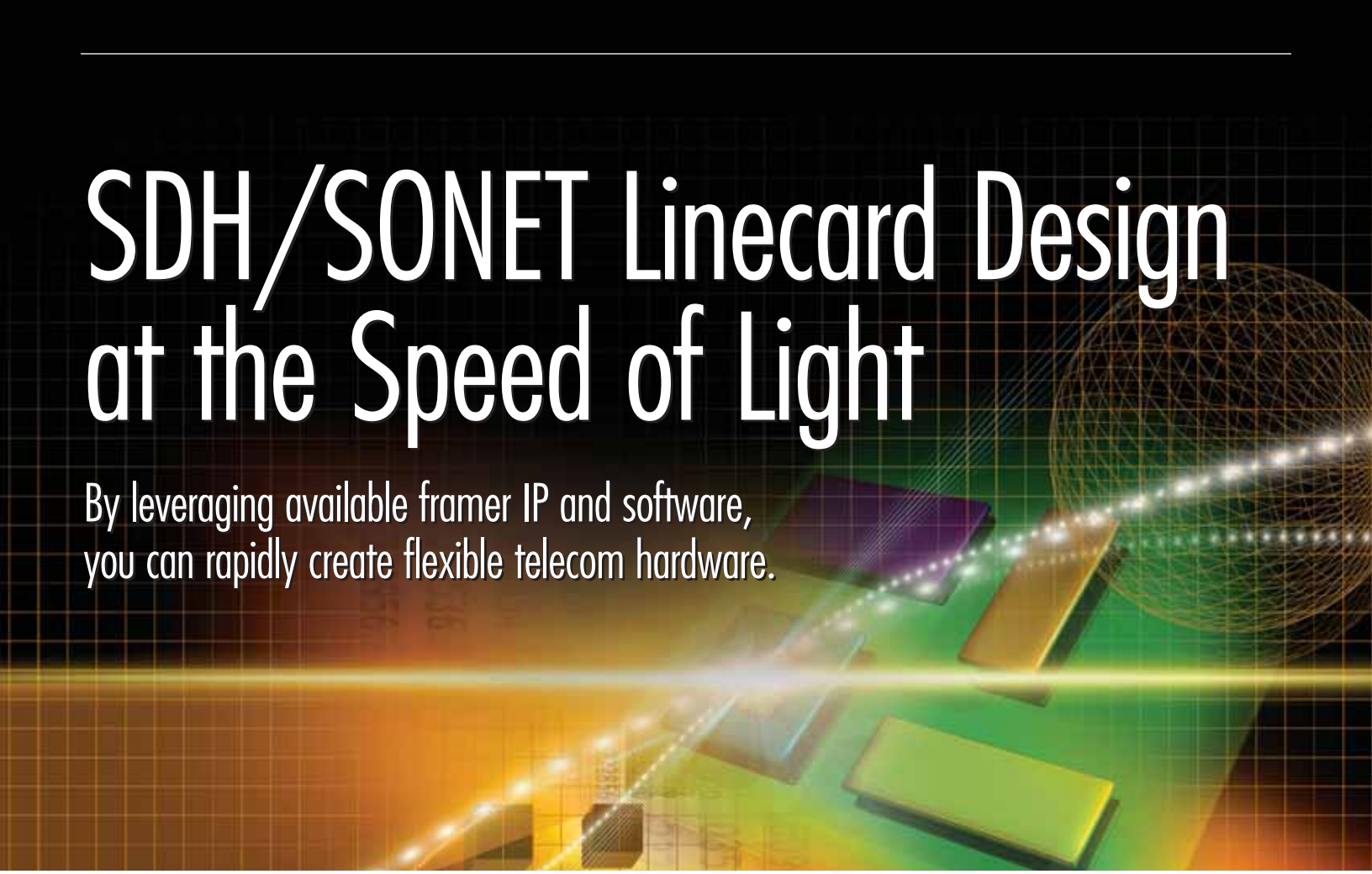
SDH/SONET Linecard Design at the Speed of Light



By leveraging available framer IP and software, you can rapidly create flexible telecom hardware.

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Framers are an inherent part of SDH/SONET system architectures. Many telecom OEMs enhance their own framer designs by combining their proprietary ideas with off-the-shelf IP, creating both a competitive edge and shorter development times. Xilinx® Platform FPGAs coupled with new developments from Aliathon and NComm are further enabling this trend by delivering validated IP in addition to operations, administration, and maintenance (OAM) system management tools.

There are several good reasons for choosing an FPGA for your next SONET framer design. One is that you may need only a subset of features from a very large, complex ASIC or ASSP device to meet the functionality you require. For example, an STM-1/4 or OC-3/12 framer ASIC may be underutilized by the application. Perhaps you need only the transmit section, or just the receive section, or the structure being generated is fixed and the device is not being used to its fullest. With an FPGA, you can have just the functionality you need when you need it, saving board space, cost, and power.

Another reason is that in multi-service communication networks, you may be forced to put several separate framer devices on your card to get the functionality you need. Additionally, many designs require an FPGA connected to a framer. Why not put it all in one FPGA? The result could be a much smaller and lower cost design. With the low static and dynamic power consumption in the Virtex™-4 family, you will probably save power, too. Figure 1 illustrates the potential level of integration possible in today's FPGAs.

Multi-Channel Framers Increase Throughput

Aliathon Ltd., a Xilinx Alliance Program member, can support framer requirements for copper networks or the latest high-speed optical networks through its feature-rich soft IP. Aliathon targets only FPGAs and, as a result, gets the very best from the technology.

Aliathon has made good use of Xilinx logic and memory architectures to handle a very large number of channels simultaneously. For instance, Aliathon IP can process hundreds of T1s packed into a high-speed optical channel (such as a T1 over OC-3/12/48 or E1 over STM-1/4/16) using only a small amount of logic and the fast on-chip memory of Xilinx FPGAs. Table 1 is an example of logic utilization for a E1/T1/J1 multi-channel framer and other cores.

To complete the picture, Virtex-4 technology includes, along with lots of fast logic and memory, multi-gigabit transceivers to interface to your high-speed network directly, as well as the embedded PowerPC™ processor to give a bit more intelligence to your designs. All in all, Virtex-4 devices are the ideal solution for most of your framer needs.

The benefits of using FPGAs are significant. You can implement very complex systems, because you only use the logic you

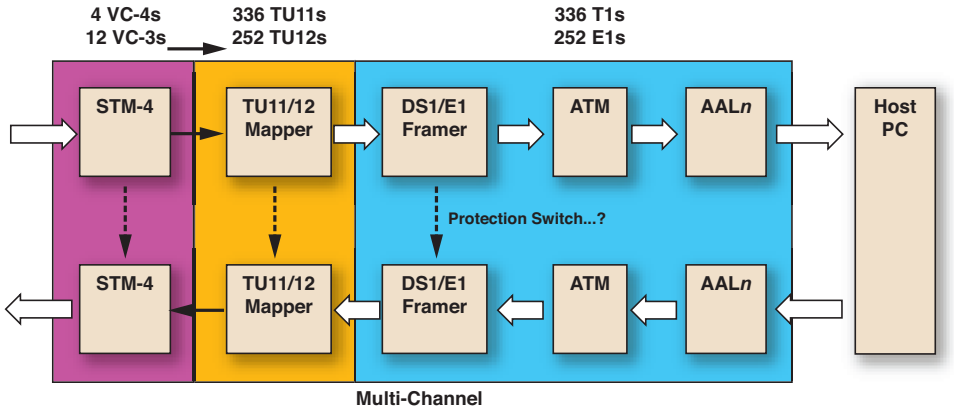

Figure 1 – Virtex-4 FPGAs enable higher design integration.

Function	Slices (Approximate)	Block RAM (Approximate)	Fmax
OC-3/12 Deframer	850	0	>80 MHz
OC-3/12 Framer	700	0	>80 MHz
OC-3/12 Demapper	1,250	5	>80 MHz
OC-3/12 Mapper	1,400	5	>80 MHz
E1/T1 Deframer	800	27	>80 MHz
E1/T1 Framer	400	2	>80 MHz
ATM Deframer	400	4	>80 MHz
ATM Framer	400	4	>80 MHz

Table 1 - Example FPGA resource utilization for cores described in Figure 1

need. You can even target very different architectures by simply loading a new FPGA image. For example, you might use the same card for concatenated or deeply channelized applications. If you don't need both at the same time, you get an even smaller design - something that is impossible with an ASSP/ASIC-based card.

Aliathon has a range of IP covering PDH, SONET/SDH, and OTN networks (see Figures 2, 3, and 4). Its IP is supported on Virtex-4 devices as well as the Spartan™-3 device family.

Drivers and OAM Application Software

When creating a SONET/SDH system with a wide area network (WAN) interface using an FPGA-based Aliathon framer, the end customer (a carrier) often requires OAM functions as part of the system design specification. Xilinx is collaborating with NComm to deliver this more comprehensive OAM solution.

NComm's Trunk Management Software, or TMS, is a completely functional suite of T1/E1, T3/E3, and SONET/SDH software providing configuration, alarm, maintenance/performance monitoring, loopback activation, robbed-bit signaling (T1) and channel-associated signaling (E1) functionality. The TMS sits between the developer's product and the framer driver below. It does not deal with the data payload, but handles the control, monitoring, and reporting required to keep the trunk operating as effectively as possible and in a standards-compliant manner.

OAM functions are typically implemented in software that requires a device driver for the framer, as shown in Figure 5. The effort required to develop the driver and application software in a WAN interface is often underestimated, resulting in missed deadlines, lost profits, unsatisfactory product performance, and cost overruns. By sourcing both software and driver from WAN experts, you can almost always accelerate time to market with the highest quality interface at the lowest cost. Aliathon, NComm, and Xilinx have collaborated to create the necessary NComm device driver module that supports Aliathon's OC-48 framer core for NComm's OAM software.

The framer establishes the network connection, inserts and removes data, and provides the information needed to manage the interface. The software required to control the framer is dependent on the design of the framer hardware.

For example, the definition of an out-of-frame (OOF) condition is defined across all interfaces of a technology - whether T1, SONET, or some other interface - but internal framer mechanics are unique to each device. As long as what enters and emerges complies with the applicable standards, you have the freedom to engineer as you see fit.

The driver enables the software on the processor to communicate with the device's registers. At the SONET/SDH driver API, the commands are the same for all framers supporting SONET/SDH. But beneath the API, the driver communicates with the specific hardware registers - allowing a clear separation between framer-specific software and hardware-independent reusable software.

Above this driver API, required functions are the same regardless of the underlying framer and implement the required OAM functions. OAM software provides non-device-specific processing and routines for the interface. While the data payload is being sent to higher layer applications, the management system performs alarm-management and performance-monitoring (PMON) functions.

The alarm management handles creating alarms from defects. Defects are an immediate indicator of the condition of the lines. When defects like AIS-L/MS-AIS

occur, they are reported up from the framer, and a timer is started. If the condition persists for 2.5 seconds, an AIS alarm is declared. AIS is propagated to the downstream entities and a RDI-L/MS-RDI is sent back to the equipment on the other end.

PMON is proactive, collecting and time-stamping performance reports and other data every second. PMON data is analyzed to detect deteriorating conditions before service interruption, but should a hard failure occur, you can use this information, along with loopbacks, to isolate the source of the problem. You can also set threshold crossing alerts (TCAs) to trigger if something exceeds an expected range.

Standards define a restoration method called automatic protection switching (APS), which enables SONET/SDH traffic to be moved from one fiber to another with minimal disruption to user data in the event of a line failure. Because SONET/SDH supports higher payload capacity, the failures have greater impact, necessitating restoration techniques like APS.

Driver/OAM Solution for Aliathon Framers

NComm's TMS provides drivers and OAM processing packages. Coupled with an Aliathon framer, developers have a full-function, standards-compliant SONET/SDH interface almost immediately.

Unlike many protocol stacks, NComm's TMS does not require additional development to make it work. Within minutes of bringing up the software, you have a complete interface, which can be demonstrated immediately.

Interfacing to the driver API, TMS performs all of the necessary framer, span configuration, alarming, performance monitoring, and line testing OAM functions that carriers and service providers expect. NComm's APS software functions whether the protection line is on the same framer/card or in a separate chassis. The SONET/SDH software is completely data-driven, allowing configuration of operating mode, alarm timers, and thresholds on a static or run-time basis.

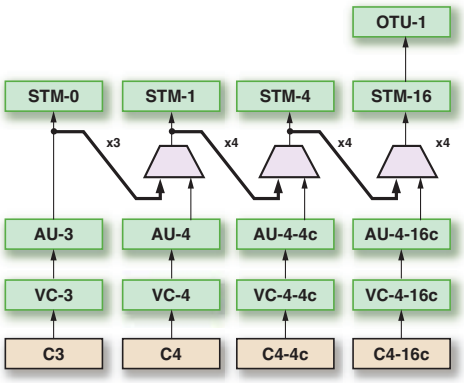

Figure 2 – SONET/SDH framing IP

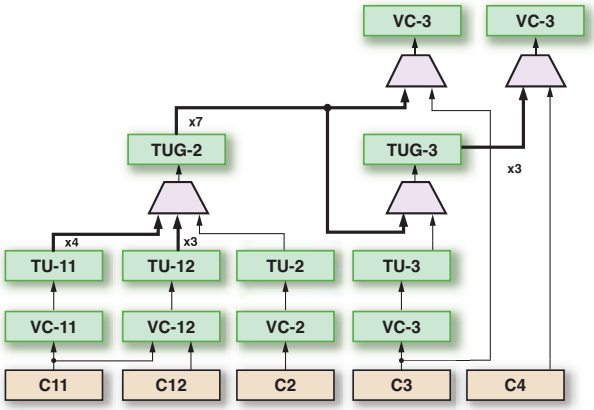

Figure 3 – SONET/SDH mapping IP

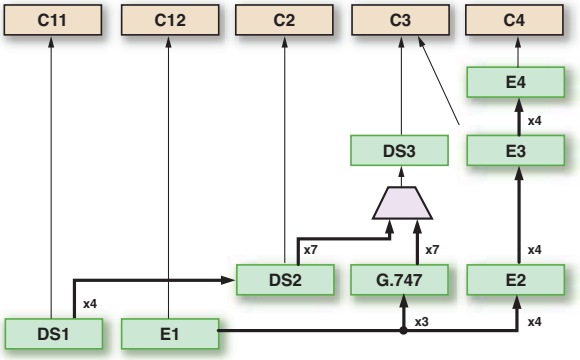

Figure 4 – PDH mapping IP

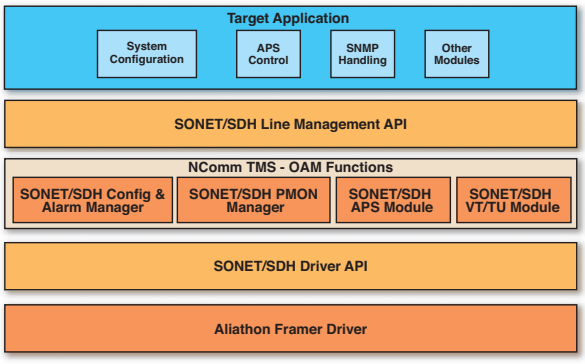

Figure 5 - Driver and OAM software

TMS is designed to work in complex, multi-technology environments where, for example, T1s are being extracted from a SONET interface using VT mapping or an M13 multiplexer. TMS handles these situations whether implemented with discrete framers and mappers or with an integrated framer/mapper.

TMS is operating system- and processor-independent. NComm offers pre-ports to the most popular operating environments: Linux (2.4/2.6), VxWorks, OSE, and Nucleus Plus. Other operating systems can typically be accommodated in a few days.

Whatever your design objectives, there is no faster, more flexible, or economical path to a robust SONET/SDH interface. NComm's TMS software coupled with Aliathon IP is a proven combination with demonstrated results.

Conclusion

SDH/SONET-based communications systems are being used ever more broadly for new applications, like triple-play services (audio, video, and data). So although many have declared that SDH/SONET will be replaced with other transport methods, this has not happened. The hardware and system software design you are creating today must be leveraged for the new developments that will inevitably occur tomorrow.

You can accomplish robust and scalable SONET/SDH framer designs from the pre-validated IP, drivers, and application software from Aliathon and NComm. Let us know if we can help you reach your next framer design goals. For more information, visit *www.aliathon.com* or *www.ncomm.com.*