(12) **United States Patent**　　(10) Patent No.: **US 8,170,040 B2**
Konda　　(45) Date of Patent: ***May 1, 2012**

(54) **FULLY CONNECTED GENERALIZED BUTTERFLY FAT TREE NETWORKS**

(75) Inventor: **Venkat Konda**, San Jose, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 273 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/601,273**

(22) PCT Filed: **May 22, 2008**

(86) PCT No.: **PCT/US2008/064603**

§ 371 (c)(1),
(2), (4) Date: **Nov. 22, 2009**

(87) PCT Pub. No.: **WO2008/147926**

PCT Pub. Date: **Dec. 4, 2008**

(51) **Int. Cl.**
H04L 12/28　　(2006.01)
(52) **U.S. Cl.** **370/408**
(58) **Field of Classification Search** 370/351–357, 370/359–360, 369–370, 372, 375, 380, 386–390, 370/400, 408, 422, 427, 901, 902–903
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,991,168 A * 2/1991 Richards 370/381
5,018,129 A * 5/1991 Netravali et al. 398/55
(Continued)

Primary Examiner — Derrick Ferris
Assistant Examiner — Omar Ghowrwal

(57)　　**ABSTRACT**

A generalized butterfly fat tree network comprising ($\log_d N$) stages is operated in strictly nonblocking manner for unicast and in rearrangeably nonblocking manner for arbitrary fan-out multicast when $s \geqq 2$, and is operated in strictly nonblocking manner for arbitrary fan-out multicast when $s \geqq 3$, includes a leaf stage consisting of an input stage having

$$\frac{N}{d}$$

switches with each of them having d inlet links and s×d outgoing links connecting to its immediate succeeding stage switches, and an output stage having

$$\frac{N}{d}$$

switches with each of them having d outlet links and s×d incoming links connecting from switches in its immediate succeeding stage. The network also has ($\log_d N$)−1 middle stages with each middle stage, excepting the root stage, having
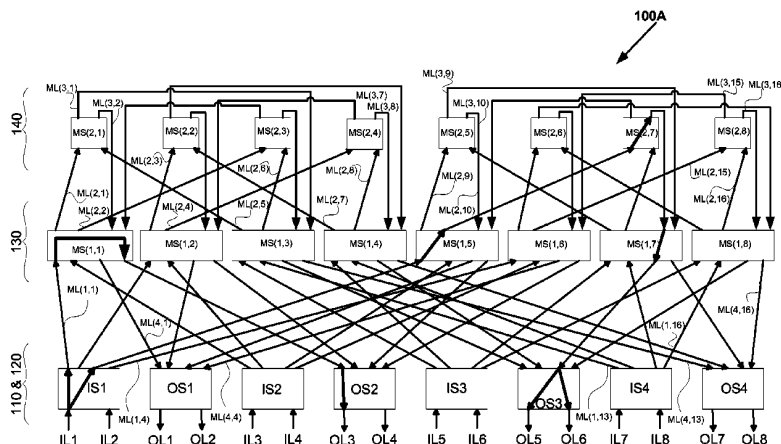
$$\frac{s \times N}{d}$$

switches, and each switch in the middle stage has d incoming links connecting from the switches in its immediate preceding stage, d incoming links connecting from the switches in its immediate succeeding stage, d outgoing links connecting to the switches in its immediate succeeding stage, d outgoing links connecting to the switches in its immediate preceding stage, and the root stage having

$$\frac{s \times N}{d}$$

switches, and each switch in the middle stage has d incoming links connecting from the switches in its immediate preceding stage and d outgoing links connecting to the switches in its immediate preceding stage.
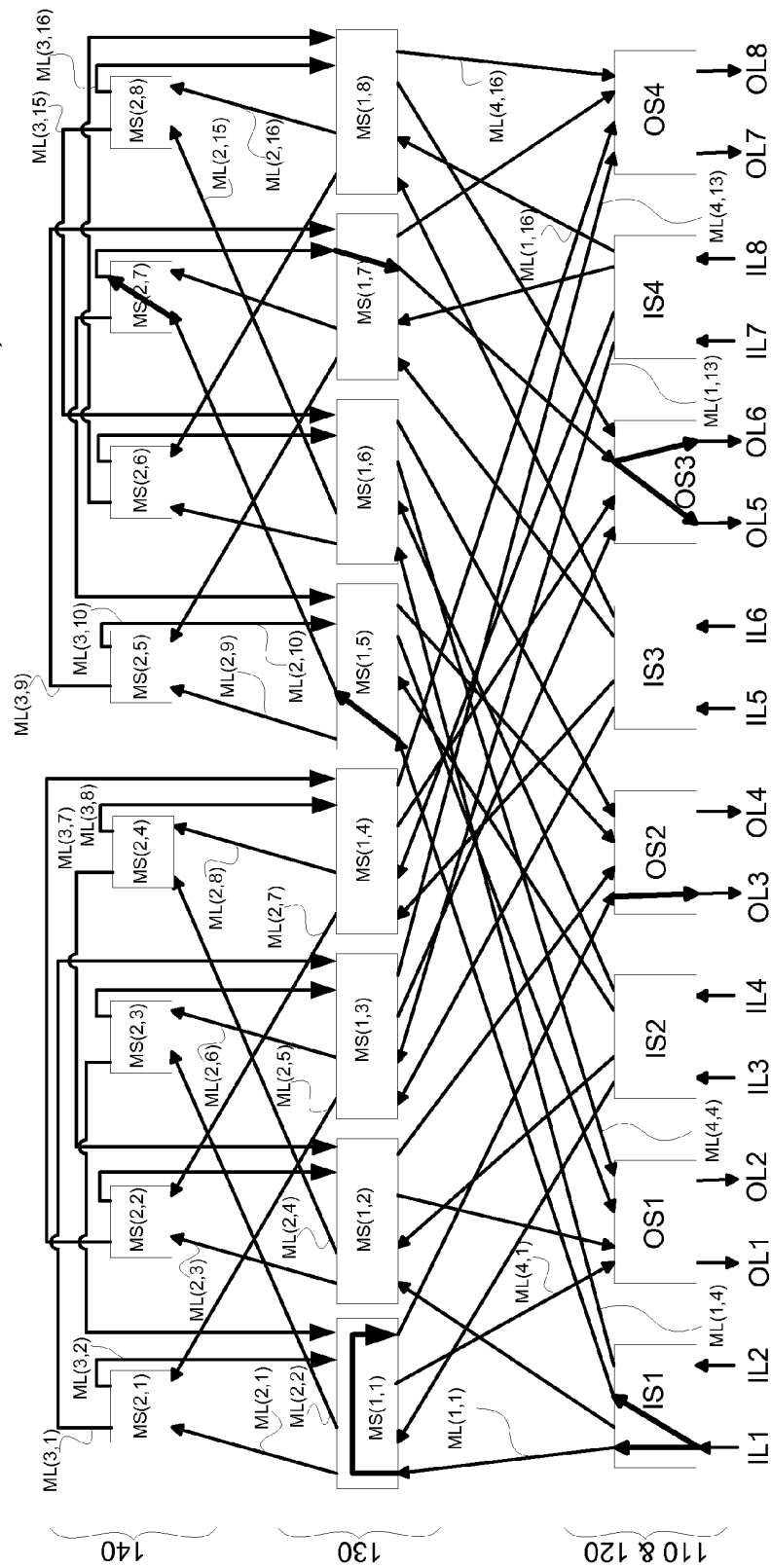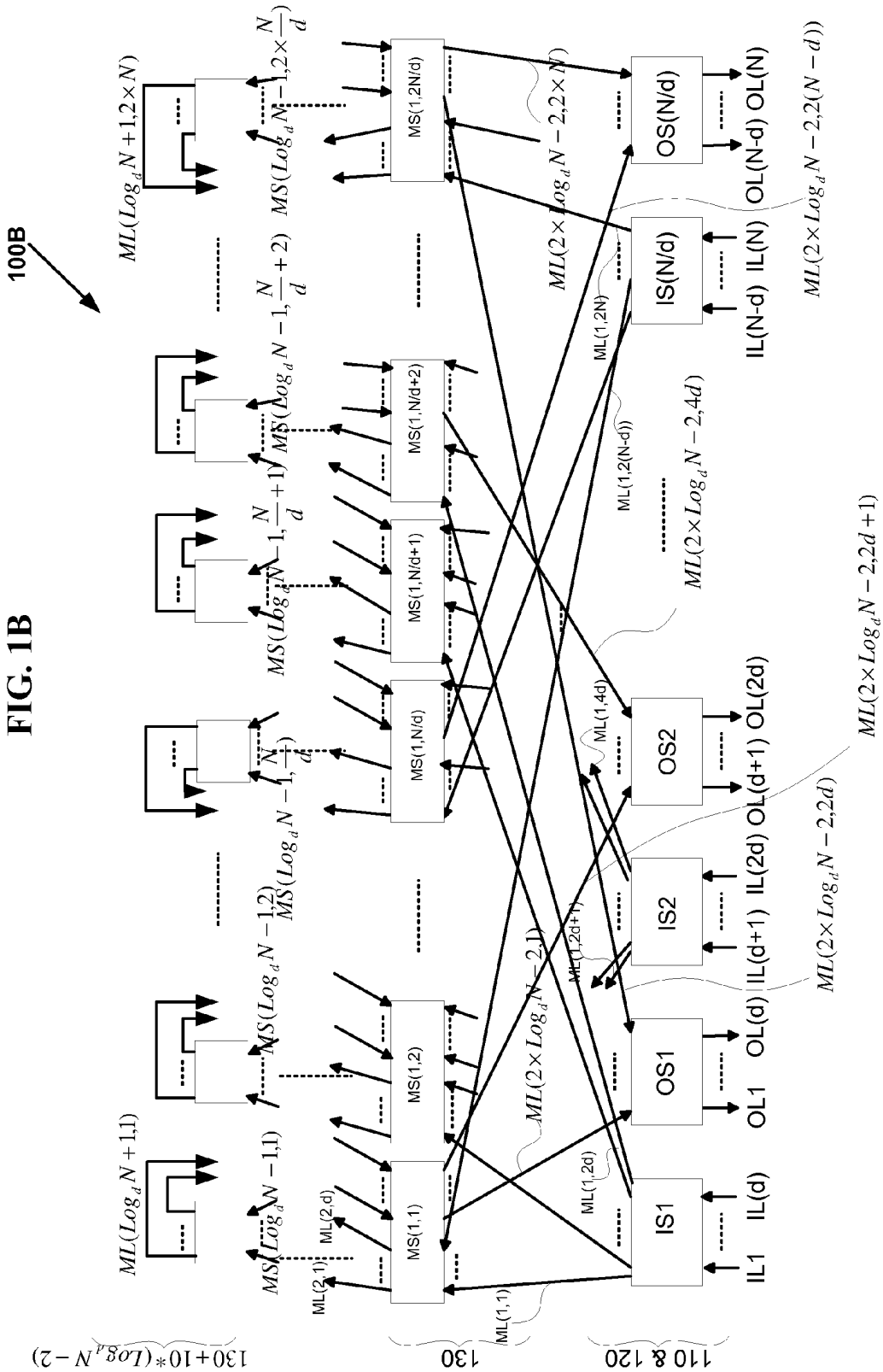
22 Claims, 20 Drawing Sheets

U.S. PATENT DOCUMENTS

5,179,551	A	*	1/1993	Turner	370/398
5,541,914	A	*	7/1996	Krishnamoorthy et al.	370/427
5,689,506	A	*	11/1997	Chiussi et al.	370/388
5,864,552	A	*	1/1999	Du et al.	370/388
6,307,852	B1	*	10/2001	Fisher et al.	370/352
6,452,926	B1	*	9/2002	Wiklund	370/388
6,868,084	B2	*	3/2005	Konda	370/395.1
6,885,669	B2	*	4/2005	Konda	370/395.1
7,378,938	B2	*	5/2008	Konda	340/2.22
7,424,010	B2	*	9/2008	Konda	370/388
7,424,011	B2	*	9/2008	Konda	370/388
2004/0032866	A1	*	2/2004	Konda	370/388
2004/0056757	A1	*	3/2004	Konda	340/2.22
2005/0053061	A1	*	3/2005	Konda	370/388
2005/0063410	A1	*	3/2005	Konda	370/432
2005/0094644	A1	*	5/2005	Konda	370/395.4
2005/0105517	A1	*	5/2005	Konda	370/370
2005/0117573	A1	*	6/2005	Konda	370/388
2005/0117575	A1	*	6/2005	Konda	370/389
2005/0129043	A1	*	6/2005	Konda	370/412
2006/0159078	A1	*	7/2006	Konda	370/386
2006/0165085	A1	*	7/2006	Konda	370/395.1
2006/0268691	A1	*	11/2006	Ramanan	370/229
2007/0053356	A1	*	3/2007	Konda	370/390
2010/0135286	A1	*	6/2010	Konda	370/388
2011/0044329	A1	*	2/2011	Konda	370/388

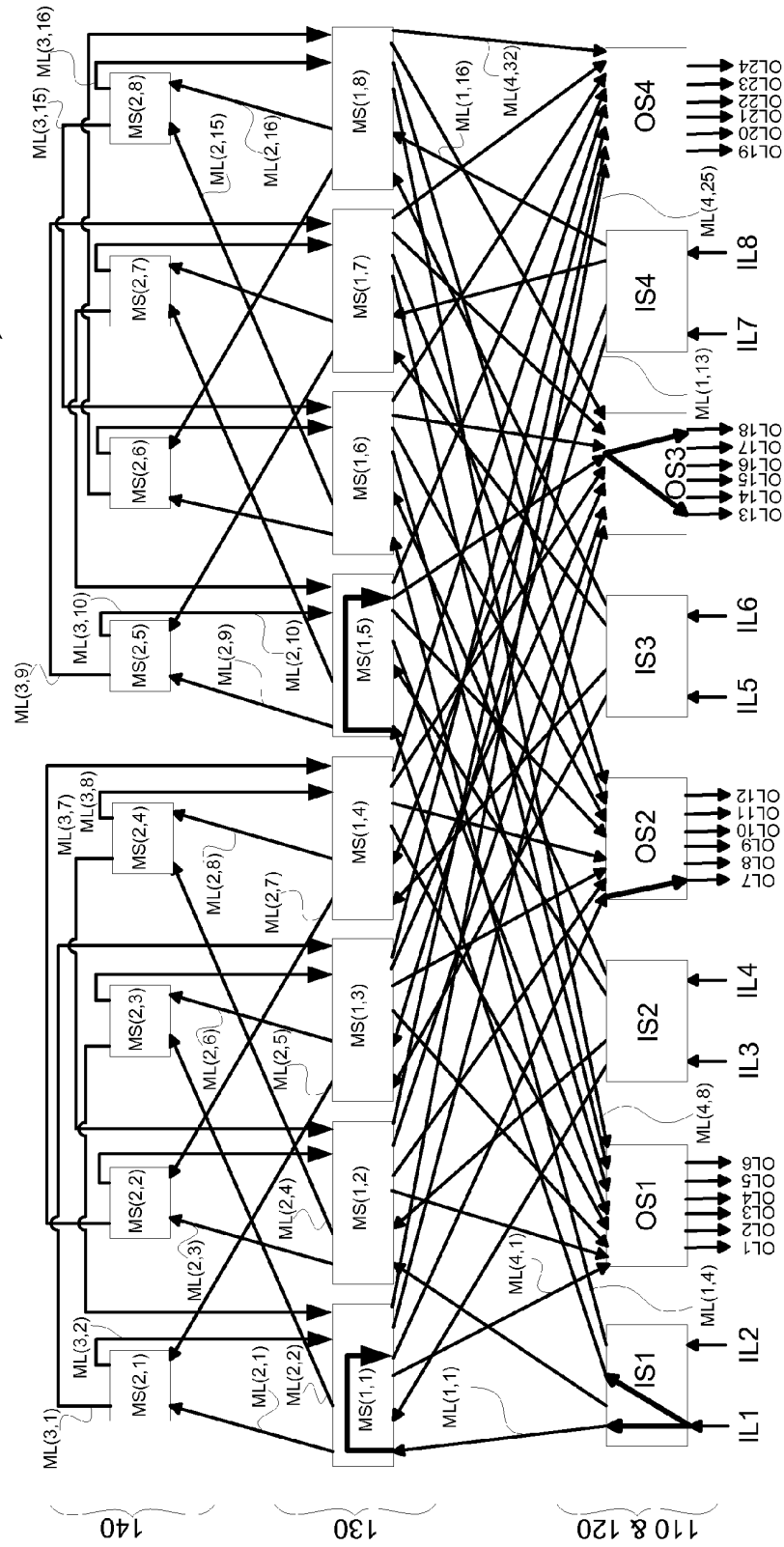* cited by examiner

FIG. 1A

100A

FIG. 1B

FIG. 1C

DOCKET ALARM

Explore Litigation Insights

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

Real-Time Litigation Alerts

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

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

Advanced Docket Research

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

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

Analytics At Your Fingertips

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

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

API

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

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

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

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.