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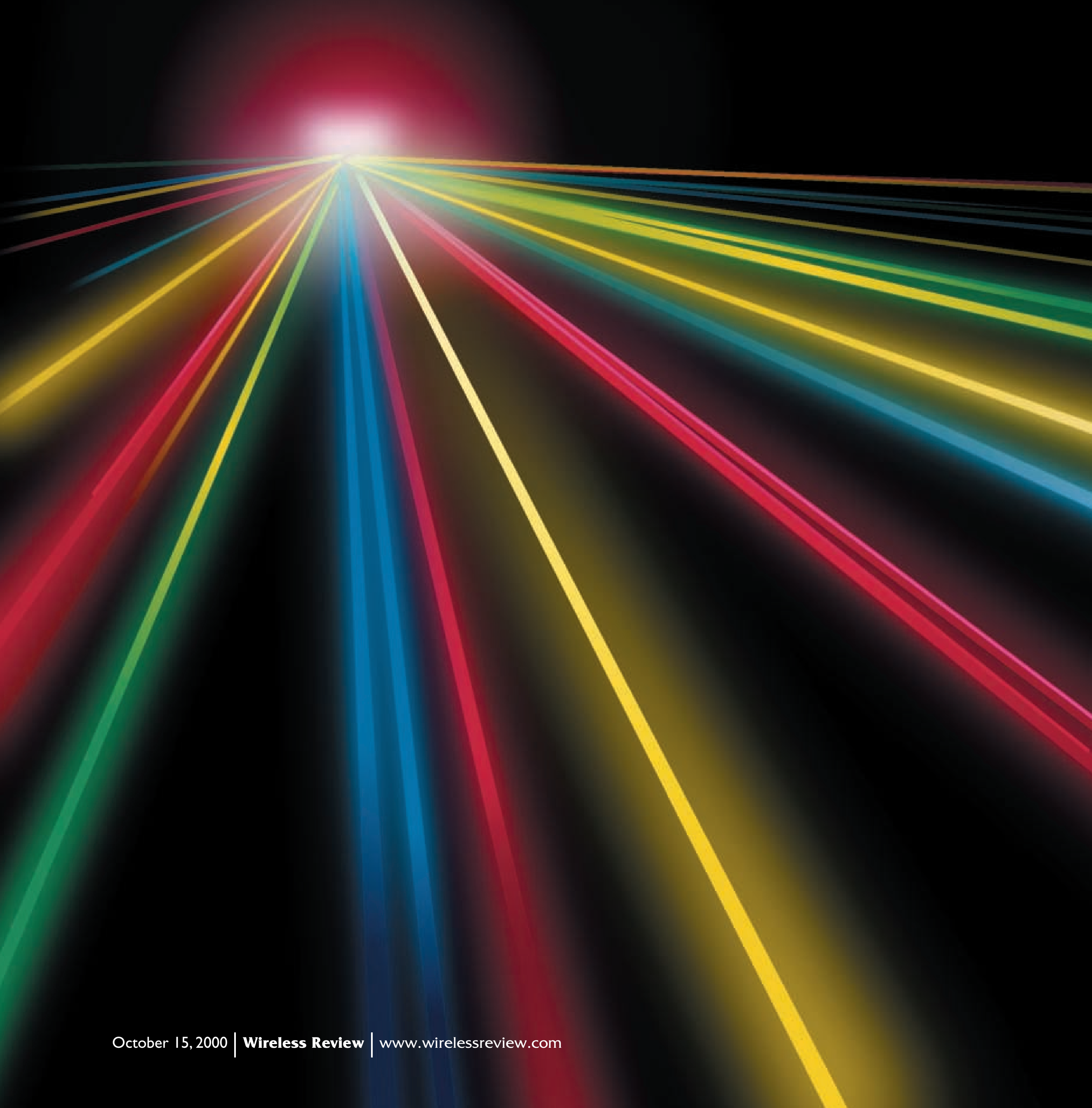


Bright Idea

Recent releases of wireless, or fiberless, optical technology could give wireless providers another backhaul alternative.

Wireless providers have used fiber optics as a backhaul option for years, but recent releases of new wireless optical technology, also known as fiberless optics, lasers or free-space optics, could give wireless providers yet another backhaul alternative.

Although fiber-optic systems are buried in the ground or strung along poles, wireless optical systems work through technology placed on rooftops that sends traffic via lasers from transmitters on one building to receivers, or detectors, on other buildings. Traditional free-space optics have been around for 10 to 15 years, but they were 10Mb lasers that primarily were used to connect buildings in campus environments. Today's wireless optical systems claim speeds in the gigabit range.

BY BETSY HARTER

So far, few wireless providers have explored wireless optical networks as a backhaul option, but as 3G emerges and providers need more bandwidth and capacity, these systems offer several advantages over microwave and fiber backhauling methods.

The Wireless Optical Architecture

AirFiber and TeraBeam are two companies offering wireless optical solutions. Both have OEM agreements with big-name vendors; Nortel Networks is marketing AirFiber's OptiMesh products to customers worldwide, while Lucent is working with TeraBeam to develop and deploy TeraBeam's fiberless optical networking system. However, AirFiber and TeraBeam have approached wireless optical technology differently.

Attenuation due to weather or scintillation has been a challenge that traditional free-space laser technology has faced.

Janet McVeigh, AirFiber vice president, said AirFiber takes traditional free-space optics technology, which has been around for some time, and combines it with telecommunications software technology. The company has created OptiMesh based on lasers that go over a meshed network of wireless optical links. A meshed network means putting a node on all the buildings in a city that the provider wants to connect in a grid configuration.

AirFiber's OptiMesh rooftop node supports a mesh network of wireless optical links.

"Each building can have two to four optical links connecting to adjacent buildings, so you end up with a grid over your city," she said.

Each AirFiber node contains a small ATM switch that manages the grid. So if a temporary line-of-sight obstruction blocks a laser beam, all the traffic that was going over that link is rerouted to another path, which creates many redundant paths.

"LMDS, traditional microwave and traditional free-space optics offer point-to-point links, so if something happens to that link, you are dead," she said. "With meshing, because it is a network as opposed to a point-to-point link, you can recover."

Also unlike traditional free-space optics, AirFiber uses very short links, which offers 99.999% reliability.

While AirFiber bases its technology on ATM, TeraBeam's solution is based on Ethernet and IP standards. Jim Masterson, TeraBeam vice president of sales and marketing, said that TeraBeam has built its technology in rings, which is typical of fiber-optic systems.

"We build a ring of 2.5Gb/s to start off with, and if we have to, we add another ring of 2.5Gb/s," he said. "Most fiber providers today build fiber rings because they are more scaleable; they can just pull more fiber if they need to add capacity. In our case, we just pull more light."

To picture a ring configuration, imagine a ring with 12 dots around it, representing 12 nodes, or antennas. TeraBeam strings a series of antennas connecting 12 buildings using a gigabit of backhaul over that entire ring. As it transmits in a "water sprinkler fashion," it can connect to any building in its range. If one connection point in the ring goes down, the traffic reverses, which creates redundancy and reliability, Masterson said.

Another difference between the two companies is that AirFiber operates in the 780-nanometer spectrum, while TeraBeam operates service in the 1,550-nanometer spectrum.

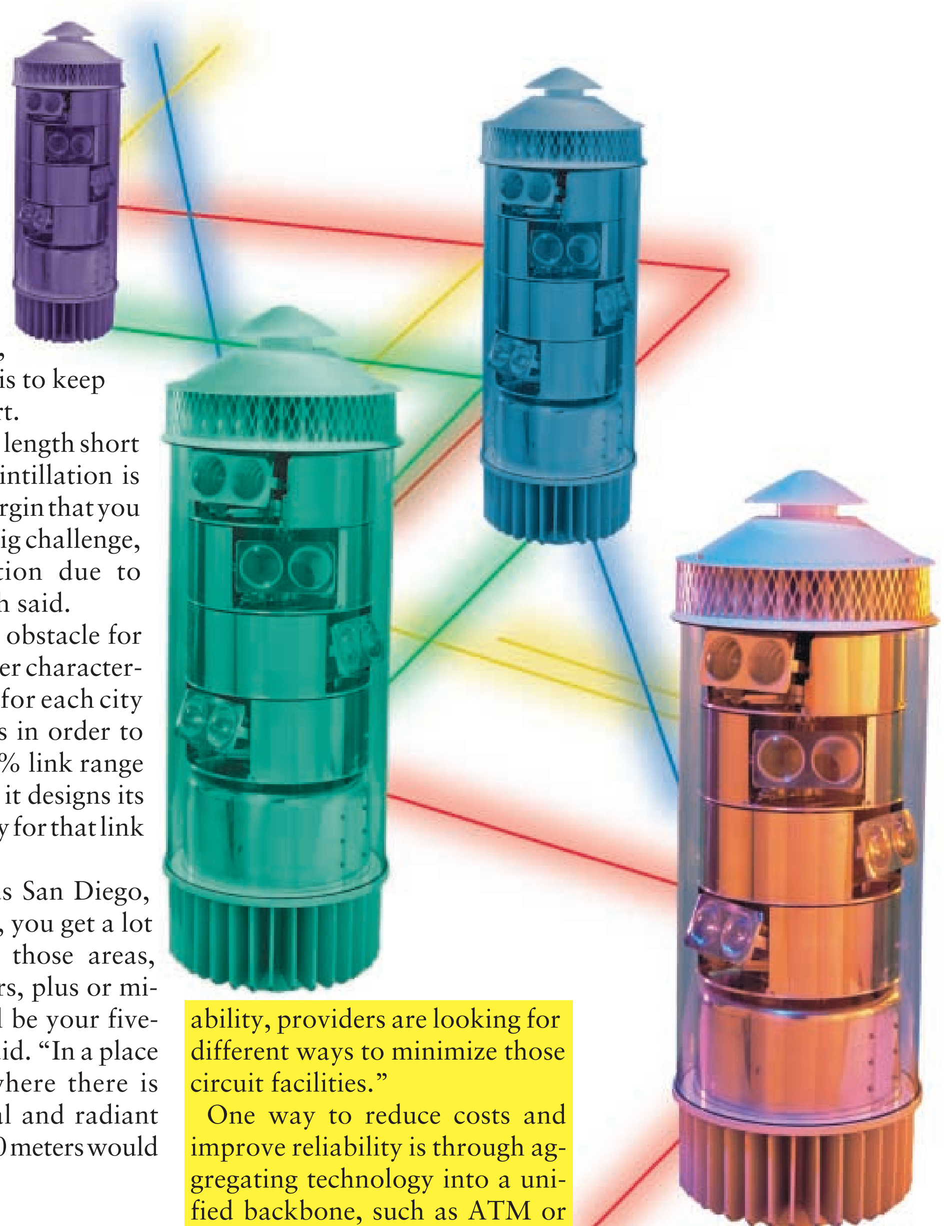
"We are talking about a great deal more bandwidth because of that," Masterson said. "AirFiber technology is based upon an architecture that maxes out at 622Mb/s, and our architecture basically scratches the surface at a gigabit, and we scale from there."

Optical Delusions

McVeigh noted that traditional free-space optical systems were fraught with problems that today's wireless optical systems have overcome. Lasers must transmit in a tight beam, or else they spread out and can't go as far. However, buildings can move as much as several feet due to wind or heat, which can block those targeted signals.

To accommodate moving buildings, AirFiber's system does automatic tracking, which means it periodically sends information locally over that link. When that information is communicated, the system measures received signal strength (RSS) between the laser and the detector, and the beam makes minor changes in its pointing angle to optimize that RSS.

Attenuation due to weather or scintillation also has been another challenge that traditional free-space laser technology has faced. In clear air, scintillation creates air pockets that are at slightly different indices of refraction than other parts of the air, which causes constructive and destructive interference of a laser. In the past, the industry dealt with scintillation by using big detectors and multiple transmitters that



follow different paths and have different scintillation effects. Then, they would average them together to get the real signal. AirFiber's approach, on the other hand, is to keep the link length short.

"We keep the link length short enough that the scintillation is smaller than the margin that you need for the other big challenge, which is attenuation due to weather," McVeigh said.

Fog is the biggest obstacle for light beams. AirFiber characterizes the fog profile for each city in which it deploys in order to discern the 99.999% link range for that city. Then, it designs its network specifically for that link length.

"In places such as San Diego, Seattle or Portland, you get a lot of coastal fog. In those areas, typically 200 meters, plus or minus 20 meters, will be your five-nines point," she said. "In a place such as Tucson where there is not a lot of coastal and radiant fog, maybe up to 500 meters would be the five nines."

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Backhauling Applications

It remains to be seen whether wireless providers will embrace wireless optical systems for backhaul the way they have fiber and microwave. Don Coover, V-Comm vice president, said that when cellular was at its infancy, providers used DS1s or installed microwaves on cell sites as the primary backhaul mechanism to route traffic back to the MSC. Most used a star configuration, also called hub-and-spoke, meaning each site had a direct facility from its location to the MSC. However, the setup offered poor reliability and was expensive.

"Interconnect is the largest recurring cost in the network," Coover said. "In order to drive the cost down and improve reliability, providers are looking for different ways to minimize those circuit facilities."

One way to reduce costs and improve reliability is through aggregating technology into a unified backbone, such as ATM or IP-over-ATM transport, which allows wireless providers to maximize their available bandwidth rather than adding more bandwidth to handle traffic increases, Coover said. On the other hand, wireless optical systems are geared specifically toward broadband applications, and wireless providers should consider the technology as a viable backhaul option.

Masterson noted that backhaul typically is thought of in two ways: interconnection in metropolitan area networks (MANs) or interconnection to backbone national networks. Although wireless optical systems are not a fit for backhaul in the backbone national network, they work well for backhaul in MANs. As a result, wireless optical companies are targeting LMDS providers more than cellular and PCS providers at this point.

Coover noted that LMDS providers are exploring wireless optical because LMDS was originally launched as a packet-based technology, whereas PCS and cellular providers offer voice, which is circuit-switched. Wireless providers today are just starting to migrate to broadband packet networks. As cellular and PCS providers roll out 3G networks, their bandwidth requirements will increase, and they will seek broadband pipes for backhaul.

"And, (wireless optical) could very well provide an alternative prior to 3G, depending on a provider's requirements," he added.

Masterson agreed that wireless optics do have cellular and PCS backhauling applications.

"TeraBeam's system runs on IP, and PCS providers are planning on using their PCS networks for carrying data traffic as they migrate to Internet services, and they are using IP to do that," he said. "Because of that, they have to interconnect with whoever is going to carry that traffic for them with IP as the underlying protocol."

Dan Gulliford, Triton Network Systems vice president of advanced technology, pointed out that while Triton's technology is not wireless optical, it also offers high bandwidth (155Mb/s) radio links through millimeter wave radios. Similarly, wireless optical companies profess speeds in the gigabit range. Right now, none of this super-high-bandwidth technology is ideal for backhauling today because wireless providers do not need that much bandwidth to backhaul their traffic, he explained. For instance, a cellular base station has 100 channels on it, each consuming 564kb/s, which adds up to 6Mb/s. Providers don't need high-bandwidth technologies to carry 6Mb of traffic. However, both wireless optics and millimeter wave radios will be perfect backhauling alternatives as wireless providers roll out 3G services.

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"Although we are not really intended to backhaul cellular or PCS base stations as they are today, during future implementations of 3G, it would make perfect sense to use the large amount of bandwidth available from either millimeter waves, such as Triton, or (wireless) optics, such as AirFiber or TeraBeam," he said.

McVeigh said that today, AirFiber's potential customers are not cellular and PCS providers, they are CLECs, including LMDS providers such as Winstar and Teligent. Wireless CLECs can combine their technology or networks with wireless optical systems for the last-mile solution.

Cellular and PCS providers could theoretically use wireless optical for backhaul, but McVeigh said reliability and link lengths would be issues.

"Backhaul would depend on the size of cell site and density in the area," she said. "Typically, cell sites are larger than the distance we are going, so it would take a lot of relay nodes. If a cellular or PCS provider already had a network and wanted to add backhaul on as an additional application, that would work great; it is a perfect application for that."

Others don't see wireless optical as a backhaul alternative at all.

"I have a very difficult time seeing laser systems as having applications for backhaul because the range is so short, 200 to 400 meters," said Lou Olsen, Teligent vice president of technology development. "Typically for backhaul you need very high bandwidth and reasonable range, because by definition backhaul is going back to your central office or some switching point, which you typically don't have a lot of if you are going to deploy in a metro area."

However, Olsen said Teligent is evaluating wireless optical systems for applications in campus networks where buildings are physically close and require connectivity between one another. The company currently is testing an AirFiber system is its Washington, D.C., lab.

"If you have a bunch of servers or PBXs in adjacent buildings, laser systems are great for hooking those together," Olsen said. "We definitely don't see (wireless optical) replacing fiber or point-to-point microwave because fiber has tremendously more bandwidth than free-space lasers, and wireless has the range advantage."

Even in a 3G environment, Olsen does not see wireless optical as a backhaul alternative for wireless providers. Since so much investment and creativity is going into fiber optics and microwave radios right now, Olsen predicts that the prices of those systems will drop well below wireless optical systems.

Lease Vs. Build

When it comes to backhaul, the big question is always whether to lease or to build. Wireless optical networks are no different. Whether you are a cellular, PCS or LMDS provider, it is important to evaluate whether to have a company build a private network for your backhaul or to lease the network.

"The core business of a wireless provider is to provide wireless-access technology to customers and not necessarily to run an interconnect network," V-Comm's Coover pointed out. "While backhaul supports their core business, running a backbone network today is not their core business, and I have not seen any of our clients look at wireless optical as a private network."

For example, TeraBeam's business model works through leasing. Masterson said if a wireless provider wanted a wireless optical system for backhaul, TeraBeam would sell it a leased-based network and deliver the service at a monthly rate. TeraBeam also would manage and monitor the system as part of its service.

No one knows for certain if wireless optical systems will fit in nicely with wireless providers' networks, or compete directly against them for customers. However, the improvements in laser technology present an interesting business case for wireless providers to consider. ■

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