Product Overview
SONET/SDH is a widely deployed, mature enabling technology used in providing high-speed, large-scale IP networks. This dependable technology combines high-bandwidth capacity with efficient link utilization, making it a major building block for accommodating a fast growing IP infrastructure both in the core and on the edge.

As demand for more bandwidth increases, so does the demand to build out new, state-of-the-art IP infrastructures to achieve greater backbone throughput and faster network response times. Juniper Networks is at the forefront of IP infrastructure build-out with its feature-rich offering of high speed OC-192c/STM-64 and OC-768c/STM-256 SONET PICs.

Product Description
The Juniper Networks® high-speed SONET/SDH PIC modules support rich packet processing, multiple IP services, and uncompromising performance while offering market-leading port density and flexibility. These modules provide IP-over-SONET/SDH optical connectivity to backbone and access circuits.

SONET/SDH PICs support SONET Automatic Protection Switching (APS), SDH Multiplexer Switching Protection (MSP), MPLS fast reroute, and link aggregation. Additionally, these PICs support filtering, sampling, load balancing, rate limiting, class of service (CoS), and other key features necessary for deploying secure, dependable, high-performance IP services.

Architecture and Key Components

Automatic Protection Switching
The SONET/SDH PICs support APS 1+1 switching (bidirectional), which enables two routers and a SONET add/drop multiplexer (ADM) to communicate. This functionality ensures a secondary path in the case of a router-to-ADM circuit failure, interface failure or router failure. This functionality is interoperable with any ADM that uses GR-253-CORE-style signaling (K1/K2). In addition to the automatic switchover, service providers can manually initiate the switchover.

MPLS Fast Reroute
MPLS fast reroute provides fast recovery if any circuit or router along a predetermined MPLS path, known as the label-switched path (LSP), fails. Each router along the LSP computes a standby detour path that avoids its downstream hop. If a circuit fails, the nearest upstream router automatically activates the detour paths.

Link Aggregation
Link aggregation is the ability to bundle together a set of ports configured with the same speed in full-duplex mode into a virtual link, thereby supporting simultaneous parallel physical links between Juniper Networks platforms. Service providers can configure up to 16 links per group and 16 groups per chassis. If a link goes down, the traffic is redistributed among the remaining links, thereby improving network reliability.
Features and Benefits

The Juniper Networks high-speed SONET/SDH PICs comprise the following:

- 1-port OC192c/STM64 with fixed Very Short Reach (VSR) optics
- 1-port OC192c/STM64 with pluggable XFP optics
- 4-port OC192c/STM64 with pluggable XFP optics
- 1-port OC768c/STM256 with fixed Short Reach (SR) optics

The 4-port OC-192c PIC supports both a four-fiber and a single-fiber solution. In the four-fiber solution, each fiber carries the OC-192 frames; in the single-fiber solution, an external passive multiplexer is used to aggregate the four data streams onto one fiber to carry OC-768 frames. For a detailed discussion on this PIC, please refer to the 4-port OC-192 PIC datasheet.

### Feature

<table>
<thead>
<tr>
<th>Feature Description</th>
<th>Benefit</th>
</tr>
</thead>
</table>
| Predictable performance and consistent service-enabling features across all M Series Multiservice Edge Routers and T Series Core Routers PICs | • Increases service reliability  
• Simplifies configuration  
• Accelerates deployment time  
• Reduces operational complexity  
• Decreases operational costs  
• Minimizes training time for operational staff |
| High-density interfaces with the ability to mix and match up to four PICs within a single Flexible PIC Concentrator (FPC) slot | • Increases configuration flexibility by enabling service providers to mix different speeds, technologies and IP services  
• Enables service providers to add uplink interfaces without wholly consuming an FPC slot  
• Reduces operational costs by maximizing Point of Presence (POP) space. |
| SONET APS, SDH MSP and MPLS fast reroute protection mechanisms | • Increases network reliability with under 50 ms failover |
| Link aggregation | • Increases performance by multiplying available bandwidth  
• Provides link redundancy  
• Increases scalability using existing SONET/SDH technology to provide additional bandwidth |

### Port Density and Flexibility

<table>
<thead>
<tr>
<th>Platform</th>
<th>OC-192c/STM-64</th>
<th>OC-768/STM-256</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-port</td>
<td>4-port</td>
</tr>
<tr>
<td>M120</td>
<td>6</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>–</td>
</tr>
<tr>
<td>M320</td>
<td>16</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>–</td>
</tr>
<tr>
<td>T320</td>
<td>16</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>–</td>
</tr>
<tr>
<td>T640</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>T1600/T4000</td>
<td>32</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>64</td>
<td>128</td>
</tr>
</tbody>
</table>

### Specifications

- 9,192-byte maximum transmission unit (MTU)

### Encapsulation

- Cisco High-level Data Link Control (cHDLC)
- Point-to-Point Protocol (PPP)
- MPLS circuit cross-connect (CCC)
- MPLS translational cross-connect (TCC)
- Frame Relay
- MPLS

### LEDs

- Off – PIC not enabled
- Green – online with no alarms or failures
- Amber – online with alarms for remote failures
- Red – active with a local alarm; router has detected a failure

### Agency Approvals

**EMC**

- AS 3548 Class A (Australia)
- EN55022 Class A (Europe)
- FCC Class A (USA)
- VCCI Class A (Japan)
- BSMi Class A (Taiwan)
### Immunity
- EN-61000-3-2 Power Line Harmonics
- EN-61000-4-2 ESD
- EN-61000-4-3 Radiated Immunity
- EN-61000-4-4 EFT
- EN-61000-4-5 Surge
- EN-61000-4-6 Low Frequency Common Immunity
- EN-61000-4-11 Voltage Dips and Sags
- ETS-300386-2 Switching Equipment

### NEBS
- SR-3580 NEBS Criteria Levels
- GR-63-CORE: NEBS, Physical Protection
- GR-1089-CORE: EMC and Electrical Safety for Network Telecommunications Equipment

### Alarms
#### SONET Alarms
- Alarm indication signal—line (AIS-L)
- Alarm indication signal—path (AIS-P)
- Bit error rate signal degrade (BERR-SD)
- Bit error rate signal fail (BERR-SF)
- Bit interleaved parity (BIP) error B1
- Bit interleaved parity (BIP) error B2
- Bit interleaved parity (BIP) error B3
- Loss of frame (LOF)
- Loss of pointer (LOP-P)
- Loss of signal (LOS)
- Far-end bit error: remote error indication—line (REI-L) (CV-LFE)

#### SDH Alarms
- Multiplex section alarm indication signal (MS-AIS)
- Administrative unit alarm indication signal (AU-AIS)
- Bit error rate signal degrade (BERR-SD)
- Bit error rate signal fail (BERR-SF)
- Bit interleaved parity (BIP) error B1
- Bit interleaved parity (BIP) error B2
- Bit interleaved parity (BIP) error B3
- Loss of frame (LOF)
- Loss of pointer (HP-LOP)
- Loss of signal (LOS)
- Multiplex section remote error indication (MS-REI)
- Higher path label mismatch (HP-PLM)
- Higher path unequipped (HP-UNEQ)
- Multiplex section remote defect indication (MS-RDI)
- Higher path remote defect indication (HP-RDI)
- Errored seconds (ES-S, ES-L, ES-P), far-end errored seconds (ES-LFE, ES-PFE), far-end severely errored seconds (SES-LFE, SES-PFE), far-end unavailable seconds (UAS-LFE, UAS-PFE)
- Severely errored framing (SEF), severely errored framing seconds (SEFS-S), severely errored seconds (SES-S, SES-L, SES-P), unavailable seconds (UAS-L, UAS-P)

### Table

<table>
<thead>
<tr>
<th>Transceiver</th>
<th>OC-192c/STM-64 1-port</th>
<th>OC-192c/STM-64 with XFP 1-port and 4-port</th>
<th>OC-768c/STM-256 1-port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transceiver model number</td>
<td>N/A</td>
<td>XFP-10G-L-OC192-SR1</td>
<td>XFP-10G-E-OC192-IR2</td>
</tr>
<tr>
<td>Transceiver type</td>
<td>Fixed</td>
<td>XFP</td>
<td>XFP</td>
</tr>
<tr>
<td>Standard</td>
<td>OIF VSR4-1</td>
<td>Telcordia GR-253 OC192 SR1</td>
<td>Telcordia GR-253 OC192 SR1</td>
</tr>
<tr>
<td>Maximum distance</td>
<td>MMF cable: 984.25 feet/300 m</td>
<td>SMF cable: 6.21 miles/10 km</td>
<td>SMF cable: 24.8 miles/40 km</td>
</tr>
<tr>
<td>Transmitter wavelength</td>
<td>830 nm through 860 nm</td>
<td>1290 nm through 1330 nm</td>
<td>1530 nm through 1565 nm</td>
</tr>
<tr>
<td>Average launch power</td>
<td>–10 through –3 dBm</td>
<td>–6 through –1 dBm</td>
<td>–1.0 through 2 dBm</td>
</tr>
<tr>
<td>Receiver saturation</td>
<td>–3 dBm</td>
<td>–1.0 dBm</td>
<td>–1.0 dBm</td>
</tr>
<tr>
<td>Receiver sensitivity</td>
<td>–16 dBm</td>
<td>–11 dBm</td>
<td>–14 dBm</td>
</tr>
</tbody>
</table>
Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit www.juniper.net/us/en/products-services.

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.

Ordering Information

<table>
<thead>
<tr>
<th>Model Number</th>
<th>PIC</th>
<th>Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC-192c/STM-64</td>
<td>M120-cFPC-10C192-XFP</td>
<td>M120</td>
</tr>
<tr>
<td></td>
<td>PC-10C192-SON-VSR</td>
<td>M120, M320, T320, T640, T1600, T4000</td>
</tr>
<tr>
<td></td>
<td>PD-10C192-SON-XFP</td>
<td>M120, M320, T320, T640, T1600, T4000</td>
</tr>
<tr>
<td></td>
<td>PD-4OC192-SON-XFP</td>
<td>T640, T1600, T4000</td>
</tr>
</tbody>
</table>

OC-768c/STM-256

<table>
<thead>
<tr>
<th>Model Number</th>
<th>PIC</th>
<th>Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD-1OC768-SON-SR</td>
<td>1-port, single-mode, short reach fixed optics</td>
<td>T640, T1600, T4000</td>
</tr>
</tbody>
</table>

Optical Modules Options

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC-192c/STM-64</td>
<td>OC-192 XFP, 1290 nm through 1330 nm, 10 km reach, single-mode</td>
</tr>
<tr>
<td>XFP-10G-L-OC192-SR1</td>
<td>OC-192 XFP, 1530 nm through 1565 nm, 40 km reach, single-mode</td>
</tr>
<tr>
<td>XFP-10G-Z-OC192-LR2</td>
<td>OC-192 XFP, 1530 nm through 1565 nm, 80 km reach, single-mode</td>
</tr>
</tbody>
</table>