node and the time of receipt of the packet at the peer node. A time of return of the packet to the originating node is noted, so as to determine an originating node difference between a time of transmission of the packet from the originating node to the peer node and the time of return of the packet to the originating node. The latency is calculated by taking a difference between the originating node difference and the peer node difference.

20 Claims, 2 Drawing Sheets





US007127523B2

(12) **United States Patent**
Kotser

(10) **Patent No.:** **US 7,127,523 B2**
(45) **Date of Patent:** **Oct. 24, 2006**

(54) **SPANNING TREE PROTOCOL TRAFFIC IN A
TRANSPARENT LAN**

(75) Inventor: **Yoav Kotser**, Givatayim (IL)

(73) Assignee: **Corrigent Systems 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 731 days.

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Primary Examiner—Rupal Dharja

Assistant Examiner—Ranodhi Serrao

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

A method for controlling a system of label-switched tunnels through a communication network, the method including pushing a signaling label onto a signaling frame at a first node in the network, and sending the signaling frame through the label-switched tunnels to one or more recipient nodes in the network. The signaling label is popped off the signaling frame at the one or more recipient nodes, which responsive to the signaling label, process the signaling frame so as to eliminate loops formed by the label-switched tunnels.

19 Claims, 4 Drawing Sheets

(21) Appl. No.: **10/057,332**

(22) Filed: **Jan. 25, 2002**

(65) **Prior Publication Data**

US 2003/0037162 A1 Feb. 20, 2003

Related U.S. Application Data

(60) Provisional application No. 60/308,410, filed on Jul. 27, 2001.

(51) **Int. Cl.**

G06F 15/173 (2006.01)

G06F 15/177 (2006.01)

H04L 12/28 (2006.01)

H04L 12/56 (2006.01)

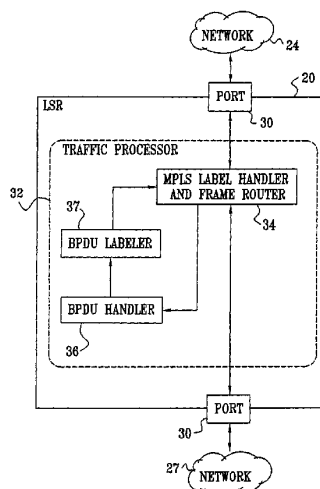
(52) **U.S. Cl.** **709/238**; 709/239; 709/221;
370/392; 370/395.1

(58) **Field of Classification Search** 709/221,
709/238, 239; 370/395.1, 392
See application file for complete search history.

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US007133415B2

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

(10) **Patent No.:** **US 7,133,415 B2**
(45) **Date of Patent:** **Nov. 7, 2006**

(54) **SONET CIRCUIT EMULATION WITH VT COMPRESSION**

(75) Inventors: **David Zelig**, Givatayim (IL); **Leon Bruckman**, Petah Tikva (IL); **Nitzan Kappel**, Zoran (IL)

(73) Assignee: **Corrigent Systems 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 1003 days.

(21) Appl. No.: **09/978,342**

(22) Filed: **Oct. 17, 2001**

(65) **Prior Publication Data**

US 2003/0012188 A1 Jan. 16, 2003

Related U.S. Application Data

(60) Provisional application No. 60/304,369, filed on Jul. 10, 2001.

(51) **Int. Cl.**
H04J 3/16 (2006.01)

(52) **U.S. Cl.** 370/466; 370/907

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Chau Nguyen

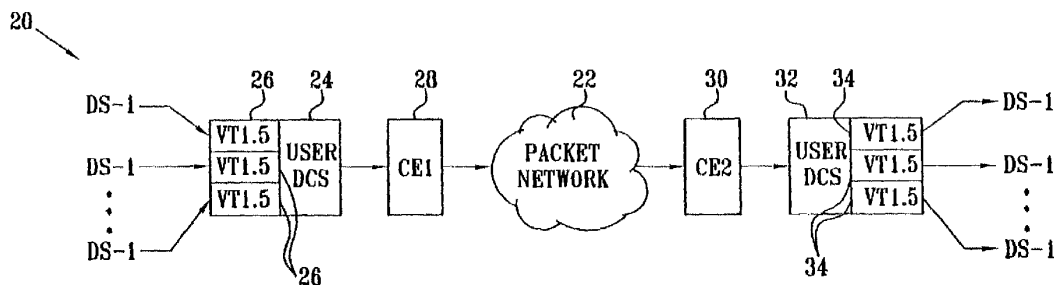
Assistant Examiner—Rhonda Murphy

(74) *Attorney, Agent, or Firm*—Ladas and Parry LLP

(57) **ABSTRACT**

A method for data communications includes receiving a time-division-multiplexed (TDM) input signal on a first circuit, the signal including an input sequence of frames of data, each such frame divided into sections for carrying respective sub-rate payloads. After determining which of the sections are active, such that the data in the sub-rate payloads of the active sections include user data, and which of the sections are inactive, the user data in the active sections are encapsulated into data packets for transmission over a packet network, while omitting from the packets at least some of the data from the inactive sections.

58 Claims, 5 Drawing Sheets





US007142516B2

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

(10) **Patent No.:** **US 7,142,516 B2**
(45) **Date of Patent:** **Nov. 28, 2006**

(54) **PERFORMANCE MONITORING OF HIGH SPEED COMMUNICATIONS NETWORKS**

(75) Inventors: **Kobi Lev**, Ramat Gan (IL); **Ophir Fuchs**, Rishon lezion (IL)

(73) Assignee: **Corrigent Systems 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 1046 days.

(21) Appl. No.: **10/128,459**

(22) Filed: **Apr. 24, 2002**

(65) **Prior Publication Data**

US 2003/0204595 A1 Oct. 30, 2003

(51) **Int. Cl.**
G06F 11/00 (2006.01)

(52) **U.S. Cl.** **370/244**; 370/252

(58) **Field of Classification Search** 370/244, 370/252
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Hassan Kizou

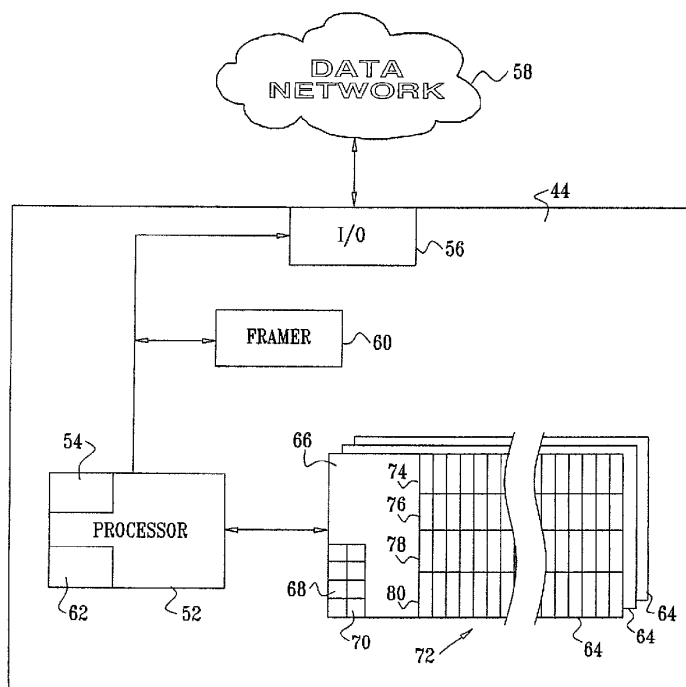
Assistant Examiner—Anthony Sol

(74) Attorney, Agent, or Firm—Sterne, Kessler, Goldstein & Fox P.L.L.C.

(57) ABSTRACT

A performance monitoring system for a digital network is installed in network elements having performance monitoring responsibilities. Apparatus is provided for network elements, in which a bitmap representation of performance primitives detected during an acquisition interval is used as a control in the tracking and updating of network performance parameters. Immediate access to states that enable and inhibit the evaluation of individual performance parameters is available.

47 Claims, 7 Drawing Sheets





US007145878B2

(12) **United States Patent**
Katz

(10) **Patent No.:** **US 7,145,878 B2**
(45) **Date of Patent:** **Dec. 5, 2006**

(54) **AVOIDING OVERLAPPING SEGMENTS IN
TRANSPARENT LAN SERVICES ON
RING-BASED NETWORKS**

(75) Inventor: **Shachar Katz**, Raanana (IL)

(73) Assignee: **Corrigent Systems 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 968 days.

(21) Appl. No.: **10/054,845**

(22) Filed: **Jan. 25, 2002**

(65) **Prior Publication Data**

US 2003/0026209 A1 Feb. 6, 2003

Related U.S. Application Data

(60) Provisional application No. 60/308,410, filed on Jul.
27, 2001.

(51) **Int. Cl.**
H04L 12/26 (2006.01)

(52) **U.S. Cl.** **370/238**; 370/235; 370/254;
709/241

(58) **Field of Classification Search** 370/238,
370/281, 235, 216, 254–256, 401–405, 222;
709/239, 241

See application file for complete search history.

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Primary Examiner—Ricky Q. Ngo

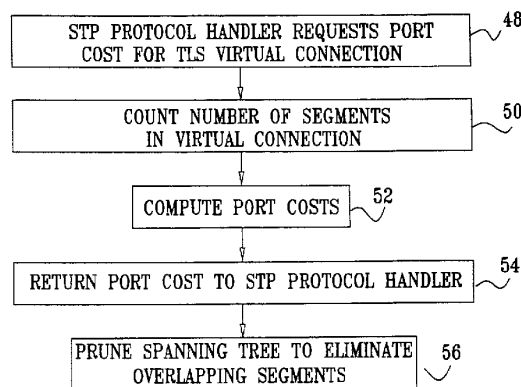
Assistant Examiner—Nguyen Ngo

(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland,
Maier & Neustadt, P.C.

(57) **ABSTRACT**

A method for eliminating loops in a communication network
in which the nodes operate as virtual bridges, having virtual
ports that link the virtual bridges over virtual connections,
each of the virtual connections coinciding respectively with
one or more segments of the network. Respective port costs
are assigned to the virtual ports responsive to a count of the
network segments with which the respective virtual connec-
tions coincide, so as to favor virtual paths between pairs of
the nodes that are made up of a greater number of the virtual
connections, relative to the virtual paths that are made up of
a lesser number of the virtual connections. Respective path
costs are computed for the virtual paths, based on the port
costs, and the virtual connections over which to send traffic
between the virtual bridges are selected responsive to the
path costs.

36 Claims, 2 Drawing Sheets





US007154899B2

(12) **United States Patent**
Khill

(10) **Patent No.:** **US 7,154,899 B2**
(45) **Date of Patent:** **Dec. 26, 2006**

(54) **PROTECTING THE FILTERING DATABASE
IN VIRTUAL BRIDGES**

(75) Inventor: **Uzi Khill**, Netanya (IL)

(73) Assignee: **Corrigent Systems 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 992 days.

(21) Appl. No.: **10/061,721**

(22) Filed: **Feb. 1, 2002**

(65) **Prior Publication Data**

US 2003/0147405 A1 Aug. 7, 2003

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/401**

(58) **Field of Classification Search** None
See application file for complete search history.

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Primary Examiner—Chau Nguyen

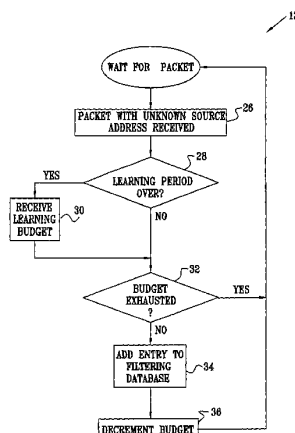
Assistant Examiner—Jung Park

(74) *Attorney, Agent, or Firm*—Blakely Sokoloff Taylor & Zafman

(57) **ABSTRACT**

A method for budgeted learning of link information in a network includes providing a database to contain the link information, for use by an entity connected to the network in transferring traffic over the network, and setting a maximum rate for addition of entries to the database. New entries to be added to the database are determined responsive to the traffic on the network during a learning period. The new entries are added to the database only if the addition of the entries during the learning period has not exceeded the maximum rate.

14 Claims, 2 Drawing Sheets





US007158721B2

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

(10) **Patent No.:** **US 7,158,721 B2**
(45) **Date of Patent:** **Jan. 2, 2007**

(54) **PERFORMANCE MONITORING OF
MULTIPLE CHANNELS IN AN AUTOMATIC
PROTECTION SWITCHED NETWORK**

(75) Inventors: **Sharon Mantin**, Tel Aviv (IL); **David Zelig**, Givatayim (IL); **Shmuel Ilan**, Raanana (IL); **Leon Bruckman**, Petah Tikva (IL)

(73) Assignee: **Corrigent Systems 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 624 days.

(21) Appl. No.: **10/082,771**

(22) Filed: **Feb. 25, 2002**

(65) **Prior Publication Data**

US 2004/0208527 A1 Oct. 21, 2004

(51) **Int. Cl.**
H04B 10/00 (2006.01)

(52) **U.S. Cl.** **398/25; 398/1**

(58) **Field of Classification Search** 398/1-39
See application file for complete search history.

(56) **References Cited**

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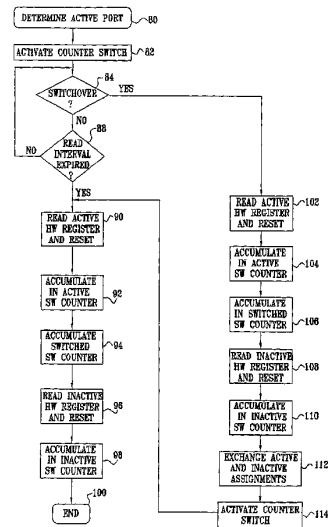
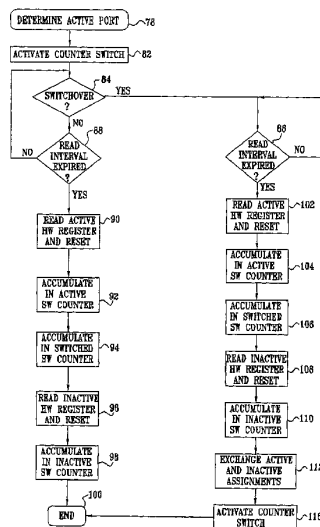
Primary Examiner—Agustin Bello

(74) *Attorney, Agent, or Firm*—Weingarten, Schurgin, Gagnebin & Lebovici LLP

(57) **ABSTRACT**

A performance management unit manages a primary interface and a standby or secondary interface to two channels of an optical communications network having APS capabilities. Each performance parameter is associated with three counters. First and second counters are linked to registers of the primary and the secondary ports, and the third counter is linked to the registers of the currently active port. When a protection switch occurs, the first and second counters are immediately read and reset. The third counter continues accumulating data, but becomes associated with the new active port. At the end of a read interval, the third counter correctly reflects the number of data received, regardless of switchovers between the primary and secondary channels.

42 Claims, 7 Drawing Sheets





US007280560B2

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

(10) **Patent No.:** **US 7,280,560 B2**
(45) **Date of Patent:** **Oct. 9, 2007**

(54) **DIFFERENTIATED SERVICES WITH
MULTIPLE TAGGING LEVELS**

(75) Inventors: **Leon Bruckman**, Petah-Tikva (IL);
Omer Goldfisher, Givataim (IL); **Gal
Mor**, Hezeli (IL); **David Zelig**,
Givataim (IL)

(73) Assignee: **Corrigent Systems 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 945 days.

(21) Appl. No.: **10/128,454**

(22) Filed: **Apr. 24, 2002**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04L 12/50 (2006.01)

(52) **U.S. Cl.** **370/468**; 370/230; 370/230.1;
370/231; 370/235; 370/235.1

(58) **Field of Classification Search** 370/229,
370/230, 352, 389, 392, 400, 401, 464, 465,
370/468, 235, 235.1, 230.1
See application file for complete search history.

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Primary Examiner—Wing Chan

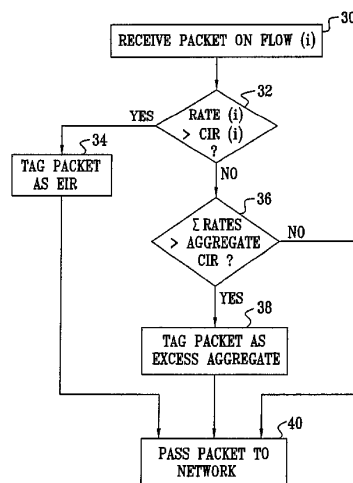
Assistant Examiner—Mark A. Mais

(74) *Attorney, Agent, or Firm*—Sterne, Kessler, Goldstein & Fox, P.L.L.C.

(57) **ABSTRACT**

A method for handling traffic in a communication network includes setting an aggregate limit on a total rate of transmission of information by a group of flows to be transmitted over the network, and setting a respective individual limit on an individual rate of transmission by each of the flows in the group. When the information carried by packets in any given one of the flows is in excess of the respective individual limit, the packets in excess of the respective individual limit in the given one of the flows are tagged with a first excess flow tag. When the total rate of transmission of the information is in excess of the aggregate limit, the packets in excess of the aggregate limit are tagged with a second excess flow tag. Resources in the network are allocated to convey the packets responsive to the first and second excess flow tags.

14 Claims, 2 Drawing Sheets





US007283465B2

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

(10) **Patent No.:** **US 7,283,465 B2**
(45) **Date of Patent:** **Oct. 16, 2007**

(54) **HIERARCHICAL VIRTUAL PRIVATE LAN
SERVICE PROTECTION SCHEME**

(75) Inventors: **David Zelig**, Givataim (IL); **Leon
Bruckman**, Petah Tikva (IL); **Yoav
Kotser**, Givataim (IL)

(73) Assignee: **Corrigent Systems 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 634 days.

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Primary Examiner—Robert Beausoliel
Assistant Examiner—Matthew Urick
(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland,
Maier & Neustadt, P.C.

(21) Appl. No.: **10/337,382**

(22) Filed: **Jan. 7, 2003**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
G06F 11/00 (2006.01)

(52) **U.S. Cl.** **370/219; 370/217; 370/218;**
714/4; 709/238; 709/239

(58) **Field of Classification Search** 714/4;
370/216, 217, 219, 220, 225; 709/238, 239
See application file for complete search history.

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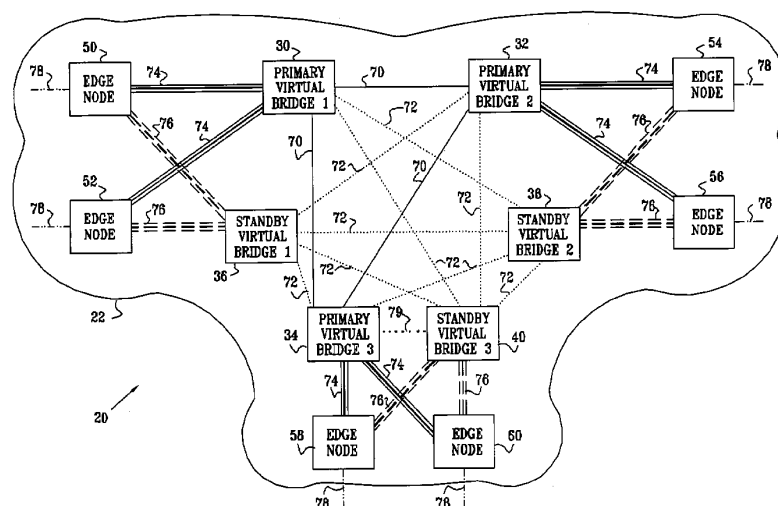
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(57) **ABSTRACT**

A data communication network includes a plurality of
primary virtual bridges, interconnected by primary virtual
connections so as to transmit and receive data packets over
the network to and from edge devices connected thereto.
One or more backup virtual bridges, each associated with at
least one of the primary virtual bridges, are connected by at
least one secondary virtual connection to at least another one
of the primary virtual bridges, so that upon a failure of one
of the primary virtual bridges with which it is associated, the
backup virtual bridge transmits and receives the data packets
over the network via the at least one secondary virtual
connection in place of the at least one of the primary virtual
bridges.

30 Claims, 3 Drawing Sheets





US007283478B2

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

(10) **Patent No.:** **US 7,283,478 B2**
(45) **Date of Patent:** **Oct. 16, 2007**

(54) **TRAFFIC ENGINEERING IN
BI-DIRECTIONAL RING NETWORKS**

(75) Inventors: **Yossi Barsheshet**, Givatayim (IL); **Alex Levit**, Tel-Aviv (IL)

(73) Assignee: **Corrigent Systems 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 1029 days.

(21) Appl. No.: **10/211,066**

(22) Filed: **Aug. 2, 2002**

(65) **Prior Publication Data**

US 2003/0103449 A1 Jun. 5, 2003

Related U.S. Application Data

(60) Provisional application No. 60/333,936, filed on Nov. 28, 2001.

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/238; 370/405; 370/406**

(58) **Field of Classification Search** **370/238, 370/405, 406**
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Hassan Kizou

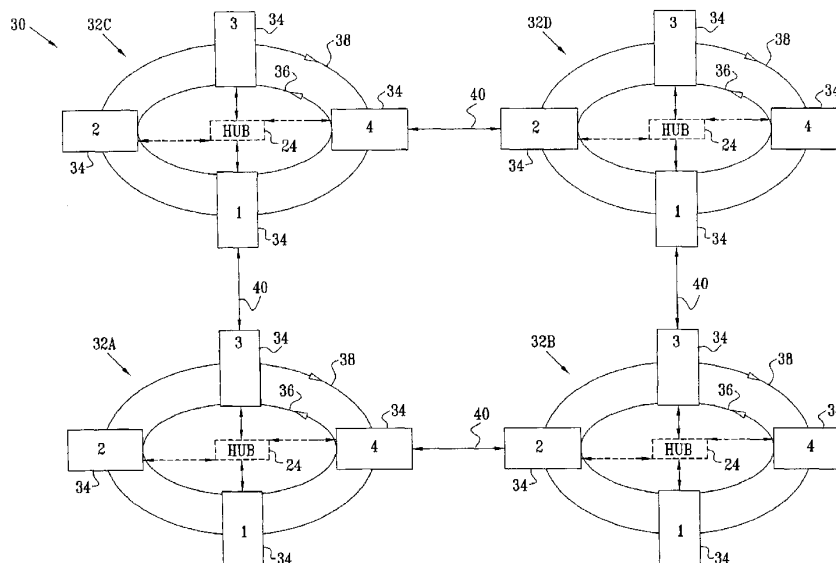
Assistant Examiner—Jay P. Patel

(74) *Attorney, Agent, or Firm*—Darby & Darby

(57) **ABSTRACT**

A method for traffic engineering in a communication system made up of network nodes arranged in multiple interconnected networks, including at least one bi-directional ring network having an inner ring and an outer ring. The bi-directional ring network is defined as a multi-access network for purposes of a routing protocol used in the system. Constraint information is advertised with regard to connections on the inner and outer rings between the nodes within the at least one bi-directional ring network. Traffic flow is routed through the system in accordance with the routing protocol, so that the flow passes through the at least one bi-directional ring network on at least one of the connections to one of the inner and outer rings that is selected responsive to the constraint information.

16 Claims, 3 Drawing Sheets





US007330431B2

(12) **United States Patent**
Bruckman

(10) **Patent No.:** **US 7,330,431 B2**
(45) **Date of Patent:** **Feb. 12, 2008**

(54) **MULTIPOINT TO MULTIPOINT
COMMUNICATION OVER RING
TOPOLOGIES**

(75) Inventor: **Leon Bruckman**, Petah Tikva (IL)

(73) Assignee: **Corrigent Systems 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 700 days.

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(21) Appl. No.: **10/933,572**

(22) Filed: **Sep. 3, 2004**

(65) **Prior Publication Data**

US 2006/0050665 A1 Mar. 9, 2006

(51) **Int. Cl.**
H04L 12/26 (2006.01)

(52) **U.S. Cl.** **370/232; 370/231; 370/235**

(58) **Field of Classification Search** **370/229-235, 370/237-238, 395.2-395.21**
See application file for complete search history.

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Primary Examiner—Chi Pham

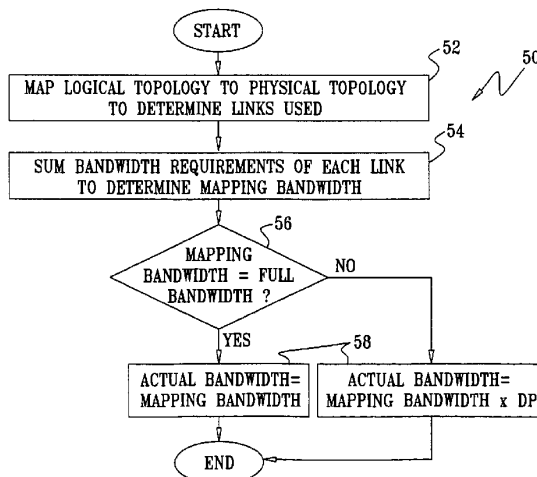
Assistant Examiner—Thai Hoang

(74) *Attorney, Agent, or Firm*—Weingarten, Schurgin, Gagnebin & Lebovici LLP

(57) **ABSTRACT**

A method for assigning bandwidth in a network including nodes coupled by links arranged in a physical topology, the method including: defining between the nodes logical connections associated with a data transmission service to be provided over the network, the logical connections having a connection topology different from the physical topology, and determining respective bandwidth requirements for the logical connections based on parameters of the service. The method further includes mapping the connection topology to the physical topology, so that each of the logical connections is associated with one or more links of the physical topology, and allocating a bandwidth for the service on each of the links in response to the bandwidth requirements of the logical connections and to the mapping.

30 Claims, 4 Drawing Sheets





US007336605B2

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

(10) **Patent No.:** **US 7,336,605 B2**
(45) **Date of Patent:** **Feb. 26, 2008**

(54) **BANDWIDTH ALLOCATION FOR LINK AGGREGATION**

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Primary Examiner—Ricky Q. Ngo
Assistant Examiner—Ankit P. Gandhi
(74) *Attorney, Agent, or Firm*—Welsh & Katz, Ltd.

(75) Inventors: **Leon Bruckman**, Petah Tikva (IL); **Gal Mor**, Herzliya (IL); **Zvi Menahemi**, Modiin (IL)

(73) Assignee: **Corrigent Systems, Inc.**, 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 933 days.

(21) Appl. No.: **10/436,516**

(22) Filed: **May 13, 2003**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04J 13/06 (2006.01)

(52) **U.S. Cl.** **370/230; 370/395.21; 370/468**

(58) **Field of Classification Search** 370/468,
370/395.43, 412, 392, 401

See application file for complete search history.

(56) **References Cited**

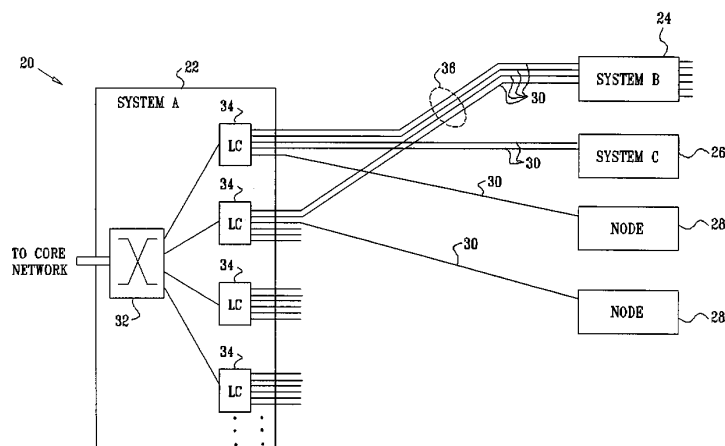
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6,922,394 B2 7/2005 Kajiwara

(57) **ABSTRACT**

A method for establishing a connection with a guaranteed bandwidth for transmitting data over a logical link that includes a plurality of parallel physical links between first and second endpoints. A link bandwidth is allocated on each of the physical communication links so as to include a predefined safety margin, based on either a failure protection policy, or a measure of fluctuation that occurs in a rate of data transmission over the physical links, or both. A sum of the allocated link bandwidth over the plurality of the parallel physical links is substantially greater than the guaranteed bandwidth of the connection. The data are conveyed over the logical link by distributing the data for transmission among the physical links in accordance with the allocated link bandwidth.

18 Claims, 3 Drawing Sheets





US007339929B2

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

(10) **Patent No.:** **US 7,339,929 B2**
(45) **Date of Patent:** **Mar. 4, 2008**

(54) **VIRTUAL PRIVATE LAN SERVICE USING A MULTICAST PROTOCOL**

(75) Inventors: **David Zelig**, Givataim (IL); **Leon Bruckman**, Petah Tikva (IL); **Gal Mor**, Herzliya (IL); **Zvi Menahemi**, Modi'in (IL)

(73) Assignee: **Corrigent Systems 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 944 days.

(21) Appl. No.: **10/226,525**

(22) Filed: **Aug. 23, 2002**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/390; 370/392**

(58) **Field of Classification Search** 370/389, 370/390, 312, 391, 392, 395, 395.1, 397, 370/398, 399, 400, 395.2, 395.3, 395.31, 370/395.52, 395.53, 401, 402, 386
See application file for complete search history.

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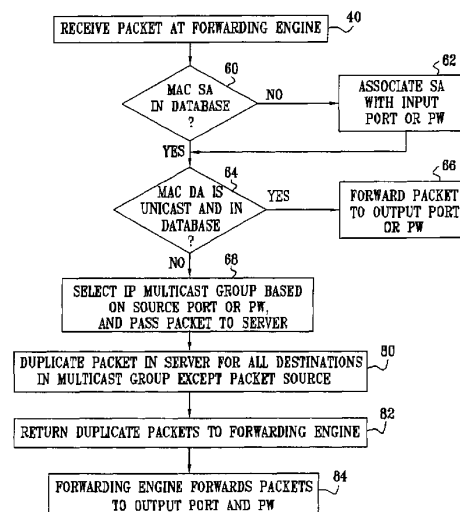
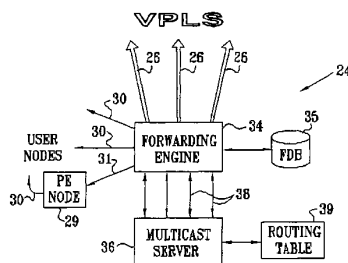
Primary Examiner—Brenda Pham

(74) *Attorney, Agent, or Firm*—Christie, Parker & Hale, LLP

(57) **ABSTRACT**

A method for data broadcast over a network includes receiving at a virtual bridge a data packet to be flooded over the network, and passing the data packet from the virtual bridge to a multicast-capable router, along with a broadcast indication. Responsive to the broadcast indication, the router determines a group of destination addresses to which the packet should be multicast, and creates copies of the packet for transmission over the network to the destination addresses in the group.

40 Claims, 5 Drawing Sheets





US007386010B2

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

(10) **Patent No.: US 7,386,010 B2**
(45) **Date of Patent: Jun. 10, 2008**

(54) **MULTIPROTOCOL MEDIA CONVERSION**

(75) Inventors: **Ronen Solomon**, Givatayim (IL);
David Zelig, Givatayim (IL)

(73) Assignee: **Corrigent Systems 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 941 days.

(21) Appl. No.: **10/461,807**

(22) Filed: **Jun. 13, 2003**

(65) **Prior Publication Data**

US 2004/0252717 A1 Dec. 16, 2004

(51) **Int. Cl.**
H04J 3/16 (2006.01)
H04J 12/28 (2006.01)
G06F 15/173 (2006.01)

(52) **U.S. Cl.** **370/466**; 370/389; 370/401;
370/395.53; 709/224; 709/249

(58) **Field of Classification Search** 370/395.6,
370/545, 389, 401, 395.53, 463-469; 709/218,
709/224, 230, 249

See application file for complete search history.

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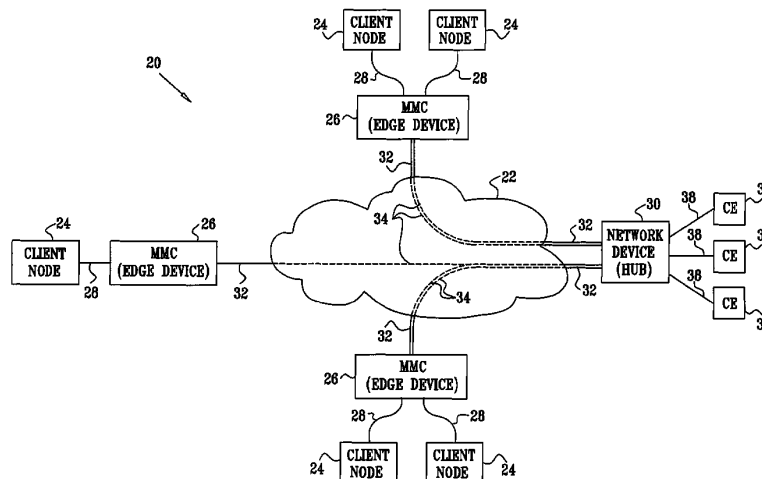
(Continued)

Primary Examiner—Edan Orgad
Assistant Examiner—Venkatesh Haliyur
(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

(57) **ABSTRACT**

A method for data communications includes linking a plurality of edge devices to communicate with a remote network device via a network in accordance with a packet-oriented Layer 2 communication protocol. At each of the plurality of edge devices, incoming data frames are received from client nodes in accordance with respective native Layer 2 protocols, at least one of which is different from the packet-oriented Layer 2 communication protocol. The received incoming data frames are converted at each of the edge devices from at least a first format specified by the native Layer 2 protocols to a second format specified by the packet-oriented Layer 2 communication protocol. The incoming data frames are transmitted in the second format via the network to the hub.

27 Claims, 2 Drawing Sheets





US007418000B2

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

(10) **Patent No.:** **US 7,418,000 B2**
(45) **Date of Patent:** **Aug. 26, 2008**

(54) **AUTOMATED WEIGHT CALCULATION FOR PACKET NETWORKS**

(75) Inventors: **Leon Bruckman**, Petah Tikva (IL); **Gal Mor**, Herzliya (IL)

(73) Assignee: **Corrigent Systems Ltd. (IL)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 717 days.

(21) Appl. No.: **10/861,272**

(22) Filed: **Jun. 3, 2004**

(65) **Prior Publication Data**

US 2005/0271084 A1 Dec. 8, 2005

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/412; 370/468**

(58) **Field of Classification Search** **370/412, 370/395.41, 395.42, 395.43**

See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Chau Nguyen

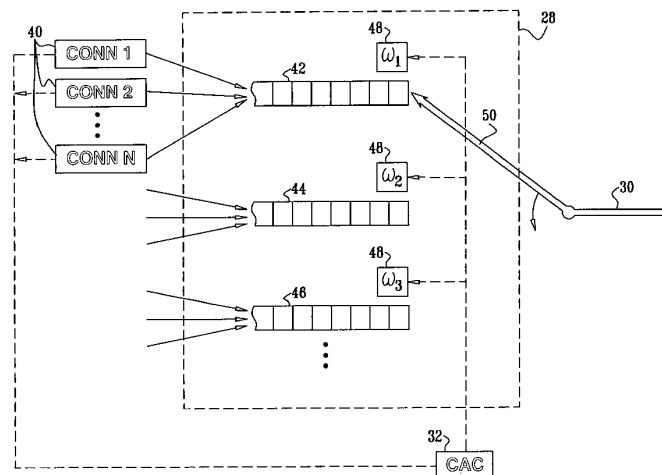
Assistant Examiner—Suk Jin Kang

(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

(57) **ABSTRACT**

A method for communication includes setting respective overbooking ratios for multiple categories of data traffic, and assigning respective bandwidth allocations to a plurality of connections for transmitting the data traffic in one or more of the categories over a network. The data traffic from the connections is coupled into respective queues, such that each of the queues is associated with one or more of the connections. Respective weights are computed for the queues responsively to the bandwidth allocations and to the overbooking ratios of the categories of the data traffic to be transmitted on the connections that are associated with each of the queues. A multiplexer multiplexes among the queues responsively to the respective weights so as to transmit the data traffic from the connections over a link in the network.

16 Claims, 3 Drawing Sheets





US007420922B2

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

(10) **Patent No.:** **US 7,420,922 B2**
(45) **Date of Patent:** **Sep. 2, 2008**

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6,624,917 B1 9/2003 Paschal et al.
- (75) Inventors: **Leon Bruckman**, Petah Tikva (IL); **Rafi Harel**, Beit Hashmonia (IL); **Muly Ilan**, Ramat Gan (IL)
- (73) Assignee: **Corrigent Systems 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 1041 days.

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(21) Appl. No.: **10/387,657**

U.S. Appl. No. 10/211,066, Office Action dated Sep. 29, 2006, 9 pages.

(22) Filed: **Mar. 12, 2003**

(65) **Prior Publication Data**

US 2004/0179518 A1 Sep. 16, 2004

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Primary Examiner—Wing F. Chan

Assistant Examiner—Gregory B Sefcheck

(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

- (51) **Int. Cl.**
H04J 3/22 (2006.01)
H04L 12/26 (2006.01)
H04L 12/28 (2006.01)
G06F 15/16 (2006.01)

(52) **U.S. Cl.** **370/236; 370/252; 370/254; 709/208; 709/233**

(58) **Field of Classification Search** None
See application file for complete search history.

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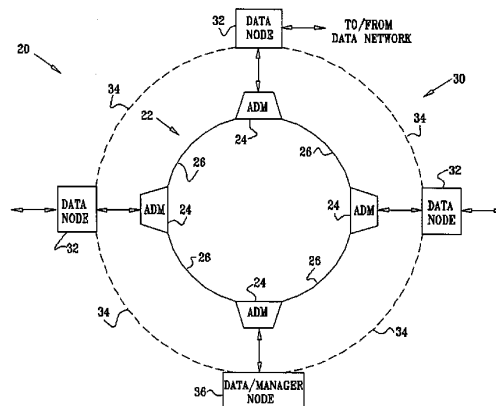
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(57) **ABSTRACT**

A method for changing a network characteristic or capability, such as the communication rate of network segments, software version or protocol. All nodes in the network perform the change synchronously while continuing to communicate within the existing capabilities. A new configuration is downloaded to the nodes, and a manager node exchanges validation messages with the other nodes in order to verify that the nodes can be reconfigured and will be able to complete the process successfully. The manager node then sends a command message to the other nodes to execute the change. In response, the other nodes begin substantially simultaneously to communicate in accordance with the new characteristics and/or capabilities. This method helps to minimize the duration of the upgrade process, while avoiding traffic hits and minimizing abnormal operation that may occur during the upgrade.

18 Claims, 5 Drawing Sheets





US007463580B2

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

(10) **Patent No.:** **US 7,463,580 B2**
(45) **Date of Patent:** **Dec. 9, 2008**

- (54) **RESOURCE SHARING AMONG NETWORK TUNNELS**
- (75) Inventors: **Gideon Agmon**, Kfar-Sava (IL); **Moran Roth**, Tel-Aviv (IL)
- (73) Assignee: **Corrigent Systems, 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 397 days.

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(21) Appl. No.: **11/305,486**

(22) Filed: **Dec. 15, 2005**

(Continued)

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04L 12/26 (2006.01)

(52) **U.S. Cl.** **370/218**; 370/222; 709/239;
714/4

(58) **Field of Classification Search** 370/248,
370/395.5, 218, 216, 225, 227; 709/239;
379/22.01; 714/4

See application file for complete search history.

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Primary Examiner—Hassan Kizou
Assistant Examiner—Jeffrey M Rutkowski
(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

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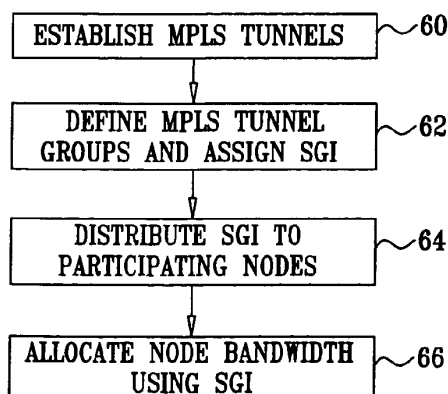
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(57) **ABSTRACT**

A method for communication includes defining a resource-sharing group including two or more communication paths that traverse at least two different routes through a communication network, the routes traversing at least one common network element. A notification of an affiliation of the two or more communication paths with the resource-sharing group is distributed over the network. A resource associated with the at least one common network element is allocated so as to share an allocation of the resource among the communication paths in the resource-sharing group responsively to the notification.

22 Claims, 2 Drawing Sheets





US007478382B2

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

(10) **Patent No.:** **US 7,478,382 B2**
(45) **Date of Patent:** **Jan. 13, 2009**

(54) **SYNCHRONIZED RING SOFTWARE
DOWNLOAD**

(75) Inventors: **Zvika Menahemi**, Modi'in (IL); **Alex
Levit**, Ramat-Gan (IL); **Muly Ilan**,
Ramat-Gan (IL)

(73) Assignee: **Corrigent Systems 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 907 days.

(21) Appl. No.: **10/951,575**

(22) Filed: **Sep. 27, 2004**

(65) **Prior Publication Data**
US 2006/0070058 A1 Mar. 30, 2006

(51) **Int. Cl.**
G06F 9/45 (2006.01)

(52) **U.S. Cl.** **717/168**

(58) **Field of Classification Search** **717/171**
See application file for complete search history.

(56) **References Cited**
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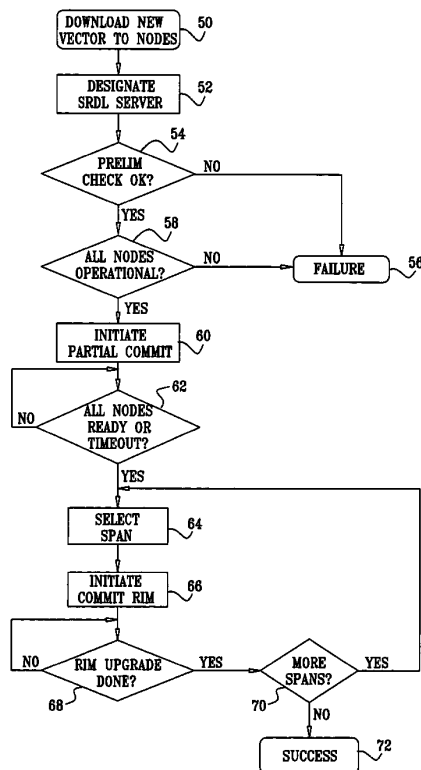
Primary Examiner—John Chavis

(74) *Attorney, Agent, or Firm*—Townsend and Townsend and
Crew LLP

(57) **ABSTRACT**

According to a disclosed embodiment of the invention, software download and installation in a ring network are synchronized in a two-stage operation in order to minimize service disruption time. In a first phase, the MPM's and UIM's in all the nodes are upgraded in parallel. Each node has two main processing modules, allowing one to be upgraded while the other continues to operate the node. In a second phase, the RIM's at the edges of a single ring segment are upgraded, one ring segment after the other, during which time each terminal node continues to operate with respect to the span connecting to its opposite side. While a span is non-operative, traffic is wrapped or diverted as necessary to maintain service of the ring. While one RIM of a node is being upgraded, the other RIM remains operational.

33 Claims, 5 Drawing Sheets





US007483399B2

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

(10) **Patent No.:** **US 7,483,399 B2**
(45) **Date of Patent:** **Jan. 27, 2009**

(54) **SIGNALING MPLS OVER RPR RINGS**

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(76) Inventors: **David Zelig**, 1 Hadganim Street,
Givataim (IL); **Leon Bruckman**, 3 Degel
Reuven Street, Petah Tikva (IL); **Yoav**
Kotser, 78 Jabotinsky Street, Givataim
(IL)

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 1053 days.

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EP 105 2808 A1 11/2000

(21) Appl. No.: **10/369,953**

(22) Filed: **Feb. 20, 2003**

(Continued)

(65) **Prior Publication Data**

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Primary Examiner—Michael J Moore, Jr.

Related U.S. Application Data

(60) Provisional application No. 60/386,468, filed on Jun.
5, 2002.

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/258**; 370/392; 370/522

(58) **Field of Classification Search** None
See application file for complete search history.

(57) **ABSTRACT**

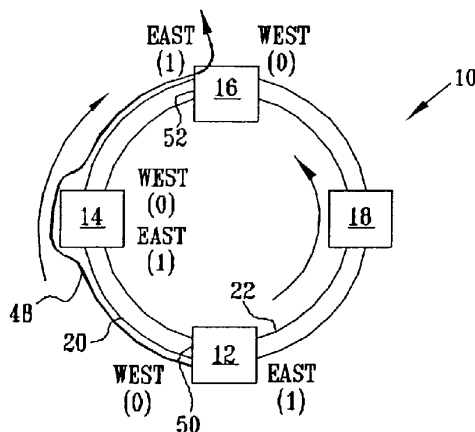
Explicit routing of network traffic over RPR rings using
MPLS signaling techniques, including unnumbered links. A
modified LSP_TUNNEL_INTERFACE_ID object is pro-
vided with a RPR IP address instead of the conventional LSR
Router ID, and with a direction indicator in place of the
conventional interface ID. A novel subobject is included in
the ERO and RRO, which holds the RPR IP address of the
sending node in place of the conventional router ID, and a
direction indicator in place of the conventional interface ID.
The network nodes inspect the directional indicator that is
received in a path message or a Resv message to determine the
direction in which traffic is to be sent and received in an
explicit route.

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6 Claims, 4 Drawing Sheets





US007515536B2

(12) **United States Patent**
Roth

(10) **Patent No.:** **US 7,515,536 B2**
(45) **Date of Patent:** **Apr. 7, 2009**

(54) **TRANSPARENT TRANSPORT OF FIBRE
CHANNEL TRAFFIC OVER
PACKET-SWITCHED NETWORKS**

(75) Inventor: **Moran Roth**, Tel-Aviv (IL)

(73) Assignee: **Corrigent Systems 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 129 days.

(21) Appl. No.: **11/479,595**

(22) Filed: **Jun. 29, 2006**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 60/698,538, filed on Jul.
11, 2005.

(51) **Int. Cl.**
H04L 12/26 (2006.01)
H04L 12/28 (2006.01)
H04J 3/18 (2006.01)

(52) **U.S. Cl.** **370/230; 370/391; 370/477**

(58) **Field of Classification Search** **370/229,**
370/230, 232, 235, 236, 391, 400, 401, 464-467,
370/477

See application file for complete search history.

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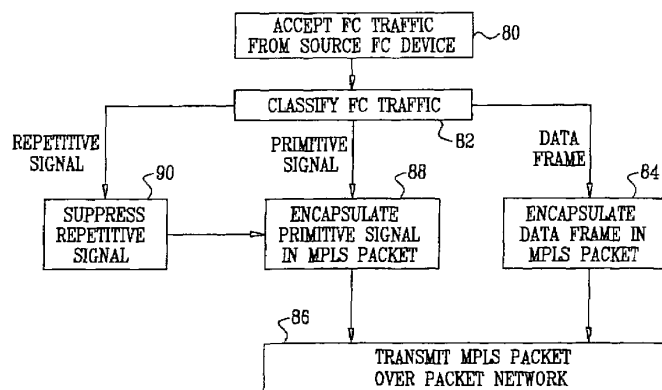
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Primary Examiner—Hong Cho
(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for transporting fibre channel (FC) traffic over a packet-switched communication network includes identifying a sub-sequence of repetitive FC signals in a first sequence of FC words accepted over a FC link from a source FC device. The first sequence of FC words is translated into a second sequence of data packets in accordance with a communication protocol supported by the packet-switched communication network. The second sequence includes a repetition indication packet that identifies the sub-sequence of repetitive FC signals. The second sequence of the data packets is transported to a receiver over the packet-switched communication network using the communication protocol.

15 Claims, 5 Drawing Sheets





US007515605B2

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

(10) **Patent No.:** **US 7,515,605 B2**
(45) **Date of Patent:** **Apr. 7, 2009**

(54) **EFFICIENT TRANSPORT OF TDM SERVICES
OVER PACKET NETWORKS**

(75) Inventors: **Rafi Harel**, Beit Hashmonia (IL); **David Zelig**, Givataim (IL); **Leon Bruckman**, Petah Tikva (IL); **Nitzan Kappel**, Zoran (IL)

(73) Assignee: **Corrigent Systems 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 1424 days.

(21) Appl. No.: **10/396,008**

(22) Filed: **Mar. 24, 2003**

(65) **Prior Publication Data**
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H04J 3/16 (2006.01)
(52) **U.S. Cl.** **370/466**; 370/352; 370/474
(58) **Field of Classification Search** 370/465,
370/466, 469, 470, 472, 474, 476, 498, 503,
370/352, 353, 354, 355, 356, 400, 401
See application file for complete search history.

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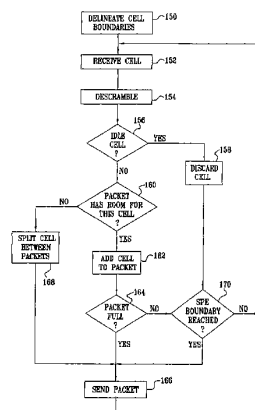
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Primary Examiner—Chi H. Pham
Assistant Examiner—Kevin Mew
(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

(57) **ABSTRACT**

A method for data communications includes receiving a time-division-multiplexed (TDM) input signal carrying a payload comprising data and determining whether the data comprise synchronous or non-synchronous data. A first encapsulation scheme is selected if the data comprise synchronous data, and a second encapsulation scheme is selected if the data comprise non-synchronous data. The data are encapsulated for transmission over a packet-switched network in accordance with the selected encapsulation scheme.

11 Claims, 9 Drawing Sheets





US007545740B2

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

(10) **Patent No.:** **US 7,545,740 B2**
(45) **Date of Patent:** **Jun. 9, 2009**

(54) **TWO-WAY LINK AGGREGATION**

(75) Inventors: **David Zelig**, Givatayim (IL); **Ronen Solomon**, Givatayim (IL); **Uzi Khill**, Netanya (IL)

(73) Assignee: **Corrigent Systems 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 461 days.

(21) Appl. No.: **11/279,045**

(22) Filed: **Apr. 7, 2006**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04L 12/56 (2006.01)

(52) **U.S. Cl.** **370/230; 370/235; 370/445**

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Chi H. Pham

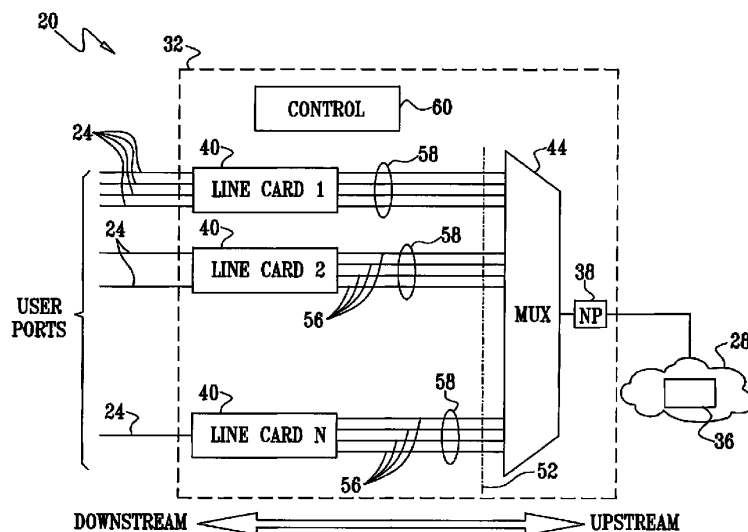
Assistant Examiner—Soon D Hyun

(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for communication includes coupling a network node to one or more interface modules using a first group of first physical links arranged in parallel. Each of the one or more interface modules is coupled to a communication network using a second group of second physical links arranged in parallel. A data frame having frame attributes sent between the communication network and the network node is received. A first physical link out of the first group and a second physical link out of the second group are selected in a single computation based on at least one of the frame attributes. The data frame is sent over the selected first and second physical links. This method allows two or more link aggregation groups to be concatenated, using a single processing stage to determine port assignment for each frame in each of the link aggregation groups.

31 Claims, 3 Drawing Sheets





US007551599B2

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

(10) **Patent No.:** **US 7,551,599 B2**
(45) **Date of Patent:** **Jun. 23, 2009**

(54) **LAYER-3 NETWORK ROUTING WITH RPR
LAYER-2 VISIBILITY**

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5,025,807 A 6/1991 Zabara

(75) Inventors: **Alex Levit**, Ramat-Gan (IL); **Gideon
Agmon**, Kfar-Sava (IL); **Ronen
Solomon**, Givatayim (IL); **Zvika
Menahemi**, Modi'in (IL)

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(73) Assignee: **Corrigent Systems Ltd.**, Tel Aviv (IL)

WO WO 01/10375 2/2001

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 1131 days.

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ing Group, Apr. 1998.

(21) Appl. No.: **10/812,321**

(22) Filed: **Mar. 29, 2004**

(Continued)

(65) **Prior Publication Data**

US 2005/0213558 A1 Sep. 29, 2005

Primary Examiner—Wing F Chan

Assistant Examiner—Prenell P Jones

(74) *Attorney, Agent, or Firm*—Husch Blackwell Sanders
LLP Welsh & Katz

(51) **Int. Cl.**

H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/351; 370/254**

(58) **Field of Classification Search** 370/351,
370/419, 223, 392, 254, 222, 238, 405, 406,
370/221, 230, 255, 401; 709/238, 227, 201,
709/239, 242, 224, 223; 705/1, 10
See application file for complete search history.

(57) **ABSTRACT**

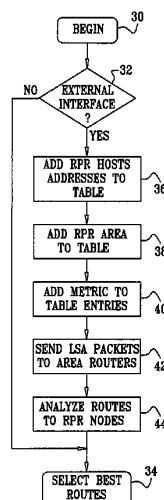
Routing tables of OSI layer-3 network elements are modified
in order to enable entry to a RPR subnet at different entry
points. This enables virtual tunnels or routing paths to utilize
all existing entry links to the RPR subnet and to minimize cost
factors, such as the number of RPR spans required to traverse
the RPR subnet from the entry point to a destination RPR
node. The routing tables of RPR subnet elements are modi-
fied, such that traffic leaving different elements but destined
for the same network location outside the RPR subnet may
have individualized RPR exit nodes. The respective RPR exit
points for the network elements are chosen to minimize cost
factors, such as the number of RPR spans required to reach the
exit node from each RPR node.

(56) **References Cited**

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84 Claims, 2 Drawing Sheets





US007593400B2

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

(10) **Patent No.:** **US 7,593,400 B2**
(45) **Date of Patent:** **Sep. 22, 2009**

(54) **MAC ADDRESS LEARNING IN A
DISTRIBUTED BRIDGE**

(75) Inventors: **David Zelig**, Givatayim (IL); **Leon
Bruckman**, Petah Tikva (IL); **Ronen
Solomon**, Givatayim (IL); **Zeev Oster**,
Modi'in (IL); **David Rozenberg**,
Rehovot (IL); **Uzi Khill**, Netanya (IL)

(73) Assignee: **Corrigent Systems Ltd.**, Tel Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/419,444**

(22) Filed: **May 19, 2006**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H04L 12/54 (2006.01)

(52) **U.S. Cl.** **370/389; 370/392; 370/401**

(58) **Field of Classification Search** **370/389,
370/392, 400, 401, 428, 475; 709/238, 245**
See application file for complete search history.

(56) **References Cited**

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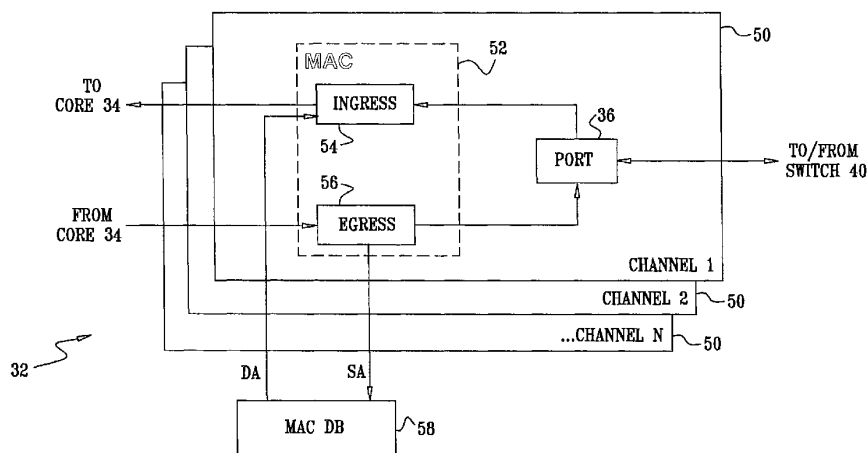
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Primary Examiner—Wing F Chan
Assistant Examiner—Duc T Duong
(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for communication includes configuring a network
node having at least first and second line cards, the line cards
having respective ports, to operate as a distributed media
access control (MAC) bridge in a Layer 2 network. Each of
the line cards has a respective forwarding database (FDB).
Upon receiving a data packet on a port of the network node
from a MAC source address, the data packet is conveyed to at
least the first line card for transmission to the MAC destina-
tion address. The MAC source address of the data packet is
checked against the records in the FDB of the first line card.
If the FDB does not contain a record of an association of the
MAC source address with the port on which the data packet
was received, the record is added to the FDB of the first line
card, which sends a message to at least the second line card
informing the second line card of the association.

20 Claims, 3 Drawing Sheets





US007596088B2

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

(10) **Patent No.:** **US 7,596,088 B2**
(45) **Date of Patent:** **Sep. 29, 2009**

- (54) **ROUTE SELECTION WITH BANDWIDTH SHARING OPTIMIZATION OVER RINGS**
- (75) Inventors: **Gideon Agmon**, Kfar-Sava (IL); **Yossi Barsheshet**, Ashdod (IL)
- (73) Assignee: **Corrigent Systems 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 91 days.

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(21) Appl. No.: **11/339,148**

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(65) **Prior Publication Data**
US 2007/0171832 A1 Jul. 26, 2007

- (51) **Int. Cl.**
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- (52) **U.S. Cl.** **370/230; 370/229; 370/328; 370/338; 370/400**
- (58) **Field of Classification Search** **370/238, 370/404, 230, 395.5, 328, 338**
See application file for complete search history.

(56) **References Cited**
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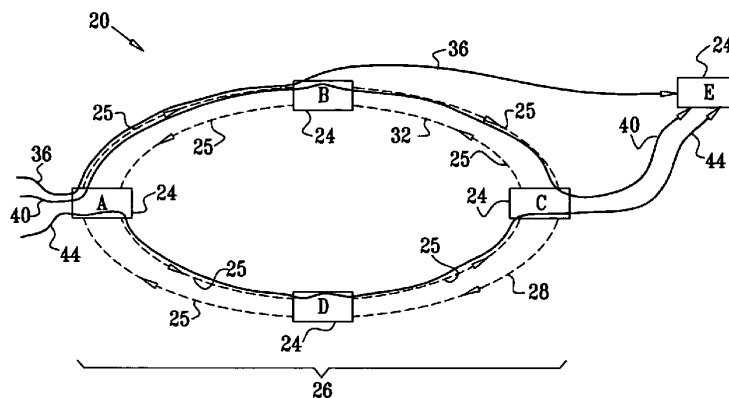
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Primary Examiner—Kevin C Harper
Assistant Examiner—Henry Baron
(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for establishing a connection through a communication network that includes multiple segments includes providing a sharing definition defining a sharing of bandwidth among connections in the network. Two or more candidate routes for a new connection to be established through the network are identified. For each of the two or more candidate routes, a cumulative additional bandwidth reservation to be allocated to the new connection in the segments along the candidate route is calculated responsively to the sharing definition. A preferred route having a minimum value of the cumulative additional bandwidth reservation is selected out of the two or more candidate routes. The new connection is established using the preferred route.

20 Claims, 2 Drawing Sheets





US007626930B2

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

(10) **Patent No.:** **US 7,626,930 B2**
(45) **Date of Patent:** **Dec. 1, 2009**

(54) **HASH-BASED MULTI-HOMING**

(75) Inventors: **Gideon Agmon**, Kfar-Sava (IL); **David Zelig**, Ramat-Gan (IL); **Zvika Menahemi**, Modi'in (IL)

(73) Assignee: **Corrigent Systems 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 314 days.

(21) Appl. No.: **11/778,286**

(22) Filed: **Jul. 16, 2007**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 11/559,037, filed on Nov. 13, 2006, now abandoned.

(51) **Int. Cl.**
G06F 15/173 (2006.01)
H04L 12/24 (2006.01)
H04L 12/56 (2006.01)

(52) **U.S. Cl.** **370/230; 370/235; 370/400; 370/401; 709/238**

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Chi H Pham

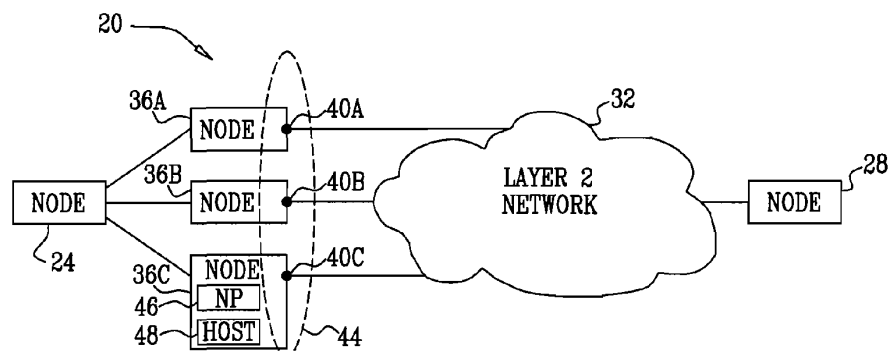
Assistant Examiner—Soon-Dong D Hyun

(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for communication between first and second nodes via a communication network includes assigning multiple communication ports in two or more network nodes between the first and second nodes to serve as member ports of a multi-homing group (MHG). Each of the member ports is associated with a different, respective communication path between the first and second nodes via the communication network. A frame transmitted from the first node to the second node is accepted at the two or more network nodes. The frame has a header including header fields. A single port is selected from among the member ports by applying a hashing function to one or more of the header fields at each of the two or more network nodes. The frame is forwarded via the selected port over the respective communication path that is associated with the selected port.

28 Claims, 3 Drawing Sheets





US007660234B2

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

(10) **Patent No.:** **US 7,660,234 B2**
(45) **Date of Patent:** **Feb. 9, 2010**

(54) **FAULT-TOLERANT MEDIUM ACCESS
CONTROL (MAC) ADDRESS ASSIGNMENT
IN NETWORK ELEMENTS**

(75) Inventors: **Shmuel Ilan**, Ramat-Gan (IL); **Leon
Bruckman**, Petah Tikva (IL)

(73) Assignee: **Corrigent Systems Ltd.**, Tel Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this
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(21) Appl. No.: **11/534,556**

(22) Filed: **Sep. 22, 2006**

(65) **Prior Publication Data**
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(52) **U.S. Cl.** **370/216; 370/389; 370/392;
370/401**

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**
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Primary Examiner—Steven H Nguyen

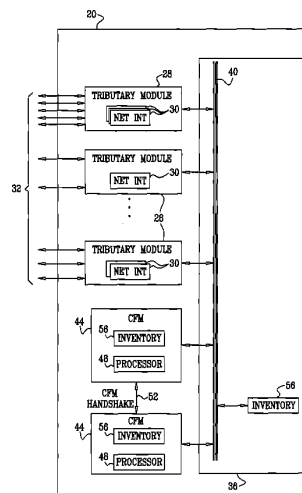
(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A network element includes a backplane, which includes a
backplane memory holding first medium access control
(MAC) address values. The network element further includes
multiple tributary modules coupled to the backplane, which
include network interfaces that are configured to communi-
cate over network trunks using MAC addresses that are
respectively assigned to the network interfaces. The network
element further includes a common function module (CFM),
which communicates with the tributary modules and the
backplane memory via the backplane, and which includes a
CFM memory holding second MAC address values.

The CFM is arranged to assign the MAC addresses to the
network interfaces by selecting the MAC addresses from
among the first MAC address values when the CFM is able to
access the backplane memory, and by selecting the MAC
addresses from among the second MAC address values when
the CFM is unable to access the backplane memory.

19 Claims, 2 Drawing Sheets





US007660303B2

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

(10) **Patent No.:** **US 7,660,303 B2**
(45) **Date of Patent:** **Feb. 9, 2010**

(54) **POINT-TO-MULTIPOINT FUNCTIONALITY
IN A BRIDGED NETWORK**

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(75) Inventors: **Ronen Solomon**, Givatayim (IL); **Leon Bruckman**, Petah Tikva (IL); **Rafi Ram**, Herzlia (IL); **David Zelig**, Ramat-Gan (IL); **Shachar Katz**, Raanana (IL)

(73) Assignee: **Corrigent Systems Ltd.**, Tel Aviv (IL)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 527 days.

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(21) Appl. No.: **11/508,599**

(22) Filed: **Aug. 22, 2006**

(65) **Prior Publication Data**

US 2008/0049764 A1 Feb. 28, 2008

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Primary Examiner—Chirag G Shah

Assistant Examiner—Otis L Thompson, Jr.

(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/389; 370/401**

(58) **Field of Classification Search** None
See application file for complete search history.

(57) **ABSTRACT**

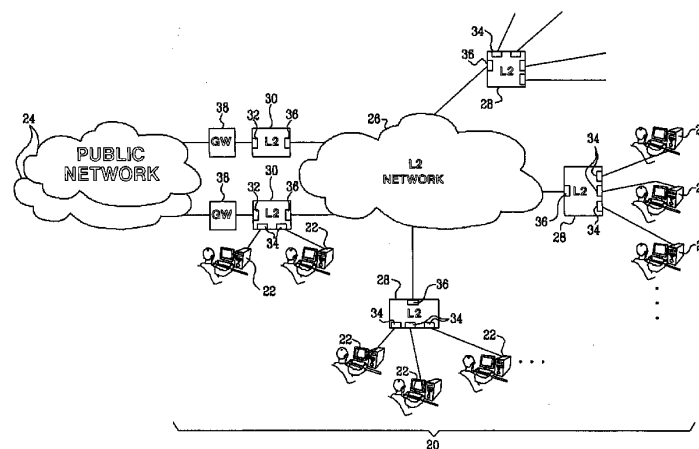
A method for communication includes coupling a group of switches in a Layer-2 bridged network. The interfaces of the switches are configured so that at least one interface of at least one of the switches is configured as a first interface type, and a plurality of other interfaces are configured as a second interface type. Upon receiving frames through the interfaces of the first and second types for transmission over the network, the received frames are labeled with corresponding first and second type indications. The frames are forwarded through the Layer-2 bridged network using the switches responsively to the type indications. Frames labeled with the second type indication are permitted to be transmitted through the interfaces of the first type and prevented from being transmitted through the interfaces of the second type.

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20 Claims, 6 Drawing Sheets





US007697525B2

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

(10) **Patent No.:** **US 7,697,525 B2**
(45) **Date of Patent:** **Apr. 13, 2010**

(54) **FORWARDING MULTICAST TRAFFIC OVER LINK AGGREGATION PORTS**

(75) Inventors: **David Zelig**, Ramat-Gan (IL); **Rafi Ram**, Herzlia (IL); **Leon Bruckman**, Petah Tikva (IL); **Zeev Oster**, Modi'in (IL); **Ronen Solomon**, Givatayim (IL)

(73) Assignee: **Corrigent Systems 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 635 days.

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(21) Appl. No.: **11/644,773**

(22) Filed: **Dec. 21, 2006**

(65) **Prior Publication Data**

US 2008/0151890 A1 Jun. 26, 2008

(51) **Int. Cl.**
H04L 12/56 (2006.01)

(52) **U.S. Cl.** **370/390; 370/230.1; 455/453**

(58) **Field of Classification Search** **370/229-235, 370/389, 390; 455/453**

See application file for complete search history.

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Primary Examiner—Ricky Ngo

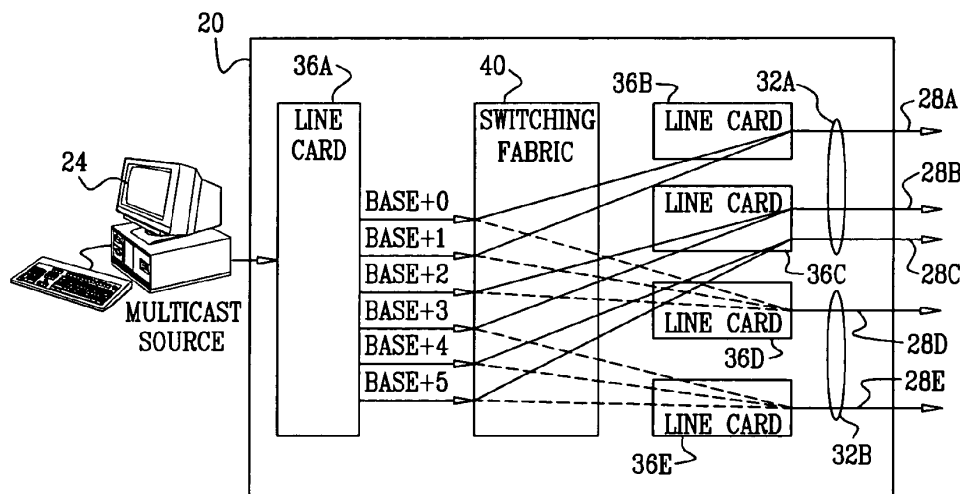
Assistant Examiner—Gary Mui

(74) Attorney, Agent, or Firm—Darby & Darby P.C.

(57) **ABSTRACT**

A network node in a communication network includes a plurality of ports, at least a subset of which is grouped in a link aggregation (LAG) group. The node includes packet processing logic, which is coupled to receive data packets having respective destination addresses that specify forwarding the packets to groups of multiple recipients through at least one of the ports and to process the data packets so as to forward only a single copy of each of the data packets via the output ports in the subset, while distributing forwarded copies of the data packets among the output ports in the subset so as to balance a traffic load within the LAG group.

24 Claims, 1 Drawing Sheet





US007697532B2

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

(10) **Patent No.:** **US 7,697,532 B2**
(45) **Date of Patent:** **Apr. 13, 2010**

(54) **FRAME CONCATENATION WITH DROP PRECEDENCE ASSIGNMENT**

(75) Inventors: **Rafi Ram**, Herzliya (IL); **Leon Bruckman**, Petah Tikva (IL)

(73) Assignee: **Corrigent Systems 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 666 days.

(21) Appl. No.: **11/704,615**

(22) Filed: **Feb. 8, 2007**

(65) **Prior Publication Data**

US 2008/0192747 A1 Aug. 14, 2008

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/392**; 370/230; 370/257;
370/395.42

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

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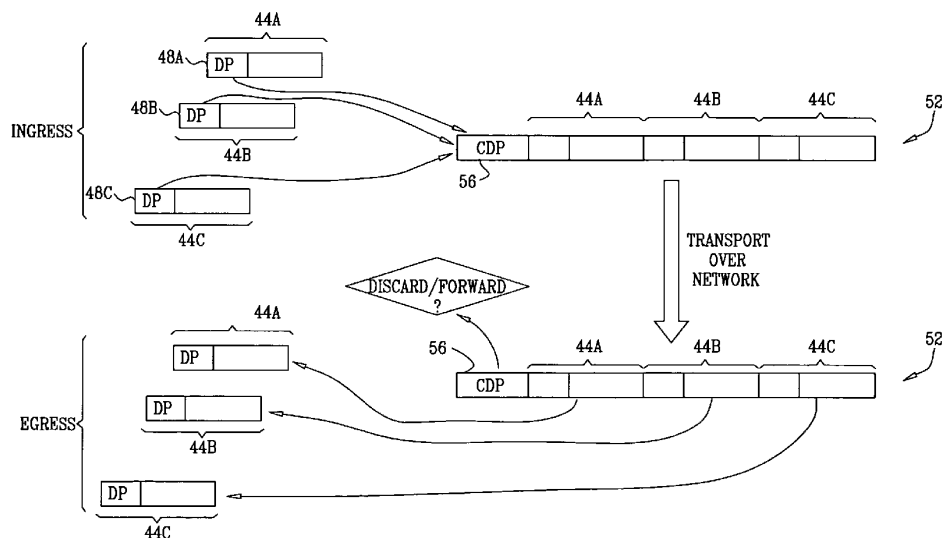
Primary Examiner—Duc C Ho

(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for communication includes encapsulating multiple data packets, which carry data and have respective drop precedence (DP) values selected from a range of possible DP values, to produce a concatenated frame of a transport protocol. A composite drop precedence (CDP) value is assigned from the range to the concatenated frame using a pseudo-random assignment function that depends on a distribution of the DP values of the data packets in the concatenated frame. The concatenated frame is transported through a communication network using the transport protocol, in accordance with the pseudo-randomly assigned CDP value.

19 Claims, 4 Drawing Sheets





US007697552B2

(12) **United States Patent**
Bruckman

(10) **Patent No.:** **US 7,697,552 B2**
(45) **Date of Patent:** **Apr. 13, 2010**

(54) **MAC ADDRESS SCALABILITY IN INTERCONNECTED RINGS**

(75) Inventor: **Leon Bruckman**, Petah Tikva (IL)

(73) Assignee: **Corrigent Systems 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 284 days.

(21) Appl. No.: **11/764,764**

(22) Filed: **Jun. 18, 2007**

(65) **Prior Publication Data**

US 2008/0107125 A1 May 8, 2008

Related U.S. Application Data

(60) Provisional application No. 60/857,285, filed on Nov. 6, 2006.

(51) **Int. Cl.**
H04L 12/66 (2006.01)

(52) **U.S. Cl.** **370/405**; 370/223; 370/404;
370/424

(58) **Field of Classification Search** 370/405,
370/223, 404, 424
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Dang T Ton

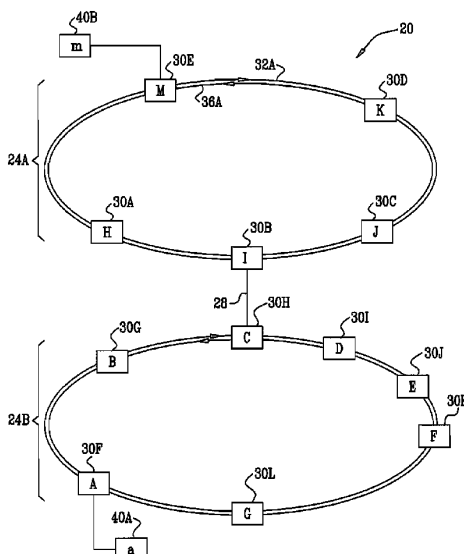
Assistant Examiner—Pamit Kaur

(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

A method for communication is used in a communication network that includes multiple ring nodes arranged in at least first and second ring networks, which are connected by one or more of the ring nodes serving as interconnect nodes. A data packet is accepted from a source user node served by the first ring network, for forwarding to a destination user node served by the second ring network. An identifier, which identifies an interconnect node in the first ring network through which the data packet is to be forwarded to the second ring network, is attached to the data packet in the first ring network. The data packet is forwarded over the first ring network, accepted at the interconnect node and, responsively to the identifier, forwarded from the interconnect node to the second ring network. The data packet is forwarded over the second ring network to the destination user node.

22 Claims, 5 Drawing Sheets





US007768928B2

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

(10) **Patent No.:** **US 7,768,928 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

(54) **CONNECTIVITY FAULT MANAGEMENT (CFM) IN NETWORKS WITH LINK AGGREGATION GROUP CONNECTIONS**

(75) Inventors: **Rafi Harel**, Beer Yaakov (IL); **Ronen Solomon**, Givataim (IL)

(73) Assignee: **Corrigent Systems 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 286 days.

(21) Appl. No.: **11/483,650**

(22) Filed: **Jul. 11, 2006**

(65) **Prior Publication Data**

US 2008/0016402 A1 Jan. 17, 2008

(51) **Int. Cl.**
H04J 1/16 (2006.01)
H04J 3/14 (2006.01)

(52) **U.S. Cl.** **370/241.1**; 370/241; 370/242; 370/245

(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

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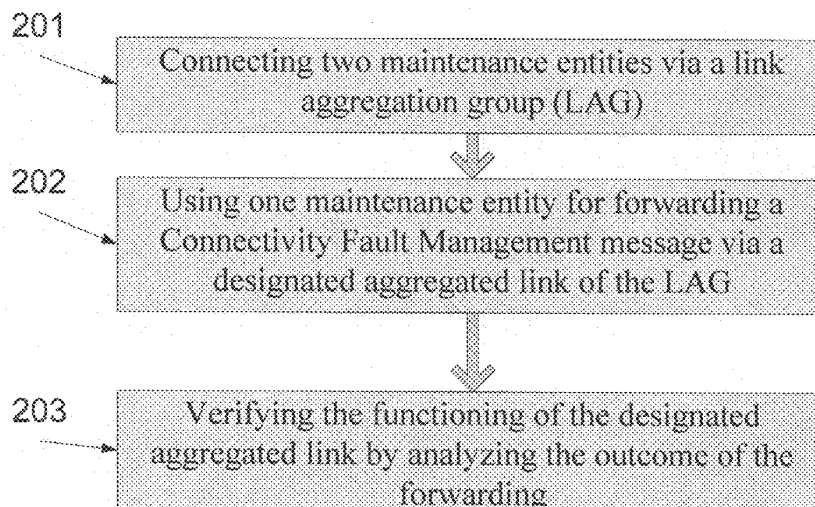
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Primary Examiner—Ajit Patel

(57) **ABSTRACT**

A maintenance entity for an Ethernet Connectivity Fault Management (CFM) domain. The maintenance entity comprises a port definer module and a connection which is connected to a group of aggregated link. The port definer module examines a designated link of the group by forwarding CFM messages via the designated link.

32 Claims, 8 Drawing Sheets





US007773508B2

(12) **United States Patent**
Khill

(10) **Patent No.:** **US 7,773,508 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **PROTECTING THE FILTERING DATABASE
IN VIRTUAL BRIDGES**

(75) Inventor: **Uzi Khill**, Netanya (IL)

(73) Assignee: **Corrigent Systems 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 665 days.

(21) Appl. No.: **11/595,635**

(22) Filed: **Nov. 9, 2006**

(65) **Prior Publication Data**

US 2007/0121654 A1 May 31, 2007

Related U.S. Application Data

(63) Continuation of application No. 10/061,721, filed on Feb. 1, 2002, now Pat. No. 7,154,899.

(51) **Int. Cl.**
G01R 31/08 (2006.01)

(52) **U.S. Cl.** **370/230; 370/256**

(58) **Field of Classification Search** **370/229, 370/230, 256, 401, 402; 709/238, 239, 240; 726/22-25**

See application file for complete search history.

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Primary Examiner—Jayanti K Patel

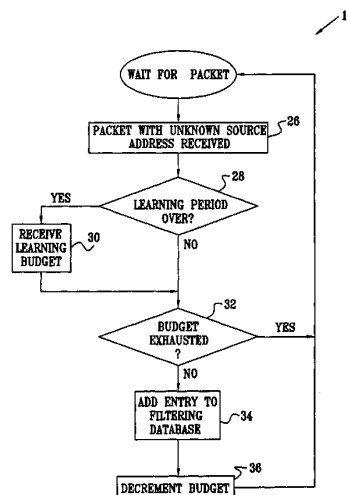
Assistant Examiner—Jung Park

(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman

(57) **ABSTRACT**

A method for budgeted learning of link information in a network includes providing a database to contain the link information, for use by an entity connected to the network in transferring traffic over the network, and setting a maximum rate for addition of entries to the database. New entries to be added to the database are determined responsive to the traffic on the network during a learning period. The new entries are added to the database only if the addition of the entries during the learning period has not exceeded the maximum rate.

10 Claims, 2 Drawing Sheets





US007808931B2

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

(10) **Patent No.:** **US 7,808,931 B2**
(45) **Date of Patent:** **Oct. 5, 2010**

(54) **HIGH CAPACITY RING COMMUNICATION NETWORK**

(75) Inventors: **David Zelig**, Givatayim (IL); **Leon Bruckman**, Petah Tiqva (IL); **Ronen Solomon**, Giv'atayim (IL); **Gideon Agmon**, Kfar-Sava (IL); **Vladimir Kleiner**, Yahud (IL)

(73) Assignee: **Corrigent Systems 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 843 days.

(21) Appl. No.: **11/367,231**

(22) Filed: **Mar. 2, 2006**

(65) **Prior Publication Data**

US 2007/0206618 A1 Sep. 6, 2007

(51) **Int. Cl.**
H04L 12/28 (2006.01)

(52) **U.S. Cl.** **370/258**

(58) **Field of Classification Search** 370/351–356,
370/389, 391, 394, 397, 395.43, 395.5, 395.51,
370/465, 535–538; 709/239–241
See application file for complete search history.

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Primary Examiner—Chirag G Shah

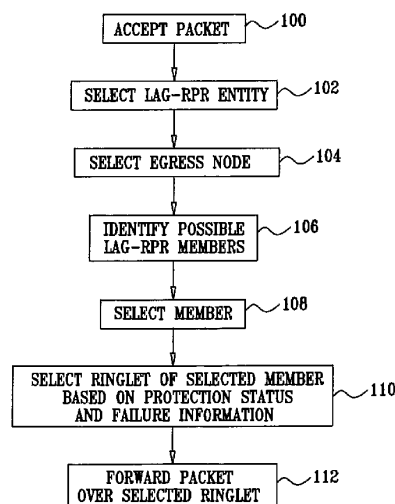
Assistant Examiner—Amarnauth Persaud

(74) Attorney, Agent, or Firm—Fish & Richardson P.C.

(57) **ABSTRACT**

A method for communication includes configuring a plurality of ring nodes to communicate over a communication network that includes two or more overlapping communication rings, each ring including two unidirectional ringlets in mutually-opposite directions. A data packet including one or more header fields is accepted at an ingress ring node. An egress ring node to which the data packet is to be forwarded by the ingress ring node is determined. A subset of the rings including one or more common rings that are connected to both the ingress and egress ring nodes is identified. A ringlet of a ring among the one or more common rings is selected responsively to a respective value of at least one of the header fields of the packet. The data packet is forwarded from the ingress ring node to the egress ring node over the selected ringlet.

29 Claims, 5 Drawing Sheets



SECTION 5

IPINVESTMENTS GROUP

*The Forum, Suite 140
3930 E. Jones Bridge Road
Atlanta, Georgia 30092*

*Main: (404) 962-8740
Fax: (404) 962-8741
www.ipinvestmentsgroup.com*

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Please direct any questions or inquiries to:

Ryan E. Strong
Principal
Direct Line – (404) 962-8743
rstrong@ipinvestmentsgroup.com

Grant E. Moss
Director
Direct Line – (404) 962-8738
gmoss@ipinvestmentsgroup.com