LIGHTPOINTE™

DUALPATH™ ARCHITECTURE FOR OUTDOOR WIRELESS PRODUCTS: FAST ETHERNET THROUGHPUT AND 99.999% UPTIME

White Paper

LIGHTPOINTE COMMUNICATIONS, INC.

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Introduction: What is DualPath Architecture for Outdoor Wireless?

DualPath Architecture for outdoor wireless is the combination (blending) of two market-adopted outdoor wireless technologies to provide the highest available connectivity throughput and network uptime, more commonly referred to as "network availability." Only through an integrated, combined outdoor wireless solution can shortcomings of current stand-alone outdoor wireless products be addressed, resulting in new and improved alternatives for Enterprises and Mobile Carriers seeking to deploy point-to-point connections with true fiber-optic capacity and coveted 99.999% network availability. No standalone outdoor wireless product today can provide this fiber-like performance — let alone provide it both easily and economically. DualPath Architecture for outdoor wireless is a proprietary design platform patented by LightPointe in the United States and Europe (US 6,763,195 B1; and EP 1 249 084 B1). DualPath Architecture takes the best of existing standalone outdoor wireless products and combines them as an integrated and superior outdoor wireless point-to-point solution with seamless switching and Quality of Service (QoS) features.

Optical Wireless Based on Free-Space Optics (FSO)

TECHNOLOGY AND PRODUCTS OVERVIEW:

Commercially available Optical Wireless products based on FSO technology have been in the Enterprise marketplace for more than a decade. They are deployed by the world's best-known brands and organizations, representing all industries and geographic regions. Optical Wireless products are license-free worldwide and operate in the unlicensed terahertz frequency, also referred to as "near infrared" spectrum. Optical Wireless products utilize pulses of invisible light and specially designed optical lenses to transmit voice, video or data between two points up to distances of 5 kilometers (3.1 miles). FSO technology first emerged in the 1960s during the Cold War as secure and tap-proof outdoor wireless communications for military use in the field. During this era, FSO links were set up within a matter of minutes. Highly classified military information and troop movement strategies could be sent and received without fear of interception, due to the fact that the beams of light were confined to a narrow cone of "free space" and immune to radio frequency jamming or interception devices. Today, Optical Wireless products based on FSO technology are commercially installed in more than 60 countries, carrying mission-critical information, including financial, health-care and patient data, corporate communications and voice traffic. Optical Wireless products provide throughput at rates as high as 1.25 gigabits (Gbps) in Enterprise and Mobile Carrier networks. Known for true, fiber-like capacity and ease of installation, Optical Wireless products serve a customer base that faces one or more of the following network challenges:

- Lack of fiber-optic cable access between two or more buildings in a local area network (LAN)
- Access to fiber-optic cable but the inability to justify the costs to lease the fiber monthly from a local fixed-line service provider
- Rights-of-way and freedom to trench private fiber-optic cable but the lack of economic resources to complete such an intensive and time-consuming project
- Spectrum challenges from multiple, competing radio frequency outdoor wireless products that render 802.11b outdoor bridges ineffective or technically impossible to deploy

Optical Wireless products provide a range of bandwidth. They can deliver true fiber-like capacity of full-duplex 100 megabits (Mbps), also called "Fast Ethernet," and 1.25 Gbps, which is also known as "Gigabit Ethernet." Optical Wireless products provide full-duplex capacity in a point-to-point network topology via line-of-sight. The products are traditionally mounted atop buildings or other stable structures. When deployed in dry climates and at distances of 5 km or below, Optical Wireless products can provide customers with network availability from 99% to as high as 99.9%. A network availability performance of 99% means that during a full 1% of

the time over the course of a year, the network connection will be lost. In the case of Optical Wireless products, such network outages are most often due to dense fog, sand storms or thick smog from airborne pollution. These three environmental conditions — the most challenging of which is fog for FSO-based products — restrict the performance of Optical Wireless products and their effective performance range. In clear and dry climates, Optical Wireless products are capable of their highest network availability. The majority of the world's regions, however, experience some forms of morning and late afternoon fog, and varying degrees of air pollution. For many Enterprises, 1% percent of network downtime poses harsh economic penalties and is unacceptable for IT professionals who operate the network and are accountable for its day-to-day operations. Other Enterprises may not even find that 99.9% of network uptime meets stringent business requirements. For the critical network requirement of uptime, Optical Wireless may not always present the most attractive solution, although in many instances, they are the most cost-effective and highest bandwidth delivery option. In a perfect scenario, Enterprises are able to deploy their own fiber-optic cable between LANs, and price or rights-of-way pose no restrictions. But this is rarely the scenario for Enterprises.

Unlicensed Radio Frequency in the 5 GHz Spectrum

TECHNOLOGY AND PRODUCTS OVERVIEW

As with Optical Wireless solutions, radio frequency (RF) technology has also proven itself as a cost-effective alternative to standard leased lines for building-to-building connections. Yet, while Optical Wireless products provide high bandwidth at the sacrifice of availability (especially in fog or severe weather conditions), RF point-to-point solutions provide lower bandwidth with higher availability (99.999%).

Since its first use in World War II military applications over 50 years ago, wireless local area networking (wireless LAN) has evolved into a mainstream technology used for a variety of in-building and outdoor implementations. This, however, was not always the case. Initial wireless LAN implementations were proprietary — operating at only 1 Mbps to 2 Mbps, primarily in the 902-928 MHz Industrial, Scientific, Medical (ISM) frequency bands. This 900 MHz band, as it is more commonly referred to, was one of three unlicensed bands allocated by the FCC in 1980 for license-free spread spectrum devices — the other two were at 2.4-2.483 GHz and 5.725-5.85 GHz.

In June 1997, the first wireless LAN standard was ratified by the Institute of Electrical and Electronic Engineers (IEEE) thereby paving the way for wireless LAN's widespread adoption and usage. IEEE 802.11 set the guidelines for wireless LANs to operate at the 2.4 GHz frequency with data rates of 1 Mbps to 2 Mbps. In September 1999, due to increased pressure to ensure wireless LAN data rates remained on par with wired Ethernet speeds, IEEE 802.11b and IEEE 802.11a standards were defined in the 2.4 GHz and 5.8 GHz frequency bands, respectively. IEEE 802.11b defined the rules for an 11 Mbps wireless LAN solution. IEEE 802.11a, on the other

hand, provided a broader frequency band capable of supporting data rates of 54 Mbps and potentially higher. Wireless LANs were suddenly a viable networking option with data rates meeting or exceeding traditional Enterprise network speeds of 11 Mbps up to 54 Mbps. And the WiFi world as we know it today was born.

Historically, wireless LANs were focused on in-building applications such as retail, warehousing and portable computing where an 11 Mbps network pipe is adequate. An outdoor RF link, however, requires a much larger pipe for handling the traffic of multiple remote LANs. Because the majority of outdoor RF links are simply outdoor implementations of WiFi — using specialized bridges, routers and antennas to reach distances of 10 miles or beyond in some cases — even a 54 Mbps data rate may not be enough to handle the traffic load of two or more networks. The need for a higher speed backhaul-type link becomes apparent.

When discussing wireless LAN speeds, it is important to understand that data rates do not equate to actual network throughput. The data rate for the IEEE 802.11a standard, for example, is 54 Mbps. Actual throughput, however, is closer to 20 Mbps to 30 Mbps. Why the difference? There could be several reasons for this discrepancy, but the primary cause is due to the wireless LAN protocol and its associated overhead. As with Ethernet, wireless LANs are based on a Carrier Sense Multiple Access network protocol. But unlike Ethernet which implements a Collision Detection scheme (where data is retransmitted if a collision is detected), wireless LANs implement a Collision Avoidance scheme (where data is only sent when the air is free). This CSMA/CA protocol, as defined, does not allow for simultaneous, two-way traffic. Thus, while Optical Wireless solutions are "full-duplex," RF solutions are, by their very nature, "half-duplex." Thus, an 11 Mbps IEEE 802.11b network will, on average, have an effective throughput of only 4 Mbps to 6 Mbps, while a 54 Mbps IEEE 802.11a network has a resulting throughput of 20 Mbps to 30 Mbps.

To meet the higher bandwidth requirement for outdoor RF links, the latest outdoor wireless solutions have focused on modified versions of the IEEE 802.11a standard to reach even greater network speeds. Most have implemented a modified OFDM (Orthogonal Frequency Division Multiplex) encoding and modulation scheme to achieve greater data rates (up to 72 Mbps) and increase network efficiency. OFDM uses multiple overlapping carrier signals instead of just one signal. By using multiple signals just far apart to avoid interference, data is no longer compromised by radio anomalies, whereas in a single signal mode a problem can result in a lost link. This is similar to a multi-lane highway where traffic continues to move, despite one lane being blocked. A problem on a single lane road, by contrast, can halt traffic for hours.

Even with OFDM implementations, however, outdoor wireless links, even with data rates of 72 Mbps (or 30 Mbps to 40 Mbps throughput half-duplex), pale in comparison to Optical Wireless from a capacity perspective. Optical Wireless products and their 100 Mbps full-duplex data rates and higher are more than capable of handling the network load required of a building-to-building link. But, weather conditions including fog, do not impact RF signals to the extent that they may completely halt the Optical Wireless solution.

A blended outdoor wireless solution of both Optical Wireless and RF is ideal in bandwidth-intensive, mission-critical applications such as Voice-over-IP, medical imaging, CAD/graphic design and video.

Seamless Switching Between the Primary Optical Wireless Path and Secondary RF Path

To provide Fast Ethernet full-duplex primary connectivity and 72 Mbps half-duplex secondary connectivity, a layer 2 network switch with proprietary customization and software is required. A very small percentage of Enterprise customers who deploy Optical Wireless products for a primary network path have installed layer 2 switches that can route network traffic to a secondary path, which may rely on E1/T1 fixed 1.54 Mbps lines or unlicensed RF in the 2.4 GHz spectrum. But these in-the-field "solutions" are not seamless and capable of switching traffic from primary to secondary path without a disruption in services. The common technical term of the pause or multiple changes between primary and secondary path is known as "flapping." With the bandwidth-intensive applications employed in today's Enterprises, disruptions in mission critical network services can mean the loss of customer voice calls or even crucial financial information being sent and received over wireless connections. Enterprises deploy multiple paths of wired infrastructure to prevent against loss of connectivity and mission critical services. They now have the option of doing the same with integrated switching that is at the heart of DualPath Architecture for outdoor wireless.

Proprietary seamless switching between a primary Optical Wireless Path and secondary RF Path ensures no disruptions in service, including dropped voice calls, unwanted jitter or latency, or lost data. True, seamless switching is accomplished through proprietary design of hardware and software in the Optical Wireless link heads, so the layer 2 switch can determine — based on a customer's threshold for severe fog or airborne particulate matter — when it is appropriate to "failover" to the RF path. The process occurs before the Optical Path ever fails during a harsh environmental event, enabling 99.999% network availability. The layer 2 switch at the heart of DualPath Architecture is programmed to remain on "active ready" at all times (24/7) and provides for this proprietary functionality.

An example of this benefit of DualPath Architecture can best be illustrated by the following: In a 99% uptime Optical Wireless Enterprise network deployment with a Fast Ethernet solution, a customer enjoys 100 Mbps of full-duplex connectivity for all but 1% of the time over the course of a year. During an annual period (365 days or 8,760 hours), that 1% equates to 87 hours of downtime, or an average of approximately 14 minutes per day of downtime. Simply by deploying an outdoor wireless product based on DualPath Architecture, an Enterprise customer eliminates all downtime (including loss of data, mission-critical voice calls) and operates a network that provides full-duplex Fast Ethernet connectivity for 99% of the time and 72 Mbps half-duplex RF the remaining 1% of the time — or just on average 14 minutes per 24-hour period.

The failover from primary Optical Path to RF Secondary Path is seamless, and the variance in bandwidth is minimal, given the limited amount of time the RF is acting as the primary path while an Optical Wireless path is broken by extenuating weather circumstances.

Network Configuration and Monitoring

DualPath Architecture for outdoor wireless products enables easy network configuration and monitoring from any Internet connection via a Web-based tool. The Web-based tool provides IT professionals with a real-time window into the performance of the primary Optical path and the secondary RF path. The following block diagram illustrates the Web-based graphical user interface (GUI) utilized for DualPath Architecture outdoor wireless products.

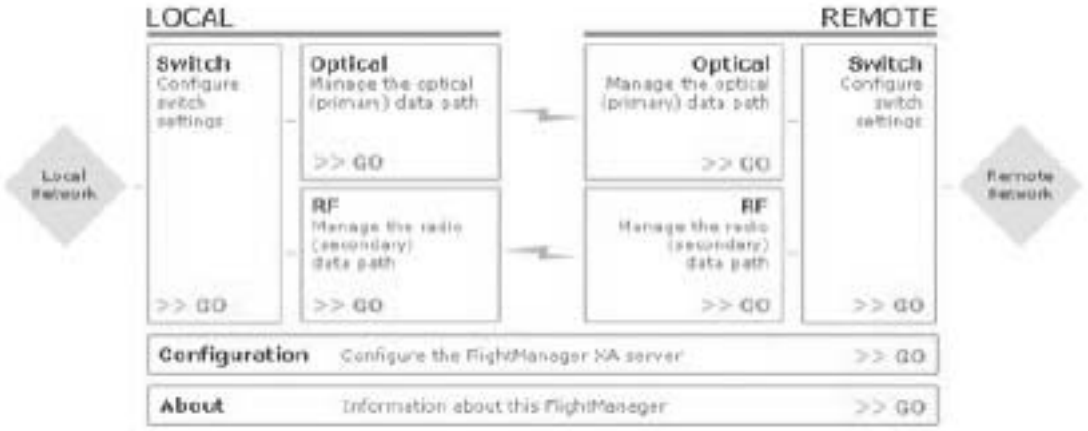


Fig. 1:
Graphical User Interface (GUI) for DualPath Architecture outdoor wireless product. The GUI is a Web-based tool for configuration and management of the primary Optical path, the secondary RF path, and the seamless layer 2 switch. Source: LightPointe

The Benefits of DualPath Architecture for Outdoor Wireless

Today's Enterprises demand true high-bandwidth network connectivity and uptime to be efficient and competitive. This connectivity is needed for inter-building linkage of Enterprise LANs that operate at Fast Ethernet and Gigabit Ethernet speeds to support bandwidth-intensive applications such as combined voice and data solutions, healthcare digital imaging, and video. Today, 17 percent of all Enterprise LANs operate at Gigabit Ethernet speed inside buildings.

But legacy E1/T1 wired infrastructure is the primary connectivity option available outside between buildings or to reach fiber-optic network backbones. When operating 100 Mbps LANs or Gigabit Ethernet LANs, 1.54 Mbps lines are insufficient, creating significant bottlenecks and recurring costs, due to long-term leases with local service providers that provide access to E1/T1 connectivity.

OUTDOOR WIRELESS ALTERNATIVES TO BYPASS E1/T1 BOTTLENECKS

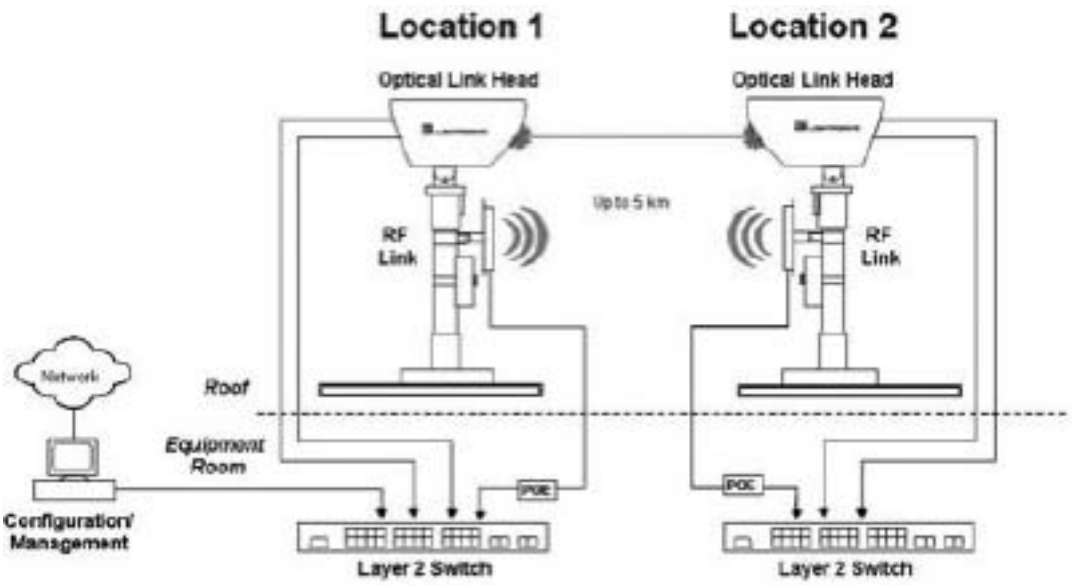
- Optical Wireless solutions (based on free-space optics — FSO — technology), which provide fiber-like bandwidth but cannot ensure 99.999% uptime.
- Unlicensed radio frequency (RF) solutions, which cannot provide the full line speed of Fast Ethernet or Gigabit Ethernet but deliver 99.999% uptime.
- Licensed RF solutions, which can provide the bandwidth of many FSO-based systems, but at double or triple the costs, in addition to requirements for regulatory approval.
- Each of the three outdoor wireless connectivity solutions by themselves have shortcoming and create challenges for Enterprises in search of cost-effective, true fiber-like outdoor wireless bandwidth and 99.999% uptime.
- The only current option for 99.999% uptime with fiber-like bandwidth for Enterprises is redundant paths of fiber-optic cable between buildings or connecting back to fiber-optic backbones. But the enormous upfront costs to trench privately owned fiber or recurring leases with service providers to lease fiber creates an insurmountable hurdle for all but the most financially flush Enterprises.

NEW OUTDOOR WIRELESS CHOICE

- Enterprises need a new outdoor wireless connectivity choice that enables their organizations to realize LAN investments made to operate networks designed for bandwidth-intensive, mission critical application such as VoIP, healthcare digital imaging and video.
- LightPointe has created a new outdoor wireless Enterprise alternative in the FlightStrata™ 100 XA, which provides full-duplex Fast Ethernet connectivity and 99.999% uptime for the Enterprise at distances up to 5 kilometers and at an attractive price point.
- LightPointe, the leader in Optical Wireless solutions based on FSO technology, has deployed more than 2,700 Optical Wireless products in 60 countries in all weather conditions. Optical Wireless solutions can achieve 99% and 99.9% uptime at distances up to 5 kilometers in climates with excellent visibility.
- In some environmental conditions, such as dense fog, Optical Wireless systems alone may not be capable of delivering the 99.999% uptime desired by some installations. Enterprises that require the highest of network availability and fiber-like bandwidth face less-than-attractive alternatives among current wireless offerings. However, when Optical Wireless and unlicensed RF solutions are combined as an integrated solution powered by intelligent switching and network management, they deliver a high-performance balance of throughput and network availability.
- The FlightStrata 100 XA is optimal for Enterprises whose networks require fiber-like bandwidth and 99.999% network uptime.

DUALPATH ARCHITECTURE FEATURES AND BENEFITS

- 100 Mbps, full-duplex primary path of license-free Fast Ethernet connectivity at distances up to 5 km
- Half-duplex secondary path of license-free RF connectivity (half-duplex 72 Mbps) at distances beyond 5 km
- Proprietary auto-switching functionality that enables transparent failover between optical and radio path should the optical path be disrupted or blocked by harsh environmental conditions, including dense fog, airborne particulates or snow
- Web-based network management GUI that provides network professionals simple system configuration as well as 24/7 monitoring capability for all critical elements of the integrated solution.
- IP Protocol
- Power over Ethernet (PoE) for RF
- RJ-45 Interface for both the optical and radio path
- Secure — the optical path uses beams of invisible light, while the RF path has built-in encryption capability for WEP and AES
- Outdoor, point-to-point solution
- License-free



DualPath and WiMAX: Differentiation

WiMAX has received much attention and commentary in the past three years. This potential network phenomenon — as yet to be proven in the marketplace — is appealing: Internet access of 50+ Mbps via mobile wireless connectivity. Some pundits have dubbed WiMAX as "WiFi on steroids." Market reality, however, is that the primary chipset maker of WiMAX technology only announced commercial availability in April 2005. The adoption of WiFi technology required nearly a decade of intensive lobbying, organizing, and industry maneuvering to make it a reality, priced appropriately for the marketplace.

The most important differentiation between DualPath Architecture and WiMAX is network topology. DualPath Architecture is based on a point-to-point high throughput topology. WiMAX — as promoted — is a point-to-multipoint network topology.

The second important differentiation between DualPath Architecture and WiMAX is technology. DualPath Architecture relies on Optical technology for its primary transmission. This enables full-duplex Fast Ethernet and Gigabit Ethernet throughput. WiMAX relies on RF technology, and throughput rates are dependent on the number of users accessing the network, network applications overhead, and the distance between base stations and access points.

The third important differentiation between DualPath Architecture and WiMAX is target market. DualPath Architecture is aimed at the short-haul, high-capacity market, primarily the Enterprise, with an eye on future products that will serve the Mobile Carrier market for its backhaul requirements to handle a growing subscriber base and the deployment of 3G networks. WiMAX, as promoted, is aimed at the service provider market seeking to provide end-customer access to the Internet at distances beyond what DualPath Architecture offers.

Summary

DualPath Architecture for outdoor wireless products is a patented design that brings to market a fully integrated outdoor wireless solution for Enterprises. LightPointe's DualPath Architecture product, FlightStrata 100 XA, blends Optical Wireless and unlicensed radio frequency products with an intelligent seamless switch to provide Fast Ethernet throughput and 99.999% uptime in all weather conditions at distances up to 5 kilometers.

No other outdoor wireless market solution can offer the combination of network availability, throughput or distance to serve Enterprise customers.

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