

# NETWORK WORLD

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## Microwave technique extends E-net links

NEARnet, vendors devise way to split signal to allow distances of up to 8.6 miles between nets.

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BOSTON — Members of the fledgling New England Academic and Research network (NEARnet) and two vendors have developed a way to double the reach of a single microwave span used to link remote Ethernets.

The technique enables users to link Ethernets at distances up to 8.6 miles while retaining compatibility with the IEEE 802.3 specification.

Previously, microwave could only be used to bridge Ethernets at distances up to 4.3 miles without using relays.

NEARnet, formed in late 1988 by Harvard University, Boston University (BU) and the Massachusetts Institute of Technology, is a nonprofit regional net that will eventually support connections to similar nets in six states.

The group currently has 12 members located in a 50-mile radius. Besides the university founders, other NEARnet members include Digital Equipment Corp., Thinking Machines Corp. and Encore Computer Corp.

### Twelve-mile link

NEARnet and Microwave Bypass Systems, Inc. technicians recently linked MIT Lincoln Laboratory's Ethernet with the school's main campus network in Cambridge, Mass., 12 miles away via a microwave connection using only one repeater.

The 12-mile link, which supports a full 10M bit/sec Ethernet bandwidth, uses a single repeater between the two campuses that breaks the transmission into a

four- and an eight-mile segment.

The microwave technology enabled NEARnet to cut its network costs by about 40% over traditional microwave techniques, which would have required another hop, according to Kent England, director of networks and systems engineering at BU and a cofounder of NEARnet.

Further, unlike dial-up and leased-line services, users that purchase microwave equipment only incur onetime purchase costs, rather than recurring monthly usage charges.

### Traffic patterns

NEARnet engineers developed the microwave link with Microwave Bypass of Braintree, Mass., and Cisco Systems, Inc. of Menlo Park, Calif. They discovered a way to extend the microwave reach by splitting a 23-GHz microwave signal into two channels and devoting each channel to one-way data traffic, one channel to send and one to receive, according to Microwave Bypass President David Theodore.

Microwave is inherently a full-duplex medium, capable of simultaneously sending and receiving data packets. But the 23-GHz radios have enough capacity to support two 10M bit/sec Ethernet channels, Theodore said.

With ordinary full-duplex microwave links that exceed four miles, the data transmission delay surpassed the maximum allowed by the IEEE 802.3 standard.

Consequently, users experienced undetected collisions that

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randomly destroyed data packets and adversely affected network performance, England said.

Splitting the transmit and receive signals was a surprisingly simple and feasible matter, he said. Users no longer are constrained to the single-hop, 4.3-mile limitation and can transmit data at the 8.6-mile maximum distance of microwave while conforming to 802.3.

Once the signal passes through Microwave Bypass' Etherwave Transceiver — a local net-to-microwave interface — it goes through a router that joins the channels for full-duplex transmission across the local Ethernet.

"We had this crazy idea that it was technically possible to extend the distance between remote local Ethernets beyond the four-mile point and at the same time avoid undetected collisions," BU's England said.

Splitting the signal, however, did create a small problem. Internetwork routers, which are used to direct traffic among remote Ethernets, do not recognize one-way data traffic. Routers are traditionally configured to send and receive all information about data packets on one Ethernet line.

So Cisco Systems, which supplies many of the routers for NEARnet, modified the software on its AGS/2 internetwork router to understand and accept the two separate one-way, serial-line Ethernet signals, England said.

"The trade-off is that we've had to use two Ethernet interfaces on each router to achieve the equivalent full-duplex transmission path," England said.

### Breaking ground

Doug Gold, manager of communications industry research for local networks at market research firm International Data Corp. in Framingham, Mass., said users have traditionally shied away from running Ethernet transmissions over microwave because they didn't think it could get the full 10M bit/sec Ethernet speed.

"This not only proves them wrong, but it breaks new ground. It lets users transfer huge amounts of data over previously impossible distances within seconds," Gold said.

With the trial of the new microwave technology, NEARnet becomes the first network to extend the distance between