



BridgeWave
COMMUNICATIONS

Gigabit Wireless Leased-Line Replacement

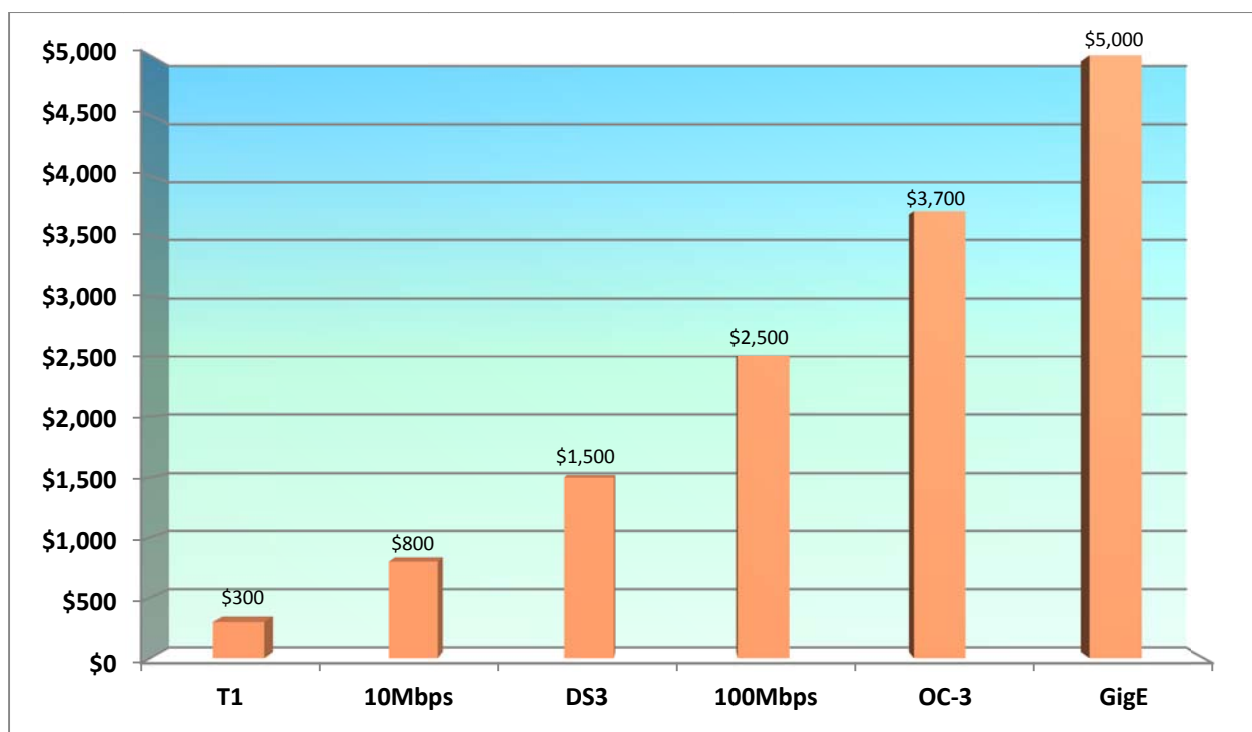
Utilizing gigabit wireless links to provide fiber-like performance at significant savings compared to leased lines.



Backhaul Evolved[®]

Introduction

When considering high-bandwidth connections between locations, conventional thinking used to be that the only way to get service was to pick up the phone, call the service provider and order up a circuit. As long as the start-up costs and monthly recurring charges were within the IT budget, and the IT manager and business administrators were content with the level of service provided, writing a monthly check to the service provider wasn't a problem. If troubles were encountered with the service, a phone call to the provider was all that was necessary to resolve the problem.

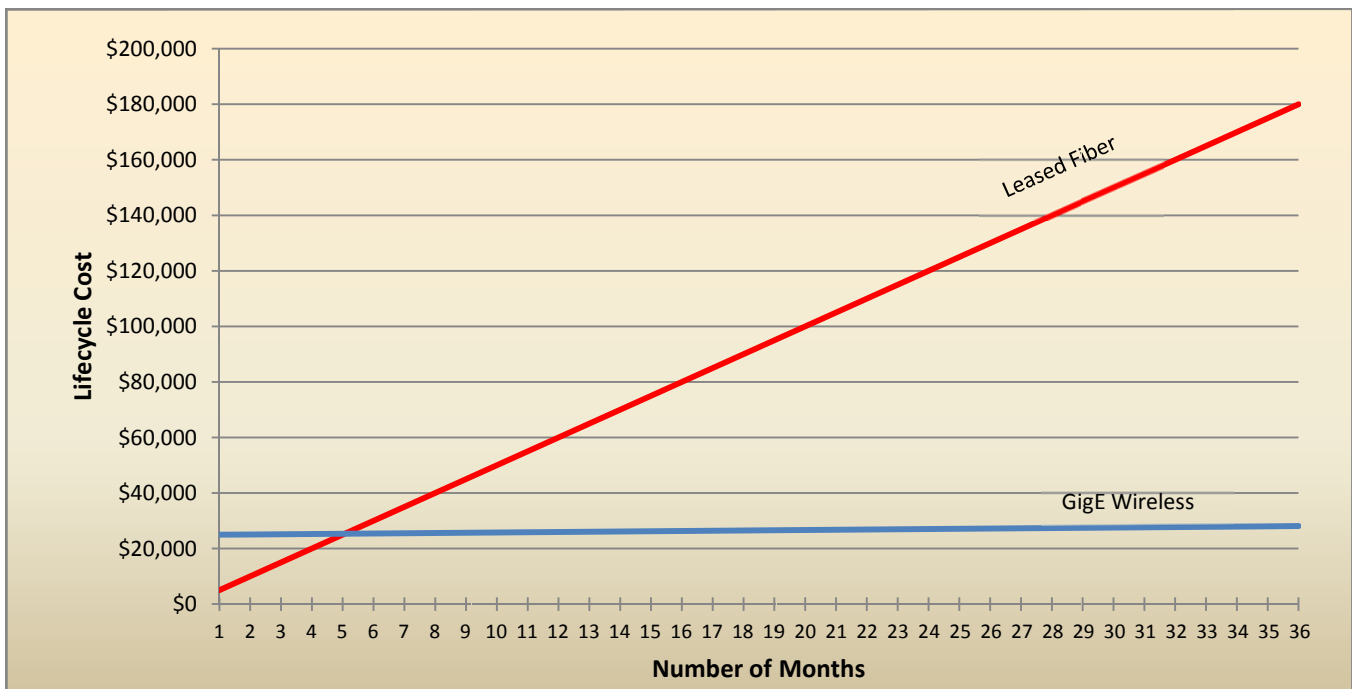


Businesses relying on leased lines find a wide range of performance options tailored to suit their needs, from T1 (1.5 Mbps), 10Mb Ethernet, DS3 (45 Mbps), Fast Ethernet (100 Mbps) OC-3 (155 Mbps) and even gigabit (1000 Mbps) data rates. The chart above details the typical *monthly* lease costs for a variety of point-to-point connections in the United States as polled by a number of service provider websites. Establishing leased line service often entails start-up fees, in addition to the monthly OPEX charges, that can range from a few hundred dollars to hundreds of thousands of dollars when new fiber circuits must be constructed. If the installation requires special considerations, additional cost and time to provision the circuits are usually added to the above pricing. In most cases, there is a multi-year commitment allowing the service provider to recoup their initial investment, further adding to the expenditure.

In today's economic environment of shrinking budgets, and/or in order to maintain competitive advantages, government entities and businesses are increasingly looking to IT departments to improve productivity and control costs. This paper examines the benefits of replacing costly leased line circuits with affordable gigabit Ethernet wireless links.

Replacing Wired Services with High Capacity Wireless Links

Microwave radio systems have been used for decades to provide highly reliable, trouble-free transmission of voice, data, and video, for service providers who depend on them to generate revenues, or for businesses that need backhaul for essential company network services between disparate facilities. Because of their limited bandwidth, transmission rates of these microwave solutions top out at a few hundred megabits per second. With the opening of millimeter wave spectrum in the 60 - 80 GHz bands, full gigabit (GigE) wireless transmission has become an affordable alternative to high capacity leased circuits.



For businesses, there are many advantages of utilizing high-capacity gigabit wireless links to replace fiber or aging copper based circuits, both in terms of cost and of network performance. On the cost side, GigE wireless links provide a rapid return-on-investment, relative to the costs of leasing high-speed circuits. By comparison, a GigE wireless link can provide equivalent fiber-like speeds for a one-time expenditure comparable to the annual cost of leasing fiber-based service. In many cases when new fiber runs must be constructed, the initial installation costs for fiber services actually exceed the cost of installing a GigE wireless system. As the life cycle costs are charted above, it is evident that the financial advantage of the small initial CAPEX investment in GigE wireless systems can be realized in a relatively short period of time compared to the recurring OPEX charges for leased lines. In many cases, the breakeven point is measured in months, not years.

How GigE Wireless Links are Being Utilized

BridgeWave's gigabit wireless solutions are used in vertical markets such as healthcare, education, local government and private network (enterprise) applications where users have benefitted from their fiber-like performance in terms of throughput and latency, and their minimal investment compared to leasing or implementing fiber.



Local/State Government

BridgeWave's full-rate GigE links provide seamless primary inter-building connections, highly secure backhaul for intelligence and CCTV surveillance systems or can be run as diverse paths in parallel with fiber cabling to provide redundant fiber overlay. Optional 256-bit AES encryption eliminates the need for external encryption devices. When unexpected urgent needs arise, links can be used to quickly create temporary or disaster-recovery connections.



Healthcare

BridgeWave gigabit wireless solutions offer full-GigE LAN performance for healthcare networks. Transmission of sensitive medical data such as MRIs and x-rays is both fast and secure with BridgeWave GigE links. BridgeWave GigE solutions provide a fast-to-deploy, flexible alternative to costly inter-building fiber installations. These systems can provide a cost-effective 100% alternate route, redundant path for mission-critical fiber connections.



Education

Bandwidth-consuming mobile devices are becoming a ubiquitous part of today's university life, straining campus networks with their insatiable need for capacity. The widespread use of Wi-Fi access hubs, as well as security cameras across campuses, compels the need for capacity that can be quickly and easily deployed. BridgeWave's GigE wireless solutions enable future-proof, high-speed 'on-the-go' connectivity for students, faculty and administrators, with all the performance benefits of fiber, while yielding a significant cost savings compared to metro fiber cabling.



Enterprise

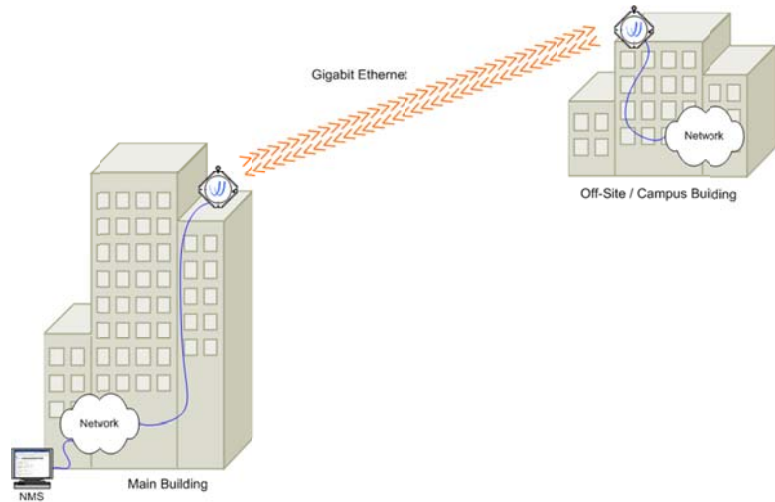
BridgeWave's gigabit wireless solutions are ideal for corporate/campus LAN extensions due to their ability to seamlessly integrate with existing LAN backbone. Users off the main building experience the same LAN connectivity as their counterparts connected to the main network. With future-proof network connectivity and the bandwidth to handle the most demanding business applications, GigE wireless links offer efficiencies in server centralization, data backup and storage and in addition to the rapid deployment offered, also provide alternate route traffic overlays for business continuity and disaster recovery situations.

The Economics of Leased Line Services

In this section we'll consider four scenarios that involve interconnecting buildings located within a few miles of each other, and detail the savings that can be realized by using GigE wireless compared to leasing fiber.

Corporate LAN Extensions

In the first scenario, a growing small business needs room to house its expanding workforce and finds a suitable building one mile away from the main office. The IT manager is tasked to connect the two buildings with voice and data being the primary applications. Since a T1 connection doesn't provide enough capacity to handle the need, a 10 Mbps Ethernet service is considered from the service provider at a monthly rate of \$800. It also requires an initial start-up connection fee of \$2,500. In order to secure the best rate, a thirty-six month commitment is required. This amounts to \$31,300 for the three year lease to provide a 10 Mbps connection between the company headquarters and the satellite office.



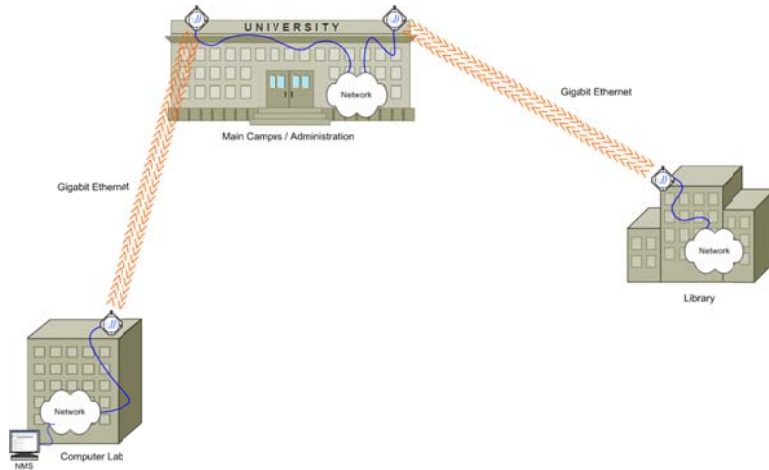
Replacing this leased circuit with a 1000 Mbps 60 GHz link would not only save 30% over the leased costs, but also yield 100x faster speeds between locations. The 60 GHz, 1000 Mbps link provides a future-proof solution with enough capacity to handle the most demanding applications that run over the network today, with ample bandwidth for tomorrow's new business applications.

The table below details the cost analysis of using a 60 GHz GigE wireless link compared to a three year lease of a 10 Mbps circuit.

| | 60 GHz GE Wireless | Leased 10 Mbps |
|-------------------------------|--------------------|------------------|
| Monthly Leased Circuit Fee | \$ 0 | \$ 800 |
| Number of Months | N/A | 36 |
| Connection Charge | \$ 0 | \$ 2,500 |
| 60 GHz GE60 radios | \$ 17,900 | \$ 0 |
| Installation Services | \$ 4,000 | \$ 0 |
| 60 GHz License (license-free) | \$ 0 | \$ 0 |
| Implemented Total | \$ 21,900 | \$ 31,300 |
| Throughput | 1000 Mbps | 10 Mbps |
| Cost per Mbps | \$ 21.90 | \$ 3,130.00 |

Education Networks

In the second scenario, a 100 Mbps leased line is used to extend campus LAN connectivity across three buildings at a local university. Services such as voice, data, Internet access, and classroom video are transported over the circuit. The use of mobile devices, including tablet computers has dramatically increased utilization on the network, straining the leased line backbone connection. The recurring monthly charges of \$2,500 for each connection are based on a thirty-six month contract. There was also a start-up cost of \$5,000. When one adds up



the start-up and recurring costs for this circuit, the school will pay \$185,000 for this three year commitment to lease two 100 Mbps circuits to connect their three buildings on campus.



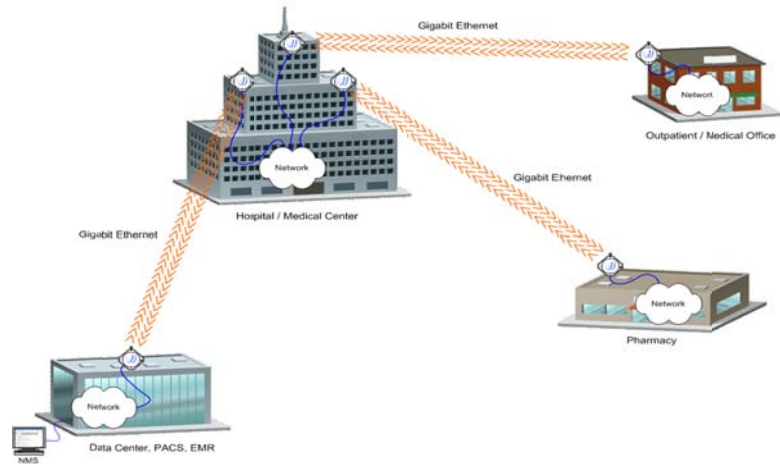
A much more cost-effective solution would be to connect the campus buildings together using gigabit Ethernet 80 GHz wireless links. Replacing the 100 Mbps leased circuits with these links would save 66% over the life-cycle cost of leasing the lines, with the added benefit of a ten times improvement in connection speed.

The table below details the cost analysis of using these 80 GHz GigE wireless link compared to a four year lease of a 100 Mbps circuit. In the above scenario, a third GigE link could be used to completely enclose the network in a ring topology, adding resiliency to the network with very little CAPEX cost when considering the overall cost of the 100 Mbps fiber implementation. When comparing the cost per megabit alternatives, it is clearly apparent that significant savings can be realized by using GigE wireless solutions.

| | 80 GHz GE Wireless | Leased 100Mbps |
|--|--------------------|-------------------|
| Monthly Leased Circuit Fee | \$ 0 | \$ 2,500 (x2) |
| Number of Months | N/A | 36 |
| Connection Charge (Initial Installation) | \$ 0 | \$5,000 |
| 80 GHz GE80 radios | \$ 27,500 (x2) | \$ 0 |
| Installation Services | \$4,000 (x2) | \$ 0 |
| 80 GHz License | \$ 75 (x2) | \$ 0 |
| Implemented Total | \$ 63,150 | \$ 185,000 |
| Throughput | 1000 Mbps | 100 Mbps |
| Cost per Mbps | \$63.15 | \$1,850.00 |

Healthcare Networks

In the third scenario, gigabit leased lines are used to provide high speed connectivity from an outpatient clinic to a hospital two miles away. Other facilities within the healthcare campus include a pharmacy and data center, all requiring high-speed GigE connectivity, transporting patient medical records, prescription filling, medical image files (MRIs, X-Rays), as well as providing Internet/intranet access and VoIP services to the doctors, nurses and administrators tasked with providing healthcare services to their clients.



As it's unlikely the hospital will move in the next five years, the administrator signs a long term contract with the service provider to get the best possible per-month price on these gigabit leased lines. For a gigabit fiber-based circuit, the rates are approximately \$5,000 per month, and the service provider has waived the start-up connection costs due to the long term lease. The hospital will pay \$900,000 over the life of the contract for these high-speed connections.



Considering the use of 80 GHz gigabit wireless links in lieu of leasing fiber, the hospital would save 86% over the life-cycle cost of leasing the lines with an equivalent gigabit speed and with improved latency between the buildings.

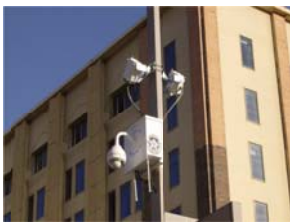
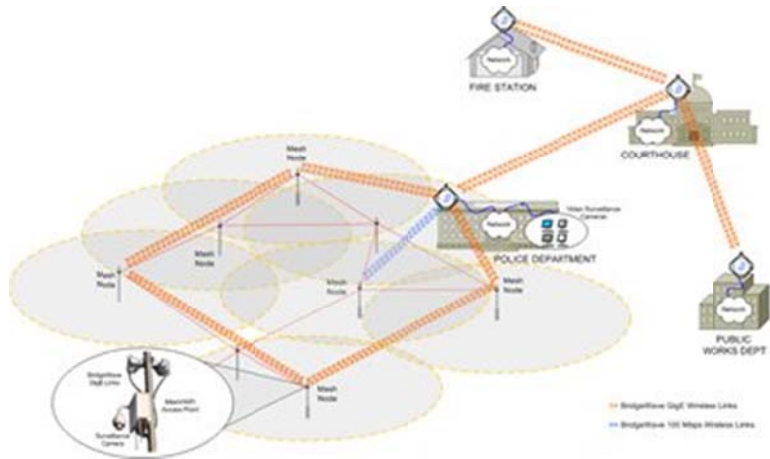
Gigabit wireless links can also provide cost-effective redundant links to existing fiber-based connections, as well as diverse path in lieu of a break in the main fiber.

The table below details the cost analysis of using these 80 GHz GigE wireless link compared to a long term lease of a gigabit circuit. When comparing the cost per megabit alternatives, it is clearly apparent that significant savings can be realized by using GigE wireless solutions.

| | 80 GHz AR Wireless | Leased GigE |
|----------------------------|--------------------|-------------------|
| Monthly Leased Circuit Fee | \$ 0 | \$ 5,000 (x3) |
| Number of Months | N/A | 60 |
| Connection Charge | \$ 0 | \$ 0 |
| 80 GHz AR80X-AES radios | \$ 39,250 (x3) | \$ 0 |
| Installation Services | \$ 4,000 (x3) | \$ 0 |
| 80 GHz License | \$ 75 (x3) | \$ 0 |
| Total | \$ 129,975 | \$ 900,000 |
| Throughput | 1000 Mbps | 1000 Mbps |
| Cost per Mbps | \$ 129.98 | \$ 900.00 |

Government Networks

In the fourth scenario, a government initiative to modernize IT infrastructure is considered. This involves placing HD-IP video cameras in spots in high-crime traffic areas as well as improving connectivity for government facilities within the municipality. The police department is building a video monitoring center in the basement of their facility, and requires high-speed, low-latency backhaul for HD-IP camera pan/tilt/zoom operation. At the same time, other departments are considering high-bandwidth connectivity for VoIP, data, video conferencing, CAD file transmission, CRM, etc. Trenching through streets and digging up sidewalks to lay city-owned fiber proved to be too disruptive to the local businesses, not to mention put the project way over budget. A second option was to review leased-fiber from the service provider, however gigabit speeds were ruled out due to their cost. A compromise of 100 Mbps fiber to each location was considered. As seen earlier, for a 100 Mbps fiber-based circuit, the rates are around \$2,500 per month, and do not include start-up connection costs. When considering the scope of this project, the eight lines needed to connect HD-IP video cameras and disparate facilities together on the network would cost \$1,200,000 over the life of the five year contract.



Considering the use of 80 GHz gigabit wireless links in lieu of 100 Mbps leased fiber would save 77% over the life-cycle cost with the added benefit of ten times performance improvement while still providing low latency connectivity for HD-IP camera manipulation. Additionally, these GigE wireless links can be re-used in different locations should the cameras need to be rapidly re-deployed to other positions. The table below details the cost analysis of using these 80 GHz GigE wireless links compared to a five year lease of 100 Mbps circuits. When comparing the cost per megabit alternatives, it is clearly apparent that significant savings can be realized by using GigE wireless solutions.

| | 80 GHz AR Wireless | Leased 100 Mbps |
|----------------------------|--------------------|--------------------|
| Monthly Leased Circuit Fee | \$ 0 | \$ 2,500 (x8) |
| Number of Months | N/A | 60 |
| Connection Charge | \$ 0 | \$ 0 |
| 80 GHz AR80 radios | \$ 30,500 (x8) | \$ 0 |
| Installation Services | \$ 4,000 (x8) | \$ 0 |
| 80 GHz License | \$ 75 (x8) | \$ 0 |
| Implemented Total | \$ 276,600 | \$1,200,000 |
| Throughput | 1000 Mbps | 100 Mbps |
| Cost per Mbps | \$ 276.60 | \$12,000.00 |

Server Centralization Utilizing Gigabit Wireless Links

Often the greatest savings realized by deploying gigabit wireless links are not in the direct savings from eliminating monthly leased-line charges, but in the indirect savings resulting from centralizing IT facilities and staff. Rather than tying together remote-site server facilities using lower-speed leased lines, gigabit wireless links provide the performance needed to centralize servers, while providing remote users with server access performance equal to those of local users. This consolidation eliminates duplicated server hardware, software licenses, backup systems and server room costs at multiple locations, which can result in significant savings. Also, centralizing servers greatly simplifies network administration and server management, improving service reliability and reducing the costs of deploying new applications and server capacity.

Other Tangible Benefits to Replacing Leased Line Services with High Capacity Wireless Links

In addition to the significant savings realized by utilizing high capacity gigabit wireless links, businesses can future-proof their networks, and provide ample capacity as new applications need to be transported over the link or the workforce continues to expand. Transmission rates provided by these gigabit wireless links mean that the backbone will remain free of bottlenecks as application capacity needs grow.

In regards to performance, these millimeter wave GigE wireless links provide full-rate non-blocked gigabit throughput speeds with very low latency, yielding a fiber-equivalent backbone link that is perfect for transporting real-time applications such as video and VoIP. With GigE wireless links, there are no protocol conversions to make (e.g. SONET/ATM-to-IP), no expensive edge devices to purchase, configure and maintain; GigE wireless links provide the simplicity of native IP interfaces, matching the interfaces used by server and user systems.

Even when the costs of leased line services are deemed to be acceptable, often the time to provision these services can be prohibitive. High-speed wireless links can be commissioned in days, allowing the organization to react quickly to changes in the business environment, while new fiber installations are often burdened with the red tape associated with obtaining relevant permits and construction delays of many months.

While it can be comforting to simply call someone else (e.g. a service provider) to address network issues or outages, many IT organizations prefer to have local control over their own network to ensure that any network issue troubleshooting or resolution actions can be undertaken without being dependent on outside parties. Gigabit wireless links include extensive management facilities that are consistent with those found on other Ethernet switching equipment. This allows network administrators to easily integrate the links into their existing network management systems without the complexity of dealing with proprietary management solutions. This gives IT managers' complete visibility into their network, with the tools necessary to quickly diagnose issues without waiting for a service provider to respond to a trouble ticket.

Gigabit wireless links provide a direct substitution for leased services, with the performance, reliability and security of fiber. These links allow IT departments to simultaneously improve user services while reducing communications expenses. The direct savings over recurring leased-line costs are compounded by the indirect savings realized through IT facility centralization and simplified network management, as well as providing the peace-of-mind of complete network visibility and control.

About BridgeWave Communications

BridgeWave Communications is the leading supplier of high-capacity 4G millimeter wave backhaul and gigabit wireless connectivity solutions. BridgeWave's carrier-grade, point-to-point wireless FlexPort® links provide a future-proof mobile backhaul solution for carriers and mobile operators looking to support 4G/LTE/WiMAX adoption. PicoHaul™ links provide the same carrier-grade high-capacity, small-cell backhaul for dense cell deployments. The company's 60 GHz and 80 GHz links offer up to ten times the bandwidth of comparably-priced lower-frequency license-free and licensed-band wireless links, while providing superior interference immunity and data security. Founded in 1999, BridgeWave is headquartered in Santa Clara, California, USA. For more information, visit <http://www.bridgewave.com>.



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