White Paper

FiberLinX

Proven, Profitable First Mile Ethernet

IMC Networks

Making Your Net Work Better

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Introduction

As the need for bandwidth increases, more and more businesses are outgrowing xDSL and the legacy copper access technologies such as T1 and DS3, and requiring optical fiber connections. To upgrade customers to faster connections, service providers have traditionally needed to deploy expensive and inflexible Synchronous Optical Network (SONET) based circuits in such applications, with significant protocol conversion overhead, and heavy investments in equipment, time and labor.

With the right approach, native Ethernet/IP can be used in the "last mile" to provide point-to-point connectivity with significant advantages in terms of system flexibility and cost-effectiveness. The *FiberLinX* system from IMC Networks allows service providers to provision remotely managed, bandwidth-scaleable Ethernet fiber connections at a much lower total system cost per customer than other alternatives, leading to a rapid return on the initial capital investment. Introduced in 1999, *FiberLinX* is standards-based, field-proven technology with a large number of successful customer deployments, validating its unique capabilities and benefits to service providers.

Fiber Access Approaches

The business case for Ethernet-based broadband access and "Transparent LAN" services has been widely discussed. Readily available equipment from competitive suppliers, well-understood technical issues, scaleable bandwidth throughout the network, drastically reduced installation complexity, and more efficient data transport are just a few of the benefits of a network technology with over a half a billion installed nodes. However, service providers require the right access equipment in order to maximize the benefits of direct Ethernet interfaces to customers. While simple access devices may lower the initial investment, they represent significant maintenance costs over the life of the installation and lack the operation and administration capabilities mandatory for a revenue-generating network. Similarly, too complex an access device may be so cost-prohibitive to purchase and maintain, that the service provider cannot turn a profit, or offer a reliable service within an acceptable time frame, putting a halt to the whole business plan before it can even get off the ground.

Following are some common solutions for Ethernet optical access along with their advantages and disadvantages.

Media Converter as Access Device

The most basic function of an optical Ethernet access device is to terminate the service provider's fiber and present a standard RJ-45 Ethernet port to the customer. This approach provides a well-defined demarcation point, and means that the customer need not be involved with the wavelength, power budget, modality, termination, and other technical parameters associated with fiber optic data communications. The most basic device for performing this fiber-to-copper translation is known as an unmanaged media converter. Operating strictly at Layer 1 of the ISO-OSI stack, a media converter terminates the fiber connection on one port and provides a copper connection on the other, simply passing frames back and forth from one media to the other. In a fundamental sense, a media converter can be simply considered a patch cord that converts electrical signals into optical and vice versa.

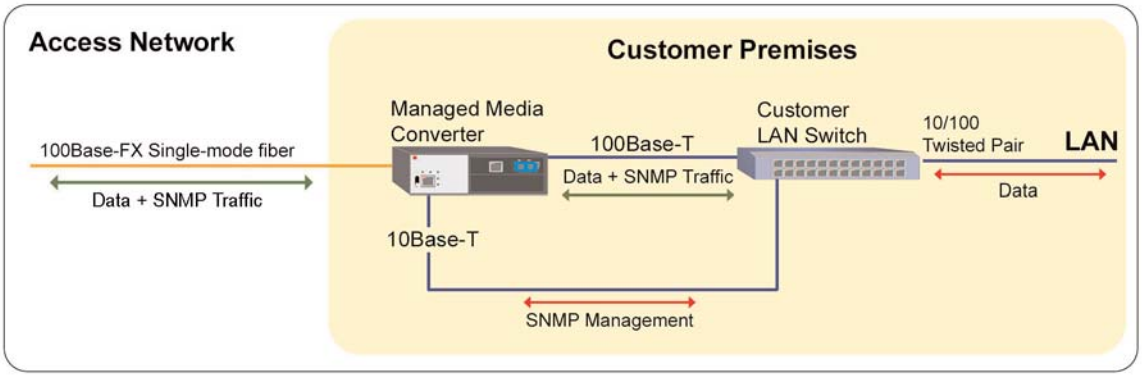
Media converters are inexpensive, widely available and provide a simple customer demarcation point. However, what an unmanaged media converter cannot do is provide status information back to the service provider head end or point of presence (POP). This means that any problem between the POP switching equipment and the customer LAN will require technical intervention— be it by phone or an engineer visit to the customer site— to troubleshoot the loss of connectivity. In addition, unmanaged media converters do not have the capability of provisioning bandwidth at the access point, or trapping and logging frame errors, plus it is necessary to physically change out a remote unit when upgrading a customer from 10 Mbps to 100 Mbps.

Managed Media Converter as Access Device

The next step up is a managed media converter. Introduced in 1997 by IMC Networks, a managed media converter features an SNMP (Simple Network Management Protocol) agent that can acquire various pieces of diagnostic status data from the media converter and communicate this information back to the network administrator at the head-end. This means that many common failures can be determined remotely and proactively, possibly even before the customer notices degradation; appropriate action can be taken proactively rather than reactively. Some media converters include troubleshooting features which help determine where an apparent problem actually resides on the customer side of the demarcation point, saving the service provider a truck roll.

Managed media converters are very useful in wholly-owned networks (i.e. when the head-end and remote location are part of the same collision domain). The problem comes when a managed media converter is used at the customer premises as an access device; the agent sits outside the data path itself and requires a separate physical connection. This means that in practice, the management information must be injected into the customer data stream, and looped back around the customer's network, to finally exit through the fiber port interfacing to the provider's network. While blurring the line of responsibility, this is not so much a physical wiring problem as it is a security issue.

The service provider may not want the customer to have the ability to monitor, and perhaps manipulate, the SNMP data to the media converter (and potentially hack the service provider's management network.) In addition, the customer WAN connection to the media converter may include hardware such as a router or a firewall that would need to be configured to route data intended for the agent's IP address back or transport protocols to the management port on the media converter. At a minimum, this costs the customer a switch port.



A table-top media conversion chassis with an SNMP agent can provide the optical demarcation in Customer Premises applications– however, this implementation blurs the line between service provider and customer networks, since the provider SNMP traffic is forwarded via the customer LAN back to the fiber.

Switch as Access Device

Of course, the service provider could install a multi-port, SNMP managed Layer 2/3 switch with a fiber WAN port at the customer premises. These units can generally be configured to accept management information embedded in the data stream and direct it to the switch's agent without presenting it to the copper ports on the customer side. Switches have the capability of allocating a certain amount of bandwidth to the customer data stream, either in a coarse 10 or 100 Mbps selection or with a finer degree of granularity, typically in 1 Mbps increments.

However, deploying a high-end switch for optical Ethernet access is somewhat of an overkill for the application: When only one 10/100 copper port is required for the customer connection; what do you do with the other ports on the switch? Furthermore, most switches with fixed or modular (GBIC) fiber ports are limited in the selection of fiber interfaces (optical wavelength, single/multi-mode, optical power budget) and carry a significant price tag.

The *FiberLinX* Advantage

So, if a managed switch is overkill, and a simple media converter is inadequate, what is the optimal access equipment for Optical Ethernet or "Transparent LAN" services?

IMC Networks' *FiberLinX* combines the remote management capability and advanced features of an expensive switch with the low cost and small size of a media converter. You can deploy *FiberLinX* as a standalone Customer Premises Equipment (CPE), or in pairs to provision a point-to-point fiber connection between the head-end and customer LAN. When *FiberLinX* are deployed in pairs, the key benefit is that the entire end-to-end fiber connection is managed as a one unified system, and as a single IP address, rather than three individual elements (the head-end, fiber optic cabling, and the CPE).

FiberLinX includes the following features beneficial to Ethernet/IP service providers:

Electrical-to-Optical Conversion

FiberLinX provides an optical network interface and a service hand-off at the customer network edge. Featuring a standard 10/100 twisted pair port, *FiberLinX* offers the customer a familiar Ethernet-based interface to the WAN. Since *FiberLinX* is also a media converter, the service provider can achieve cost-savings by using a copper switch at the head-end instead of fiber blades.

Variety of Optical Interfaces

The *FiberLinX* WAN port supports a wide variety of fiber types: 1300 nm multi-mode, 1310 or 1550 nm single-mode, with medium or long haul power budgets, and a choice of a ST or SC connector types. In addition to the standard connector types, *FiberLinX* is also available with a single strand fiber connection that uses wavelength division multiplexing technology to achieve full duplex operation over just one strand of fiber— effectively doubling the capacity of fiber. This saves the service provider not only in the cost of the fiber itself, but also the labor and material involved in terminating one versus two fiber strands at each end.

SNMP Management

FiberLinX features an SNMP management agent for monitoring the status and activity on copper and fiber ports at the remote end. Perform initial setup of the unit and modifications in the field via:

A) IMC Networks' *iView²* SNMP application

B) Telnet, or

C) local serial connection.

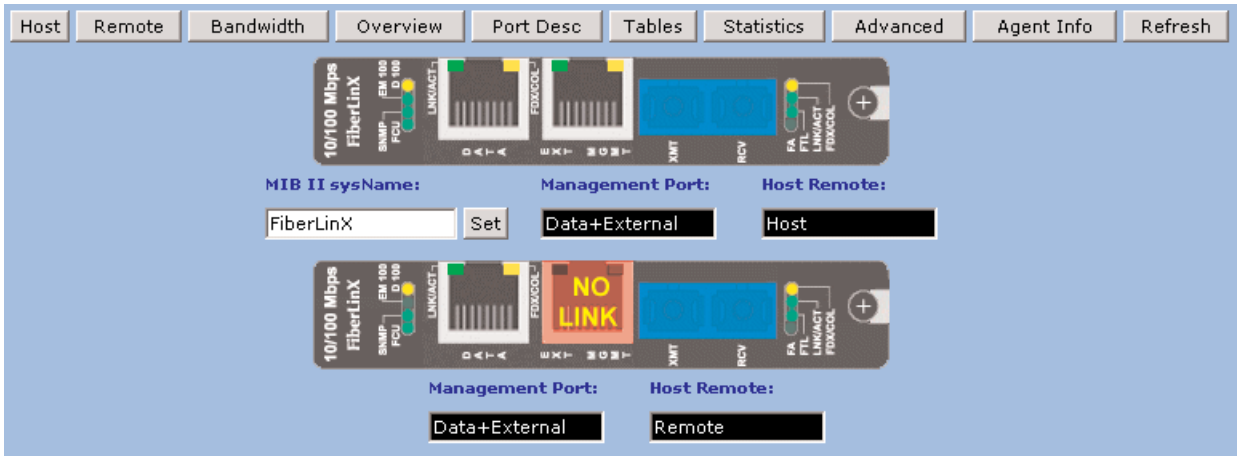
The operational information available via SNMP includes link status, total bytes transmitted and received, and any link-level errors seen on either copper or fiber ports.

Security

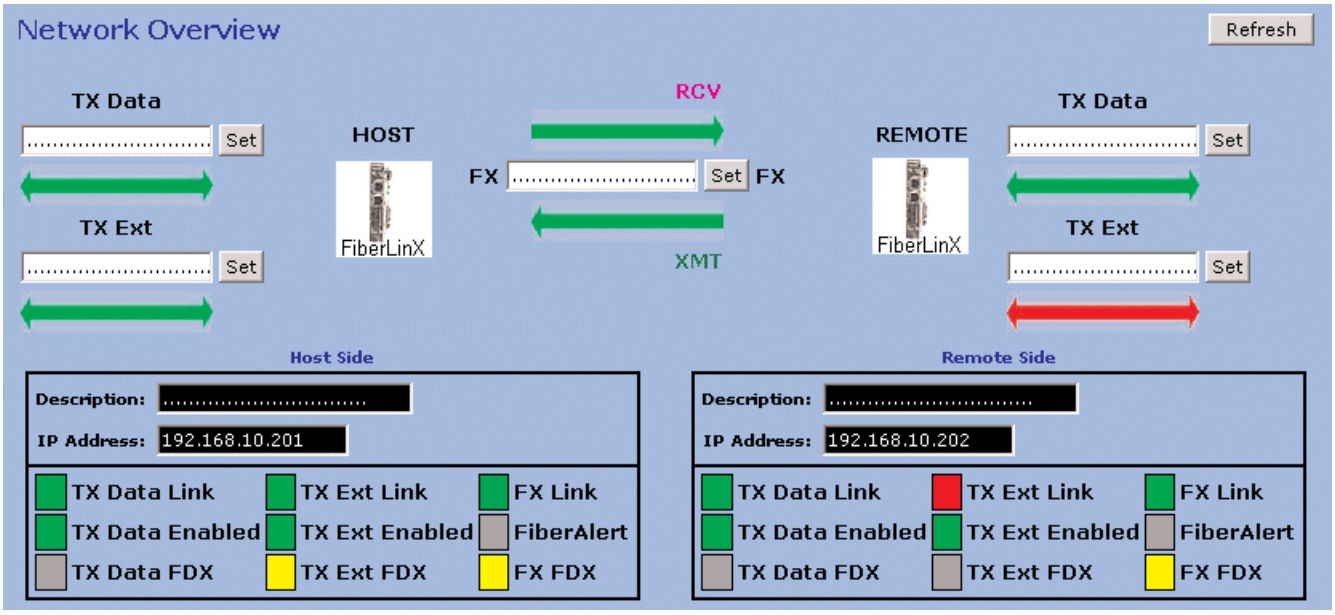
A key security advantage to *FiberLinX* is that it can be configured to only accept and transmit management traffic on a designated port. For example, if a single *FiberLinX* is used at a remote site, management traffic will only be transmitted on the fiber WAN port and will not be visible or available at the customer's LAN port. A *FiberLinX* installed at the head-end can utilize the data port for management traffic, if the service provider has a shared management/ data network, or it may be routed through the dedicated management port for transport to a separate management network. In addition, you can also tag the SNMP traffic with a VLAN ID.

Link Integrity

FiberLinX provides end-to-end fiber management, from the head end to a remote location. While you can deploy a single *FiberLinX* at the customer premises with a standard fiber switch connection or media converter used at the head-end, the real value of the *FiberLinX* concept comes when used in pairs. With a *FiberLinX* at either end of the connection, there is only one SNMP agent (with one IP address) that manages both Host and Remote *FiberLinX* units, as well as the fiber between, as a unified system rather than individual elements.



The Host *FiberLinX* communicates with, and controls, the Remote *FiberLinX*, so that the system administrator need only deal with what appears to be one managed unit. If a problem occurs, there is no need for the administrator to determine the mapping between head-end and remote devices, query each individually, and correlate that information to diagnose the situation. Instead, as the *iView²* screen shot below illustrates, an easy to understand graphical interface shows at one glance the status of the entire connection from the head-end to the customer demarcation point.



Full Range of VLAN IDs

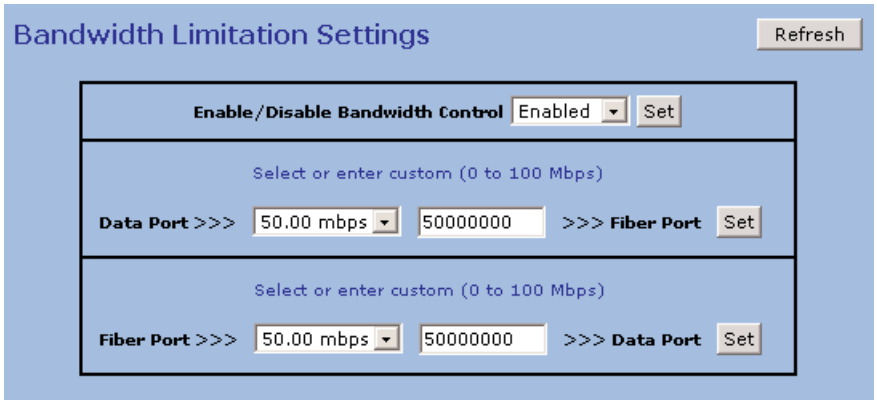
Service providers routinely use IEEE 802.1Q Virtual Local Area Network (VLAN) tagging to secure, separate and differentiate customer traffic. *FiberLinX* supports the full range of available VLAN IDs (1 to 4,094), enabling service providers to support multiple VLAN-based applications:

- To supply service to multiple customers via one fiber uplink, use VLANs to segregate customer traffic so that it may be demultiplexed by a standard switch supporting 802.1Q.
- Use VIDs to isolate management data from customer data in a remote-only *FiberLinX* configuration.
- In a dual *FiberLinX* configuration, configure the remote unit, with VIDs, to direct management data (again isolated from customer traffic) to both the internal SNMP agent and to the external management port. This feature sounds somewhat arcane, but what it means in practice is that other remote devices can be controlled through *FiberLinX* on a physically separate management network without interacting with the customer's data network.
- VLAN tags may be added to / removed from customer data.
- VLAN tags may be transparently passed through *FiberLinX*.
- In addition to 802.1Q VLANs, *FiberLinX* can also use 802.1p priority tags to establish two levels of priority (two queues) for inbound and outbound traffic. This feature is beneficial in situations where the service provider is selling customer bandwidth that is below the "wire-speed" such as 1Mbps, 3Mbps, etc.

Bandwidth Management

In addition to the managed physical and link layer functions, *FiberLinX* also has a number of higher-level functions valuable to service providers. Of significant importance in ensuring profitable differentiated service is the ability to limit bandwidth both upstream (LAN to WAN) and downstream (WAN to LAN.) Configure initial maximum bandwidth (in very fine 32 Kbps increments, measured over 1 second intervals), along with other set-up parameters as discussed earlier. Once installed in the field, the service provider's administrator can easily change that bandwidth allocation, remotely, in seconds via SNMP. There are no hardware changes, physical reconfiguration or other visits to the customer site required for bandwidths between 32 Kbps and 100 Mbps.

As discussed above, *FiberLinX* also provides traffic statistics such as total bytes transmitted and received, a useful feature for billing services.



Cost Advantage

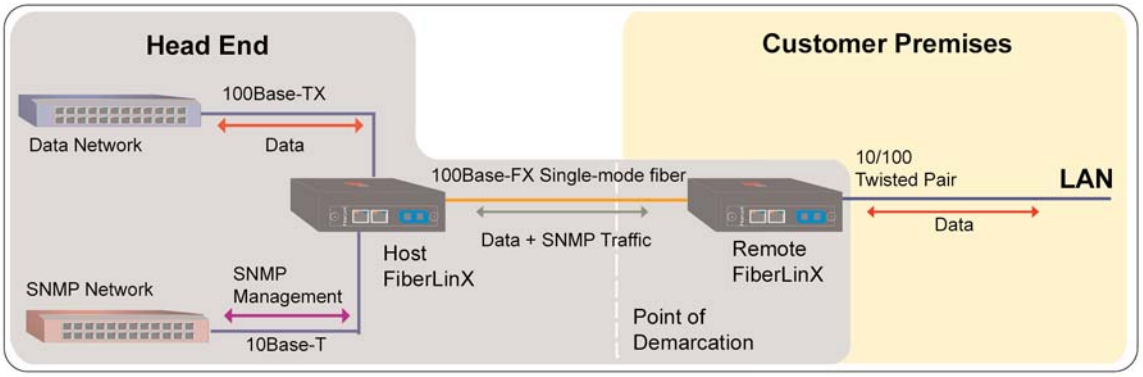
FiberLinX provides optical access, remote management, VLAN tagging and rate limiting all in one compact, cost-effective unit. This eliminates the need for installing multiple units— such as CSU/DSUs, edge routers and VLAN switches— at the customer premises. *FiberLinX* can save hundreds of dollars in equipment cost per customer, enabling service providers to profit from Ethernet/IP services much faster than with other access technologies or equipment.

FiberLinX Applications

FiberLinX technology is field-proven and has been used in revenue-generating optical Ethernet networks since 1999. Following are the most common configurations for provisioning point-to-point fiber services.

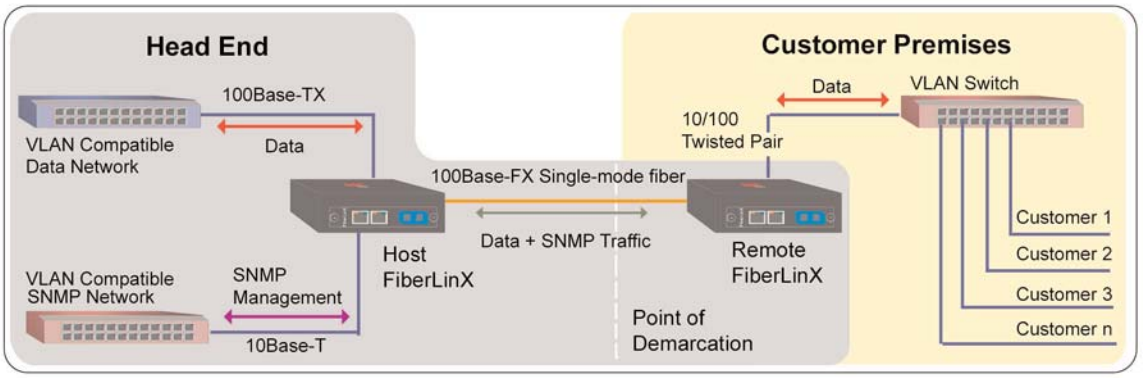
FiberLinX End-to-End Remote Management

As mentioned, *FiberLinX's* unique features, and subsequent benefits to the operator, can be fully realized when deployed back-to-back. In the application below, the Host unit installs at the central office and connects to 100Base-TX data and management networks. The Host controls the Remote *FiberLinX* over a single-mode fiber connection (duplex or single-strand) up to 100 km. The Remote *FiberLinX* unit provides the service hand-off to the customer network with a 10/100 twisted pair port. When deployed in pairs, *FiberLinX* monitors the head-end, the customer premises and the fiber between as a single entity (and a single IP address), not as three separate network elements. This unique capability enables service providers to manage and control the entire access network, and to minimize customer visits after the initial set-up.



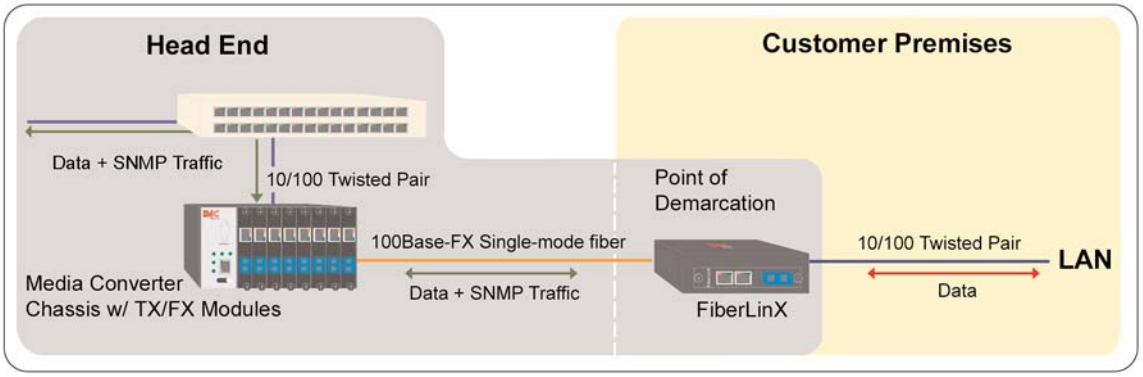
FiberLinX in Multi-Tenant Unit Applications

When supplying Optical Ethernet services to multi-tenant units, *FiberLinX* provides an optical demarcation and a remotely managed VLAN-gateway to the access network. *FiberLinX* supports a full range of VLAN IDs, making it possible to use a Layer 2 VLAN switch in addition to the *FiberLinX* unit at the customer premises to separate and secure customer traffic. The network topology is the same as in the example above, except the *FiberLinX* 10/100 twisted pair data port connects to a multi-port Ethernet switch.



FiberLinX at the Edge

Service providers can deploy one *FiberLinX* as a intelligent standalone access device at the customer premises to terminate the fiber and provide the Ethernet service hand-off. Simply pair the *FiberLinX* with a TX-to-FX media converter at the central office. This scenario eliminates the need for additional devices, e.g. edge router. The *FiberLinX* SNMP management agent enables service providers to receive traffic statistics, port status and link information as well as enable/disable services, and control customer bandwidth— all without sending a technician to the customer site. The device management traffic remains completely isolated from the customer data traffic and does not impact customer bandwidth.



Summary

In today's market, network operators under pressure to maintain and enhance profitability need to select optical access equipment based not on promises but on performance. Simple access equipment such as media converters may cost less up front, but have significant hidden lifetime costs due to more difficult operation, administration and maintenance. Expensive, high-feature-equipment may have lower lifetime costs, but cannot be cost-justified based on the time it takes to return the original investment.

With IMC Networks' *FiberLinX*, service providers have an alternative that is tailored specifically to the optical Ethernet access applications, combining the low cost of simpler alternatives with the appropriate level of embedded features to minimize the cost of operating the network. The flexibility of *FiberLinX* allows it to be adapted to the service provider's preferred network architecture, rather than requiring the network to be designed around the access device. And, *FiberLinX* is a field-proven, standards-based product with hundreds of installations in both public and private networks.

Contact IMC Networks Fiber Consulting Services free-of-charge at 800-624-1070 or fcs@imcnetworks.com for more information, or hands-on assistance in designing a *FiberLinX* configuration for your last mile access network.

About IMC Networks

IMC Networks is a leading ISO 9001 certified manufacturer of optical networking and LAN/WAN bandwidth management solutions for enterprise, telecommunications and service provider applications. The company provides the industry's widest variety of copper-to-fiber media converters, fiber mode converters, as well as optical repeaters and wavelength division multiplexers. In addition to physical layer products, IMC Networks offers remotely managed Customer Premises Equipment and Layer 3 and Layer 4 bandwidth control and packet classification solutions.

Fiber Consulting Services

IMC Networks' Fiber Consulting Services (FCS) assists network managers and system integrators with the design and development of fiber-based networks. Consulting services are free of charge. Please contact us at fcs@imcnetworks.com or by calling 800-624-1070 in the USA or +1-949-465-3000 outside of USA.

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