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Can Superservers Scale Up to Enterprise Status?

LAN Interconnect via Microwave

Net Management Vendors Come Through with APIs

Data Comm PBX User Survey

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LAN Interconnect Takes to the Airwaves

For short-distance connections between LANs, microwave links can be cheaper, faster, and more reliable than conventional LAN interconnect solutions

When it comes to connecting local-area networks over short distances, the cheapest and most reliable alternative rarely is chosen. In fact, it usually isn't even considered.

A vast majority of network installations use fiber optic links, T1 trunks, or leased lines to connect LANs. Yet for LAN connections of up to 20 miles, microwave links can be more economical to install than fiber. For Ethernet LANs, microwave provides the full 10 Mbit/s of bandwidth, which means it offers about six and a half times more bandwidth than a full T1 line and about 15 times more than a DS-0 channel. And microwave systems can even exceed the 99.85 percent reliability standard set by the Bell operating companies for their phone lines.

Network managers have shied away from microwave as a LAN interconnect option for two basic reasons. Compared with T1 and leased lines, the initial cost of installing a microwave transmission system is high, typically running close to $40,000. Microwave systems also have a reputation for being difficult to install and maintain.

In many cases, these reasons to avoid microwave no longer are valid. Once the initial cost of setting up a microwave link is absorbed, an organization has free unlimited use of the link; leased-line and fiber options entail monthly charges that can add up to the cost of microwave gear within a couple of years. Improvements in microwave radios and the development of new microwave-to-LAN interface units have made microwave links a lot easier to install.

For many users, microwave links won't replace leased-line or fiber as the primary LAN interconnect medium—for distances over 20 miles, the cost of microwave can become prohibitive, and organizations that have ready access to fiber lines probably need look no further for a LAN interconnect solution. But organizations that don't have fiber links already installed should give microwave some careful thought, both as a primary interconnect option and as a complementary or backup system.

For LAN connections of up to 20 miles, microwave links can be more economical to install than fiber.

Microwave connections between LANs are now being used in the largest native Ethernet LAN in the world. NEARnet—the New England Academic and Research Network—is a regional spur of the Internet that links nearly 100,000 users at dozens of prominent institutions in the Boston area, including the Massachusetts Institute of Technology, Massachusetts General Hospital, and Harvard University. The network includes thousands of host processors, workstations, and servers, as well as several supercomputers that serve more than 1,000 scientists and researchers. Microwave links serve as the primary backbone; leased lines are used for backup and to link some smaller sites to the network. The 10-Mbit/s microwave connections also enable medical personnel to transfer X-ray and CAT-scan images and other critical medical information at 10 Mbit/s, about 15 times faster than is possible with leased lines.

MEDIA OPTIONS

The most important factors to consider in evaluating LAN interconnect options are the cost of the link, the bandwidth needs of the application, the availability of different media (particularly fiber), and the need for complementary or backup links between sites.

As with most other technology evaluations, LAN interconnect involves a series of trade-offs, usually between cost and performance. Leased lines and fiber are at the two ends of the trade-off spectrum. Leased lines are more convenient to install, requiring only a call to the phone company, but they don't provide enough bandwidth for heavy LAN-to-LAN traffic. If the connection medium doesn't offer enough bandwidth to give users quick access to the network, usage could drop off, thus affecting productivity and costing more in the long run. Fiber offers massive amounts of bandwidth and is highly reliable, but it can be complicated and costly to install if a clear right of way hasn't already been established or if leased fiber connections are not readily available.

For connecting LANs short distances, T1 and fiber optic links can be expensive. A four-mile T1 link, for instance,

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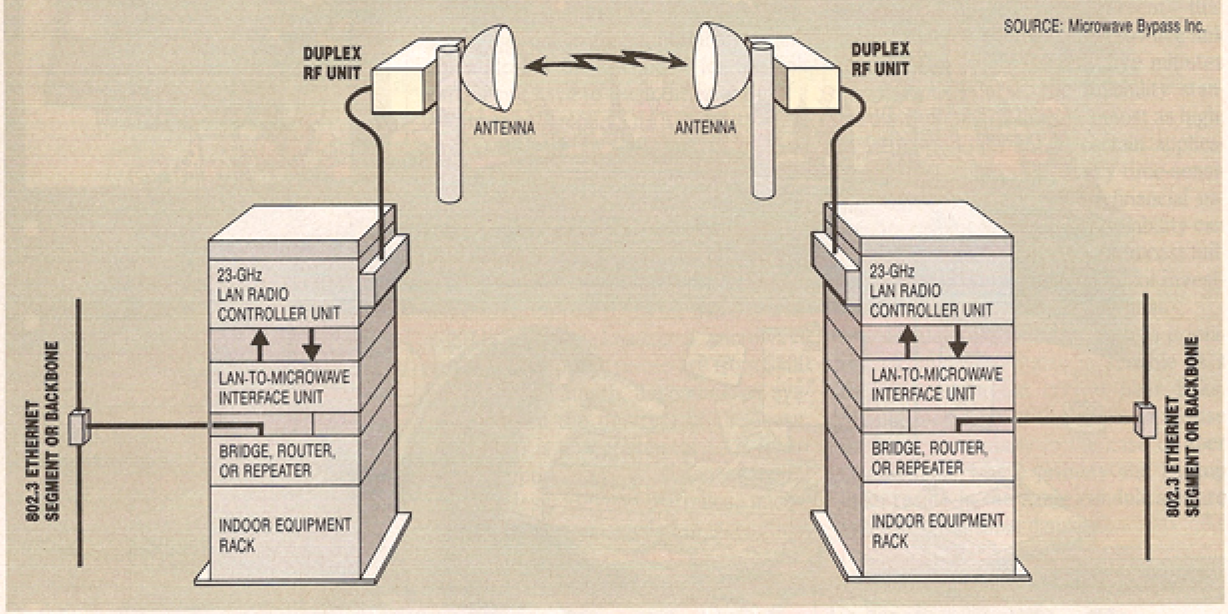
Wireless LAN Links

A Microwave Backbone for Ethernet

Each end of a microwave link between two Ethernet LANs typically comprises a radio frequency (RF) unit with antenna, a controller unit, a LAN-to-microwave interface, and a retiming device, such as a bridge, router, or repeater.



Microwave links are absolutely transparent, acting as an extension of the Ethernet backbone or segment. Because it is fully compatible with the IEEE 802.3 Ethernet standard, microwave supports all Ethernet functionality and applications without the need for any special software or network configuration changes.

THE MICROWAVE-TO-LAN LINK

Configuring a microwave link to connect LANs involves no magic (see "A Commonsense Approach to Microwave"). In general, the methods for linking all types of LANs via microwave are the same, but specific issues, such as retiming and bridging, differ according to LAN type. For Ethernet connections, the interface between the microwave gear and the network is virtually identical to that between the LAN and any cable medium, where retiming devices and transceivers at each end of the cable combine to extend the Ethernet cable segments.

Each end of a 10-Mbit/s Ethernet microwave link typically consists of an 18- or 23-GHz duplex microwave radio frequency (RF) unit; a parabolic antenna measuring one, two, or four feet in diameter; an indoor microwave control unit; an Ethernet-to-microwave interface; and an Ethernet retiming device, such as a repeater, bridge, or router (see figure). The choice of retiming device depends on the application. For example, if the application requires packet filtering, a bridge must be part of the configuration; for connections that require IP routing, the use of a router is necessary.

The vast majority of installed microwave systems operate at 23 GHz, the first frequency licensed for LAN bandwidth by the Federal Communications Commission (FCC). The 23-GHz radios used for Ethernet links use frequency modulation over the 21.2- to 23.6-GHz frequency band, also known as the K band. The designation "23 GHz" actually refers to a frequency band containing 22 individual frequency pairs separated from one another by about 50 MHz.

The baseband bandwidth of the microwave radio is 20 MHz, with a conversion of 1 bit per hertz. This bandwidth offers ample room for a 10-Mbit/s Ethernet channel and a T1 channel. The T1 is provided through the use of a filter that occupies the first 3 MHz of the baseband bandwidth, leaving the remaining 17 MHz for the LAN connection.

The LAN-to-microwave interface connects the Ethernet to the microwave radio and performs the functions of a standard 802.3 transceiver. It also matches levels and impedances between the Ethernet and the radio, converting the radio baseband signal to an Ethernet format. Several vendors offer these products (see "LAN-to-Microwave Interface Options"). The interface is connected to the microwave control unit via two coaxial cables. A standard attachment unit interface (AUI) transceiver cable connects the interface to the Ethernet repeater, bridge, or router on the network segment or backbone.

Because this type of configuration is fully compliant with the IEEE 802.3 specification, no special software or network design is needed to use microwave to extend Ethernets. All traffic is handled at whatever OSI layer is supported by the Ethernet retiming device.

One misconception about microwave systems is that they are prone to failure whenever weather conditions are less than ideal. The truth is that micro-

Wireless LAN Links

wave is not adversely affected by fog, snow, or smog. Only a torrential rain of more than four inches per hour can cause a microwave outage. On average, such rainfall occurs less than several minutes per year in most of the United States.

Single-path, Ethernet microwave connections are, however, limited to a transmission distance of about 8.6 miles, a limitation caused by Ethernet's timing constraints. A low-frequency radio path can carry a signal for over 40 miles, but Ethernet allows for a round-trip propagation delay of only 46.4 microseconds (μs). This means that before an Ethernet signal has traveled 46.4 μs, it must be retimed through a repeater, bridge, or router.

THE NEED FOR REDUNDANCY

Redundant configurations provide maximum protection in the event that a primary link fails. Of course, the more critical an application is, the more important it is to have a backup LAN link. And, as noted earlier, many organizations are more comfortable with putting their transmission eggs in different baskets—having a microwave link to back up a fiber connection, for instance.

In a redundant system, bridges or routers are connected to the LAN-to-microwave interface units serving both the primary and backup links. Both links are kept running at all times; the backup link can run in standby mode, with all traffic going over the primary link, or the two links can share the transmission load. If one of the systems fails, the bridge or router can automatically switch all traffic to the other transmission system. Another backup method involves forming a triangle or loop among three or more locations so that traffic can be rerouted if the link between any two locations fails.

The more critical an application is to an organization, the more important it is to have a backup LAN link.

Troubleshooting an Ethernet microwave link is a relatively simple step-by-step process. The first step in finding the source of a problem is to check the obvious. First, the indoor rack-mounted control unit should be inspected to make sure that all cables are firmly connected and all units are receiving power. Front-panel LED indicators and meters should be examined for unusual readings that could pinpoint the nature of the problem.

If the readings on the LEDs and meters show no problems, the next step is to

LAN-to-Microwave Interface Options

Although all microwave links for Ethernet LANs use the same basic components, manufacturers disagree about how those devices should be integrated. Several vendors package their microwave-to-LAN interfaces and bridges in one box. In its Metrowave product, Digital Equipment Corp. (Maynard, Mass.) integrates a microwave interface with a DEC bridge, the LAN Bridge 150. Similarly, microwave radios sold by Microwave Networks Inc. (Houston) come with bridges and interfaces manufactured by Cryptall Communications Corp. (Smithfield, R.I.). Microwave Bypass Inc. (Braintree, Mass.), meanwhile, sells its interface, the Etherwave Transceiver, as a separate unit. The company manufactures a bridge, the LAN Link 1000, for use with the Etherwave Transceiver but says that customers could use their own bridges.

The integrated approach yields products that are easier to install. With the discrete approach, users can install bridges or other retiming devices from third parties. In some applications—such as those that call for IP routing, which bridges cannot perform—the ability to swap in other devices is a must. A network failure caused by a blown bridge also can be fixed more easily. *—Johna Till Johnson*

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disconnect the microwave link from the network segments to test the integrity of the microwave path. Packet generators test continuity across the microwave link. If continuity is not established, the microwave-to-LAN interface and Ethernet retiming devices should be checked for defects.

If there are no problems in the LAN interface components, the link is the source of failure. Link failures could be hardware-related or caused by misaligned antennas or an obstruction in the signal path. Radio failures in the RF or controller units can be isolated via digital voltmeters and oscilloscopes. Link outages may also be caused by an instability or drift in the frequency. ■

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