



# LightLEADER™ 4000 PLATFORM

LightLEADER 4000 is a powerful modular, carrier class optical protection platform, designed to handle all the network protection needs of service providers and large enterprises. This versatile 1RU, NEBS/ETSI-compliant add-on platform features redundant and hot-swappable AC or DC power supplies, a control/management module, and an array of intelligent plug-in modules supporting a wide spectrum of high-availability (5'9s) applications such as: end-to-end wavelength services protection, DWDM link protection, fiber link protection, equipment protection as well as optical bypass of failed network sites. The LightLEADER 4000 can be controlled by CLI or SNMP based EMS (LynxVision).

To meet specific deployment needs, the LightLEADER 4000 supports various protection schemes such as single and dual-ended 1+1 protection, 1:1 protection, 1:N protection, tandem 1+1 protection and single bi-directional fiber protection. Some of the system's key features include support for dual homing, bi-directional protection, extra traffic, CLI/SNMP management and an optional protocol-based failure detection module. The system is designed to detect current and imminent failures and provide quick response, whether by alerting the operator or through fast automatic switchover (under 50msc) to protect the failed network resource.

The space-efficient, plug-and-play LightLEADER 4000 is easily installed and managed at either the enterprise/campus premise or at the carrier's point of presence over existing network infrastructure. It offers a protection solution that is cost-effective, highly reliable and truly transparent, even when power is down. The 1U 19" rack-mountable LightLEADER 4000 platform supports up to six pluggable units in any combination, allowing operators to increase the number of protected clients on a pay-as-you-grow basis. The system offers full front-panel connectivity for easy access and is compliant with 300mm ETSI and NEBS standards.

## *CARRIERS AND SYSTEM INTEGRATORS*

With LightLEADER 4000, you can provide wavelength services over DWDM as well as high-speed metro Ethernet services with the same 5'9s availability of SONET/SDH networks. LYNX's versatile LightLEADER 4000 platform offers a comprehensive solution for your network availability and disaster-recovery requirements.

## *ENTERPRISES*

Protect your high-rate mission-critical optical services, for all types of traffic, networking equipment and service providers. The compact, plug-and-play LightLEADER 4000 is easily installed and managed at your premises, over your existing network infrastructure. With LightLEADER 4000 you are in full control over your network availability.

## WAVELENGTH SERVICE PROTECTION

Wavelength services are used by high-end network users for point-to-point links between their sites. Typically, 2.5 and 10 Gbps traffic is transported over fiber optic DWDM channels, carrying mission-critical content and new generation services such as packetized voice and video.

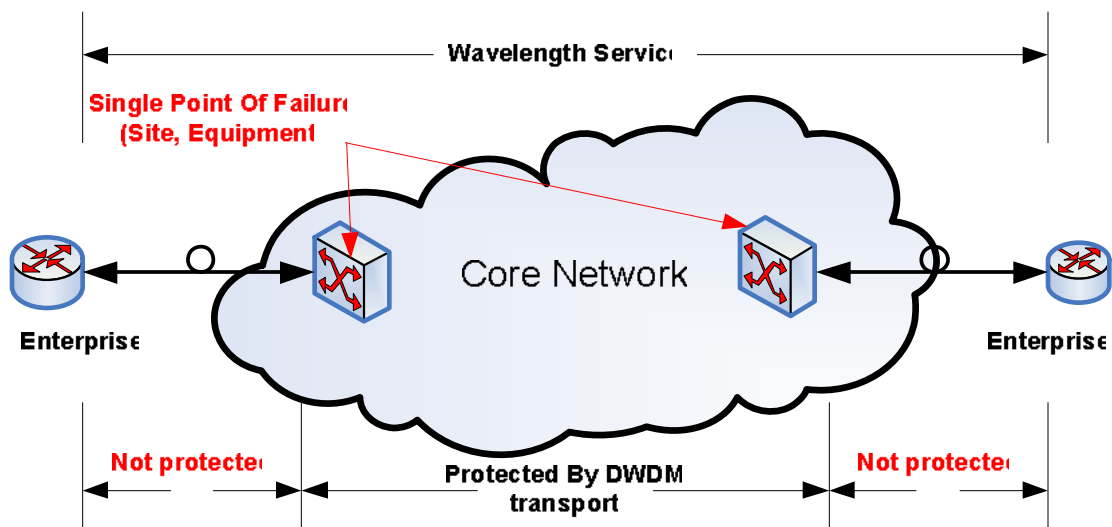
While optical and low rate TDM services are often protected by SONET/SDH-like availability (5'9s), higher rate end-to-end wavelength services, delivered over DWDM networks, are difficult to protect and are therefore often offered without protection. Some DWDM equipment vendors provide limited built-in wavelength protection, but in most cases enterprises must find their own solutions, such as expensive protocol-based protection mechanisms (such as MPLS) or make do with unprotected network links.

Today, however, there is a simple yet comprehensive add-on solution from Lynx Photonic Networks for wavelength service protection, which is cost-effective, highly reliable, and fast.

### BENEFITS OF LYNX'S WAVELENGTH PROTECTION SOLUTION

#### End-to-end protection:

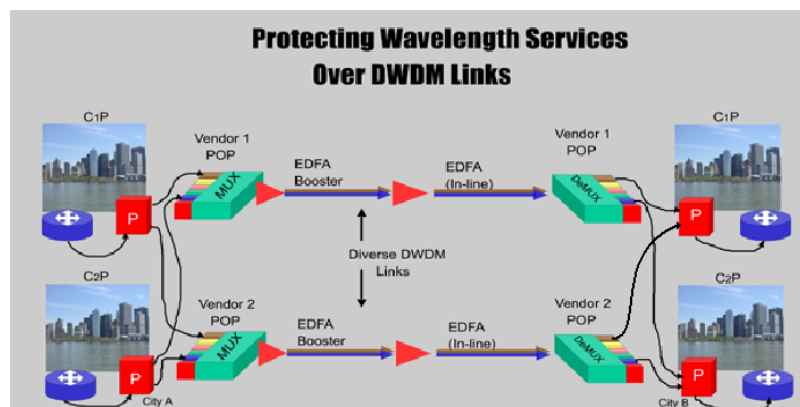
In many cases the core network does not extend to the client's premises. Regardless of the availability level of the core network, for full end-to-end protection the so-called last mile links from the premises to the transport network must be redundant, with protection equipment being located at the customer's premises. An optical add-on protection system, such as the Lynx LightLEADER 4000, offers the most cost-effective solution and is interoperable with any CPE or transport equipment, regardless of the make, protocol and data rate.



DWDM based wavelength service 1:1 protection: no end-to-end, no full diversity

## Path Diversity through Dual Homing:

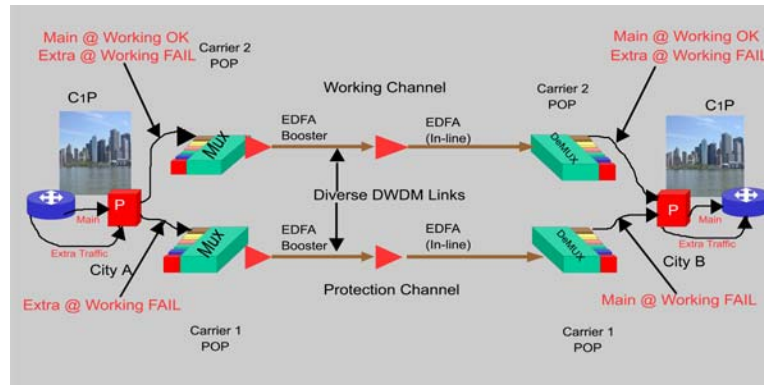
High availability requires that the two redundant paths be fully diverse. This guarantees that failure of a single, common point such as fiber, equipment or network site, will not bring down the entire channel. When using a carrier's transport network, path diversity is maximized when the customer's premises are connected to two geographically diverse transport systems (ideally in two separate COs, possibly by two different carriers). Based on the carrier's operational considerations, the two diverse transport systems may be different makes or models. This approach is not supported by built-in redundancy offered by some DWDM equipment vendors, since it requires a separate, stand-alone protection system. The Lynx LightLEADER system provides such a solution and works with all transport equipment makes and models.



Dual homing end-to-end wavelength service 1:1 protection

## Support of Extra Traffic:

Protection requires full resource redundancy (fiber and equipment). Transporting two different traffic streams over the redundant paths optimizes resource utilization. Certain APS modules of the LightLEADER system support 1:1 protection with transport of extra traffic. Under normal conditions, when both paths are operational, the protected stream is transported along with lower priority traffic. This typically accounts for 99.7% of the network run time. When the primary path transporting the protected stream fails, the secondary path is preempted to provide network continuity of the protected stream. This is a win-win situation both for the carrier and for the enterprise. Carriers gain additional revenue while gaining better resource utilization by transporting extra traffic over existing infrastructure. Enterprises can double their effective bandwidth for just a small incremental cost. Enterprises who buy/lease two unprotected lines and take care of protection on their own, can double their effective capacity with no additional transport cost.



## Dual homing end-to-end wavelength service 1:1 protection + Extra traffic support

### Support for Unidirectional & Bi-directional protection:

In most cases where protected wavelength services are offered, either through built-in DWDM protection or through higher protocol layers such as MPLS, 1+1 unidirectional protection is used. With this set up, failure of just one path direction will result in the use of two diverse paths for the two traffic directions. This behavior causes differences in latency between the two directions, which is problematic in some applications, such as VoIP. Additionally, it is extremely difficult to monitor the traffic.

In most optical protection systems, the signaling between the two link ends that is necessary for bi-directional protection works only when clear fiber is used. When protecting optical channels that consist of fiber and embedded equipment, only unidirectional protection is supported. The Lynx LightLEADER system employs an in-band signaling mechanism to support bi-directional (1+1 or 1:1) protection of both clear fiber as well as optical channels.

### Complementing Higher-Layer Protection Mechanisms:

Higher layer protection mechanisms such as IP or MPLS provide bandwidth efficient mesh protection. Protection involves rerouting and often impacts large portions of the network, resulting in unpredictable load patterns, degraded service quality and inefficient use of resources. By complementing the protection capability of the higher layers with optical (physical) layer protection, the LightLEADER system localizes the recovery, speeding it up and overcoming the issues mentioned above.

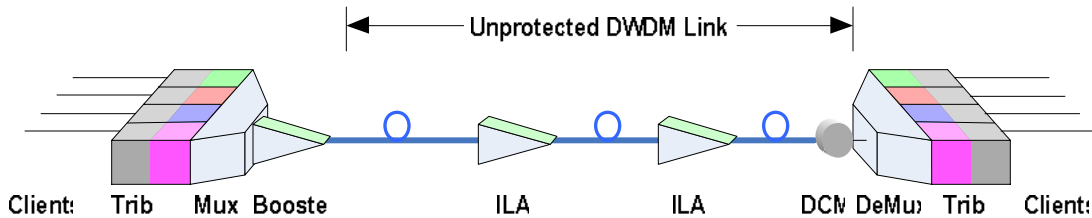
### Extended Failure Detection Capability:

While failure detection in fiber protection can be handled by an OPM (Optical Power Monitoring), this method may not work when wavelength services are protected. During certain failures some types of DWDM equipment may continue to send signals, but without proper payloads. The signal usually contains AIS (Alarm Information Signal) that cannot be detected by an OPM. The LightLEADER system offers an optional OFM module, capable of identifying such failure conditions and triggers a switchover.

## DWDM LINK PROTECTION

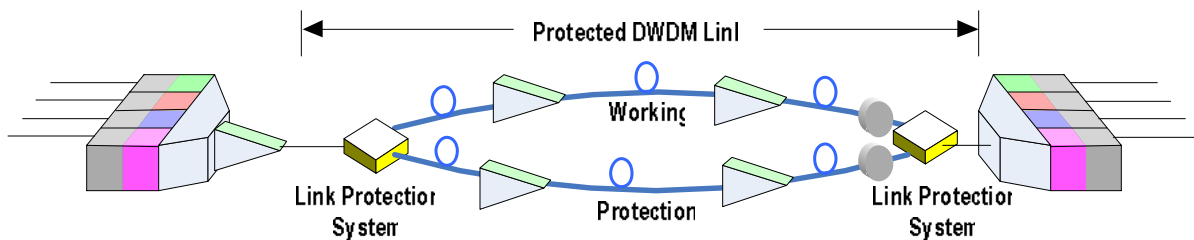
DWDM links connecting 2 DWDM terminals carry multiple (40, 80 or more) wavelengths. Typical data rates of each channel (transported over one wavelength) are 2.5Gbit/s or 10Gbit/s.

The DWDM link consist of multiplexing and demultiplexing functions at both ends of the link, single mode fibers, embedded optical amplifiers and possibly OEO equipment (e.g. OADM, regenerators). In some cases additional equipment is used to compensate for chromatic dispersion or other such phenomena.



Any link failure, be it fiber or equipment, will cause all channels to fail. While a few of the channels contain low-rate services that are protected at their tributary sources (such as SONET OC3) other channels may carry high-rate traffic that needs additional protection to enable high availability.

Depending on the deployment specifics, these channels may be protected individually or the entire DWDM may be re-routed to another operational link through a single all-optical protection switch (at each end of the link). Lynx's LightLEADER 4000 system supports both of these types of protection. This document focuses on the second method. The diagram below shows an application in which a Lynx DWDM link protection system is used.



### **BENEFITS OF ALL-OPTICAL DWDM LINK PROTECTION**

- √ Fast recovery of high-value links.
- √ Using a single protection system for the entire wavelength makes it extremely cost-effective.
- √ Assuming that the DWDM terminals are sufficiently reliable, only the DWDM links (fiber and embedded amplifiers) need to be duplicated for redundancy.
- √ The terminal equipment can be more separately and economically protected by shared 1:n protection.

#### **Comprehensive Failure Detection capability:**

The LightLEADER 4000 incorporates two types of failure detection in order to support various deployment configurations:

- a) Failure Detection based on OPM (Optical Power Monitoring)  
This method is used when the DWDM consists of clear fiber, links with embedded constant gain amplifiers (EDFA), or links that only contain embedded equipment that shuts off during failure. In all cases, a failure results in drop of the optical power at the receiver.
- b) Failure Detection based on Monitoring of the Received Optical Signal  
This method is used in all cases where a failure within the link doesn't necessarily imply a drop in the received optical power.

#### **Support for fiber pair or single fiber links:**

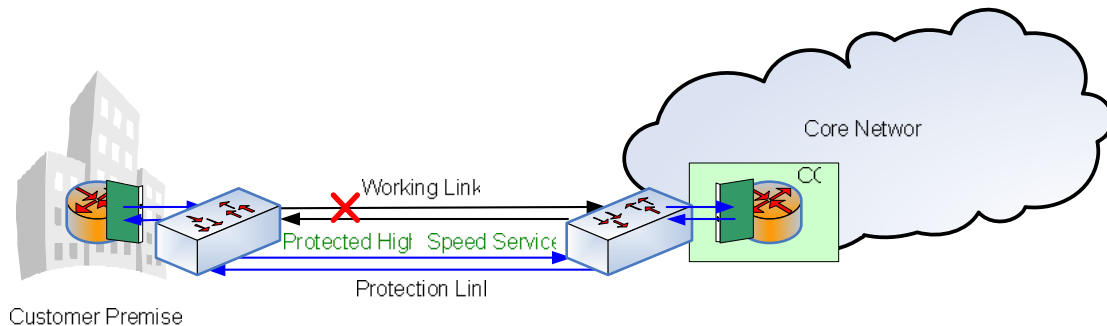
Traffic over DWDM is usually bi-directional. Bi-directional traffic can be transported over a fiber pair, one for each direction, or over a single fiber utilizing two wavelength bands, one for each direction.

The LightLEADER 4000 can protect both types of DWDM links. When protecting single bi-directional links, two wavelength ranges are supported: 1310/1550 or red/blue bands.

## FIBER LINK PROTECTION

Fiber cuts, a common network failure, require time-consuming repairs - entailing significant financial losses if they are not protected. The LightLEADER 4000 protection system protects links from failures that result from fiber degradation or from fiber cuts - and is designed for both fiber pairs (one per direction) and single bi-directional fiber.

The figure below depicts deployment of LightLEADER systems in fiber protection applications.



### BENEFITS OF ALL-OPTICAL FIBER LINK PROTECTION

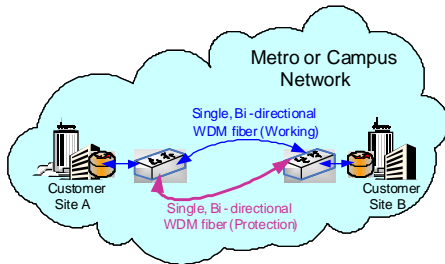
- √ High customer satisfaction
- √ Prevents SLA penalties
- √ Low CapEx: Inexpensive protection switch
- √ Low OpEx: Reduced space and power consumption
- √ Fast recovery: Under 50 milliseconds
- √ High reliability
- √ Carries traffic during power outage
- √ Versatility & future proof: Traffic transparency (data rate, protocol, format, wavelength)

### BENEFITS OF THE LYNX FIBER PROTECTION SOLUTION

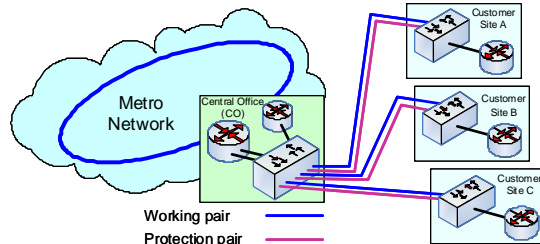
#### Advantages over protocol layers protection:

Some higher layer protocols such as IP, MPLS and RPR offer protection. However, even when available, protection is expensive (requiring the use of redundant line cards), slow and traffic-sensitive (i.e. works only for specific data rates and protocols). Additionally, network recovery may affect large portions of the network, resulting in unpredictable traffic loads and degraded service. The LightLEADER optical protection solution solves these problems, providing the most cost-effective protection solution for high-speed links. A smart system with comprehensive functionality, it is easy to install and use.

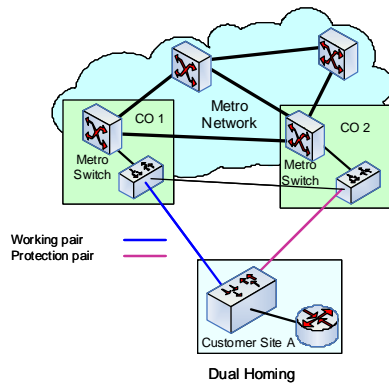
**Supports various access fiber network topologies:**



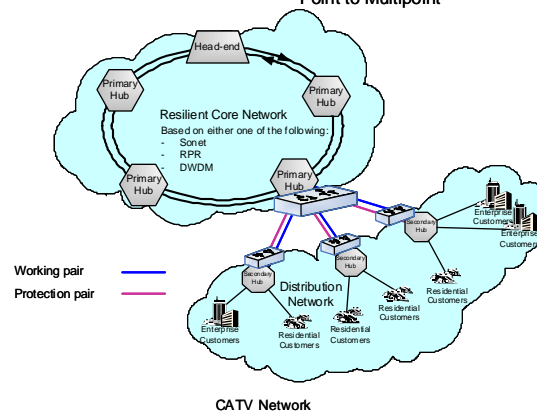
Point to Point



Point to Multipoint



Dual Homing



CATV Network

Example of network topologies

**In-band Management:**

In many cases the carrier providing the protection switches has no management link to the enterprise, yet needs to manage the “remote” switch located at the customer premises.

The LightLEADER system provides in-band management. A management station, connected to a local switch at the CO, can manage the remote side, by exchanging management traffic over the protected fiber link. In-band management is supported in both point-to-point and point to multipoint topologies.

To reduce cost, the LightLEADER supports also tandem 1+1 protection in which the local side is active and the remote side is purely passive. This solution is based on the assumption that fiber failures typically affect both directions of the link.

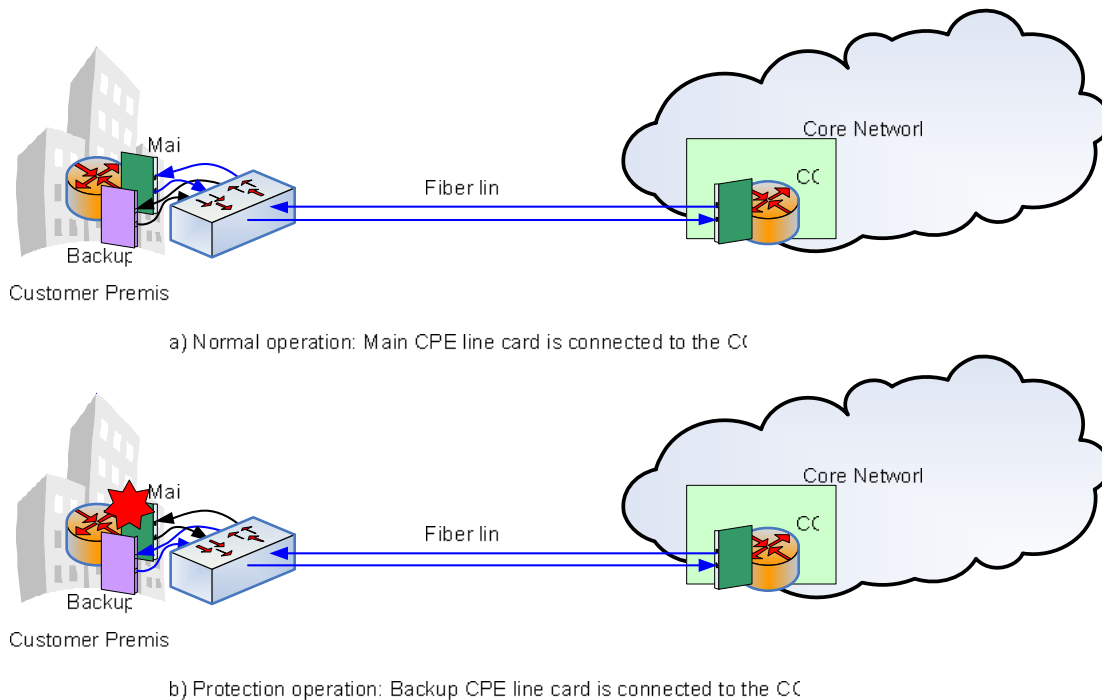
## LINE CARD PROTECTION

Equipment failure typically results in service disruption. The use of optical equipment protection is a cost effective method for increasing service availability. Lynx' LightLEADER 4000 offers several equipment protection solutions.

### CPE line card protection

Operators of critical CPE may choose to add redundant line cards, as a means for protecting their network links from equipment (line-card) failures. Typically, the use of a second, diversely routed link, is required in order to use the spare line card.

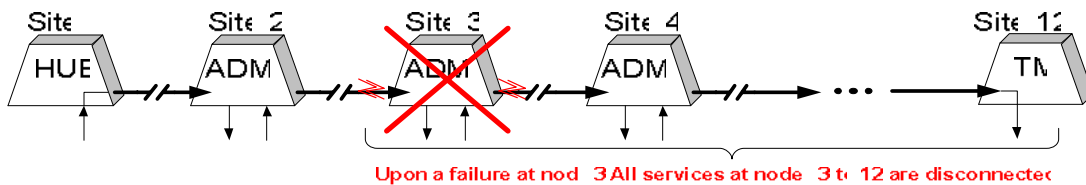
In cases where a redundant link is not available or prohibitively expensive, an optical protection switch offers a cost-effective method for achieving line card protection. The switch is used to route any of the line-cards, primary or spare, to the single link. The figure below depicts the all-optical CPE line card protection solution.



✦ Lynx' LightLEADER 4000 supports both 1:1 and 1:N equipment protection.

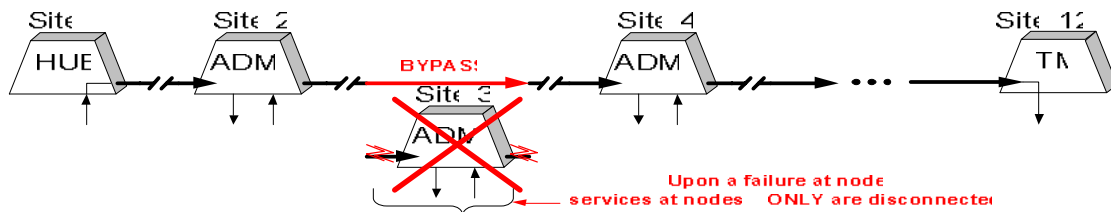
## OPTICAL NODE BYPASS

Networks are susceptible to power outages, particularly in areas affected by storms or floods. Even though certain ring and mesh architectures provide some level of resilience, typically they can recover only from a single node failure, as is the case for SONET/SDH rings. Other topologies, such as linear or hub-based networks, in many cases cannot provide protection from even a single failure. Such failures affect not just services originate or terminate at the failed nodes, but may cause the collapse of the entire network. The drawing below shows an example of a hub-based linear network. Failure of Site 3 results in the collapse of all the nodes downstream.



### BYPASS SWITCHING TO THE RESCUE

The LightLEADER 4000 provides an optical node bypass solution, whereby sites affected by power outages are bypassed and connectivity is maintained among the operational sites. Upon power failure, an optical switch automatically connects the ingress and egress fibers to the site/equipment and the failed node is bypassed. This mechanism doesn't utilize other protection mechanisms, such as SONET/SDH, leaving them available for protection from other failures



### Configurable reconnection delays:

The LightLEADER 4000 optical bypass system provides a user-configurable delay, governing the reconnection time. Once power is restored the system may remain in bypass mode for a predefined period in order to allow the bypassed equipment/node to boot.

### Manual Bypass:

The LightLEADER 4000 allows users to induce bypass during normal power conditions in order to facilitate maintenance operations.



LYNX Photonic Networks is a leading developer and provider of all-optical switching solutions, based on the company's patented solid-state light management technology. The company's products include a large family of small and cost-effective add-on systems for network availability and business continuity, as well as a line of wavelength management modules for agile optical networks.

LYNX's network availability products can be added to existing network infrastructure. They offer true data and protocol transparency, space savings, high reliability and functional integration.

LYNX has offices in the US, Israel, Italy and China.

*FOR ORDERING INFORMATION, PLEASE CONTACT:*

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