For the First Mile:

Broadband IP Growth Redefines the Role of Media Converters

MSAPS and IEEE 802.3ah bring fiber closer to customers on legacy loops

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IEEE 802.3ah, also referred to as the Ethernet in the First Mile (EFM) standard, is less than a year old but already has a well-established reputation within the industry. It lays ground rules for implementing Ethernet in service provider networks. Thus, the same characteristics that have enabled Ethernet to flourish in enterprise networks can now be taken advantage of in carrier networks. The high bandwidth offered by Ethernet provides service providers an option to unplug the current bottleneck created by lower bandwidth protocols in the first mile of service.

The technique is to use Multi Service Access Points – MSAPs – with media converters to link between fiber and copper networks. Thanks to 3ah, the media converters have become easier to deploy and manage, and thus have found a new place on the network map. Media converters, once used primarily in enterprise networks, have been a key contributor to the success of broadband networks and the increased usage of fiber optics in carriers' access networks. They handle not only different network media (copper, coax and fiber, for instance) but also convert different protocols to and from Ethernet.

Such features as remote management, loopback, bandwidth allocation and service provisioning, once reserved for premium-price equipment, are now standard features on media converters designed for use in Central Office (CO) and Customer premises (CP) settings.

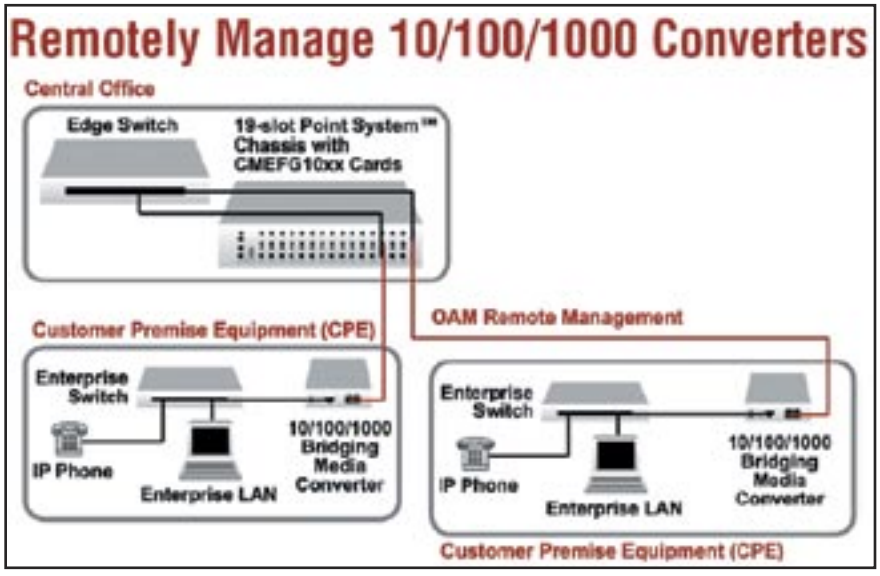

Figure 1. Media conversion cards in the MSAP bring fiber directly to the customer's existing Ethernet LAN, even if it is copper-based.

The 802.3ah Impact

IEEE 802.3ah clearly opens the door for Ethernet to become a protocol of choice for broadband access networks.

Ethernet equipment costs are lower because of Ethernet's global domination in enterprise environments for decades. An added benefit is the less complex architecture of an Ethernet network, which in turn allows simpler management.

Competitive Local Exchange Carriers (CLECs) and Independent Local Exchange Carriers (ILECs) will find that they can play in a competitive market by offering low-cost Ethernet services to business and residential customers such as multi-tenant units (MTUs). By offering tiered services based on diversified levels of bandwidth, customers can finally obtain cost effective services to meet their current network bandwidth needs.

Vital Role for Media Converters

Since EFM removes the need for expensive routers, carriers can install intelligent media converters at the CO and customer premises to provision the access to copper LAN environments and to manage the entire Ethernet link remotely from the CO.

Carriers can save by installing copper switches along with a media conversion platform at the central office,

instead of a more costly fiber switch. Lower cost equipment, in conjunction with network simplicity, make EFM technologies a strong consideration for new residential and business services.

Media Converters in 802.3ah Links

Media converters have been present in Ethernet LANs for decades. Now the converters have evolved to become a true customer premise device that helps service providers bridge the gap between optical infrastructure and copper-based interfaces in newly created IP Networks. Today, media converters interface with CO equipment and offer an excellent managed demarcation capability at the customer premises.

Media conversion devices can now be deployed at both the CO and the CP to provide an end-to-end Ethernet in the First Mile solution. Installed at the CO is the 1000BaseTX edge switch. The RJ-45 ports on the switch will be connected by copper to the 802.3ah compliant 10/100/1000 copper-to-fiber media conversion cards, loaded in a chassis platform. Fiber is then run from the BX or LX ports on the cards out to the individual customers at the CP. At the CP, the 802.3ah compliant 10/100/1000 copper to fiber media conversion stand-alone devices then convert the optical signal into an electrical signal. The customer can connect to the Ethernet network with his or her existing copper-based network devices. (See figure 1.)

This solution allows access network operators to take full advantage of the advanced features provided by the media converters to completely manage the Ethernet link in the last mile, such as remote management, bandwidth allocation, VLAN tagging, and SNMP management. Of course, full OAM support enables the vital features to troubleshoot and monitor the link.

After the units are connected and the OAM management communication flow is established, the operator is ready to manage the link in its entirety. Remote in-band management over fiber allows administrators access to the remote device to check status and enable/disable features without the need for a truck roll.

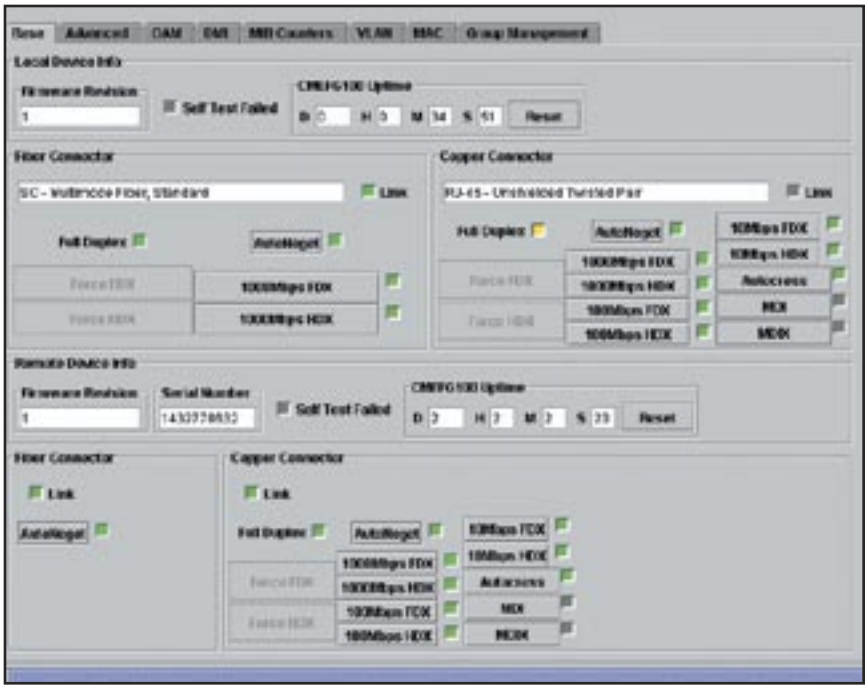

Figure 2. Web-based interface to control the media converter from a central location.

Managing media converters today is intuitive and fast. Media converters are shipped with Autonegotiation enabled on both copper and fiber ports. This setting allows for a plug-n-play functionality and removes the need to manually set-up any connection speed or mode parameters. If manual setting is required, the operators can perform these operations straight from their Network Management Station. (See figure 2.)

The service provider can choose what speed should be a part of the Autonegotiation process. This is helpful when one wants to make sure that the devices will not advertise and connect at undesired speeds. If "hard setting" is required, one can disable Autonegotiation and force ports to particular speeds and duplex modes. This offers the providers the flexibility to connect to various customer interfaces such as 10Mbps, 100Mbps, 10/100Mbps or 1000Mbps with just one SKU.

The converter offers an ideal migration path for the service provider to upgrade service without changing the customer premises equipment. Modern media converters ease the setup process by providing means for automatic MDI/MDI-X detection. This feature automatically detects and configures the twisted pair port on the converter to the correct MDI or MDI-X configuration so the installers do not have to worry about straight-through or crossover cable selection.

A full suite of management statistics is offered on the new media converters. The administrator has an immediate access to OAM discovery information, Criticle event alerts, link fault alerts, and remote loopback status. Same status information is immediately available for a discovered remote unit. This screen assures the operator about the state of the link and OAM channel operation. (See Figure 3 on the next page.)

Here's what buyers should look for:

Vendor-Specific Enhancements

Bandwidth allocation. Although 802.3ah specifies Ethernet as an access platform, it does not specify any bandwidth allocation mechanisms. These features needed to be implemented by

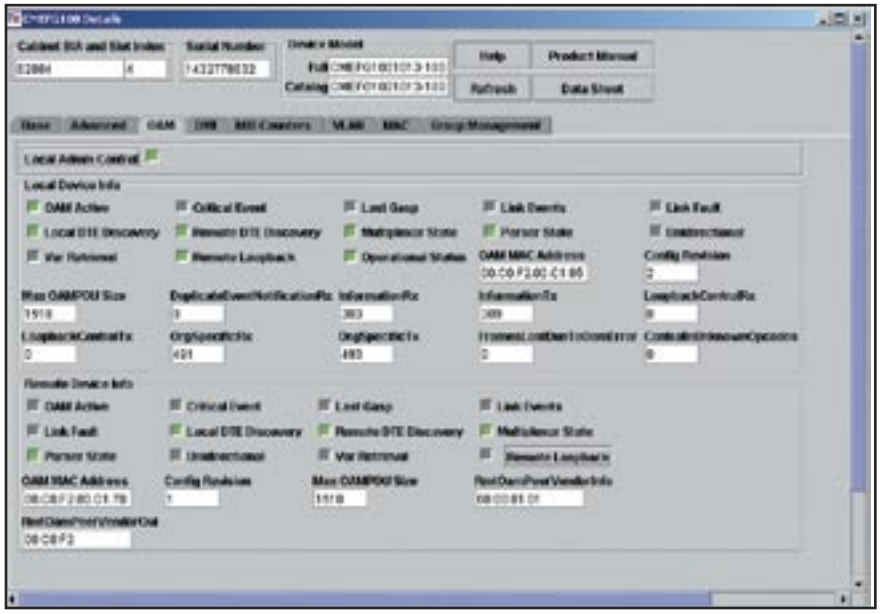

Figure 3. Checking the media converter's status, to help manage the network.

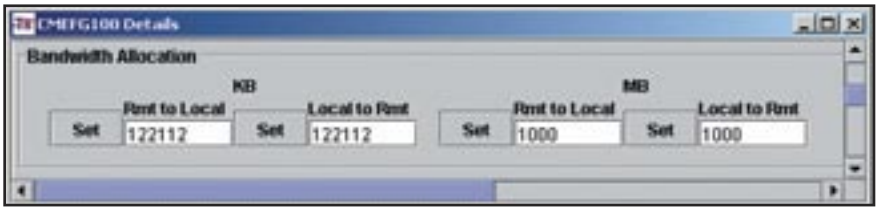

Figure 4. On-the-fly bandwidth allocation using intelligent media converter.

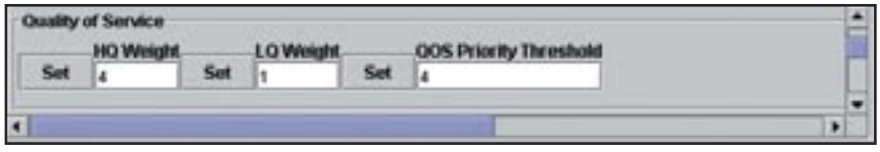

Figure 5. One approach to QoS management.

media converters under a "vendor specific enhancement." One key feature offered by many is the ability to allocate bandwidth. Converters are offered with the ability to allocate in as little as 64KB increments all the way to 1 Gbps.

This allows carriers to offer contracts in a variety of service levels, based on customer needs. Controlling bandwidth with media converters permits the switch to perform its main switching function without loosing processing power to bandwidth management. Both upstream and downstream bandwidth levels can be controlled. The bandwidth allocation is monitored and managed via SNMP Graphical User Interface (GUI), Web browser or Command Line Interface (CLI). In GUI easy to use screens allow users to enter exact bandwidth requirement either in KBps or Mbps. (See Figure 4.)

Quality of Service (QoS). Interestingly, EFM does not specify any Quality of Service (QoS) mechanisms either. Media converters today offer 802.1P management with high- and low-priority queues to support prioritization across the access segment. These are essential for video or Voice-over-IP (VoIP) applications where packet flow affects the quality of the voice or video transmissions. (See Figure 5 – QoS.)

VLANs (802.1Q). Full support for 4096 VLAN IDs is now standard on the remotely managed media converters. Today's service provider networks cannot operate without full VLAN support. Untagged traffic is simply not allowed on the service provider's network. Administrators can effectively filter out the network traffic without VLAN assignments using media converters before the packet gets to an edge switch.

Media converters can now insert a VLAN tag, remove the tag, or change the tag in the packets passing through the converter. Administrators can create VLAN policies for each of 4096 VLANs. Each VLAN, finally, can be assigned with numerous "What if" scenarios separately for the customer side or access side of the link.

Media converters with VLAN capability benefit providers by offering the capability to isolate different customers' traffic, control who uses their network and specify what resources are available to particular customers.

Converters can also reprioritize the traffic (change the 802.1P priority tag) based on the VLAN assignment. (See Figure 6 – 802.1Q VLAN Management.)

Dynamic VLAN management is also enhanced with the static MAC address assignment. Up to 256 MAC addresses can be assigned to a specific port with 802.1Q tagging enabled or disabled. This function will effectively allow service providers to "provision" MAC addresses to access the network.

Digital Loopback. New media converters enable the device to loop back the signal from either media for testing and troubleshooting purposes. Test signals can be inserted into the link and looped back as received by a device to test a particular segment of the link (for instance, copper or fiber). Loopback can be either local or remote, depending on the location of the converter in the link. Some converters have separate copper and fiber loopback functions that can be enabled separately, while others will loopback both copper and fiber at the same time when enabled. The loopback offers customers an easy way of diagnosing the links from a local or

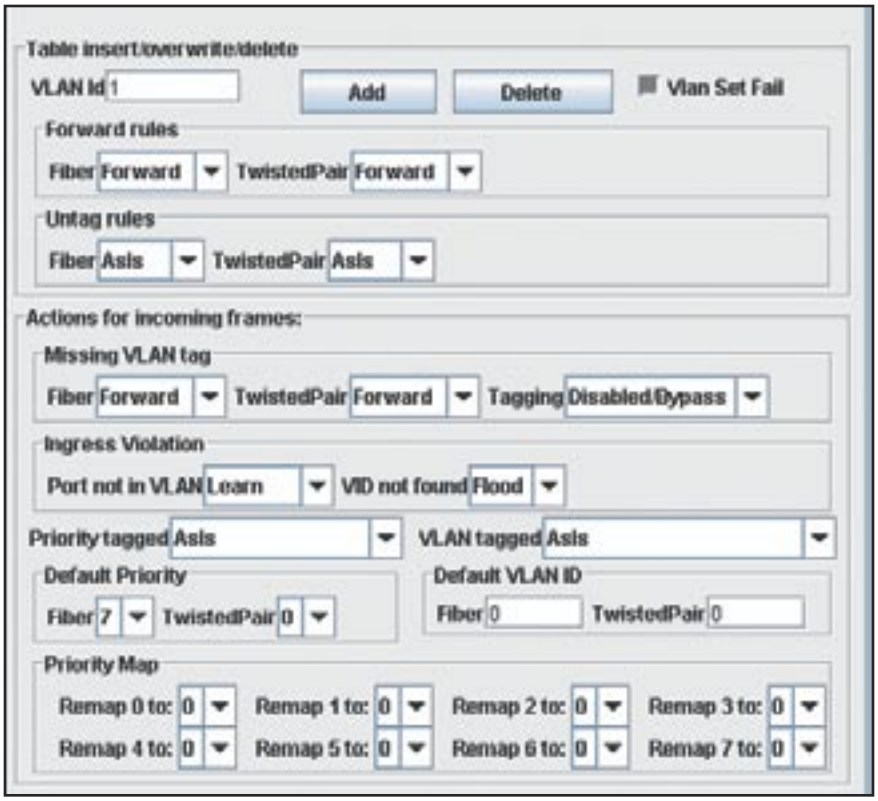

Figure 6. Using IEEE 802.1Q to manage the virtual LAN.

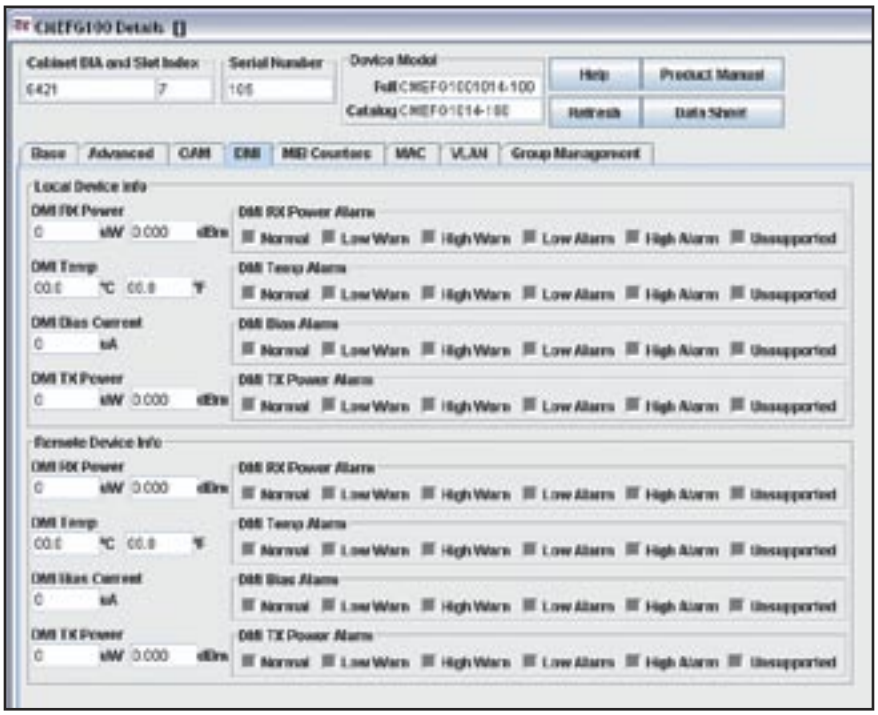

Figure 7. Using digital diagnostics to measure temperature, power and so forth.

remote location without leaving the office. Loopback allows providers to quickly pinpoint problem areas of end to end link by testing a particular segment one at a time.

Digital diagnostics (DMI). DMI can be implemented on the optical link to measure temperature as well as

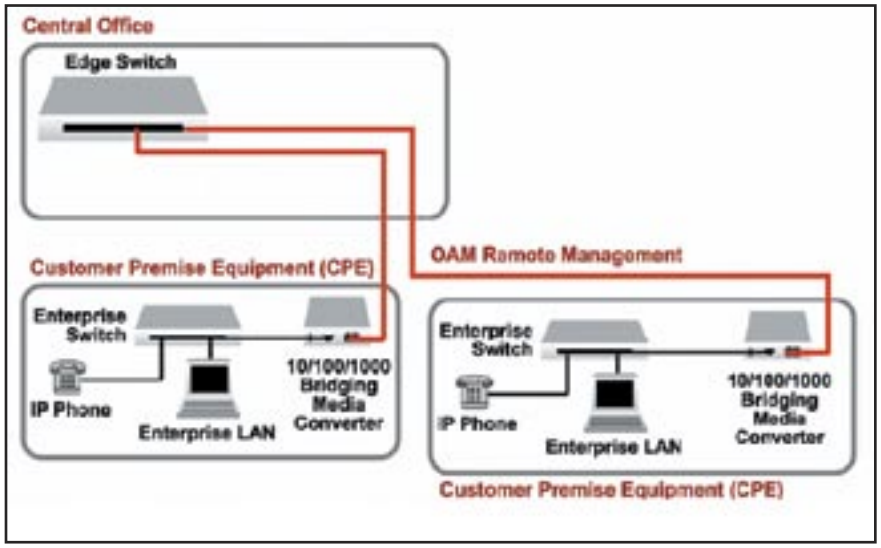

Figure 8. The alternative, where geography permits: Installing fiber switch at the central office.

transmit and receive power levels. This feature allows the carriers to monitor the optical performance levels of any of the link segments. The diagnostics report launch and receive power along with the temperature of the optics. Carriers also receive notifications if the temperature or optical levels reach minimum or maximum levels. This is important because it helps service providers remotely monitor the quality of optical link and possibly respond to the changing performance levels of the line. (See Figure 7 – DMI on the previous page.)

Remote monitoring RMON Group 1. Data channel statistics – RMON Group 1 – should also be available for each of the link segments. Such information includes a counter for number of packets by size and type as well as CRC/FCS errors, alignment errors, and so forth.

Automatic Link Restoration – Self Restore. With all the advances in premium features, it is surprising to see that only few media converter vendors offer the capability for the converter to unconditionally restore the link, without any need for user intervention, once a fault condition is removed. This consequently eliminates the need to send a technician to the field.

Alternative Applications for Media Conversion in EFM Solutions

When conversion technology is used only at the customer premises end to connect to copper hardware, basic "Operations and Management" (OAM) should still be maintained through 802.3ah support.

Another configuration would be to install an 802.3ah compliant fiber switch at the central office. The fiber can then be run to the customer premises and to 802.3ah compliant standalone media converters, which in turn would provide an RJ-45 port to the customer to connect their existing copper switch to the high bandwidth Ethernet network. Although the carrier will loose the ability to enable the vendor-enhanced features, basic OAM such as remote unit discovery and remote loopback are supported. (See Figure 8 – Alternative EFM Solution.)

Carrier Grade media converters allow the fiber to be connected to the existing equipment. Converters can also offer advanced remote management far beyond EFM standards.

Conclusion

Media converters clearly provide another excellent solution for service providers implementing the EFM standard. Carriers increasingly install intelligent media converters at the customer premises to cost effectively connect customers' LAN environments to the network.

Media converters for service providers differ from enterprise-grade converters. Remote management, remote loopback, bandwidth allocation, service provisioning, channel statistics and, most importantly, Automatic Link Restoration are a must in access networks.

Finally, media converters allow service providers to turn inexpensive copper-based Ethernet switches into carrier-grade devices.

They protect the investment made in copper-based equipment, offer an excellent migration path to 10/100/1000 interfaces and bandwidth allocation. Converters help lowering capital expenditures, as it is not necessary to immediately replace that equipment with more expensive models designed with fiber optic interfaces or remote EFM management.

Carrier Grade media converters allow the fiber to be connected to the existing equipment. Converters can also offer advanced Remote management far beyond EFM standards, thus lowering the cost associated with the truck roll. **BBP**

About the Author

Sev Sadura is a Product Manager with Transition Networks, Inc. He can be reached at sevs@transition.com. Transition Networks offers networking connectivity solutions that make the conversion between disparate media types possible. For more information, please contact Transition Networks at (800) 526-9267 or see www.transition.com. For more details on 802.3ah itself, see "A Boost for Ethernet to the Home: A New IEEE Standard, 802.3ah, Makes Last Mile Hookups Easier," by Carole Hackenberg in the February issue.