The Future of Sonet/SDH

EXECUTIVE SUMMARY

ABSTRACT
The last three years have seen a remarkable reversal in attitudes to Sonet/SDH within the telecommunications industry.

Sonet/SDH is no longer spoken of as a “legacy technology” – something to be replaced by the “next big thing.” There is a growing and urgent realization among carriers around the world that when it comes to next-generation telco infrastructure, Sonet/SDH is the next big thing – and that for at least the next decade it represents the future of telecommunications.

But to deliver on this future, Sonet/SDH equipment manufacturers must evolve their equipment so that it conforms to the needs of the world’s largest operators – and those carriers are setting the bar high, demanding affordable, standards-based platforms that are compact and yet highly scaleable, and that deliver packet and TDM services both seamlessly and without manual configuration.

To meet these requirements equipment vendors know that they must do far more than simply bolt packet data interfaces onto the outside of a Sonet ADM. Instead, they have developed systems that span from customer to core, leveraging advances in multiprotocol traffic adaptation, service multiplexing, and end-to-end operations management.

The stakes are huge for all parties involved. Heavy Reading believes that next-generation Sonet platforms will be as fundamental to telecom networks in the coming decade as routers were to the Internet in the 90s. For manufacturers, the goal is to produce a product that allows them to emerge as a “Sonet Cisco” – achieving the same level of dominance in next-gen Sonet as Cisco has in routing.

For carriers, the stakes are equally high. Their success, and survival, lies in being able to evolve their legacy transmission networks into multiservice networks, using a new generation of Sonet infrastructure as the unifying medium for all protocols and services.

NEXT-GEN SONET/SDH CATALYSTS
Though a small number of operators in Europe, East Asia, and India are attempting to build networks without any Sonet/SDH layer whatsoever, in the rest of the world Sonet/SDH is here to stay. Some of the reasons for this are well known.

For one thing, Sonet’s installed base is too large for carriers to simply walk away from. Though arguments have been made for “cap-and-grow” strategies that favor all-optical or native Ethernet transport, most operators cannot associate enough predicted revenue with that new overlay to justify capping growth altogether on their profitable Sonet/SDH networks. (Note: while carriers in the West are not widely deploying native Ethernet products, the very presence of this technology has served to benefit them indirectly, by forcing vendors of Sonet/SDH technology to price their next-generation products competitively versus simpler native Ethernet alternatives.)

Another factor is the tremendous growth in data transport and services. Nearly all of this data remains transported within Sonet/SDH (Frame Relay, ATM, Packet over Sonet, Ethernet over Sonet, etc.), and it is this very multiplicity of data formats that is driving carriers to standardize on a unified method of transport. Though services may begin as IP, Ethernet, Fibre Channel, Frame Relay, or ATM, a carrier’s capex and opex can be greatly improved with a common transmission solution that has some degree of data intelligence.
This explains why all new Sonet/SDH gear shipping in 2003 is to some degree “data-aware.” Vendors are all positioning their Sonet/SDH offerings as capable of supporting cost-effective native data transport and, in some cases, switched Layer 2 Ethernet services. Further data awareness is being contemplated for Frame Relay, ATM, POS, and storage.

All of this product development is well-timed to meet with the requirements of service provider transmission groups that are looking to shore up private-line profits that are being eroded by price competition, by adding “data private lines” with enhanced management and SLA options for native data transport over Sonet/SDH. The Sonet/SDH MSPP is a critical tool for providing these new services.

**HEAVY READING’S RESEARCH METHODOLOGY**

While it’s clear that Sonet/SDH will be a fundamental tenet of next-generation networks, many key questions remain unanswered, including:

- Which vendors are leading the next-generation Sonet/SDH development race?
- How (and when) will leading service providers deploy profitable Ethernet and storage private-line services over Sonet/SDH?
- Which new technologies are needed to create functional next-gen Sonet/SDH solutions? Which are red herrings?
- Which startups have the right products to fill the gaps in the incumbent vendors’ lines?
- How far should network element integration be pushed?

To answer these questions, Heavy Reading spent the last four months conducting telephone or in-person interviews with all 21 public and private manufacturers of next-generation Sonet/SDH hardware, as well as interviews with a dozen major service providers and carriers.

**Public equipment manufacturers covered in this report:**

ADVA AG Optical Networking (Frankfurt: ADV), Alcatel SA (NYSE: ALA; Paris: CGEP:PA), Ciena Corp. (Nasdaq: CIEN), Cisco Systems Inc. (Nasdaq: CSCO), ECI Telecom Ltd. (Nasdaq/NM: ECIL), Fujitsu Ltd. (OTC: FJTSY), Larscom Inc. (Nasdaq: LARS), Lucent Technologies Inc. (NYSE: LU), Marconi Corp. plc (Nasdaq: MRCIY; London: MONI), NEC Corp. (Nasdaq: NIPNY; Tokyo: 6701), Nortel Networks Corp. (NYSE/Toronto: NT), Siemens AG (NYSE: SI; Frankfurt: SIE), Sycamore Networks Inc. (Nasdaq: SCMR), Tellabs Inc. (Nasdaq: TLAB; Frankfurt: BTLA), Tellium Inc. (Nasdaq: TELM)

**Startup equipment manufacturers covered in this report:**


**Service providers and carriers covered in this report:**

AT&T Corp. (NYSE: T), Bell Canada (NYSE/Toronto: BCE), BellSouth Corp. (NYSE: BLS), British Telecommunications plc (BT) (NYSE: BTY; London: BTA), COLT Telecom Group plc (Nasdaq: COLT; London: CTML), Cox Communications Inc. (NYSE: COX), Deutsche Telekom AG (NYSE: DT), PPL Telcom (NYSE: PPL), SBC Communications Inc. (NYSE: SBC), Sprint Corp. (NYSE: FON), Time Warner Telecom Inc. (Nasdaq: TWTC), Verizon Communications Inc. (NYSE: VZ)

The interviews revealed that carriers are both ready and willing to deploy next-generation Sonet/SDH, and clearly indicate which product features they believe are critical to the deployment of profitable services using the technology.

“We are reevaluating our entire network in light of GFP and VCAT. Once you put it in the network in one place, it has a ripple effect through the rest of the network.” – VP, North American IXC.

“We've been putting next-gen Sonet in the network for over two years now, but what we need today is not just more MSPPs, but end-to-end solutions that go all the way to the customer premises. This expands our services portfolio and reduces our leased access costs considerably.” – EVP of Network Architecture and Planning, North American IXC.

“Our solution for Ethernet services today doesn’t scale. Going forward, we are planning to implement RPR network-wide.” – VP, North American IXC.

“The Ethernet Private Line is the most important new service we are rolling out, and it is part of our overall strategy of 'Everything over Sonet' in metros.” – Director of Network Planning and Operations, North American ILEC.
“Time Warner Telecom offers both carrier and enterprise customers traditional TDM services and our new Metro Ethernet solutions over our Sonet platform. Sonet’s redundancy and diversity is important to us and our customers in delivering our premium metro Ethernet services to meet their mission-critical data applications needs. For disaster recovery and specialized data needs, our customers demand the resiliency and reliability that Sonet provides. In short, Sonet is a critical component of a global telecommunications infrastructure, today and tomorrow.” – Michael Rouleau, SVP of Business Development and Strategy, Time Warner Telecom

“Sonet is moving quickly to support the evolution of data services with support for LCAS and GFP. However, it is not designed to do the level of oversubscription that Ethernet equipment provides to enable profitable services for the carriers. On the other hand, Ethernet still has a long way to go. Ethernet, by nature, is still not carrier-class, and some Layer 3 vendors don’t understand the issues required to make their equipment carrier-class.” – Steve Plote, Looking Glass Networks

“We're looking at circuit emulation over Ethernet, but few if any of our customers ask for it. They want TDM circuits for voice.” – Director of Network Engineering and Planning, European City Carrier

“We don't see Ethernet replacing SDH for transport. RPR over Ethernet may work in certain geographies, but until Ethernet itself can match the OAM capabilities of SDH and the scaleability of SDH, it will remain a service interface. There has not been enough fundamental architectural thinking around signaling, routing, traffic descriptors, and OAM to make Ethernet a service provider global network.” – VP of Network Strategy, European PTT

“We’re beginning to see increasing demand for Ethernet services not just for data but also for customers using Fibre Channel over IP. This accounts for much of our growth in 100-Mbit/s Ethernet services.” – VP of Network Engineering and Planning, European City Carrier

“Switched Ethernet services over Sonet may just spell the end of Telcordia’s complete dominance of OSS. Vendor-provided OSS will become more important over time. The Osmine standard won’t go away, but it will be augmented by vendor OSS for Ethernet services management.” – Director of Worldwide Networking Planning, North American ILEC

“Ethernet will be a critical part of our network-based VPN offers in the future. We plan to unite VPN access across Layer 2 boundaries, so an individual enterprise can have some offices connected via Frame Relay, Ethernet, and even DSL, participating in a common network-based VPN.” – Exec. Director of Services, North American ILEC

In order to make sense of the mass of data gathered the analysis in this report is broken into two parts.

- **Part 1 (Sections I through V)** takes a hard look at the technologies and standards behind next-gen Sonet/SDH features, evaluating how well vendors are implementing them in their product lines.

- **Part 2 (Sections VI and VII)** focuses on services – specifically, analyzing in depth the next-gen Sonet/SDH strategies and plans of the major carriers, and then evaluating the services themselves.

**Key Technology Findings**

- In the quest to combine transport and data applications in a more seamless manner there are two models developing – one based on a pure packet MPLS infrastructure using PWE3 circuit emulation and the other based on a next-generation Sonet/SDH transmission model with enhancements for support of data services. The debate within large carriers will go on, but Heavy Reading believes the transmission folks have the upper hand: They have the money and they don’t trust circuit emulation.

- The Sonet/SDH ADM has evolved into the MSPP (multiservice provisioning platform), and the opportunity for startups to succeed here is limited to independent LECs, some foreign PTTs, and MSOs. The US ILECs and IXCs are spoken for already by incumbent vendors.

- In the metro core, 10-Gig ADMs and metro DWDM systems are merging into a new product category, the MSTP (multiservice transport platform), supporting a tight integration of Sonet ADM and metro/regional DWDM for high-capacity services multiplexing and transport. Most incumbent vendors have something they consider an MSTP, but integrated ROADM (reconfigurable add/drop multiplexing) and an automated optical layer separates wannabes from contenders.

- The traditional Sonet/SDH digital crossconnect system is evolving into the MSSP (multiservice switching platform), a key product category, performing scalable, flexible bandwidth grooming and data service multiplexing and switching. Vendors without an MSSP in their portfolio will need to either build one or partner with or acquire an MSSP vendor to remain competitive.

- While all vendors have an MSPP, many have gaps in MSTP or MSSP, creating M&A opportunities for startups offering those products.
• GFP (Generic Framing Procedure) is a key standard to follow, not just for its traffic adaptation features, but because it sets the stage for a true convergence between the packet-switched network and the transmission network by supporting the mapping of MPLS flows directly into GFP.

• LCAS (Link Capacity Adjustment Scheme) will not be used for dynamic bandwidth adjustment, but for survivability options for next-gen Sonet services.

• RPR (Resilient Packet Ring) will succeed because next-gen Sonet isn’t just about supporting Ethernet, it’s about the integration of efficient bandwidth management and packet services support. No other standards-based solution delivers these capabilities like RPR.

Key Services Findings

• Switched Ethernet over Sonet/SDH services will cause the end of the age-old separation between transmission and services divisions within major carriers worldwide. In the US, it will also spell the end of Telcordia’s complete dominance of ILEC OSS, opening up opportunities for vendors and third party OSS developers to add greater value to carriers directly.

• Next-gen Sonet/SDH is not only for legacy operators, but is already selling well into independent local operators, cable MSOs, and CLECs.

• The “data private line” is part of incumbent carrier strategies to shore up private-line profits in the face of an ongoing price war. Fibre Channel and Ethernet are the first of many data private lines coming.

• Ethernet over Sonet/SDH is a rather limited point-to-point service today. For carriers to profit from Ethernet over Sonet/SDH they must support services multiplexing, multipoint services, and class of service. RPR is the answer in metro access, the MSSP is the answer in the metro core.

• Ethernet over Sonet/SDH will not fare as well in Asia/Pacific Rim markets because of major efforts already underway to build Ethernet-over-Optical network infrastructures.

• In the U.S., RBOCs are more committed to Frame Relay than often cited. ATM continues to be a part of broadband access services as well. For next-gen Sonet/SDH to flourish, it must accommodate more efficient handling of Frame Relay and ATM, not just Ethernet. RPR with MPLS is the answer.

• Storage over Sonet/SDH services are in their infancy, but show signs of at least attaining modest standing within carriers as storage extension distance requirements increase from large enterprises.

• Video (DVB-ASI) over Sonet/SDH transport is an often requested feature of vendors, yet traction thus far is limited to select cable MSOs and some ambitious independent LECs. Video in the ILECs is still an open question.

Vendor Rankings

Our analysis of both vendors and carriers comes together in the section of The Future of Sonet/SDH that ranks each Sonet/SDH equipment manufacturer’s products and strategies, using criteria that were derived directly from the face-to-face carrier interviews.

During these service provider discussions a picture of the ideal next-gen Sonet/SDH system began to emerge. We used this model as a way to judge vendor offerings today – and as the basis of a methodology with which to rank vendors according to their technology selection, product line breadth, features, and market power.

Based on interviews with carriers, Heavy Reading believes any competitive next-gen Sonet/SDH solution must include the following technological features:

• GFP, which elegantly maps both Layer 2 and Layer 1 client signals onto Sonet/SDH, typically using virtual concatenation to provide “right-sized” pipes for data services. Nearly every vendor has this now, so it is little more than table stakes.

• Scaleable high-order (STS-1/VC-4) and low-order (VT1.5/VC12) switching to optimize TDM bandwidth management. The move to dense, scaleable, low-order bandwidth management is a key differentiation point for many vendors going forward.

• RPR, not just for bandwidth-efficient Ethernet services support, but for unified support for all packet services transport. This may surprise some, but Heavy Reading found that major carriers are catching on to RPR, eagerly awaiting its standardization and ready to take advantage of its rich feature set.

• Support for end-to-end operations management: Despite its clear advantages, GMPLS has turned out to be more than most carriers are willing to digest at this point. Alternatives, leveraging GFP or Sonet’s own path overhead, will prevail for the near term.
• **Optical Layer Integration**: In the MSPP, this is ideally accomplished via pluggable optics, to support optional direct integration with a passive or active optical layer solution. For metro core products, integration with the optical layer can be accomplished directly on the platform, with integrated ROADM.

During the process of designing our ranking system, we also discovered that it was necessary to update the way in which next-generation Sonet/SDH equipment is categorized or defined.

**Next-Gen Sonet/SDH Categories**

While most of the telecommunications industry has been focused on multiservice provisioning platforms (MSPPs) as the obvious next-gen Sonet platform, the fact of the matter is that other categories of equipment have emerged over the last the years, which also will play a critical role in the deployment of these advanced multiservice Sonet nets.

The *Future of Sonet/SDH* defines these new categories and ranks vendors in part by their ability to support a comprehensive portfolio of these products:

- **Access CLE** (customer-located equipment): Next-gen Sonet gear that supports a mix of TDM and packet services over Sonet/SDH transport. This is the classic “pizza box” product form factor, typically under $10,000 list price with a mix of private-line and Ethernet ports. Important developments in this product category include support for GFP, virtual concatenation, and in some cases, RPR for bandwidth efficient transport to the carrier end office. Nearly every vendor has an access product, and this remains a difficult product category for startups and small players. Partnerships are key.

- **MSPP**: The multiservice provisioning platform (MSPP) is common to almost every vendor and represented the first product category of the next-gen Sonet/SDH market. The MSPP typically supports a mix of TDM and Ethernet client interfaces, OC48 and OC192 trunk interfaces. In some cases vendors include storage interfaces such as Fibre Channel. Other means of differentiation include RPR support, either on a per-blade basis or as integral to a complete “Packet ADM” solution; VT.15/VC-4 switching; packet or cell switch fabric for service multiplexing and multipoint packet services support; GMPLS support for end-to-end provisioning and management; and, in the rare case, Layer 3 support for tighter integration to the IP network and IP services.

- **MSSP (Multiservice Switching Platform)**: This product category is difficult to define clearly at this time, but we believe it is an essential product for the large incumbent vendors to offer as part of a complete next-gen Sonet/SDH solution. The values of network simplification, reduced opex and capex, and improved data-over-Sonet/SDH services management have been validated by carriers in many trials over the past three years. The time is imminent for this product category to take off. Today, vendors who have built these from scratch are in the best position. Those who are adapting their broadband DCS, core optical switch, or MSPPs for this function tend to fall short. Key criteria to be met in this product category include density of interfaces, switching of at least 160G of STS-1/VC4, at least 20G VT1.5/VC12 switching support, and subtending ring aggregation of at least 32 rings per system. For a perfect score, the system should support more than just data services mapping but rather true data services multiplexing.
• **Core STS-1/VC4 switch.** This is a product category that evolved out of the broadband DCS, often called a “Super BDCS” for its ability to switch whole OC48s through the core of a transmission network while at the same time grooming subrate circuits (STS-1/VC4) in a non-blocking fashion through the core switch matrix. This product category does not necessarily require data-over-Sonet/SDH support, so it is somewhat peripheral to the Sonet/SDH universe, but an important part of a large vendor’s product portfolio. The requirement for this product category includes at least 640G of switching capacity and subrate grooming support.

As well as defining these categories the report provides the context necessary to compare them with previous iterations of Sonet/SDH technology (see table).

### The Three Generations of Sonet/SDH

<table>
<thead>
<tr>
<th></th>
<th>PROPRIETARY OPTICAL MUX</th>
<th>ORIGINAL SONET</th>
<th>NEXT-GEN SONET</th>
<th>THIRD-GEN SONET</th>
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<tbody>
<tr>
<td><strong>Timeframe</strong></td>
<td>1980s</td>
<td>1990s</td>
<td>1998 – 2003</td>
<td>MSA (multiservice access), MSPP (multiservice provisioning platform), MSSP (multiservice switching platform), MSTP (multiservice transport platform), core optical switching system</td>
</tr>
<tr>
<td><strong>Network Elements</strong></td>
<td>Fiber terminal multiplexer</td>
<td>ADM, WBDCS, BBDCS</td>
<td>MSPP, core optical switching system</td>
<td></td>
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<tr>
<td><strong>Market Drivers</strong></td>
<td>Low-cost, reliable long-distance transmission</td>
<td>Support for private-line services, ATM transport</td>
<td>Improve capex and opex via integration. Support for native data interfaces</td>
<td>Improved multiservice support (Ethernet, storage, FR, ATM, POS); further consolidation of functionality</td>
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<td><strong>Multi-point Configurations</strong></td>
<td>Asynchronous systems mostly limited to point-to-point configurations</td>
<td>Sonet DCS support grooming among interconnected networks at the STS-1 or VT level</td>
<td>Further support for mesh topologies through the introduction of a distributed control plane</td>
<td>Mesh (physical and virtual) and ring in metro and core networks. Introduction of GMPLS and OIF UNI</td>
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<td><strong>Optical Interconnect</strong></td>
<td>Proprietary solutions mean no multivendor interoperability</td>
<td>Utopia of the mid-span meet. Reality of standards-defined solutions with limited interoperability</td>
<td>Still limited interoperability; decreased interoperability in some cases due to immature data-over-Sonet/SDH standards</td>
<td>Interoperability becomes an issue again as ring aggregation solutions often require interoperability between ring nodes and headend switch</td>
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<td><strong>OAM&amp;P</strong></td>
<td>Separate OSSs are used to provide centralized single-ended maintenance</td>
<td>Makes OAM&amp;P an integral part of the transmission standard</td>
<td>Adds IP intelligence to the solution, allowing for more advanced end-to-end provisioning and management of Sonet services</td>
<td>OAM&amp;P expanded to encompass DWDM layer, GFP layer, and services layer. Work underway to unify the OAM of multiservice Sonet/SDH networks with GMPLS</td>
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<tr>
<td><strong>Advanced Services</strong></td>
<td>Transport only</td>
<td>Support for ATM-based services; packet-over-Sonet transport</td>
<td>Adds proprietary mappings for Ethernet, storage</td>
<td>Standards-based mapping for Ethernet, Escon, Fibre Channel, and other protocols. Integration of Layer 2 switching and some Layer 3 supports Ethernet VPNs</td>
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*Source: Heavy Reading*

Our vendor ranking system also factors in the issue of ‘market power.’ Does the vendor have an installed base worldwide? Is it recognized as a leader in the categories of MSPP, metro Ethernet, and optical switching? If it’s a startup, has it inked key OEM and reseller arrangements? The results will likely surprise some readers, as some incumbent vendors considered innovators in the field are suffering from reliance on a single product, a small customer base, or poor technology choices.
**CONCLUSION**

The purpose of *The Future of Sonet/SDH* is not to forecast the market for ports shipped or customers added, but instead to perform a detailed market and technology assessment of what constitutes next-gen Sonet/SDH.

It’s apparent that the future success of leading incumbent vendors is being determined now, today, by how they are evolving their Sonet/SDH product lines. Success or otherwise will be the deciding factor in determining which equipment vendor will emerge to dominate the telecom market in the next ten years. For carriers, success lies in their choice of technology provider and the timing of their migration to multiservice networking over Sonet/SDH.

Through exhaustive original research *The Future of Sonet/SDH* provides professionals in every part of the telecommunications industry with a comprehensive analysis of this unique (and uniquely exciting) technology market.

- **Incumbent Equipment Vendors** can use the report data for competitive analysis, as well as to gauge the market opportunity for next-gen Sonet/SDH technology.
- **Service providers** can use the rankings of vendors – based on product lines, features, and market status – as a first step in narrowing the product selection process, as well as getting insights into their competitors’ next-gen Sonet service strategies.
- **Communications chip vendors** can use the information on vendors’ future product strategies to understand where to place their R&D bets in the next-gen Sonet/SDH market.
- **Startup equipment vendors** can use the report data to tailor their product positioning to appeal to service providers making critical decisions about their transmission networks, or to vendors looking to make acquisitions.
- **Investors** will get the information and analysis they need to manage their investments – making focused decisions on which portfolio companies to sustain, which to cut loose, and how to continue to profit from Sonet/SDH evolution.

*The Future of Sonet/SDH* is published in PDF format.