WHITE PAPER:

EoVDSL: A Cost-Effective Solution for Transmitting Ethernet Data Over Existing Copper Wiring for ITS and Traffic Applications

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EoVDSL: A Cost-Effective Solution for Transmitting Ethernet Data Over Existing Copper Wiring for ITS and Traffic Applications

There is a very large and evolving market for Ethernet transmission over existing low-speed copper circuits in the ITS/transportation market, particularly from an aftermarket standpoint. As the traffic and transportation market witnesses the wholesale transition from legacy serial data, frequency shift keying (FSK), and baseband analog video equipment, to later generation Ethernet-based hardware, the previously installed communications infrastructure may not be capable of supporting the unique transmission requirements associated with Ethernet. Many users who are considering upgrading their current systems to Ethernet, find the existing installed copper communications media previously used for FSK circuits may not be compatible with this data protocol. Although the use and technical benefits of optical fiber for Ethernet transmission are well known and accepted, the cost of installing a new fiber plant to support an Ethernet-based network may be prohibitive from a budget standpoint.

Figure 1 –
Basic Point-to-Point:
*IP Camera Utilizing*
Twisted Copper Pair
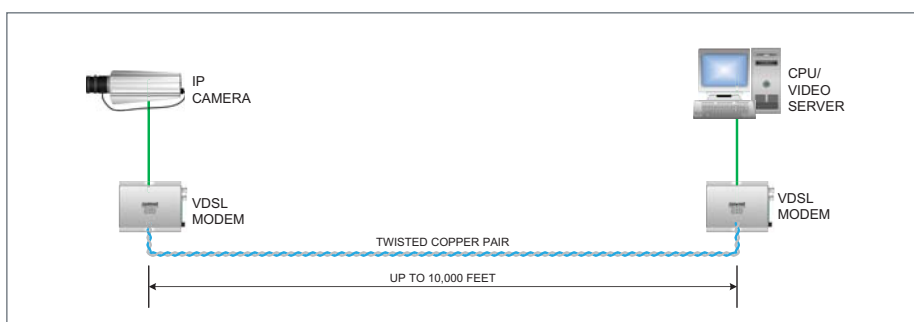
EoVDSL is an acronym for Ethernet over Very High Speed Digital Subscriber Line, and is a technology that was originally developed for the internet service provider (ISP) and common carrier/telephone service provider markets, to enable existing or newly deployed coaxial cable or telephone-grade twisted copper pair circuits to support high speed Ethernet service to the home or other subscriber-based facilities.

A user with an installed base of copper media desiring to upgrade his existing communications system with the latest-generation Ethernet equipment faces a major dilemma; how to effectively interface the two successfully, as a twisted copper pair or coaxial cable is not directly usable with Ethernet. To complicate matters further, according to the IEEE 802.3 standard associated with it, Ethernet is limited to the relatively short transmission distance through CAT-5E copper cabling of 328 feet (100 meters), maximum.

One possible solution entails the construction of new communications infrastructure; this could be a new fiber optic cable plant, or a wireless network. However, the costs associated with this are significant, and are usually well beyond the current budget of many users, and both approaches may require the installation of additional transmission

Figure 2 –
Basic Point-to-Point:
IP Camera Utilizing Coaxial Cable
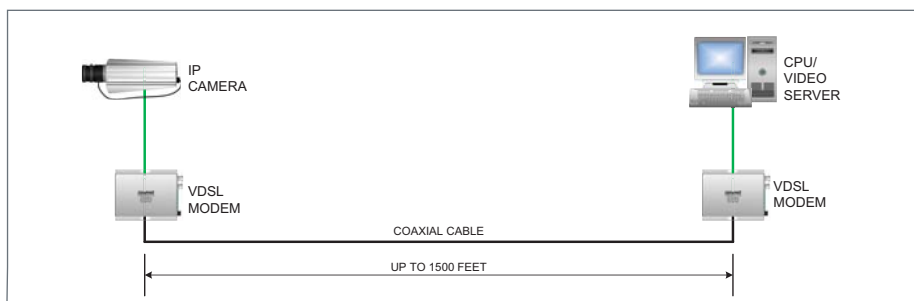
Figure 3 –
Point-to-Point with
Dual-Channel Unit:
Two IP Cameras over
Two Twisted Copper Pairs
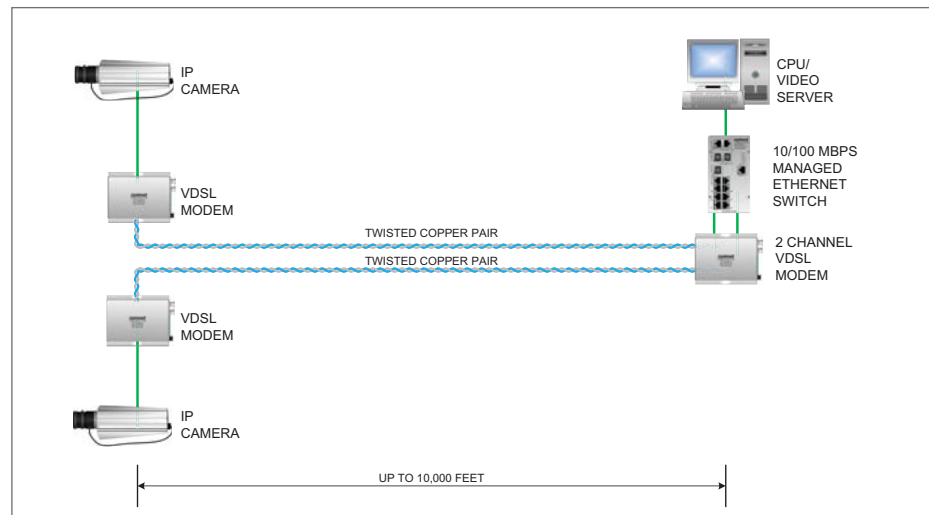
equipment, such as managed Ethernet switches with an optical interface, or wireless transceivers, further driving the system cost and complicating the design.

EoVDSL addresses these issues head-on, by allowing Ethernet to be transmitted over extended distances on the users' existing coaxial or twisted copper pair circuits that may have been utilized previously for a FSK-based signalization system, in an inexpensive and easy-to-install manner.

When considering EoVDSL modems for upgrading an existing copper-based signalization system to Ethernet, there are several key features to look for in the equipment. These include:

A) Utilization of the Latest VDSL Signal Processing System, VDSL2: VDSL2 is characterized by higher Ethernet data rates and greater transmission distances through copper transmission circuits, when compared to the earlier generation VDSL standard.

B) Supports Both Twisted Copper and Coaxial Cable: Either standard telephone-grade twisted copper pair or 50 or 75 ohm coaxial cable are supported. Signalization systems employing RF transmission through coaxial cable are supported as well.

C) Automatic Operation: The fastest usable data rate is automatically selected by the modem, depending upon the cable length and quality.

D) Environmentally Hardened: For those applications where these devices are to be deployed in a roadside or out-of-plant environment, is the EoVDSL modem equipment ruggedized to the environmental requirements associated with NEMA TS-2 for Traffic Signal Control equipment?

E) Compatibility: EoVDSL modems provide a 100 Mbps Ethernet electrical input and output, and they may be used with virtually all other Ethernet-compatible equipment, regardless of manufacturer, including media converters, managed or unmanaged switches, terminal servers, and wireless transmission equipment. This compatibility provides the user with the ability to configure a network using a combination of fiber optic, copper-based, and wireless communications equipment; obviously, such a network can range from the very simple, to one of major complexity, and is limited only by the unique needs of each customer and their particular application.

Types of EoVDSL Networks Supported: Although the primary intended network architecture for EoVDSL was originally for full-duplex or two-way point-to-point communications systems (*see Figures 1 through 5*), EoVDSL modems may also be used to create a point-to-multipoint or drop-and-repeat topology by the simple addition of a low-cost managed 100 mbps Ethernet switch (*see Figure 6*). This is very important, as many of the existing copper based FSK networks are configured as drop-and-repeat systems, and this architecture may be easily retained when converting to an EoVDSL-based design.

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Figure 4 –
Point-to-Point with
Dual-Channel Unit:
Two IP Cameras over
Twisted Copper Pair and
Coaxial Cable Circuits
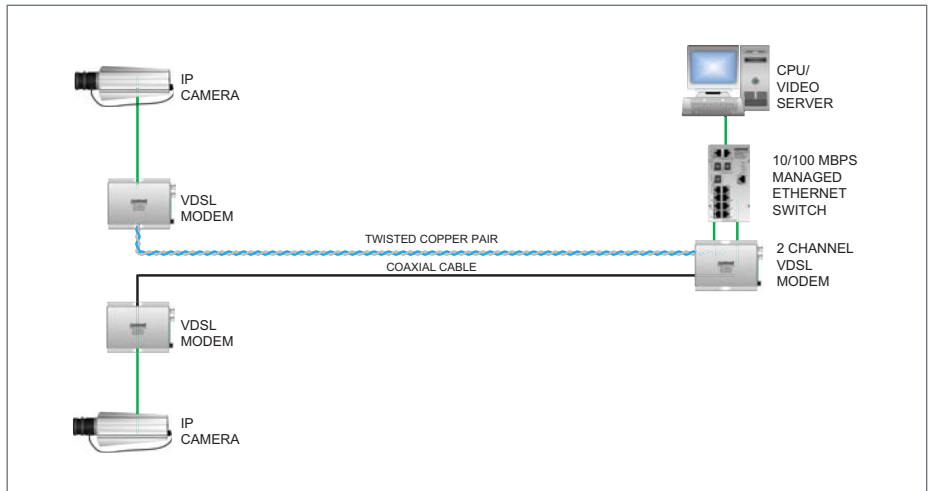
A fully managed EoVDSL network utilizing a combination of twisted copper pair, coaxial cable, and optical fiber may also be easily confi gured with this equipment. Such a system would be capable of supporting not only the data for the traffi c signalization system, but video for incident detection or a video detection system (VDS), contact closure for preemption applications, or any other standard electrical signals utilized within the network that may be converted to Ethernet.

For those drop-and-repeat or point-to-point networks where the run length of copper is so long that reliable and error-free communications are not possible, a two-channel EoVDSL modem may be easily confi gured as an active

Figure 5 –
Ethernet Network Utilizing
*Twisted Copper Pair and*
Coaxial Cable Circuits
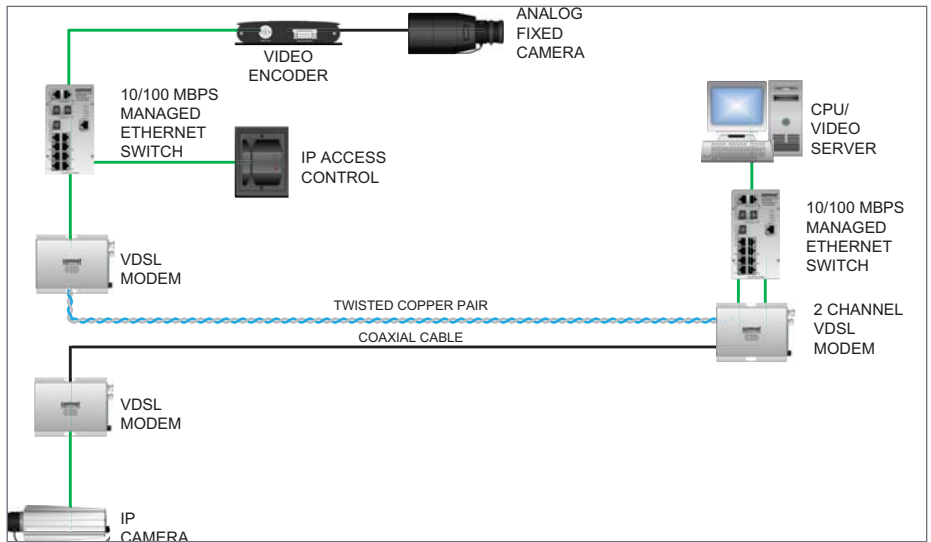
repeater. A simple jumper change in the field will allow this device to function as a repeater, greatly extending the usable transmission distance through either a standard twisted copper pair or coaxial cable circuit (*see Figure 7*).

Although EoVDSL offers numerous signifi cant benefi ts, as with any technology, there are certain limitations involved as well. These include:

A) Distance/Bandwidth Limitation: All copper transmission circuits exhibit a characteristic known as the distance/bandwidth limitation. Simply stated, as the run length of the copper is increased, the data rate or throughput decreases. This is why the Ethernet standard of 100 meters maximum transmission distance through CAT-5E copper exists. For example, a 19 to 26 AWG twisted copper pair path with a run length of 1000 feet (305 meters) can support a maximum data rate of 70 Mbps using a pair of ComNet EoVDSL modems in a point-to-point topology. If this same cable was increased in length to 10,000 feet (3048 meters),

*Figure 6 –
Drop-and-Repeat
Network Utilizing Twisted
Copper Pair Circuits*
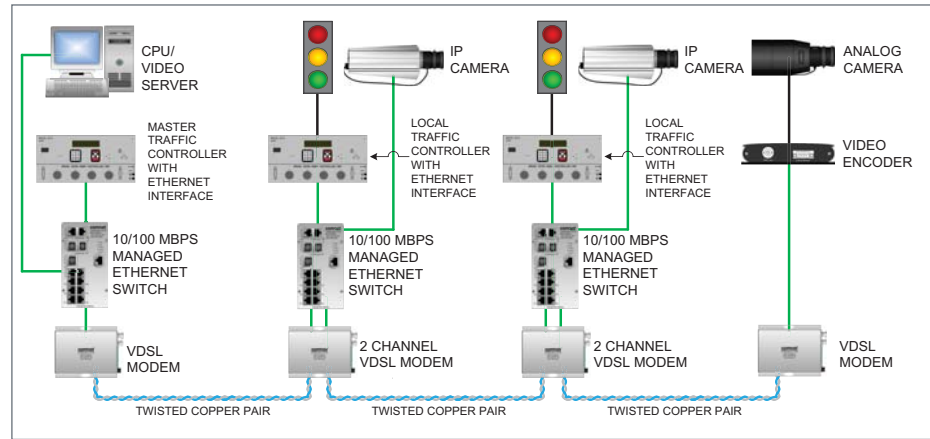
the maximum usable data rate decreases to 1 Mbps. As with many things electronic, these are limitations due in large part to the current state-of-the-art of the technology, and the physics involved.

B) Susceptibility to External Electrical and Radio Frequency Interference, and Lightning: As EoVDSL is a copper-based communications technology, these modems may be susceptible to damage from lightning and other stray voltage effects that could be induced in the copper transmission circuit. It is the responsibility of the installer of this product to take appropriate steps to ensure that proper installation and integration practices are followed, so as to minimize the possibility of damage to this equipment from these voltages. This will be particularly true of those installations where the equipment is to be installed in an out-of-plant or roadside operating environment, where long runs of copper may be encountered. Inexpensive and off-the-shelf surge and voltage transient protection devices for twisted copper or coaxial circuits are readily available, and provide a high measure of EoVDSL modem protection in these kinds of environments. The user can assume that these issues may be somewhat less frequently encountered when the product is fielded within a building or other more benign electrical environment.

Typical Applications: These modems are intended to be used in those instances where Ethernet data at data rates of up to 100 Mbps is to be transmitted over existing or newly installed telephone-grade twisted copper pair, legacy serial data cabling, or standard 50 or 75 ohm coaxial cable circuits. They provide a simple, easy to install and maintain "black-box" interface for converting Ethernet-compatible equipment to these copper circuits, and then converting the signal at the opposite end of the link back to Ethernet. They are designed to be electrically transparent to the Ethernet input and output signal in this regard. Point-to-point or point-to-multipoint/drop-and-repeat communications networks may be easily created. Potential EoVDSL traffi c and ITS-related applications include connecting any of the following equipment onto an existing twisted copper pair or coaxial cable circuit:

- Ethernet-based traffic signal controller equipment
- IP-compatible camera for video detection system (VDS) or incident detection applications
- Analog cameras with an external MPEG-4 or H.264 encoder
- Any legacy RS-232/RS-422/RS-485 traffic signal control equipment equipped with a terminal server, for

*Figure 7 –
Drop-and-Repeat ITS Network Utilizing
Twisted Copper Pair Circuits, with a
Repeater to Support Extremely
Long Distance Transmission*
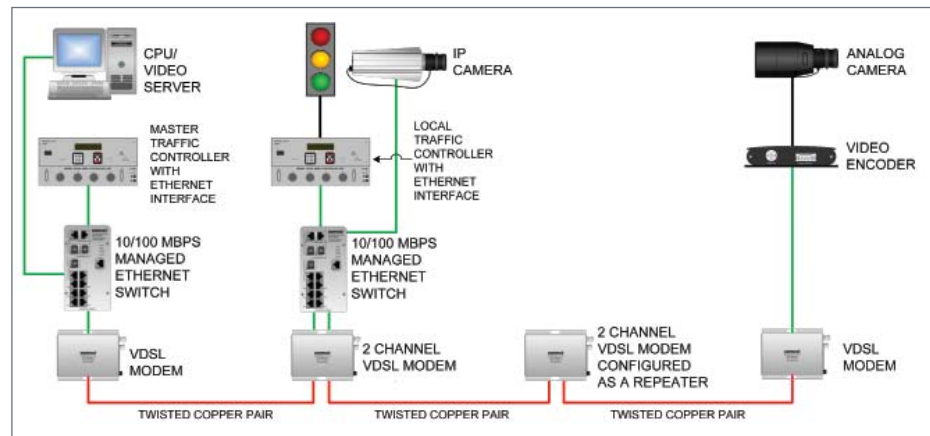
ComNet offers an extensive line of environmentally hardened fiber optic and copper-based video and data transmission equipment as well as a line of Ethernet networking equipment that is uniquely designed to meet the needs of the Industrial Security, Intelligent Transportation, and industrial control markets.

Bruce Berman is responsible for directing and promoting the application of ComNet products in markets that can benefit from their use. In many cases he educates System Designers and customers on all levels about the benefits that ComNet products and technology bring to their projects. Berman has a Bachelor's Degree in Communications from the State University of New York at Geneseo.

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