# *Addressing the Demands of Modular SONET/SDH Systems Using Exar Solutions*


Sid Yenamandra
Senior Manager, Strategic Marketing
Exar Corporation


Experience *Our* Connectivity.

SONET/SDH equipment are well known for showcasing carrier class reliability with features such as sub 50 ms recovery times, automatic protection switching and enhanced performance monitoring capabilities. These high reliability features however, come at a price as well as trade off's in terms of system flexibility and scalability. In contrast, competing Ethernet/IP systems showcase greater scalability and flexibility but not the carrier class reliability shown by SONET/SDH systems. Architected to reliably transport voice-grade traffic, SONET/SDH is a popular technology with a large existing install base in the metro as well as long-haul networks. According to recent reports by the Dell'Oro group, the optical equipment market is said to have grown 6% in revenue and 12% in unit shipment since 2000. Dell'Oro further adds that one of the key market drivers for this growth in the optical segment is SONET/SDH.

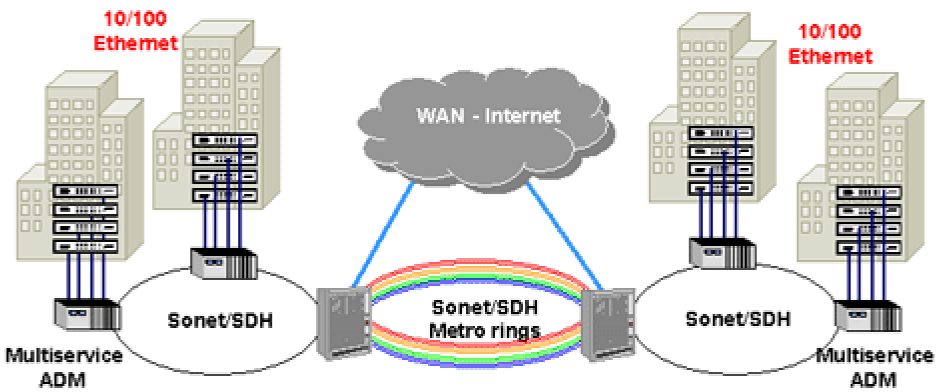



Figure 1: SONET/SDH Network Topology

SONET/SDH networks (as shown in figure 1) typically consist of various systems such as Add/Drop Multiplexers, Digital Cross-Connect Systems, Multi-Service Provisioning Platforms as well as DWDM systems. Typical telecom systems are priced anywhere between $15K and $25K depending on feature-set and data rates while comparable Ethernet systems are priced at about a third of the cost. SONET/SDH telecom systems are typically architected around a range of silicon products such as SONET/SDH framers/mappers, Line interface units, fabric interface chips and a TDM fabric at the core of the system. Telecom solutions can be segmented in a number of ways, such as low cost "pizza box" or fixed configurations and modular chassis configurations. Yet another way of segmenting these solutions is by target network application in the core or access networks. Systems deployed in the access networks are typically low cost and fixed in configuration while the systems deployed in the metro core tend to be modular.

With a reduction in overall CAPEX by carriers as well as increased competition by other low cost technologies such as Ethernet/IP, telecom OEM's are under tremendous pressure to provide enhanced capabilities and feature flexibility yet at the same time reducing the total cost of ownership (TCO) of SONET/SDH platforms. In response to the total Bill-of-Material cost (BOM) concerns, several telecom ASSP suppliers have introduced products termed as "ADM-on-chip" and other such telecom System-on-Chip (SoCs) products. These silicon devices support features such as multiple integrated SONET/SDH transceivers, multiple DS3/DS1/DS0 mappers and line interface Units (LIU's) integrated on chip, OC-3/OC-12/OC-48 SONET/SDH performance monitoring, overhead & pointer processing, STS-1/VT cross-connect etc. Some of these devices also support Ethernet interfaces in order to overlay Ethernet traffic over existing SONET/SDH links. These integrated "ADM-on-a-chip" products have definitely raised the bar on functional integration in silicon but are they ideal for all types of telecom platforms? The simple answer is no. These highly integrated products have helped to reduce system BOM cost concerns but they have raised more fundamental concerns such as disrupting system architecture modularity and reducing feature & interface flexibility.

Most telecom systems deployed in the networks are modular in nature built in a chassis configuration. These systems are typically architected around several line cards such as DS3/DS1/DSO channelized cards, STS-12/STS-48 aggregation cards and TDM switch card/backplanes. ADM's also support advanced SONET/SDH features such as STS-1/VT grooming, performance monitoring and pointer processing. Modular telecom system architectures are developed around distributed models in order to increase the overall reliability of the systems and to meet the stringent carrier class requirements. Therefore, Telecom SoC's or ADM-on-a-chip type of products on one hand address the cost concerns more characteristic of low-cost "pizza box" configurations but at the same time do not address architecture compatibility with modular systems that require separate cards for DS3/DS1/DS0 mapping, centralized switching and aggregation functions. To re-iterate the point, chassis-based telecom systems demand functional modularity of telecom silicon components to ensure scalability of architectures, as well as to enable interface and feature flexibility. To add to their requirements, modular systems still require a high level of integration in silicon to lower the total overall Bill-of-Material (BOM) cost. Achieving this optimal balance between cost, modularity and flexibility is a critical challenge several telecom component vendors face and struggle with.

Experienced system designers prefer to segment their architecture in order to use discrete components for SONET/SDH framing, overhead processing & grooming functionality, DS3/DS1/DS0 mapping and LIU functionality in order to optimize the design and provide adequate scalability and flexibility of architecture. Therefore, in order to effectively address the modular SONET/SDH system requirements, telecom component vendors need to provide "Total Solutions" such as external DS3 mappers/LIU's, high speed transceivers but a high level of integration on key functions such SONET/SDH framing, performance monitoring, flexible overhead processing, integrated multi-rate transceiver and cross-connect capabilities.

To meet this need, Exar enables Total Systems Solutions targeting a wide set of interfaces spanning from T/E to OC-48. A specific example of a device that enables an optimal balance between modularity in functionality as well as feature-set integration is the XRT94L55. The XRT94L55 provides a high level of integration and cost savings for ADM and metro aggregation applications by integrating high-performance clock and data-recovery circuits. With up to 16 integrated OC-12/STM-4 and OC-3/STM-1 CDR's, system designers can choose to interface the XRT94L55 device directly with the backplane or with industry standard optical modules (Please see figure 2). The device has a built-in STS-1 cross-connect that enables highly modular systems with backplanes designed for OC-12/STM-4 and OC-3/STM-1 rates to aggregate or cross-connect up to OC-48/STM-16 at STS-1 levels of granularity.

XRT94L55's unique overhead transparency feature enables system designers to optionally configure the device such that POH and TOH bytes are transparently sent from low-speed ports to high-speed ports. This feature enables system designers to architect sophisticated systems providing enhanced provisioning, grooming and performance monitoring capabilities. The device supports Double Data Rate (DDR) port access capability on all its interface ports providing substantial design and cost benefits over competitive solutions. Using the DDR port access feature, the XRT94L55 can process clock rates at half the clock speed of normal operation making system design much easier when interfacing the device with other ASICs or FPGAs. Additionally, the device includes three STS-48/STM-16 SERDES interfaces with 1+1 redundancy on the line side along with an OC-48/STM-16 TDM access port enabling flexible system designs and APS architectures such as 1+1, UPSR and BLSR.

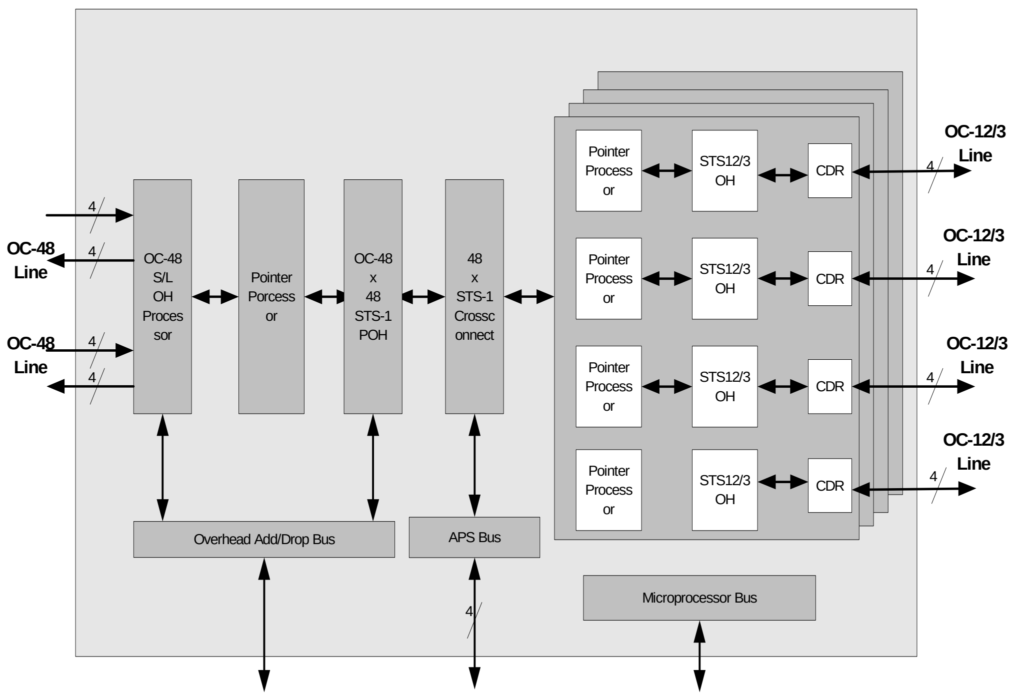
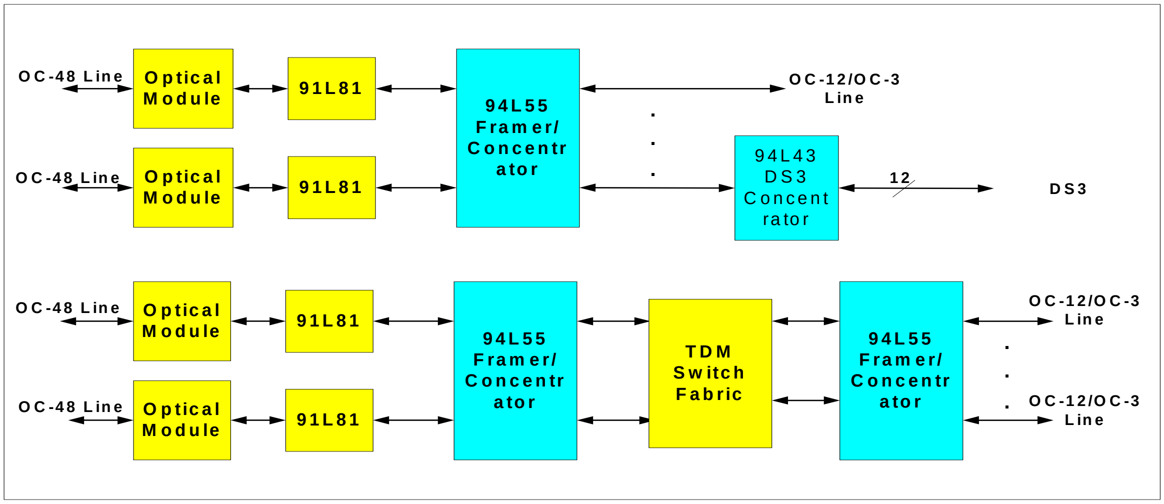



Figure 2: XRT94L55 Block Diagram

The XRT94L55 device multiplexes data between STS-48/STM-16 interfaces as well as 4xSTS-12/16xSTS-3 interfaces. The XRT94L55 supports the following line interfaces: high-speed; 1+1 Protected STS-48/STM-16, 4-bit parallel LVDS, low-speed; SONET/SDH compliant 4xOC-12 and 16xOC-3 PECL interfaces with integrated CDR that meet all the relevant jitter specifications and compatible with industry standard optical modules.

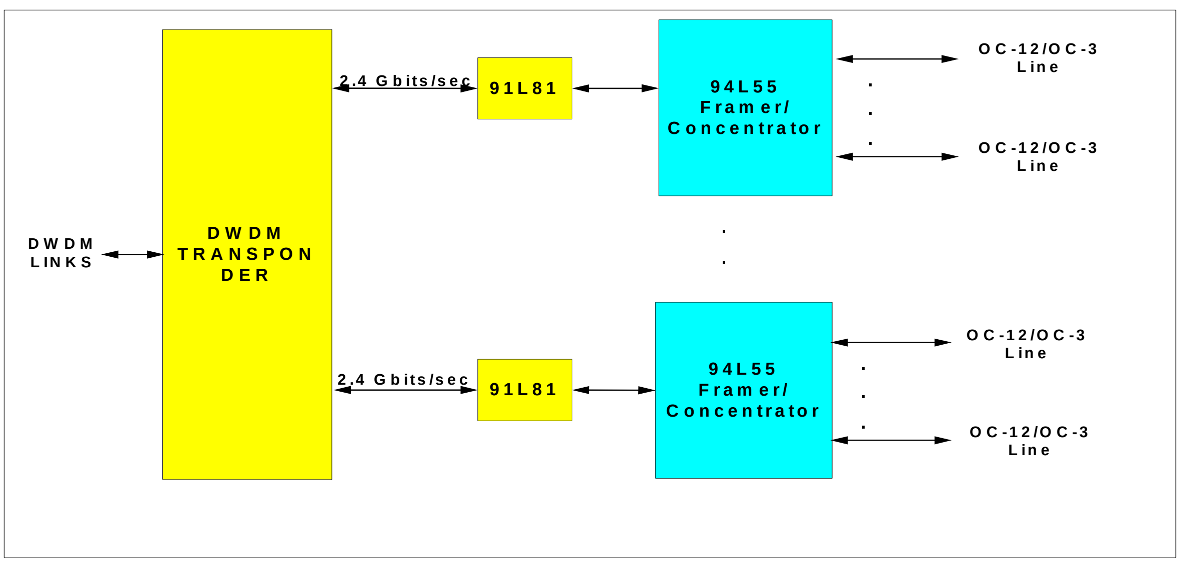
The device enables a multitude of modular as well as fixed configuration system applications such as DWDM, Add/Drop multiplexer and OC-48 aggregation/concentration applications. Add-Drop Multiplexer/Cross-connect Applications typically require a large number of OC-12/OC-3 interfaces to be aggregated into an OC-48 interface (Please see figure 3). In addition to aggregating either OC-12 or OC-3 interfaces, the XRT94L55 can also interface with other access devices such as XRT94L43 (12-channel DS3/STS-1 aggregation device).




**ADD/DROP MULTIPLEXER APPLICATIONS**

Figure 3

DWDM Applications require a large number of OC-12/OC-3 interfaces to be aggregated into a higher speed interface to reduce the number of different wavelengths used for data transmission (Please see figure 4). Through its low speed OC-12/OC-3 interfaces, XRT94L55 allows 4 OC-12 or 16 OC3 interfaces to be aggregated into an OC-48 data stream. Using Exar's 91L81, the data can then be sent to transponders to be transported on DWDM links.




**DWDM APPLICATIONS**

Figure 4

The XRT94L55 device allows feature and interface flexibility by enabling system designers to use discrete components such as the XRT94L55 device in combination with the XRT94L43

(DS3 to STS-1 aggregation device) and XRT75R12 (12-channel DS3 LIU) to achieve the exact system configuration required for a given application. Please see figure 5 as an example of an ADM application with a mix of 2 DS3 & 2 OC-3/OC-12 interfaces.

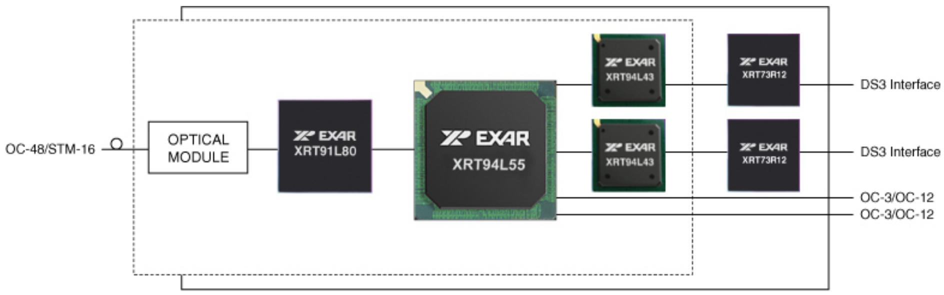



Figure. 5 Optimal System Architecture for an ADM with mix of services

Using an "ADM on a chip" type of product for an application requiring a mix of interfaces would not be effective as the system designer would be constrained to the functionality supported by the device with a centralized architecture. Therefore, system designers looking to optimally design modular systems would like to choose discrete components so that functional boundaries can be drawn in a logical manner as shown in figure 5.

Conclusion

As SONET/SDH system designers look to develop low cost modular systems with feature flexibility, they have several types of silicon solutions they can choose from. Some components such as "ADM-on-Chip" & Telecom SoC type products offer benefits of integration which are attractive for fixed configuration/"pizza box" systems but are far from ideal for modular systems. In order to address the pain points of modular SONET/SDH system designers, Exar enables line card integration with the XRT94L55 (XRT94L55) device in combination with other discrete components such as the XRT94L43 (DS3 aggregation device) and the high performance SONET/SDH PHY (XRT91L80/81) products. Exar's Total solution approach addresses the key pain points of modular system designers such as feature and interface flexibility while promoting modularity in architecture.



**EXAR** Corporation • 48720 Kato Road, Fremont, CA 94538 • (510) 668-7000 • (510) 668-7001