APPLICATION NOTE

ZHONE

Ethernet in the First Mile (EFM) for Municipal Operations Monitoring

How cities and regional traffic authorities can use extended Ethernet technology to remotely control traffic lights, metering systems, and surveillance cameras.

Traditionally, telecommunications carriers and Internet service providers have been the groups most interested in *Ethernet in the First Mile (EFM)* equipment. They typically use EFM products to build communications services that extend the reach of their customers' local-area networks. These Ethernet-extension services provide very fast user access to corporate and Internet resources over longer distances than traditional Ethernet can accommodate.

Now that industry EFM standards are complete and have been implemented in network equipment, additional uses for EFM are also emerging. Municipalities, for example, can use the capabilities to affordably monitor, control, and maintain citywide equipment such as traffic lights and surveillance cameras. Such monitoring can also be helpful in the prompt dispatch of first responders when emergency situations are detected.

Many city and county governments have begun behaving like network service providers. A number now offer Web-based municipal transactions, Internet access, and even heavy-bandwidth IPTV services to citizens, for which EFM can also be used. First and foremost, though, municipalities operate as enterprises with internal communications requirements. Many municipal enterprise applications focus on keeping public works operations flowing smoothly, which is the focus here.

A city's automated traffic control and surveillance systems require monitoring a large number of individual devices to ensure their continuous operation and the public's safety. Ideally, cities would like to manage these scattered devices electronically from a single network operations center (NOC), which scales much better than repeatedly sending operations personnel out into the field to check on them.

The biggest challenge of remotely monitoring numerous, widely distributed city devices is the cost and effort of cabling them all to the municipal network.

The Zhone Multiple Access Line Concentrator (MALC) and EtherXtend access equipment is already being used to enable this centralized NOC application in municipal environments. Let's take a look at how it might be set up.

Cabling Issues and Solutions

The biggest challenge of remotely monitoring numerous, widely distributed city devices is the cost and effort of cabling them all to the municipal network and getting the fast transmission speeds needed to accommodate video and other aggregated content. Many municipalities have already installed some high-capacity fiber-optic cabling to certain locations. Today, it primarily runs between a NOC and a handful of citywide buildings or enclosures called *data nodes*, which house both network and non-network equipment.

To easily and affordably extend the speed and connectivity of the fiber links out to individual devices for NOC-based monitoring, the Zhone MALC or EtherXtend device can be installed in these distributed data nodes. Zhone EFM products ease the labor and financial burden of reaching large volumes of distributed devices, because they enable Ethernet's high speeds over inexpensive copper wiring. Fiber supports very high speeds but is quite costly – and so are the trained personnel required to splice and install the fragile optical strands of glass. Fiber cabling, associated electronics, and installation usually cost about 20% to 25% more than using copper.

Facilities personnel without specialized fiber expertise can string the copper wiring from the Zhone device in the data node out to the various lights, control systems, and cameras. Ethernet frames run in their native format over the copper-wire extensions, using underlying DSL, T1/E1, and T3/E3 modulation and signaling. EFM is highly efficient, in that it can regain the 20% of overhead that has traditionally been consumed by ATM-based systems. Ethernet also simplifies network deployments and lowers operational costs because of its ubiquity and economies of scale.

Using Ethernet First Mile (EFM) access equipment, traditional Ethernet services are extended over the same voice-grade copper used for traditional telephone and DSL services.

EFM-Standard Technology and Products

This Ethernet transport process relies on industry-standard EFM technology, formally known as *IEEE 802.3ah* and sometimes informally called "*carrier Ethernet*." The standard technology is supported in the Zhone MALC, a chassis-based system that supports multiple EFM modules, and the Zhone EtherXtend device, a standalone appliance. The Zhone devices transmit Ethernet frames over symmetric high-speed DSL (SHDSL), T1/E1, T3/E3, and other Layer 1 technologies.

One or more modules can be used in the MALC, each supporting the specific type of modulation and signaling the municipality chooses for each remote connection. SHDSL, for example, is a good candidate for extending Ethernet by distances of up to three miles (5 km); for longer distances, *loop-bonded* SHDSL or T1/E1 technology is recommended. Loop bonding is further explained below.

Extending Distance and Capacity

Using EFM access equipment, traditional Ethernet services are extended over the same voice-grade copper used for traditional telephone and DSL services. The EFM access devices connect directly to Ethernet switches or routers in the NOC. Two of these devices transmit data from these networks to remote data nodes at 5.7 Mbps over distances of about 2700 meters or 1.7 miles using SHDSL.

On longer lines, bandwidth begins to degrade until the maximum distance – approximately 24,000 feet – is reached. To get double the bandwidth, perhaps for transmitting surveillance video or other high-volume content, municipalities can install two pairs of copper wires and use the EFM-standard loop-bonding technique, mentioned earlier, to gain 11.4 Mbps aggregate bandwidth.

Similarly, if a copper pair is too long to support high data rates, loop bonding may be used to increase the bandwidth available at any given distance. For example, a long loop capable of supporting only 2 Mbps can be used to offer a 10 Mbps Ethernet service by bonding five copper pairs together.

Operations personnel located in any building where an EtherXtend is installed can use a local management station to access, analyze, and control the remotely collected data.

Network Design Basics

In a typical municipal monitoring network design using EFM, several data nodes reside around the city, each within a few miles or kilometers of a group of devices to be monitored. An EtherXtend or a MALC EFM device resides in each data node.

Fiber-optic cabling terminates in a MALC chassis in the data node at rates of up to 1Gbps. The MALC uses an EFM line card to switch or route this data to remote nodes over SHDSL, T1/E1, and so forth. These EFM interfaces typically transmit over copper pairs, which are strung out to intersections and other areas where there are lights and surveillance cameras. There, the copper pairs terminate in an EtherXtend device that is installed in a remote pedestal or cabinet, buried within an in-ground enclosure, or otherwise housed physically near the lights and cameras.

The remote EtherXtend device can support up to eight ports, one for each nearby device to be monitored. 100Base-T copper wiring runs the relatively short distance from the remote EtherXtend device to each of the managed devices. Data is collected from the individual devices and transported over the copper wires to the data node, where the MALC terminates and aggregates the connections from any number of distributed EtherXtend devices and passes it to the fiber cabling, which transports it to an Ethernet switch in the NOC *(see figure 1)*.

Operations personnel in the NOC can view the data and video and make decisions based on what they see. For additional flexibility, operations personnel located in any building where an EtherXtend device is installed can use a local management station to access, analyze, and control the remotely collected data. This setup provides a redundant “back door” into the data, should connectivity to the NOC for any reason be lost.

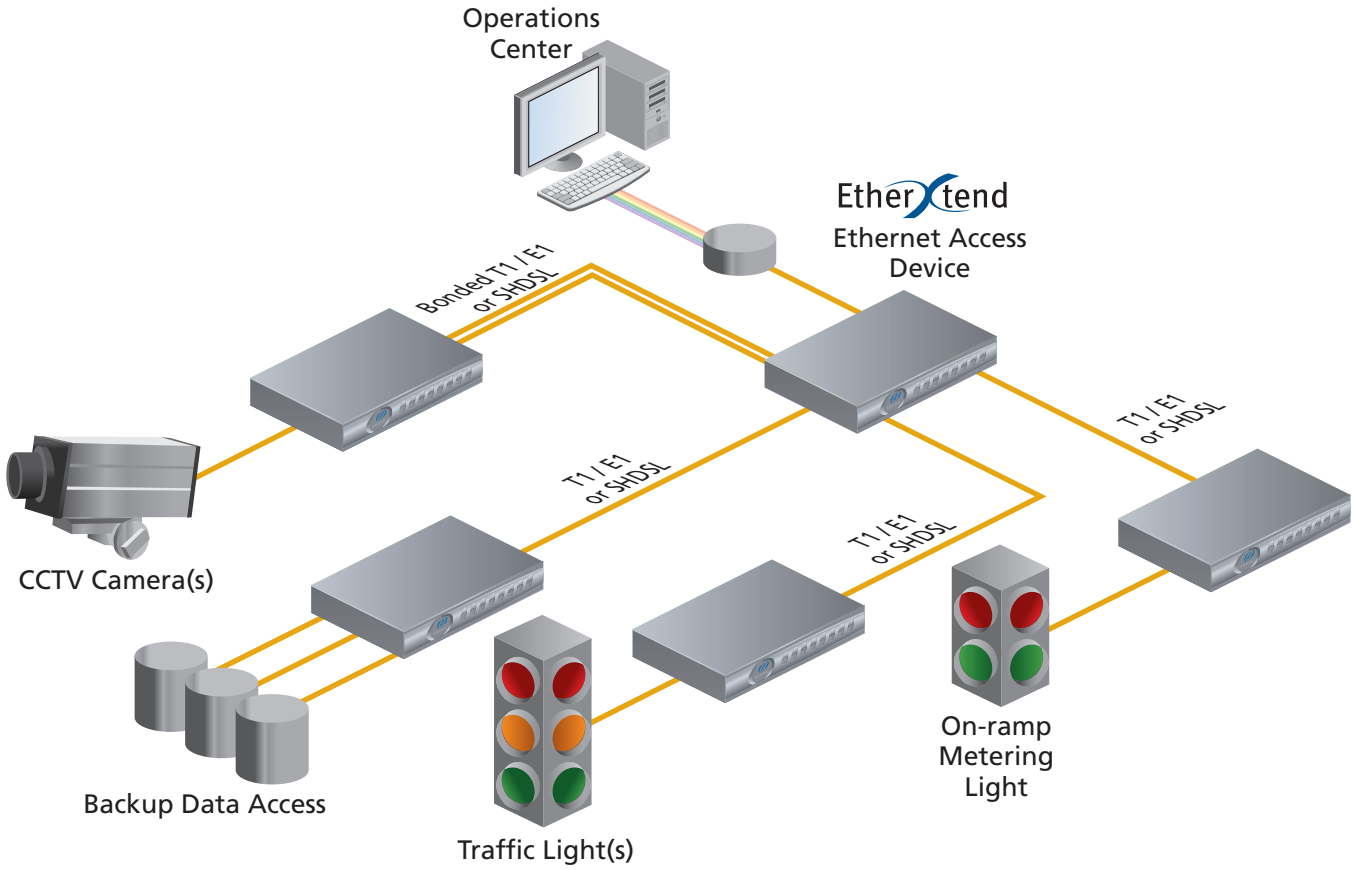

Figure 1: Typical network design

Applications, Management, and Service Control

From the management station attached to a local Ethernet switch in the NOC, operations personnel can access applications that present the collected data in ways that allow them to analyze traffic flows and make changes to automated settings. For example, they might wish to alter the timing of traffic lights or metering lights based on the current traffic congestion load at different intersections.

By viewing video feeds from the surveillance cameras, personnel – who are also networked to other departments such as police and fire – might see a situation that requires immediate dispatching of emergency responders. With the link from the NOC to these departments, the required assistance can be made available in minimum time.

By extending existing core fiber networks with inexpensive copper, municipalities can easily and affordably run Ethernet to any number of citywide devices for remote monitoring, management, and prompt dispatch of emergency personnel.

Special multimedia traffic management (MTM) features are bundled into the Zhone devices to supply security and quality of service. It is recommended that each service (data from traffic lights, video from cameras, and so forth) be assigned its own policy, which might prioritize certain traffic or set rate limits on how much bandwidth any one service can consume. Such policies preserve the quality of video, which might otherwise be degraded by congestion from the other traffic streams.

Summary

Standards-based EFM now has a number of applications for network service providers, enterprises, and organizations that function in both roles, such as municipalities. By extending their existing core fiber networks with inexpensive copper using standards-based Zhone EFM products, local and county governments can easily and affordably run Ethernet all the way to any number of public citywide devices for remote monitoring, management, and prompt dispatch of emergency personnel.

Personnel in a NOC can view the operational status of city devices, such as traffic lights, metering ramps, surveillance cameras, streetlights, and roadside phones. They can also better control city traffic by learning of congestion and accidents and taking appropriate action. Zhone EFM equipment supports a number of lower-layer transmission formats to provide municipalities with the flexibility to remotely monitor, control, and survey data and video collected by different types of multimedia devices.

Zhone's Ethernet First Mile Solution Overview

MALC EFM

Ethernet Aggregation

MALC EFM provides carrier class high-density Ethernet aggregation over SHDSL, Zhone's Multimedia Traffic Management (MTM) and fully integrated OAM features for advanced management of Ethernet lines.

The MALC platform supports Zhone's market leading Network Extender CPE, as well as providing an aggregation point for Zhone's new EtherXtend EFM CPE.

Network Extender

Cost-effective
Point-to-Point / CPE

1 to 8 port devices, Zhone's Network Extenders provide 802.3ah-compliant Ethernet over bonded SHDSL (2Base-TL), or Ethernet over bonded T1/E1, or DS3.

Ethernet over SHDSL offers high-bandwidth symmetrical Ethernet services demanded by businesses and enterprises. Ethernet over T1 / E1 and DS3 provide the ubiquity required when interconnecting geographically disperse customers, building municipal E-LANs, or providing cellular data backhaul services.

EtherXtend

Full-featured EFM
Point-to-Point / CPE

4 and 8 port EtherXtend Ethernet Access Devices are designed to deliver bonded high-speed Ethernet First Mile (EFM) services over SHDSL.

EtherXtend CPE combines 802.3ah-compliant SHDSL bonding with management in single-line deployments, in multi-point applications, or as CPE in conjunction with MALC EFM.

For more information, see www.zhone.com/products/ethernet/

ZHONE

Zhone Technologies, Inc.
@ Zhone Way
7001 Oakport Street
Oakland, CA 94621
510.777.7000 phone
www.zhone.com

For more information about Zhone and its products, please visit the Zhone Web site at www.zhone.com or e-mail info@zhone.com

EFM_AP_0407