December 22, 2000

UCSB's Dan Blumenthal Publishes on Routing Internet Packets with Light

Will Light Route Packets Over the Internet of the Future?

Santa Barbara, Calif. -- Right now on the information superhighway, all systems use electronics to route packets. In the January 2001 issue of Scientific American, Daniel Blumenthal, associate professor of electrical and computer engineering at the University of California at Santa Barbara (UCSB), assesses the possibility of "Routing Packets With Light."

"Packets," by the thousands, are what every e-mail message becomes in order to be routed over different pathways before being reassembled using Internet Protocol (IP) for final delivery.

According to Blumenthal, "The all-optical network that does the heavy hauling [today's light-pipes] may serve as only one stage in the evolution toward a truly all-optical network."

Blumenthal, who is associate director of the Center on Multidisciplinary Optical Switching Technology (MOST), which is funded by the Defense Advanced Research Projects Agency, does not envision the eventual ascendancy of optics over electronics as a sure thing. Instead, he reasons cautiously trying to use implications drawn from the present state of the technology to bring the future into focus.

First of all, he points out, optical fiber -- essentially glass -- markedly outperforms other transmission media such as air, coaxial cable, or microwave tubing in terms of the diminution of signal per meter of travel, thereby making fiber the choice both now and in the future for long-distance carrier.

"Even," said Blumenthal, "with systems that have a lot of colors on the light pipe, the signal can go 60 kilometers before it has to be boosted." By "colors" he means the different wavelengths of light with each wavelength acting in effect as though it were a separate channel for transmission of information.

For boosting and for switching the signal, optical amplifiers work by matching new photons with the ones coming in. "What's key with optical amplification," said Blumenthal, "is that it works regardless of the rate of data coming through. And that is not true with electronics, where everything scales higher with frequency." By "everything" he means difficulty, energy consumption, heat generation, cost, and time.

And one seemingly sure bet about the future of network transmissions is the increase in bits per second.

"In coming years, a router may have to break down a data stream carrying 40 gigabits (billions of bits) a second over a single wavelength into 16 parallel electronic data streams, each transmitting 2.5 gigabits a second with the router," writes Blumenthal. "Moving a massive number of packets every second through multiple layers of electronics in a router can lead to congestion and degrade network performance."

The near-term solution to the problem is to use optical circuit switches akin to those used for railroad track

switching. Such circuit switches change the direction of information flow but do nothing with the contents. All the reading and sorting of the packets would then be done using today's Internet electronic routing technology.

Blumenthal is co-founder with UCSB colleague John Bowers (professor of electrical and computer engineering) of Calient Networks. Headquartered in San Jose, Calif., with manufacturing facilities in Santa Barbara, the company produces optical switches based on MEMS (microelectromechanical systems) devices, which essentially steer light from fiber to fiber using tiny mirrors.

The long-term solution, Blumenthal speculates in the Scientific American article, may lie with photonic packet switching. A potential standard is now being engineered. Known as All-Optical Label Swapping (AOLS), it enables the tagging of packets (or bundles of packets) with an optical label which will direct gross transport much the way a zip code does in the United States for paper envelopes without the need for recourse to the full address. Dispensing with the necessity of referring to the full U.S. postal address to route paper mail is like dispensing with the electronics of today's routers to direct e-mail dismembered into packets.

What stands in the way of photonic packet switching?

"Nothing that can't be engineered," said Blumenthal.

Images

Media Contact

Tony Rairden
trairden@engineering.ucsb.edu
805.893.4301