By Tim Smith

The challenge of grooming disparate cable plants has beleaguered telecommunications engineers since fiber was first a part of the network. A new standard that provides flexible interfaces and improved signal management may just be what is needed to put the brass ring of universal network grooming within reach.

The small form-factor pluggable (SFP) standard defines a series of small, hot-swappable port interface modules that provide physical layer signaling for data, voice, storage and video-transport networks. They provide significant advantages over traditional, fixed-form interfaces in terms of density, flexibility, management and cost savings. The SFP standard evolved from the Gigabit Interface Converter (GBIC) modules that were standardized as a part of Gigabit Ethernet. From that start, came an industry-wide Multiple Source Agreement that spawned SFP connectors in a wide range of protocols and connector types.

The spread of SFP technology has been rapid, and today there is an extremely broad selection of optical interfaces. Only a year ago, the first monochromatic units were shipped supporting 850, 1310, and 1550nm links. Now, networks can be designed using a complete CWDM band plan based on pluggable transceivers. More recently, DWDM ITU grid SFP transceivers for high-density WDM applications have been demonstrated.

SFP-based transceivers can be found in a number of traditional media conversion devices, providing a dramatic transformation of how these devices and systems can help the telecom engineer in the field.

Transition or Chaos?

Demand for higher-speed data and converged communications services is putting even greater pressure on service providers today to make the most of their network, and that means looking for a new and better ways to groom fiber optic infrastructure.

Until now, the solution has been an unmanaged array of application specific, physical layer media converters used throughout the network wherever a transition connection is needed: multimode to single mode, dual fiber to single fiber, short haul to long haul, etc. However, this ad hoc system is posing problems for telecommunications engineers that need to quickly solve cabling issues and support new services over the existing cabling plant.

Using SFP transceivers, it is possible to create a universal media management device that goes well beyond the capabilities and limitations of the traditional media converter. New capabilities offered by SFP-enabled media management devices include the agility to

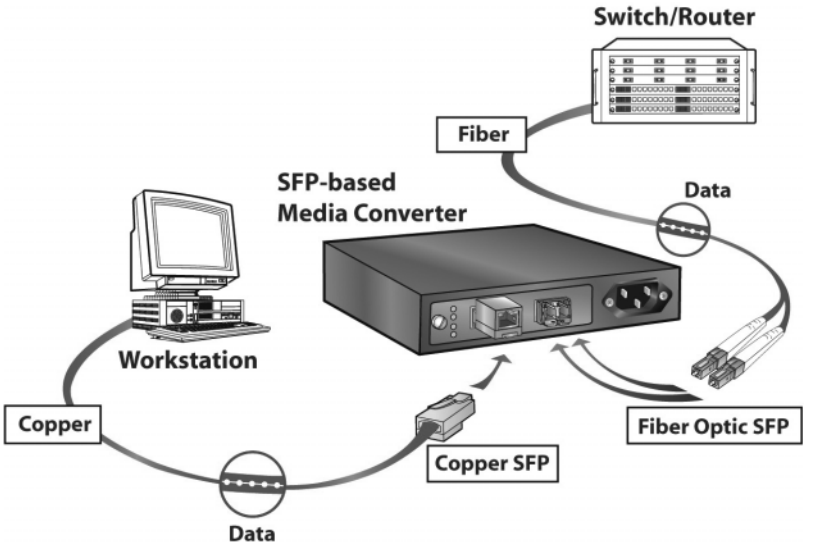

Figure 1. Universal Media: SFP Media converters allow new flexibility and physical layer management.

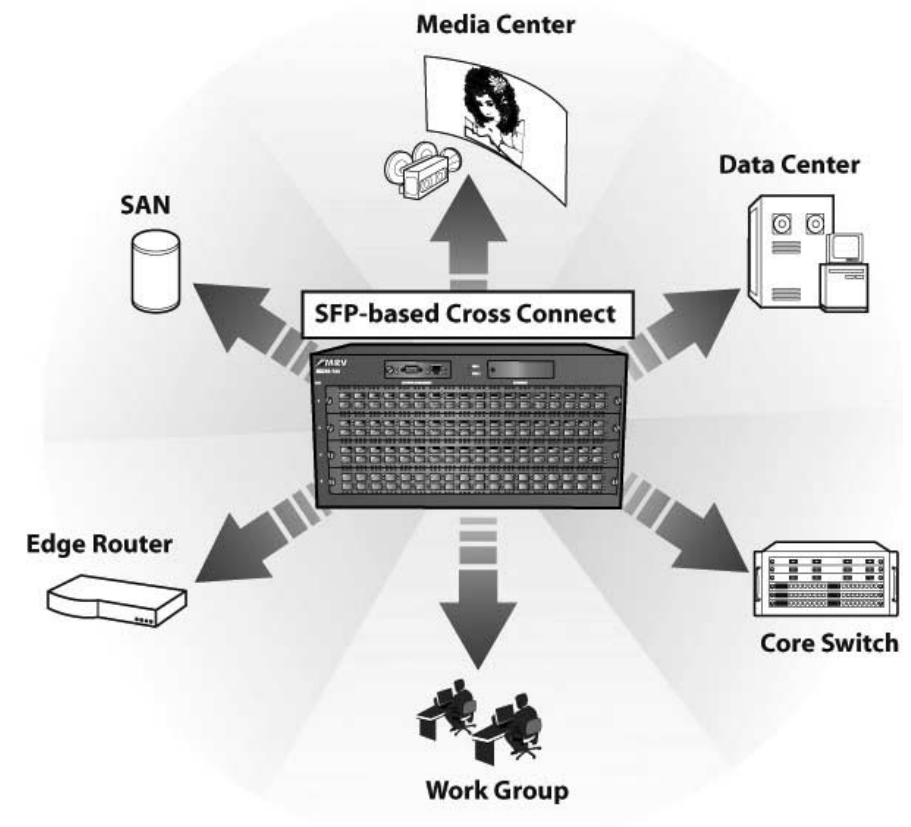

Figure 2. Wire Once Patch Panel: The patch panel provides a manageable Layer One network that connects all network protocols.

change protocols, speeds, and interface characteristics with the flip of a switch or a command from a remote management station. They can also offer the ability to provision and rate limit at the physical network layer. (See Figure 1.)

With these new pluggable transceivers, media converters now have troubleshooting and diagnostic capabilities that add intelligence to Layer 1 physical plants, along with in-circuit optical link testing for rapid fault isolation that can lower maintenance and repair expenses.

Which Cable Goes Where?

Beyond standalone media conversion devices, SFP transceivers can also be used in patch panels. It goes without saying that today's rapid bandwidth growth and build-out call for a flexible cabling system that is highly adaptive to change. Here, the new breed of SFP-enabled digital patch panel offers much promise for the "wire once" network concept.

Think of a digital patch panel as a replacement for the traditional passive patch panel, and the tangle of media converters and non-standard cabling management systems. (See Figure 2.) Often referred to as digital cross-connect because of its any-port-to-any-port programmable connectivity, the new digital patch panel offers the ability to accept virtually any type of media by customizing ports with different SFP transceivers as needed. Not only does this give cable plant managers the latitude of adapting the physical plant to changing technologies, it also reduces cost in the long run with improved maintainability.

Network planners widely accept the fact that there is the need to provide a plan for common cable management. Typical convergence points occur between single mode fiber network segments and legacy multimode fiber and copper segments. However, no matter how well planned, the management and documentation of a network comprised of mixed media can be very complicated and easily outdated.

The need for an effective cable management plan is starkly illustrated when a network outage occurs. When a problem occurs, a troubleshooting escalation plan is normally executed to confirm that the network equipment involved is working before considering the cable plant. With unmanaged and isolated media converters, this becomes a job that requires someone scrambling to perform onsite status checks and, when the issue is located, tracing that to the other end of the connection.

Now let's picture the same scenario with an SFP-based digital patch panel in place. At the first hint of a network problem the telecom engineer is able to inspect any physical connection involved by querying the associated patch point. In addition to connection status, the digital diagnostics of an SFP optical interface adds another troubleshooting tool. If you are unable to deduct where the problem's source is, you can advance your troubleshooting reach by requesting optical parameters, which might include laser or LED power levels. From the receiving end you can observe incoming light and report actual measurements.

If an optical analyzer is necessary, you can "park" it on any digital patch panel port and instruct the device to mirror the data stream to the analyzer port, allowing you to observe traffic in real time on all of the patch panel ports. After finding the trouble spot, you can reconfigure your network remotely to bypass the fault before dispatching additional personnel.

Buttoned-Up From the Inside Out

SFP transceivers can open the door for extremely flexible network configurations. For instance, the network may be configured with an expensive switch or router using an equally expensive optical interface designed to directly interface to a long haul single mode fiber span. From a fiber management

perspective, that design is inherently flawed as there is no delineation between the router and the outside world. Any problems or troubleshooting attempts will invariably require that router to participate, and most fiber-optic router interfaces do not have the ability to perform even rudimentary optical testing. Situations like this have caused numerous truck rolls to the CO/PoP because the only way to effectively test the fiber is to disconnect each of them and measure optical performance on each strand independently.

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As SFP technology becomes available in switches and routers, telecom engineers will benefit so long as the device is not at fault. If you can't reach the device console, you cannot access the SFP digital diagnostics to test and diagnose the physical plant. It may sound old school, but it's still recommended to create a fiber delineation point so that the physical plant can be managed completely independent of the router or workgroup devices. If the switch or router is misbehaving, then the SFP host still has management access to allow inspection of optical levels, perform loop back, reconfigure and provision ports, and more.

An additional benefit with this setup is that as routers are upgraded or replaced they need only be equipped with the lowest-cost local interface (fixed optic, GBIC or SFP). External SFP-enabled media converters or digital cross-connects can be used to groom connections to any media or wavelength, and be managed independently. This is known as external grooming.

Good Grooming for The Future

Networks evolve. Ten years ago no one would have believed that we would be using the bandwidth we are today. This growth places an enormous burden on networks to be scaleable without a forklift upgrade. By utilizing the external grooming approach discussed above, it's even easier to scale into aggregation technologies such as CWDM or DWDM.

If a network is supporting a single connection today and is bound to only one or two fiber strands, the modularity of the SFP-based network design pays off. The engineer can simply drop in a passive optical multiplexer and add one or more additional pluggable transceivers, each using unique wavelengths to create a rudimentary wave division multiplexer. (See Figure 3.) Consequently, much of the system is reused and investments are protected.

The SFP standard is fueling today's advancements in next-generation fiber grooming to allow telecom engineers the ability to seamlessly blend existing multimode fiber, copper, or single mode fiber. Although still fairly new on the market, they are available in a wide variety of interfaces for all the common protocols in use today. Astute shoppers will even find SFPs supporting native digital video (including HDTV), tri-speed CAT5, 10/100 switching, single fiber (full duplex) interfaces, FireWire, and more.

Today, vendors are offering "anything-to-anything" converters and transponders for a lower price than their earlier fixed converter cousins of only a year ago. And included for free are the diagnostics, interchangeability, and flexibility in adapting to a network's evolving requirements.

The selection of the SFP transceiver as your interface of choice may be the single most important decision to make when designing and grooming a network. With it, the network is guaranteed a level of compatibility and afforded a much higher level of modularity then ever before possible.

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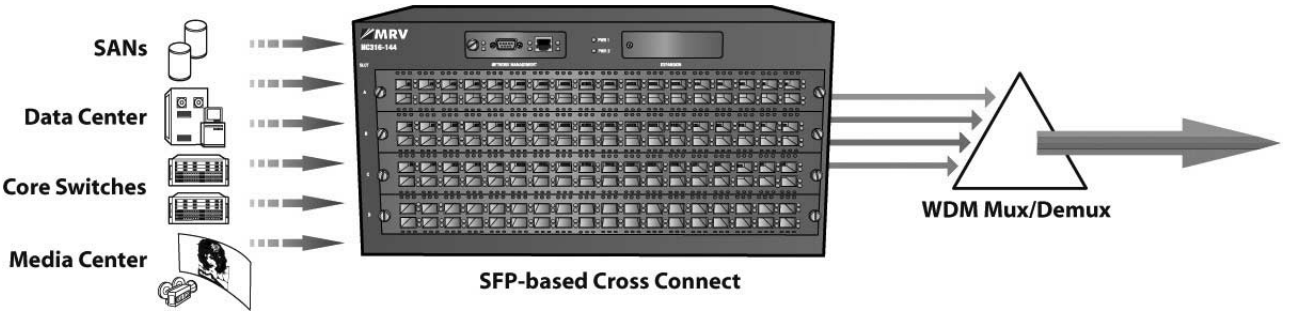

FIGURE 3: Do-It-Yourself WDM: Combining the cross connect and a passive multiplexer creates a wave division multiplexer.