BLACK BOX WHITEPAPER: HOW MEDIA CONVERTERS DELIVER COST-EFFECTIVE FIBER CONNECTIVITY

LEAVE THE TECH TO US

MEDIA CONVERTERS: YOUR KEY TO COST-EFFECTIVE NETWORK INTEGRATION

Copper cable is the defacto standard for horizontal wiring in local area networks (LANs). Copper CATx cabling has evolved to accommodate Ethernet speeds of 10 gigabits per second and beyond.

Fiber optic cable can be a logical choice for horizontal LAN runs in several use cases that we will examine in this white paper. If your network requires both copper and fiber, media converters can be used to extend the reach of your LAN over fiber, improve network security, or bring fiber to the desktop.

In this white paper, we will explore the specific benefits that fiber cabling provides, such as: speed, distance, security, RF immunity, and scalability. We will also discuss ways to integrate copper and fiber cable in new and existing IT infrastructures to provide the greatest advantages with limited capital investment.

ADVANTAGES OF FIBER

The low cost, simplicity, and scalability of Ethernet over fiber make it an excellent choice for growing networks. Let's explore some of the specific advantages fiber cable offers:

SPEED

Copper cable has evolved in a series of steps from 10 Mbps to 10 Gbps. Fiber can handle network speed increases without the need for costly upgrades.

DISTANCE

One of the most compelling reasons that fiber cable is preferred over copper cable is distance. While a run of copper cable is limited to 328 feet (100 m), fiber cable can be run 700 times further, 49 miles (80 km) or more.

INSTALLATION

Installing large copper-based LANs requires network switches and wiring closets with significant hardware and labor costs. Fiber cable is lighter and easier to install. And, because it covers longer distances, it can reduce the number of wiring closets and switch hardware.

CAPACITY

When speed and bandwidth requirements increase, fiber cable is able to satisfy greater demands without an upgrade.

SECURITY

Unlike copper cable, fiber does not produce electromagnetic emissions that can be monitored by rogue third parties. Fiber cable provides greater security; it is immune to electromagnetic interference (EMI), crosstalk, and impedance issues.

SCALABILITY

Multi-strand fiber can be installed for a slight increase in cost compared to single pair, in preparation for future expansion.

BRINGING FIBER FROM THE DATA CENTER TO THE DESKTOP WITH MEDIA CONVERTERS

While the advantages of using fiber cable are significant and many, replacing an entire network system with fiber would be cost prohibitive for most. Fortunately, media converters provide an affordable way to continue using existing infrastructures and equipment while gaining the benefits of fiber cable. These simple networking devices are used most often to connect copper to fiber cable, but they can be used to connect other types of cable as well. Mode converters are similar; they provide connectivity between single-mode and multi-mode fiber cables.

UNDERSTANDING THE SEVEN LAYERS OF ISO

The first generation of media converters provided connectivity between two types of media. As time went on, additional features, such as autosensing ports, switch chips, and multiple ports were added changing the functionality to closely resemble network switches. One way to eliminate confusion concerning the functionality required, is to refer the ISO 7-layer model of the Ethernet, illustrated in the following chart. This basic reference model of open systems interconnection (ISO/IEC 7498-1) was developed by a joint technical committee of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

Media Converters, as they were originally designed, were limited to sending and receiving bits – a function of Layer 1. Ensuring that messages are delivered to the proper device on a LAN, detecting errors, and repackaging data puts them into Layer 2 functionality with switches. Distinguishing between the two categories is important when evaluating system integration objectives.

LAYERS			PROTOCOL DATA UNIT	FUNCTION
HOST	7	APPLICATION	DATA	PROVIDES A USER INTERFACE
	6	PRESENTATION	DATA	PRESENTS DATA HANDLES PROCESSING SUCH AS ENCRYPTION
	5	SESSION	DATA	KEEPS DIFFERENT APPLICATIONS' DATA SEPARATE
	4	TRANSPORT	SEGMENTS	PROVIDES RELIABLE OR UNRELIABLE DELIVERY PERFORMS CORRECTION BEFORE TRANSMISSION
MEDIA	3	NETWORK	PACKETS	PROVIDES LOGICAL ADDRESSING WHICH ROUTERS USE FOR PATH DETERMINATION
	2	DATA LINK	FRAMES	ENCAPSULATES NETWORK PACKETS WITH HEADER AND TRAILER FORM FRAMES PROVIDES ACCESS TO MEDIA USING MAC ADDRESS PERFORMS ERROR DETECTION
	1	PHYSICAL	BITS	MOVES BITS BETWEEN DEVICES SPECIFIES VOLTAGE, WIRE SPEED, AND PIN-OUT OF CABLES

"This reference model is a conceptual blueprint of how communications should take place. It addresses all the processes required for effective communication and divides these processes into logical groupings called layers. When a communication system is designed in this manner, it's known as layered architecture."

"CCNAX 200-120 | The OSI Reference Model." Accessed October 24, 2016. http://www.learncisco.net/courses/ccna/part-1-internetworking/the-osi-reference-model.html.

TYPES OF FIBER CONVERSION

CONVERTING COPPER TO FIBER

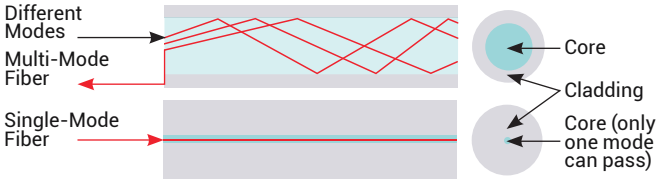
To address the 328 feet (100 meters) distance limitation of copper cable, network managers may deploy a core switch with 100BASE-TX or Gigabit Ethernet (GE) copper ports and use media converters to connect to a fiber backbone or LAN. Copper to fiber switching media converters with a 10/100/1000 auto negotiating copper ports and Fast Ethernet (FE) or GE fiber ports can be used to connect legacy copper switches to a fiber LAN or GE.

SINGLE-STRAND AND DUAL-STRAND FIBER

Traditional fiber optic media converters require two strands of glass, or a dual-strand, to transmit and receive signals. Single-strand fiber media converters increase segment capacity by supporting transmit and receive signals on two different wavelengths along one fiber.

SINGLE-MODE VERSUS MULTI-MODE FIBER

Fiber optic cable is available in single-mode and multi-mode. Single-mode has a small core that carries a single propagation mode of light and multi-mode has a larger core that carries several propagation modes of light simultaneously. Each type has specific applications that relate to its characteristics with the greatest difference being concerns over data integrity. The modal propagation of a single-mode fiber will not interfere or overlap as it is transmitted over long distances, extending possible distances more than 50 times beyond, and up to twice the bandwidth of multi-mode fiber cable.



MEDIA CONVERTER CHARACTERISTICS

The specific characteristics of media converters determine how and where they may be used. In the following sections, we will examine all of the available options: form, connector, protocol, management, hardening, power, wavelength, distance, and speed.

FORM

Media converters are available in several modular forms: standalone, chassis-based, and hybrid:

- Standalone media converters are self-contained and have a power supply. They convert between two cable types and can be used to extend a network over fiber in pairs or with a chassis-based system as a remote unit. Many are compact and can therefore easily fit on a desktop, tucked behind a PC.
- Chassis-based media converters consist of a chassis where compatible media converter modules are housed and powered. Primarily used in data centers, chassis-based media converters satisfy a wide range of requirements in network connectivity and distance. They provide a central location for connecting multiple media types, Ethernet switches and segments. Available rack-mountable and desktop, many chassis-based media converters are SNMP manageable, configurable, and monitored. Ideal for growing systems, chassis-based modules can be reconfigured as needed. Hot-swappable modules also ease troubleshooting and minimize downtime.
- Hybrid systems feature standalone media converters that can be used in a rackmount chassis. The value of these systems is versatility because each media converter can be used and reused as needed: in a data center rackmount or as a standalone unit on the desktop.

PROTOCOL

Each media converter is designed to work with a specific protocol, determined by your system. Black Box provides media converters for the following protocols:

ATM – For fiber multi-mode to single-mode conversion at 1300 nm, 5-28 km, and 155 Mbps with SC or ST connectors.

Ethernet – A wide variety of options are available at 10, 100, 1,000, 1,250, and 10,000 Mbps.

RS-232 – Dual-strand, single-mode, or multi-mode fiber conversion at 850 or 1310 nm, 2.5-60 km, and 1.115 Mbps with SC or ST connectors

T1/E1 – Dual-strand, single-mode, or multi-mode fiber line driver at 1300 or 1310 nm, 5-28 km, and 1.5 Mbps with SC or ST connectors.

MANAGEMENT

Administrators of enterprise-level networks use managed media converters to manage and monitor large networks spanning multiple sites. Having the ability to quickly isolate problems helps to minimize network downtime. Broad selections of managed and unmanaged media connectors are readily available.

SNMP Management – Simple Network Management Protocol (SNMP) is a network management protocol used for configuring and collecting information from network devices on an IP network. SNMP enables administrators to set up link alarms or traps and turn features on and off from a central terminal. If a network device goes down, SNMP enables LAN administrators to efficiently pinpoint and troubleshoot the problem, maximizing network uptime. Many managed media converters utilize SNMP protocol.

Link Loss Pass Through – Link Loss Pass Through is a configuration that communicates the loss of a link on one side of a media converter through to the other side, so that upstream equipment will alert the administrator to fault conditions that would otherwise be masked due to the extension. This function may be enabled or disabled to help pinpoint and troubleshoot problems.

CONNECTORS

Media converters work with many different interfaces including:

ST – FIBER WITH BAYONET LOCKING SYSTEM

SC – FIBER WITH MOLDED BODY AND A PUSH-PULL LOCKING

LC – SMALL FORM FACTOR FIBER WITH CERAMIC FERRULE

RJ-45 – UTP COPPER

SFP AND SFP+ – FIBER TRANSCEIVERS

HARDENED

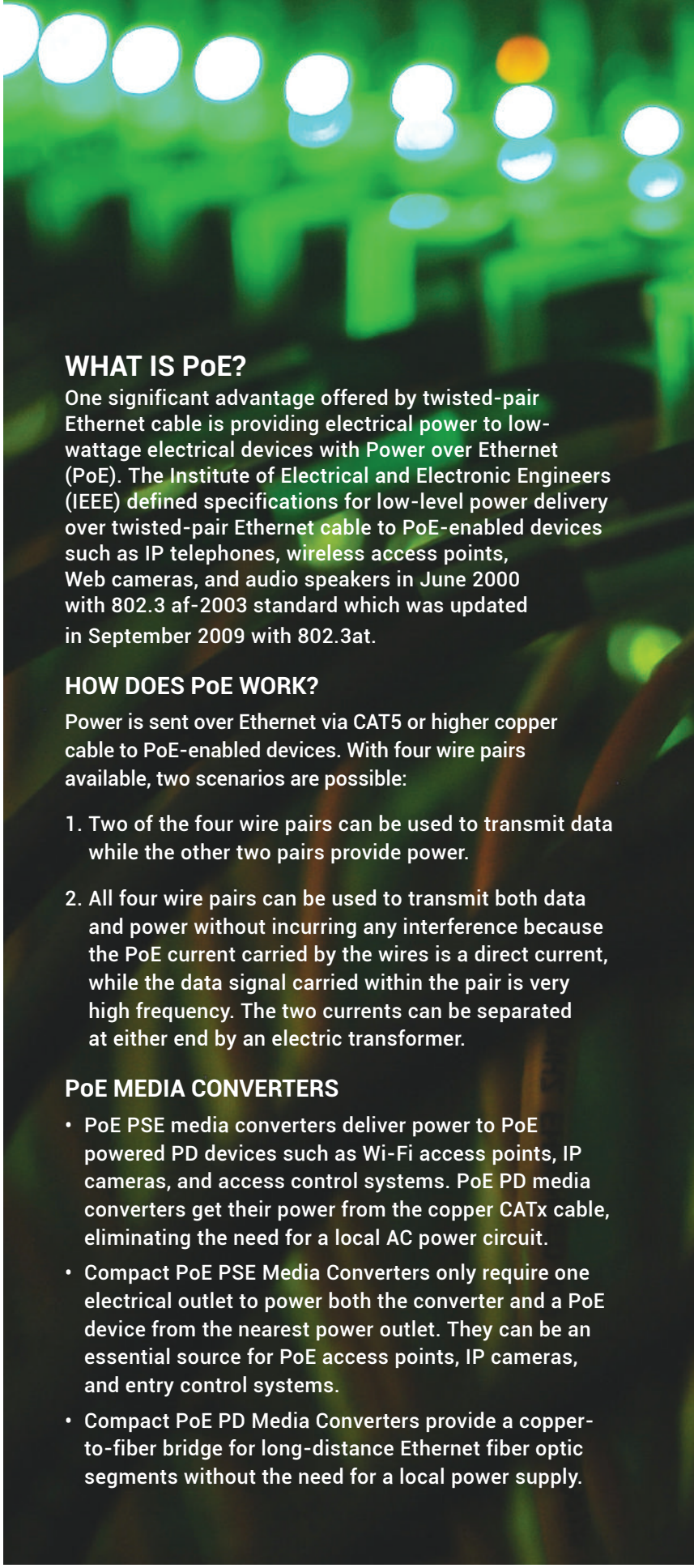
Hardened (or industrial) media converters are housed in hardened metal cases that protect them from moisture, dirt, and electromagnetic interference. Designed for use in harsh conditions, standard industrial media converters will be able to tolerate temperature fluctuations -13 to 140° F (-25 to +60° C) and others can withstand extended temperatures from -40 to 167° F (-40 to +75° C).

POWER

Most media converters come with an AC power supply that plugs into a standard wall outlet. Some standalone media converters can be powered by a PC's USB port. Installations that do not have power outlets nearby may be able to provide power to the media converter and other network devices through the Ethernet, which is referred to as Power over Ethernet (PoE).

WAVELENGTH

Fiber optic cable uses light to transmit data. Light is defined by its wavelength, a measure of frequency expressed in nanometers (nm). The wavelengths supported by media converters correspond to the types of fiber optic cable they convert. Media converters for TX and RX combinations of single-strand fiber are available in 1310 and 1550 nm and media converters for dual-strand fiber are available in 850 nm to 1550 nm.



WHAT IS PoE?

One significant advantage offered by twisted-pair Ethernet cable is providing electrical power to low-wattage electrical devices with Power over Ethernet (PoE). The Institute of Electrical and Electronic Engineers (IEEE) defined specifications for low-level power delivery over twisted-pair Ethernet cable to PoE-enabled devices such as IP telephones, wireless access points, Web cameras, and audio speakers in June 2000 with 802.3 af-2003 standard which was updated in September 2009 with 802.3at.

HOW DOES PoE WORK?

Power is sent over Ethernet via CAT5 or higher copper cable to PoE-enabled devices. With four wire pairs available, two scenarios are possible:

1. Two of the four wire pairs can be used to transmit data while the other two pairs provide power.
2. All four wire pairs can be used to transmit both data and power without incurring any interference because the PoE current carried by the wires is a direct current, while the data signal carried within the pair is very high frequency. The two currents can be separated at either end by an electric transformer.

PoE MEDIA CONVERTERS

- PoE PSE media converters deliver power to PoE powered PD devices such as Wi-Fi access points, IP cameras, and access control systems. PoE PD media converters get their power from the copper CATx cable, eliminating the need for a local AC power circuit.
- Compact PoE PSE Media Converters only require one electrical outlet to power both the converter and a PoE device from the nearest power outlet. They can be an essential source for PoE access points, IP cameras, and entry control systems.
- Compact PoE PD Media Converters provide a copper-to-fiber bridge for long-distance Ethernet fiber optic segments without the need for a local power supply.

DISTANCE

The distance between network devices is an important differentiator between available network infrastructures. The range of media converters currently available will accommodate distances from .14 miles to 43 miles (.22 km to 80 km).

SPEED

As the amount of data and the complexity of network applications expands, the need to deliver data quickly also increases. The media converters currently available can accommodate speeds up to 10 Gbps.

Because every media converter application has specific requirements, it is important to understand the differences between options. Existing infrastructure, speed and distance requirements, and environmental conditions are important criteria for every application.

MEDIA CONVERTER APPLICATIONS

There are many circumstances for which media converters can facilitate a necessary extension of the reach of an existing copper or fiber network. Whether it means increasing the bandwidth, speed, distance, or resistance to interference or hacking, or providing power to PoE-enabled devices, media converters provide a cost-effective way to maximize the potential of your network. Let's examine some specific applications where media converters are essential.

DATA CENTERS

In the data center, copper-to-fiber conversion extends the productive life of existing copper-based switches by providing a gradual migration path from copper to fiber. Chassis-based media converters mount in racks beside network switches, enabling conversion of copper ports on legacy switches to fiber. Media converters can also be used with new copper switches that have fixed RJ-45 ports, which are significantly less expensive than equivalent fiber switches.

FIBER TO THE DESKTOP

Instead of incurring the expense of running fiber throughout your network and replacing cable, switches, patch panels, and network interface cards, media converters can provide the same advantages as a 100% fiber network while retaining existing network devices and copper ports at a significant cost savings.

Media converters provide organizations with a cost-effective way to reap the benefits of 100Mbps and Gigabit speeds available with fiber and the PoE benefits of copper.

A standalone media converter tucked behind a PC can connect a fiber cable to its RJ-45 Ethernet port. Unlike a fiber NIC, media converters do not take up a slot on the PC nor do they cause conflicts because they are transparent to the Operating System (OS) – no drivers are required. Limited electrical access? No problem. Many media converters can be powered by a PC's USB port.

INDUSTRIAL SAFETY AND AUTOMATION

Manufacturing and other industrial environments that employ automation technology require network devices that can operate reliably under harsh conditions. In many cases, this equipment may be exposed to extreme temperatures, vibrations, chemical exposure, and electromagnetic interference. Industrial media converters are one of many industrial grade devices that can be employed to separate essential equipment from harsh conditions and ensure that the integrity of the network infrastructure remains in-tact.

SECURITY AND SURVEILLANCE

When planning the implementation or expansion of a security or surveillance IP infrastructure, one of the major concerns that will be addressed is power. Using PoE-enabled media converters allows each IP-based camera to be powered over Ethernet lines instead of running separate power lines. This type of solution has proven to be extremely reliable and cost-effective.

BRIDGING LANS OVER FIBER

When expanding the reach of the LAN to multiple locations, media converters provide LAN extensions that form one large network that spans a limited geographic area. Because most premises networks are copper-based with a limit of 328 foot (100 m), media converters can extend the reach of the LAN over single-mode fiber up to 80 miles (130 km) with 1550 wavelength optics.

UPGRADING LEGACY SYSTEMS

Media converters help ease the transition from older fiber technologies to Ethernet. Businesses that employ older LAN technologies benefit significantly from transitioning to Ethernet on fiber. Mediaconverters help bridge this gap by connecting existing network devices to fiber to improve scalability, flexibility, and ease of administration. In addition, enabling a gradual migration to Ethernet on fiber increases speed and cabling distances while reducing EMI.

HORIZONTAL CABLE EXTENSION

A proven higher standard for LAN backbone applications, the use of fiber cable is becoming more common in horizontal cable extensions. Media converters enable fiber cable extensions to increase data capacity needed for streaming media and VoIP.

KVM OVER IP

Mission critical control rooms are typically jam-packed with displays and workstations where teams are busy with time-sensitive tasks. KVM technology enables them to streamline their workflows and remove noisy, heat-generating equipment from the immediate vicinity. When this equipment is housed a significant distance from the control room, media converters provide long distance extension without loss or latency.

VoIP

Many organizations today take advantage of Voice over Internet Protocol (VoIP), which sends digitized voice data over IP networks as an alternative to traditional phone service. PoE-enabled media converters help deliver the distance and speed advantages of fiber, limiting VoIP latency and loss by securing a reliable high-speed IP network with guaranteed bandwidth in addition to providing power through PoE-enabled devices over copper.

MEETING YOUR EXPANDING NETWORK NEEDS THROUGH FIBER

Increasing speed, distance, and bandwidth requirements driven by innovations in technology has made extending LANs over fiber cable and bringing fiber to the desktop essential for many industries. Media converters provide a cost-effective method of integrating fiber optic cabling and existing equipment and copper networks to provide the benefits of both.

Whether running a call center, a manufacturing plant, or a financial hub, Black Box is ready to assist you with using media converters to expand the capabilities of your network and providing an efficient transition that enables you to take advantage of the latest technology.

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