OPTICAL·INTERNETWORKING·FORUM

OIF Very Short Reach (VSR) Interface Implementation Agreements

Abstract: *This paper describes the work of the OIF on definition of Very Short Reach Interfaces to connect network elements in the emerging optical internetwork, beginning with the motivation for this work.*

1. The Need for Optical Interconnection

The last few years have seen an explosive growth in demand for bandwidth, leading to the rise of optical internetworking. As a result, large numbers of network elements have been, and continue to be, deployed in carrier networks. These systems span multiple layers of the OSI protocol stack, and include IP routers, MPLS, ATM, and Frame Relay switches, as well as optical crossconnects (OXC's) and transport platforms such as wavelength division multiplexing, or WDM, systems.

Optical connections are required among these network elements within service providers' offices – typically between devices providing functionality at different network layers. These connections have typically been implemented using optical transceivers which were originally designed for connections between offices. These transceivers are designed to have performance much higher than that required for the short distances traversed within a central office, hence their cost is quite high. When the number of optical connections was relatively small, the aggregate impact of these high-cost modules had little impact on overall network economics.

However, as the number of network elements in nodes has proliferated, so has the number of optical connections amongst them, making the cost impact of using over-designed components significant. This cost impact is most dramatic for state-of-the-art, high speed connections – at present, OC-192 (10 Gb/s). Lower-cost alternatives for these applications are therefore required. For such alternatives to bring value to service providers, however, they must be supported by a variety of industry participants, including module and equipment vendors, as well as service providers themselves – hence the need for a set of implementation agreements.

2. OIF VSR Interfaces

The OIF is leading the industry forward in defining a set of implementation agreements for very short reach (VSR) intra-office interfaces using the OC-192 rate and format (10 Gbps). For this application, unlike longer-reach interfaces, it is not mandatory that the OC-192 signal be transferred serially between network elements. It is possible for the signal to be mapped into a number of parallel channels for transmission between systems (either over multiple fibers, or using multiple wavelengths over a single fiber), as long as it is reassembled correctly at the receiving end. In addition, a variety of different fiber types and wavelengths may be used. The choice amongst the various options must be made so as to provide sufficient performance at minimum cost to the end user, while at the same time meeting a range of other practical user requirements.

The OIF has studied a variety of possible interfaces for OC-192 VSR applications. Given the rapid rate of technology change and the wide range of customer requirements, it was not believed that a single interface definition would meet all the needs, as well as guaranteeing the lowest cost. As a result, implementation agreements (IA's) for four interface definitions have been arrived at.

The first IA (VSR-1), shown in Figure 1, uses the same lasers and multi-mode fiber (MMF) technology used in Gigabit Ethernet. It uses 12 parallel 850 nm channels in each direction, running over a pair of 12-fiber ribbons for a full duplex link. Each channel uses Vertical Cavity Surface Emitting Lasers (VCSEL's) running at a speed of 1.25 Gb/s, with a reach of 300 m using 400 MHz.km 62.5 μm fiber. The lasers and photodetectors can be fabricated and packaged in arrays, and the fiber ribbons are terminated with an MPO/MTP connector. 10 fibers carry the data, one carries CRC error correction information, and the 12th fiber carries parity of the 10 data fibers. This enables hitless correction of errors on any single fiber, including the loss of a fiber. Field termination is supported, and the link electronics automatically compensate for ribbon orientation.

The second IA (VSR-2), shown in Figure 2, is a serial 1310 nm interface with a reach of 600 m. It is based on ITU G.691, and uses uncooled 1310 nm Fabry-Perot lasers or other devices producing a similar optical output. This solution allows increased dispersion and reduced reach compared with existing SONET Short Reach (SR) interfaces, with the intent of enabling lower cost devices. VSR-2 is compatible with existing installed fiber within central offices, and allows links to traverse very large installations with relatively low fiber costs.

The third VSR interface (VSR-3) is shown in Figure 3. Like VSR-1, it utilizes 850 nm VCSEL's and multimode ribbon fiber technology. It uses one 12-fiber ribbon per full duplex link, with 4 fibers transmitting at 2.5 Gb/s in each direction, and 4 fibers remaining unused. This solution has a reach of 300 m, using 500 MHz.km 50 μm fiber. As with VSR-1, the lasers and photodetectors can be fabricated in arrays, and the fiber ribbon is terminated with an MPO/MTP connector. By using only a single parallel fiber ribbon, VSR-3 reduces cable costs for larger central offices, while still allowing the use of relatively low speed components.

VSR-4 is shown in Figure 4. It uses 850 nm VCSEL's operating serially at 10 Gb/s over a pair of multimode fibers to achieve a full duplex link. It has a reach of 85 m using 500 MHz.km 50 μm fiber, or 300 m over 2000 MHz.km 50 μm fiber. The relaxed alignment tolerances of MMF, use of a single laser and detector, and the use of VCSEL's make this a potentially low-cost serial solution.

The four VSR interface solutions described above are believed to cover the range of requirements and applications faced by service providers within their network nodes. At the same time, they offer a range of technology choices, providing equipment vendors and service providers one or more low cost solutions, regardless of how technology and cost curves evolve over time.

	Reach	Fiber Type	Number of Fibers (Half duplex)	Laser Type	Wavelength
VSR-1	300 m	MMF	12	VCSEL	850 nm
VSR-2	600 m	SMF	1	FP	1310 nm
VSR-3	300 m	MMF	4	VCSEL	850 nm
VSR-4	300 m	MMF	1	VCSEL	850 nm

Table 1 Comparison of OIF Implementation Agreements.

In addition to the VSR IA's, common electrical interfaces have also been defined (and IA's reached) for connecting the electronic chips used in implementing the interfaces. SFI-4 defines a common electrical interface between OC-192 framers and serializer/deserializer (serdes) chips, while SPI-4 defines the interface between framers and chips performing higher-layer functions. These are described elsewhere.

At the request of service provider members, additional work is currently underway within the OIF to define an enhanced serial VSR interface that would support intervening patch panels and transparent optical devices, such as photonic crossconnects (PXC's). In order to support PXC's currently available or in development, and to use PXC ports efficiently, this solution will have to use a single pair of SMF's, and a wavelength in the 1310 or 1550 nm regions. Additionally, it will have a higher loss budget than currently defined in VSR-2. This solution will help address service provider needs into the future.

In addition to defining optical and electrical interfaces, the OIF is investigating the definition of a common footprint and pin definition for VSR modules. This would simplify design of systems by allowing interchangeability of VSR solutions, reducing time to market, as well as development and supply chain costs.

3. Future Optical Interface Work

While OC-192 interfaces presently represent the state-of-the-art in optical networking, OC-768 links (40 Gb/s) are expected to appear in the market and see widespread deployment over the next several years. The OIF has therefore initiated work towards a set of implementation agreements for 40 Gb/s VSR interfaces, with the intention of having a low-cost interface (or set thereof) defined by the time 40 Gb/s systems begin to enter mass deployment.

Optical internetworking is in its infancy, both technologically and as a business. As such, both technology and requirements are expected to change rapidly and continually. Thus, a simple one-time definition of a set of interfaces is insufficient to meet industry needs. Rather, ongoing work is required to ensure that the needs of industry members continue to be met as networks and technology evolve. As a forum which brings together service providers, equipment vendors, and manufacturers of modules and components, the OIF is uniquely positioned to meet these needs.

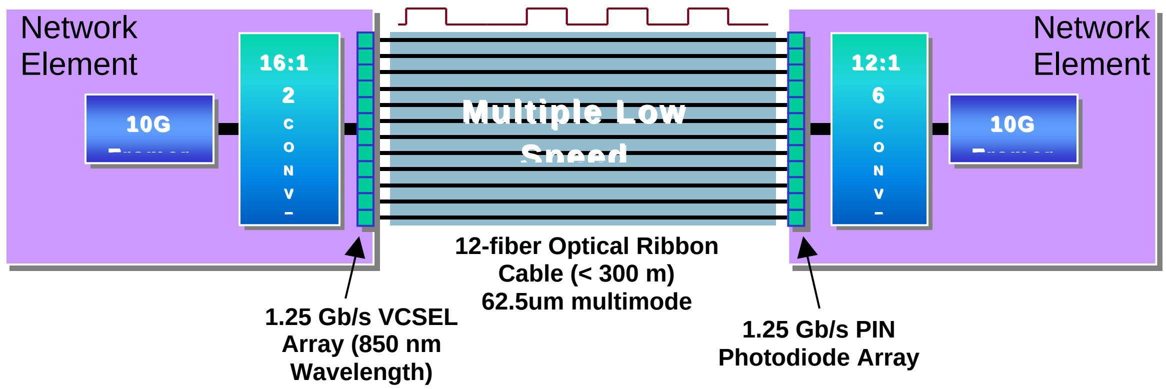

Figure 1 VSR-1: 12-fiber optical link between two network elements. Only one half of a full-duplex link is shown.

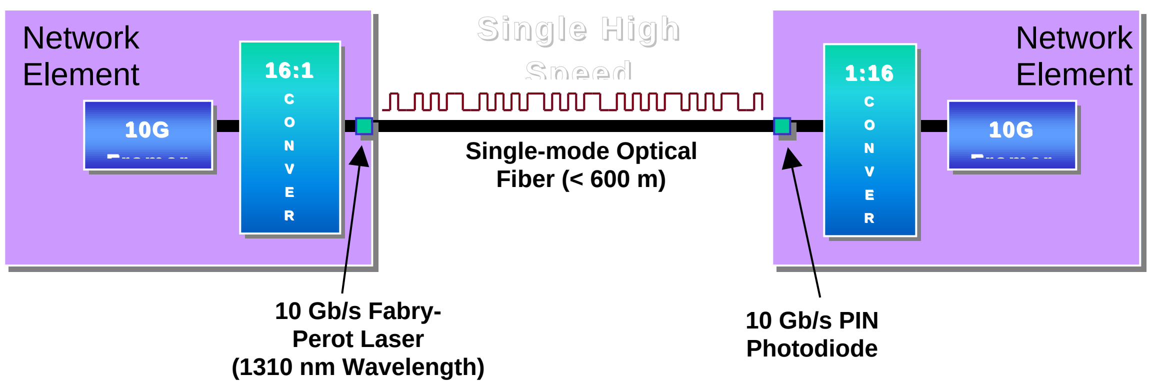

Figure 2 1310 nm serial SMF VSR optical link (VSR-2) between two network elements. Only one half of a full-duplex link is shown.

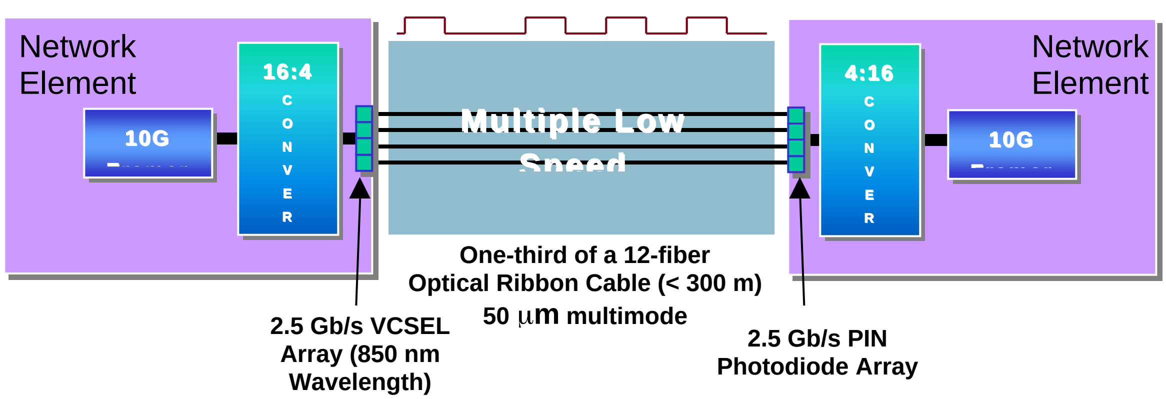

Figure 3 4-fiber parallel VSR optical link (VSR-3) between two network elements. Only one half of a full-duplex link is shown.

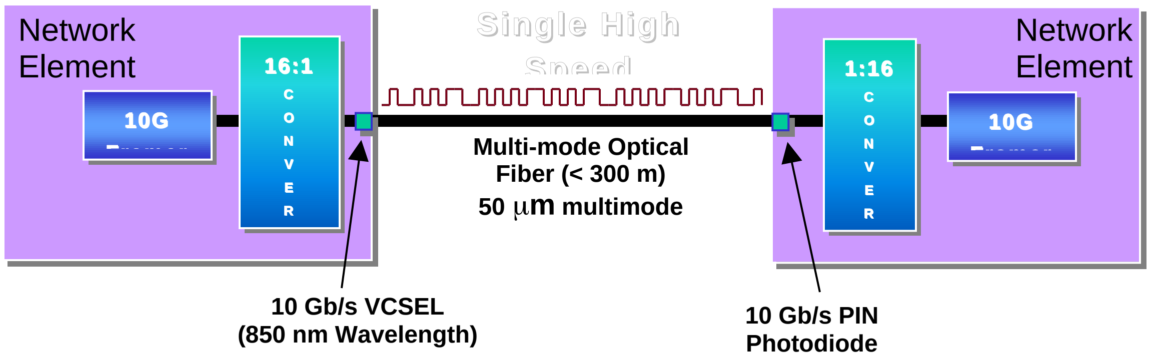

Figure 4 4-fiber parallel VSR optical link (VSR-3) between two network elements. Only one half of a full-duplex link is shown.

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