Solarflare® Server Adapter User Guide

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The Product is not intended for use in medical, life saving, life sustaining, critical control or safety systems, or in nuclear facility applications.

A list of patents associated with this product is at http://www.solarflare.com/patent

SF-103837-CD

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1

Introduction

This is the User Guide for Solarflare® Server Adapters. This chapter covers the following topics:

- Virtual NIC Interface on page 1
- Advanced Features and Benefits on page 2
- Product Specifications on page 4
- Software Driver Support on page 16
- Solarflare AppFlex™ Technology Licensing. on page 17
- Open Source Licenses on page 17
- Support and Download on page 18
- Regulatory Information on page 19
- Regulatory Approval on page 21

**NOTE:** Throughout this guide the term Onload refers to both OpenOnload® and EnterpriseOnload® unless otherwise stated. Users of Onload should refer to the Onload User Guide, SF-104474-CD, which describes procedures for download and installation of the Onload distribution, accelerating and tuning the application using Onload to achieve minimum latency and maximum throughput.

1.1 Virtual NIC Interface

Solarflare’s VNIC architecture provides the key to efficient server I/O and is flexible enough to be applied to multiple server deployment scenarios. These deployment scenarios include:

- **Kernel Driver** – This deployment uses an instance of a VNIC per CPU core for standard operating system drivers. This allows network processing to continue over multiple CPU cores in parallel. The virtual interface provides a performance-optimized path for the kernel TCP/IP stack and contention-free access from the driver, resulting in extremely low latency and reduced CPU utilization.

- **Accelerated Virtual I/O** – The second deployment scenario greatly improves I/O for virtualized platforms. The VNIC architecture can provide a VNIC per Virtual Machine, giving over a thousand protected interfaces to the host system, granting any virtualized (guest) operating system direct access to the network hardware. Solarflare's hybrid SR-IOV technology, unique to Solarflare
Ethernet controllers, is the only way to provide bare-metal I/O performance to virtualized guest operating systems whilst retaining the ability to live migrate virtual machines.

- **OpenOnload™** – The third deployment scenario aims to leverage the host CPU(s) to full capacity, minimizing software overheads by using a VNIC per application to provide a kernel bypass solution. Solarflare has created both an open-source and Enterprise class high-performance application accelerator that delivers lower and more predictable latency and higher message rates for TCP and UDP-based applications, all with no need to modify applications or change the network infrastructure. To learn more about the open source OpenOnload project or EnterpriseOnload, download the Onload user guide (SF-104474-CD) or contact your reseller.

### Advanced Features and Benefits

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virtual NIC support</strong></td>
<td>The core of Solarflare technology. Protected VNIC interfaces can be instantiated for each running guest operating system or application, giving it a direct pipeline to the Ethernet network. This architecture provides the most efficient way to maximize network and CPU efficiency. The Solarflare Ethernet controller supports up to 1024 vNIC interfaces per port. On IBM System p servers equipped with Solarflare adapters, each adapter is assigned to a single Logical Partition (LPAR) where all VNICS are available to the LPAR.</td>
</tr>
<tr>
<td><strong>PCI Express</strong></td>
<td>Implements PCI Express 3.1.</td>
</tr>
<tr>
<td><strong>High Performance</strong></td>
<td>Support for 40G Ethernet interfaces and a new internal datapath micro architecture.</td>
</tr>
<tr>
<td><strong>Hardware Switch Fabric</strong></td>
<td>Full hardware switch fabric in silicon capable of steering any flow based on Layer 2, Layer 3 or application level protocols between physical and virtual interfaces. Supporting an open software defined network control plane with full PCI-IOV virtualization acceleration for high performance guest operating systems and virtual applications.</td>
</tr>
<tr>
<td><strong>Improved flow processing</strong></td>
<td>The addition of dedicated parsing, filtering, traffic shaping and flow steering engines which are capable of operating flexibly and with an optimal combination of a full hardware data plane with software based control plane.</td>
</tr>
<tr>
<td>TX PIO</td>
<td>Transmit Programmed input/output is the direct transfer of data to the adapter without CPU involvement. As an alternative to the usual bus master DMA method, TX PIO improves latency and is especially useful for smaller packets.</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Multicast Replication</td>
<td>Received multicast packets are replicated in hardware and delivered to multiple receive queues.</td>
</tr>
</tbody>
</table>
| Sideband management | NCSI RMII interface for base board management integration.  
|                    | SMBus interface for legacy base board management integration.                                                                                                                                       |
| PCI Single-Root-IOV, SR-IOV, capable | 16 Physical functions and up to 240 Virtual functions per adapter.  
|                    | Flexible deployment of 1024 channels between Virtual and Physical Functions.  
|                    | Support Alternate Routing ID (ARI).  
|                    | SR-IOV is not supported for Solarflare adapters on IBM System p servers.                                                                                                                                 |
| 10 Gigabit Ethernet | Supports the ability to design a cost effective, high performance 10 Gigabit Ethernet solution.                                                                                                    |
| Receive Side Scaling (RSS) | IPv4 and IPv6 RSS raises the utilization levels of multi-core servers dramatically by distributing I/O load across all CPUs and cores.                                                                 |
| Stateless offloads | Through the addition of hardware based TCP segmentation and reassembly offloads, VLAN, VxLAN, NVGRE and GENEVE offloads.                                                                                             |
| Jumbo frame support | Support for up to 9216 byte jumbo frames.                                                                                                                                                           |
| MSI-X support | 2048 MSI-X interrupt support enables higher levels of performance.  
|                    | Can also work with MSI or legacy line based interrupts.                                                                                                                                              |
| Ultra low latency | Cut through architecture. < 7µs end to end latency with standard kernel drivers, < 3µs with Onload drivers.                                                                                             |
### Remote boot
Support for PXE boot 2.1 and UEFI Boot provides flexibility in cluster design and diskless servers (see Solarflare Boot Manager on page 371).

Network boot is not supported for Solarflare adapters on IBM System p servers.

### MAC address filtering
Enables the hardware to steer packets based on the MAC address to a VNIC.

### Hardware timestamps
The Solarflare Flareon™ SFN7000 and XtremeScale™ SFN8000 series adapters can support hardware timestamping for all packets, sent and received - including PTP.

The adapters incorporate a highly accurate stratum 3 compliant oscillator with drift of 0.37 PPM per day (c. 32ms/day).

The SFN6322F adapter can generate hardware timestamps of PTP packets.

## 1.2 Product Specifications

### Solarflare XtremeScale™ Network Adapters

#### Solarflare XtremeScale™ SFN8722 Dual-Port 10GbE SFP+ PCIe 3.1 OCP Server Adapter

<table>
<thead>
<tr>
<th>Part numbers</th>
<th>SFN8722</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9240</td>
</tr>
<tr>
<td>Power</td>
<td>10.5W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3.1 (8.0GT/s)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled for the Onload and Plus versions)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Yes (factory enabled for the Plus version)</td>
</tr>
<tr>
<td>1PPS</td>
<td>No</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>
## Solarflare XtremeScale™ SFN8542 Dual-Port 40GbE QSFP+ PCIe 3.1 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part numbers</th>
<th>SFN8542 or SFN8542-Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9240</td>
</tr>
<tr>
<td>Power</td>
<td>12.5W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>16 lanes Gen 3.1 (8.0GT/s), x16 edge connector</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled for the Plus version)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Yes (factory enabled for the Plus version)</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x QSFP+ (40G/10G)</td>
</tr>
</tbody>
</table>

## Solarflare XtremeScale™ SFN8522 Dual-Port 10GbE SFP+ PCIe 3.1 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part numbers</th>
<th>SFN8522, SFN8522-Onload, or SFN8522-Plus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9240</td>
</tr>
<tr>
<td>Power</td>
<td>10.5W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3.1 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled for the Onload and Plus versions)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Yes (factory enabled for the Plus version)</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>
## Solarflare Flareon™ Network Adapters

### Solarflare Flareon™ Ultra SFN7322F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7322F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9120</td>
</tr>
<tr>
<td>Power</td>
<td>5.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Yes (factory enabled)</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

### Solarflare Flareon™ Ultra SFN7142Q Dual-Port 40GbE QSFP+ PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7142Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9140</td>
</tr>
<tr>
<td>Power</td>
<td>13W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x QSFP+ (40G/10G)</td>
</tr>
</tbody>
</table>
### Solarflare Flareon™ Ultra SFN7124F Quad-Port 10GbE SFP+ PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7124F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9140</td>
</tr>
<tr>
<td>Power</td>
<td>13W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>4 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

### Solarflare Flareon™ Ultra SFN7122F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7122F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9120</td>
</tr>
<tr>
<td>Power</td>
<td>5.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>1Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts.</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes (factory enabled)</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>AppFlex™ license required</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>
## Solarflare Flareon™ SFN7042Q Dual-Port 40GbE QSFP+ PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7042Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9140</td>
</tr>
<tr>
<td>Power</td>
<td>13W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x QSFP+ (40G/10G)</td>
</tr>
</tbody>
</table>

## Solarflare Flareon™ Ultra SFN7024F Quad-Port 10GbE SFP+ PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7024F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9140</td>
</tr>
<tr>
<td>Power</td>
<td>13W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>No</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>4 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>
### Solarflare Flareon™ Ultra SFN7022F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7022F</th>
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</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9120</td>
</tr>
<tr>
<td>Power</td>
<td>5.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts.</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed.</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

### Solarflare Flareon™ SFN7004F Quad-Port 10GbE SFP+ PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7004F</th>
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</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9140</td>
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<tr>
<td>Power</td>
<td>13W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>No</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>4 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>
### Solarflare Flareon™ SFN7002F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN7002F</th>
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</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9120</td>
</tr>
<tr>
<td>Power</td>
<td>5.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen 3 (8.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>PCIe features support</td>
<td>Per adapter: 16 PF, 240 VF, 2048 VI, 2048 MSI-X Interrupts.</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>PTP and hardware timestamps</td>
<td>Enabled by installing AppFlex license</td>
</tr>
<tr>
<td>1PPS</td>
<td>Optional bracket and cable assembly – not factory installed.</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

### Solarflare Onload Network Adapters

#### Solarflare SFA6902F Dual-Port 10GbE SFP+ ApplicationOnload™ Engine

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFA6902F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>25W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>
# Solarflare SFN6322F Dual-Port 10GbE SFP+ Server Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN6122F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>5.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

# Solarflare SFN6122F Dual-Port 10GbE SFP+ Server Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN6122F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>5.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes¹</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
<tr>
<td>Regulatory Product Code</td>
<td>S6102</td>
</tr>
</tbody>
</table>

¹. SR-IOV is not supported for Solarflare adapters on IBM System p servers.
### Solarflare SFN5122F Dual-Port 10G SFP+ Server Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN5122F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>4.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

### Solarflare SFN5121T Dual-Port 10GBASE-T Server Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN5121T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFL9021</td>
</tr>
<tr>
<td>Power</td>
<td>12.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x 10GBASE-T (10G/1G/100M)</td>
</tr>
</tbody>
</table>
Solarflare Performant Network Adapters

**Solarflare SFN5162F Dual-Port 10G SFP+ Server Adapter**

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN5162F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>4.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>No</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes(^1)</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x SFP+ (10G/1G)</td>
</tr>
</tbody>
</table>

1. SR-IOV is not supported for Solarflare adapters on IBM System p servers.

**Solarflare SFN5161T Dual-Port 10GBASE-T Server Adapter**

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN5161T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFL9021</td>
</tr>
<tr>
<td>Power</td>
<td>12.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots)</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>No</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Network ports</td>
<td>2 x 10GBASE-T (10G/1G/100M)</td>
</tr>
</tbody>
</table>
Solarflare Mezzanine Adapters

**Solarflare SFN6832F Dual-Port 10GbE SFP+ Mezzanine Adapter**

| Part number | SFN6832F-C61 for DELL PowerEdge C6100 series  
|            | SFN6832F-C62 for DELL PowerEdge C6200 series  
| Controller silicon | SFC9020  
| Power | 5.9W typical  
| PCI Express | 8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port  
| Virtual NIC support | 1024 vNIC interfaces per port  
| Supports OpenOnload | Yes  
| SR-IOV | Yes  
| Ports | 2 x SFP+ (10G/1G)  
| Regulatory Product Code | S6930  

**Solarflare SFN6822F Dual-Port 10GbE SFP+ FlexibleLOM Onload Server Adapter**

| Part number | SFN6822F  
| Controller silicon | SFC9020  
| Power | 5.9W typical  
| PCI Express | 8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port  
| Virtual NIC support | 1024 vNIC interfaces per port  
| Supports OpenOnload | Yes  
| SR-IOV | Yes  
| Ports | 2 x SFP+ (10G/1G)  

## Solarflare SFN5814H Quad-Port 10G Ethernet Mezzanine Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN5814H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>2 x SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>7.9W typical</td>
</tr>
<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Ports</td>
<td>4 x 10GBASE-KX4 backplane transmission</td>
</tr>
</tbody>
</table>

## Solarflare SFN5812H Dual-Port 10G Ethernet Mezzanine Adapter

<table>
<thead>
<tr>
<th>Part number</th>
<th>SFN5812H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller silicon</td>
<td>SFC9020</td>
</tr>
<tr>
<td>Power</td>
<td>3.9W typical</td>
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<tr>
<td>PCI Express</td>
<td>8 lanes Gen2 (5.0GT/s), x8 edge connector (usable in x8 and x16 slots), 127 SR-IOV virtual functions per port</td>
</tr>
<tr>
<td>Virtual NIC support</td>
<td>1024 vNIC interfaces per port</td>
</tr>
<tr>
<td>Supports OpenOnload</td>
<td>Yes</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Yes</td>
</tr>
<tr>
<td>Ports</td>
<td>2 x 10GBASE-KX4 backplane transmission</td>
</tr>
</tbody>
</table>
1.3 Software Driver Support

The software driver is currently supported on the following distributions:

- Windows® Server 2008, R2 only.
- Windows® Server 2012, including R2.
- Red Hat Enterprise Linux 6 (6.5 or later)
- Red Hat Messaging Realtime and Grid 2 update 5
- Red Hat Enterprise Linux 7.x
- Red Hat Enterprise Linux for Realtime 7.x
- SUSE Linux Enterprise Server 11 (SP3 or later), and 12 (base release).
- SUSE Linux Enterprise Real Time 11 (SP3 or later).
- Ubuntu 14.04 LTS, 14.10, 15.04, 15.10 and 16.04 LTS.
- Debian 7.x and 8.x.
- FreeBSD 10.x.
- VMware® ESX™ 5.0, ESXi™ 5.1, 5.5 and 6.0.
- Linux® KVM.

Support includes all minor updates/releases/service packs of the above major releases, for which the distributor has not yet declared end of life/support.

Solarflare are not aware of any issues preventing building and installing the driver on other Linux variants that use kernel versions 2.6.18 - 4.11 inclusive.

Solarflare SFN6122F and SFN5162Fadapters are supported on the IBM POWER architecture (PPC64) running RHEL 6.4 on IBM System p servers.

The Solarflare accelerated network middleware, OpenOnload and EnterpriseOnload, is supported on all Linux, Ubuntu, and Debian variants listed above, and is available for all Solarflare Onload network adapters. Solarflare are not aware of any issues preventing OpenOnload installation on other Linux variants such as Centos and Fedora.
1.4 Solarflare AppFlex™ Technology Licensing.

Solarflare AppFlex technology allows Solarflare server adapters to be selectively configured to enable on-board applications. AppFlex licenses are required to enable selected functionality on the Solarflare XtremeScale™ and Flareon™ adapters and on the AOE ApplicationOnload™ Engine.

Customers can obtain access to AppFlex applications via their Solarflare sales channel by obtaining the corresponding AppFlex authorization code. The authorization code allows the customer to generate licenses at the MyAppFlex page at https://support.solarflare.com/myappflex.

The sfkey utility application is used to install the generated license key file on selected adapters. For detailed instructions for sfkey and license installation refer to License Install with sfkey on page 97.

1.5 Open Source Licenses

Solarflare Boot Manager

The Solarflare Boot Manager is installed in the adapter’s flash memory. This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.
Controller Firmware

The firmware running on the SFC9xxx controller includes a modified version of libcoroutine. This software is free software published under a BSD license reproduced below:

Copyright (c) 2002, 2003 Steve Dekorte
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1.6 Support and Download

Solarflare network drivers, RPM packages and documentation are available for download from https://support.solarflare.com/.

Software and documentation for OpenOnload is available from www.openonload.org.
1.7 Regulatory Information

Warnings

Do not install the Solarflare network adapter in hazardous areas where highly combustible or explosive products are stored or used without taking additional safety precautions. Do not expose the Solarflare network adapter to rain or moisture.

The Solarflare network adapter is a Class III SELV product intended only to be powered by a certified limited power source.

The equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. The equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If the equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by Solarflare Communications, the party responsible for FCC compliance, could void the user’s authority to operate the equipment.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

Underwriters Laboratory Inc ('UL') has not tested the performance or reliability of the security or signaling aspects of this product. UL has only tested for fire, shock or casualty hazards as outlined in the UL's Standard for Safety UL 60950-1. UL Certification does not cover the performance or reliability of the security or signaling aspects of this product. UL makes no representations, warranties or certifications whatsoever regarding the performance or reliability of any security or signaling related functions of this product.
Laser Devices

The laser safety of the equipment has been verified using the following certified laser device module (LDM):

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>CDRH Accession No</th>
<th>Mark of conformity</th>
<th>File No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avago Technologies</td>
<td>AFBR-703SDZ</td>
<td>9720151-072</td>
<td>TUV</td>
<td>R72071411</td>
</tr>
<tr>
<td>Finisar Corporation</td>
<td>FTLX8571D3BCL</td>
<td>9210176-094</td>
<td>TUV</td>
<td>R72080250</td>
</tr>
</tbody>
</table>

When installed in a 10Gb Ethernet network interface card from the Solarflare SFN5000, SFN6000, SFN7000 or SFN8000 series, the laser emission levels remain under Class I limits as specified in the FDA regulations for lasers, 21 CFR Part 1040.

The decision on what LDMs to use is made by the installer. For example, equipment may use one of a multiple of different LDMs depending on path length of the laser communication signal. This equipment is not basic consumer ITE.

The equipment is installed and maintained by qualified staff from the end user communications company or subcontractor of the end user organization. The end product user and/or installer are solely responsible for ensuring that the correct devices are utilized in the equipment and the equipment with LDMs installed complies with applicable laser safety requirements.
1.8 Regulatory Approval

Additional Regulatory Information for SFN8722 and SFN8542 adapters

この装置は、クラスA情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。VCCI・A

警告使用者：

這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

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产品中有害物质的名称及含量

<table>
<thead>
<tr>
<th>部件名称</th>
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<tr>
<td>ERJ-2GE series resistor</td>
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</tr>
<tr>
<td>CRCW0402 series resistor</td>
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</tr>
<tr>
<td>NC7NZ34K8X</td>
<td>x</td>
</tr>
</tbody>
</table>

本表格依据 SJ/T 11364 的规定编制。

o：表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

x：表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。
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¹ The safety assessment has been concluded on this product as a component/sub-assembly only.
Additional Regulatory Information for SFN8522 adapter.

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B 級 器 (公定電波騷動級): 這是公定電波騷動級 (B 級) 的電波傳播器，這種類型的電器會對無線電訊系統造成干擾，因此用戶可能需要採取適當的措施。

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|          |               | UL 60950-1 2nd Ed. |
|          | Canada        | CSA C22.2 60950-1-07 2nd Ed. |

| RoHS     | Europe        | Complies with EU directive 2011/65/EU |

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1. The safety assessment has been concluded on this product as a component/sub-assembly only.
Additional Regulatory Information for SFN7322F, SFN7142Q, SFN7122F, SFN7042Q, SFN7022F, SFN7002F, SFN6322F, SFN6122F and SFN5122F adapters

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Additional Regulatory Information for SFN7124F, SFN7024F and SFN7004F adapters

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Additional Regulatory Information for SFA6902F adapter

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Additional Regulatory Information for SFN6832F, SFN6822F, SFN5814H and SFN5812H adapters

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## Additional Regulatory Information for SFN5162F, SFN5161T and SFN5121T adapters

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2

Installation

This chapter covers the following topics:

- Solarflare Network Adapter Products on page 31
- Fitting a Full Height Bracket (optional) on page 33
- Inserting the Adapter in a PCI Express (PCIe) Slot on page 33
- Attaching a Cable (RJ-45) on page 34
- Attaching a Cable (SFP+) on page 35
- Supported SFP+ Cables on page 37
- Supported SFP+ 10G SR Optical Transceivers on page 39
- Supported SFP+ 10G LR Optical Transceivers on page 40
- Supported SFP 1000BASE-T Transceivers on page 44
- Supported 1G Optical Transceivers on page 45
- Supported Speed and Mode on page 45
- LED States on page 47
- Configure QSFP+ Adapter on page 48
- Single Optical Fiber - RX Configuration on page 50
- Installing the OCP Mezzanine AdapterSolarflare Mezzanine Adapters: SFN5814H and SFN5812H on page 50
- Solarflare Mezzanine Adapter SFN6832F-C61 on page 52
- Solarflare Mezzanine Adapter SFN6832F-C62 on page 54
- Solarflare Precision Time Synchronization Adapters on page 55
- Solarflare ApplicationOnload™ Engine on page 55

**CAUTION:** Servers contain high voltage electrical components. Before removing the server cover, disconnect the mains power supply to avoid the risk of electrocution.

**CAUTION:** Static electricity can damage computer components. Before handling computer components, discharge static electricity from yourself by touching a metal surface, or wear a correctly fitted anti-static wrist band.
2.1 Solarflare Network Adapter Products

**Solarflare XtremeScale™ adapters**
- Solarflare XtremeScale SFN8722 Dual-Port 10GbE SFP+ PCIe 3.1 OCP Server Adapter
- Solarflare XtremeScale SFN8542 Dual-Port 40GbE PCIe 3.1 QSFP+ Server Adapter
- Solarflare XtremeScale SFN8522 Dual-Port 10GbE PCIe 3.1 SFP+ Server Adapter

**Solarflare Flareon™ adapters**
- Solarflare Flareon Ultra SFN7322F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter
- Solarflare Flareon Ultra SFN7142Q Dual-Port 40GbE PCIe 3.0 QSFP+ Server Adapter
- Solarflare Flareon Ultra SFN7124F Quad-Port 10GbE PCIe 3.0 SFP+ Server Adapter
- Solarflare Flareon Ultra SFN7122F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter
- Solarflare Flareon SFN7042Q Dual-Port 40GbE PCIe 3.0 QSFP+ Server Adapter
- Solarflare Flareon Ultra SFN7024F Quad-Port 10GbE PCIe 3.0 SFP+ Server Adapter
- Solarflare Flareon Ultra SFN7022F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter
- Solarflare Flareon SFN7004F Quad-Port 10GbE PCIe 3.0 SFP+ Server Adapter
- Solarflare Flareon SFN7002F Dual-Port 10GbE PCIe 3.0 Server I/O Adapter.

**Solarflare Onload adapters**
- Solarflare SFA6902F Dual-Port 10GbE ApplicationOnload™ Engine
- Solarflare SFN6322F Dual-Port 10GbE Precision Time Stamping Server Adapter
- Solarflare SFN6122F Dual-Port 10GbE SFP+ Server Adapter
- Solarflare SFN5122F Dual-Port 10G SFP+ Server Adapter
- Solarflare SFN5121T Dual-Port 10GBASE-T Server Adapter.

**Solarflare Performant network adapters**
- Solarflare SFN5162F Dual-Port 10G SFP+ Server Adapter
- Solarflare SFN5161T Dual-Port 10GBASE-T Server Adapter.
Solarflare Mezzanine adapters

- Solarflare SFN6832F-C61 Dual-Port 10GbE SFP+ Mezzanine Adapter for DELL PowerEdge C6100 series servers
- Solarflare SFN6832F-C62 Dual-Port 10GbE SFP+ Mezzanine Adapter for DELL PowerEdge C6200 series servers
- Solarflare SFN6822F Dual-Port 10GbE SFP+ FlexibleLOM Onload Server Adapter
- Solarflare SFN5814H Quad-Port 10G Ethernet Mezzanine Adapter for IBM BladeCenter
- Solarflare SFN5812H Dual-Port 10G Ethernet Mezzanine Adapter for IBM BladeCenter.

Solarflare network adapters can be installed on Intel/AMD x86 based 32 bit or 64 bit servers. The network adapter must be inserted into a PCIe x8 OR PCIe x 16 slot for maximum performance. Refer to PCI Express Lane Configurations on page 233 for details.

Solarflare SFN6122F and SFN5162F adapters are supported on the IBM POWER architecture (PPC64) running RHEL 6.4 on IBM System p servers.
2.2 Fitting a Full Height Bracket (optional)

Solarflare adapters are supplied with a low-profile bracket fitted to the adapter. A full height bracket has also been supplied for PCIe slots that require this type of bracket.

To fit a full height bracket to the Solarflare adapter:

1. From the back of the adapter, remove the screws securing the bracket.
2. Slide the bracket away from the adapter.
3. Taking care not to overtighten the screws, attach the full height bracket to the adapter.

2.3 Inserting the Adapter in a PCI Express (PCIe) Slot

To insert the adapter in a PCI Express (PCIe) slot:

1. Shut down the server and unplug it from the mains. Remove the server cover to access the PCIe slots in the server.
2. Locate an 8-lane or 16-lane PCIe slot (refer to the server manual if necessary) and insert the Solarflare card.
3. Secure the adapter bracket in the slot.
4. Replace the cover and restart the server.
5 After restarting the server, the host operating system may prompt you to install drivers for the new hardware. Click Cancel or abort the installation and refer to the relevant chapter in this manual for how to install the Solarflare adapter drivers for your operating system.

2.4 Attaching a Cable (RJ-45)

Solarflare 10GBASE-T Server Adapters connect to the Ethernet network using a copper cable fitted with an RJ-45 connector (shown below).
RJ-45 Cable Specifications

Table 1 below lists the recommended cable specifications for various Ethernet port types. Depending on the intended use, attach a suitable cable. For example, to achieve 10 Gb/s performance, use a Category 6 cable. To achieve the desired performance, the adapter must be connected to a compliant link partner, such as an IEEE 802.3an-compliant gigabit switch.

Table 1: RJ-45 Cable Specification

<table>
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<th>Port type</th>
<th>Connector</th>
<th>Media Type</th>
<th>Maximum Distance</th>
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<tr>
<td>10GBASE-T</td>
<td>RJ-45</td>
<td>Category 6A</td>
<td>100m (328 ft.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Category 6 unshielded twisted pairs (UTP)</td>
<td>55m (180 ft.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Category 5E</td>
<td>55m (180 ft.)</td>
</tr>
<tr>
<td>1000BASE-T</td>
<td>RJ-45</td>
<td>Category 5E, 6, 6A UTP</td>
<td>100m (328 ft.)</td>
</tr>
<tr>
<td>100BASE-TX</td>
<td>RJ-45</td>
<td>Category 5E, 6, 6A UTP</td>
<td>100m (328 ft.)</td>
</tr>
</tbody>
</table>

2.5 Attaching a Cable (SFP+)

Solarflare SFP+ Server Adapters can be connected to the network using either an SFP+ Direct Attach cable or a fiber optic cable.

Attaching an SFP+ Direct Attach Cable

To attach an SFP+ Direct Attach cable:

1. Turn the cable so that the connector retention tab and gold fingers are on the same side as the network adapter retention clip.
2. Push the cable connector straight in to the adapter socket until it clicks into place.
**Removing an SFP+ Direct Attach Cable**

To remove an SFP+ Direct Attach cable:

1. Pull straight back on the release ring to release the cable retention tab. Alternatively, you can lift the retention clip on the adapter to free the cable if necessary.

2. Slide the cable free from the adapter socket.

**Attaching a fiber optic cable**

**WARNING:** *Do not* look directly into the fiber transceiver or cables as the laser beams can damage your eyesight.

To attach a fiber optic cable:

1. Remove and save the fiber optic connector cover.

2. Insert a fiber optic cable into the ports on the network adapter bracket as shown. Most connectors and ports are keyed for proper orientation. If the cable you are using is not keyed, check to be sure the connector is oriented properly (transmit port connected to receive port on the link partner, and vice versa).
Removing a fiber optic cable

**WARNING:** Do not look directly into the fiber transceiver or cables as the laser beams can damage your eyesight.

To remove a fiber optic cable:

1. Remove the cable from the adapter bracket and replace the fiber optic connector cover.
2. Pull the plastic or wire tab to release the adapter bracket.
3. Hold the main body of the adapter bracket and remove it from the adapter.

### 2.6 Supported SFP+ Cables

Table 2 is a list of supported SFP+ cables that have been tested by Solarflare. Solarflare is not aware of any issues preventing the use of other brands of SFP+ cables (of up to 5m in length) with Solarflare network adapters. However, only cables in the table below have been fully verified and are therefore supported.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Cable</th>
<th>Notes</th>
<th>SF N5xxx</th>
<th>SF N6xxx</th>
<th>SF N7xxx</th>
<th>SF N8xxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arista</td>
<td>CAB-SFP-SFP-1M</td>
<td>1m</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Arista</td>
<td>CAB-SFP-SFP-3M</td>
<td>3m</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Arista</td>
<td>CBL-00006-02</td>
<td>5m</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Cisco</td>
<td>SFP-H10GB-CU1M</td>
<td>1m</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Cisco</td>
<td>SFP-H10GB-CU3M</td>
<td>3m</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
The Solarflare SFA6902F adapter has been tested and certified with direct attach cables up to 3m in length.

### Table 2: Supported SFP+ Direct Attach Cables

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Cable</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco</td>
<td>SFP-H10GB-CU5M</td>
<td>5m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>HP</td>
<td>J9283A/B Procurve</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Juniper</td>
<td>EX-SFP-10GE-DAC-1m</td>
<td>1m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Juniper</td>
<td>EX-SFP-10GE-DAC-3m</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Molex</td>
<td>74752-1101</td>
<td>1m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Molex</td>
<td>74752-2301</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Molex</td>
<td>74752-3501</td>
<td>5m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Molex</td>
<td>74752-9093</td>
<td>1m</td>
<td>✔️ ✔️ ✔️ ✔️ / 0K585N</td>
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<tr>
<td>Molex</td>
<td>74752-9094</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️ / 0J564N</td>
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<td>Molex</td>
<td>74752-9096</td>
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<td>Panduit</td>
<td>PSF1PXA1M</td>
<td>1m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Panduit</td>
<td>PSF1PXA3M</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Panduit</td>
<td>PSF1PXD5MBU</td>
<td>5m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPP30-01</td>
<td>1m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPP30-02</td>
<td>2m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPP30-03</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPP24-05</td>
<td>5m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Tyco</td>
<td>2032237-2 D</td>
<td>1m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
<tr>
<td>Tyco</td>
<td>2032237-4</td>
<td>3m</td>
<td>✔️ ✔️ ✔️ ✔️</td>
</tr>
</tbody>
</table>
2.7 Supported SFP+ 10G SR Optical Transceivers

Table 3 is a list of supported SFP+10G SR optical transceivers that have been tested by Solarflare. Solarflare is not aware of any issues preventing the use of other brands of 10G SR transceivers with Solarflare network adapters. However, only transceivers in the table below have been fully verified and are therefore supported.

Table 3: Supported SFP+ 10G Optical SR Transceivers

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8xxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arista</td>
<td>SFP-10G-SR</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Arista</td>
<td>XVR-00002-02</td>
<td>10G</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-703SDZ</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-703SDDZ</td>
<td>Dual speed 1G/10G optic.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-703SMZ</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-709SMZ-SF1</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLX8571D3BCL</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>Finisar</td>
<td>FTLX8571D3BCL-SL</td>
<td>10G</td>
<td>✔️</td>
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<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Finisar</td>
<td>FTLX8571D3BCV</td>
<td>Dual speed 1G/10G optic.</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLX8574D3BCL</td>
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<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>HP</td>
<td>456096-001</td>
<td>Also labeled as 455883-B21 and 455885-001</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td>Intel</td>
<td>AFBR-703SDZ</td>
<td>10G</td>
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<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>JDSU</td>
<td>PLRXPL-SC-S43-22-N</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>JDSU</td>
<td>PLRXPL-SC-S43-SF</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Juniper</td>
<td>AFBR-700SDZ-JU1</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>MergeOptics</td>
<td>TRX10GVP2010</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Solarflare</td>
<td>SFM-10G-SR</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Vorboss</td>
<td>VBO-PXG-SR-300</td>
<td>10G</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
2.8 Supported SFP+ 10G LR Optical Transceivers

Table 4 is a list of supported SFP+10G LR optical transceivers that have been tested by Solarflare. Solarflare is not aware of any issues preventing the use of other brands of 10G LR transceivers with Solarflare network adapters. However, only transceivers in the table below have been fully verified and are therefore supported.

Table 4: Supported SFP+ 10G LR Optical Transceivers

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8xxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avago</td>
<td>AFCT-701SDZ</td>
<td>10G single mode fiber</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLX1471D3BCL</td>
<td>10G single mode fiber</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
</tbody>
</table>
2.9 QSFP+ Transceivers and Cables

The following tables identify QSFP+ transceiver modules and cables tested by Solarflare with the SFN7000 and SFN8000 series QSP+ adapters. Solarflare are not aware of any issues preventing the use of other brands of QSFP+ 40G transceivers and cables with Solarflare SFN7000 and SFN8000 series QSFP+ adapters. However, only products listed in the tables below have been fully verified and are therefore supported.

Supported QSFP+ 40GBASE-SR4 Transceivers

Solarflare Flareon Ultra SFN7000 series and XtremeScale SFN8542 QSFP+ adapters have been tested with the following QSFP+ 40GBASE-SR4 optical transceiver modules.

Table 5: Supported QSFP+ SR4 Transceivers

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8542</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arista</td>
<td>AFBR-79E4Z</td>
<td>Standard 100m (OM3 Multimode fiber) range.</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-79EADZ</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-79EIDZ</td>
<td></td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-79EQDZ</td>
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<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avago</td>
<td>AFBR-79EQPZ</td>
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<td></td>
</tr>
<tr>
<td>Finisar</td>
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<td>JDSU</td>
<td>JQP-04SWAA1</td>
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<td>JDSU</td>
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<tr>
<td>Solarflare</td>
<td>SFM-40G-SR4</td>
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</tbody>
</table>
Supported QSFP+ 40G Active Optical Cables (AOC)

Solarflare Flareon Ultra SFN7000 series and XtremeScale SFN8542 QSFP+ adapters have been tested with the following QSFP+ Active Optical Cables (AOC).

Table 6: Supported QSFP+ Active Optical Cables

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8542</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avago</td>
<td>AFBR-7QER05Z</td>
<td>3m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Finisar</td>
<td>FCBG410QB1C03</td>
<td>3m</td>
<td>✔ ✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finisar</td>
<td>FCBN410QB1C05</td>
<td>5m</td>
<td>✔</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Supported QSFP+ 40G Direct Attach Cables

Solarflare Flareon Ultra SFN7000 series and XtremeScale SFN8542 QSFP+ adapters have been tested with the following QSFP+ Direct Attach Cables (DAC). QSFP cables may not work with all switches.

Table 7: Supported QSFP+ Direct Attach Cables

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8542</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arista</td>
<td>CAB-Q-Q-3M</td>
<td>3m</td>
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<tr>
<td>Arista</td>
<td>CAB-Q-Q-5M</td>
<td>5m</td>
<td>✔</td>
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</tr>
<tr>
<td>Cisco</td>
<td>QSFP-H40G-CU3M</td>
<td>3m</td>
<td>✔ ✔</td>
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<tr>
<td>FCI</td>
<td>10093084-2010LF</td>
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<td>FCI</td>
<td>10093084-3030LF</td>
<td>3m</td>
<td>✔ ✔</td>
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<td></td>
</tr>
<tr>
<td>Molex</td>
<td>74757-1101</td>
<td>1m</td>
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</tr>
<tr>
<td>Molex</td>
<td>74757-2101</td>
<td>1m</td>
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<td></td>
</tr>
<tr>
<td>Molex</td>
<td>74757-2301</td>
<td>3m</td>
<td>✔ ✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panduit</td>
<td>40GBASE-CR4-PQSFPIXA3MBU</td>
<td>3m</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Siemon</td>
<td>QSFP30-01</td>
<td>1m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siemon</td>
<td>QSFP30-03</td>
<td>3m</td>
<td>✔ ✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siemon</td>
<td>QSFP26-05</td>
<td>5m</td>
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</table>
Supported QSFP+ to SFP+ Breakout Cables

Solarflare QSFP+ to SFP+ breakout cables enable users to connect Solarflare dual-port QSFP+ server I/O adapters to work as a quad-port SFP+ server I/O adapters. The breakout cables offer a cost-effective option to support connectivity flexibility in high-speed data center applications.

These high performance direct-attach assemblies support 2 lanes of 10 Gb/s per QSFP+ port and are available in lengths of 1 meters and 3 meters. The SOLR-QSFP2SFP-1M, -3M copper DAC cables are fully tested and compatible with the Solarflare SFN7142Q and SFN7042Q server I/O adapters. These cables are compliant with the SFF-8431, SFF-8432, SFF-8436, SFF-8472 and IBTA Volume 2 Revision 1.3 specifications.

Table 8: Supported QSFP+ to SFP+ Breakout Cables

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8542</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solarflare</td>
<td>SOLR-QSFP2SFP-1M</td>
<td>1m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solarflare</td>
<td>SOLR-QSFP2SFP-3M</td>
<td>3m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arista</td>
<td>QSFP-4SFP</td>
<td>3m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arista</td>
<td>CAB-Q-S-3M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arista</td>
<td>QSFP-4SFP</td>
<td>5m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arista</td>
<td>CAB-Q-S-5M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mellanox</td>
<td>MC2609130-003</td>
<td>3m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panduit</td>
<td>PHQ4SFPXA1MBL</td>
<td>1m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolabs</td>
<td>CU1.0M-QSFP-2SFP-NS-13-C</td>
<td>1m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolabs</td>
<td>CU1.5M-QSFP-2SFP-NS-13-C</td>
<td>1.5m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPPQSFP30-01</td>
<td>1m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPPQSFP28-03</td>
<td>3m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siemon</td>
<td>SFPPQSFP28-05</td>
<td>5m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10GTek</td>
<td>CAB-QSFP.4SFP-P1M</td>
<td>1m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10GTek</td>
<td>CAB-QSFP.4SFP-P3M</td>
<td>3m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10GTek</td>
<td>CAB-QSFP.4SFP-P5M</td>
<td>5m</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Breakout cables have been tested with the SFN8542 family of adapters. Testing is not complete on other 8000 series adapters.

2.10 Supported SFP 1000BASE-T Transceivers

Table 9 is a list of supported SFP 1000BASE-T transceivers that have been tested by Solarflare. Solarflare is not aware of any issues preventing the use of other brands of 1000BASE-T transceivers with the Solarflare network adapters. However, only transceivers in the table below have been fully verified and are therefore supported.

Table 9: Supported SFP 1000BASE-T Transceivers

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Notes</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8xxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arista</td>
<td>SFP-1G-BT</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Avago</td>
<td>ABCU-5710RZ</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Cisco</td>
<td>30-1410-03</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Dell</td>
<td>FCMJ-8521-3-(DL)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Finisar</td>
<td>FCLF-8521-3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Finisar</td>
<td>FCMJ-8521-3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Finisar</td>
<td>FCLF8522P2BTL</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>HP</td>
<td>453156-001</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td></td>
<td>453154-B21</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>3COM</td>
<td>3CSFP93</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>
2.11 Supported 1G Optical Transceivers

Table 10 is a list of supported 1G transceivers that have been tested by Solarflare. Solarflare is not aware of any issues preventing the use of other brands of 1G transceivers with Solarflare network adapters. However, only transceivers in the table below have been fully verified and are therefore supported.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Code</th>
<th>Type</th>
<th>SFN5xxx</th>
<th>SFN6xxx</th>
<th>SFN7xxx</th>
<th>SFN8xxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avago</td>
<td>AFBR-5710PZ</td>
<td>1000Base-SX</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>Cisco</td>
<td>GLC-LH-SM</td>
<td>1000Base-LX/LH</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Cisco</td>
<td>30-1299-01</td>
<td>1000Base-LX</td>
<td></td>
<td>✔️</td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLF8519P2BCL</td>
<td>1000Base-SX</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLF8519P3BNL</td>
<td>1000Base-SX</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLF1318P2BCL</td>
<td>1000Base-LX</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Finisar</td>
<td>FTLF1318P3BTL</td>
<td>1000Base-LX</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>HP</td>
<td>453153-001</td>
<td>1000Base-SX</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td></td>
<td>453151-B21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.12 Supported Speed and Mode

Solarflare network adapters support either QSFP+, SFP, SFP+ or Base-T standards.

On Base-T adapters three speeds are supported 100Mbps, 1Gbps and 10Gbps. The adapters use auto negotiation to automatically select the highest speed supported in common with the link partner.

On SFP+ adapters the SFP module (transceiver) determines the supported speeds, typically SFP modules only support a single speed. Some Solarflare SFP+ adapters support dual speed optical modules that can operate at either 1Gbps or 10Gbps. However, these modules do not auto-negotiate link speed and operate at the maximum (10G) link speed unless explicitly configured to operate at a lower speed (1G).
The tables below summarize the speeds supported by Solarflare network adapters.

### Table 11: SFN5000, SFN6000, SFN7000 and SFN8000 series SFP+/QSFP+ Adapters

<table>
<thead>
<tr>
<th>Supported Modes</th>
<th>Auto neg speed</th>
<th>Speed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSFP+ direct attach cables</td>
<td>No</td>
<td>10G or 40G</td>
<td>SFN8542, SFN7142Q, SFN7042Q</td>
</tr>
<tr>
<td>QSFP+ optical cables</td>
<td>No</td>
<td>10G or 40G</td>
<td>SFN8542, SFN7142Q, SFN7042Q</td>
</tr>
<tr>
<td>SFP+ direct attach cable</td>
<td>No</td>
<td>10G</td>
<td></td>
</tr>
<tr>
<td>SFP+ optical module (10G)</td>
<td>No</td>
<td>10G</td>
<td></td>
</tr>
<tr>
<td>SFP optical module (1G)</td>
<td>No</td>
<td>1G</td>
<td>Dual speed modules run at the maximum speed (10G) unless explicitly configured to the lower speed (1G)</td>
</tr>
<tr>
<td>SFP+ optical module (10G/1G)</td>
<td>No</td>
<td>10G or 1G</td>
<td></td>
</tr>
<tr>
<td>SFP 1000BASE-T module</td>
<td>No</td>
<td>1G</td>
<td>These modules support only 1G and will not link up at 100Mbps</td>
</tr>
</tbody>
</table>

### Table 12: SFNS161T and SFN5121T 10GBASE-T Adapters

<table>
<thead>
<tr>
<th>Supported Modes</th>
<th>Auto neg speed</th>
<th>Speed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>100Base-T</td>
<td>Yes</td>
<td>100Mbps</td>
<td>Typically the interface is set to auto negotiation speed and automatically selects the highest speed supported in common with its link partner. If the link partner is set to 100Mbps, with no autoneg, the adapter will use “parallel detection” to detect and select 100Mbps speed. If needed any of the three speeds can be explicitly configured</td>
</tr>
<tr>
<td>1000Base-TX</td>
<td>Yes</td>
<td>1Gbps</td>
<td></td>
</tr>
<tr>
<td>10GBase-T</td>
<td>Yes</td>
<td>10Gbps</td>
<td></td>
</tr>
</tbody>
</table>

100Base-T in a Solarflare adapter back-to-back (no intervening switch) configuration will not work and is not supported.
2.13 LED States

There are two LEDs on the Solarflare network adapter transceiver module. LED states are as follows

<table>
<thead>
<tr>
<th>Adapter Type</th>
<th>LED Description</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>QSFP+, SFP/SFP+</td>
<td>Speed</td>
<td>Green (solid) at all speeds</td>
</tr>
<tr>
<td></td>
<td>Activity</td>
<td>Flashing green when network traffic is present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LEDs are OFF when there is no link present</td>
</tr>
<tr>
<td>BASE-T</td>
<td>Speed</td>
<td>Green (solid) 10Gbps</td>
</tr>
<tr>
<td></td>
<td>Yellow (solid) 100/1000Mbps</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Activity</td>
<td>Flashing green when network traffic is present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LEDs are OFF when there is no link present</td>
</tr>
</tbody>
</table>
2.14 Configure QSFP+ Adapter

SFN7x42Q adapters can operate as 2 x 10Gbps per QSFP+ port, or as 1 x 40Gbps per QSFP+ port. A configuration of 1 x 40G and 2 x 10G ports is not supported.

Figure 1: QSFP+ Port Configuration for SFN7x42Q

The Solarflare 40G breakout cables have only 2 physical cables (see Supported QSFP+ to SFP+ Breakout Cables on page 43). Breakout cables from other suppliers may have 4 physical cables. When connecting a third party breakout cable into an SFN7x42Q 40G QSFP+ cage (in 10G mode), only cables 1 and 3 will be active.
The SFN8542 adapter can operate as 4 x 10Gbps on QSFP+ port 0, or as 1 x 40Gbps per QSFP+ port. A configuration of 1 x 40G and 2 x 10G ports is not supported.

**Figure 2: QSFP+ Port Configuration for SFN8542**

The sfboot utility from the Solarflare Linux Utilities package (SF-107601-LS) is used to configure a Solarflare QSFP+ adapter for 10G or 40G operation. For example:

```
# sfboot port-mode=2x40G pf-count=1
```
2.15 Single Optical Fiber - RX Configuration

The Solarflare adapter will support a receive (RX) only fiber cable configuration when the adapter is required only to receive traffic, but have no transmit link. This can be used, for example, when the adapter is to receive traffic from a fiber tap device.

Solarflare have successfully tested this configuration on a 10G link on SFN5000, SFN6000, SFN7000 and SFN8000 series adapters when the link partner is configured to be TX only (this will always be the case with a fiber tap). Some experimentation might be required when splitting the light signal to achieve a ratio that will deliver sufficient signal strength to all endpoints.

Solarflare adapters do not support a receive only configuration on 1G links.

2.16 Solarflare Mezzanine Adapter: SFN8722 OCP

The Solarflare XtremeScale SFN8722 Dual-Port 10GbE SFP+ PCIe 3.1 OCP Server Adapter is an Open Compute Project mezzanine adapter for Ethernet connectivity.

The adapter meets the design requirements of the OCP Mezzanine Card 2.0 Design Specification.

1. Shut down the server and unplug from the power source before removing the server cover.

2. Locate the mezzanine slot and the SFP+ port slots - refer to the server manual if necessary.

3. Align the SFP+ cages with the port slots and seat the adapter in the mezzanine slot. Secure the adapter to the standoffs.

4. Figure 3: Installing the OCP Mezzanine Adapter Solarflare Mezzanine Adapters: SFN5814H and SFN5812H
The Solarflare SFN5814H Quad-Port and SFN5812H Dual-Port are 10G Ethernet Mezzanine Adapters for the IBM BladeCenter.

Solarflare mezzanine adapters are supported on the IBM BladeCenter E, H and S chassis, HS22, HS22V and HX5 servers. The IBM BladeCenter blade supports a single Solarflare mezzanine adapter.

1. The blade should be extracted from the BladeCenter in order to install the mezzanine adapter.

2. Remove the blade top cover and locate the two retaining posts towards the rear of the blade - (Figure 4). Refer to the BladeCenter manual if necessary.

3. Hinge the adapter under the retaining posts, as illustrated, and align the mezzanine port connector with the backplane connector block.

4. Lower the adapter, taking care to align the side positioning/retaining posts with the recesses in the adapter. See Figure 5.
5 Press the port connector gently into the connector block ensuring that the adapter is firmly and correctly seated in the connector block.

6 Replace the blade top cover.

7 When removing the adapter raise the release handle (shown on Figure 5) to ease the adapter upwards until it can be freed from the connector block.

2.17 Solarflare Mezzanine Adapter SFN6832F-C61

The Solarflare SFN6832F-C61 is a Dual-Port SFP+ are 10GbE Mezzanine Adapters for the DELL PowerEdge C6100 series rack server. Each DELL PowerEdge node supports a single Solarflare mezzanine adapter.

1 The node should be extracted from the rack server in order to install the mezzanine adapter. Refer to the PowerEdge rack server manual if necessary.
Figure 6: SFN6832F-C61 - Installing into the rack server node

2 Secure the side retaining bracket as shown in Figure 5 (top diagram).

3 Fit riser PCB card into the slot as shown in Figure 5 (top diagram). Note that the riser card only fits one way.

4 Offer the adapter to the node and ensure it lies underneath the chassis cover.

5 Lower the adapter into position making sure to connect the adapter slot with the to of the PCB riser card.
6 Secure the adapter using the supplied screws at the positions shown in the diagram.

2.18 Solarflare Mezzanine Adapter SFN6832F-C62

The Solarflare SFN6832F-C61 is a Dual-Port SFP+ 10GbE Mezzanine Adapters for the DELL PowerEdge C6200 series rack server. Each DELL PowerEdge node supports a single Solarflare mezzanine adapter.

1 The node should be extracted from the rack server in order to install the mezzanine adapter. Refer to the PowerEdge rack server manual if necessary.

Figure 7: SFN6832F-C62 - Installing into the rack server node
2. Fit the PCB riser card to the underside connector on the adapter.
3. Offer the adapter to the rack server node ensuring it lies underneath the chassis cover.
4. Lower to adapter to connect the riser PCB card into the slot in the node.
5. Secure the adapter with the supplied screws at the points shown in the diagram.

2.19 Solarflare Precision Time Synchronization Adapters

The Solarflare SFN8542-Plus, SFN8522-Plus, SFN7322F, SFN7142Q\(^1\), SFN7124F\(^1\), SFN7122F\(^1\), SFN7042Q\(^1\), SFN7024F\(^1\), SFN7022F\(^1\) and SFN6322F adapters can generate hardware timestamps for PTP packets in support of a network precision time protocol deployment compliant with the IEEE 1588-2008 specification.

Customers requiring configuration instructions for these adapters and Solarflare PTP in a PTP deployment should refer to the Solarflare Enhanced PTP User Guide (SF-109110-CD).

2.20 Solarflare ApplicationOnload™ Engine

The ApplicationOnload™ Engine (AOE) SFA7942Q is a half-length, full-height PCIe form factor adapter combining the ultra-low latency dual-port 40GbE adapter with an Altera Stratix V FPGA. For details of the SFA7942Q adapter refer to the Solarflare ApplicationOnload Users Guide (SF-115020-CD).

The ApplicationOnload™ Engine (AOE) SFA6902F is a full-length PCIe form factor adapter that combines an ultra-low latency adapter with a tightly coupled ‘bump-in-the-wire’ FPGA. For details of installation and configuring applications that run on the SFA6902F AOE refer to the Solarflare AOE User’s Guide (SF-108389-CD). For details on developing custom applications to run on the FPGA refer to the AOE Firmware Development Kit User Guide (SF-108390-CD).

---

1. Requires an AppFlex™ license - refer to Solarflare AppFlex™ Technology Licensing. on page 17.
Solarflare Adapters on Linux

This chapter covers the following topics on the Linux® platform:

- System Requirements on page 57
- Linux Platform Feature Set on page 57
- Solarflare RPMs on page 59
- Installing Solarflare Drivers and Utilities on Linux on page 61
- Red Hat Enterprise Linux Distributions on page 61
- SUSE Linux Enterprise Server Distributions on page 62
- Installing DKMS Driver and Utilities on Ubuntu/Debian Servers on page 63
- Unattended Installations on page 64
- Unattended Installation - Red Hat Enterprise Linux on page 65
- Unattended Installation - SUSE Linux Enterprise Server on page 67
- Configuring the Solarflare Adapter on page 68
- Setting Up VLANs on page 70
- Setting Up Teams on page 71
- NIC Partitioning on page 71
- NIC Partitioning with SR-IOV on page 75
- Receive Side Scaling (RSS) on page 78
- Receive Flow Steering (RFS) on page 80
- Solarflare Accelerated RFS (SARFS) on page 81
- Transmit Packet Steering (XPS) on page 82
- Linux Utilities RPM on page 84
- Configuring the Boot Manager with sfboot on page 85
- Upgrading Adapter Firmware with sfupdate on page 93
- License Install with sfkey on page 97
- Performance Tuning on Linux on page 100
- Interrupt Affinity on page 110
- Module Parameters on page 120
- Linux ethtool Statistics on page 122
3.1 System Requirements

Refer to Software Driver Support on page 16 for supported Linux Distributions.

NOTE: Many Linux distributions include a version of the Solarflare network adapter driver that is taken from the upstream kernel. This driver might be out of date, and might not support the latest Solarflare adapters and features.

To update the supplied driver, see Installing Solarflare Drivers and Utilities on Linux on page 61. See also the OS-specific sections that follow, such as Red Hat Enterprise Linux Distributions on page 61, and SUSE Linux Enterprise Server Distributions on page 62.

3.2 Linux Platform Feature Set

Table 14 lists the features supported by Solarflare adapters on Red Hat and SUSE Linux distributions.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Fault diagnostics**            | Support for comprehensive adapter and cable fault diagnostics and system reports.  
|                                  | • See Linux Utilities RPM on page 84                                    |
| **Firmware updates**             | Support for Boot ROM, Phy transceiver and adapter firmware upgrades.    
|                                  | • See Upgrading Adapter Firmware with sfupdate on page 93               |
| **Hardware Timestamps**          | Solarflare XtremeScale SFN8542-Plus and SFN8522-Plus adapters, and Solarflare Flareon SFN7322F, SFN7142Q, SFN7124F, SFN7122F, SFN7042Q, SFN7024F, SFN7022F, and SFN6322F adapters support the hardware timestamping of all received packets - including PTP packets.  
|                                  | The Linux kernel must support the SO_TIMESTAMPING socket option (2.6.30+) to allow the driver to support hardware packet timestamping. Therefore hardware packet timestamping is not available in RHEL 5. |
| **Jumbo frames**                 | Support for MTUs (Maximum Transmission Units) from 1500 bytes to 9216 bytes.  
<p>|                                  | • See Configuring Jumbo Frames on page 70                               |</p>
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>PXE and UEFI booting</td>
<td>Support for diskless booting to a target operating system via PXE or UEFI boot.</td>
<td>• See Configuring the Boot Manager with sfboot on page 85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• See Solarflare Boot Manager on page 371</td>
</tr>
<tr>
<td>PXE or UEFI boot are not supported for Solarflare adapters on IBM System p servers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Support for RSS multi-core load distribution technology.</td>
<td>• See Receive Side Scaling (RSS) on page 78.</td>
</tr>
<tr>
<td>ARFS</td>
<td>Linux Accelerated Receive Flow Steering.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improve latency and reduce jitter by steering packets to the core where a receiving application is running.</td>
<td>See Receive Flow Steering (RFS) on page 80.</td>
</tr>
<tr>
<td>SARFS</td>
<td>Solarflare Accelerated RFS.</td>
<td>See Solarflare Accelerated RFS (SARFS) on page 81.</td>
</tr>
<tr>
<td>Transmit Packet Steering (XPS)</td>
<td>Supported on Linux 2.6.38 and later kernels. Selects the transmit queue when transmitting on multi-queue devices.</td>
<td>See Transmit Packet Steering (XPS) on page 82.</td>
</tr>
<tr>
<td>NIC Partitioning</td>
<td>Each physical port on an SFN7000 or SFN8000 series adapter can be exposed as up to 8 PCIe Physical Functions (PF).</td>
<td>See NIC Partitioning on page 71.</td>
</tr>
<tr>
<td>SR-IOV</td>
<td>Support for Linux KVM SR-IOV.</td>
<td>• See SR-IOV Virtualization Using KVM on page 323</td>
</tr>
<tr>
<td></td>
<td>SR-IOV is not supported for Solarflare adapters on IBM System p servers.</td>
<td></td>
</tr>
<tr>
<td>Task offloads</td>
<td>Support for TCP Segmentation Offload (TSO), Large Receive Offload (LRO), and TCP/UDP/IP checksum offload for improved adapter performance and reduced CPU processing requirements.</td>
<td>• See Configuring Task Offloading on page 69</td>
</tr>
<tr>
<td>TX PIO</td>
<td>Use of programmed IO buffers in order to reduce latency for small packet transmission.</td>
<td>• See TX PIO on page 107.</td>
</tr>
</tbody>
</table>
3.3 Solarflare RPMs

Solarflare supply RPM packages in the following formats:

- DKMS
- Source RPM

**DKMS RPM**

Dynamic Kernel Module Support (DKMS) is a framework where device driver source can reside outside the kernel source tree. It supports an easy method to rebuild modules when kernels are upgraded.

Execute the command `dkms --version` to determine whether DKMS is installed.

To install the Solarflare driver DKMS package execute the following command:

`rpm -i sfc-dkms-<version>.noarch.rpm`

Load the driver:

`modprobe sfc`
Building the Source RPM

These instructions may be used to build a source RPM package for use with Linux distributions or kernel versions where DKMS packages are not suitable.

**NOTE:** RPMs can be installed for multiple kernel versions.


2. To build a source RPM for the running kernel version from the source RPM, enter the following at the command-line:

   ```
   rpmbuild --rebuild <package_name>
   ```

   where `package_name` is the full path to the source RPM.

3. To build for a different kernel to the running system, enter the following command:

   ```
   rpmbuild --define 'kernel <kernel version>' --rebuild <package_name>
   ```

4. Install the resulting RPM binary package, as described in Installing Solarflare Drivers and Utilities on Linux

5. Load the driver:

   ```
   modprobe sfc
   ```

**NOTE:** The location of the generated RPM is dependent on the distribution and often the version of the distribution and the RPM build tools.

The RPM build process should print out the location of the RPM towards the end of the build process, but it can be hard to find amongst the other output.

Typically the RPM will be placed in `/usr/src/<dir>/RPMS/<arch>/`, where `<dir>` is distribution specific. Possible folders include Red Hat, `packages` or `extra`. The RPM file will be named using the same convention as the Solarflare provided pre-built binary RPMs.

The command: `find /usr/src -name "*sfc*.rpm"` will list the locations of all Solarflare RPMs.
3.4 Installing Solarflare Drivers and Utilities on Linux

- Red Hat Enterprise Linux Distributions on page 61
- SUSE Linux Enterprise Server Distributions on page 62

Linux drivers for Solarflare are available in DKMS and source RPM packages. The source RPM can be used to build binary RPMs for a wide selection of distributions and kernel variants. This section details how to install the resultant binary RPM.

Solarflare recommend using DKMS RPMs if the DKMS framework is available. See DKMS RPM on page 59 for more details.

**NOTE:** The Solarflare adapter should be physically installed in the host computer before installing the driver. The user must have root permissions to install the adapter drivers.

3.5 Red Hat Enterprise Linux Distributions

These instructions cover installation and configuration of the Solarflare network adapter drivers on Red Hat Enterprise Linux Server. Refer to Software Driver Support on page 16 for details of supported Linux distributions.

Refer to Building the Source RPM on page 60 for directions on creating the binary RPM.

1. Install the RPMs:
   
   ```
   # rpm -ivh kernel-module-sfc-RHEL6-2.6.32-279.el6.x86_64-3.3.0.6262-1.x86_64.rpm
   ```

2. Make the new network settings.
   
   Solarflare recommend using the NetworkManager service and associated GUI tools. For more information about this refer to https://wiki.gnome.org/NetworkManager.

3. Apply the new network settings.
   
   If you are using the NetworkManager service and associated GUI tools, you will need to reboot. Alternatively you can restart the networking service, by typing the following before the new Solarflare interface can be used:
   
   ```
   # service network restart
   ```

Various other tools that can be used for configuring network adapters. See the documentation supplied with the tool.
3.6 SUSE Linux Enterprise Server Distributions

These instructions cover installation and configuration of the Solarflare Network Adapter drivers on SUSE Linux Enterprise Server. Refer to Software Driver Support on page 16 for details of supported distributions.

Refer to Building the Source RPM on page 60 for directions on creating the binary RPM.

1. The Solarflare drivers are currently classified as 'unsupported' by SUSE Enterprise Linux 10 and 11. To allow unsupported drivers to load in SLES10, edit the following file:

   `/etc/sysconfig/hardware/config`

   Find the line:

   `LOAD_UNSUPPORTED_MODULES_AUTOMATICALLY=no`

   and change no to yes.

   For SLES 11, edit the last line in `/etc/modprobe.d/unsupported-modules` to:

   `allow_unsupported_modules 1`

2. Install the RPMs:

   `# rpm -ivh kernel-module-sfc-2.6.5-7.244-smp-2.1.0111-0.sf.1.SLES9.i586.rpm`

3. Run YaST to configure the Solarflare Network Adapter. When you select the Ethernet Controller, the Configuration Name will take one of the following forms:

   - `eth-bus-pci-dddd:dd:dd.N` where N is either 0 or 1.
   - `eth-id-00:0F:53:XX:XX:XX`

   Once configured, the Configuration Name for the correct Ethernet Controller will change to the second form, and an ethX interface will appear on the host. If the incorrect Ethernet Controller is chosen and configured, then the Configuration Name will remain as `eth-bus-pci-dddd:dd:dd.1` after configuration by YaST, and an ethX interface will not appear on the system. In this case, you should remove the configuration for this Ethernet Controller, and configure the other Ethernet Controller of the pair.
3.7 Installing DKMS Driver and Utilities on Ubuntu/Debian Servers

Net Driver DKMS
The Solarflare net driver DKMS package (SF-104979-LS) is available from:
https://support.solarflare.com/
1. Download the DKMS source package SF-104979-LS and unzip on the target server.
2. Create the .deb file:
   ```
sudo alien -c sfc-dkms-<version>.sf.1.noarch.rpm
   
   This command generates the sfc-dkms_<version>_all.deb file.
   
   The -c option is required to convert source scripts and build the driver.
   ```
3. Install the deb file:
   ```
sudo dpkg -i -dkms_<version>_all.deb
   ```
4. Reload the sfc driver:
   ```
   modprobe -r sfc
   modprobe sfc
   ```

Utilities
The Solarflare Linux Utilities package (SF-107601-LS) is available from:
https://support.solarflare.com/
1. Download and unzip the package on the target server.
2. Create the .deb file:
   ```
sudo alien sfutils-<version>.x86_64.rpm
   
   This command generates the sfutils_<version>_amd64.deb file.
   ```
3. Install the deb file:
   ```
sudo dpkg -i sfutils_<version>_amd64.deb
   ```
4. Utilities sfupdate, sfkey, sfctool and sfboot are available on the server.
3.8 Unattended Installations

Building Drivers and RPMs for Unattended Installation

Linux unattended installation requires building two drivers:

- A minimal installation Solarflare driver that only provides networking support. This driver is used for network access during the installation process.
- An RPM that includes full driver support. This RPM is used to install drivers in the resultant Linux installation.

![Diagram showing Unattended Installation RPM](image)

**Figure 8: Unattended Installation RPM**

Figure 8 shows how the unattended installation process works.

1. Build a minimal Solarflare driver needed for use in the installation kernel (Kernel A in the diagram above). This is achieved by defining “sfc_minimal” to rpmbuild. This macro disables hardware monitoring, MTD support (used for access to the adapters flash), I2C and debugfs. This results in a driver with no dependencies on other modules and allows networking support from the driver during installation.

   # as normal user
   $ mkdir -p /tmp/rpm/BUILD
   $ rpm -i sfc-<ver>-1.src.rpm
   $ rpmbuild -bc -D 'sfc_minimal=1' -D 'kernel=<installer kernel>' \
   /tmp/rpm/SPECS/sfc.spec

2. The Solarflare minimal driver sfc.ko can be found in /tmp/rpm/BUILD/sfc-<ver>/linux_net/sfc.ko. Integrate this minimal driver into your installer kernel, either by creating a driver disk incorporating this minimal driver or by integrating this minimal driver into initrd.

3. Build a full binary RPM for your Target kernel and integrate this RPM into your Target (Kernel B).
Driver Disks for Unattended Installations

Table 15 below identifies the various stages of an unattended installation process:

<table>
<thead>
<tr>
<th>In Control</th>
<th>Stages of Boot</th>
<th>Setup needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS</td>
<td>PXE code on the adapter runs.</td>
<td>Adapter must be in PXE boot mode. See Solarflare Boot Manager on page 371.</td>
</tr>
<tr>
<td>SF Boot ROM (PXE)</td>
<td>DHCP request from PXE (SF Boot ROM).</td>
<td>DHCP server filename and next-server options.</td>
</tr>
<tr>
<td>SF Boot ROM (PXE)</td>
<td>TFTP request for filename to next-server, e.g. pxelinux.0</td>
<td>TFTP server.</td>
</tr>
<tr>
<td>pxelinux</td>
<td>TFTP retrieval of pxelinux configuration.</td>
<td>pxelinux configuration on TFTP server.</td>
</tr>
<tr>
<td>pxelinux</td>
<td>TFTP menu retrieval of Linux kernel image initrd.</td>
<td>pxelinux configuration Kernel, kernel command, initrd</td>
</tr>
<tr>
<td>Linux kernel/installer</td>
<td>Installer retrieves kickstart configuration, e.g. via HTTP.</td>
<td>Kickstart/AutoYaST configuration.</td>
</tr>
<tr>
<td>Target Linux kernel</td>
<td>kernel reconfigures network adapters.</td>
<td>DHCP server.</td>
</tr>
</tbody>
</table>

3.9 Unattended Installation - Red Hat Enterprise Linux

Documentation for preparing for a Red Hat Enterprise Linux network installation can be found at:


The prerequisites for a Network Kickstart installation are:

- Red Hat Enterprise Linux installation media.
- A Web server and/or FTP Server for delivery of the RPMs that are to be installed.
- A DHCP server for IP address assignments and to launch PXE Boot.
• A TFTP server for download of PXE Boot components to the machines being kickstarted.
• The BIOS on the computers to be Kickstarted must be configured to allow a network boot.
• A Boot CD-ROM or flash memory that contains the kickstart file or a network location where the kickstart file can be accessed.
• A Solarflare driver disk.

Unattended Red Hat Enterprise Linux installations are configured with Kickstart. The documentation for Kickstart can be found at:


To install Red Hat Enterprise you need the following:

1. A modified initrd.img file with amended modules.alias and modules.dep which incorporates the Solarflare minimal driver for the installation kernel.

   Find current aliases with the modinfo command:

   ```bash
   modinfo sfc | grep alias
   ```

   Then add the aliases found to the modules.alias file:

   ```
   pci:v00001924d00001A03sv*sd*bc*sc*i*
   pci:v00001924d00000A03sv*sd*bc*sc*i*
   pci:v00001924d00001923sv*sd*bc*sc*i*
   pci:v00001924d00000923sv*sd*bc*sc*i*
   pci:v00001924d00001903sv*sd*bc*sc*i*
   pci:v00001924d00000903sv*sd*bc*sc*i*
   pci:v00001924d00000813sv*sd*bc*sc*i*
   pci:v00001924d00000803sv*sd*bc*sc*i*
   ```

2. Identify the driver dependencies using the modinfo command:

   ```bash
   modinfo ./sfc.ko | grep depends
   ```

   ```
   depends:  i2c-core, mii, hwmon, hwmon-vid, i2c-algo-bit mtdcore mtdpart
   ```

   All modules listed as depends must be present in the initrd file image. In addition the user should be aware of further dependencies which can be resolved by adding the following lines to the modules.dep file:

   ```
   sfc:  i2c-core mii hwmon hwmon-vid i2c-algo-bit mtdcore mtdpart
   i2c-algo-bit:  i2c-core
   mtdpart:  mtdcore
   ```

3. A configured kickstart file with the Solarflare Driver RPM manually added to the %Post section. For example:

   ```
   %post
   /bin/mount -o ro <IP Address of Installation server>:/<path to
   ```

1. For Red Hat Enterprise Linux from version 5.5 add mdio to this line.
location directory containing Solarflare RPM> /mnt
/bin/rpm -Uvh /mnt/<filename of Solarflare RPM>
/bin/umount /mnt

3.10 Unattended Installation - SUSE Linux Enterprise Server

Unattended SUSE Linux Enterprise Server installations are configured with AutoYaST. The documentation for AutoYaST can be found at:


The prerequisites for a Network AutoYaST installation are:

- SUSE Linux Enterprise installation media.
- A DHCP server for IP address assignments and to launch PXE Boot.
- A NFS or FTP server to provide the installation source.
- A TFTP server for the download of the kernel boot images needed to PXE Boot.
- A boot server on the same Ethernet segment.
- An install server with the SUSE Linux Enterprise Server OS.
- An AutoYaST configuration server that defines rules and profiles.
- A configured AutoYaST Profile (control file).

Further Reading

- SUSE Linux Enterprise Server remote installation:

- SUSE install with PXE Boot:
3.11 Configuring the Solarflare Adapter

Ethtool is a standard Linux tool that you can use to query and change Ethernet adapter settings. Ethtool can be downloaded from http://sourceforge.net/projects/gkernel/files/ethtool/.

The general command for ethtool is as follows:

```
ethtool <option> <ethX>
```

where X is the identifier of the interface. Root access is required to configure adapter settings.

Hardware Timestamps

The Solarflare Flareon SFN7000 and XtremeScale SFN8000 series adapters can support hardware timestamping for all received network packets.

The Linux kernel must support the SO_TIMESTAMPING socket option (2.6.30+) therefore hardware packet timestamping is not supported on RHEL 5.

For more information about using the kernel timestamping API, users should refer to the Linux documentation: http://lxr.linux.no/linux/Documentation/networking/timestamping.txt

Configuring Speed and Modes

Solarflare adapters by default automatically negotiate the connection speed to the maximum supported by the link partner.

- On the 10GBASE-T adapters “auto” instructs the adapter to negotiate the highest speed supported in common with its link partner.
- On SFP+ adapters, “auto” instructs the adapter to use the highest link speed supported by the inserted SFP+ module.

On 10GBASE-T and SFP+ adapters, any other value specified will fix the link at that speed, regardless of the capabilities of the link partner, which may result in an inability to establish the link. Dual speed SFP+ modules operate at their maximum (10G) link speed unless explicitly configured to operate at a lower speed (1G).

The following commands demonstrate ethtool to configure the network adapter Ethernet settings.

- Identify interface configuration settings:
  ```
ethtool ethX
```
- Set link speed:
  ```
ethtool -s ethX speed 1000|100
```
- To return the connection speed to the default auto-negotiate, enter:
  ```
ethtool -s <ethX> autoneg on
```
- Configure auto negotiation:
ethtool -s ethX autoneg [on|off]

• Set auto negotiation advertised speed 1G:
ethtool -s ethX advertise 0x20

• Set autonegotiation advertised speed 10G:
ethtool -s ethX advertise 0x1000

• Set autonegotiation advertised speeds 1G and 10G:
ethtool -s ethX advertise 0x1020

• Identify interface auto negotiation pause frame setting:
ethtool -a ethX

• Configure auto negotiation of pause frames:
ethtool -A ethX autoneg on [rx on|off] [tx on|off]

**NOTE:** Due to a limitation in ethtool, when auto-negotiation is enabled, the user must specify both speed and duplex mode or speed and set an advertise mask otherwise speed configuration will not function.

### Configuring Task Offloading

Solarflare adapters support transmit (Tx) and receive (Rx) checksum offload, as well as TCP segmentation offload. To ensure maximum performance from the adapter, all task offloads should be enabled, which is the default setting on the adapter. For more information, see Performance Tuning on Linux on page 100.

To change offload settings for Tx and Rx, use the ethtool command:

`ethtool --offload <ethX> [rx on|off] [tx on|off]`

### Configuring Receive/Transmit Ring Buffer Size

By default receive and transmit ring buffers on the Solarflare adapter support 1024 descriptors. The user can identify and reconfigure ring buffer sizes using the ethtool command.

To identify the current ring size:
ethtool -g ethX

To set the new transmit or receive ring size to value N

ethtool -G ethX [rx N] [tx N]

The ring buffer size must be a value between 128 and 4096. On the SFN7000 and SFN8000 series adapters the maximum TX buffer size is restricted to 2048. Buffer size can also be set directly in the modprobe.conf file or add the options line to a file under the /etc/modprobe.d directory e.g.

```plaintext
options sfc rx_ring=4096
```

Using the modprobe method sets the value for all Solarflare interfaces. Then reload the driver for the option to become effective:
modprobe -r sfc
modprobe sfc

Configuring Jumbo Frames

Solarflare adapters support frame sizes from 1500 bytes to 9216 bytes. For example, to set a new frame size (MTU) of 9000 bytes, enter the following command:

```
ifconfig <ethX> mtu 9000
```

To make the changes permanent, edit the network configuration file for `<ethX>`; for example, `/etc/sysconfig/network-scripts/ifcfg-eth1` and append the following configuration directive, which specifies the size of the frame in bytes:

```
MTU=9000
```

3.12 Setting Up VLANs

VLANs offer a method of dividing one physical network into multiple broadcast domains. In enterprise networks, these broadcast domains usually match with IP subnet boundaries, so that each subnet has its own VLAN. The advantages of VLANs include:

- Performance
- Ease of management
- Security
- Trunks
- You don’t have to configure any hardware device, when physically moving your server to another location.

To set up VLANs, consult the following documentation:

- To configure VLANs on SUSE Linux Enterprise Server, see:
- To configure tagged VLAN traffic only on Red Hat Enterprise Linux, see:
- To configure mixed VLAN tagged and untagged traffic on Red Hat Enterprise Linux, see:
  [http://kbase.redhat.com/faq/docs/DOC-8064](http://kbase.redhat.com/faq/docs/DOC-8064)
3.13 Setting Up Teams

Teaming network adapters (network bonding) allows a number of physical adapters to act as one, virtual adapter. Teaming network interfaces, from the same adapter or from multiple adapters, creates a single virtual interface with a single MAC address.

The virtual adapter or virtual interface can assist in load balancing and providing failover in the event of physical adapter or port failure.

Teaming configuration support provided by the Linux bonding driver includes:
- 802.3ad Dynamic link aggregation
- Static link aggregation
- Fault Tolerant

To set up an adapter team, consult the following documentation:

- General:
- RHEL 5:
- RHEL 6:
- SLES:

3.14 NIC Partitioning

NIC Partitioning is a feature supported on Solarflare adapters starting with the SFN7000 series. By partitioning the NIC, each physical network port can be exposed to the host as multiple PCIe Physical Functions (PF) with each having a unique interface name and unique MAC address.

When the Solarflare NET driver (sfc.ko) is loaded in the host, each PF is backed by a virtual adapter connected to a virtual port. A switching function supports the transport of network traffic between virtual ports (vport) and the physical port. Partitioning is particularly useful when, for example, splitting a single 40GbE interface into multiple PFs.

- Up to 16 PFs and 16 MAC addresses are support PER ADAPTER.
- On a 10GbE dual-port adapter each physical port can be exposed as a maximum 8 PFs.
• On a 40GbE dual-port adapter (in 2*40G mode) each physical port can be exposed as a maximum 8 PFs.
• On a 40GbE dual-port adapter (in 4*10G mode) each physical port can be exposed as a maximum 4 PFs.

**NIC Partitioning Without VLANs**

![Diagram of NIC Partitioning Without VLANs]

• Configured without VLANs, all PFs are in the same Ethernet layer 2 broadcast domain i.e. a packet broadcast from any one PF would be received by all other PFs.
• Transmitted packets go directly to the wire. Packets sent between PFs are routed through the local TCP/IP stack loopback interface without touching the sfc driver.
• Received broadcast packets are replicated to all PFs.
• Received multicast packets are delivered to each subscriber.
• Received unicast packets are delivered to the PF with a matching MAC address. Because the TCP/IP stack has multiple network interfaces on the same broadcast domain, there is always the possibility that any interface could respond to an ARP request. To avoid this the user should use `arp_ignore=2` to avoid ARP cache pollution ensuring that ARP responses are only sent from an interface if the target IP address in the ARP request matches the interface address with both sender/receiver IP addresses in the same subnet.
• To set `arp_ignore` for the current session:
  ```bash
echo 2 > /proc/sys/net/ipv4/conf/all/arp_ignore```
To set `arp_ignore` permanently (does not affect the current session), add the following line to the `/etc/sysctl.conf` file:
```
net.ipv4.conf.all.arp_ignore = 2
```

The MUXER function is a layer2 switching function for received traffic enabled in adapter firmware. When the OS delivers traffic to local interfaces via the loopback interface, the MUXER acts as a layer2 switch for both transmit and receive.

### VLAN Support

When PFs are configured with VLAN tags each PF must be in a different VLAN. The MUXER function acts as a VLAN aggregator such that transmitted packets are sent to the wire and received packets are demultiplexed based on the VLAN tags. VLAN tags are added/striped by the adapter firmware transparent to the OS and driver. VLAN tags can be assigned when PFs are enabled using the `sfboot` command. A single PF can be assigned VLAN tag 0 allowing it to receive untagged traffic.

```
# sfboot switch-mode=partitioning pf-count=3 pf-vlan=0,200,300
```

The first VLAN ID in the `pf-vlan` comma separated list is assigned to the first PF of the physical port and thereafter tags are assigned to PFs in lowest MAC address order.

![Figure 10: NIC Partitioning - VLAN Support](image)
NIC Partitioning Configuration

Up to 16 PFs and 16 MAC addresses are supported per adapter. The PF count value applies to all physical ports. Ports cannot be configured individually.

1. Ensure the Solarflare adapter driver (sfc.ko) is installed on the host.
2. The sfboot utility (pf-count) from the Solarflare Linux Utilities package (SF-107601-LS) is used to partition physical interfaces to the required number of PFs.
3. To partition all ports (example configures 4 PFs per port):
   
   ```
   # sfboot switch-mode=partitioning pf-count=4
   Solarflare boot configuration utility [v4.5.0]
   Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005
   ```
   
   eth2:
   
<table>
<thead>
<tr>
<th>Option</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boot image</td>
<td>Option ROM only</td>
</tr>
<tr>
<td>Link speed</td>
<td>Negotiated automatically</td>
</tr>
<tr>
<td>Link-up delay time</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Banner delay time</td>
<td>2 seconds</td>
</tr>
<tr>
<td>Boot skip delay time</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Boot type</td>
<td>Disabled</td>
</tr>
<tr>
<td>Physical Functions per port</td>
<td>4</td>
</tr>
<tr>
<td>MSI-X interrupt limit</td>
<td>32</td>
</tr>
<tr>
<td>Number of Virtual Functions</td>
<td>0</td>
</tr>
<tr>
<td>VF MSI-X interrupt limit</td>
<td>8</td>
</tr>
<tr>
<td>Firmware variant</td>
<td>full feature / virtualization</td>
</tr>
<tr>
<td>Insecure filters</td>
<td>Disabled</td>
</tr>
<tr>
<td>MAC spoofing</td>
<td>Disabled</td>
</tr>
<tr>
<td>VLAN tags</td>
<td>None</td>
</tr>
<tr>
<td>Switch mode</td>
<td>Partitioning</td>
</tr>
</tbody>
</table>

A cold reboot of the server is required for sfboot changes to be effective.

4. Following reboot each PF will be visible using the `lspci` command:
   
   ```
   # lspci -d 1924:
   ```
   
   
   07:00.0 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.1 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.2 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.3 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.4 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.5 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.6 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.7 Ethernet controller: Solarflare Communications Device 0903 (rev 01)

   - If more than 8 functions are required the server must support ARI - see Alternative Routing-ID Interpretation (ARI) on page 325.
   - Solarflare also recommend setting `pci=realloc` in the kernel configuration grub file - refer to Kernel Configuration on page 325 for details.

5. To identify which physical port a given network interface is using:
   
   ```
   # cat /sys/class/net/eth<N>/device/physical_port
   ```
6 If the Solarflare driver is loaded, PFs will also be visible using the `ifconfig` command where each PF is listed with a unique MAC address.

**Software Requirements**

The server must have the following (minimum) net driver and firmware versions to enable NIC Partitioning:

```
# ethtool -i eth<N>
driver: sfc
version: 4.4.1.1017
firmware-version: 4.4.2.1011 rx0 tx0
```

The adapter must be using the `full-feature` firmware variant which can be selected using the `sfboot` utility and confirmed with `rx0 tx0` appearing after the version number in the output from `ethtool` as shown above.

The firmware update utility (`sfupdate`) and boot ROM configuration tool (`sfboot`) are available in the Solarflare Linux Utilities package (SF-107601-LS issue 28 or later).

### 3.15 NIC Partitioning with SR-IOV

When combining NIC partitioning with SR-IOV, every partition (PF) must be in a separate VLAN. The user is able to create a number of PFs per physical port and associate a number of VFs with each PF. Within this layer2 broadcast domain there is switching between a PF and its associated VFs.

![Diagram of NIC Partitioning with SR-IOV](image)

**Figure 11: NIC Partitioning with SR-IOV**
Configuration

1. Use the sfboot utility to set the firmware switch-mode, create PFs, assign unique VLAN ID to each PF and assign a number of VFs for each PF.

In the following example 4 PFs are configured per physical port and 2 VFs per PF:

```
# sfboot switch-mode=partitioning-with-sriov pf-count=4 / pf-vlans=0,100,110,120 vf-count=2
```

eth10:
   Interface-specific boot options are not available. Adapter-wide options are available via eth4 (00-0F-53-21-00-60).

eth11:
   Interface-specific boot options are not available. Adapter-wide options are available via eth4 (00-0F-53-21-00-60).

eth12:
   Interface-specific boot options are not available. Adapter-wide options are available via eth4 (00-0F-53-21-00-60).

eth13:
   Interface-specific boot options are not available. Adapter-wide options are available via eth4 (00-0F-53-21-00-60).

eth14:
   Interface-specific boot options are not available. Adapter-wide options are available via eth4 (00-0F-53-21-00-60).

eth15:
   Interface-specific boot options are not available. Adapter-wide options are available via eth4 (00-0F-53-21-00-60).

eth4:
   Boot image
   Option ROM only
   Link speed
   Negotiated automatically
   Link-up delay time
   5 seconds
   Banner delay time
   2 seconds
   Boot skip delay time
   5 seconds
   Boot type
   Disabled
   Physical Functions per port
   4
   MSI-X interrupt limit
   32
   Number of Virtual Functions
   2
   VF MSI-X interrupt limit
   8
   Firmware variant
   full feature / virtualization
   Insecure filters
   Disabled
   MAC spoofing
   Disabled
   VLAN tags
   0,100,110,120
   Switch mode
   Partitioning with SRIOV

eth5:
   Boot image
   Option ROM only
   Link speed
   Negotiated automatically
   Link-up delay time
   5 seconds
   Banner delay time
   2 seconds
Boot skip delay time 5 seconds
Boot type Disabled
Physical Functions per port 4
MSI-X interrupt limit 32
Number of Virtual Functions 2
VF MSI-X interrupt limit 8
Firmware variant full feature / virtualization
Insecure filters Disabled
MAC spoofing Disabled
VLAN tags 0,100,110,120
Switch mode Partitioning with SRIOV

2 PF interfaces are visible in the host using the ifconfig command:

- eth4 Link encap:EthernetHWaddr 00:0F:53:21:00:60
- eth5 Link encap:EthernetHWaddr 00:0F:53:21:00:61
- eth10 Link encap:EthernetHWaddr 00:0F:53:21:00:64
- eth11 Link encap:EthernetHWaddr 00:0F:53:21:00:65
- eth12 Link encap:EthernetHWaddr 00:0F:53:21:00:66
- eth13 Link encap:EthernetHWaddr 00:0F:53:21:00:63
- eth14 Link encap:EthernetHWaddr 00:0F:53:21:00:62
- eth15 Link encap:EthernetHWaddr 00:0F:53:21:00:67

3 The output from steps 1 and 2 above identifies a server with 2 physical interfaces (eth4/eth5), 4 PFs per physical port and identifies the following PF-VLAN configuration:

<table>
<thead>
<tr>
<th>Interface</th>
<th>MAC Address</th>
<th>PF</th>
<th>VLAN ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>eth4</td>
<td>00:0F:53:21:00:60</td>
<td>PF0</td>
<td>0</td>
</tr>
<tr>
<td>eth10</td>
<td>00:0F:53:21:00:64</td>
<td>PF4</td>
<td>110</td>
</tr>
<tr>
<td>eth12</td>
<td>00:0F:53:21:00:66</td>
<td>PF6</td>
<td>120</td>
</tr>
<tr>
<td>eth14</td>
<td>00:0F:53:21:00:62</td>
<td>PF2</td>
<td>100</td>
</tr>
<tr>
<td>eth5</td>
<td>00:0F:53:21:00:61</td>
<td>PF1</td>
<td>0</td>
</tr>
<tr>
<td>eth11</td>
<td>00:0F:53:21:00:65</td>
<td>PF5</td>
<td>110</td>
</tr>
<tr>
<td>eth13</td>
<td>00:0F:53:21:00:63</td>
<td>PF3</td>
<td>100</td>
</tr>
<tr>
<td>eth15</td>
<td>00:0F:53:21:00:67</td>
<td>PF7</td>
<td>120</td>
</tr>
</tbody>
</table>

4 Refer to SR-IOV Configuration on page 329 for procedures to create VMs and VFs.

**VLAN Configuration**

When using partitioning with SR-IOV, all PFs must have a unique VLAN tag. A single PF from each physical port can use tag 0 (zero) to receive untagged traffic. VLAN tags are transparently inserted/stripped by the adapter firmware.
LACP Bonding

LACP Bonding is not currently supported using the NIC Partitioning configuration mode as the LACP partner i.e. the switch will be unaware of the configured partitions.

Users are advised to refer to the sfc driver release notes for current limitations when using the NIC partitioning features.

3.16 Receive Side Scaling (RSS)

Solarflare adapters support Receive Side Scaling (RSS). RSS enables packet receive-processing to scale with the number of available CPU cores. RSS requires a platform that supports MSI-X interrupts. RSS is enabled by default.

When RSS is enabled the controller uses multiple receive queues to deliver incoming packets. The receive queue selected for an incoming packet is chosen to ensure that packets within a TCP stream are all sent to the same receive queue – this ensures that packet-ordering within each stream is maintained. Each receive queue has its own dedicated MSI-X interrupt which ideally should be tied to a dedicated CPU core. This allows the receive side TCP processing to be distributed amongst the available CPU cores, providing a considerable performance advantage over a conventional adapter architecture in which all received packets for a given interface are processed by just one CPU core. RSS can be restricted to only process receive queues on the NUMA node local to the Solarflare adapter. To configure this the driver module option rss_numa_local should be set to 1.

By default the driver enables RSS and configures one RSS Receive queue per CPU core. The number of RSS Receive queues can be controlled via the driver module parameter rss_cpus. The following table identifies rss_cpus options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Interrupt Affinity (MSI-X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;num_cpus&gt;</td>
<td>Indicates the number of RSS queues to create.</td>
<td>A separate MSI-X interrupt for a receive queue is affinitized to each CPU.</td>
</tr>
<tr>
<td>packages</td>
<td>An RSS queue will be created for each multi-core CPU package. The first CPU in the package will be chosen.</td>
<td>A separate MSI-X interrupt for a receive queue, is affinitized to each of the designated package CPUs.</td>
</tr>
</tbody>
</table>
Add the following line to `/etc/modprobe.conf` file or add the options line to a user created file under the `/etc/modprobe.d` directory. The file should have a `.conf` extension:

```
options sfc rss_cpus=<option>
```

To set `rss_cpus` equal to the number of CPU cores:

```
options sfc rss_cpus=cores
```

Sometimes, it can be desirable to disable RSS when running single stream applications, since all interface processing may benefit from taking place on a single CPU:

```
options sfc rss_cpus=1
```

The driver must be reloaded to enable option changes:

```
rmmod sfc
modprobe sfc
```

**NOTE:** The association of RSS receive queues to a CPU is governed by the receive queue’s MSI-X interrupt affinity. See `Interrupt Affinity on page 110` for more details.

**NOTE:** RSS also works for UDP packets. For UDP traffic the Solarflare adapter will select the Receive CPU based on IP source and destination addresses. Solarflare adapters support IPv4 and IPv6 RSS.

### Table 17: `rss_cpus` Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Interrupt Affinity (MSI-X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cores</td>
<td>An RSS queue will be created for each CPU. The first hyperthread instance (if CPU has hyperthreading) will be chosen.</td>
<td>A separate MSI-X interrupt for a receive queue, is affinity-zed to each of the CPUs.</td>
</tr>
<tr>
<td></td>
<td>The default option.</td>
<td></td>
</tr>
<tr>
<td>hyperthreads</td>
<td>An RSS queue will be created for each CPU hyperthread (hyperthreading must be enabled).</td>
<td>A separate MSI-X interrupt for a receive queue, is affinity-zed to each of the hyperthreads.</td>
</tr>
</tbody>
</table>
3.17 Receive Flow Steering (RFS)

RFS will attempt to steer packets to the core where a receiving application is running. This reduces the need to move data between processor caches and can significantly reduce latency and jitter. Modern NUMA systems, in particular, can benefit substantially from RFS where packets are delivered into memory local to the receiving thread.

Unlike RSS which selects a CPU from a CPU affinity mask set by an administrator or user, RFS will store the application's CPU core identifier when the application process calls recvmsg() or sendmsg().

- A hash is calculated from a packet’s addresses or ports (2-tuple or 4-tuple) and serves as the consistent hash for the flow associated with the packet.
- Each receive queue has an associated list of CPUs to which RFS may enqueue the received packets for processing.
- For each received packet, an index into the CPU list is computed from the flow hash modulo the size of the CPU list.

There are two types of RFS implementation; Soft RFS and Hardware (or Accelerated) RFS.

Soft RFS is a software feature supported since Linux 2.6.35 that attempts to schedule protocol processing of incoming packets on the same processor as the user thread that will consume the packets.

Accelerated RFS requires Linux kernel version 2.6.39 or later, with the Linux sfc driver or Solarflare v3.2 network adapter driver.

RFS can dynamically change the allowed CPUs that can be assigned to a packet or packet stream and this introduces the possibility of out of order packets. To prevent out of order data, two tables are created that hold state information used in the CPU selection.

- **Global_flow_table**: Identifies the number of simultaneous flows that are managed by RFS.
- **Per_queue_table**: Identifies the number of flows that can be steered to a queue. This holds state as to when a packet was last received.

The tables support the steering of incoming packets from the network adapter to a receive queue affinitized to a CPU where the application is waiting to receive them. The Solarflare accelerated RFS implementation requires configuration through the two tables and the ethtool -K command.

The following sub-sections identify the RFS configuration procedures:

**Kernel Configuration**

Before using RFS the kernel must be compiled with the kconfig symbol CONFIG_RPS enabled. Accelerated RFS is only available if the kernel is compiled with the kconfig symbol CONFIG_RFS_ACCEL enabled.
Global Flow Count

Configure the number of simultaneous flows that will be managed by RFS. The suggested flow count will depend on the expected number of active connections at any given time and may be less than the number of open connections. The value is rounded up to the nearest power of two.

```
# echo 32768 > /proc/sys/net/core/rps_sock_flow_entries
```

Per Queue Flow Count

For each adapter interface there will exist a ‘queue’ directory containing one ‘rx’ or ‘tx’ subdirectory for each queue associated with the interface. For RFS only the receive queues are relevant.

```
# cd /sys/class/net/eth3/queue
```

Within each ‘rx’ subdirectory, the rps_flow_cnt file holds the number of entries in the per-queue flow table. If only a single queue is used then rps_flow_cnt will be the same as rps_sock_flow_entries. When multiple queues are configured the count will be equal to rps_sock_flow_entries/N where N is the number of queues, for example:

\[ rps_sock_flow_entries = 32768 \text{ and there are 16 queues then } rps_flow_cnt \text{ for each queue will be configured as 2048.} \]

```
# echo 2048 > /sys/class/net/eth3/queues/rx-0/rps_flow_cnt
# echo 2048 > /sys/class/net/eth3/queues/rx-1/rps_flow_cnt
```

Disable RFS

To turn off RFS using the following command:

```
# ethtool -K <devname> ntuple off
```

### 3.18 Solarflare Accelerated RFS (SARFS)

The Solarflare Accelerated RFS feature directs TCP flows to queues processed on the same CPU core as the user process which is consuming the flow. By querying the CPU when a TCP packet is sent, the transmit queue can be selected from the interrupt associated with the correct CPU core. A hardware filter directs the receive flow to the same queue.

SARFS is provided for servers that do not support standard Linux ARFS. For details of Linux ARFS, refer to the previous section. Additional information can be found at the following link:


Overall SARFS can improve bandwidth, especially for smaller packets and because core assignment is not subject to the semi-random selection of transmit and receive queues, both bandwidth and latency become more consistent.
The SARFS feature is disabled by default and can be enabled using net driver module parameters. Driver module parameters can be specified in a user created file (e.g. sfc.conf) in the /etc/modprobe.d directory:

- `sxps_enabled`
- `sarfs_table_size`
- `sarfs_global_holdoff_ms`
- `sarfs_sample_rate`

If the kernel supports XPS, this should be enabled when using the SARFS feature. When the kernel does not support XPS, the `sxps_enabled` parameter should be enabled when using SARFS.

**NOTE:** `sxps_enabled` is known to work on RHEL version up to and including RHEL6.5, but does not function on RHEL7 due to changes in the interrupt hint policy.

Refer to Module Parameters on page 120 for a description of the SARFS driver module parameters.

### 3.19 Transmit Packet Steering (XPS)

Transmit Packet Steering (XPS) is supported in Linux 2.6.38 and later. XPS is a mechanism for selecting which transmit queue to use when transmitting a packet on a multi-queue device.

XPS is configured on a per transmit queue basis where a bitmap of CPUs identifies the CPUs that may use the queue to transmit.

**Kernel Configuration**

Before using XPS the kernel must be compiled with the kconfig symbol `CONFIG_XPS` enabled.

**Configure CPU/Hyperthreads**

Within in each `/sys/class/net/<interface>/queues/tx-N` directory there exists an `xps_cpus` file which contains a bitmap of CPUs that can use the queue to transmit. In the following example transmit queue 0 can be used by the first two CPUs and transmit queue 1 can be used by the following two CPUs:

```bash
# echo 3 > /sys/class/net/eth3/queues/tx-0/xps_cpus
# echo c > /sys/class/net/eth3/queues/tx-0/xps_cpus
```

If hyperthreading is enabled, each hyperthread is identified as a separate CPU, for example if the system has 16 cores but 32 hyperthreads then the transmit queues should be paired with the hyperthreaded cores:

```bash
# echo 30003 > /sys/class/net/eth3/queues/tx-0/xps_cpus
# echo c000c > /sys/class/net/eth3/queues/tx-0/xps_cpus
```
XPS - Example Configuration

System Configuration:
- Single Solarflare adapter
- 2 x 8 core processors with hyperthreading enabled to give a total of 32 cores
- rss_cpus=8
- Only 1 interface on the adapter is configured
- The IRQ Balance service is disabled

Identify interrupts for the configured interface:
```
# cat /proc/interrupts | grep 'eth3\ CPU'
```

```
> cat /proc/irq/132/smp_affinity
00000000,00000000,00000000,00000001
> cat /proc/irq/133/smp_affinity
00000000,00000000,00000000,00001000
> cat /proc/irq/134/smp_affinity
00000000,00000000,00000000,00000002
 [...]snip...
> cat /proc/irq/139/smp_affinity
00000000,00000000,00000000,00000800
```

The output identifies that IRQ-132 is the first queue and is routed to CPU0. IRQ-133 is the second queue routed to CPU8, IRQ-134 to CPU2 and so on.

Map TX queue to CPU

Hyperthreaded cores are included with the associated physical core:
```
> echo 110011 > /sys/class/net/eth3/queues/tx-0/xps_cpus
> echo 11001100 > /sys/class/net/eth3/queues/tx-1/xps_cpus
> echo 220022 > /sys/class/net/eth3/queues/tx-2/xps_cpus
> echo 22002200 > /sys/class/net/eth3/queues/tx-3/xps_cpus
> echo 440044 > /sys/class/net/eth3/queues/tx-4/xps_cpus
> echo 44004400 > /sys/class/net/eth3/queues/tx-5/xps_cpus
> echo 880088 > /sys/class/net/eth3/queues/tx-6/xps_cpus
> echo 88008800 > /sys/class/net/eth3/queues/tx-7/xps_cpus
```

Configure Global and Per Queue Tables
- The flow count (number of active connections at any one time) = 32768
- Number of queues = 8 (rss_cpus)
- So the flow count for each queue will be 32768/8

```
> echo 32768 > /proc/sys/net/core/rps_sock_flow_entries
> echo 4096 > /sys/class/net/eth3/queues/rx-0/rps_flow_cnt
> echo 4096 > /sys/class/net/eth3/queues/rx-1/rps_flow_cnt
> echo 4096 > /sys/class/net/eth3/queues/rx-2/rps_flow_cnt
> echo 4096 > /sys/class/net/eth3/queues/rx-3/rps_flow_cnt
> echo 4096 > /sys/class/net/eth3/queues/rx-4/rps_flow_cnt
```
3.20 Linux Utilities RPM

The Solarflare Linux Utilities RPM contains:

- A boot ROM utility.
  See Configuring the Boot Manager with sfboot on page 85.
- A flash firmware update utility.
  See Upgrading Adapter Firmware with sfupdate on page 93.
- A license key install utility.
  See License Install with sfkey on page 97.

The RPM package, is supplied as 64bit and 32bit binaries compiled to be compatible with GLIBC versions for all supported distributions. The Solarflare utilities RPM file can be downloaded from the following location:

https://support.solarflare.com/

- SF-104451-LS is a 32bit binary RPM package.
- SF-107601-LS is a 64bit binary RPM package.

For example, to install the 64bit package:

1. Download and copy the zipped binary RPM package to the required directory.
2. Unzip the package:
   ```bash
   # unzip SF-107601-LS-<version>_Solarflare_LinuxUtilities_RPM_64bit.zip
   ```
3. Install the binary RPM:
   ```bash
   # rpm -Uvh sfutils-<version>.x86_64.rpm
   Preparing... ################################################################################ [100%]
   1: sfutils ################################################################################ [100%]
   ```
4. Check that the RPM installed correctly:
   ```bash
   # rpm -q sfutils
   sfutils-<version>.x86_64
   ```

Directions for the use of the utility programs are explained in the following sections.
3.21 Configuring the Boot Manager with sfboot

- **Sfboot: Command Usage** on page 85.
- **Sfboot: Command Line Options** on page 86.
- **Sfboot: Examples** on page 91.

Sfboot is a command line utility for configuring Solarflare adapter Boot Manager options, including PXE and UEFI booting. Using sfboot is an alternative to using Ctrl + B to access the Boot ROM agent during server startup.

See **Solarflare Boot Manager** on page 371 for more information on the Boot Rom agent.

PXE and UEFI network boot is not supported for Solarflare adapters on IBM System p servers.

**Sfboot: SLES 11 Limitation**

Due to limitations in SLES 11 using kernel versions prior to 2.6.27.54 it is necessary to reboot the server after running the sfboot utility.

**Sfboot: Command Usage**

The general usage for sfboot is as follows (as root):

```
.sfboot [--adapter=eth<N>] [options] [parameters]
```

When the --adapter option is not specified, the sfboot command applies to all adapters present in the target host.

The format for the parameters are:

```
<parameter>=<value>
```
Sfboot: Command Line Options

Table 18 lists the options for sfboot, Table 19 lists the available global parameters, and Table 20 lists the available per-adapter parameters. Note that command line options are case insensitive and may be abbreviated.

**NOTE:** Abbreviations in scripts should be avoided, since future updates to the application may render abbreviated scripts invalid.

### Table 18: Sfboot Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-h, --help</code></td>
<td>Displays command line syntax and provides a description of each sfboot option.</td>
</tr>
<tr>
<td><code>-V, --version</code></td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td><code>-v, --verbose</code></td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td><code>-y, --yes</code></td>
<td>Update without prompting.</td>
</tr>
<tr>
<td><code>-s, --quiet</code></td>
<td>Suppresses all output, except errors; no user interaction. The user should query the completion code to determine the outcome of commands when operating silently.</td>
</tr>
<tr>
<td><code>-l, --list</code></td>
<td>Lists all available Solarflare adapters. This option shows the ifname and MAC address. Note: this option may not be used in conjunction with any other option. If this option is used with configuration parameters, those parameters will be silently ignored.</td>
</tr>
<tr>
<td><code>-i, --adapter</code> <code>=&lt;ethX&gt;</code></td>
<td>Performs the action on the identified Solarflare network adapter. The adapter identifier ethX can be the ifname or MAC address, as output by the --list option. If --adapter is not included, the action will apply to all installed Solarflare adapters.</td>
</tr>
<tr>
<td><code>-c, --clear</code></td>
<td>Resets all adapter configuration options to their default values. If an adapter is specified, options for the given adapter are reset, but global options (shown in Table 19) are not reset. Note that --clear can also be used with parameters, allowing you to reset to default values, and then apply the parameters specified.</td>
</tr>
<tr>
<td><code>-r, --repair</code></td>
<td>Restore firmware configuration settings to default values. The sfboot option should only be used if a firmware upgrade/downgrade using sfboot has failed.</td>
</tr>
</tbody>
</table>
The following global parameters in Table 19 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

### Table 19: Sfboot Global Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>boot-image= all</td>
<td>optionrom</td>
</tr>
</tbody>
</table>
| port-mode= default|1x10G|2x10G|4x10G|2x40G | Configure the port mode to use. This is for SFN7000 and SFN8000 series adapters only. The values specify the connectors available after using any splitter cables. The usable values are adapter-dependent:  
  • SFN8722: 2x10G  
  • SFN8542: 4x10G, 2x40G (default)  
  • SFN8522: 2x10G (default)  
  • SFN7xx4F: 2x10G, 4x10G (default)  
  • SFN7xx2Q: 2x10G, 4x10G, 2x40G (default)  
  • SFN7xx2F: 1x10G, 2x10G (default)  
Changes to this setting with sfboot require a cold reboot to become effective. MAC address assignments may change after altering this setting. |
| firmware-variant= full-feature|ultra-low-latency|capture-packed-stream|auto | Configure the firmware variant to use. This is for SFN7000 and SFN8000 series adapters only:  
  • the SFN7002F adapter is factory set to full-feature  
  • all other adapters are factory set to auto.  
Default value = auto - means the driver will select a variant that meets its needs:  
  • the VMware driver always uses full-feature  
  • otherwise, ultra-low-latency is used.  
The ultra-low-latency variant produces best latency without support for TX VLAN insertion or RX VLAN stripping (not currently used features). It is recommended that Onload customers use the ultra-low-latency variant. This is a global option and applies to all ports on the NIC. |
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>insecure-filters=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>mac-spoofing=default</td>
<td>enabled</td>
</tr>
<tr>
<td>rx-dc-size=8</td>
<td>16</td>
</tr>
<tr>
<td>change-mac=default</td>
<td>enabled</td>
</tr>
<tr>
<td>tx-dc-size=8</td>
<td>16</td>
</tr>
<tr>
<td>vi-count=&lt;vi count&gt;</td>
<td>Sets the total number of virtual interfaces that will be available on the NIC.</td>
</tr>
<tr>
<td>event-merge-timeout=&lt;timeout in nanoseconds&gt;</td>
<td>Specifies the timeout in nanoseconds for RX event merging. A timeout of 0 means that event merging is disabled.</td>
</tr>
</tbody>
</table>
The following per-adapter parameters in Table 20 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| link-speed=auto|10g|1g|100m | Specifies the network link speed of the adapter used by the Boot ROM. The default is auto. On the 10GBASE-T adapters, auto instructs the adapter to negotiate the highest speed supported in common with its link partner. On SFP+ adapters, auto instructs the adapter to use the highest link speed supported by the inserted SFP+ module. On 10GBASE-T and SFP+ adapters, any other value specified will fix the link at that speed, regardless of the capabilities of the link partner, which may result in an inability to establish the link.  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| linkup-delay=|<delay time in seconds> | Specifies the delay (in seconds) the adapter defers its first connection attempt after booting, allowing time for the network to come up following a power failure or other restart. This can be used to wait for spanning tree protocol on a connected switch to unblock the switch port after the physical network link is established. The default is 5 seconds.  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| banner-delay=|<delay time in seconds> | Specifies the wait period for Ctrl-B to be pressed to enter adapter configuration tool.  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| bootskip-delay=|<delay time in seconds> | Specifies the time allowed for Esc to be pressed to skip adapter booting.  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| boot-type=pxe|disabled | Sets the adapter boot type – effective on next boot.  

- pxe – PXE (Preboot eXecution Environment) booting  
- disabled – Disable adapter booting
This is the number of available PCIe PFs per physical network port. This setting is applied to all ports on the adapter. Changes to this setting with sfboot require a cold reboot to become effective. MAC address assignments may change after altering this setting.

Specifies the maximum number of MSI-X interrupts that each PF will use. The default is 32. Note: Using the incorrect setting can impact the performance of the adapter. Contact Solarflare technical support before changing this setting.

Enable SR-IOV support for operating systems that support this. Not required on SFN7000 or SFN8000 series adapters.

The number of virtual functions (VF) advertised to the operating system for each Physical Function on this physical network port.

SFN5000/6000 series adapters support 1024 interrupts
SFN7000/8000 series adapters support 2048 interrupts
Solarflare adapters support a total limit of 127 virtual functions per port.

Depending on the values of msix-limit and vf-msix-limit, some of these virtual functions may not be configured.

Enabling all 127 VFs per port with more than one MSI-X interrupt per VF may not be supported by the host BIOS - in which case you may get 127 VFs on one port and none on others. Contact your BIOS vendor or reduce the VF count.

The sriov parameter is implied if vf-count is greater than zero.

Changes to this setting with sfboot require a cold reboot to become effective.

The maximum number of interrupts a virtual function may use.

Table 20: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pf-count=&lt;pf count&gt;</td>
<td>This is the number of available PCIe PFs per physical network port. This setting is applied to all ports on the adapter. Changes to this setting with sfboot require a cold reboot to become effective. MAC address assignments may change after altering this setting.</td>
</tr>
<tr>
<td>msix-limit=8</td>
<td>16</td>
</tr>
<tr>
<td>sriov=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>vf-count=&lt;vf count&gt;</td>
<td>The number of virtual functions (VF) advertised to the operating system for each Physical Function on this physical network port. SFN5000/6000 series adapters support 1024 interrupts SFN7000/8000 series adapters support 2048 interrupts Solarflare adapters support a total limit of 127 virtual functions per port. Depending on the values of msix-limit and vf-msix-limit, some of these virtual functions may not be configured. Enabling all 127 VFs per port with more than one MSI-X interrupt per VF may not be supported by the host BIOS - in which case you may get 127 VFs on one port and none on others. Contact your BIOS vendor or reduce the VF count. The sriov parameter is implied if vf-count is greater than zero. Changes to this setting with sfboot require a cold reboot to become effective.</td>
</tr>
<tr>
<td>vf-msix-limit=1</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 20: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pf-vlans=&lt;tag&gt;[,&lt;tag&gt;[,...]]</td>
<td>none Comma separated list of VLAN tags for each PF in the range 0-4094 - see sfboot --help for details. Setting pf-vlans=none will clear all VLAN tags on the port. pf-vlans should be included after the pf-count option on the sfboot command line. If the number of PFs is changed then the VLAN tags will be cleared.</td>
</tr>
<tr>
<td>switch-mode=</td>
<td>default</td>
</tr>
</tbody>
</table>

Sfboot: Examples

- Show the current boot configuration for all adapters:
  ```bash
  ./sfboot
  ```

  # ./sfboot
  Solarflare boot configuration utility [v4.3.1]
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

  eth4:
  Boot image                      Option ROM only
  Link speed                      Negotiated automatically
  Link-up delay time              5 seconds
  Banner delay time               2 seconds
  Boot skip delay time            5 seconds
  Boot type                       Disabled
  Physical Functions per port     1
  MSI-X interrupt limit           32
  Number of Virtual Functions     0
  VF MSI-X interrupt limit        8

Issue 19 © Solarflare Communications 2017 91
Firmware variant: full feature / virtualization
Insecure filters: Disabled
VLAN tags: None
Switch mode: Default

- List all Solarflare adapters installed on the localhost:
  
  ```bash
  sfbboot --list
  ```

  **Solarflare boot configuration utility [v4.3.1]**
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005
  
  Adapter list:
  
  - eth4
  - eth5

- Enable SR-IOV (SFN5000 and SFN6000 series adapters only)
  
  ```bash
  sfbboot sriov=enabled vf-count=16 vf-msix-limit=1
  ```

  - SFN7000 and SFN8000 series - Firmware Variant
    
    ```bash
    sfbboot firmware-variant=full-feature
    ```

  **Solarflare boot configuration utility [v4.3.1]**
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005
  
  eth4:
  
  - SFN7000 and SFN8000 series - SR-IOV enabled and using Virtual Functions
    
    ```bash
    sfbboot switch-mode=sriov vf-count=4
    ```

  **Solarflare boot configuration utility [v4.3.1]**
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005
  
  eth4:
  
  - Physical Functions per port: 1
  - MSI-X interrupt limit: 32
  - Number of Virtual Functions: 4
  - VF MSI-X interrupt limit: 8
  - Firmware variant: full feature / virtualization
  - Insecure filters: Disabled
  - VLAN tags: None
  - Switch mode: SRIOV
3.22 Upgrading Adapter Firmware with sfupdate

- Sfupdate: Command Usage on page 93.
- Sfupdate: Command Line Options on page 95.
- Sfupdate: Examples on page 96.

Sfupdate is a command line utility to manage and upgrade the Solarflare adapter Boot ROM, Phy and adapter firmware. Embedded within the sfupdate executable are firmware images for the Solarflare adapter - the exact updates available via sfupdate depend on the specific adapter type.

See Solarflare Boot Manager on page 371 for more information on the Boot Rom agent.

⚠️ CAUTION: All Applications accelerated with OpenOnload should be terminated before updating the firmware with sfupdate.

⚠️ CAUTION: Solarflare PTP (sfptpd) should be terminated before updating firmware.

Sfupdate: Command Usage

The general usage for sfupdate is as follows (as root):

```
sfupdate [---adapter=eth<N>] [options]
```

where:

- ethN is the interface name (ifname) of the Solarflare adapter to be upgraded.
- option is one of the command options listed in Table 21.

The format for the options are:

```
<option>=<parameter>
```

Running the command sfupdate with no additional parameters will show the current firmware version for all Solarflare adapters and identifies whether the firmware version within sfupdate is more up to date. To update the firmware for all Solarflare adapters run the command sfupdate --write

Solarflare recommend the following procedure:

1. Run sfupdate to check that the firmware on all adapters is up to date.
2. Run sfupdate --write to update the firmware on all adapters.

Sfupdate: Linux MTD Limitations

The driver supplied “inbox” within RedHat and Novell distributions has a limitation on the number of adapters that sfupdate can support. This limitation is removed from RHEL 6.5 onwards. The Solarflare supplied driver is no longer subject to this limitation on any distro/kernel.
Linux kernel versions prior to 2.6.20 support up to 16 MTD (flash) devices. Solarflare adapters are equipped with 6 flash partitions. If more than two adapters are deployed within a system a number of flash partitions will be inaccessible during upgrade.

The limit was raised to 32 in Linux kernel version 2.6.20 and removed altogether in 2.6.35.

If issues are encountered during sfupdate, the user should consider one of the following options when upgrading firmware on systems equipped with more than two Solarflare adapters:

- Upgrade two adapters at a time with the other adapters removed.
- Upgrade the kernel.
- Rebuild the kernel, raising the value of `MAX_MTD_DEVICES` in `include/linux/mtd/mtd.h`.

**Overcome Linux MTD Limitations**

An alternative method is available to upgrade the firmware without removing the adapters.

1. Unbind all interfaces from the drivers:

   ```bash
   # for bdf in $(lspci -D -d 1924: | awk '{ print $1 }'); do 
   echo -n ${bdf} > /sys/bus/pci/devices/${bdf}/driver/unbind; done
   ```

2. Identify the bus/device/function for all Solarflare interfaces.

   Using `ifconfig -a` will not discover any Solarflare interfaces. Use `lspci`:

   ```bash
   # lspci -D -d 1924:
   ```

   Output similar to the following will be produced (5 NICs installed in this example):

   ```bash
   0000:02:00.0 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:02:00.1 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:03:00.0 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:03:00.1 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:04:00.0 Ethernet controller: Solarflare Communications SFL9021 [Solarstorm]
   0000:04:00.1 Ethernet controller: Solarflare Communications SFL9021 [Solarstorm]
   0000:03:00.0 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:03:00.1 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:04:00.0 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   0000:04:00.1 Ethernet controller: Solarflare Communications SFC9020 [Solarstorm]
   ```

3. There are enough resources to upgrade two NICs at a time, so re-bind interfaces in groups of four (2x2NICs):

   ```bash
   # echo -n "0000:02:00.0" > /sys/bus/pci/drivers/sfc/bind
   # echo -n "0000:02:00.1" > /sys/bus/pci/drivers/sfc/bind
   # echo -n "0000:03:00.0" > /sys/bus/pci/drivers/sfc/bind
   # echo -n "0000:03:00.1" > /sys/bus/pci/drivers/sfc/bind
   ```
Run sfupdate to update these NICs (command options may vary):

```
# sfupdate --write --yes --force
```

Run the command to unbind the interfaces again. There will be failures reported because some of the interfaces are not bound:

```
# for bdf in $(lspci -D -d 1924: | awk '{ print $1 }'); do \
   echo -n ${bdf} > /sys/bus/pci/devices/${bdf}/driver/unbind; done
```

Repeat the process for the other interfaces (0000:04:00.x; 0000:83:00.x and 0000:84:00.x) doing so in pairs until all the NICs have been upgraded.

Rebind all interfaces, doing so en-mass and ignoring errors from those already bound:

```
# for bdf in $(lspci -D -d 1924: | awk '{ print $1 }'); do \
   echo -n ${bdf} > /sys/bus/pci/drivers/sfc/bind; done
```

Alternatively reload the sfc driver:

```
# onload_tool reload
```

or:

```
# modprobe -r sfc
# modprobe sfc
```

Run `ifconfig -a` again to find that all the interfaces are reported and all have been firmware upgraded without having to physically touch the server or change the kernel.

**Sfupdate: SLES 11 Limitation**

Due to limitations in SLES 11 using kernel versions prior to 2.6.27.54 it is necessary to reboot the server after running the sfupdate utility to upgrade server firmware.

**Sfupdate: Command Line Options**

Table 21 lists the options for sfupdate.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-h, --help</code></td>
<td>Shows help for the available options and command line syntax.</td>
</tr>
<tr>
<td><code>-i, --adapter=ethX</code></td>
<td>Specifies the target adapter when more than one adapter is installed in the localhost. ethX = Adapter ifname or MAC address (as obtained with --list).</td>
</tr>
<tr>
<td><code>--list</code></td>
<td>Shows the adapter ID, adapter name and MAC address of each adapter installed in the localhost.</td>
</tr>
</tbody>
</table>
Table 21: Sfupdate Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>--write</td>
<td>Re-writes the firmware from the images embedded in the sfupdate tool. To re-write using an external image, specify --image=&lt;filename&gt; in the command. --write fails if the embedded image is the same or a previous version. To force a write in this case, specify --force in the command.</td>
</tr>
<tr>
<td>--force</td>
<td>Force the update of all firmware, even if the installed firmware version is the same as, or more recent than, the firmware embedded in sfupdate.</td>
</tr>
<tr>
<td>--backup</td>
<td>Backup existing firmware image before updating. This option may be used with --write and --force.</td>
</tr>
<tr>
<td>--image=(filename)</td>
<td>Update the firmware using the binary image from the given file rather than from those embedded in the utility.</td>
</tr>
<tr>
<td>--ipxe-image= (filename)</td>
<td>Install an iPXE image from the given file, replacing the Solarflare boot ROM image. sfupdate will not automatically replace the iPXE image in subsequent flash updates unless the --restore-bootrom option is used.</td>
</tr>
<tr>
<td>--restore-bootrom</td>
<td>Replace an iPXE image in flash with the standard Solarflare Boot Manager PXE image included in sfupdate.</td>
</tr>
<tr>
<td>-y, --yes</td>
<td>Update without prompting. This option can be used with the --write and --force options.</td>
</tr>
<tr>
<td>-v, --verbose</td>
<td>Verbose mode.</td>
</tr>
<tr>
<td>-s, --silent</td>
<td>Suppress output while the utility is running; useful when the utility is used in a script.</td>
</tr>
<tr>
<td>-V, --version</td>
<td>Display version information and exit.</td>
</tr>
</tbody>
</table>

Sfupdate: Examples

- Display firmware versions for all adapters:

  sfupdate

Solarstorm firmware update utility [v4.3.1]
Copyright Solarflare Communications 2006-2013, Level 5 Networks 2002-2005

eth4 - MAC: 00-0F-53-21-00-61
   Controller type: Solarflare SFC9100-family
   Controller version: unknown
Boo ROM version: unknown

This utility contains more recent Boot ROM firmware [v4.2.1.1000]
- run "sfupdate --write" to perform an update
This utility contains more recent controller firmware [v4.2.1.1010]
- run "sfupdate --write" to perform an update

eth5 - MAC: 00-0F-53-21-00-60
Controller type: Solarflare SFC9100-family
Controller version: unknown
Boot ROM version: unknown

This utility contains more recent Boot ROM firmware [v4.2.1.1000]
- run "sfupdate --write" to perform an update
This utility contains more recent controller firmware [v4.2.1.1010]
- run "sfupdate --write" to perform an update

3.23 License Install with sfkey

The sfkey utility is distributed with the Linux Utilities RPM package. This utility is used to install Solarflare AppFlex™ licenses and enable selected on-board services for Solarflare adapters. For more information about license requirements see Solarflare AppFlex™ Technology Licensing, on page 17.

sfkey: Command Usage

```
# sfkey [--adapter=eth<N>] [options]
```

If the adapter option is not specified, operations will be applied to all installed adapters.

- To view all sfkey options:
  
  `# sfkey --help`

- To list (by licensing ID) all adapters that support licensing:
  
  `# sfkey --inventory --all`

```
eth2: 714100101282140148200014
```

- To display an adapter’s licensing ID and installed license keys:
  
  `# sfkey --adapter=eth2 --report`

```
eth2: 714100101282140148200014 (Flareon)
Product name: Solarflare SFN7141Q QSFP+ Flareon Ultra Server Adapter
Installed keys Onload
```

- To install a license:
  
  Copy the license key data to a .txt file on the target server. All keys can be in the same key file and the file applied on multiple servers. The following example uses a license key file called key.txt created on the local server.

  `# sfkey --adapter=eth2 --install keys.txt`
License Inventory

Use the combined --inventory and --keys options to identify the licenses installed on an adapter.

```
# sfkey --adapter=eth2 --inventory --keys
eth2: 714100101282140148200014 (Flareon), $ONL, !PTP, !SCL, SCP, CSS, !SSFE, !PM, !NAC
```

License information is displayed in [Prefix] [AppID] [Suffix] format.

<table>
<thead>
<tr>
<th>Prefix:</th>
<th>&lt;none&gt;</th>
<th>Licensed</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td></td>
<td>Factory-fitted</td>
</tr>
<tr>
<td>!</td>
<td></td>
<td>Not present</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AppID:</th>
<th>An</th>
<th>Application ID number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;name&gt;</td>
<td></td>
<td>Application acronym</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Suffix:</th>
<th>&lt;none&gt;</th>
<th>Licensed</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td></td>
<td>Site licensed</td>
</tr>
<tr>
<td>~</td>
<td></td>
<td>Evaluation license</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td>Inactive license</td>
</tr>
<tr>
<td>@</td>
<td></td>
<td>Inactive site license</td>
</tr>
<tr>
<td>-</td>
<td></td>
<td>No state available</td>
</tr>
</tbody>
</table>
## sfkey Options

Table 22 describes all sfkey options.

### Table 22: sfkey options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>--backup</td>
<td>Output a report of the installed keys in all adapters. The report can be saved to file and later used with the --install option.</td>
</tr>
</tbody>
</table>
| --install <filename>  | Install license keys from the given file and report the result. To read from stdin use “-” in place of filename. Keys are installed to an adapter, so if an adapter’s ports are eth4 and eth5, both ports will be affected by the keys installed.  
                       | *sfc driver reload is required after sfkey installs certain types of license (e.g. a PTP license).*  
                       | To reload the sfc driver:  
                       | # modprobe -r sfc; modprobe sfc  
                       | or when Onload is installed:  
                       | # onload_tool reload |
| --inventory           | List the adapters that support licensing. By default this will list adapters that support licenses. To list all adapters use the --all option. To list keys use the --keys option. |
| --keys                | Include keys in --inventory output - see License Inventory above.                                                                                                                                 |
| --noevaluationupdate  | Do not update any evaluation keys.                                                                                                                                 |
| -a, --all             | Apply sfkey operation to all adapters that support licensing.                                                                                                                                 |
| -c, --clear           | Delete all existing license keys from an adapter - except factory installed keys.                                                                                                                                 |
| -h, --help            | Display all sfkey options.                                                                                                                                 |
| -i, --adapter         | Identify specific adapter to apply sfkey operation to.                                                                                                                                 |
3.24 Performance Tuning on Linux

- Introduction on page 100
- Tuning settings on page 101
- Other Considerations on page 112

Introduction

The Solarflare family of network adapters are designed for high-performance network applications. The adapter driver is pre-configured with default performance settings that have been designed to give good performance across a broad class of applications. Occasionally, application performance can be improved by tuning these settings to best suit the application.

There are three metrics that should be considered when tuning an adapter:

- Throughput
- Latency
- CPU utilization

Different applications may be more or less affected by improvements in these three metrics. For example, transactional (request-response) network applications can be very sensitive to latency whereas bulk data transfer applications are likely to be more dependent on throughput.

The purpose of this section is to highlight adapter driver settings that affect the performance metrics described. This section covers the tuning of all Solarflare adapters.
Latency will be affected by the type of physical medium used: 10GBase-T, twinaxial (direct-attach), fiber or KX4. This is because the physical media interface chip (PHY) used on the adapter can introduce additional latency. Likewise, latency can also be affected by the type of SFP/SFP+/QSFP module fitted.

In addition, you may need to consider other issues influencing performance, such as application settings, server motherboard chipset, CPU speed, cache size, RAM size, additional software installed on the system, such as a firewall, and the specification and configuration of the LAN. Consideration of such issues is not within the scope of this guide.

**Tuning settings**

**Port mode**

The selected port mode for SFN7000 and SFN8000 series adapters should correspond to the speed and number of connectors in use, after using any splitter cables. If a restricted set of connectors is configured, the driver can then transfer resources from the unused connectors to those configured, potentially improving performance.

**Adapter MTU (Maximum Transmission Unit)**

The default MTU of 1500 bytes ensures that the adapter is compatible with legacy 10/100Mbps Ethernet endpoints. However, if a larger MTU is used, adapter throughput and CPU utilization can be improved. CPU utilization is improved, because it takes fewer packets to send and receive the same amount of data. Solarflare adapters support an MTU of up to 9216 bytes (this does not include the Ethernet preamble or frame-CRC).

Since the MTU should ideally be matched across all endpoints in the same LAN (VLAN), and since the LAN switch infrastructure must be able to forward such packets, the decision to deploy a larger than default MTU requires careful consideration. It is recommended that experimentation with MTU be done in a controlled test environment.

The MTU is changed dynamically using ifconfig, where ethX is the interface name and <size> is the MTU size in bytes:

```
# /sbin/ifconfig <ethX> mtu <size>
```

Verification of the MTU setting may be performed by running ifconfig with no options and checking the MTU value associated with the interface. The change in MTU size can be made to persist across reboots by editing the file `/etc/sysconfig/network-scripts/ifcfg-ethX` and adding `MTU=<mtu>` on a new line.
Interrupt Moderation (Interrupt Coalescing)

Interrupt moderation reduces the number of interrupts generated by the adapter by coalescing multiple received packet events and/or transmit completion events together into a single interrupt.

The interrupt moderation interval sets the minimum time (in microseconds) between two consecutive interrupts. Coalescing occurs only during this interval:

- When the driver generates an interrupt, it starts timing the moderation interval.
- Any events that occur before the moderation interval expires are coalesced together into a single interrupt, that is raised only when the interval expires. A new moderation interval then starts, during which no interrupt is raised.
- An event that occurs after the moderation interval has expired gets its own dedicated interrupt, that is raised immediately. A new moderation interval then starts, during which no interrupt is raised.

Solarflare adapters, by default, use an adaptive algorithm where the interrupt moderation delay is automatically adjusted between zero (no interrupt moderation) and 60 microseconds. The adaptive algorithm detects latency sensitive traffic patterns and adjusts the interrupt moderation interval accordingly.

Interrupt moderation settings are critical for tuning adapter latency:

- Disabling the adaptive algorithm will:
  - reduce jitter
  - allow setting the moderation interval as required to suit conditions.

- Increasing the interrupt moderation interval will:
  - generate less interrupts
  - reduce CPU utilization (because there are less interrupts to process)
  - increase latency
  - improve peak throughput.

- Decreasing the interrupt moderation interval will:
  - generate more interrupts
  - increase CPU utilization (because there are more interrupts to process)
  - decrease latency
  - reduce peak throughput.

- Turning off interrupt moderation will:
  - generate the most interrupts
  - give the highest CPU utilization
  - give the lowest latency
  - give the biggest reduction in peak throughput.
For many transaction request-response type network applications, the benefit of reduced latency to overall application performance can be considerable. Such benefits typically outweigh the cost of increased CPU utilization. It is recommended that:

- Interrupt moderation is disabled for applications that require best latency and jitter performance, such as market data handling.
- Interrupt moderation is enabled for high throughput single (or few) connection TCP streaming applications, such as iSCSI.

Interrupt moderation can be changed using ethtool, where ethX is the interface name. Before adjusting the interrupt moderation interval, it is recommended to disable adaptive moderation:

```
ethtool -C <ethX> adaptive-rx off
```

To set the RX interrupt moderation interval in microseconds (μs):

```
ethtool -C <ethX> rx-usecs <interval>
```

To turn off interrupt moderation, set an interval of zero (0):

```
ethtool -C <ethX> rx-usecs 0
```

The above example also sets the transmit interrupt moderation interval, unless the driver module parameter separate_tx_channels is enabled. (Normally packet RX and TX completions will share interrupts, so RX and TX interrupt moderation intervals must be equal, and the adapter driver automatically adjusts tx-usecs to match rx-usecs.) Refer to Table 27 on page 120.

To set the TX interrupt moderation interval, if separate_tx_channels is enabled:

```
ethtool -C <ethX> tx-usecs <interval>
```

Interrupt moderation settings can be checked using ethtool -c.

**NOTE:** The performance benefits of TCP Large Receive Offload are limited if interrupt moderation is disabled. See TCP Large Receive Offload (LRO) on page 104.

**TCP/IP Checksum Offload**

Checksum offload moves calculation and verification of IP Header, TCP and UDP packet checksums to the adapter. The driver has all checksum offload features enabled by default. Therefore, there is no opportunity to improve performance from the default.

Checksum offload is controlled using ethtool:

- **Receive Checksum:**
  ```
  # /sbin/ethtool -K <ethX> rx <on|off>
  ```

- **Transmit Checksum:**
  ```
  # /sbin/ethtool -K <ethX> tx <on|off>
  ```

Verification of the checksum settings may be performed by running ethtool with the -k option.

**NOTE:** Solarflare recommend you do not disable checksum offload.
TCP Segmentation Offload (TSO)

TCP Segmentation Offload (TSO) offloads the splitting of outgoing TCP data into packets to the adapter. TSO benefits applications using TCP. Applications using protocols other than TCP will not be affected by TSO.

Enabling TSO will reduce CPU utilization on the transmit side of a TCP connection and improve peak throughput, if the CPU is fully utilized. Since TSO has no effect on latency, it can be enabled at all times. The driver has TSO enabled by default. Therefore, there is no opportunity to improve performance from the default.

TSO is controlled using ethtool:

```
# /sbin/ethtool -K <ethX> tso <on|off>
```

Verification of the TSO settings may be performed by running ethtool with the –k option.

TCP and IP checksum offloads must be enabled for TSO to work.

**NOTE:** Solarflare recommend that you do not disable this setting.

TCP Large Receive Offload (LRO)

TCP Large Receive Offload (LRO) is a feature whereby the adapter coalesces multiple packets received on a TCP connection into a single larger packet before passing this onto the network stack for receive processing. This reduces CPU utilization and improves peak throughput when the CPU is fully utilized. The effectiveness of LRO is bounded by the interrupt moderation delay, and is limited if interrupt moderation is disabled (see Interrupt Moderation (Interrupt Coalescing) on page 102). Enabling LRO does not itself negatively impact latency.

**NOTE:** The Solarflare network adapter driver enables LRO by default. By its design, LRO is of greater benefit when working with smaller packets. For Solarflare adapter, LRO will become disabled if the MTU is set larger than 3979. When the MTU is set larger than 3978, LRO cannot be enabled and will be reported as ‘fixed disabled’ by ethtool.

**NOTE:** LRO should **NOT** be enabled when using the host to forward packets from one interface to another. For example, if the host is performing IP routing.
NOTE: It has been observed that as RHEL6 boots the libvirtd daemon changes the default forwarding setting such that LRO is disabled on all network interfaces. This behavior is undesirable as it will potentially lower bandwidth and increase CPU utilization - especially for high bandwidth streaming applications.

To determine if LRO is enabled on an interface:
```
ethtool -k ethX
```

If IP forwarding is not required on the server, Solarflare recommends either:

- Disabling the libvirtd service (if this is not being used),

- Or, as root before loading the Solarflare driver:
```
sysctl -w net.ipv4.conf.default.forwarding=0
```
(This command can be loaded into `/etc/rc.local'),

- Or, after loading the Solarflare driver, turn off forwarding for only the Solarflare interfaces and re-enable LRO:
```
sysctl -w net.ipv4.conf.ethX.forwarding=0
ethtool -K ethX lro on
```
(Where X is the id of the Solarflare interface).

Disabling the libvirtd service is a permanent solution, whereas the other recommendations are temporary and will not persist over reboot.

LRO should not be enabled if IP forwarding is being used on the same interface as this could result in incorrect IP and TCP operation.

LRO can be controlled using the module parameter `lro`. Add the following line to `/etc/modprobe.conf` or add the options line to a file under the `/etc/modprobe.d` directory to disable LRO:
```
options sfc lro=0
```
Then reload the driver so it picks up this option:
```
rmmod sfc
modprobe sfc
```

The current value of this parameter can be found by running:
```
cat /sys/module/sfc/parameters/lro
```

LRO can also be controlled on a per-adaptor basis by writing to this file in `/sysfs`:
```
/sys/class/net/ethX/device/lro
```

- To disable LRO:
  ```
echo 0 > /sys/class/net/ethX/device/lro
```
- To enable LRO:
  ```
echo 1 > /sys/class/net/ethX/device/lro
```
To show the current value of the per-adapter LRO state:

```
cat /sys/class/net/ethX/device/lro
```

Modifying this file instantly enables or disables LRO, no reboot or driver reload is required. This setting takes precedence over the `lro` module parameter.

Current LRO settings can be identified with Linux `ethtool` e.g.

```
ethtool -k ethX
```

TCP and IP checksum offloads must be enabled for LRO to work.

### TCP Protocol Tuning

TCP Performance can also be improved by tuning kernel TCP settings. Settings include adjusting send and receive buffer sizes, connection backlog, congestion control, etc.

For Linux kernel versions, including 2.6.16 and later, initial buffering settings should provide good performance. However for earlier kernel versions, and for certain applications even on later kernels, tuning buffer settings can significantly benefit throughput. To change buffer settings, adjust the `tcp_rmem` and `tcp_wmem` using the `sysctl` command:

- **Receive buffering:**
  ```
sysctl net.ipv4.tcp_rmem="<min> <default> <max>"
  ```

- **Transmit buffering:**
  ```
sysctl net.ipv4.tcp_wmem="<min> <default> <max>"
  ```

(tcp_rmem and tcp_wmem can also be adjusted for IPV6 and globally with the `net.ipv6` and `net.core` variable prefixes respectively).

Typically it is sufficient to tune just the max buffer value. It defines the largest size the buffer can grow to. Suggested alternate values are max=500000 (1/2 Mbyte). Factors such as link latency, packet loss and CPU cache size all influence the affect of the max buffer size values. The minimum and default values can be left at their defaults minimum=4096 and default=87380.

### Buffer Allocation Method

The Solarflare driver has a single optimized buffer allocation strategy. This replaces the two different methods controlled with the `rx_alloc_method` driver module parameter which were available using 3.3 and previous drivers.

The net driver continues to expose the `rx_alloc_method` module option, but the value is ignored and it only exists to not break existing customer configurations.
TX PIO

PIO (programmed input/output) describes the process where data is directly transferred by the CPU to or from an I/O device. It is an alternative technique to the I/O device using bus master DMA to transfer data without CPU involvement.

Solarflare SFN7000 and SFN8000 series adapters support TX PIO, where packets on the transmit path can be “pushed” to the adapter directly by the CPU. This improves the latency of transmitted packets but can cause a very small increase in CPU utilization. TX PIO is therefore especially useful for smaller packets.

The TX PIO feature is enabled by default for packets up to 256 bytes. The maximum packet size that can use PIO can be configured with the driver module option piobuf_size.

3.25 Web Server - Driver Optimization

Introduction

The Solarflare net driver from version 4.4.1.1017 on Solarflare SFN7000 and SFN8000 series adapters includes optimizations aimed specifically at web service providers and cloud based applications.

Tuning recommendations are documented in Table 23 for users concerned with Content Delivery Networks (CDN), HTTP web hosting application technologies such as HA Proxy, nginx and HTTP web servers.

When tested on the Solarflare SFN7122 and SFN7002 adapters using the recommended driver and firmware with minimal driver/hardware tunings, performance improvements have been observed in the following areas:

- increased the rate at which servers can process new HTTP connections
- increased the rate at which servers can process HTTP requests
- increased sustained throughput when processing large files via HTTP
- improved kernel throughput performance

Customers requiring further details or to access test data should send an email to support@solarflare.com.
Driver Tuning

Whilst most driver enhancements are internal changes, transparent and non-configurable by the user, the following driver module options can be used to tune the driver for particular user applications.

- **rss_numa_local**
  Using the 4.4.1.1017 driver this option is enabled by default. This will restrict RSS to use CPU cores only on the NUMA node closest to the adapter. This is particularly important for processors supporting DDOI.
  RSS channels not on the local NUMA node can still be accessed using the `ethtool -U` commands to identify a core (action) on which to process the specified ethtool ntuple filter traffic. For example if `rss_cpus=cores`, then an RSS receive channel and associated MSI-X interrupt is created for every core.

- **rx_recycle_ring_size**
  The default value for the maximum number of receive buffers to recycle pages for has been changed to 512, and in newer drivers will be further increased to 1024.

- **rx_copybreak**
  A default value of 192 bytes has been selected as the maximum size of packet (bytes) that will be copied directly to the network stack.

Driver module options can be enabled in a user-created file (e.g `sfc.conf`) in the `/etc/modprobe.d` directory, for example:

```bash
options sfc rss_numa_local=Y
options sfc rx_recycle_ring_size=512
```

For further descriptions and to list all sfc driver module options:

```
# modinfo sfc
```

**nginx Tuning**

<table>
<thead>
<tr>
<th>Tuning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO_REUSEPORT</td>
<td>Solarflare testing involving nginx used version v1.7.9 with applied patch to support so_reuseport. See the following link for details: <a href="http://forum.nginx.org/read.php?29,241283,241283">http://forum.nginx.org/read.php?29,241283,241283</a>.</td>
</tr>
<tr>
<td>rss_cpus=N</td>
<td>Create N receive queues where N=(number of logical cores)/2. See Receive Side Scaling (RSS) on page 78 for options.</td>
</tr>
</tbody>
</table>
To benefit from recent driver optimizations, the following (minimum) net driver and firmware versions should be used:

```bash
# ethtool -i eth<N> 
driver: sfc
version: 4.4.1.1017
firmware-version: 4.4.2.1011 rx1 tx1
```

For latency sensitive applications, the adapter firmware variant should be set with the sfboot utility to ultra-low-latency:

```bash
# sfboot --adapter=eth<N> firmware-variant=ultra-low-latency
```

The ultra-low-latency firmware variant is being used when the output from ethtool (above) shows the rx1 and tx1 values.

A reboot of the server is required after changes using sfboot.

---

**Table 23: nginx Server Tuning**

<table>
<thead>
<tr>
<th>Tuning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>rss_numa_local=1</td>
<td>On SMP systems it is recommended to have all interrupts on the NUMA node local to the Solarflare adapter: rss_numa-local=1, and pin nginx threads to the free CPUs even when these are on the non-local node. When this is not possible, CPU cores can be divided equally between interrupts and nginx threads. rss_numa_local=1 is the default setting.</td>
</tr>
<tr>
<td>Pinning threads</td>
<td>Application threads and interrupts should not be pinned to the same CPU cores.</td>
</tr>
<tr>
<td>ethtool -C adaptive-rx off</td>
<td>Disable the irq-balance service to prevent re-distribution of interrupts by the kernel. Disable adaptive interrupt moderation before setting the interrupt moderation interval.</td>
</tr>
<tr>
<td>ethtool -C rx-usecs 60</td>
<td>Set the interrupt moderation interval. When processing smaller packets it is generally better to set a higher interval i.e. 60µsecs and for larger packets a lower interval or even zero to disable interrupt moderation. See Interrupt Moderation (Interrupt Coalescing) on page 102.</td>
</tr>
</tbody>
</table>
3.26 Interrupt Affinity

Interrupt affinity describes the set of host CPUs that may service a particular interrupt.

This affinity therefore dictates the CPU context where received packets will be processed and where transmit packets will be freed once sent. If the application can process the received packets in the same CPU context by being affinitized to the relevant CPU, then latency and CPU utilization can be improved. This improvement is achieved because well tuned affinities reduce inter-CPU communication.

Tuning interrupt affinity is most relevant when MSI-X interrupts and RSS are being used. The irqbalance service, which typically runs by default in most Linux distributions, is a service that automatically changes interrupt affinities based on CPU workload.

In many cases the irqbalance service hinders rather than enhances network performance. It is therefore necessary to disable it and then set interrupt affinities.

- To disable irqbalance permanently, run:
  `/sbin/chkconfig -level 12345 irqbalance off`
- To see whether irqbalance is currently running, run:
  `/sbin/service irqbalance status`
- To disable irqbalance temporarily, run:
  `/sbin/service irqbalance stop`

Once the irqbalance service has been stopped, the Interrupt affinities can be configured manually.

**NOTE:** The Solarflare driver will evenly distribute interrupts across the available host CPUs (based on the `rss_cpus` module parameter).

To use the Solarflare driver default affinities (recommended), the irqbalance service must be disabled before the Solarflare driver is loaded (otherwise it will immediately overwrite the affinity configuration values set by the Solarflare driver).

**Example 1:**

How affinities should be manually set will depend on the application. For a single streamed application such as Netperf, one recommendation would be to affinitize all the Rx queues and the application on the same CPU. This can be achieved with the following steps:

1. Determine which interrupt line numbers the network interface uses. Assuming the interface is eth0, this can be done with:

   ```
   # cat /proc/interrupts | grep eth0-
   123: 13302 0 0 0  PCI-MSI-X eth0-0
   131: 0 24 0 0  PCI-MSI-X eth0-1
   139: 0 0 32 0  PCI-MSI-X eth0-2
   147: 0 0 0 21  PCI-MSI-X eth0-3
   ```
This output shows that there are four channels (rows) set up between four CPUs (columns).

2 Determine the CPUs to which these interrupts are assigned to:

```
# cat /proc/irq/123/smp_affinity
00000000,00000000,00000000,00000000,00000000,00000000,00000000,00000001
# cat /proc/irq/131/smp_affinity
00000000,00000000,00000000,00000000,00000000,00000000,00000000,00000002
# cat /proc/irq/139/smp_affinity
00000000,00000000,00000000,00000000,00000000,00000000,00000000,00000004
# cat /proc/irq/147/smp_affinity
00000000,00000000,00000000,00000000,00000000,00000000,00000000,00000008
```

This shows that RXQ[0] is affinitized to CPU[0], RXQ[1] is affinitized to CPU[1], and so on. With this configuration, the latency and CPU utilization for a particular TCP flow will depend on that flow’s RSS hash, and which CPU that hash resolves onto.

**NOTE:** Interrupt line numbers and their initial CPU affinity are not guaranteed to be the same across reboots and driver reloads. Typically, it is therefore necessary to write a script to query these values and apply the affinity accordingly.

3 Set all network interface interrupts to a single CPU (in this case CPU[0]):

```
# echo 1 > /proc/irq/123/smp_affinity
# echo 1 > /proc/irq/131/smp_affinity
# echo 1 > /proc/irq/139/smp_affinity
# echo 1 > /proc/irq/147/smp_affinity
```

**NOTE:** The read-back of /proc/irq/N/smp_affinity will return the old value until a new interrupt arrives.

4 Set the application to run on the same CPU (in this case CPU[0]) as the network interface’s interrupts:

```
# taskset 1 netperf
# taskset 1 netperf -H <host>
```

**NOTE:** The use of taskset is typically only suitable for affinity tuning single threaded, single traffic flow applications. For a multi threaded application, whose threads for example process a subset of receive traffic, taskset is not suitable. In such applications, it is desirable to use RSS and Interrupt affinity to spread receive traffic over more than one CPU and then have each receive thread bind to each of the respective CPUs. Thread affinities can be set inside the application with the shed_setaffinity() function (see Linux man pages). Use of this call and how a particular application can be tuned is beyond the scope of this guide.

If the settings have been correctly applied, all interrupts from eth0 are being handled on CPU[0]. This can be checked:

```
# cat /proc/interrupts | grep eth0-
123:  13382  0  0  0  PCI-MSI-X  eth0-0
131:  0  24  0  0  PCI-MSI-X  eth0-1
139:  0  0  32  0  PCI-MSI-X  eth0-2
147:  0  0  0  21  PCI-MSI-X  eth0-3
```
Example 2:

An example of affinitizing each interface to a CPU on the same package:

First identify which interrupt lines are servicing which CPU and IO device:

```
# cat /proc/interrupts | grep eth0-
123:  13302  0 1278131  0  PCI-MSI-X  eth0-0
# cat /proc/interrupts | grep eth1-
131:  0  24   0   0  PCI-MSI-X  eth1-0
```

Find CPUs on same package (have same ‘package-id’):

```
# more /sys/devices/system/cpu/cpu*/topology/physical_package_id
:::::::::::::::::::
/sys/devices/system/cpu/cpu0/topology/physical_package_id
:::::::::::::::::::
1
:::::::::::::::::::
/sys/devices/system/cpu/cpu10/topology/physical_package_id
:::::::::::::::::::
1
:::::::::::::::::::
/sys/devices/system/cpu/cpu11/topology/physical_package_id
:::::::::::::::::::
0
```

Having determined that cpu0 and cpu10 are on package 1, we can assign each ethX interface’s MSI-X interrupt to its own CPU on the same package. In this case we choose package 1:

```
# echo 1 > /proc/irq/123/smp_affinity      # 1hex is bit 0 = CPU0
# echo 400 > /proc/irq/131/smp_affinity    # 400hex is bit 10 = CPU10
```

Other Considerations

**PCI Express Lane Configurations**

The PCI Express (PCIe) interface used to connect the adapter to the server can function at different speeds and widths. This is independent of the physical slot size used to connect the adapter. The possible widths are multiples x1, x2, x4, x8 and x16 lanes of (2.5Gbps for PCIe Gen 1, 5.0 Gbps for PCIe Gen 2 and 8.0Gbps for PCIe Gen 3) in each direction. **Solarflare adapters are designed for x8 or x16 lane operation.**

On some server motherboards, choice of PCIe slot is important. This is because some slots (including those that are physically x8 or x16 lanes) may only electrically support x4 lanes. In x4 lane slots, Solarflare PCIe adapters will continue to operate, but not at full speed. The Solarflare driver will warn if it detects that the adapter is plugged into a PCIe slot which electrically has fewer than x8 lanes.

Solarflare SFN5000 and SFN6000 series adapters require a PCIe Gen 2 x8 slot for optimal operation. Solarflare SFN7000 and SFN8000 series adapters require a PCIe Gen 3 x8 or x16 slot for optimal performance. The Solarflare driver will warn if it detects that the adapter is placed in a sub-optimal slot.
Warning messages can be viewed in dmesg from /var/log/messages.
The lspci command can be used to discover the currently negotiated PCIe lane width and speed:

```bash
lspci -d 1924: -vv
 02:00.1 Class 0200: Unknown device 1924:0710 (rev 01)
  ... Link: Supported Speed 2.5Gb/s, Width x8, ASPM L0s, Port 1
  Link: Speed 2.5Gb/s, Width x8
```

**NOTE:** The Supported speed may be returned as 'unknown', due to older lspci utilities not knowing how to determine that a slot supports PCIe Gen. 2.0/5.0 Gb/s or PCIe Gen 3.0/8.0 Gb/s.

In addition, the latency of communications between the host CPUs, system memory and the Solarflare PCIe adapter may be PCIe slot dependent. Some slots may be “closer” to the CPU, and therefore have lower latency and higher throughput. If possible, install the adapter in a slot which is local to the desired NUMA node. Please consult your server user guide for more information.

**CPU Speed Service**

Most Linux distributions will have the cpuspeed service running by default. This service controls the CPU clock speed dynamically according to current processing demand. For latency sensitive applications, where the application switches between having packets to process and having periods of idle time waiting to receive a packet, dynamic clock speed control may increase packet latency. Solarflare recommend disabling the cpuspeed service if minimum latency is the main consideration.

The service can be disabled temporarily:

```
/sbin/service cpuspeed stop
```

The service can be disabled across reboots:

```
/sbin/chkconfig –level 12345 cpuspeed off
```

**CPU Power Service**

On RHEL7 systems, cpuspeed is replaced with cpupower. Solarflare recommend disabling the cpupower service if minimum latency is the main consideration. The service is controlled via systemctl:

```
systemctl stop cpupower
systemctl disable cpupower
```

**Tuned Service**

On RHEL7 systems, it may be beneficial to disable the tuned service if minimum latency is the main consideration. Users are advised to experiment. The service is controlled via systemctl:

```
systemctl stop tuned
systemctl disable tuned
```
Busy poll
If the kernel supports the *busy poll* features (Linux 3.11 or later), and minimum latency is the main consideration, Solarflare recommend that the busy_poll socket options should be enabled with a value of 50 microseconds as follows:

```
sysctl net.core.busy_poll=50 && sysctl net.core.busy_read=50
```

Only sockets having a non-zero value for SO_BUSY_POLL will be polled, so the user should do one of the following:

- set the poll timeout with the global busy_read option, as shown above,
- set the per-socket SO_BUSY_POLL socket option on selected sockets.

Setting busy_read also sets the default value for the SO_BUSY_POLL option.

Memory bandwidth
Many chipsets use multiple channels to access main system memory. Maximum memory performance is only achieved when the chipset can make use of all channels simultaneously. This should be taken into account when selecting the number of memory modules (DIMMs) to populate in the server. For optimal memory bandwidth in the system, it is likely that:

- all DIMM slots should be populated
- all NUMA nodes should have memory installed.

Please consult the motherboard documentation for details.

Intel® QuickData / NetDMA
On systems that support Intel I/OAT (I/O Acceleration Technology) features such as QuickData (a.k.a NetDMA), Solarflare recommend that these are enabled as they are rarely detrimental to performance.

Using Intel® QuickData Technology allows data copies to be performed by the system and not the operating system. This enables data to move more efficiently through the server and provide fast, scalable, and reliable throughput.

**Enabling QuickData**

- On some systems the hardware associated with QuickData must first be enabled (once only) in the BIOS
- Load the QuickData drivers with `modprobe ioatdma`

Server Motherboard, Server BIOS, Chipset Drivers
Tuning or enabling other system capabilities may further enhance adapter performance. Readers should consult their server user guide. Possible opportunities include tuning PCIe memory controller (PCle Latency Timer setting available in some BIOS versions).
Tuning Recommendations

The following tables provide recommendations for tuning settings for different applications.

- Throughput - Table 24 on page 115
- Latency - Table 25 on page 116
- Forwarding - Table 26 on page 118

Recommended Throughput Tuning

Table 24 shows recommended tuning settings for throughput:

Table 24: Throughput Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU Size</td>
<td>Configure to maximum supported by network:</td>
</tr>
<tr>
<td></td>
<td>/sbin/ifconfig &lt;ethX&gt; mtu &lt;size&gt;</td>
</tr>
<tr>
<td>Interrupt moderation</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Segmentation Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Large Receive Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default for 2.6.16 and later kernels.</td>
</tr>
<tr>
<td></td>
<td>For earlier kernels:</td>
</tr>
<tr>
<td></td>
<td>sysctl net.core.tcp_rmem 4096 87380 524288</td>
</tr>
<tr>
<td></td>
<td>sysctl net.core.tcp_wmem 4096 87380 524288</td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Application dependent</td>
</tr>
<tr>
<td>Interrupt affinity &amp; irqbalance service</td>
<td>Interrupt affinity settings are application dependent</td>
</tr>
<tr>
<td></td>
<td>Stop irq balance service:</td>
</tr>
<tr>
<td></td>
<td>/sbin/service irqbalance stop</td>
</tr>
<tr>
<td></td>
<td>Reload the drivers to use the driver default interrupt affinity.</td>
</tr>
<tr>
<td>Buffer Allocation Method</td>
<td>Leave at default. Some applications may benefit from specific setting.</td>
</tr>
<tr>
<td></td>
<td>The Solarflare driver now supports a single optimized buffer allocation strategy and any value set by the rx_alloc_method parameter is ignored.</td>
</tr>
</tbody>
</table>
Table 24: Throughput Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI Express Lane Configuration</td>
<td>Ensure the adapter is in an x8 slot (2.0 or later), and that current speed (not the supported speed) reads back as “x8 and 5GT/s”, or “x8 and 8GT/s”, or “x8 and Unknown”.</td>
</tr>
<tr>
<td>CPU Speed Service (cpuspeed)</td>
<td>Leave enabled.</td>
</tr>
<tr>
<td>Memory bandwidth</td>
<td>Ensure memory utilizes all memory channels on system motherboard.</td>
</tr>
<tr>
<td>Intel QuickData (Intel chipsets only)</td>
<td>Enable in BIOS and install driver: modprobe ioatdma</td>
</tr>
</tbody>
</table>

Recommended Latency Tuning

Table 25 shows recommended tuning settings for latency:

Table 25: Latency Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU Size</td>
<td>Configure to maximum supported by network:</td>
</tr>
<tr>
<td></td>
<td>/sbin/ifconfig &lt;ethX&gt; mtu &lt;size&gt;</td>
</tr>
<tr>
<td>Interrupt moderation</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td>ethtool -C &lt;ethX&gt; rx-usecs-irq 0</td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Segmentation Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Large Receive Offload</td>
<td>Disable using sysfs:</td>
</tr>
<tr>
<td></td>
<td>echo 0 &gt; /sys/class/net/ethX/device/lro</td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default, but changing does not impact latency.</td>
</tr>
<tr>
<td>Receive Side Scaling</td>
<td>Application dependent.</td>
</tr>
<tr>
<td>Interrupt affinity &amp; irqbalance service</td>
<td>Interrupt affinity settings are application dependent</td>
</tr>
<tr>
<td></td>
<td>Stop irq balance service:</td>
</tr>
<tr>
<td></td>
<td>/sbin/service irqbalance stop</td>
</tr>
<tr>
<td></td>
<td>Reload the drivers to use the driver default interrupt affinity.</td>
</tr>
</tbody>
</table>
## Table 25: Latency Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
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<tbody>
<tr>
<td>Buffer Allocation Method</td>
<td>Leave at default. Some applications may benefit from specific setting. The Solarflare driver now supports a single optimized buffer allocation strategy and any value set by the rx_alloc_method parameter is ignored.</td>
</tr>
<tr>
<td>PCI Express Lane Configuration</td>
<td>Ensure the adapter is in an x8 slot (2.0 or later), and that current speed (not the supported speed) reads back as “x8 and 5GT/s”, or “x8 and 8GT/s”, or “x8 and Unknown”.</td>
</tr>
<tr>
<td>CPU Speed Service (cpuspeed)</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td>/sbin/service cpuspeed stop</td>
</tr>
<tr>
<td>CPU Power Service (cpupower)</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td>systemctl stop cpupower</td>
</tr>
<tr>
<td></td>
<td>systemctl disable cpupower</td>
</tr>
<tr>
<td>Tuned Service</td>
<td>Experiment disabling this with:</td>
</tr>
<tr>
<td></td>
<td>systemctl stop tuned</td>
</tr>
<tr>
<td></td>
<td>systemctl disable tuned</td>
</tr>
<tr>
<td>Busy poll (Linux 3.11 and later)</td>
<td>Enable with a value of 50µs:</td>
</tr>
<tr>
<td></td>
<td>sysctl net.core.busy_poll=50 \</td>
</tr>
<tr>
<td></td>
<td>&amp;&amp; sysctl net.core.busy_read=50</td>
</tr>
<tr>
<td>Memory bandwidth</td>
<td>Ensure memory utilizes all memory channels on system motherboard.</td>
</tr>
<tr>
<td>Intel QuickData (Intel chipsets only)</td>
<td>Enable in BIOS and install driver:</td>
</tr>
<tr>
<td></td>
<td>modprobe i oatdma</td>
</tr>
</tbody>
</table>
## Recommended Forwarding Tuning

Table 26 shows recommended tuning settings for forwarding.

### Table 26: Forwarding Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU Size</td>
<td>Configure to maximum supported by network:</td>
</tr>
<tr>
<td></td>
<td><code>/sbin/ifconfig &lt;ethX&gt; mtu &lt;size&gt;</code></td>
</tr>
<tr>
<td>Interrupt moderation</td>
<td>Configure an explicit interrupt moderation interval by setting the following driver options (see Driver Tuning on page 108):</td>
</tr>
<tr>
<td></td>
<td><code>irq_adapt_enable=0</code></td>
</tr>
<tr>
<td></td>
<td><code>tx_irq_mod_usec=150</code></td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Segmentation Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Large Receive Offload</td>
<td>Disable using sysfs:</td>
</tr>
<tr>
<td></td>
<td><code>echo 0 &gt; /sys/class/net/&lt;ethX&gt;/device/lro</code></td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default for 2.6.16 and later kernels.</td>
</tr>
<tr>
<td></td>
<td>For earlier kernels:</td>
</tr>
<tr>
<td></td>
<td><code>sysctl net.core.tcp_rmem 4096 87380 524288</code></td>
</tr>
<tr>
<td></td>
<td><code>sysctl net.core.tcp_wmem 4096 87380 524288</code></td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Leave the <code>rss_cpus</code> option at the default, to use all CPUs for RSS.</td>
</tr>
<tr>
<td></td>
<td>Ensure the <code>rss_numa_local</code> driver option is set to its default value of 1 (see Driver Tuning on page 108).</td>
</tr>
<tr>
<td>Interrupt affinity &amp;</td>
<td>Interrupt affinity. Affinitize each ethX interface to its own CPU (if possible select CPU’s on the same Package). Refer to Interrupt Affinity on page 110.</td>
</tr>
<tr>
<td>irqbalance service</td>
<td>Stop irqbalance service:</td>
</tr>
<tr>
<td></td>
<td><code>/sbin/service irqbalance stop</code></td>
</tr>
<tr>
<td>Buffer Allocation Method</td>
<td>Leave at default. Some applications may benefit from specific setting.</td>
</tr>
<tr>
<td></td>
<td>The Solarflare driver now supports a single optimized buffer allocation strategy and any value set by the <code>rx_alloc_method</code> parameter is ignored.</td>
</tr>
</tbody>
</table>
Table 26: Forwarding Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer Recycling</td>
<td>Make receive buffer recycling more aggressive by setting the following driver option (see Driver Tuning on page 108):</td>
</tr>
<tr>
<td></td>
<td><code>rx_recycle_ring_size=256</code></td>
</tr>
<tr>
<td>PIO</td>
<td>Disable PIO by setting the following driver option (see Driver Tuning on page 108):</td>
</tr>
<tr>
<td></td>
<td><code>piobuf_size=0</code></td>
</tr>
<tr>
<td>Transmit push</td>
<td>Disable transmit push by setting the following driver option (see Driver Tuning on page 108):</td>
</tr>
<tr>
<td></td>
<td><code>tx_push_max_fill=0</code></td>
</tr>
<tr>
<td>Direct copying</td>
<td>Disable copying directly from the network stack for transmits by setting the following driver option (see Driver Tuning on page 108):</td>
</tr>
<tr>
<td></td>
<td><code>tx_copybreak=0</code></td>
</tr>
<tr>
<td>Ring sizes</td>
<td>Change the number of descriptor slots on each ring by setting the following driver options (see Driver Tuning on page 108):</td>
</tr>
<tr>
<td></td>
<td><code>tx_ring=512</code></td>
</tr>
<tr>
<td></td>
<td><code>rx_ring=512</code></td>
</tr>
<tr>
<td></td>
<td>Note that as the <code>tx_irq_mod_usec</code> interrupt moderation interval increases, the number of required <code>tx_ring</code> and <code>rx_ring</code> descriptor slots also increases. Insufficient descriptor slots will cause dropped packets.</td>
</tr>
</tbody>
</table>
### 3.27 Module Parameters

Table 27 lists the available parameters in the Solarflare Linux driver module (`modinfo sfc`):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Possible Value</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>sxps_enabled</td>
<td>Enable or disable the Solarflare net driver to perform transmit flow steering. If the kernel does support XPS, this should be enabled in the kernel before using the SARFS feature.</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>sarfs_table_size</td>
<td>The size of the table used to maintain SARFS filters.</td>
<td>uint</td>
<td>256</td>
</tr>
<tr>
<td>sarfs_global_holdoff_ms</td>
<td>The maximum rate at which SARFS will insert or remove filters. This can be increased on heavily loaded servers or decreased to increase responsiveness.</td>
<td>uint</td>
<td>10ms</td>
</tr>
<tr>
<td>sarfs_sample_rate</td>
<td>The frequency at which TCP packets are inspected by the SARFS feature. This can be increased on heavily loaded servers to reduce the CPU usage by ARFS. Setting the sample rate to a non-zero value enables the SARFS feature. See also sxps_enabled above. The recommended sample rate is 20.</td>
<td>uint</td>
<td>0 packets</td>
</tr>
<tr>
<td>piobuf_size</td>
<td>Identify the largest packet size that can use PIO. Setting this to zero effectively disables PIO.</td>
<td>uint</td>
<td>256 bytes</td>
</tr>
<tr>
<td>rx_alloc_method</td>
<td>Allocation method used for RX buffers. The Solarflare driver now supports a single optimized buffer allocation strategy and any value set by the rx_alloc_method parameter is ignored. See Buffer Allocation Method on page 106.</td>
<td>uint</td>
<td>AVN(0) new kernels. PAGE(2) old kernels</td>
</tr>
<tr>
<td>rx_refill_threshold</td>
<td>RX descriptor ring fast/slow fill threshold (%).</td>
<td>uint</td>
<td>90</td>
</tr>
<tr>
<td>lro_table_size$^1$</td>
<td>Size of the LRO hash table. Must be a power of 2.</td>
<td>uint</td>
<td>128</td>
</tr>
</tbody>
</table>
### Table 27: Driver Module Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Possible Value</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lro_chain_max&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Maximum length of chains in the LRO hash table.</td>
<td>uint</td>
<td>20</td>
</tr>
<tr>
<td>lro_idle_jiffies&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Time (in jiffies) after which an idle connection's LRO state is discarded.</td>
<td>uint</td>
<td>101</td>
</tr>
<tr>
<td>lro_slow_start_packets&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Number of packets that must pass in-order before starting LRO.</td>
<td>uint</td>
<td>20000</td>
</tr>
<tr>
<td>lro_loss_packets&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Number of packets that must pass in-order following loss before restarting LRO.</td>
<td>uint</td>
<td>20</td>
</tr>
<tr>
<td>rx_desc_cache_size</td>
<td>Set RX descriptor cache size.</td>
<td>int</td>
<td>64</td>
</tr>
<tr>
<td>tx_desc_cache_size</td>
<td>Set TX descriptor cache size.</td>
<td>int</td>
<td>16</td>
</tr>
<tr>
<td>rx_xoff_thresh_bytes</td>
<td>RX fifo XOFF threshold.</td>
<td>int</td>
<td>-1 (auto)</td>
</tr>
<tr>
<td>rx_xon_thresh_bytes</td>
<td>RX fifo XON threshold.</td>
<td>int</td>
<td>-1 (auto)</td>
</tr>
<tr>
<td>lro</td>
<td>Large receive offload acceleration</td>
<td>int</td>
<td>1</td>
</tr>
<tr>
<td>separate_tx_channels</td>
<td>Use separate channels for TX and RX</td>
<td>uint</td>
<td>0</td>
</tr>
<tr>
<td>rss_cpus</td>
<td>Number of CPUs to use for Receive-Side Scaling, or 'packages', 'cores' or 'hyperthreads'</td>
<td>uint or string</td>
<td>&lt;empty&gt;</td>
</tr>
<tr>
<td>irq_adapt_enable</td>
<td>Enable adaptive interrupt moderation</td>
<td>uint</td>
<td>1</td>
</tr>
<tr>
<td>irq_adapt_low_thresh</td>
<td>Threshold score for reducing IRQ moderation</td>
<td>uint</td>
<td>10000</td>
</tr>
<tr>
<td>irq_adapt_high_thresh</td>
<td>Threshold score for increasing IRQ moderation</td>
<td>uint</td>
<td>20000</td>
</tr>
<tr>
<td>irq_adapt_irqs</td>
<td>Number of IRQs per IRQ moderation adaptation</td>
<td>uint</td>
<td>1000</td>
</tr>
<tr>
<td>napi_weight</td>
<td>NAPI weighting</td>
<td>uint</td>
<td>64</td>
</tr>
<tr>
<td>rx_irq_mod_usec</td>
<td>Receive interrupt moderation (microseconds)</td>
<td>uint</td>
<td>60</td>
</tr>
<tr>
<td>tx_irq_mod_usec</td>
<td>Transmit interrupt moderation (microseconds)</td>
<td>uint</td>
<td>150</td>
</tr>
<tr>
<td>allow_load_on_failure</td>
<td>If set then allow driver load when online self-tests fail</td>
<td>uint</td>
<td>0</td>
</tr>
<tr>
<td>onload_offline_selftest</td>
<td>Perform offline self-test on load</td>
<td>uint</td>
<td>1</td>
</tr>
<tr>
<td>interrupt_mode</td>
<td>Interrupt mode (0=MSIX, 1=MSI, 2=legacy)</td>
<td>uint</td>
<td>0</td>
</tr>
<tr>
<td>falcon_force_internal_sram</td>
<td>Force internal SRAM to be used</td>
<td>int</td>
<td>0</td>
</tr>
</tbody>
</table>
The Linux command `ethtool` will display an extensive range of statistics originated from the MAC on the Solarflare network adapter. To display statistics use the following command:

```
ethtool -S ethX
```

(where X is the ID of the Solarflare interface)

Using a Solarflare net driver earlier than version 4.4.1.1017, the `ethtool` statistics counters can be reset by reloading the `sfc` driver:

```
# modprobe -r sfc
# modprobe sfc
```

Drivers from version 4.4.1.1017 (included in onload-201502) have to manage multi-PF configurations and for this reason statistics are not reset by reloading the driver. The only methods currently available to reset stats is to cold-reboot (power OFF/ON) the server or reload the firmware image.

Per port statistics (port_) are from the physical adapter port. Other statistics are from the specified PCIe function.

Table 28 below lists the complete output from the `ethtool -S` command.

**NOTE:** `ethtool -S` output depends on the features supported by the adapter type.
Table 28: Ethtool -S output

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>port_tx_bytes</td>
<td>Number of bytes transmitted.</td>
</tr>
<tr>
<td>port_tx_packets</td>
<td>Number of packets transmitted.</td>
</tr>
<tr>
<td>port_tx_pause</td>
<td>Number of pause frames transmitted with valid pause op code.</td>
</tr>
<tr>
<td>port_tx_control</td>
<td>Number of control frames transmitted. Does not include pause frames.</td>
</tr>
<tr>
<td>port_tx_unicast</td>
<td>Number of unicast packets transmitted. Includes flow control packets.</td>
</tr>
<tr>
<td>port_tx_multicast</td>
<td>Number of multicast packets transmitted.</td>
</tr>
<tr>
<td>port_tx_broadcast</td>
<td>Number of broadcast packets transmitted.</td>
</tr>
<tr>
<td>port_tx_lt64</td>
<td>Number of frames transmitted where the length is less than 64 bytes.</td>
</tr>
<tr>
<td>port_tx_64</td>
<td>Number of frames transmitted where the length is exactly 64 bytes.</td>
</tr>
<tr>
<td>port_tx_65_to_127</td>
<td>Number of frames transmitted where the length is between 65 and 127 bytes</td>
</tr>
<tr>
<td>port_tx_128_to_255</td>
<td>Number of frames transmitted where the length is between 128 and 255 bytes</td>
</tr>
<tr>
<td>port_tx_256_to_511</td>
<td>Number of frames transmitted where the length is between 256 and 511 bytes</td>
</tr>
<tr>
<td>port_tx_512_to_1023</td>
<td>Number of frames transmitted where the length is between 512 and 1023 bytes</td>
</tr>
<tr>
<td>port_tx_1024_to_15xx</td>
<td>Number of frames transmitted where the length is between 1024 and 1518 bytes (1522 with VLAN tag).</td>
</tr>
<tr>
<td>port_tx_15xx_to_jumbo</td>
<td>Number of frames transmitted where length is between 1518 bytes (1522 with VLAN tag) and 9000 bytes.</td>
</tr>
<tr>
<td>port_rx_bytes</td>
<td>Number of bytes received. Not include collided bytes.</td>
</tr>
<tr>
<td>port_rx_good_bytes</td>
<td>Number of bytes received without errors. Excludes bytes from flow control packets.</td>
</tr>
</tbody>
</table>
### Table 28: Ethtool -S output

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>port_rx_bad_bytes</td>
<td>Number of bytes with invalid FCS. Includes bytes from packets that exceed the maximum frame length.</td>
</tr>
<tr>
<td>port_rx_packets</td>
<td>Number of packets received.</td>
</tr>
<tr>
<td>port_rx_good</td>
<td>Number of packets received with correct CRC value and no error codes.</td>
</tr>
<tr>
<td>port_rx_bad</td>
<td>Number of packets received with incorrect CRC value.</td>
</tr>
<tr>
<td>port_rx_pause</td>
<td>Number of pause frames received with valid pause op_code.</td>
</tr>
<tr>
<td>port_rx_control</td>
<td>Number of control frames received. Does not include pause frames.</td>
</tr>
<tr>
<td>port_rx_unicast</td>
<td>Number of unicast packets received.</td>
</tr>
<tr>
<td>port_rx_multicast</td>
<td>Number of multicast packets received.</td>
</tr>
<tr>
<td>port_rx_broadcast</td>
<td>Number of broadcasted packets received.</td>
</tr>
<tr>
<td>port_rx_lt64</td>
<td>Number of packets received where the length is less than 64 bytes.</td>
</tr>
<tr>
<td>port_rx_64</td>
<td>Number of packets received where the length is exactly 64 bytes.</td>
</tr>
<tr>
<td>port_rx_65_to_127</td>
<td>Number of packets received where the length is between 65 and 127 bytes.</td>
</tr>
<tr>
<td>port_rx_128_to_255</td>
<td>Number of packets received where the length is between 128 and 255 bytes.</td>
</tr>
<tr>
<td>port_rx_256_to_511</td>
<td>Number of packets received where the length is between 256 and 511 bytes.</td>
</tr>
<tr>
<td>port_rx_512_to_1023</td>
<td>Number of packets received where the length is between 512 and 1023 bytes.</td>
</tr>
<tr>
<td>port_rx_1024_to_15xx</td>
<td>Number of packets received where the length is between 1024 and 1518 bytes (1522 with VLAN tag).</td>
</tr>
<tr>
<td>port_rx_15xx_to_jumbo</td>
<td>Number of packets received where the length is between 1518 bytes (1522 with VLAN tag) and 9000 bytes.</td>
</tr>
</tbody>
</table>
### Table 28: Ethtool -S Output

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>port_rx_gjtumbo</td>
<td>Number of packets received with a length greater than 9000 bytes.</td>
</tr>
<tr>
<td>port_rx_bad_gjtumbo</td>
<td>Number of packets received with a length greater than 9000 bytes, but with incorrect CRC value.</td>
</tr>
<tr>
<td>port_rx_overflow</td>
<td>Number of packets dropped by receiver because of FIFO overrun.</td>
</tr>
<tr>
<td>port_rx_nodesc_drop_cnt</td>
<td>Number of packets dropped by the network adapter because of a lack of RX descriptors in the RX queue.</td>
</tr>
<tr>
<td>port_rx_nodesc_drops</td>
<td></td>
</tr>
<tr>
<td>port_rx_pm_trunc_bb_overflow</td>
<td>Overflow of the packet memory burst buffer - should not occur.</td>
</tr>
<tr>
<td>port_rx_pm_discard_bb_overflow</td>
<td>Number of packets discarded due to packet memory buffer overflow.</td>
</tr>
</tbody>
</table>

Packets can be dropped by the NIC when there are insufficient RX descriptors in the RX queue to allocate to the packet. This problem occurs if the receive rate is very high and the network adapter receive cycle process has insufficient time between processing to refill the queue with new descriptors.

A number of different steps can be tried to resolve this issue:

- Disable the irqbalance daemon in the OS
- Distribute the traffic load across the available CPU/cores by setting rss_cpus=cores. Refer to Receive Side Scaling section
- Increase receive queue size using ethtool.
<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>port_rx_pm_trunc_vfifo_full</code></td>
<td>Number of packets truncated or discarded because there was not enough packet memory available to receive them. Happens when packets cannot be delivered as quickly as they arrive due to:</td>
</tr>
<tr>
<td></td>
<td>• packet rate exceeds maximum supported by the adapter.</td>
</tr>
<tr>
<td></td>
<td>• adapter is inserted into a low speed or low width PCI slot – so the PCIe bus cannot support the required bandwidth.</td>
</tr>
<tr>
<td></td>
<td>• packets are being replicated by the adapter and the resulting bandwidth cannot be handled by the PCIe bus.</td>
</tr>
<tr>
<td></td>
<td>• host memory bandwidth is being used by other devices resulting in poor performance for the adapter.</td>
</tr>
<tr>
<td><code>port_rx_pm_discard_vfifo_full</code></td>
<td>Count of the number of packets dropped because of a lack of main packet memory on the adapter to receive the packet into.</td>
</tr>
<tr>
<td><code>port_rx_trunc_qbb</code></td>
<td>Not currently supported.</td>
</tr>
<tr>
<td><code>port_rx_pm_discard_qbb</code></td>
<td>Not currently supported.</td>
</tr>
<tr>
<td><code>port_rx_pm_discard_mapping</code></td>
<td>Number of packets dropped because they have an 802.1p priority level configured to be dropped.</td>
</tr>
<tr>
<td><code>port_rx_dp_q_disabled_packets</code></td>
<td>Increments when the filter indicates the packet should be delivered to a specific rx queue which is currently disabled due to configuration error or error condition.</td>
</tr>
<tr>
<td><code>port_rx_dp_di_dropped_packets</code></td>
<td>Number of packets dropped because the filters indicate the packet should be dropped. Can happen because:</td>
</tr>
<tr>
<td></td>
<td>• the packet does not match any filter.</td>
</tr>
<tr>
<td></td>
<td>• the matched filter indicates the packet should be dropped.</td>
</tr>
</tbody>
</table>
### Table 28: Ethtool -S output

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>port_rx_dp_streaming_packets</td>
<td>Number of packets directed to RXDP streaming bus which is used if the packet matches a filter which directs it to the MCPU. Not currently used.</td>
</tr>
<tr>
<td>port_rx_dp_hlb_fetch</td>
<td>Count the number of times the adapter descriptor cache is empty when a new packet arrives, for which the adapter must do an emergency fetch to replenish the cache with more descriptors.</td>
</tr>
<tr>
<td>port_rx_dp_hlb_wait</td>
<td>Increments each time the adapter has done an hlb_fetch which has not yet completed.</td>
</tr>
<tr>
<td>rx_unicast</td>
<td>Number of unicast packets received.</td>
</tr>
<tr>
<td>rx_unicast_bytes</td>
<td>Number of unicast bytes received.</td>
</tr>
<tr>
<td>rx_multicast</td>
<td>Number of multicast packets received.</td>
</tr>
<tr>
<td>rx_multicast_bytes</td>
<td>Number of multicast bytes received.</td>
</tr>
<tr>
<td>rx_broadcast</td>
<td>Number of broadcast packets received.</td>
</tr>
<tr>
<td>rx_broadcast_bytes</td>
<td>Number of broadcast bytes received.</td>
</tr>
<tr>
<td>rx_bad</td>
<td>Number of packets received with incorrect CRC value.</td>
</tr>
<tr>
<td>rx_bad_bytes</td>
<td>Number of bytes received from packets with incorrect CRC value.</td>
</tr>
<tr>
<td>rx_overflow</td>
<td>Number of packets dropped by receiver because of FIFO overrun.</td>
</tr>
<tr>
<td>tx_unicast</td>
<td>Number of unicast packets transmitted.</td>
</tr>
<tr>
<td>tx_unicast_bytes</td>
<td>Number of unicast bytes transmitted.</td>
</tr>
<tr>
<td>tx_multicast</td>
<td>Number of multicast packets transmitted.</td>
</tr>
<tr>
<td>tx_multicast_bytes</td>
<td>Number of multicast bytes transmitted.</td>
</tr>
<tr>
<td>tx_broadcast</td>
<td>Number of broadcast packets transmitted.</td>
</tr>
<tr>
<td>tx_broadcast_bytes</td>
<td>Number of broadcast bytes transmitted.</td>
</tr>
<tr>
<td>tx_bad</td>
<td>0.</td>
</tr>
<tr>
<td>tx_bad_bytes</td>
<td>0.</td>
</tr>
</tbody>
</table>
### Table 28: Ethtool -S output

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tx_overflow</td>
<td>Number of packets dropped by transmitter because of FIFO overrun.</td>
</tr>
<tr>
<td>tx_merge_events</td>
<td>The number of TX completion events where more than one TX descriptor was completed.</td>
</tr>
<tr>
<td>tx_tso_bursts</td>
<td>Number of times when outgoing TCP data is split into packets by the adapter driver. Refer to TCP Segmentation Offload (TSO) on page 104.</td>
</tr>
<tr>
<td>tx_tso_long_headers</td>
<td>Number of times TSO is applied to packets with long headers.</td>
</tr>
<tr>
<td>tx_tso_packets</td>
<td>Number of physical packets produced by TSO.</td>
</tr>
<tr>
<td>tx_pushes</td>
<td>Number of times a packet descriptor is ‘pushed’ to the adapter from the network adapter driver.</td>
</tr>
<tr>
<td>tx_pio_packets</td>
<td>Number of packets sent using PIO.</td>
</tr>
<tr>
<td>rx_reset</td>
<td>0</td>
</tr>
<tr>
<td>rx_tobe_disc</td>
<td>Number of packets marked by the adapter to be discarded because of one of the following:</td>
</tr>
<tr>
<td></td>
<td>• Mismatch unicast address and unicast promiscuous mode is not enabled.</td>
</tr>
<tr>
<td></td>
<td>• Packet is a pause frame.</td>
</tr>
<tr>
<td></td>
<td>• Packet has length discrepancy.</td>
</tr>
<tr>
<td></td>
<td>• Due to internal FIFO overflow condition.</td>
</tr>
<tr>
<td></td>
<td>• Length &lt; 60 bytes.</td>
</tr>
<tr>
<td>rx_ip_hdr_chksum_err</td>
<td>Number of packets received with IP header Checksum error.</td>
</tr>
<tr>
<td>rx_tcp_udp_chksum_err</td>
<td>Number of packets received with TCP/UDP checksum error.</td>
</tr>
</tbody>
</table>
Table 28: Ethtool -S output

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx_eth_crc_err</td>
<td>Number of packets received where the CRC did not match the internally generated CRC value. This is the total of all receive channels receiving CRC errors.</td>
</tr>
<tr>
<td>rx_mcast_mismatch</td>
<td>Number of unsolicited multicast packets received. Unwanted multicast packets can be received because a connected switch simply broadcasts all packets to all endpoints or because the connected switch is not able or not configured for IGMP snooping - a process from which it learns which endpoints are interested in which multicast streams.</td>
</tr>
<tr>
<td>rx_frm_trunc</td>
<td>Number of frames truncated because an internal FIFO is full. As a packet is received it is fed by the MAC into a 128K FIFO. If for any reason the PCI interface cannot keep pace and is unable to empty the FIFO at a sufficient rate, the MAC will be unable to feed more of the packet to the FIFO. In this event the MAC will truncate the frame - marking it as such and discard the remainder. The driver on seeing a 'partial' packet which has been truncated will discard it.</td>
</tr>
<tr>
<td>rx_merge_events</td>
<td>Number of RX completion events where more than one RX descriptor was completed.</td>
</tr>
<tr>
<td>rx_merge_packets</td>
<td>Number of packets delivered to the host through merge events.</td>
</tr>
<tr>
<td>tx-0.tx_packets</td>
<td>Per TX queue transmitted packets.</td>
</tr>
<tr>
<td>tx_1.tx_packets</td>
<td>Per TX queue transmitted packets.</td>
</tr>
<tr>
<td>rx_0.rx_packets</td>
<td>Per RX queue received packets.</td>
</tr>
<tr>
<td>rx_1.rx_packets</td>
<td>Per RX queue received packets.</td>
</tr>
</tbody>
</table>
**Table 28: Ethtool -S output**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx_no_skb_drops</td>
<td>Number of packets dropped by the adapter when there are insufficient socket buffers available to receive packets into. See also port_rx_nodesc_drop_cnt and port_rx_nodesc_drops above.</td>
</tr>
<tr>
<td>rx_nodesc_trunc</td>
<td>Number of frames truncated when there are insufficient descriptors to receive data into. Truncated packets will be discarded by the adapter driver.</td>
</tr>
<tr>
<td>ptp_good_syncs</td>
<td>These PTP stats counters relate to the mechanism used by sfptpd to synchronize the system clock and adapter clock(s) in a server.</td>
</tr>
<tr>
<td>ptp_fast_syncs</td>
<td></td>
</tr>
<tr>
<td>ptp_bad_syncs</td>
<td>For each synchronization event sfptpd will select a number of system clock times to be compared to the adapter clock time. If the times can be synchronized, the good_syns counter is incremented, otherwise the bad_syns counter is incremented. If sfptpd is unable to synchronize the clocks at this event, the sync_timeout counter is incremented. sfptpd will synchronize clocks 16 times per second - so incrementing counters does not necessarily indicate bad synchronization between local server clocks and an external PTP master clock.</td>
</tr>
<tr>
<td>ptp_sync_timeouts</td>
<td></td>
</tr>
<tr>
<td>ptp_no_time_syncs</td>
<td></td>
</tr>
<tr>
<td>ptp_invalid_sync_windows</td>
<td></td>
</tr>
<tr>
<td>ptp_undersize_sync_windows</td>
<td></td>
</tr>
<tr>
<td>ptp_oversize_sync_windows</td>
<td></td>
</tr>
<tr>
<td>ptp_rx_no_timestamp</td>
<td>Number of PTP packets received for which a hardware timestamp was not recovered from the adapter.</td>
</tr>
<tr>
<td>ptp_tx_timestamp_packets</td>
<td>Number of PTP packets transmitted for which the adapter generated a hardware timestamp.</td>
</tr>
<tr>
<td>ptp_rx_timestamp_packets</td>
<td>Number of PTP packets received for which the adapter generated a hardware timestamp.</td>
</tr>
<tr>
<td>ptp_timestamp_packets</td>
<td>Total number of PTP packets for which the adapter generated a hardware timestamp.</td>
</tr>
</tbody>
</table>
NOTE: The adapter will double count packets less than 64 bytes (port_rx_lt64) as also being a CRC error. This can result in port_rx_bad => rx_eth_crc_err counter. The difference should be equal to the port_rx_lt64 counter.

### 3.29 Driver Logging Levels

For the Solarflare net driver, two settings affect the verbosity of log messages appearing in dmesg output and /var/log/messages:

- The kernel console log level
- The netif message per network log level

The kernel console log level controls the overall log message verbosity and can be set with the command `dmesg -n` or through the `/proc/sys/kernel/printk` file:

```
echo 6 > /proc/sys/kernel/printk
```

Refer to ‘man 2 syslog’ for log levels and Documentation/sysctl/kernel.txt for a description of the values in `/proc/sys/kernel/printk`.

The netif message level provides additional logging control for a specified interface. These message levels are documented in Documentation/networking/netif-msg.txt. A message will only appear on the terminal console if both the kernel console log level and netif message level requirements are met.

The current netif message level can be viewed using the following command:

```
ethtool <iface> | grep -A 1 'message level:'
```

Changes to the netif message level can be made with ethtool. Either by name:

```
ethtool -s <iface> msglvl rx_status on
```

or by bit mask:

```
ethtool -s <iface> msglvl 0x7fff
```

The initial setting of the netif msg level for all interfaces is configured using the debug module parameter e.g.

```
modprobe sfc debug=0x7fff
```
ethtool <iface> | grep -A 1 'message level:'

Current message level: 0x00007fff (32767)
drv probe link timer ifdown ifup rx_err
tx_err tx_queued intr tx_done rx_status pktdata hw wol

3.30 Running Adapter Diagnostics

You can use ethtool to run adapter diagnostic tests. Tests can be run offline (default) or online. Offline runs the full set of tests, which can interrupt normal operation during testing. Online performs a limited set of tests without affecting normal adapter operation.

**CAUTION:** Offline tests should not be run while sfptpd is running. The PTP daemon should be terminated before running the offline test.

As root user, enter the following command:

ethtool --test ethX offline|online

The tests run by the command are as follows:

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>core.nvram</code></td>
<td>Verifies the flash memory ‘board configuration’ area by parsing and examining checksums.</td>
</tr>
<tr>
<td><code>core.registers</code></td>
<td>Verifies the adapter registers by attempting to modify the writable bits in a selection of registers.</td>
</tr>
<tr>
<td><code>core.interrupt</code></td>
<td>Examines the available hardware interrupts by forcing the controller to generate an interrupt and verifying that the interrupt has been processed by the network driver.</td>
</tr>
<tr>
<td><code>tx/rx.loopback</code></td>
<td>Verifies that the network driver is able to pass packets to and from the network adapter using the MAC and Phy loopback layers.</td>
</tr>
<tr>
<td><code>core.memory</code></td>
<td>Verifies SRAM memory by writing various data patterns (incrementing bytes, all bit on and off, alternating bits on and off) to each memory location, reading back the data and comparing it to the written value.</td>
</tr>
<tr>
<td><code>core.mdio</code></td>
<td>Verifies the MII registers by reading from PHY ID registers and checking the data is valid (not all zeros or all ones). Verifies the MMD response bits by checking each of the MMDs in the Phy is present and responding.</td>
</tr>
</tbody>
</table>
### 3.31 Running Cable Diagnostics

Cable diagnostic data can be gathered from the Solarflare 10GBASE-T adapters physical interface using the `ethtool -t` command which runs a comprehensive set of diagnostic tests on the controller, PHY, and attached cables. To run the cable tests enter the following command:

```bash
ethtool -t ethX [online | offline]
```

Online tests are non-intrusive and will not disturb live traffic.

**CAUTION:** Offline tests should not be run while sfptpd is running. The PTP daemon should be terminated before running the offline test.

The following is an extract from the output of the `ethtool` diagnostic offline tests:

```
phy cable.pairA.length 9
phy cable.pairB.length 9
phy cable.pairC.length 9
phy cable.pairD.length 9
phy cable.pairA.status 1
phy cable.pairB.status 1
phy cable.pairC.status 1
phy cable.pairD.status 1
```

Cable length is the estimated length in metres. A length value of 65535 indicates length not estimated due to pair busy or cable diagnostic routine not completed successfully.

The cable status can be one of the following values:

- **0** - invalid, or cable diagnostic routine did not complete successfully
- **1** - pair ok, no fault detected
- **2** - pair open or Rt > 115 ohms
- **3** - intra pair short or Rt < 85 ohms
- **4** - inter pair short or Rt < 85 ohms
- **9** - pair busy or link partner forces 100Base-Tx or 1000Base-T test mode.
4 Solarflare Adapters on Windows

This chapter covers the following topics on the Microsoft Windows® platform:

- System Requirements on page 134
- Windows Feature Set on page 135
- Installing the Solarflare Driver Package on Windows on page 137
- Adapter Drivers Only Installation on page 138
- Full Solarflare Package Installation on page 139
- Install Drivers and Options From a Windows Command Prompt on page 143
- Unattended Installation on page 147
- Managing Adapters with SAM on page 151
- Managing Adapters Remotely with SAM on page 153
- Using SAM on page 153
- Configuring Network Adapter Properties in Windows on page 181
- Windows Command Line Tools on page 186
- Completion codes (%errorlevel%) on page 212
- Teaming and VLANs on page 213
- Performance Tuning on Windows on page 225
- Windows Event Log Error Messages on page 241

4.1 System Requirements

- Refer to Software Driver Support on page 16 for details of supported Windows versions.

- The optional Solarflare Adapter Manager utility requires Microsoft .NET Framework 3.5 on all supported Windows versions.
4.2 Windows Feature Set

Table 30 lists the features supported by Solarflare adapters on Windows.

Users should refer to Microsoft documentation to check feature availability and support on specific Windows OS versions.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jumbo frames</strong></td>
<td>Solarflare adapters support MTUs (Maximum Transmission Units) from 1500 bytes to 9216 bytes.</td>
</tr>
<tr>
<td></td>
<td>• See Ethernet Frame Length on page 164</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Network Adapter Properties in Windows on page 181</td>
</tr>
<tr>
<td><strong>Task offloads</strong></td>
<td>Solarflare adapters support Large Segmentation Offload (LSO), Receive Segment Coalescing (RSC), and TCP/UDP/IP checksum offload for improved adapter performance and reduced CPU processing requirements.</td>
</tr>
<tr>
<td></td>
<td>• See Segmentation Offload on page 162</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Network Adapter Properties in Windows on page 181</td>
</tr>
<tr>
<td><strong>Receive Side Scaling (RSS)</strong></td>
<td>Solarflare adapters support RSS multi-core load distribution technology.</td>
</tr>
<tr>
<td></td>
<td>• See Using SAM to View Statistics and State Information on page 173</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Network Adapter Properties in Windows on page 181</td>
</tr>
<tr>
<td><strong>Interrupt Moderation</strong></td>
<td>Solarflare adapters support Interrupt Moderation to reduce the number of interrupts on the host processor from packet events.</td>
</tr>
<tr>
<td></td>
<td>• See RSS and Interrupts on page 160</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Network Adapter Properties in Windows on page 181</td>
</tr>
</tbody>
</table>
Teaming and/or Link Aggregation

Improve server reliability and bandwidth by bonding physical ports, from one or more Solarflare adapters, into a team, having a single MAC address and which function as a single port providing redundancy against a single point of failure.

- See Using SAM to Configure Teams and VLANs on page 165
- See Sfteam: Adapter Teaming and VLAN Tool on page 197
- See Teaming and VLANs on page 213

Virtual LANs (VLANs)

Support for multiple VLANs per adapter:

- See Using SAM to Configure Teams and VLANs on page 165
- See Sfteam: Adapter Teaming and VLAN Tool on page 197
- See Teaming and VLANs on page 213

PXE and UEFI booting

Solarflare adapters support PXE and UEFI booting, enabling diskless systems to boot from a remote target operating system.

- See Using SAM for Boot ROM Configuration on page 178
- See Sfboot: Boot ROM Configuration Tool on page 187
- See Solarflare Boot Manager on page 371

Fault diagnostics

Solarflare adapters provide comprehensive adapter and cable fault diagnostics and system reports.

- See Using SAM to Run Adapter and Cable Diagnostics on page 174
- See Sfcable: Cable Diagnostics Tool on page 202

Firmware updates

Solarflare adapters support adapter firmware upgrades.

- See Sfupdate: Firmware Update Tool on page 195
### 4.3 Installing the Solarflare Driver Package on Windows

- Adapter Drivers Only Installation on page 138
- Full Solarflare Package Installation on page 139
- Repair, Remove and Change Drivers and Utilities on page 142

**NOTE:** The Solarflare adapter should be physically inserted before installing the drivers. See Installation on page 30.

The user must have administrative rights to install adapter drivers and may be prompted to enter an administrator user name and password.

If Windows attempts to install the drivers automatically, cancel the Windows New Hardware Found wizard and follow the instructions below.

Solarflare does not recommend installing drivers via Remote Desktop Protocol (RDP). For example via Terminal Services.

The drivers install package is named after the Solarflare document part number e.g. SF-107785-LS-2_Solarflare_Windows_x64_64-bit_Driver_Package.exe

This can be renamed e.g. setup.exe before use.
4.4 Adapter Drivers Only Installation

The steps below describe how to install only the Solarflare adapter drivers in Windows. To install the drivers from the command line, see Install Drivers and Options From a Windows Command Prompt on page 143.

1. Double-click the supplied Setup.exe to start the Solarflare Driver Package Setup wizard. If prompted, confirm your administrator privileges to continue installing the drivers.

![Solarflare Driver Package Setup](image)

**Figure 12: Solarflare Driver Package Setup**

2. From the Custom Setup screen, select the Install Solarflare® device drivers option only.
Click **Finish** to close the wizard. Restart Windows if prompted to do so.

### 4.5 Full Solarflare Package Installation

This section cover the following topics:

- Prerequisites on page 139
- Solarflare Package Installation Procedure on page 140
- Solarflare Package Installation Procedure on page 140
- Repair, Remove and Change Drivers and Utilities on page 142

**Prerequisites**

- The Solarflare Adapter Manager Utility (SAM) requires Microsoft .NET Framework 3.5 assemblies. These are available by installing .NET version 3.5 and may also be available in version 4.x with backward compatibility for 3.5.

To install the required components from Powershell prompt (Windows Server editions only):

- `Install-WindowsFeature NET-Framework-Core`

Alternatively on Windows 8 and later:

- `Enable-WindowsOptionalFeature -FeatureName NetFx3 -Online -All`
Solarflare Package Installation Procedure

The steps below describe how to install the complete Solarflare installation package. To install this from the command line, see Install Drivers and Options From a Windows Command Prompt on page 143.

1. Double-click the supplied Setup.exe. The Solarflare Driver Package Setup wizard starts.

![Solarflare Driver Package Setup]

Figure 14: Solarflare Driver Package Setup

If prompted, confirm your administrator privileges to continue installing the drivers.

2. Follow the setup instructions in the wizard to complete the driver installation procedure. See Figure 15:
Table 31 lists the setup options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Install Solarflare device drivers</strong></td>
<td>Installs Solarflare drivers for Windows.</td>
</tr>
<tr>
<td></td>
<td>The Solarflare drivers are installed by default.</td>
</tr>
<tr>
<td><strong>Install Solarflare command line tools</strong></td>
<td>Installs the following Solarflare Windows command line tools:</td>
</tr>
<tr>
<td></td>
<td>sfboot.exe – Boot ROM configuration tool</td>
</tr>
<tr>
<td></td>
<td>sfupdate.exe – Firmware update tool</td>
</tr>
<tr>
<td></td>
<td>sfteam.exe – Adapter teaming tool</td>
</tr>
<tr>
<td></td>
<td>sfcable.exe – Cable diagnostics tool</td>
</tr>
<tr>
<td></td>
<td>sfkey.exe – License management tool</td>
</tr>
<tr>
<td></td>
<td>sfnet.exe – Adapter configuration tool</td>
</tr>
<tr>
<td></td>
<td>See Windows Command Line Tools on page 186.</td>
</tr>
<tr>
<td></td>
<td>These tools are installed by default.</td>
</tr>
</tbody>
</table>
### Table 31: Solarflare Custom Setup

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Install Solarflare Adapter Manager</strong></td>
<td>Installs Solarflare Adapter Manager (SAM) for easy access to adapter configuration options, wizards for teaming and VLAN setup, adapter statistics, and diagnostic tools. See Managing Adapters with SAM on page 151 for more details.</td>
</tr>
</tbody>
</table>
| **Install Solarflare management tools notification area icon** | Installs a Solarflare notification area icon for launching Solarflare Adapter Manager (SAM) locally or for a remote computer.  
The icon is not installed by default. |

3. Click **Finish** to close the wizard. Restart Windows if prompted to do so.

To confirm the drivers installed correctly, do either of the following:

- Open the Windows Device Manager and check the Solarflare adapter is present under Network Adapters.
- Start Solarflare Adapter Manager (Start > All Programs > Solarflare Drivers > Solarflare Adapter Manager). If the Solarflare adapter is installed and working correctly, it will be shown in the SAM main screen, along with any other adapters, as in Table 17 on page 152.

### Repair, Remove and Change Drivers and Utilities

From the Control Panel > Programs > Programs and Features, select the Solarflare Driver Package then select Uninstall, Change or Repair from the menu bar above the program list.
4.6 Install Drivers and Options From a Windows Command Prompt

This section covers the following subjects:
Command Line Usage on page 143
Using ADDLOCAL on page 145

Command Line Usage

To view command line options available, run the setup-<release>.exe /? command to extract files using the Solarflare Setup Bootstrapper. When this has completed the Solarflare Driver Package Setup Window will be displayed.

![Solarflare Setup Bootstrapper](image)

**Figure 16: Command Line Install.**

Installing from the Windows command line allows scripted, silent and unattended installation of the core Solarflare drivers and package utilities. The drivers install package is named after the Solarflare document part number e.g. SF-107785-LS-2_Solarflare_Windows_x64_64-bit_Driver_Package.exe

This can be renamed e.g setup.exe before invoking from the command line.

The following example will install default package options silently with no message output:

```
setup.exe /Quiet /Install
```

*Table 32* lists other command line examples. Note that command line options are case insensitive, so /install and /INSTALL are the same.

**Table 32: Solarflare Installation Options**

<table>
<thead>
<tr>
<th>Example</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>setup.exe /Admininstall &lt;path&gt;</code></td>
<td>Allows an administrator to unpack and install the package to a network share and to specify which features of the package can be installed by users.</td>
</tr>
<tr>
<td><code>setup.exe /Extract &lt;path&gt;</code></td>
<td>Extracts the contents of <code>setup.exe</code> to the specified path.</td>
</tr>
</tbody>
</table>
### Table 32: Solarflare Installation Options

<table>
<thead>
<tr>
<th>Example</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>setup.exe /ExtractDrivers &lt;path&gt;</code></td>
<td>Extract the adapter driver to the specified path.</td>
</tr>
<tr>
<td><code>setup.exe /Filename &lt;filename&gt;</code></td>
<td>Log all output to the specified file.</td>
</tr>
<tr>
<td><code>setup.exe /Force</code></td>
<td>Allow passive or quiet mode to replace an existing installation with an earlier version.</td>
</tr>
<tr>
<td><code>setup.exe /Help</code></td>
<td>Shows a help screen and exits.</td>
</tr>
<tr>
<td><code>setup.exe /Install</code></td>
<td>Installs or configures the package.</td>
</tr>
<tr>
<td><code>setup.exe /Install /Log &lt;filename&gt;</code></td>
<td>Install the drivers and logs messages to the specified file.</td>
</tr>
<tr>
<td><code>setup.exe /Install /Package &lt;packagefilename&gt;</code></td>
<td>Installs the drivers and utilities specified in packagefilename.</td>
</tr>
<tr>
<td><code>setup.exe /Install /Passive</code></td>
<td>Performs an unattended installation of the drivers and utilities, rebooting the host to complete the installation as required.</td>
</tr>
<tr>
<td><code>setup.exe /Install /Quiet</code></td>
<td>Performs a silent installation of the drivers and utilities, rebooting the host – without prompting – to complete the installation as required.</td>
</tr>
<tr>
<td><code>setup.exe /Reinstall</code></td>
<td>Reinstalls the drivers and utilities.</td>
</tr>
<tr>
<td><code>setup.exe /Uninstall</code></td>
<td>Removes the drivers and utilities from the host operating system.</td>
</tr>
<tr>
<td><code>setup.exe /Install /Verbose</code></td>
<td>Performs a verbose installation of the drivers and utilities, outputting details for each stage of the installation procedure.</td>
</tr>
<tr>
<td><code>setup.exe /Package &lt;PackageFilename&gt;</code></td>
<td>Identify the package file to use for the operation.</td>
</tr>
<tr>
<td><code>setup.exe /Version</code></td>
<td>Shows version information for the drivers.</td>
</tr>
<tr>
<td><code>setup.exe /Quiet /Install</code> ADDLOCAL=NetworkAdapterManager</td>
<td>Silently installs the drivers and Solarflare Adapter Manager only (other utilities will not be installed). See, Using ADDLOCAL on page 145.</td>
</tr>
</tbody>
</table>
Using ADDLOCAL

ADDLOCAL is a standard Windows Installer property that controls which features are installed via the command line. For Solarflare adapters, the following features can be installed from the command line:

- **CoreDrivers** – Installs the core adapter drivers
- **NetworkAdapterManager** – Installs Solarflare Adapter Manager (SAM)
- **CommandLineTools** – Installs Solarflare command line tools: sfboot.exe, sfupdate.exe, sfupdate.exe, sfkey.exe, sfteam.exe, sfnet.exe.
- **Launcher** – Installs the Solarflare system tray icon, providing easy access to the Solarflare Adapter Manager (SAM).

Multiple features may be installed by separating each feature with a comma (spaces are not allowed).

ADDLOCAL cannot prevent Launcher from being installed if either NetworkAdapterManager or CommandLineTools are not installed or are still being installed.

**ADDLOCAL examples**

- Install the package interactively with the default installation options selected (equivalent to Setup.exe or Setup.exe /Install).
  
  ```
  Setup.exe /Install ADDLOCAL=CoreDrivers,
  NetworkAdapterManager,CommandLineTools,Launcher
  ```

- Install the package without any management tools. Displays a limited user interface with status and progress only.
  
  ```
  Setup.exe /Quiet /Install ADDLOCAL=CoreDrivers
  ```

- Install Solarflare Adapter Manager (SAM) only. This command shows no user interface during installation and will restart the host system if required.
  
  ```
  Setup.exe /Quiet /Install ADDLOCAL=NetworkAdapterManager
  ```
Using REBOOT

REBOOT is a standard Windows Installer property that controls when reboots occur:

- **Force** – force a reboot at the end of the installation
- **Suppress** – suppress any reboot at the end of the installation
- **ReallySuppress** – suppress any reboots during the installation, and at the end.


**REBOOT example**

- Install Solarflare Adapter Manager (SAM) only, showing no user interface during installation, but suppress the auto-reboot at the end of the installation.

  ```
  Setup.exe /Quiet /Install ADDLOCAL=NetworkAdapterManager REBOOT=Suppress
  ```

**Extract Solarflare Drivers**

If it is necessary to extract the Solarflare Windows drivers, e.g. before WDS installs, this can be done from the Windows command line.

1. From the Command prompt, navigate to the directory where the installation package is located.
2. Enter the following command:

   ```
   Setup.exe /Extract <DestinationDirectory>
   ```

The Destination Directory will list the following sub-directory structure - The actual folders/files displayed will depend on the Solarflare driver package installed:

```
WIN7
WIN8
WINBLUE
License
ReleaseNotes
SETUP
SETUPPKG
```

Table 33 lists the drivers supplied with the Solarflare Driver installation package:

<table>
<thead>
<tr>
<th>Folder</th>
<th>Where Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>WIN7</td>
<td>Driver for Windows Server 2008 R2, for use on a WDS server.</td>
</tr>
<tr>
<td>WIN8</td>
<td>Driver for Windows Server 2012, for use on a WDS server.</td>
</tr>
<tr>
<td>WINBLUE</td>
<td>Driver for Windows Server 2012 R2, for use on a WDS server.</td>
</tr>
</tbody>
</table>
4.7 Unattended Installation

This section covers the following subjects:

- Windows Driver Locations on page 147
- Unattended Installation using WDS on page 147
- Adding Solarflare Drivers to the WDS Boot Image on page 148
- Create Custom Install Image on page 149
- Create the WDSClientUnattend.xml File on page 150
- Create the AutoUnattend.xml File on page 150
- Further Reading on page 151

Windows Driver Locations

The following steps use drivers extracted from the Solarflare installation package. Refer to Table 33 for driver folder locations.

Unattended Installation using WDS

Windows Deployment Services (WDS) enables the deployment of Windows over a network (from a WDS server), avoiding the need to install each operating system directly from a CD or DVD.

- This guide assumes you have installed and are familiar with WDS. For more information on WDS, see Further Reading on page 151.
- You should also be familiar with PXE booting over Solarflare adapters. See Configure the Boot Manager on page 178 for more information.

The following steps are an example of how to set up an unattended installation using the WDS interface:

Add a Boot Image

1. From the left hand pane of the WDS MMC snap in, right-click the Boot Images node and select Add Boot Image.
2. Specify a name for the image group and click Add Boot Image.
3 Select the boot \*.wim file from the Windows installation DVD (in the \Sources folder). The Boot \*.wim file contains the Windows PE and the Windows Deployment Services client.

4 Click Open, then click Next.

5 Follow the instructions in the wizard to add the boot image.

Add an Install Image

1 From the left hand pane of the WDS MMC snap in, right-click the Install Images node and select Add Install Image.

2 Specify a name for the image group and click Add Install Image.

3 Select the install \*.wim file from your installation DVD (in the \Sources folder), or create your own install image. Consult the WDS documentation for details on creating custom install images.

4 Click Open, then click Next.

5 Follow the instructions in the wizard to add the image.

Adding Solarflare Drivers to the WDS Boot Image

These steps describe how to add the Solarflare drivers into the Boot Image.

Modifying the Boot Image

You next need to modify the boot image to include the Solarflare Drivers extracted from the setup package. Table 33 identifies drivers required for the target operating system. To modify the boot image Solarflare recommends using the ImageX tool supplied with the Windows Automated Installation Kit (AIK).

1 Within WDS, expand the server where the boot image is located and select the boot image you want to modify. From the right-click menu, select Disable.

2 Create a Windows PE customization working directory (in this example c:\windowspe-x86). Within a command prompt, from:
   C:\program files\windows aik\tools\petools\ and enter the following command:
   copy.cmd x86 c:\windowspe-x86

3 Enter the following ImageX commands from the PE customization working directory:
   imagex /info <Drive>:\remoteinstall\boot\x86\images\<boot.wim>
   
   **NOTE:** <Drive> is the path where the remoteinstall folder is located. <boot.wim> is the name of your boot image.

4 Mount the boot image with the following command from your PE customization working directory:
   imagex /mountrw <Drive>:\remoteinstall\boot\x86\images\<boot.wim> 2 mount
5 Copy the contents of the appropriate Solarflare driver folder (see Table 33) to a subdirectory within your PE customization working directory (in this example c:\windowspe-x86\drivers).

6 Add the Solarflare VBD driver to the image by entering the following command from your PE customization working directory:
   peimg /inf=c:\windowspe-x86\drivers\netSFB*.inf mount\windows

7 Add the Solarflare NDIS driver to the image by entering the following command from your PE customization working directory:
   peimg /inf=c:\windowspe-x86\drivers\netSFN6*.inf mount\windows

8 Unmount the image, using the following command from your PE customization working directory:
   imagex /unmount /commit mount

9 From WDS, expand the server where the boot image is located and select the boot image you have modified. From the right-click menu, select Enable.

Create Custom Install Image

These steps describe how to add the Solarflare drivers into the Custom Install Image. These are the same Solarflare drivers added to the boot image.

Preparing the Custom Install Image

1 From WDS, locate the install image from the Install Images folder on your server.

2 Right-click the image and select Export Image from the menu.

3 Export the image to a location where it can be mounted. Solarflare recommend using the Windows PE customization working directory as this saves creating a second directory. In this example: c:\windowspe-x86.

Modifying the Install Image

1 Mount the install image with the following command from your PE customization working directory:
   imagex /mountrw <Drive>:\<path>\install.wim> 1 mount
   \NOTE: <Drive> is the path where the remoteinstall folder is located. <boot.wim> is the name of your boot image.

2 Copy the contents of the appropriate Solarflare driver folder in Table 33 to a sub-directory in your PE customization working directory (in this example c:\windowspe-x86\drivers). If you are using the same directory as for the boot image, this directory should already be present.

3 Add the Solarflare VBD driver to the image by entering the following command from your PE customization working directory:
   peimg /inf=c:\windowspe-x86\drivers\netSFB*.inf mount\windows
4 Add the Solarflare NDIS driver to the image by entering the following command from your PE customization working directory:
peimg /inf=c:\windowspe-x86\drivers\netSFN6*.inf mount\windows

5 Unmount the image, using the following command from your PE customization working directory:
imagex /unmount /commit mount

Import the Custom Image to WDS
1 From WDS, select the Image group you want to add the image to. Right-click and select Import Image.
2 Browse to the location of the custom image, and click Next.
3 Follow the instructions in the wizard to import the image.

Create the WDSClientUnattend.xml File

The WDSClientUnattend.xml file is used by the Windows PE boot environment to configure settings including the language, credentials for connecting to the WDS server, the partitioning of the disk and which image to deploy.

NOTE: You can use the Windows System Image Manager (Part of the Windows Automated Installation Kit) to create the WDSClientUnattend.xml file.

To associate your WDSClientUnattend.xml file with your modified boot image:
1 Copy the WDSClientUnattend.xml file to the following folder in the RemoteInstall folder: RemoteInstall\WDSClientUnattend.
2 Open the Windows Deployment Services MMC snap-in, right-click the server that contains the Windows Server 2008 R2, 2012, or 2012 R2 boot image with which you want to associate the file, and then select Properties.
3 On the Client tab, select Enable unattended installation, browse to the WDSClientUnattend.xml file, then click Open.
4 Click OK to close the Properties page.

Create the AutoUnattend.xml File

The AutoUnattend.xml file is used during the installation of Windows Server 2008 R2, 2012, and 2012 R2 to automatically populate the various configuration settings.

NOTE: You can use the Windows System Image Manager (Part of the Windows Automated Installation Kit) to create the AutoUnattend.xml file.

To associate your AutoUnattend.xml file with your custom install image:
1 Copy the AutoUnattend.xml file to the following folder in the RemoteInstall folder: RemoteInstall\WDSClientUnattend.
2 Open the Windows Deployment Services MMC snap-in, select the custom install image with which you want to associate the file, right-click and then select Properties.

3 Select the **Allow image to install in unattend mode** option.

4 Click **Select File** and browse to your AutoUnattend.xml file.

**Further Reading**

- How to add network driver to WDS boot image: [http://support.microsoft.com/kb/923834](http://support.microsoft.com/kb/923834)

### 4.8 Managing Adapters with SAM

- Introduction on page 152
- Managing Adapters Remotely with SAM on page 153
- Using SAM on page 153
- Using SAM to Configure Adapter Features on page 157
- Using SAM to Configure Teams and VLANs on page 165
- Using SAM to View Statistics and State Information on page 173
- Using SAM to Run Adapter and Cable Diagnostics on page 174
- Using SAM for Boot ROM Configuration on page 178

**NOTE:** The Windows dialog boxes displayed by SAM will appear differently on different Microsoft Windows OS versions.
Introduction

The Solarflare Adapter Manager (SAM) is a Microsoft Management Console (MMC) plug-in for managing Solarflare adapters, teams and VLANs. SAM shows information for all adapters installed on the server, alongside the standard MMC plug-in Actions pane.

Using SAM, you can easily configure Ethernet and task offloading settings, set up teams and VLANs, configure the Boot ROM for PXE or UEFI booting, and upgrade the adapter firmware.

![Figure 17: SAM Main Screen - Windows Server 2012](image_url)

SAM’s diagnostics utilities allow you to run tests on the adapter, and on 10GBASE-T adapters, on the cable to discover any potential issues which may be affecting adapter performance. Also, SAM’s detailed statistics and state information can be used to view data transfer figures, sent and received packet types, as well as other traffic-related details.

SAM is included with the Solarflare drivers installation package.
4.9 Managing Adapters Remotely with SAM

SAM can be used to administer Solarflare adapters on your server from a remote computer. SAM can be used remotely to administer adapters on any supported Windows platform, including a Windows Server Core Installation. Remote Administration provides access to all SAM features, except for generating a system report.

To allow SAM to remotely administer your server, you need to add a Computer Management snap-in to the computer Microsoft Management Console (MMC).

4.10 Using SAM

Starting SAM

There are various ways of starting SAM.

To manage a local computer, do one of the following:

• If the Solarflare notification area icon is installed, right-click the icon and choose **Manage network adapters on this computer**.

• On Windows Server 2008 R2, choose **Start > All Programs > Solarflare Network Adapters > Manage network adapters on this computer**.

On Windows Server 2012 or later, click the **Start** button followed by the arrow button, then choose **Solarflare Network Adapters > Manage network adapters on this computer**.

• On Windows Server 2008 R2, choose **Start > Administrative Tools > Computer Management > System Tools > Network Adapters**.

On Windows Server 2012 or later, click the **Start** button, then choose **Administrative Tools > Computer Management > System Tools > Network Adapters**.

![SAM icons on Start screen](image-url)
NOTE: You may be asked for permission to continue by the User Account Control when starting SAM. You must run SAM as an administrator to make any changes.

To manage a remote computer, do one of the following:

- If the Solarflare notification area icon is installed, right-click the icon and choose **Manage network adapters on a remote computer**.
- On Windows Server 2008 R2, choose **Start > All Programs > Solarflare Network Adapters > Manage network adapters on a remote computer**.

On Windows Server 2012 or later, click the Start button followed by the arrow button, then choose **Solarflare Network Adapters > Manage network adapters on a remote computer**.

### Viewing Adapter Details

SAM lists all available network adapters installed in the server, regardless of manufacturer or adapter type.

<table>
<thead>
<tr>
<th>Name</th>
<th>Network Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solarflare SNT712P SPFv4 Server Adapter</td>
<td>Local Area Cor</td>
</tr>
<tr>
<td>Solarflare SNT712P SPFv4 Server Adapter R2</td>
<td>Local Area Cor</td>
</tr>
<tr>
<td>Broadcom BCM5781C NetXtreme II GigE IOMS VBD</td>
<td>Local Area Cor</td>
</tr>
<tr>
<td>Broadcom BCM5781C NetXtreme II GigE IOMS VBD</td>
<td>Local Area Cor</td>
</tr>
</tbody>
</table>

![Solarflare Adapter Manager (SAM)](image)

For each adapter, SAM provides the following details:

- Name and network interface
- IP address (IPv4 and IPv6, if available)
- MAC address
- Transmit load
- Receive load
For Solarflare adapters only, SAM also lists any teams or VLANs that have been configured, along with details that allow you to quickly check performance and status.

**Viewing Performance Graphs**

To view Solarflare performance graphs, Right-click on an adapter and select *Show graphs* from the menu. By default, SAM shows the load, transmitted packets and received packets graphs only. To view other available graphs, Select *Graphs* from the right-click menu, or from the Actions Pane/Action menu. For non-Solarflare adapters only the load graph is displayed.

**Configuring Options in SAM**

SAM allows you to change the units used to display data, enable separators when displaying large numbers and disable/enable warning messages.

**To configure SAM options:**

1. Start SAM.
2. From the *Actions* pane, click *Options*, or choose *Action > Options*. 
3 In the Configuration window, select required options (see Table 34).
4 Click **OK** to save your options or **Cancel** to retain the existing settings.

**Table 34: SAM Configuration Options**

<table>
<thead>
<tr>
<th>Tab</th>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Values</strong></td>
<td><strong>Display values using SI units</strong></td>
<td>Displays values using metric prefixes (K, M, G, T, P, E), for example 2.3M for the value 2,300,000. Enabled by default. This can be useful when dealing with the large Tx/Rx numbers that can accumulate with 10Gb networking. Note: The Transmit and Receive bytes columns ignore this setting.</td>
</tr>
<tr>
<td></td>
<td><strong>Use separators in large values</strong></td>
<td>Use separators with large numbers, for example 2,341,768. Enabled by default.</td>
</tr>
<tr>
<td><strong>Values</strong></td>
<td><strong>Load/bandwidth units</strong></td>
<td>Use bits per second (default setting), or bytes per second when displaying data transfer figures.</td>
</tr>
</tbody>
</table>
| **Warnings**               | **Warnings displayed before a major action takes place** | Warnings for the following actions can be enabled or disabled in SAM:  
  - Deleting a VLAN or removing a network adapter from a team  
  - Deleting a team                                      |
Working with Third-Party Adapters

Third-party adapters installed in the server are also listed in the SAM’s Network Adapters list, along with the Solarflare adapters and any teams and VLANs which have been set up on the server.

SAM provides some options for working with third-party adapters. The available actions for third party adapters are shown in the Action pane.

4.11 Using SAM to Configure Adapter Features

SAM allows you to configure the following features on Solarflare adapters:

- Accessing Adapter Feature Settings on page 157
- Checksum Offload on page 160
- RSS and Interrupts on page 160
- Segmentation Offload
- Ethernet Link Speed on page 163
- Ethernet flow control on page 163
- Ethernet Frame Length on page 164

**NOTE:** Changing the value of an Adapter feature can negatively impact the performance of the adapter. You are strongly advised to leave them at their default values.

**NOTE:** Before making any changes to your Solarflare adapter features, read the Performance Tuning on Windows section on page 225 first.

Accessing Adapter Feature Settings

Use one of the following methods to access the Adapter Features Dialog:

From SAM, right-click on an adapter and select Configuration > Configure Offload tasks, Ethernet and other features.
From SAM, select an adapter and from the Action menu, select **Configure Offload tasks, Ethernet and other features**.

The **Adapter Features** dialog box will be displayed:
Click **Apply** or **OK** when changes to Adapter Features are modified.

Note that the **Receive** legend in the **Segmentation Offload** field differs, depending on the version of Windows that is installed:

- for Windows Server 2008 R2, it is **Large Receive Offload (LRO)**
- for Windows Server 2012 and later, it is **Receive Segment Coalescing (RSC)**, as shown.

For more information see **Segmentation Offload on page 162**.
Checksum Offload

Checksum offloading is supported on IP, TCP and UDP packets. Before transmitting a packet, a checksum is generated and appended to the packet. At the receiving end, the same checksum calculation is performed against the received packet. By offloading the checksum process to the network adapter, the load is decreased on the server CPU.

By default, Solarflare adapters are set up to offload both the calculation and verification of TCP, IP and UDP checksums. The following Checksum Offload options are supported:

<table>
<thead>
<tr>
<th>Check box selected</th>
<th>Transmit and Receive</th>
<th>Transmit checksums are generated and received checksums are enabled. This is the default setting.</th>
</tr>
</thead>
</table>
| Check selected but selection grayed out | Transmit Only or Receive Only | For either transmit or received checksum only.  
NOTE: The Transmit or Receive Only states can only be set from the Advanced tab of the Driver Properties. See Configuring Network Adapter Properties in Windows on page 181 for more details. |
| Check box cleared                   | Disabled             | Disabled. Data will be checksummed by the host processor for both transmitted and received data. |

You can also configure Checksum Offload settings from the network adapter properties. See Configuring Network Adapter Properties in Windows on page 181 for more details.

NOTE: Changing the Checksum Offload settings can impact the performance of the adapter. Solarflare recommend that these remain at the default values. Disabling Checksum Offload disables Large Send Offload.

RSS and Interrupts

Solarflare network adapters support RSS (Receive Side Scaling) and interrupt moderation. Both are enabled by default and can significantly improve the performance of the host CPU when handling large amounts of network data.

RSS attempts to dynamically distribute data processing across the available host CPUs in order to spread the workload. Interrupt moderation is a technique used to reduce the number of interrupts sent to the CPU. With interrupt moderation, the adapter will not generate interrupts closer together than the interrupt moderation interval. An initial packet will generate an interrupt immediately, but if subsequent packets arrive before the interrupt moderation interval, interrupts are delayed.
You can also configure RSS and interrupts settings from the network adapter properties. See Configuring Network Adapter Properties in Windows on page 181 for more details.

**NOTE:** Changing the RSS and Interrupt Moderation settings can impact the performance of the adapter. You are strongly advised to leave them at their default values.

### RSS and Interrupts Options

Table 36 shows the RSS and interrupts options.

<table>
<thead>
<tr>
<th><strong>Table 36: RSS and Interrupts Options</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Displayed (supported) options will differ between Windows OS versions and different Solarflare drivers.</strong></td>
</tr>
</tbody>
</table>

| **RSS** | Disabled - RSS is disabled.  
Closest Processor - use cores from a single NUMA node.  
Closest Processor Static - Network traffic is distributed across available CPUs from a single NUMA node, but there is no dynamic load balancing.  
NUMA Scaling - CPUs are assigned on a round-robin basis across every NUMA node.  
NUMA Scaling Static - As for NUMA Scaling but without dynamic load balancing.  
Conservative Scaling - RSS will use as few processors as possible to sustain the current network load. This helps to reduce the number of interrupts. |
| **Max. RSS processors** | Set the number of processors to be used by RSS.  
If this is greater than or equal to the number of logical processors in the system then all processors are used. |
| **Interrupt moderation** | Adaptive - adjusts the interrupt rates dynamically, depending on the traffic type and network usage.  
Disabled - interrupt moderation is disabled.  
Enabled - interrupt moderation is enabled. |
| **Max (microseconds)** | This setting controls the value for the interrupt moderation time. The default value is 60 microseconds and can be changed for deployments requiring minimal latency. |
| **Base RSS processor** | The base processor to be used by RSS. The value is specified as a group (range 0-9) and CPU number (range 0-63). |
Further Reading

For more information on Windows RSS profiles and options refer to http://msdn.microsoft.com/en-us/library/windows/hardware/ff570864%28v=vs.85%29.aspx

Table 36: RSS and Interrupts Options

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. RSS processor</td>
<td>The maximum processor available to RSS. The value is specified as a group (range 0-9) and CPU number (range 0-63).</td>
</tr>
<tr>
<td>Max. RSS processors</td>
<td>The maximum number of processors to be used by RSS. The value is in the range 0-256.</td>
</tr>
<tr>
<td>Max. RSS queues</td>
<td>The maximum number of receive queues created per interface. The value is in the range 0-64.</td>
</tr>
<tr>
<td>NUMA node id</td>
<td>The NUMA node id drop down list box is displayed on Windows platforms that support NUMA architectures. This constrains the set of CPU cores used for RSS to the specified NUMA node. Solarflare recommend you leave this at the default setting of All. The adapter will attempt to use only processors from the specified NUMA node for RSS. If this is set to ALL or it is greater than or equal to the number of NUMA nodes in the system, all NUMA nodes are used.</td>
</tr>
</tbody>
</table>

4.12 Segmentation Offload

Solarflare adapters offload the tasks of packet segmentation and reassembly to the adapter hardware, reducing the CPU processing burden and improving performance.

- Large Send Offload (LSO), when enabled, offloads to the adapter the splitting of outgoing TCP data into packets. This reduces CPU use and improves peak throughput. Since LSO has no effect on latency, it can be enabled at all times. The driver has LSO enabled by default.

- Receive Segment Coalescing (RSC) is a Microsoft feature introduced in Windows Server 2012. When enabled the adapter will coalesce multiple received TCP packets on a TCP connection into a single call to the TCP/IP stack. This reduces CPU use and improves peak performance. RSC has a low impact on latency. If a host is forwarding received packets from one interface to another then Windows will automatically disable RSC. RSC is enabled by default.

- Large Receive Offload (LRO) is a Solarflare proprietary mechanism similar to RSC. It is used when RSC is unavailable (i.e. on Windows Server 2008 R2). When enabled the adapter will coalesce multiple received TCP packets on a TCP connection into a single call to the TCP/IP stack. This reduces CPU use and
improves peak performance. However LRO can increase latency and should not be used if a host is forwarding received packets from one interface to another. LRO is disabled by default.

You can also configure LSO and RSC/LRO settings from the NDIS properties. See Configuring Network Adapter Properties in Windows on page 181 for more details.

**Ethernet Link Speed**

Generally, it is neither necessary or desirable to configure the link speed of the adapter. The adapter by default will negotiate the link speed dynamically, connecting at the maximum, supported speed. However, if the adapter is unable to connect to the link partner, you may wish to try setting a fixed link speed. For further information see ‘Link Speed’ in Table 43 on page 182.

**Ethernet flow control**

Ethernet flow control allows two communicating devices to inform each other when they are being overloaded by received data. This prevents one device from overwhelming the other device with network packets. For instance, when a switch is unable to keep up with forwarding packets between ports. Solarflare adapters allow flow control settings to be auto-negotiated with the link partner.

You can also configure ethernet flow control from the network adapter properties. See Table 43 on page 182 for more details.

**Table 37: Ethernet Flow Control Options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-negotiate</td>
<td>Flow control is auto-negotiated between the devices. This is the default setting, preferring Generate and respond if the link partner is capable.</td>
</tr>
<tr>
<td>Generate and respond</td>
<td>Adapter generates and responds to flow control messages.</td>
</tr>
<tr>
<td>Respond only</td>
<td>Adapter responds to flow control messages but is unable to generate messages if it becomes overwhelmed.</td>
</tr>
<tr>
<td>Generate only</td>
<td>Adapter generates flow control messages but is unable to respond to incoming messages and will keep sending data to the link partner.</td>
</tr>
<tr>
<td>None</td>
<td>Ethernet flow control is disabled on the adapter. Data will continue to flow even if the adapter or link partner is overwhelmed.</td>
</tr>
</tbody>
</table>
Ethernet Frame Length

The maximum Ethernet frame length used by the adapter to transmit data is (or should be) closely related to the MTU (maximum transmission unit) of your network. The network MTU determines the maximum frame size that your network is able to transmit across all devices in the network.

**NOTE:** For optimum performance set the Ethernet frame length to your network MTU.

If the network uses Jumbo frames, SAM supports frames up to a maximum of 9216 bytes.

Virtual Machine Queue

Solarflare adapters support VMQ to offload the classification and delivery of network traffic destined for Hyper-V virtual machines to the network adapter thereby reducing the CPU load on Hyper-V hosts.

Windows Server 2008 R2 allows the administrator user to statically configure the number of CPUs available to process interrupts for VMQ. Interrupts are spread across the specified cores, however the static configuration does not provide best performance when the network load varies over time.

Dynamic VMQ, supported in Windows Server 2012 and later, will dynamically distribute received network traffic across available CPUs while adjusting for network load by, if necessary, bringing in more processors or releasing processors under light load conditions.

VMQ supports the following features:

- Classification of received network traffic in hardware by using the destination MAC address (and optionally also the VLAN identifier) to route packets to different receive queues dedicated to each virtual machine.
- Can use the network adapter to directly transfer received network traffic to a virtual machine's shared memory avoiding a potential software-based copy from the Hyper-V host to the virtual machine.
- Scaling to multiple processors by processing network traffic destined for different virtual machines on different processors.

<table>
<thead>
<tr>
<th>Table 38: VMQ Mode Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enabled</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### 4.13 Using SAM to Configure Teams and VLANs

- About Teaming on page 165
- Setting Up Teams on page 166
- Reconfiguring a Team on page 167
- Adding Adapters to a Team on page 169
- Deleting Teams on page 170
- Setting up Virtual LANs (VLANs) on page 171
- Deleting VLANs on page 173

#### About Teaming

**NOTE:** To set up teams and VLANs in Windows using the sfteam command line tool, see *Sfteam: Adapter Teaming and VLAN Tool on page 197.*

Solarflare adapters support the following teaming configurations:

- IEEE 802.3ad Dynamic link aggregation
- Static link aggregation
- Fault tolerant teams

Teaming allows the user to configure teams consisting of all Solarflare adapter ports on all installed Solarflare adapters or might consist of only selected adapter ports e.g. from a dual port Solarflare adapter, the first port could be a member of team A and the second port a member of team B or both ports members of the same team.

This section is only relevant to teams of Solarflare adapters. Solarflare adapters can be used in multi-vendor teams when teamed using the other vendor’s teaming driver.

**CAUTION:** Windows Server 2012 introduced native support for teaming. Windows teaming and Solarflare teaming configuration should not be mixed in the same server.
Setting Up Teams

SAM’s Create a Team setup wizard will guide you through setting up an adapter team, automatically assigning the active adapter, key adapter and standby adapter.

To create a team:

1. Before creating a team, Solarflare strongly recommend taking the server offline to avoid disrupting existing services as the team is being configured.
2. Start SAM and select a Solarflare adapter in the Network Adapter list.
3. From the Action menu, select Create a Team. The Solarflare Create a team Wizard starts.

4. Team Create Wizard
5. The wizard will guide you through the process of creating a team and optionally adding VLANs to your team (see Table 40 on page 172 for help when selecting VLAN options).
6. Bring the server back online.
7. After creating a team, you can use the Configure this Team option from the Actions pane to change team settings, such as the Ethernet frame length, key adapter assignment, and adapter priorities within the team.

CAUTION: Before physically removing an adapter from a server, first check it is not the key adapter. You must reassign the key adapter if you want to remove it from the team to avoid duplicating the MAC address on your network. See Table 39 on page 168 for details on reassigning the key adapter.
Reconfiguring a Team

When setting up teams, SAM assigns the key, active and standby adapters, and specifies the Ethernet frame length for the team. To change any of these settings, use the **Configure this Team** option, as described below.

To change team settings:

**NOTE:** Changing team settings can disrupt network traffic flow to and from services running on the server. Solarflare recommend only changing network settings when disruption to the services can be tolerated.

1. Start SAM and, from the Network Adapter list, select the team you want to reconfigure.
2. From the Action menu, select **Configure this Team**. The **Configure a Team** dialog box displays.

![Configure a Team](image)

**Figure 22: Configure a Team**

By default, all teamed adapters are given an equal priority (indicated by the grouped number 1). The current active adapter is indicated by the green active symbol. The key adapter is indicated with the key symbol. Adapters in standby are indicated by the yellow standby symbol. For link aggregated teams there may be more than one active adapter.
Figure 23: Prioritized Adapters

Figure 23 shows the active adapter with the highest priority, with the second adapter being second priority.

Table 39: Configure a Team Options

| To change the key adapter: | Select the new key adapter, then click the key button.  
| Note: Before physically removing an adapter from a server, first check it is not the key adapter. You must reassign the key adapter if you want to remove it from the team to avoid duplicating the MAC address on your network. |
| To change adapter priority: | By default, all adapters have equal priority. Select an adapter and use the up or down buttons to promote or demote the adapter priority as required.  
| Note: For Fault-Tolerant Teams, the highest priority adapter in a team becomes the active adapter, passing all network traffic for the team. |
3 After making your changes, click Set and then click Close.

### Adding Adapters to a Team

If additional Solarflare adapters are installed in your server, you can add them to an existing team to increase the overall resilience or performance (aggregation) of the server connection.

To add adapters to a team:

**NOTE:** Changing team settings can disrupt current services running on the server. Solarflare recommend only changing network settings when disruption to the services can be tolerated.

1 Start SAM and select a Solarflare adapter team from the Network Adapter list.

2 From the Actions list, click Add one or more adapters, or choose Actions > Add one or more adapters. The Available Network Adapters dialog box is displayed:

### Table 39: Configure a Team Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>To specify a new active adapter:</td>
<td>For Fault-Tolerant Teams only. Set your preferred active adapter to the highest prioritized adapter in the team. The highest prioritized adapter becomes the active adapter in the team after you apply your changes. To change adapter priority, use the up and down buttons.</td>
</tr>
</tbody>
</table>
| To specify the Ethernet frame length/MTU: | Specify a value between 1514 and 9216 bytes. Check your network supports the new frame length before setting the new value. **Note:** This setting affects all adapters in the team, and will override any individual adapter settings made from the Configure Offload tasks, Ethernet and other features window. See Using SAM to Configure Adapter Features on page 157 for more details.
3 Select the adapter(s) to add to the team. Click **OK** to add the selected adapters and close the dialog box.

**Deleting Teams**

You can delete a team by selecting **Delete this team** in SAM. Once a team has been deleted, all of its adapters are returned to their original configuration settings and become available on the server once again. Any VLANs set up for the team will be deleted when the team is deleted.

**To delete a team:**

**NOTE:** Changing team settings can disrupt current services running on the server. Solarflare recommend only changing network settings when disruption to network services can be tolerated.

1 Start SAM and select a Solarflare adapter team from the Network Adapter list.

2 From the **Action** menu, select **Delete this team**. Alternatively, to delete all teams and VLANs on the server, select **Delete all teams and VLANs**. The Confirm Action Dialog box is displayed.
3 Confirm the deletion when prompted.

**NOTE:** Delete all teams and VLANs will cause a display refresh which may take some time to complete, depending on the number of teams and VLANs being deleted.

### Setting up Virtual LANs (VLANs)

SAM allows you to add up to 64 VLANs per team or adapter. Each VLAN is a virtual network adapter, visible in the Windows Device Manager, through which the operating system is able to receive data tagged with the correct VLAN ID (VID). You may assign one VLAN to accept VLAN 0 or untagged traffic, which allows the interface to communicate with devices that do not support VLAN tagging, or that are sending traffic on VLAN 0.

**To create VLANs:**

**NOTE:** Creating VLANs can disrupt current services running on the server. Solarflare recommend only changing network settings when disruption to network services can be tolerated.

1 Start SAM and select the adapter or adapter team from the Network Adapter list.

2 From the Actions list, click Add one or more VLANs, or choose Actions > Add one or more VLANs to display the VLAN Setup Wizard.
Figure 26: Create VLANs

Table 40: VLAN Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>An optional name for the VLAN network adapter. This option will not be available when remotely administering the server.</td>
</tr>
<tr>
<td>Supports the handling of priority traffic</td>
<td>Enables the handling of traffic that is tagged as priority.</td>
</tr>
<tr>
<td>Supports untagged and VLAN 0 traffic</td>
<td>Restricts the VLAN to handling packets that are untagged or with VID 0.</td>
</tr>
<tr>
<td>Supports traffic solely on this VLAN</td>
<td>Restricts the network interface to traffic that is tagged with the specified VLAN.</td>
</tr>
</tbody>
</table>
Deleting VLANs

VLANs can be removed from a team or single adapter when no longer required.

To delete VLANs:

NOTE: Deleting VLANs can disrupt current processes and applications running on the server. Solarflare recommend only changing network settings when disruption to network services can be tolerated.

1. Start SAM.
2. In the Network adapter list, select the VLAN to delete. If necessary, expand the team if the VLAN is attached to a team then select the VLAN.
3. From the Actions list, click Delete this VLAN, or choose Action > Delete this VLAN.
4. Confirm the deletion in the Confirm Action Dialog box.

4.14 Using SAM to View Statistics and State Information

SAM’s Network Adapter list provides an overview of the adapters installed in the host computer. For a more detailed view of the adapter device settings, data transfer statistics, and other features, you can use the adapter Statistics and State.

Figure 27: Solarflare Adapter Statistics and State
To view Solarflare statistics and state information:

1. Start SAM and select a Solarflare adapter from the Network Adapter list.
2. From the Actions list, click **Statistics and State**. The **Details from <adapter name>** dialog box is displayed.

   **NOTE:** The tabs displayed will differ, dependent on whether an adapter, VLAN or Team is selected.

3. Click each tab to see the various adapter statistics and state information that is available for the adapter. Note that statistics are collated from the start of the current session. To reset the statistics, see Resetting Adapter Statistics on page 174.

4. When you have finished viewing statistics, click **Close**.

**Resetting Adapter Statistics**

Statistics for data transfer and the MAC layer are reset, either following a system restart or installing of the adapter drivers. If necessary, you can reset the adapter statistics to restart the accumulated data values at any time.

1. Start SAM and select a Solarflare adapter from the Network Adapter list.
2. From the Actions list, click **Statistics and State**, or choose **Actions > Statistics and State**. The **Details from <adapter name>** dialog box is displayed.
3. In the **General** tab, click the **Reset** button to reset statistics.
4. Click **Close**.

**4.15 Using SAM to Run Adapter and Cable Diagnostics**

You can verify the Solarflare adapter, driver and cable by running SAM’s built-in diagnostic tools (Solarflare 10GBASE-T adapter only).

The tools provide a simple way to verify that the adapter and driver are working correctly, and that the cable has the correct characteristics for high-speed data transfer.

The diagnostics tools also include an option to flash the LEDs (useful for identifying the adapter in a server room), and an option to generate a full system report, both available from the **Actions** menu.

   **NOTE:** The full system report cannot be generated when remotely administering a server.
Running Driver and Adapter Diagnostics

SAM’s driver diagnostics enable you to test the adapter and driver are functioning correctly, returning a simple pass or fail for each test run.

Figure 28: Adapter and Driver Diagnostics Window

1. Start SAM and select a Solarflare adapter from the Network Adapter list.
2. From the Action menu, select Adapter Diagnostics. The Diagnostics for <adapter name> window is displayed.
3. Select the test you want to run (no tests are selected by default). See Table 41 for a description of the tests that are available.
4. To stop as soon as a failure is detected, select Stop on first test failure.
5. To run all the tests more than once, change the value in the Test iterations box.
6. Click Start to begin testing. The results of each test will be displayed in the Diagnostics window, along with an entry in the Completion Message column describing the reason any particular test has failed.

NOTE: The adapter will stop functioning while the tests are being run. Solarflare recommend only running diagnostics tests when disruption to network services can be tolerated.

NOTE: You can click Abort to abandon running tests at any time. This may take a while to complete, dependent on the test being run at the time.
The available tests depend on the installed adapter type.

### Table 41: Adapter Diagnostic Tests

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED</td>
<td>Flashes the LEDs for 5 seconds.</td>
</tr>
<tr>
<td>NVRAM</td>
<td>Verifies the flash memory board configuration area by parsing and examining checksums.</td>
</tr>
<tr>
<td>Registers</td>
<td>Verifies the adapter registers by attempting to modify the writable bits in a selection of registers.</td>
</tr>
<tr>
<td>Interrupts</td>
<td>Examines the available hardware interrupts by requesting the controller to generate an interrupt and verifying that the interrupt has been processed by the network driver.</td>
</tr>
<tr>
<td>MAC loopback</td>
<td>Verifies that the network driver is able to pass packets to and from the network adapter using the MAC loopback layer.</td>
</tr>
<tr>
<td>PHY loopback</td>
<td>Verifies that the network driver is able to pass packets to and from the network adapter using the PHY loopback layer.</td>
</tr>
<tr>
<td>Memory</td>
<td>Verifies SRAM memory by writing various data patterns (incrementing bytes, all bit on and off, alternating bits on and off) to each memory location, reading back the data and comparing it to the written value.</td>
</tr>
<tr>
<td>MDIO</td>
<td>Verifies the MII registers by reading from PHY ID registers.</td>
</tr>
<tr>
<td>Event</td>
<td>Verifies the adapter’s event handling capabilities by posting a software event on each event queue created by the driver and checking it is delivered correctly. The driver creates an event queue for each CPU.</td>
</tr>
<tr>
<td>PHY BIST</td>
<td>Examines the PHY by initializing it and starting any available built-in self tests to run.</td>
</tr>
<tr>
<td>boot ROM</td>
<td>Verifies the Boot ROM configuration and image checksum. Will warn if no Boot ROM is present.</td>
</tr>
</tbody>
</table>

### Running Cable Diagnostics

With high-speed data networking, the suitability of the cable in achieving maximum transfer rates is especially important. SAM’s cable diagnostic tool can be used to verify the attached cable, reporting its condition, measured length and electrical characteristics for each cable pairing.

**NOTE:** Cable diagnostics are only available on Solarflare 10GBASE-T Adapters. For these adapters, Solarflare recommend using good quality Category 6, 6a or 7 cable up to the maximum length as determined by the cable category.
Start SAM and select a Solarflare adapter from the Network Adapter list.

2. From the Action menu, click Cable Diagnostics. The Cable Diagnostics for <adapter name> dialog box is displayed.

3. Click Run offline test or Run online test. Offline testing produce more detailed results, but at the expense of disrupting the connection while tests are running.

CAUTION: The offline tests will cause the network link to momentarily drop and disrupt data flow. Solarflare recommend only running diagnostics tests when disruption to your services can be tolerated.

4. The results of the testing will be displayed in the diagnostics dialog box. For analysis of the cable pair results, see Table 42.

Table 42: Cable Pair Diagnostic Results

<table>
<thead>
<tr>
<th>Result</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>Cable is operating correctly.</td>
</tr>
<tr>
<td>Length measured = ...</td>
<td>The range is ±13dB (approximately). The SNR should be positive.</td>
</tr>
<tr>
<td>SNR margin = ...</td>
<td></td>
</tr>
</tbody>
</table>
4.16 Using SAM for Boot ROM Configuration

For booting of diskless systems, Solarflare adapters support Preboot Execution Environment (PXE) and UEFI booting.

Using SAM, you can access the adapter Boot ROM to configure your firmware settings for adapter booting, as described below.

Configure the Boot Manager

To configure PXE or UEFI booting on the Solarflare Boot ROM:

1. Start SAM and select a Solarflare adapter from the Network Adapter list.

From the Action menu, select the Configure Boot ROM option. The Configure Boot ROM window displays with the General tab selected.

![Figure 30: boot ROM Configuration](image-url)
2 From the **Boot Type** panel, select either PXE or UEFI booting as required. You can also configure the types of Boot Firmware, the maximum number of MSI-X Interrupts supported and start-up configuration used by the Boot ROM utility. For more details on these options see *Sfboot: Boot ROM Configuration Tool* on page 187.

**NOTE:** Solarflare recommend not changing the MSI-X Interrupts setting.

3 If necessary, from the **Link** tab, change the **Link Speed** option depending on your link requirement. Note that **Auto-negotiated** is correct for most links and should not be changed unless advised. The Link Speed options will vary depending on the installed adapter.

![Configure Boot ROM of Solarflare SFP+ Server Adapter (local)](image)

*Figure 31: Link tab*

4 The Link up delay specifies a wait time before the boot device will attempt to make a connection. This allows time for the network to start following power-up. The default setting is 5 seconds, but can be set from 0–255 seconds. This can be used to wait for spanning tree protocol on a connected switch to unblock the switch port after the physical network link is established.

5 If you selected **PXE** as the boot type, click **OK** to finish the setup procedure.
Disabling Adapter Booting

You can stop the adapter from attempting to initiate either a PXE or UEFI boot after a restart.

1. Start SAM and select the Solarflare adapter from the Network Adapter list.
2. From the Action menu, click the Configure Boot ROM option. The Configure Boot ROM dialog box displays with the BIOS tab selected.
3. From the Boot Type panel, select Disabled.
4. Click OK or Apply to save your settings to the Boot ROM.

4.17 Managing Firmware with SAM

SAM allows you to monitor the firmware (PHY, Boot ROM and Adapter) for your Solarflare adapters. Either select Manage firmware from the Actions pane, or from the Action menu. The firmware update window is displayed:

![Solarflare firmware update window](image)

Figure 32: Solarflare firmware update window

If the firmware is up to date, the window will contain the OK button. If the firmware is out of date, the OK button is replaced with an Update and Cancel button. To update the firmware, click Update.

You can also use the sfupdate command line tool to manage the firmware on your Solarflare adapters. See Sfupdate: Firmware Update Tool on page 195 for more details.
4.18 Configuring Network Adapter Properties in Windows

Network adapter properties for the Solarflare adapter are available through the Windows Device Manager entry for the relevant network adapter. You can also access the adapter properties using SAM.

NOTE: If SAM is open, any changes made in the adapter properties will not be reflected in SAM until you close the Advanced Properties page.

To configure network adapter properties:

1. From the Control Panel, select System.
2. Select Device Manager from the left hand menu.
3. Expand the Network adapters.
4. Right-click the on the Solarflare adapter, and then click Properties to display the properties dialog box.

![Figure 33: Adapter Properties Dialog]

5. Click the Advanced tab to view and edit the NDIS properties. See Table 43 for a list of the available properties.

NOTE: Changing these properties may impact the performance of your Solarflare adapter. You are strongly advised to leave them at their default values.
NOTE: Before making any changes to your Solarflare adapter features, read the Performance Tuning on Windows section on 225 first.

Table 43: Solarflare Network Adapter Properties

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Interrupt Moderation</td>
<td>Enabled</td>
<td>This setting is dependent on the Interrupt Moderation setting. If Interrupt Moderation is enabled, Adaptive Interrupt Moderation allows the adapter to vary its interrupt moderation automatically, according to network traffic demands. If Adaptive Interrupt Moderation is disabled, interrupt moderation interval is fixed at the setting specified in Interrupt Moderation Time. Default setting: Enabled</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td>Flow Control</td>
<td>Auto Negotiation</td>
<td>Ethernet flow control (802.3x) is a way for a network device to signal to a sending device that it is overloaded, such as when a device is receiving data faster than it can process it. The adapter does this by generating a ‘pause frame’ to request the sending device to temporarily stop transmitting data. Conversely, the adapter can respond to pause frames by suspending data transmission, allowing time for the receiving device to process its data. Default setting: Auto Negotiation.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rx &amp; Tx Enabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rx Enabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx Enabled</td>
<td></td>
</tr>
<tr>
<td>Interrupt Moderation</td>
<td>Enabled</td>
<td>Interrupt moderation is a technique used to reduce the number of interrupts sent to the CPU. With interrupt moderation, the adapter will not generate interrupts closer together than the interrupt moderation time. An initial packet will generate an interrupt immediately, but if subsequent packets arrive before the interrupt moderation time period, interrupts are delayed. Default setting: Enabled</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td>Interrupt Moderation Time</td>
<td>1–1000 µs</td>
<td>Specifies the interrupt moderation period when Interrupt Moderation is enabled. The default setting (60µs) has been arrived at by lengthy and detailed system analysis, balancing the needs of the operating system against the performance of the network adapter. Default setting: 60µs</td>
</tr>
</tbody>
</table>
IP checksum offload is a hardware offload technology for reducing the load on a CPU by processing IP checksums in the adapter hardware.

Offload IP Checksum is enabled by default for transmitted and received data.

Default setting: **Rx & Tx Enabled**.

Large Receive Offload (LRO) is an offload technology for reducing the load on a CPU by processing TCP segmentation for received packets in the adapter.

This is available only on Windows Server 2008 R2.

Default setting: **Disabled**

Large Send Offload (LSO) is an offload technology for reducing the load on a CPU by processing TCP segmentation for transmitted packets in the adapter.

**Caution:** Disabling LSO may reduce the performance of the Solarflare adapter.

Default setting: **Enabled**

Assigns the specified MAC address to the adapter, overriding the permanent MAC address assigned by the adapter's manufacturer.

Addresses are entered as a block of six groups of two hexadecimal digits separated by hyphens (-), for example: 12-34-56-78-9A-BC

**Note:** To be a valid address, the second most significant digit must be a 2, 6, A or E, as in the above example.

Check the System Event Log for any configuration issues after setting this value.

Default setting: **Not Present**.

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv4 Checksum Offload</td>
<td>Disabled</td>
<td>IP checksum offload is a hardware offload technology for reducing the load on a CPU by processing IP checksums in the adapter hardware.</td>
</tr>
<tr>
<td></td>
<td>Rx &amp; Tx Enabled</td>
<td>Offload IP Checksum is enabled by default for transmitted and received data.</td>
</tr>
<tr>
<td></td>
<td>Rx Enabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx Enabled</td>
<td></td>
</tr>
<tr>
<td>Large Receive Offload (IPv4 and IPv6)</td>
<td>Enabled</td>
<td>Large Receive Offload (LRO) is an offload technology for reducing the load on a CPU by processing TCP segmentation for received packets in the adapter.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td>Large Send Offload Version 2 (IPv4 and IPv6)</td>
<td>Enabled</td>
<td>Large Send Offload (LSO) is an offload technology for reducing the load on a CPU by processing TCP segmentation for transmitted packets in the adapter.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td></td>
</tr>
<tr>
<td>Locally Administered Address</td>
<td>Value: (MAC address)</td>
<td>Assigns the specified MAC address to the adapter, overriding the permanent MAC address assigned by the adapter's manufacturer.</td>
</tr>
<tr>
<td></td>
<td>Not Present</td>
<td>Addresses are entered as a block of six groups of two hexadecimal digits separated by hyphens (-), for example: 12-34-56-78-9A-BC</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Note:</strong> To be a valid address, the second most significant digit must be a 2, 6, A or E, as in the above example. Check the System Event Log for any configuration issues after setting this value.</td>
</tr>
</tbody>
</table>

Default setting: **Not Present**.
### Table 43: Solarflare Network Adapter Properties

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max Frame Size</strong></td>
<td>1514–9216</td>
<td>Specifies the maximum Ethernet frame size supported by the adapter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Note:</strong> Devices will drop frames if they are unable to support the specified frame size, so ensure the value you set here is supported by other devices on the network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Default settings:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solarflare adapter: <strong>1514</strong> bytes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teamed adapter: <strong>1518</strong> bytes</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Note:</strong> The setting must be a multiple of 2.</td>
</tr>
<tr>
<td><strong>Maximum number of RSS Processors</strong></td>
<td>1-256</td>
<td>Maximum number of processors that can be used by RSS. Default value is <strong>16</strong>.</td>
</tr>
<tr>
<td><strong>Maximum number of RSS Queues</strong></td>
<td>1-64</td>
<td>Specify the number of RSS receive queues are created by the adapter driver. Default is <strong>8</strong>.</td>
</tr>
<tr>
<td><strong>Preferred Numa Node</strong></td>
<td>All</td>
<td>The adapter attempts to use only the CPUs from the specified NUMA node for RSS. If this is set to <strong>All</strong> or is greater than or equal to the number of NUMA nodes in the system all NUMA nodes are used.</td>
</tr>
<tr>
<td></td>
<td>0 to 15</td>
<td>Default setting: <strong>All</strong></td>
</tr>
<tr>
<td><strong>Receive Segment Coalescing</strong></td>
<td>Enabled</td>
<td>Receive Segment Coalescing (RSC) is an offload technology for reducing the load on a CPU by processing TCP segmentation for received packets in the adapter.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td>This is available on Windows Server 2012 and later.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Default setting: <strong>Enabled</strong></td>
</tr>
<tr>
<td><strong>Receive Side Scaling (RSS)</strong></td>
<td>Enabled</td>
<td>Receive Side Scaling (RSS) is a technology that enables packet receive processing to scale with the number of available processors (CPUs), distributing the processing workload across the available resources.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td>Default setting: <strong>Enabled</strong></td>
</tr>
</tbody>
</table>
### Table 43: Solarflare Network Adapter Properties

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed &amp; Duplex</td>
<td>100 Mbps Full Duplex</td>
<td>Configure the adapter speed. Default is <strong>Auto Negotiation</strong>.</td>
</tr>
<tr>
<td></td>
<td>1.0 Gbps Full Duplex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Gbps Full Duplex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 Gbps Full Duplex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Auto Negotiation</td>
<td></td>
</tr>
<tr>
<td>TCP Checksum Offload (IPv4 and IPv6)</td>
<td>Disabled</td>
<td>TCP checksum offload is a hardware offload technology for reducing the load on a CPU by processing TCP checksums in the adapter hardware.</td>
</tr>
<tr>
<td></td>
<td>Rx &amp; Tx Enabled</td>
<td>Default setting: <strong>Rx &amp; Tx Enabled</strong>.</td>
</tr>
<tr>
<td></td>
<td>Rx Enabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx Enabled</td>
<td></td>
</tr>
<tr>
<td>UDP Checksum Offload (IPv4 and IPv6)</td>
<td>Disabled</td>
<td>UDP checksum offload is a hardware offload technology for reducing the load on a CPU by processing UDP checksums in the adapter hardware.</td>
</tr>
<tr>
<td></td>
<td>Rx &amp; Tx Enabled</td>
<td>Default setting: <strong>Rx &amp; Tx Enabled</strong>.</td>
</tr>
<tr>
<td></td>
<td>Rx Enabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx Enabled</td>
<td></td>
</tr>
<tr>
<td>Virtual Machine Queues</td>
<td>Enabled</td>
<td>VMQ offloads classification and delivery of network traffic destined for Hyper-V virtual machines to the network adapter, reducing CPU utilization on Hyper-V hosts.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td>Default setting: <strong>Enabled</strong>.</td>
</tr>
<tr>
<td>VMQ VLAN Filtering</td>
<td>Enabled</td>
<td>VLAN filtering allows the adapter to use the VLAN identifier for filtering traffic intended for Hyper-V virtual machines. When disabled only the destination MAC address is used for filtering.</td>
</tr>
<tr>
<td></td>
<td>Disabled</td>
<td>Default setting: <strong>Enabled</strong>.</td>
</tr>
</tbody>
</table>
4.19 Windows Command Line Tools

The command line tools (see Table 44) provide an alternative method of managing Solarflare network adapters to SAM. They are especially useful on a Windows Server Core installation, where SAM cannot be run locally. As with SAM, you can run the command line tools remotely. The tools can also be scripted.

The command line tools are installed as part of the drivers installation on Windows. See Installing the Solarflare Driver Package on Windows on page 137.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sfboot.exe</td>
<td>A tool for configuring Solarflare adapter Boot ROM options, including PXE and UEFI booting. See Sfboot: Boot ROM Configuration Tool on page 187.</td>
</tr>
<tr>
<td>sfteam.exe</td>
<td>A tool for managing fault-tolerant adapter teams and VLANs. See Sfteam: Adapter Teaming and VLAN Tool on page 197.</td>
</tr>
<tr>
<td>sfcable.exe</td>
<td>A tool for that runs cable diagnostics for Solarflare 10GBASE-T server adapters. See Sfcable: Cable Diagnostics Tool on page 202.</td>
</tr>
<tr>
<td>sfnet.exe</td>
<td>Allows you to display and/or set the offload, Ethernet, RSS, interrupt moderation and VMQ features of any one adapter, VLAN or Team. See Sfnet on page 208.</td>
</tr>
</tbody>
</table>

To start a command line tool, open a Command Line Interface windows and enter the command tool.exe:

![Figure 34: Windows console to run Solarflare command line tools.](image)

![Figure 34: Windows console to run Solarflare command line tools.](image)
NOTE: For all the utilities, the options are documented with the forward slash (/) prefix. You can also use a single dash (-) or a double dash (-- as a prefix.

NOTE: Utilities must be run as an administrator to make any changes. When run as a non administrator, an error message will be displayed.

4.20 Sfboot: Boot ROM Configuration Tool

- Sfboot: Command Usage on page 187
- Sfboot: Command Line Options on page 188
- Sfboot: Examples on page 193

Sfboot is a Windows command line utility for configuring Solarflare adapter Boot ROM options, including PXE and UEFI booting. Using sfboot is an alternative to using Ctrl+B to access the Boot Rom agent during server startup.

See Solarflare Boot Manager on page 371 for more information on the Boot Rom agent.

Sfboot: Command Usage

1. Login with an administrator account.
2. Click Start > All Programs > Solarflare Network Adapters > Command Line Interface for Network Adapters.
3. From the Command Prompt, enter the command using the following syntax:
   
   sfboot [/Adapter <Identifier>] [options] [parameters]

   where:
   - Identifier is the name or ID of the adapter that you want to manage. Specifying the adapter is optional - if it is not included the command is applied to all Solarflare adapters in the machine.
   - option is the option you want to apply. See Sfboot: Command Line Options for a list of available options.

   If using sfboot in a configuration script, you can include the environment variable %SFTOOLS% to set the path to the Solarflare tools. For example:

   SET PATH=%PATH%;%SFTOOLS%
Sfboot: Command Line Options

Table 45 lists the options for sfboot.exe, Table 46 lists the available global parameters, and Table 47 lists the available per-adapter parameters. Note that command line options are case insensitive and may be abbreviated.

NOTE: Abbreviations in scripts should be avoided, since future updates to the application may render abbreviated scripts invalid.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Help</td>
<td>Displays command line syntax and provides a description of each sfboot option.</td>
</tr>
<tr>
<td>/Version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>/Nologo</td>
<td>Hide the version and copyright message at startup.</td>
</tr>
<tr>
<td>/Verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>/Quiet</td>
<td>Suppresses all output, including warnings and errors; no user interaction.</td>
</tr>
<tr>
<td>/Log &lt;Filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify /Silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>/Computer &lt;ComputerName&gt;</td>
<td>Performs the operation on a specified remote computer. Administrator rights on the remote computer is required.</td>
</tr>
<tr>
<td>/List</td>
<td>Lists all available Solarflare adapters. This option shows the adapter’s ID number, ifname and MAC address.</td>
</tr>
<tr>
<td></td>
<td>Note: this option may not be used in conjunction with any other option. If this option is used with configuration parameters, those parameters will be silently ignored.</td>
</tr>
<tr>
<td>/Adapter &lt;Identifier&gt;</td>
<td>Performs the action on the identified Solarflare network adapter. The adapter identifier can be the adapter ID number, ifname or MAC address, as output by the /List option. If /Adapter is not included, the action will apply to all installed Solarflare adapters.</td>
</tr>
<tr>
<td>/Clear</td>
<td>Resets all options to their default values. If an adapter is specified, options for the given adapter are reset, but global options (shown in Table 46) are not reset. Note that /Clear can also be used with parameters, allowing you to reset to default values, and then apply the parameters specified.</td>
</tr>
<tr>
<td>/repair</td>
<td>Restore configuration settings to firmware defaults.</td>
</tr>
</tbody>
</table>
The following global parameters in Table 46 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

### Table 46: Sfboot Global Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>boot-image</strong>= all</td>
<td>optionrom</td>
</tr>
<tr>
<td><strong>port-mode</strong>= default</td>
<td>1x10G</td>
</tr>
<tr>
<td>• SFN8722: 2x10G</td>
<td></td>
</tr>
<tr>
<td>• SFN8542: 4x10G, 2x40G (default)</td>
<td></td>
</tr>
<tr>
<td>• SFN8522: 2x10G (default)</td>
<td></td>
</tr>
<tr>
<td>• SFN7xx4F: 2x10G, 4x10G (default)</td>
<td></td>
</tr>
<tr>
<td>• SFN7xx2Q: 2x10G, 4x10G, 2x40G (default)</td>
<td></td>
</tr>
<tr>
<td>• SFN7xx2F: 1x10G, 2x10G (default)</td>
<td></td>
</tr>
<tr>
<td>Changes to this setting with sfboot require a cold reboot to become effective. MAC address assignments may change after altering this setting.</td>
<td></td>
</tr>
<tr>
<td><strong>firmware-variant</strong>= full-feature</td>
<td>ultra-low-latency</td>
</tr>
<tr>
<td>• the SFN7002F adapter is factory set to full-feature</td>
<td></td>
</tr>
<tr>
<td>• all other adapters are factory set to auto.</td>
<td></td>
</tr>
<tr>
<td>Default value = auto - means the driver will select a variant that meets its needs:</td>
<td></td>
</tr>
<tr>
<td>• the VMware driver always uses full-feature</td>
<td></td>
</tr>
<tr>
<td>• otherwise, ultra-low-latency is used.</td>
<td></td>
</tr>
<tr>
<td>The ultra-low-latency variant produces best latency without support for TX VLAN insertion or RX VLAN stripping (not currently used features).</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>insecure-filters=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>mac-spoofing=default</td>
<td>enabled</td>
</tr>
</tbody>
</table>
| rx/dc-size=8|16|32|64 | Specifies the size of the descriptor cache for each receive queue. This is for SFN7000 and SFN8000 series adapters only. The default is:  
- 16 if the port-mode supports the maximum number of connectors for the adapter  
- 32 if the port-mode supports a reduced number of connectors. |
| tx/dc-size=8|16|32|64 | Specifies the size of the descriptor cache for each transmit queue. This is for SFN7000 and SFN8000 series adapters only. The default is:  
- 32 if the port-mode supports the maximum number of connectors for the adapter  
- 64 if the port-mode supports a reduced number of connectors. |
| change-mac=default|enabled|disabled | This is for SFN7000 and SFN8000 series adapter only. Change the unicast MAC address for on-privileged functions on this port. This is a global option and applies to all ports on the NIC. |
| vi-count=<vi count> | Sets the total number of virtual interfaces that will be available on the NIC. |
| event-merge-timeout= <timeout in nanoseconds> | Specifies the timeout in nanoseconds for RX event merging. A timeout of 0 means that event merging is disabled. |
The following per-adapter parameters in Table 47 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

**Table 47: Sfboot Per-adapter Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| link-speed=auto|10g|1g|100m | Specifies the network link speed of the adapter used by the Boot ROM. The default is auto. On the 10GBASE-T adapters, auto instructs the adapter to negotiate the highest speed supported in common with its link partner. On SFP+ adapters, auto instructs the adapter to use the highest link speed supported by the inserted SFP+ module. On 10GBASE-T and SFP+ adapters, any other value specified will fix the link at that speed, regardless of the capabilities of the link partner, which may result in an inability to establish the link.  
auto  Auto-negotiate link speed (default)  
10G  10G bit/sec  
1G  1G bit/sec  
100M  100M bit/sec |
| linkup-delay=  |<delay time in seconds> | Specifies the delay (in seconds) the adapter defers its first connection attempt after booting, allowing time for the network to come up following a power failure or other restart. This can be used to wait for spanning tree protocol on a connected switch to unblock the switch port after the physical network link is established. The default is 5 seconds. |
| banner-delay=  |<delay time in seconds> | Specifies the wait period for Ctrl-B to be pressed to enter adapter configuration tool.  
<delay time in seconds> = 0-256 |
| bootskip-delay=  |<delay time in seconds> | Specifies the time allowed for Esc to be pressed to skip adapter booting.  
<delay time in seconds> = 0-256 |
| boot-type=pxe|disabled | Sets the adapter boot type – effective on next boot.  
pxe – PXE (Preboot eXecution Environment) booting  
disabled – Disable adapter booting |
**pf-count=<pf count>**
This is the number of available PCIe PFs per physical network port. This setting is applied to all ports on the adapter.

Changes to this setting with `sfboot` require a cold reboot to become effective. MAC address assignments may change after altering this setting.

**msix-limit=8|16|32|64|128|256|512|1024**
Specifies the maximum number of MSI-X interrupts that each PF will use. The default is 32.

Note: Using the incorrect setting can impact the performance of the adapter. Contact Solarflare technical support before changing this setting.

**sriov=enabled|disabled**
Enable SR-IOV support for operating systems that support this. Not required on SFN7000 or SFN8000 series adapters.

**vf-count=<vf count>**
The number of virtual functions (VF) advertised to the operating system for each Physical Function on this physical network port. SFN7000 and SFN8000 series adapters have a total limit of 2048 interrupts. Earlier adapters support a total limit of 127 virtual functions per port and a total of 1024 interrupts.

Depending on the values of `msix-limit` and `vf-msix-limit`, some of these virtual functions may not be configured.

Enabling all 127 VFs per port with more than one MSI-X interrupt per VF may not be supported by the host BIOS - in which case you may get 127 VFs on one port and none on others. Contact your BIOS vendor or reduce the VF count.

The `sriov` parameter is implied if `vf-count` is greater than zero.

Changes to this setting with `sfboot` require a cold reboot to become effective.

**vf-msix-limit=1|2|4|8|16|32|64|128|256**
The maximum number of interrupts a virtual function may use.
Table 47: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pf-vlans=&lt;tag&gt;[,&lt;tag&gt;[,...]]</td>
<td>none</td>
</tr>
</tbody>
</table>
| switch-mode= | default|Specifies the mode of operation that the port will be used in:  
| | sriov|partitioning|partitioning-with-sriov|pfiov |default - single PF created, zero VFs created.  
sriov - SR-IOV enabled, single PF created, VFs configured with vf-count.  
partitioning - PFs configured with pf-count, VFs configured with vf-count. See NIC Partitioning on page 71 for details.  
partitioning-with-sriov - SR-IOV enabled, PFs configured with pf-count, VFs configured with vf-count. See NIC Partitioning on page 71 for details.  
pfiov - PFIOV enabled, PFs configured with pf-count, VFs not supported. Changes to this setting with sfboot require a cold reboot to become effective. |

Sfboot: Examples

- Show the current boot configuration for all adapters:
  
sfboot
  
Sample console output:

Solarflare boot ROM configuration utility [v4.1.4]
Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

Solarflare SFN7122F SFP+ Server Adapter - MAC: 00:0F:53:21:9B:B1

<table>
<thead>
<tr>
<th>Boot image</th>
<th>Option ROM only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Link speed</td>
<td>Negotiated automatically</td>
</tr>
<tr>
<td>Link-up delay time</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Banner delay time</td>
<td>2 seconds</td>
</tr>
<tr>
<td>Boot skip delay time</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Boot type</td>
<td>Disabled</td>
</tr>
<tr>
<td>PFIOV</td>
<td>Disabled</td>
</tr>
<tr>
<td>Number of Physical Functions</td>
<td>2</td>
</tr>
<tr>
<td>MSI-X interrupt limit</td>
<td>32</td>
</tr>
<tr>
<td>Number of Virtual Functions</td>
<td>0</td>
</tr>
<tr>
<td>VF MSI-X interrupt limit</td>
<td>8</td>
</tr>
</tbody>
</table>
Firmware variant full feature / virtualization
Insecure filters Disabled

Solarflare SFN7122F SFP+ Server Adapter #2 - MAC: 00:0F:53:21:9B:B0
Boot image Option ROM only
Link speed Negotiated automatically
Link-up delay time 5 seconds
Banner delay time 2 seconds
Boot skip delay time 5 seconds
Boot type Disabled
PFIOV Disabled
Number of Physical Functions 2
MSI-X interrupt limit 32
Number of Virtual Functions 0
VF MSI-X interrupt limit 8
Firmware variant full feature / virtualization
Insecure filters Disabled

- List all Solarflare adapters installed on the localhost:
  sfboot /List
  Sample console output:

  Solarflare boot ROM configuration utility [v4.1.4]
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005
  Network adapters in this computer:
  1: Solarflare SFN7122F SFP+ Server Adapter
     MAC address: 00:0F:53:21:9B:B1
  2: Solarflare SFN7122F SFP+ Server Adapter #2
     MAC address: 00:0F:53:21:9B:B0

- List adapters installed on the remote host named “Mercutio”:
  sfboot /Computer Mercutio /List
  Sample console output (remote host has two adapters present):

  Solarflare boot ROM configuration utility [v4.1.4]
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005
  Network adapters in Mercutio:
  1: Solarflare SFN7122F SFP+ Server Adapter
     MAC address: 00:0F:53:21:9B:B1
  2: Solarflare SFN7122F SFP+ Server Adapter #2
     MAC address: 00:0F:53:21:9B:B0
### 4.21 Sfupdate: Firmware Update Tool

- **Sfupdate: Command Usage on page 195**
- **Sfupdate: Command Line Options on page 195**
- **Sfupdate: Examples on page 197**

Sfupdate is a Windows command line utility used to manage and upgrade the Solarflare adapter Boot ROM, UEFI, PHY and adapter firmware. Embedded within the sfupdate executable are firmware images for various Solarflare adapters - the exact updates available via sfupdate are therefore depend on your adapter.

#### Sfupdate: Command Usage

1. Login with an administrator account.
2. Click **Start > All Programs > Solarflare Network Adapters > Command Line Interface for network adapters**. If you installed the Solarflare system tray icon, you can right-click the icon and choose **Command-line tools** instead.
3. In the Command Prompt window, enter your command using the following syntax:
   ```
   sfupdate [/Adapter <Identifier>] [options]
   ```
   where:
   - `Identifier` is the name or ID of the adapter that you want to manage. Specifying the adapter is optional - if it is not included the command is applied to all Solarflare adapters in the machine.
   - `options` is the option to apply. See **Sfupdate: Command Line Options** for a list of available options.

Running the command `sfupdate` with no additional parameters will show the current firmware version for all Solarflare adapters and whether the firmware within `sfupdate` is more up to date. To update the firmware for all Solarflare adapters run the command `sfupdate /Write`

Solarflare recommend that you use sfupdate in the following way:

1. Run `sfupdate` to check that the firmware on all your adapters are up to date.
2. Run `sfupdate /write` to update the firmware on all adapters.

#### Sfupdate: Command Line Options

**Table 48** lists the command options for `sfupdate`. Note that command line options are case insensitive and may be abbreviated.

[i] **NOTE:** Abbreviations in scripts should be avoided, since future updates to the application may render your abbreviated scripts invalid.
See Sfupdate: Examples on page 197 for example output.

### Table 48: Sfupdate Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Help or /H or /?</td>
<td>Displays command line syntax and provides a description of each option.</td>
</tr>
<tr>
<td>/Version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>/Nologo</td>
<td>Hides the version and copyright message at startup.</td>
</tr>
<tr>
<td>/Verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>/Quiet</td>
<td>Suppresses all output, including warnings and errors; no user interaction. You should query the completion code to determine the outcome of commands when operating silently.</td>
</tr>
<tr>
<td>Aliases: /Silent</td>
<td></td>
</tr>
<tr>
<td>/Log &lt;Filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify /Silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>/Computer &lt;ComputerName&gt;</td>
<td>Performs the operation on the identified remote computer. Administrator rights on the remote host computer is required.</td>
</tr>
<tr>
<td>/Adapter &lt;Identifier&gt;</td>
<td>Performs the action on the identified Solarflare network adapter. The identifier can be the adapter ID number, name or MAC address.</td>
</tr>
<tr>
<td>/Force</td>
<td>Forces a firmware update. Can be used to force an update to an older revision of firmware when used with /Write.</td>
</tr>
<tr>
<td>/Write</td>
<td>Writes the updated firmware to the adapter.</td>
</tr>
<tr>
<td></td>
<td>If the /Image option is not specified, /Write will write the embedded image from sfupdate to the hardware.</td>
</tr>
<tr>
<td></td>
<td>The update will fail if the image on the adapter is current or newer; to force an update, specify /Force in the command line.</td>
</tr>
<tr>
<td>/Yes</td>
<td>Update without prompting for a final confirmation. This option may be used with the /Write and /Force options, but is not required with the /Quiet option.</td>
</tr>
<tr>
<td>/Image &lt;ImageFileName&gt;</td>
<td>Sources firmware image from an external file.</td>
</tr>
<tr>
<td>/ipxe-image &lt;ImageFileName&gt;</td>
<td>Install an iPXE image from the given file, replacing the Solarflare boot ROM image. sfupdate will not automatically replace the iPXE image in subsequent flash updates unless the --restore-bootrom option is used.</td>
</tr>
<tr>
<td>/restore-bootrom</td>
<td>Replace an iPXE image in flash with the standard Solarflare Boot Manager PXE image included in sfupdate.</td>
</tr>
<tr>
<td>/NoWarning</td>
<td>Suppress update warnings.</td>
</tr>
</tbody>
</table>
Sfupdate: Examples

- Display firmware versions for all adapters:
  sfupdate

  Sample output from a host with a single SFN7122F adapter installed:

  Solarflare firmware update utility [v4.1.4]
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

  1: Solarflare SFN7122F SFP+ Server Adapter
     MAC address: 00:0F:53:21:9B:B1
     Firmware: v4.1.0  - update to v4.1.4?
     Boot ROM:  v4.1.0.6723  - update to v4.2.0.1000?
     Adapter:  v4.1.0.6732  - update to v4.1.1.1020?

  2: Solarflare SFN7122F SFP+ Server Adapter #2
     MAC address: 00:0F:53:21:9B:B0
     Firmware: v4.1.0  - update to v4.1.4?
     Boot ROM:  v4.1.0.6723  - update to v4.2.0.1000?
     Adapter:  v4.1.0.6732  - update to v4.1.1.1020?

- Update all adapters to latest version of PHY and Boot ROM firmware:
  sfupdate /Write

  Sample output:

  Solarflare firmware update utility [v4.1.4]
  Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

  1: Solarflare SFN7122F SFP+ Server Adapter
     MAC address: 00:0F:53:21:9B:B1
     Firmware: v4.1.0  - update to v4.1.4
     Boot ROM:  v4.1.0.6723  - update to v4.2.0.1000
     Adapter:  v4.1.0.6732  - update to v4.1.1.1020

  2: Solarflare SFN7122F SFP+ Server Adapter #2
     MAC address: 00:0F:53:21:9B:B0
     Firmware: v4.1.0  - update to v4.1.4
     Boot ROM:  v4.1.0.6723  - update to v4.2.0.1000
     Adapter:  v4.1.0.6732  - update to v4.1.1.1020

4.22 Sfteam: Adapter Teaming and VLAN Tool

- Sfteam: Command Usage on page 198
- Sfteam: Command Line Options on page 198
- Sfteam: Examples on page 202

Sfteam is a Windows command line utility used to configure and manage the teaming and VLAN features of the Solarflare adapters. You may find it easier to create and manage teams and VLANs with SAM, Solarflare's graphical adapter manager. As an alternative, or where SAM is not available, sfteam provides a method of creating teams and VLANs from the command line or configuration script.
For general information on teaming and VLANs, see Teaming and VLANs on page 213.

**Sfteam: Command Usage**

1. Login with an administrator account.
2. Click **Start > All Programs > Solarflare Network Adapters > Command Line Interface for network adapters**. If you installed the Solarflare system tray icon, you can right-click the icon and choose **Command-line tools** instead.
3. In the Command Prompt window, enter your command using the following syntax:
   
   sfteam [option]
   
   where:
   
   - option is the command to apply. See Table 49 for a list of available options.

   If using sfteam in a configuration script, you can include the environment variable `%SFTOOLS%` to set the path to the Solarflare tools. For example:

   ```
   SET PATH=%PATH%;%SFTOOLS%
   ```
   
   or refer to sfteam as:

   ```
   %SFTOOLS%\sfteam
   ```

**Sfteam: Command Line Options**

Table 49 lists the command line options sfteam. Note that command line options are case insensitive and may be abbreviated.

**NOTE:** Abbreviations in scripts should be avoided, since future updates to the application may render your abbreviated scripts invalid.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Help or /? or /H</td>
<td>Displays command line syntax and provides a description of each sfteam option.</td>
</tr>
<tr>
<td>/Version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>/Nologo</td>
<td>Hides the version and copyright message at startup.</td>
</tr>
<tr>
<td>/Verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>/Quiet</td>
<td>Suppresses all output, including warnings and errors; no user interaction. You should query the completion code to determine the outcome of commands when operating silently.</td>
</tr>
<tr>
<td>Aliases: /Silent</td>
<td></td>
</tr>
</tbody>
</table>
### Table 49: Sfteam Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Log &lt;filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify /Silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>/Computer &lt;ComputerName&gt;</td>
<td>Performs the operation on the identified remote computer. Administrator rights on the remote host computer is required.</td>
</tr>
<tr>
<td>/List</td>
<td>Lists all available Solarflare adapters and any teams and VLANs. This option shows the adapter’s ID number, name and MAC address.</td>
</tr>
</tbody>
</table>
| /Create         | Creates a team or VLAN. To be valid, this option must be used with the /Adapter option for each adapter that you want to add to the team.  
                   To specify a name for the team, include the /Name option. 
                   To add VLANs to a team, include the /Vlan option. 
                   Note that once a team has been created, sfteam does not allow you to change its adapters, VLANs or team name. Either delete the team and set it up again, or use SAM instead to configure the team. |
| /Configure <TeamIdentifier> | Configures the identified team or group. The team identity can be specified as the team name or group ID. |
| /Delete <TeamIdentifier> | Deletes the identified team or group. The team identity can be specified as the team name or group ID. This option cannot be used to delete VLANs. |
| /Clear          | Deletes all teams and VLANs.                                                                            |
| /Adapter <AdapterId> | Specifies the adapter to add to the team. The adapter can be specified as the adapter name or ID. Repeat this option for each adapter that you want to include in the team. 
                   This option must be used when a team is first created. It cannot be applied to a team once it has been setup. |
| /Remove <AdapterId> | Specifies the adapter to remove from the team. The adapter can be specified as the adapter name or ID. Repeat this option for each adapter that you want to remove from the team. |
### Table 49: Sfteam Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

/Vlan <VLAN tag[,priority[,name [,DHCP|addr,mask[,gateway]]]]>

**Creates a VLAN with the specified ID and sets priority traffic handling option.**

- **P** – Handles priority traffic
- **N** - Does not handle priority traffic

This option must be used when a team is first created. It cannot be applied to a team once it has been setup.

If you specify an IP address, you must specify a netmask as well.

If the IP address is not specified, then DHCP is assumed. You can also use `tag,priority,name,DHCP` to be explicit.

**Formats:**
- `<tag>`
  - e.g. 2 (assumes no priority)
- "<tag>,<priority>"
  - e.g. "2,p"
- "<tag>,<priority>,<name>"
  - e.g. "2,p,my name"
- "<tag>,<priority>,<name>,DHCP"
  - e.g. "2,p,my name,DHCP"
- "<tag>,<priority>,<name>,<addr>,<mask>"  
  - e.g. "2,p,my name,10.1.2.3,255.255.255.0"
- "<tag>,<priority>,<name>,<addr>,<mask>,<gateway>"  
  - e.g. "2,p,my name,10.1.2.3,255.255.255.0,10.1.2.1"

where:
- **Tag:** 0 to 4094
- **Priority:** either **P** (priority supported) or **N** (no priority)
- **DHCP:** may be omitted, and will be assumed, if it's the last field
- **IP Addresses:** IPv4, dotted-quad format

Note that `<mask>` must be present if `<addr>` is present

| /Name <TeamName> | Specifies a name for the adapter team. This option must be used when a team is first created. It cannot be applied to a team once it has been setup. |
### Table 49: Sfteam Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Type &lt;TeamType&gt;</td>
<td>Defines what kind of team is being created. The options are:</td>
</tr>
<tr>
<td></td>
<td>• tolerant (default)</td>
</tr>
<tr>
<td></td>
<td>• dynamic</td>
</tr>
<tr>
<td></td>
<td>• static</td>
</tr>
<tr>
<td></td>
<td>See Teaming and VLANs on page 213 for an explanation on the different teaming types.</td>
</tr>
<tr>
<td>/Mode &lt;Mode&gt;</td>
<td>Specifies how the driver will select adapters to be part of the link aggregation. The option is only relevant when the /Type option is either dynamic or static. The options are:</td>
</tr>
<tr>
<td></td>
<td>• auto (default)</td>
</tr>
<tr>
<td></td>
<td>• faulttolerant</td>
</tr>
<tr>
<td></td>
<td>• bandwidth</td>
</tr>
<tr>
<td></td>
<td>• key adapter</td>
</tr>
<tr>
<td></td>
<td>See Teaming and VLANs on page 213 for an explanation of the different teaming modes.</td>
</tr>
<tr>
<td>/Distribution &lt;DistributionMode&gt;</td>
<td>Specify how the driver distributes conversations across dynamic or static link aggregation team members. The available modes are:</td>
</tr>
<tr>
<td></td>
<td>• auto (default)</td>
</tr>
<tr>
<td></td>
<td>• activeadapter</td>
</tr>
<tr>
<td></td>
<td>• layer2hash</td>
</tr>
<tr>
<td></td>
<td>• layer3hash</td>
</tr>
<tr>
<td></td>
<td>• layer4hash</td>
</tr>
<tr>
<td>/Statistics</td>
<td>Display adapter and link-aggregation statistics</td>
</tr>
<tr>
<td>/Detailed</td>
<td>Display detailed configuration statistics</td>
</tr>
<tr>
<td>/Key &lt;AdapterId&gt;</td>
<td>Specifies the key adapter. The adapter can be specified as the adapter name or ID.</td>
</tr>
</tbody>
</table>
Sfteam: Examples

- Create TeamA with adapter ID 1 and adapter ID 2:
  
  sfteam /Create /Adapter 1 /Adapter 2 /Name Team_A

  Sample output:

  Solarflare teaming configuration utility [v4.1.4]
  Copyright Solarflare Communications 2006-2014 Level 5 Networks 2002-2005

  Creating team done (new id=2F)
  Setting team name "Team_A" ... done
  Adding adapter 1 ... done
  Adding adapter 2 ... done
  Creating network interface
  - Using DHCP
  - Waiting for the new VLAN device ..
  - Waiting for the new LAN interface
  - Waiting for access to the IP stack
  - Using DHCP done

- Create a VLAN to adapter #2 with VLAN tag 4 and priority traffic handling enabled:
  
  sfteam /Create /Adapter 2 /Vlan 4,P

  Sample output:

  Solarflare teaming configuration utility [v4.1.4]
  Copyright Solarflare Communications 2006-2014 Level 5 Networks 2002-2005

  Creating VLAN group done (new id=4V)
  Setting VLAN group name (using default name "Group 4V") ... done
  Adding adapter 2 ... done
  Creating VLAN
  - id=4, priority, unnamed
  - Using DHCP
  - Waiting for the new VLAN device ..
  - Waiting for the new LAN interface
  - Waiting for access to the IP stack
  - Using DHCP done

4.23 Sfcable: Cable Diagnostics Tool

- Sfcable: Command Usage on page 203
- Sfcable: Command Line Options on page 203
- Sfcable: Sample Commands on page 204

Sfcable is a Windows command line utility to run cable diagnostics on the Solarflare 10GBASE-T server adapters. A warning will be given if the adapter is not a 10GBASE-T adapter.
Sfcable: Command Usage

1. Login with an administrator account.
2. Click Start > All Programs > Solarflare Drivers > Command Line Tools. If you installed the Solarflare system tray icon, you can right-click the icon and choose Command-line tools instead.
3. In the Command Prompt window, enter the following command:
   
   `sfcable [/Adapter <Identifier>] [options]`
   
   where:
   - Identifier is the name or ID of the adapter that you want to manage. Specifying the adapter is optional - if it is not included the command is applied to all Solarflare adapters in the machine.
   - option is the option you to apply. See Table 50 for a list of available options.

Sfcable: Command Line Options

Table 50 lists the command options for sfcable. Note that command line options are case insensitive and may be abbreviated.

![](image)

**NOTE:** Abbreviations in scripts should be avoided, since future updates to the application may render your abbreviated scripts invalid.

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Help or /? or /H</td>
<td>Displays command line syntax and provides a description of each sfcable option.</td>
</tr>
<tr>
<td>/Version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>/Nologo</td>
<td>Hides the version and copyright message at startup.</td>
</tr>
<tr>
<td>/Verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>/Quiet /Silent</td>
<td>Suppresses all output, including warnings and errors. User should query the completion code to determine the outcome of commands when operating silently (see, Performance Tuning on Windows on page 225).</td>
</tr>
<tr>
<td>/Log &lt;Filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify /Silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>/Computer &lt;ComputerName&gt;</td>
<td>Performs the operation on the identified remote computer. Administrator rights on the remote host computer is required.</td>
</tr>
</tbody>
</table>
Sfcable: Sample Commands

- Run tests offline
  
  `sfcable /Offline`

Sample output from a computer with two Solarflare adapters installed:

```
C: sfcable /Offline
Solarflare cable diagnostics utility [v4.1.4]
Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

1 : Solarflare SFN5121T 10GBASE-T Server Adapter
   MAC address: 00:0F:53:01:40:8C
   Link state:  Up
   Link speed:  10 Gbps
   Pair 1:  OK, length=9m
   Pair 2:  OK, length=9m
   Pair 3:  OK, length=9m
   Pair 4:  OK, length=9m

2 : Solarflare SFN5121T 10GBASE-T Server Adapter #2
   MAC address: 00:0F:53:01:40:8D
   Link state:  Up
   Link speed:  10 Gbps
   Pair 1:  OK, length=9m
   Pair 2:  OK, length=9m
   Pair 3:  OK, length=9m
   Pair 4:  OK, length=9m
```
4.24 Sfkey: License Management Tool

- Sfkey: Command Usage on page 205
- Sfkey: Command Line Options on page 205
- Sfkey: Sample Commands on page 207

Sfkey is a Windows command line utility for managing Solarflare AppFlex™ licenses and enabling selected on-board services for Solarflare adapters. For more information about license requirements see Solarflare AppFlex™ Technology Licensing. on page 17.

Sfkey: Command Usage

1. Login with an administrator account.
2. Click Start > All Programs > Solarflare Drivers > Command Line Tools. If you installed the Solarflare system tray icon, you can right-click the icon and choose Command-line tools instead.
3. In the Command Prompt window, enter the following command:

   sfkey [/Adapter <Identifier>] [options]

   where:

   - Identifier is the name or ID of the adapter that you want to manage. Specifying the adapter is optional - if it is not included the command is applied to all Solarflare adapters in the machine.
   - option is the option you to apply. See Table 50 for a list of available options.

Sfkey: Command Line Options

Table 50 lists the command options for sfkey. Note that command line options are case insensitive and may be abbreviated.

NOTE: Abbreviations in scripts should be avoided, since future updates to the application may render your abbreviated scripts invalid.

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Help or /? or /H</td>
<td>Displays command line syntax and provides a description of each sfkey option.</td>
</tr>
<tr>
<td>/Version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>/Nologo</td>
<td>Hides the version and copyright message at startup.</td>
</tr>
<tr>
<td>/Verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
</tbody>
</table>

Table 51:  Sfkey Options
### Table 51: Sfkey Options

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Quiet</td>
<td>Suppresses all output, including warnings and errors. User should query the completion code to determine the outcome of commands when operating silently (see, Performance Tuning on Windows on page 225).</td>
</tr>
<tr>
<td>/Log &lt;Filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify /Silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>/Computer &lt;ComputerName&gt;</td>
<td>Performs the operation on the identified remote computer. Administrator rights on the remote host computer is required.</td>
</tr>
<tr>
<td>/Adapter &lt;Identifier&gt;</td>
<td>Performs the action on the identified Solarflare network adapter. The identifier can be the adapter ID number, name or MAC address, as given by the /List option.</td>
</tr>
<tr>
<td>/List</td>
<td>Lists all available Solarflare adapters. This options shows the adapter’s ID number, name and MAC address.</td>
</tr>
<tr>
<td>/Backup &lt;Filename&gt;</td>
<td>Output a report of the installed keys in all adapters. The report can be saved to file and later used with the /Install option, or can be output to stdout by using &quot;-&quot; as the filename.</td>
</tr>
<tr>
<td>/Install &lt;Filename&gt;</td>
<td>Install license keys from the given file and report the result. To read from stdin use &quot;-&quot; in place of filename. Keys are installed to an adapter, so if an adapter has multiple ports, all ports will be affected by the keys installed.</td>
</tr>
<tr>
<td></td>
<td>A driver reload is required after sfkey installs certain types of license (e.g. a PTP license).</td>
</tr>
<tr>
<td>/Inventory</td>
<td>List the adapters that support licensing. By default this will list adapters that support licenses. To list all adapters use the --all option. To list keys use the --keys option.</td>
</tr>
<tr>
<td>/Keys</td>
<td>Include key in /Inventory output - see above.</td>
</tr>
<tr>
<td>/NoEvaluationUpdate</td>
<td>Do not update any evaluation keys.</td>
</tr>
<tr>
<td>/Clear</td>
<td>Delete all existing license keys from an adapter - except factory installed keys.</td>
</tr>
<tr>
<td>/Report</td>
<td>Report the current status.</td>
</tr>
<tr>
<td>/Xml</td>
<td>Report formatted as XML.</td>
</tr>
<tr>
<td>/NoWrite</td>
<td>Do not write changes to the adapter. Aliases /N, /DryRun</td>
</tr>
</tbody>
</table>
Sfkey: Sample Commands

- Report a summary of the installed license keys:
  - Use /Verbose to get more detailed information about the licenses granted.
  - Use /Xml for a structured output for suitable for machine processing.
  
```plaintext
sfkey /Report
```

- Get an inventory report that summarizes the license state on a single line.
  
```plaintext
sfkey /Inventory /Keys
```

- Install keys from a file, or specify - (a single hyphen) to indicate that the keys are to be read from stdin.
  
```plaintext
sfkey /Install keys.txt
```

- Backup keys to a file, or specify - (a single hyphen) to indicate that the keys are to be printed to stdout.
  
```plaintext
sfkey /Backup keys.txt
```

- Clear and remove all keys except for factory-fitted keys.
  
```plaintext
sfkey /Clear
```
4.25 Sfnet

- Sfnet: Command Usage on page 208
- Sfnet: Command Line Options on page 208
- Completion codes (%errorlevel%) on page 212

Sfnet is a Windows command line utility to configure the physical or virtual adapter settings, such as checksum offloading, RSS, VMQ and Power Management.

**NOTE:** Changing these settings may significantly alter the performance of the adapter. You should contact Solarflare technical support before changing any of these settings.

**Sfnet: Command Usage**

1. Login with an administrator account.
2. Click Start > All Programs > Solarflare Network Adapter > Command Line Interface for network adapters. If you installed the Solarflare system tray icon, you can right-click the icon and choose Command-line tools instead.
3. In the Command Prompt window, enter your command using the following syntax:
   ```shell
   sfnet [/Adapter Identifier] [options]
   ```
   where:
   - **Identifier** is the name or ID of the adapter that you want to manage. Specifying the adapter is optional - if it is not included the command is applied to all Solarflare adapters in the machine.
   - **option** is the option to apply. See **Sfnet: Command Line Options** for a list of available options.

   To see all adapters installed on the computer and their current options and parameter settings use the `sfnet /List` option.

   If using `sfnet` in a configuration script, you can include the environment variable `%SFTOOLS%` to set the path to the Solarflare tools. For example:
   ```shell
   SET PATH=%PATH%;%SFTOOLS%
   or refer to `sfnet` as:
   `%SFTOOLS%\sfnet`
   ```

**Sfnet: Command Line Options**

Table 52 lists the command options for `sfnet`. Note that command line options are case insensitive and may be abbreviated.

**NOTE:** Abbreviations in scripts should be avoided, since future updates to the application may render your abbreviated scripts invalid.
Table 52: Sfnet Options

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Help or /? or /H</td>
<td>Displays command line syntax and provides a description of each sfnet option.</td>
</tr>
<tr>
<td>/Version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>/Nologo</td>
<td>Hides the version and copyright message at startup.</td>
</tr>
<tr>
<td>/Verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>/Quiet</td>
<td>Suppresses all output, including warnings and errors; no user interaction.</td>
</tr>
<tr>
<td>Aliases: /Silent</td>
<td>You should query the completion code to determine the outcome of commands</td>
</tr>
<tr>
<td></td>
<td>when operating silently.</td>
</tr>
<tr>
<td>/Log &lt;Filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing</td>
</tr>
<tr>
<td></td>
<td>folder. Specify silent to suppress simultaneous output to screen, if</td>
</tr>
<tr>
<td></td>
<td>required.</td>
</tr>
<tr>
<td>/Computer &lt;ComputerName&gt;</td>
<td>Performs the operation on the identified remote host. Administrator rights</td>
</tr>
<tr>
<td></td>
<td>on the remote host computer is required.</td>
</tr>
<tr>
<td>/Adapter &lt;Identifier&gt;</td>
<td>Perform the action on the identified Solarflare physical or virtual network</td>
</tr>
<tr>
<td></td>
<td>adapter.</td>
</tr>
<tr>
<td>/List</td>
<td>Lists all available Solarflare adapters, options and current parameter</td>
</tr>
<tr>
<td></td>
<td>settings.</td>
</tr>
<tr>
<td>/Id</td>
<td>List output is limited to one line, containing the Id and name, per adapter.</td>
</tr>
<tr>
<td>/StopOnWarning</td>
<td>Exit the utility if a warning is output.</td>
</tr>
<tr>
<td>/Statistics</td>
<td>Display adapter statistics and configuration settings for Solarflare</td>
</tr>
<tr>
<td></td>
<td>interfaces.</td>
</tr>
</tbody>
</table>

Table 53: Supported Key Value Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ipoffload=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>tcpoffload=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>udpoffload=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>lso=enabled</td>
<td>disabled</td>
</tr>
</tbody>
</table>
### Table 53: Supported Key Value Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lro=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>flowcontrol=auto</td>
<td>enabled</td>
</tr>
<tr>
<td>speed=auto</td>
<td>40g</td>
</tr>
<tr>
<td>mtu=&lt;MTU length&gt;</td>
<td>Specify the maximum Ethernet frame length. From 1518 to 9216 bytes (even values only).</td>
</tr>
<tr>
<td>rss=disabled</td>
<td>optimized</td>
</tr>
<tr>
<td>rssbaseprocessor=&lt;group&gt;:&lt;number&gt;</td>
<td>The base processor available for RSS. If a value is given it must formatted as &lt;group&gt;:&lt;number&gt; where group is in the range 0-9 and number in the range 0 to 63.</td>
</tr>
<tr>
<td>rssmaxprocessor=&lt;group&gt;:&lt;number&gt;</td>
<td>The maximum number of processors available for RSS. If a value is given it must formatted as &lt;group&gt;:&lt;number&gt; where group is in the range 0-9 and number in the range 0 to 63.</td>
</tr>
<tr>
<td>maxrssprocessors=&lt;count&gt;</td>
<td>The maximum number of processors available for RSS. If count is specified it must be in the range 1-256. Support for this option is independent of the version of the operating system and networking stack.</td>
</tr>
<tr>
<td>rssqueuecount=balanced</td>
<td>&lt;value&gt;</td>
</tr>
<tr>
<td>numanode=all</td>
<td>&lt;value&gt;</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>moderation=disabled</td>
<td>value&gt;</td>
</tr>
<tr>
<td>adaptive=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>wake=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>sleep=enabled</td>
<td>disabled</td>
</tr>
<tr>
<td>vmq=enabled</td>
<td>nosplit</td>
</tr>
</tbody>
</table>
4.26 Completion codes (%errorlevel%)

Table 54 lists the completion codes returned by the command line utilities. The code may be determined by inspecting %errorlevel%

<table>
<thead>
<tr>
<th>Error code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Success.</td>
</tr>
<tr>
<td>1</td>
<td>The application was invoked with /? or /help.</td>
</tr>
<tr>
<td>3</td>
<td>The application was invoked with /version.</td>
</tr>
<tr>
<td>16</td>
<td>Application canceled (user probably pressed CTRL-C).</td>
</tr>
<tr>
<td>17</td>
<td>Application has requested a reboot.</td>
</tr>
<tr>
<td>18</td>
<td>Reboot is necessary to complete the action.</td>
</tr>
<tr>
<td>19</td>
<td>Incomplete team creation. Team has been created and whatever adapters that could be added have been, and the VLANs (if any) have been created. Some adapters were not able to be added.</td>
</tr>
<tr>
<td>32</td>
<td>Application failed initialization.</td>
</tr>
<tr>
<td>33</td>
<td>Access denied. Either the remote host refused a connection on the basis of account privileges, or a file could not be opened.</td>
</tr>
<tr>
<td>34</td>
<td>Cannot connect. The remote host could not be found or refused the connection because the WMI service was inaccessible (either because the service is not running or because there is a firewall or security policy preventing it being accessed remotely).</td>
</tr>
<tr>
<td>35</td>
<td>WMI classes exposed by the Solarflare drivers missing. Usually this means that either the driver have not been installed, no Solarflare adapters are present, or adapters have been disabled.</td>
</tr>
<tr>
<td>36</td>
<td>Failed to obtain driver lock. The application has tried to take the Solarflare driver lock because it wants to do something that must not be interrupted by another utility (or SAM) and failed to do so.</td>
</tr>
<tr>
<td>37</td>
<td>Adapter not found. Cannot find the adapter specified by /adapter.</td>
</tr>
</tbody>
</table>
### 4.27 Teaming and VLANs

**About Teaming**

Solarflare adapters support the following teaming configurations:

- IEEE 802.1AX (802.3ad) Dynamic link aggregation
- Static link aggregation
- Fault tolerant teams

Teaming allows the user to configure teams consisting of all Solarflare adapter ports on all installed Solarflare adapters or might consist only of selected ports e.g. from a dual port Solarflare adapter, the first port could be a member of team A and the second port a member of team B or both ports members of the same team.

This section is only relevant to teams of Solarflare adapters. Solarflare adapters can be used in multi-vendor teams when teamed using another vendor’s teaming driver.

**NOTE:** Windows Server 2012 has native Windows teaming support. The user can elect to use native Windows driver of the Solarflare teaming, but the two methods should not be mixed.

#### Table 54: Completion Codes

<table>
<thead>
<tr>
<th>Error code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Adapter not specified. Command line is missing the /adapter option.</td>
</tr>
<tr>
<td>39</td>
<td>Later version already installed.</td>
</tr>
<tr>
<td>128</td>
<td>User entered an invalid command line.</td>
</tr>
<tr>
<td>129</td>
<td>Could not open log file.</td>
</tr>
<tr>
<td>130</td>
<td>A general WMI error occurred. Can occur when the connection is lost.</td>
</tr>
<tr>
<td>131</td>
<td>Missing prerequisite. The application needs something that is not present in the system.</td>
</tr>
<tr>
<td>132</td>
<td>Not supported.</td>
</tr>
<tr>
<td>133</td>
<td>Platform/System not supported.</td>
</tr>
<tr>
<td>255</td>
<td>General exit failure.</td>
</tr>
</tbody>
</table>
Creating Teams and VLANs

To set up teams and VLANs in Windows using SAM, see Using SAM to Configure Teams and VLANs on page 165.

To set up teams and VLANs in Windows using the sfteam command line tool, see Sfteam: Adapter Teaming and VLAN Tool on page 197.

Link Aggregation

Link aggregation is a mechanism for supporting load balancing and fault tolerance across a team of network adapters and their associated switch. Link aggregation is a partner teaming mode that requires configuration at both ends of the link. Once configured, all links in the team are bonded into a single virtual link with a single MAC address.

Two or more physical links are used to increase the potential throughput available between the link partners, and also improve resilience against link failures. To be aggregated, all links in the team must be between the same two link partners and each link must be full-duplex. Traffic is distributed evenly to all links connected to the same switch. In case of link failover, traffic on the failed link will be re-distributed to the remaining links.

Link aggregation offers the following functionality:

- Teams can be built from mixed media (i.e. UTP and Fiber).
- All protocols can be load balanced without transmit or receive modifications to frames.
- Multicast and broadcast traffic can be load balanced.
- Short recovery time in case of failover.
- Solarflare supports up to 64 link aggregation port groups per system.
- Solarflare supports up to 64 ports and VLANs in a link aggregation port group.

There are two methods of link aggregation, dynamic and static.

Dynamic Link Aggregation

Dynamic link aggregation uses the Link Aggregation Control Protocol (LACP) as defined in the IEEE 802.1AX standard (previously called 802.3ad) to negotiate the ports that will make up the team. LACP must be enabled at both ends of the link for a team to be operational.

LACP will automatically determine which physical links can be aggregated, and will then perform the aggregation.

An optional LACP marker protocol provides functionality when adding and removing physical links ensuring that no frames are lost, reordered or duplicated.

Dynamic link aggregation offers both fault tolerance and load balancing.
Standby links are supported, but are not considered part of a link aggregation until a link within the aggregation fails.

VLANs are supported within 802.1AX teams.

In the event of failover, the load on the failed link is redistributed over the remaining links.

**NOTE:** Your switch must support 802.1AX (802.3ad) dynamic link aggregation to use this method of teaming.

**Figure 35** shows a 802.1AX Team configuration.
Figure 36 shows a 802.1AX team with a failed link. All traffic is re-routed and shared between the other team links.

Static Link Aggregation

Static link aggregation is a switch assisted teaming mode that requires manual configuring of the ports at both ends of the link. Static link aggregation is protocol independent and typically inter-operates with common link aggregation schemes such as Intel Link Aggregation, Cisco Fast EtherChannel and Cisco Gigabit EtherChannel.

With static link aggregation, all links share the traffic load and standby links are not supported. Static link aggregation offers both fault tolerance and load balancing. In the event of failover, the load on the failed link is redistributed over the remaining links.
Fault-Tolerant Teams

Fault tolerant teaming can be implemented on any switch. It can also be used with each network link connected to separate switches.

A fault-tolerant team is a set of one or more network adapters bound together by the adapter driver. A fault-tolerant team improves network availability by providing standby adapters. At any one moment no more than one of the adapters will be active with the remainder either in standby or in a fault state. In Figure 39, Adapter 1 is active and all data to and from the switch passes through it.
**NOTE:** All adapters in a fault-tolerant team must be part of the same broadcast domain.

![Diagram of a fault-tolerant team](image)

**Figure 39: Fault Tolerant Team**

**Failover**

The teaming driver monitors the state of the active adapter and, in the event that its physical link is lost (down) or that it fails in service, swaps to one of the standby adapters. In **Figure 40** the previously active adapter has entered a failed state and will not be available in the standby list while the failed state persists.

![Diagram of an adapter failure](image)

**Figure 40: Adapter 1 Failure**
Note that, in this example, Adapter 3 is now active. The order in which the adapters are used is determined by a number of factors, including user-definable rank.

**VLANs**

VLANs offer a method of dividing one physical network into multiple broadcast domains.

![VLANs routing through Solarflare adapter](image)

*Figure 41: VLANs routing through Solarflare adapter*
**VLANs and Teaming**

VLANs are supported on all Solarflare adapter teaming configurations.

**VLANs with Fault Tolerant Teams**

*Figure 42* shows a fault tolerant team with two VLANs.

![VLANs with Fault Tolerant Teams](image)

*Figure 42: Fault Tolerant VLANs*
Failover works in the same way regardless of the number of VLANs, as show in Figure 43.

**Figure 43: Failover in Fault Tolerant Team VLAN**

**VLANs with Dynamic or Static Link Aggregation Teams**

VLANs work in the same way with either Dynamic or Static Link Aggregation teaming configurations. Figure 44 shows how VLANs work with these teams.

**Figure 44: VLAN with Dynamic or Static Link Team**
In case of link failure, all traffic is distributed over the remaining links, as in Figure 45.

![Figure 45: VLAN with Failed Dynamic or Static Team Link](image)

**Key Adapter**

Every team must have a key adapter. Figure 46 shows Adapter 1 as both the Key and the active adapter in a Fault-Tolerant Team.

![Figure 46: Key Adapter in Fault Tolerant Team](image)
The key adapter must be a member of a team. However, it does not need to be the active adapter. It doesn’t even need to be in the list of standby adapters but it must physically be within its host. The Key Adapter defines the team’s RSS support (see Receive Side Scaling (RSS) on page 230) and provides the MAC Address that will be used for all traffic sent and received by the team.

When a link failure occurs in the active adapter (for example the physical link is lost) the driver will select another adapter to become active but it will not re-assign the Key Adapter. In Figure 47, Adapter 1 has failed and the team is now using Adapter 2 for all traffic.

![Figure 47: Failover Key Adapter](image)

Note that although the Key Adapter (Adapter 1) has a link failure, the integrity of the team is not affected by this failure.
Dynamic and Static Link Aggregation Teams

The assignment of key adapters is supported in both dynamic and static link aggregated teams, and works in the same way for both.

Any link failure on the key adapter does not affect the redistribution of traffic to the other links in the team.
4.28 Performance Tuning on Windows

- Introduction on page 225
- Tuning Settings on page 226
- Other Considerations on page 233
- Benchmarks on page 238

Introduction

The Solarflare family of network adapters are designed for high-performance network applications. The adapter driver is pre-configured with default performance settings that have been designed to give good performance across a broad class of applications. Occasionally, application performance can be improved by tuning these settings to best suit the application.

There are three metrics that should be considered when tuning an adapter:
- Throughput
- Latency
- CPU utilization

Different applications may be more or less affected by improvements in these three metrics. For example, transactional (request-response) network applications can be very sensitive to latency whereas bulk data transfer applications are likely to be more dependent on throughput.

The purpose of this section is to highlight adapter driver settings that affect the performance metrics described. This section covers the tuning of all Solarflare adapters.

Latency will be affected by the type of physical medium used: 10GBase-T, twinaxial (direct-attach), fiber or KX4. This is because the physical media interface chip (PHY) used on the adapter can introduce additional latency. Likewise, latency can also be affected by the type of SFP/SFP+/QSFP module fitted.

This section is designed for performance tuning Solarflare adapters on Microsoft Windows. This should be read in conjunction with the reference design board errata documents and the following Microsoft performance tuning guides:

In addition, you may need to consider other issues influencing performance, such as application settings, server motherboard chipset, CPU speed, cache size, RAM size, additional software installed on the system, such as a firewall, and the specification and configuration of the LAN. Consideration of such issues is not within the scope of this guide.
Tuning Settings

Tuning settings for the Solarflare adapter are available through the Solarflare Adapter Manager (SAM) utility, or via the Advanced tab in the Windows Device Manager (right-click the adapter and select Properties). See Using SAM to Configure Adapter Features on page 157 and Configuring Network Adapter Properties in Windows on page 181 for more details.

Table 55 lists the available tuning settings for Solarflare adapters on Windows.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Supported on Windows Server 2008 R2</th>
<th>Supported on Windows Server 2012 / Windows Server 2012 R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Interrupt Moderation</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Interrupt Moderation</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Interrupt Moderation Time</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Large Receive Offload (IPv4)</td>
<td>Yes</td>
<td>No¹</td>
</tr>
<tr>
<td>Large Receive Offload (IPv6)</td>
<td>Yes</td>
<td>No¹</td>
</tr>
<tr>
<td>Large Send Offload V2 (IPv4)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Large Send Offload V2 (IPv6)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Max Frame Size</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Offload IPv4 Checksum</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Port mode</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Preferred Numa Node</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Receive Segment Coalescing (IPv4)</td>
<td>No¹</td>
<td>Yes</td>
</tr>
<tr>
<td>Receive Segment Coalescing (IPv6)</td>
<td>No¹</td>
<td>Yes</td>
</tr>
<tr>
<td>Receive Side Scaling</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>RSS Interrupt Balancing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>TCP Checksum Offload (IPv4)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>TCP Checksum Offload (IPv6)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>UDP Checksum Offload (IPv4)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>UDP Checksum Offload (IPv6)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1. Large Receive Offload has been superseded by Receive Segment Coalescing (RSC). Microsoft introduced RSC in Windows Server 2012.
Port mode

The selected port mode for SFN7000 and SFN8000 series adapters should correspond to the speed and number of connectors in use, after using any splitter cables. If a restricted set of connectors is configured, the driver can then transfer resources from the unused connectors to those configured, potentially improving performance.

Max Frame Size

The default maximum frame size ensures that the adapter is compatible with legacy 10/100Mbps Ethernet endpoints. However if a larger maximum frame size is used, adapter throughput and CPU utilization can be improved. CPU utilization is improved, because it takes fewer packets to send and receive the same amount of data. Solarflare adapters support maximum frame sizes up to 9216 bytes (this does not include the Ethernet preamble or frame check sequence).

NOTE: The maximum frame size setting should include the Ethernet frame header. The Solarflare drivers support 802.1p. This allows Solarflare adapters on Windows to optionally transmit packets with 802.1Q tags for QoS applications. It requires an Ethernet frame header size of 18 bytes (6 bytes source MAC address, 6 bytes destination MAC address, 2 bytes 802.1Q tag protocol identifier, 2 bytes 802.1Q tag control information, and 2 bytes EtherType). The default maximum frame size is therefore 1518 bytes.

Since the maximum frame size should ideally be matched across all endpoints in the same LAN (VLAN), and since the LAN switch infrastructure must be able to forward such packets, the decision to deploy a larger than default maximum frame size requires careful consideration. It is recommended that experimentation with maximum frame size be done in a controlled test environment.

The maximum frame size is changed by changing the Max Frame Size setting in the Network Adapter’s Advanced Properties Page.

Interrupt Moderation (Interrupt Coalescing)

Interrupt moderation reduces the number of interrupts generated by the adapter by coalescing multiple received packet events and/or transmit completion events together into a single interrupt.

The interrupt moderation interval sets the minimum time (in microseconds) between two consecutive interrupts. Coalescing occurs only during this interval:

- When the driver generates an interrupt, it starts timing the moderation interval.
- Any events that occur before the moderation interval expires are coalesced together into a single interrupt, that is raised only when the interval expires. A new moderation interval then starts, during which no interrupt is raised.
- An event that occurs after the moderation interval has expired gets its own dedicated interrupt, that is raised immediately. A new moderation interval then starts, during which no interrupt is raised.
Solarflare adapters, by default, use an *adaptive algorithm* where the interrupt moderation delay is automatically adjusted between zero (no interrupt moderation) and 60 microseconds. The adaptive algorithm detects latency sensitive traffic patterns and adjusts the interrupt moderation interval accordingly.

Interrupt moderation settings are **critical for tuning adapter latency**:

- Disabling the adaptive algorithm will:
  - reduce jitter
  - allow setting the moderation interval as required to suit conditions.
- Increasing the interrupt moderation interval will:
  - generate less interrupts
  - reduce CPU utilization (because there are less interrupts to process)
  - increase latency
  - improve peak throughput.
- Decreasing the interrupt moderation interval will:
  - generate more interrupts
  - increase CPU utilization (because there are more interrupts to process)
  - decrease latency
  - reduce peak throughput.
- Turning off interrupt moderation will:
  - generate the most interrupts
  - give the highest CPU utilization
  - give the lowest latency
  - give the biggest reduction in peak throughput.

For many transaction request-response type network applications, the benefit of reduced latency to overall application performance can be considerable. Such benefits typically outweigh the cost of increased CPU utilization. It is recommended that:

- Interrupt moderation is disabled for applications that require best latency and jitter performance, such as market data handling.
- Interrupt moderation is enabled for high throughput single (or few) connection TCP streaming applications, such as iSCSI.

Interrupt moderation can be disabled or enabled using the Interrupt Moderation setting in the Network Adapter’s Advanced Properties Page. The interrupt moderation time value can also be configured from the Network Adapter’s Advanced Properties Page.

**NOTE:** The performance benefits of Receive Segment Coalescing and Large Receive Offload are limited if interrupt moderation is disabled. See *Receive Segment Coalescing (RSC)* on page 229 and *Large Receive Offload (LRO)* on page 230.
TCP Checksum Offload

Checksum offload moves calculation and verification of IP Header, TCP and UDP packet checksums to the adapter. The driver has all checksum offload features enabled by default. Therefore, there is no opportunity to improve performance from the default.

Checksum offload configuration is changed by changing the Offload IP Checksum, Offload UDP Checksum and Offload TCP Checksum settings in the Network Adapter’s Advanced Properties Page.

- To check that task offloads are enabled (e.g. checksum offload in particular), run the following commands:
  ```
  netsh interface tcp show global
  netsh interface ipv4 show offload
  netsh interface ipv6 show offload
  ```

**NOTE:** Solarflare recommend you do not disable checksum offload.

Large Send Offload V2 (LSO)

Large Send Offload (LSO; also known as TCP Segmentation Offload/TSO) offloads the splitting of outgoing TCP data into packets to the adapter. LSO benefits applications using TCP. Applications using protocols other than TCP will not be affected by LSO.

Enabling LSO will reduce CPU utilization on the transmit side of a TCP connection and improve peak throughput, if the CPU is fully utilized. Since LSO has no effect on latency, it can be enabled at all times. The driver has LSO enabled by default. Therefore, there is no opportunity to improve performance from the default.

LSO is changed by changing the Large Send Offload setting in the Network Adapter’s Advanced Properties Page.

TCP and IP checksum offloads must be enabled for LSO to work.

**NOTE:** Solarflare recommend that you do not disable this setting.

Receive Segment Coalescing (RSC)

TCP Receive Segment Coalescing (RSC) is a feature whereby the adapter coalesces multiple packets received on a TCP connection into a single larger packet before passing this onto the network stack for receive processing. This reduces CPU utilization and improves peak throughput when the CPU is fully utilized. The effectiveness of RSC is bounded by the interrupt moderation delay, and is limited if interrupt moderation is disabled (see Interrupt Moderation (Interrupt Coalescing) on page 227). Enabling RSC does not itself negatively impact latency.

RSC is a Microsoft feature introduced in Windows Server 2012. RSC is enabled by default. If a host is forwarding received packets from one interface to another then Windows will automatically disable RSC. For more information about RSC on Windows, see https://technet.microsoft.com/en-gb/library/hh997024.aspx.
The Solarflare network adapter driver enables RSC by default.

RSC is set by changing the Receive Segment Coalescing settings in the Network Adapter’s Advanced Properties Page.

TCP and IP checksum offloads must be enabled for RSC to work.

**Large Receive Offload (LRO)**

Large Receive Offload (LRO) is a feature whereby the adapter coalesces multiple packets received on a TCP connection into a single larger packet before passing this onto the network stack for receive processing. This reduces CPU utilization and improves peak throughput when the CPU is fully utilized. The effectiveness of LRO is bounded by the interrupt moderation delay, and is limited if interrupt moderation is disabled (see Interrupt Moderation (Interrupt Coalescing) on page 227). Enabling LRO does not itself negatively impact latency.

LRO is a Solarflare proprietary mechanism similar to the Windows Receive Segment Coalescing feature. Windows Server 2012 and newer use RSC instead of LRO, and do not support LRO. Older Windows versions that do not support RSC may use LRO instead.

The Solarflare network adapter driver disables LRO by default.

**NOTE:** LRO should **NOT** be enabled when using the host to forward packets from one interface to another. For example, if the host is performing IP routing.

LRO is set by changing the Large Receive Offload settings in the Network Adapter’s Advanced Properties Page.

TCP and IP checksum offloads must be enabled for LRO to work.

**Receive Side Scaling (RSS)**

Receive Side Scaling (RSS) was first supported as part of the scalable networking pack for Windows Server 2003 and has been improved with each subsequent operating system release. RSS is enabled by default and will be used on network adapters that support it. Solarflare recommend that RSS is enabled for best networking performance.

For further information about using RSS on Windows platforms see the Microsoft white paper “Scalable Networking: Eliminating the Receive Processing Bottleneck—Introducing RSS”

This is available from:

http://download.microsoft.com/download/5/D/6/5D6EAF2B-7DDF-476B-93DC-7CF0072878E6/NDIS_RSS.doc

Specific RSS parameters can be tuned on a per-adapter basis. For details see the Microsoft white paper “Networking Deployment Guide: Deploying High-Speed Networking Features” available from:

Solarflare network adapters optimize RSS settings by default on Windows operating systems and offer a number of RSS interrupt balancing modes via the network adapter’s advanced property page in Device Manager and Solarflare’s adapter management tools.

The number of RSS queues can be adjusted to suit the workload:

- The number of RSS CPUs is limited by the number of RSS queues. The driver does not target multiple RSS queues to the same CPU. Therefore:
  - It is best to set the maximum number of RSS queues to be equal to the maximum number of RSS CPUs (or the next higher setting if the equal option is unavailable).
  - The number of queues can be reduced in order to isolate CPU cores for application processing.
  - The number of queues can be increased to spread the load over more cores. This will also increase the amount of receive buffering due to a larger number of RX queues.

**NOTE:** If hyper-threading is enabled, RSS will only select one thread from each CPU core.

- The current number of queues can be get and set using either SAM, or the Network Adapter’s Advanced Properties Page.
- On Windows Server 2012 and later, the current number of RSS queues can also be queried and set from the PowerShell with the Get-NetAdapterRss and Set-NetAdapterRss cmdlets.

The set of RSS CPUs can also be adjusted:

- For low latency low jitter applications select the NUMA scaling static RSS profile. Set both the maximum number of RSS processors and the number of RSS queues to be equal to the number of CPU cores
  - In multi-port scenarios give each port its own set of RSS processors, using the base and max processor settings to restrict RSS to a subset of the CPUs if required.
- For other applications use as few RSS processors as required to cope with the traffic load, leaving other CPUs free for other tasks
Preferred NUMA Node

The adapter driver chooses a subset of the available CPU cores to handle transmit and receive processing. The Preferred NUMA Node setting can be used to constrain the set of CPU cores considered for processing to those on the given NUMA Node.

To force processing onto a particular NUMA Node, change the Preferred NUMA Node setting on the Network Adapter’s Advanced Properties Page.

The NUMA distance of the cores used for the RSS queue and the network application influences performance. To check the NUMA distance of each core from the interface:

- Get Coreinfo from Windows Sysinternals (https://live.sysinternals.com). The output includes processor to NUMA node mappings.
  
  To get the NUMA node local to the interface, run:
  
  ```shell
get-wmiobject -namespace root\wmi -filter "dummyinstance=false" efx_port | format-table -autosize id,name,preferrednumanode
  ```

- On Windows Server 2012 and later, you can instead run the PowerShell Get-NetAdapterRss cmdlet and look at lines starting:
  
  ```powershell
  RssProcessoArray: [Group:Number/NUMA Distance]
  ```

  This gives the NUMA distance of each core to the interface.

For low latency low jitter applications, RSS queues should be mapped to NUMA nodes that are local to the interface:

- On Windows Server 2008 R2, this should happen automatically. RSS profiles are not supported, and the default behavior is equivalent to ClosestProcessor
- On Windows Server 2012 and later, this should happen automatically if you are using one of the following RSS profiles:
  
  - ClosestProcessor
  - ClosestProcessorStatic

  The PowerShell Get-NetAdapterRss cmdlet will give this information.

  The RSS Profile can be set in the Network Adapter's Advanced Properties Page, or with the PowerShell cmdlet Set-NetAdapterRss

- It is also possible to restrict the set of cores available to RSS by setting BaseProcessorGroup/BaseProcessorNumber and MaxProcessorGroup/MaxProcessorNumber.
Likewise, for low latency low jitter applications, the network application should be run on NUMA nodes that are local to the interface:

- The application can set affinity itself with SetProcessAffinityMask and SetThreadAffinityMask, and then may present these as options to the user.
- Affinity can be set using Sysinternals Process Explorer (procexp). Right click on the process and choose Set Affinity.
- Affinity can be controlled when a process is started using:
  
  ```
  START /AFFINITY <hexmask1> <command>
  ```
  or
  ```
  START /NODE <num> <command>
  ```

  When /NODE and /AFFINITY are used together, affinity is interpreted as cores within the node.

For other applications, such as web servers:

- On Windows Server 2012 and later, use one of the following RSS profiles:
  - NumaScaling
  - NumaScalingStatic

  The PowerShell Get-NetAdapterRss cmdlet will give this information.

  The RSS Profile can be set in the Network Adapter’s Advanced Properties Page, or with the PowerShell cmdlet Set-NetAdapterRss

Other Considerations

PCI Express Lane Configurations

The PCI Express (PCIe) interface used to connect the adapter to the server can function at different speeds and widths. This is independent of the physical slot size used to connect the adapter. The possible widths are multiples x1, x2, x4, x8 and x16 lanes of (2.5Gbps for PCIe Gen 1, 5.0 Gbps for PCIe Gen 2 and 8.0Gbps for PCIe Gen 3) in each direction. Solarflare adapters are designed for x8 or x16 lane operation.

On some server motherboards, choice of PCIe slot is important. This is because some slots (including those that are physically x8 or x16 lanes) may only electrically support x4 lanes. In x4 lane slots, Solarflare PCIe adapters will continue to operate, but not at full speed. The Solarflare driver will insert a warning in the Windows Event Log if it detects that the adapter is plugged into a PCIe slot which electrically has fewer than x8 lanes.

Solarflare SFN5000 and SFN6000 series adapters require a PCIe Gen 2 x8 slot for optimal operation. Solarflare SFN7000 and SFN8000 series adapters require a PCIe Gen 3 x8 or x16 slot for optimal performance. The Solarflare driver will insert a warning in the Windows Event Log if it detects that the adapter is placed in a sub-optimal slot.
In addition, the latency of communications between the host CPUs, system memory and the Solarflare PCIe adapter may be PCIe slot dependent. Some slots may be “closer” to the CPU, and therefore have lower latency and higher throughput:

- If possible, install the adapter in a slot which is local to the desired NUMA node
- For Windows Server 2008 R2 best performance will only be obtained if the adapter is closest to NUMA node 0 (i.e. physical CPU package 0).
- Some Windows SKUs only support a single CPU package. If the adapter is plugged into a PCIe slot attached to the second package it will not appear to the OS.

Please consult your server user guide for more information.

**Memory bandwidth**

Many chipsets use multiple channels to access main system memory. Maximum memory performance is only achieved when the chipset can make use of all channels simultaneously. This should be taken into account when selecting the number of memory modules (DIMMs) to populate in the server. For optimal memory bandwidth in the system, it is likely that:

- all DIMM slots should be populated
- all NUMA nodes should have memory installed.

Please consult the motherboard documentation for details.

**BIOS Settings**

**DELL Systems**

Refer to the BIOS configuration guidelines recommended by Dell's white paper “Configuring Low-Latency Environments on Dell PowerEdge Servers” available from:


**HP Systems**

Refer to the BIOS configuration guidelines recommended by HP's white paper “Configuring the HP ProLiant Server BIOS for Low-Latency Applications” available from:


Although targeted at tuning for real-time operating systems, the recommendations equally apply to Windows Server platforms.

Other system vendors may publish similar recommendations. In general any BIOS settings guidelines that are targeted at increasing network performance whilst minimizing latency and jitter are applicable to all operating systems.
Intel® QuickData / NetDMA

On systems that support Intel I/OAT (I/O Acceleration Technology) features such as QuickData (a.k.a NetDMA), Solarflare recommend that these are enabled as they are rarely detrimental to performance.

Using Intel® QuickData Technology allows data copies to be performed by the system and not the operating system. This enables data to move more efficiently through the server and provide fast, scalable, and reliable throughput.

To enable NetDMA the EnableTCPA variable must be set to 1 in the Tcpip\Parameters system key. Locate the following key in the registry:

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters

The EnableTCPA value must be created if it is not present and set to 1:

EnableTCPA = 1

Intel Hyper-Threading Technology

On systems that support Intel Hyper-Threading Technology users should consider benchmarking or application performance data when deciding whether to adopt hyper-threading on a particular system and for a particular application. Solarflare have identified that hyper-threading is generally beneficial on systems fitted with Core i5, Core i7 and Xeon (Nehalem or later) CPUs.

TCP/IP Options

TCP timestamps, window scaling and selective acknowledgments are enabled by default on supported platforms, and include receive window tuning and congestion control algorithms that automatically adapt to 10 gigabit connections. There is therefore no need to change these settings.

Power Saving Mode

Modern processors utilize design features that enable a CPU core to drop into low power states when instructed by the operating system that the CPU core is idle. When the OS schedules work on the idle CPU core (or when other CPU cores or devices need to access data currently in the idle CPU core’s data cache) the CPU core is signaled to return to the fully on power state. These changes in CPU core power states create additional network latency and jitter. Solarflare recommend to achieve the lowest latency and lowest jitter that the “C1E power state” or “CPU power saving mode” is disabled within the system BIOS.

In general the user should examine the system BIOS settings and identify settings that favor performance over power saving. In particular look for settings to disable:

- C states / Processor sleep/idle states
- Enhanced C1 CPU sleep state (C1E)
- Any deeper C states (C3 through to C6)
- P states / Processor throttling
• Processor Turbo mode
• Ultra Low Power State
• PCIe Active State Power Management (ASPM)
• Unnecessary SMM/SMI features

The latency can be improved by selecting the highest performance power plan:

• Consider using the **Optimum performance** power plan added by the Solarflare driver package installer, which:
  - Disables all CPU idle states
  - Sets the OS device idle policy to favor performance over power savings
  - Disables PCIe ASPM (Active State Power Management)

The installer does not enable this by default as, on certain systems, it might significantly increase energy usage.

• Otherwise, select the Always On or High performance power plan.

The power plan is configured from the Control Panel > Hardware > Power Options:

You can also use the `powercfg.exe` utility that is installed with Windows:

• List all power schemes in the current user's environment:
  
  `powercfg /LIST`  
  
• Make the specified power scheme active on the computer:
  
  `powercfg /SETACTIVE <GUID>`  
  
Firewalls and anti-virus software

Depending on the system configuration, the following software may have a significant impact on throughput and CPU utilization, in particular when receiving multicast UDP traffic:

- the built-in Windows Firewall and Base Filtering Engine
- other third-party firewall or network security products
- anti-virus checkers.

This is the case even if the software has no rules configured but is still active.

Where high throughput is required on a particular port, the performance will be improved by disabling the software on that port:

NOTE: The Windows (or any third party) Firewall should be disabled with caution. The network administrator should be consulted before making any changes.

- Disable the Windows Firewall.
  
  a) Set the **Startup Type** of the Windows Firewall service to **Disabled**.
  
  b) Stop the service.

- On Windows Server 2008 R2 disable the Windows Filtering Platform (WFP).
  
  a) Set the **Startup Type** of the Base Filtering Engine (BFE) service to **Disabled**.
  
  b) Stop the service.

For more information, see [https://msdn.microsoft.com/en-us/Library/Windows/Hardware/dn653358%28v=vs.85%29.aspx](https://msdn.microsoft.com/en-us/Library/Windows/Hardware/dn653358%28v=vs.85%29.aspx).

- Disable (and if possible uninstall) any third-party firewall or network security products, and any anti-virus checkers.

Remember that even the simplest anti-virus products can inspect network traffic to look for viruses in e-mails.

Configure network applications

Consider the options, logging and statistics provided by the networking applications that are being used.
Benchmarks

Throughput Benchmark using Ntttcp

The following example shows results from running Microsoft’s ntttcp. It is suggested that first, Large Receive Offload (LRO) or Receive Segment Coalescing (RSC) is enabled.

1. On server run ntttcp:
   ```sh
   ntttcp.exe -rb 500000 -a 24 -n 100000 -l 524288 -m 1,1,<server_adapter_IP_interface>
   ```

2. On client run ntttcp test:
   ```sh
   ntttcpss.exe -rb 500000 -a 24 -n 100000 -l 524288 -m 1,1,<server_adapter_IP_interface>
   ```

C:\> ntttcpss.exe -rb 500000 -a 24 -n 100000 -l 524288 -m 1,1,<server adapter IP interface>

Copyright Version 2.4
Network activity progressing...
Thread Realtime(s) Throughput(KB/s) Throughput(Mbit/s)
========== ========= =========== =========
0 44.767 1170961.007 9367.688

Total Bytes(MEG) Realtime(s) Average Frame Size Total Throughput(Mbit/s)
========== ========= =========== ========= =========
52420.411392 44.767 1459.846 9367.688

Total Buffers Throughput(Buffers/s) Pkts(sent/intr) Intr(count/s) Cycles/Byte
========== ========= ========= ========= =========
99984.000 2233.431 27 29187.48 0.8

Packets Sent Packets Received Total Retransmits Total Errors Avg. CPU %
========== ========= ========= ========= ========= =========

---
Tuning Recommendations

The following tables provide recommendations for tuning settings for different application characteristics.

• Throughput - Table 56 on page 239
• Latency - Table 57 on page 240

Table 56: Throughput Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel QuickData (Intel chipsets only)</td>
<td>Enable in BIOS and configure as described in guide.</td>
</tr>
<tr>
<td>Interrupt Moderation</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>Adaptive Interrupt Moderation</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>Interrupt Moderation Time</td>
<td>Leave at default (60µs).</td>
</tr>
<tr>
<td>Large Receive Offloads</td>
<td>Enable in Network Adapter Advanced Properties.</td>
</tr>
<tr>
<td>Large Send Offloads</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>Max Frame Size</td>
<td>Configure to maximum supported by network in Network Adapter’s Advanced Properties.</td>
</tr>
<tr>
<td>Memory bandwidth</td>
<td>Ensure memory utilizes all memory channels on system motherboard.</td>
</tr>
<tr>
<td>Offload Checksums</td>
<td>Leave at default.</td>
</tr>
<tr>
<td>PCI Express Lane Configuration</td>
<td>Ensure the adapter is in an x8 slot (2.0 or later), and that current speed (not the supported speed) reads back as “x8 and 5GT/s”, or “x8 and 8GT/s”, or “x8 and Unknown”.</td>
</tr>
<tr>
<td>Power Saving Mode</td>
<td>Leave at default.</td>
</tr>
<tr>
<td>Receive Segment Coalescing</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Leave at default.</td>
</tr>
<tr>
<td>RSS NUMA Node</td>
<td>Leave at default (All).</td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default (install with “Optimize Windows TCP/IP protocol settings for 10G networking” option selected).</td>
</tr>
</tbody>
</table>
Table 57: Latency Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel QuickData (Intel chipsets only)</td>
<td>Enable in BIOS and configure as described in guide.</td>
</tr>
<tr>
<td>Interrupt Moderation</td>
<td>Disable in Network Adapter’s Advanced Properties.</td>
</tr>
<tr>
<td>Adaptive Interrupt Moderation</td>
<td>Leave at default. This setting is ignored when interrupt moderation is disabled.</td>
</tr>
<tr>
<td>Interrupt Moderation Time</td>
<td>Leave at default (60µs). This setting is ignored when interrupt moderation is disabled.</td>
</tr>
<tr>
<td>Large Receive Offloads</td>
<td>Disable in Network Adapter’s Advanced Properties.</td>
</tr>
<tr>
<td>Large Send Offloads</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>Max Frame Size</td>
<td>Configure to maximum supported by network in Network Adapter’s Advanced Properties.</td>
</tr>
<tr>
<td>Memory bandwidth</td>
<td>Ensure memory utilizes all memory channels on system motherboard.</td>
</tr>
<tr>
<td>Offload Checksums</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>PCI Express Lane Configuration</td>
<td>Ensure the adapter is in an x8 slot (2.0 or later), and that current speed (not the supported speed) reads back as “x8 and 5GT/s”, or “x8 and 8GT/s”, or “x8 and Unknown”.</td>
</tr>
<tr>
<td>Power Saving Mode</td>
<td>Disable C1E and other CPU sleep modes to prevent OS from putting CPUs into lowering power modes when idle.</td>
</tr>
<tr>
<td>Receive Segment Coalescing</td>
<td>Disable in Network Adapter’s Advanced Properties.</td>
</tr>
<tr>
<td>Receive Side Scaling</td>
<td>Application dependent</td>
</tr>
<tr>
<td>RSS NUMA Node</td>
<td>Leave at default (All).</td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default (install with “Optimize Windows TCP/IP protocol settings for 10G networking” option selected).</td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default</td>
</tr>
</tbody>
</table>
4.29 Windows Event Log Error Messages

The following tables list the various error messages that can be added to the event log, along with a description and action that should be taken.

**Driver Status Codes**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x60000001L</td>
<td>The driver version information.</td>
<td>Informational</td>
<td>No action required.</td>
</tr>
<tr>
<td>0x60000002L</td>
<td>The driver failed to load.</td>
<td>Informational</td>
<td></td>
</tr>
<tr>
<td>0xA0000004L</td>
<td>The driver can’t add a device due to the system being started in safe mode</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(SAFEMODE_MINIMAL).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0xA0000005L</td>
<td>The driver could not allocate memory on a specific NUMA node.</td>
<td>Warning</td>
<td>For maximum performance all</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NUMA nodes should be</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>populated. Install additional</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>memory.</td>
</tr>
</tbody>
</table>

**Device Status Codes**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x6001000BL</td>
<td>The MTU on the device was changed.</td>
<td>Informational</td>
<td>No action required.</td>
</tr>
<tr>
<td>0x6001001BL</td>
<td>Hardware MCDI version</td>
<td>Informational</td>
<td>None required.</td>
</tr>
<tr>
<td>0xA0010004L</td>
<td>The device does not have sufficient PCIe lanes to reach full bandwidth.</td>
<td>Warning</td>
<td>Move the adapter into a PCIe slot with more lanes. See PCI Express</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lane Configurations on page 233.</td>
</tr>
<tr>
<td>0xA001000CL</td>
<td>The transmit watchdog fired</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>Description</td>
<td>Severity</td>
<td>Action</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>0xA001000DL</td>
<td>An unexpected event was received from the device.</td>
<td>Warning</td>
<td>No action required.</td>
</tr>
<tr>
<td>0xA0010010L</td>
<td>A non-contiguous RX event was received from the device.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010011L</td>
<td>The device has exceeded the maximum supported temperature limit.</td>
<td>Warning</td>
<td>Improve the server cooling.</td>
</tr>
<tr>
<td>0xA0010013L</td>
<td>The device cooling has failed.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010014L</td>
<td>One of the device voltage supplies is outside of the supported voltage range.</td>
<td>Warning</td>
<td>The adapter or server maybe faulty.</td>
</tr>
<tr>
<td>0xA0010017L</td>
<td>Hardware MCDI communication suffered an error.</td>
<td>Warning</td>
<td>None required.</td>
</tr>
<tr>
<td>0xE0010002L</td>
<td>PHY firmware has failed to start.</td>
<td>Error</td>
<td>Possible PHY firmware corruption. Run sfupdate or update via SAM.</td>
</tr>
<tr>
<td>0xE0010005L</td>
<td>The device could not be added to the system.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0010006L</td>
<td>The device could not be initialized with interrupts disabled.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0010007L</td>
<td>The device could not be initialized with interrupts enabled.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0010008L</td>
<td>The device could not be started.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0010009L</td>
<td>The device could not be reset.</td>
<td>Error</td>
<td></td>
</tr>
</tbody>
</table>
There was an EFX API failure.

The device has exceeded the critical temperature limit.

One of the device voltage supplies is outside of the critical voltage range.

A non-specified hardware monitor device has reported an error condition.

Hardware MCDI communication timed out.

### NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xE0010001L</td>
<td>The parameter BreakOnEntry is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010002L</td>
<td>The parameter BreakOnEntry specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>Description</td>
<td>Severity</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>0xA0010003L</td>
<td>The parameter DebugBits is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010004L</td>
<td>The parameter DebugBits specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010005L</td>
<td>The parameter *FlowControl is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010006L</td>
<td>The parameter *FlowControl specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010007L</td>
<td>The parameter *IfType is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010008L</td>
<td>The parameter *IfType specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010009L</td>
<td>The parameter *InterruptModeration is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001000AL</td>
<td>The parameter *InterruptModeration specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001000BL</td>
<td>The parameter *IPChksumOffv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
## Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA001000CL</td>
<td>The parameter *IPChksumOffv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001000DL</td>
<td>The parameter *JumboPacket is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001000EL</td>
<td>The parameter *JumboPacket specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001000FL</td>
<td>The parameter LROIPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010010L</td>
<td>The parameter LROIPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010011L</td>
<td>The parameter *LSOv2IPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010012L</td>
<td>The parameter *LSOv2IPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010013L</td>
<td>The parameter MaxEventsPerReceive Interrupt is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010014L</td>
<td>The parameter MaxEventsPerReceive Interrupt specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010015L</td>
<td>The parameter *MediaType is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010016L</td>
<td>The parameter *MediaType specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010017L</td>
<td>The parameter *NetworkAddress is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010018L</td>
<td>The parameter *NetworkAddress specified in the registry is invalid. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010019L</td>
<td>The parameter *PhysicalMediaType is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001001AL</td>
<td>The parameter *PhysicalMediaType specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001001BL</td>
<td>The parameter *PriorityVLANTag is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001001CL</td>
<td>The parameter *PriorityVLANTag specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001001DL</td>
<td>The parameter *ReceiveBuffers is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>Description</td>
<td>Severity</td>
<td>Notes</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------</td>
</tr>
<tr>
<td>0xA001001EL</td>
<td>The parameter *ReceiveBuffers specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001001FL</td>
<td>The parameter *ReceiveInterrupt ModerationValue is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010020L</td>
<td>The parameter *ReceiveInterrupt ModerationValue specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010021L</td>
<td>The parameter *SpeedDuplex is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010022L</td>
<td>The parameter *SpeedDuplex specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010023L</td>
<td>The parameter *TCPChksumOffv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010024L</td>
<td>The parameter *TCPChksumOffv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010025L</td>
<td>The parameter *TransmitBuffers is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010026L</td>
<td>The parameter *TransmitBuffers specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010027L</td>
<td>The parameter *UDPChksumOffv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010028L</td>
<td>The parameter *UDPChksumOffv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010029L</td>
<td>The parameter VlanId is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001002AL</td>
<td>The parameter VlanId specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001002BL</td>
<td>The parameter WarnLevel is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001002CL</td>
<td>The parameter WarnLevel specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001002DL</td>
<td>The parameter *RSS is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001002EL</td>
<td>The parameter *RSS specified in the registry is invalid. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001002FL</td>
<td>The parameter *IPChecksumOffload IPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
The parameter *IPChecksumOffload IPv4 specified in the registry is out of range. Using default value.

Warning

The parameter *TCPChecksumOffload IPv4 is missing from the registry. Using default value.

Warning

The parameter *TCPChecksumOffload IPv4 is missing from the registry. Using default value.

Warning

The parameter *UDPChecksumOffloadIPv4 is missing from the registry. Using default value.

Warning

The parameter *UDPChecksumOffloadIPv4 is missing from the registry. Using default value.

Warning

The parameter *TCPConnectionOffloadIPv4 is missing from the registry. Using default value.

Warning

The parameter *TCPConnectionOffloadIPv4 specified in the registry is out of range. Using default value.

Warning

The parameter *MaxRssProcessors is missing from the registry. Using default value.

Warning

### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010030L</td>
<td>The parameter *IPChecksumOffload IPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010031L</td>
<td>The parameter *TCPChecksumOffload IPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010032L</td>
<td>The parameter *TCPChecksumOffload IPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010033L</td>
<td>The parameter *UDPChecksumOffloadIPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010034L</td>
<td>The parameter *UDPChecksumOffloadIPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010035L</td>
<td>The parameter *TCPConnectionOffloadIPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010036L</td>
<td>The parameter *TCPConnectionOffloadIPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010037L</td>
<td>The parameter *MaxRssProcessors is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010038L</td>
<td>The parameter *MaxRssProcessors specified in the registry is invalid. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010039L</td>
<td>The parameter *InterruptModeration Time is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001003AL</td>
<td>The parameter *InterruptModeration Time specified in the registry is invalid. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001003BL</td>
<td>The parameter *TCPChecksumOffloadIPv6 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001003CL</td>
<td>The parameter *TCPChecksumOffloadIPv6 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001003DL</td>
<td>The parameter *UDPChecksumOffloadIPv6 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001003EL</td>
<td>The parameter *UDPChecksumOffloadIPv6 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001003FL</td>
<td>The parameter *WakeOnPattern is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010040L</td>
<td>The parameter *WakeOnPattern specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010041L</td>
<td>The parameter *WakeOnMagicPacket is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010042L</td>
<td>The parameter *WakeOnMagicPacket specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010043L</td>
<td>The parameter *DeviceSleepOnDisconnect is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010044L</td>
<td>The parameter *DeviceSleepOnDisconnect specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010045L</td>
<td>The parameter *PMARPOffload is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010046L</td>
<td>The parameter *PMARPOffload specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010047L</td>
<td>The parameter *PMNSOffload is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010048L</td>
<td>The parameter *PMNSOffload specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>0xA0010049L</td>
<td>The parameter *LSOv2IPv6 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001004AL</td>
<td>The parameter *LSOv2IPv6 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001004BL</td>
<td>The parameter LROIPv6 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001004CL</td>
<td>The parameter LROIPv6 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001004DL</td>
<td>The parameter FlowControlAuto Negotiation is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001004EL</td>
<td>The parameter FlowControlAuto Negotiation specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001004FL</td>
<td>The parameter AdaptiveInterrupt Moderation is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010050L</td>
<td>The parameter AdaptiveInterrupt Moderation specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010051L</td>
<td>The parameter *NumaNodeId is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010052L</td>
<td>The parameter *NumaNodeId specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010053L</td>
<td>The parameter *VMQ is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010054L</td>
<td>The parameter *VMQ specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010055L</td>
<td>The parameter *VMQLookaheadSplit is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010056L</td>
<td>The parameter *VMQLookaheadSplit specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010057L</td>
<td>The parameter *VMQVlanFiltering is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010058L</td>
<td>The parameter *VMQVlanFiltering specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010059L</td>
<td>The parameter RssQueueCount is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001005AL</td>
<td>The parameter RssQueueCount specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
**Table 60: NDIS Driver Status Codes**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA001005BL</td>
<td>The parameter RssAlgorithm is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001005CL</td>
<td>The parameter RssAlgorithm specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001005DL</td>
<td>The parameter *NumRSSQueues is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001005EL</td>
<td>The parameter *NumRSSQueues specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001005FL</td>
<td>The parameter *RssProfile is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010060L</td>
<td>The parameter *RssProfile specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010061L</td>
<td>The parameter *RssBaseProcGroup is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010062L</td>
<td>The parameter *RssBaseProcGroup specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010063L</td>
<td>The parameter *RssBaseProcNumber is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0010064L</td>
<td>The parameter *RssBaseProcNumber specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010065L</td>
<td>The parameter *RSSMaxProcGroup is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010066L</td>
<td>The parameter *RSSMaxProcGroup specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010067L</td>
<td>The parameter *RssMaxProcNumber is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010068L</td>
<td>The parameter *RssMaxProcNumber specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0010069L</td>
<td>The parameter *RscIPv4 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001006AL</td>
<td>The parameter *RscIPv4 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001006BL</td>
<td>The parameter *RscIPv6 is missing from the registry. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA001006CL</td>
<td>The parameter *RscIPv6 specified in the registry is out of range. Using default value.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0020001L</td>
<td>The driver has determined that the network adapter does not support transmit checksum offloads and therefore has overridden the *IPChksumOffv4, *TCPChksumOffv4 and *UDPChksumOffv4 registry parameters.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020002L</td>
<td>The driver has determined that the network adapter does not support Large Send Offload and therefore has overridden the *LSOv2IPv4 and *LSOv2IPv6 registry parameters.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020003L</td>
<td>The driver has disabled Large Receive Offload (overriding the LROIPv4 registry parameter) as it is incompatible with IEEE 802.1p/802.1Q tagging. In order to use Large Receive Offload tagging must be disabled.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020004L</td>
<td>IPv4 Large Receive Offload support will be unavailable whilst IPv4 receive checksum offload or TCP receive checksum offload is disabled.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020005L</td>
<td>IPv4 Large Send Offload support will be unavailable whilst IPv4 transmit checksum offload or TCP transmit checksum offload is disabled.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
The driver has determined that the network adapter's maximum frame size is not configured correctly and therefore has overridden *JumboFrames registry parameter. This issue may be resolved after a system restart.

The driver has determined that the network adapter does not support TCP Connection Offload and therefore has overridden the *TCPConnection OffloadIPv4 registry parameter.

The driver has disabled TCP Connection Offload (overriding the *TCPConnection OffloadIPv4 registry parameter) as it is incompatible with IEEE 802.1p/802.1Q tagging. In order to use TCP Connection Offload tagging must be disabled.

The driver has determined that the network adapter does not support changing the current MAC address and therefore has overridden the *NetworkAddress registry parameter.

### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA0020006L</td>
<td>The driver has determined that the network adapter's maximum frame size is not configured correctly and therefore has overridden *JumboFrames registry parameter. This issue may be resolved after a system restart.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020008L</td>
<td>The driver has determined that the network adapter does not support TCP Connection Offload and therefore has overridden the *TCPConnection OffloadIPv4 registry parameter.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020009L</td>
<td>The driver has disabled TCP Connection Offload (overriding the *TCPConnection OffloadIPv4 registry parameter) as it is incompatible with IEEE 802.1p/802.1Q tagging. In order to use TCP Connection Offload tagging must be disabled.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA002000AL</td>
<td>The driver has determined that the network adapter does not support changing the current MAC address and therefore has overridden the *NetworkAddress registry parameter.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
The driver has disabled TCP Connection Offload (overriding the *TCPConnection OffloadIPv4 registry parameter) as it is incompatible with MTU values greater than 1500 bytes. Refer to the driver release notes and errata for more information.

The driver has determined that the network adapter does not support IPv6 checksum offloads and therefore has overridden the *TCPChksumOffv6 and *UDPChksumOffv6 registry parameters.

The driver has determined that the network adapter does not support Wake on LAN and therefore has overridden the *WakeOnPattern, *WakeOnMagicPacket and *DeviceSleepOn Disconnect registry parameters.

The driver has determined that the network adapter does not support protocol offload whilst the system is in a sleep state and therefore has overridden the *PMARPOffload and *PMNSOffload registry parameters.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
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<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA002000BL</td>
<td>The driver has disabled TCP Connection Offload (overriding the *TCPConnection OffloadIPv4 registry parameter) as it is incompatible with MTU values greater than 1500 bytes. Refer to the driver release notes and errata for more information.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA002000CL</td>
<td>The driver has determined that the network adapter does not support IPv6 checksum offloads and therefore has overridden the *TCPChksumOffv6 and *UDPChksumOffv6 registry parameters.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA002000DL</td>
<td>The driver has determined that the network adapter does not support Wake on LAN and therefore has overridden the *WakeOnPattern, *WakeOnMagicPacket and *DeviceSleepOn Disconnect registry parameters.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA002000EL</td>
<td>The driver has determined that the network adapter does not support protocol offload whilst the system is in a sleep state and therefore has overridden the *PMARPOffload and *PMNSOffload registry parameters.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Severity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0xA002000FL</td>
<td>The driver has determined that the network adapter does not support IPv6 Large Send Offload and therefore has overridden the *LSOv2IPv6 registry parameter.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020010L</td>
<td>IPv6 Large Receive Offload support will be unavailable whilst IPv6 TCP receive checksum offload is disabled.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020011L</td>
<td>IPv6 Large Send Offload support will be unavailable whilst IPv6 TCP transmit checksum offload is disabled.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020012L</td>
<td>The driver has determined that the network adapter does not support Virtual Machine Queues and therefore has overridden the *VMQ registry parameter.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020013L</td>
<td>The driver has been allocated insufficient MSI-X messages to support Virtual Machine Queues and therefore has overridden the *VMQ registry parameter.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020014L</td>
<td>IPv4 Receive Segment Coalescing support will be unavailable whilst IPv4 receive checksum offload or TCP receive checksum offload is disabled.</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>
### Table 60: NDIS Driver Status Codes

<table>
<thead>
<tr>
<th>Value</th>
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</tr>
</thead>
<tbody>
<tr>
<td>0xA0020015L</td>
<td>IPv6 Receive Segment Coalescing support will be unavailable whilst TCP receive checksum offload is disabled.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xA0020016L</td>
<td>The driver has determined that the network adapter does not support Receive Side Scaling and therefore has overridden the *Rss registry parameter.</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>0xE0000001L</td>
<td>The driver could not allocate the resources necessary for operation.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0000002L</td>
<td>The driver has determined that the network adapter is not functioning properly.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0000003L</td>
<td>The driver has encountered an internal error and has failed.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0000004L</td>
<td>The driver could not connect to the NDIS bus interface and has failed.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0000005L</td>
<td>The driver could not connect to the NDIS TCP Connection Offload interface and has failed.</td>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>0xE0030002L</td>
<td>The driver has encountered an unrecoverable network adapter receive data path error; a full system restart is required. Refer to the driver release notes and errata for more information.</td>
<td>Error</td>
<td></td>
</tr>
</tbody>
</table>
This chapter includes procedures for installation and configuration of Solarflare adapters on VMware®. For details of SR-IOV and Virtualization refer to SR-IOV Virtualization Using ESXi on page 348.

- System Requirements on page 261
- VMware Feature Set on page 262
- Installing Solarflare Drivers and Utilities on VMware on page 263
- Configuring Teams on page 264
- Configuring VLANs on page 265
- Running Adapter Diagnostics on page 266
- Solarflare Utilities Package on page 267
- Configuring the Boot ROM with Sfboot on page 268
- Upgrading Adapter Firmware with sfupdate on page 276
- Performance Tuning on VMware on page 278

## 5.1 System Requirements

Refer to Software Driver Support on page 16 for supported VMware host platforms.
### 5.2 VMware Feature Set

Table 61 lists the features available from the VMware host. The following options can also be configured on the guest operating system:

- Jumbo Frames
- Task Offloads
- Virtual LANs (VLANs)

**Table 61: VMware Host Feature Set**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jumbo frames</strong></td>
<td>Support for MTUs (Maximum Transmission Units) from 1500 bytes to 9000 bytes.</td>
</tr>
<tr>
<td></td>
<td>• See Adapter MTU (Maximum Transmission Unit) on page 280</td>
</tr>
<tr>
<td><strong>Task offloads</strong></td>
<td>Support for TCP Segmentation Offload (TSO), Large Receive Offload (LRO), and TCP/UDP/IP checksum offload for improved adapter performance and reduced CPU processing requirements.</td>
</tr>
<tr>
<td></td>
<td>• See TCP/IP Checksum Offload on page 282</td>
</tr>
<tr>
<td></td>
<td>• See TCP Segmentation Offload (TSO) on page 282</td>
</tr>
<tr>
<td><strong>NetQueue</strong></td>
<td>Support for NetQueue, a performance technology that significantly improves performance in 10 Gigabit Ethernet virtualized environments.</td>
</tr>
<tr>
<td></td>
<td>• See VMware ESX NetQueue on page 279</td>
</tr>
<tr>
<td><strong>Teaming</strong></td>
<td>Improve server reliability by creating teams on either the host vSwitch, Guest OS or physical switch to act as a single adapter, providing redundancy against single adapter failure.</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Teams on page 264</td>
</tr>
<tr>
<td><strong>Virtual LANs (VLANs)</strong></td>
<td>Support for VLANs on the host, guest OS and virtual switch.</td>
</tr>
<tr>
<td></td>
<td>• See Configuring VLANs on page 265</td>
</tr>
<tr>
<td><strong>PXE booting</strong></td>
<td>Support for diskless booting to a target operating system via PXE boot.</td>
</tr>
<tr>
<td></td>
<td>• See Sfboot: Command Line Options on page 269</td>
</tr>
<tr>
<td></td>
<td>• See Solarflare Boot Manager on page 371</td>
</tr>
</tbody>
</table>
5.3 Installing Solarflare Drivers and Utilities on VMware

- Using the VMware ESX Service Console on page 263
- Installing on VMware ESX 5.0, ESXi 5.1, 5.5 and 6.0 on page 263
- Granting access to the NIC from the Virtual Machine on page 264
- Solarflare Utilities Package on page 267

Using the VMware ESX Service Console

The service console is the VMware ESX Server command-line interface. It provides access to the VMware ESX Server management tools, includes a command prompt for direct management of the Server, and keeps track of all the virtual machines on the server as well as their configurations.

Installing on VMware ESX 5.0, ESXi 5.1, 5.5 and 6.0

To install or update the .VIB through the CLI:

```
esxcli software vib install -v <absolute PATH to the .vib>
esxcli software vib install -d <absolute PATH to the .zip>
```

To install through the Update Manager

Import the package in to the Update Manager and add to a baseline, then follow the normal update process. To install a new package on to a host deploy the package as part of a Host Extension type baseline rather than a Host Upgrade type.
Granting access to the NIC from the Virtual Machine

To allow guest operating systems access to the Solarflare NIC, you will need to connect the device to a vSwitch to which the guest also has a connection. You can either connect to an existing vSwitch, or create a new vSwitch for this purpose. To create a new vSwitch:

1. Log in to the VMware Infrastructure Client.
2. Select the host from the inventory panel.
3. Select the Configuration tab.
4. Choose Networking from the Hardware box on the left of the resulting panel.
5. Click Add Networking on the top right.
6. Select Virtual Machine connection type and click Next.
7. Choose Create a Virtual Switch or Use vSwitchX as desired.
8. Follow the remaining on-screen instructions.

5.4 Configuring Teams

A team allows two or more network adapters to be connected to a virtual switch (vSwitch). The main benefits of creating a team are:

- Increased network capacity for the virtual switch hosting the team.
- Passive failover in the event one of the adapters in the team fails.

**NOTE:** The VMware ESX host only supports NIC teaming on a single physical switch or stacked switches.

To create a team

1. From the host, select the Configuration tab.
2. Select Networking from the Hardware section.
3. Select Properties for the Virtual Switch you want to create the team for.
4. Select the vSwitch from the dialog box and click Edit.
5. Select NIC Teaming.

You can configure the following settings:

- Load Balancing
- Network Failover Detection
- Notify Switches
- Failover
- Failover Order
5.5 Configuring VLANs

There are three methods for creating VLANs on VMware ESX:

1. Virtual Switch Tagging (VST)
2. External Switch Tagging (EST)
3. Virtual Guest Tagging (VGT)

For EST and VGT tagging, consult the documentation for the switch or for the guest OS.

To Configure Virtual Switch Tagging (VST)

With vSwitch tagging:

- All VLAN tagging of packets is performed by the virtual switch, before leaving the VMware ESX host.
- The host network adapters must be connected to trunk ports on the physical switch.
- The port groups connected to the virtual switch must have an appropriate VLAN ID specified.

**NOTE:** VMware recommend that you create or amend VLAN details from the physical console of the server, not via the Infrastructure Client, to prevent potential disconnections.

1. From the host, select the Configuration tab.
2. Select Networking from the Hardware section.
3. Select Properties for the Virtual Switch you want to create the team for.
4. Select a Port Group and click Edit.
5. Enter a valid VLAN ID (0 equals no VLAN).
6. Click OK.

Further Reading

- NIC teaming in VMware ESX Server: http://kb.vmware.com/selfservice/microsites/search.do?cmd=displayKC&docType=kc&externalId=1004088&sliceld=1&docTypeID=DT_KB_1_1&dialogID=40304190&stateId=0%200%2037866989
• VLAN Configuration on Virtual Switch, Physical Switch, and virtual machines:

### 5.6 Running Adapter Diagnostics

You can use Ethtool to run adapter diagnostic tests. Tests can be run offline (default) or online. Offline runs the full set of tests, possibly causing normal operation interruption during testing. Online performs a limited set of tests without affecting normal adapter operation.

As root user, enter the following command:

```
ethtool --test vmnicX offline|online```

The tests run by the command are as follows:

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>core.nvram</td>
<td>Verifies the flash memory 'board configuration' area by parsing and examining checksums.</td>
</tr>
<tr>
<td>core.registers</td>
<td>Verifies the adapter registers by attempting to modify the writable bits in a selection of registers.</td>
</tr>
<tr>
<td>core.interrupt</td>
<td>Examines the available hardware interrupts by forcing the controller to generate an interrupt and verifying that the interrupt has been processed by the network driver.</td>
</tr>
<tr>
<td>tx/rx.loopback</td>
<td>Verifies that the network driver is able to pass packets to and from the network adapter using the MAC and Phy loopback layers.</td>
</tr>
<tr>
<td>core.memory</td>
<td>Verifies SRAM memory by writing various data patterns (incrementing bytes, all bit on and off, alternating bits on and off) to each memory location, reading back the data and comparing it to the written value.</td>
</tr>
<tr>
<td>core.mdio</td>
<td>Verifies the MII registers by reading from PHY ID registers and checking the data is valid (not all zeros or all ones). Verifies the MMD response bits by checking each of the MMDs in the Phy is present and responding.</td>
</tr>
</tbody>
</table>
Table 62: Adapter Diagnostic Tests

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>chanX eventq.poll</td>
<td>Verifies the adapter’s event handling capabilities by posting a software event on each event queue created by the driver and checking it is delivered correctly. The driver utilizes multiple event queues to spread the load over multiple CPU cores (RSS).</td>
</tr>
<tr>
<td>phy.bist</td>
<td>Examines the PHY by initializing it and causing any available built-in self tests to run.</td>
</tr>
</tbody>
</table>

5.7 Solarflare Utilities Package

The Solarflare Linux and VMware ESX Utilities Source package (SF-105095-LS) is available from the Solarflare support download site: https://support.solarflare.com/ - (Downloads > Linux > Misc).

The utilities (sfboot, sfupdate, sfkey, sfctool) can be built on a standard Linux OS server i.e. RHEL, before the binary utilities are extracted from the RPM package and copied to the ESXi host.

1 Download package SF-105095-LS to a temp directory (e.g /tmp) on a standard Linux machine:

   SF-105095-LS-Solarflare_Linux_and_VMware_ESX_Utilities_Source.zip

2 Unzip and build the binary RPM in the temp directory from the source package:

   # cd /tmp
   # unzip SF-105095-LS-Solarflare_Linux_and_VMware_ESX_Utilities_Source.zip
   # rpmbuild --rebuild sfutils-<version>.src.rpm

   The “Wrote...” line at the end of the build process identifies the location of the binary RPM:

   Wrote: /root/rpmbuild/RPMS/x86_64/sfutils-<version>.x86_64.rpm

3 Identify where the binary tools would be installed (but don’t actually install them):

   # rpm -qlp /root/rpmbuild/RPMS/x86_64/sfutils-<version>.x86_64.rpm
   /usr/sbin/sfaeopackage
   /usr/sbin/sfboot
   /usr/sbin/sfctool
   /usr/sbin/sfkey
   /usr/sbin/sfupdate

4 From the binary extract the utility tools (sfupdate example):

   # rpm2cpio /root/rpmbuild/RPMS/x86_64/sfutils-<version>.x86_64.rpm \\n   | cpio -ivid . /usr/sbin/sfupdate

   NOTE the . (dot) before the /usr/sbin/sfupdate to create the directories and copy the file within the current directory.
Copy the binary utilities to the ESXi machine and run them.

By default remote command execution is disabled on an ESXi host so SSH access must be enabled from the console or from the vSphere client to allow remote login and secure copy - refer to the following documentation for SSH enabling procedures:


### 5.8 Configuring the Boot ROM with Sfboot

- Sfboot: Command Usage on page 268
- Sfboot: Command Line Options on page 269
- Sfboot: Examples on page 275

Sfboot is a command line utility for configuring Solarflare adapter Boot ROM options, including options for PXE and UEFI booting. Using sfboot is an alternative to using Ctrl+B to access the Boot Rom agent during server startup.

See Solarflare Boot Manager on page 371 for more information on the Boot Rom agent.

**Sfboot: Command Usage**

Log in to the VMware Service Console as root, and enter the following command:

```
sfboot [--adapter=vmnicX] [options] [parameters]
```

Note that without --adapter, the sfboot command applies to all adapters that are present in the target host.

The format for the parameters are:

```
<parameter>=<value>
```
**Sfboot: Command Line Options**

Table 63 lists the options for sfboot.exe, Table 64 lists the available global parameters, and Table 65 lists the available per-adapter parameters. Note that command line options are case insensitive and may be abbreviated.

**NOTE:** Abbreviations in scripts should be avoided, since future updates to the application may render abbreviated scripts invalid.

Table 63: Sfboot Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-?, -h, --help</td>
<td>Displays command line syntax and provides a description of each sfboot option.</td>
</tr>
<tr>
<td>-V, --version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>--nologo</td>
<td>Hide the version and copyright message at startup.</td>
</tr>
<tr>
<td>-v, --verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>-y, --yes</td>
<td>Update without prompting.</td>
</tr>
<tr>
<td>-s, --quiet</td>
<td>Suppresses all output, including warnings and errors; no user interaction. You should query the completion code to determine the outcome of commands when operating silently (see Performance Tuning on Windows on page 225).</td>
</tr>
<tr>
<td>--log &lt;filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify --silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>--computer &lt;computer_name&gt;</td>
<td>Performs the operation on a specified remote computer. Administrator rights on the remote computer is required.</td>
</tr>
<tr>
<td>--list</td>
<td>Lists all available Solarflare adapters. This option shows the ifname and MAC address. Note: this option may not be used in conjunction with any other option. If this option is used with configuration parameters, those parameters will be silently ignored.</td>
</tr>
<tr>
<td>-i, --adapter =&lt;vmnicX&gt;</td>
<td>Performs the action on the identified Solarflare network adapter. The adapter identifier vmnicX can be the name or MAC address, as output by the --list option. If --adapter is not included, the action will apply to all installed Solarflare adapters.</td>
</tr>
</tbody>
</table>
The following global parameters in Table 64 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>boot-image=</td>
<td>Specifies which boot firmware images are served-up to the BIOS during start-up. This parameter can not be used if the --adapter option has been specified.</td>
</tr>
<tr>
<td>all</td>
<td>optionrom</td>
</tr>
<tr>
<td>port-mode=</td>
<td>Configure the port mode to use. This is for SFN7000 and SFN8000 series adapters only. The values specify the connectors available after using any splitter cables. The usable values are adapter-dependent:</td>
</tr>
<tr>
<td>default</td>
<td>1x10G</td>
</tr>
</tbody>
</table>

- SFN8722: 2x10G
- SFN8542: 4x10G, 2x40G (default)
- SFN8522: 2x10G (default)
- SFN7xx4F: 2x10G, 4x10G (default)
- SFN7xx2Q: 2x10G, 4x10G, 2x40G (default)
- SFN7xx2F: 1x10G, 2x10G (default)

Changes to this setting with sfboot require a cold reboot to become effective. MAC address assignments may change after altering this setting.
### Table 64: sfboot Global Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| firmware-variant=full-feature|ultra-low-latency|capture-packed-stream|auto | Configure the firmware variant to use. This is for SFN7000 and SFN8000 series adapters only:  
  - the SFN7002F adapter is factory set to full-feature  
  - all other adapters are factory set to auto. 
  Default value = auto - means the driver will select a variant that meets its needs:  
  - the VMware driver always uses full-feature  
  - otherwise, ultra-low-latency is used. 
  The ultra-low-latency variant produces best latency without support for TX VLAN insertion or RX VLAN stripping (not currently used features). It is recommended that Onload customers use the ultra-low-latency variant. |
| insecure-filters=enabled|disabled | If enabled bypass filter security on non-privileged functions. This is for SFN7000 and SFN8000 series adapters only. This reduces security in virtualized environments. The default is disabled. When enabled a function (PF or VF) can insert filters not qualified by their own permanent MAC address. This is a requirement when using Onload or when using bonded interfaces. |
| mac-spoofing=default|enabled|disabled | If enabled, non-privileged functions can create unicast filters for MAC addresses that are not associated with them. This is for SFN7000 and SFN8000 series adapters only. 
  The default is disabled. 
  Changes to this setting with sfboot require a cold reboot to become effective. |
| rx-dc-size=8|16|32|64 | Specifies the size of the descriptor cache for each receive queue. This is for SFN7000 and SFN8000 series adapters only. The default is:  
  - 16 if the port-mode supports the maximum number of connectors for the adapter  
  - 32 if the port-mode supports a reduced number of connectors. |
### Table 64: Sfboot Global Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tx-dc-size=8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>• 32 if the port-mode supports the maximum number of connectors for the adapter</td>
</tr>
<tr>
<td></td>
<td>• 64 if the port-mode supports a reduced number of connectors.</td>
</tr>
<tr>
<td>change-mac=</td>
<td>This is for SFN7000 and SFN8000 series adapters only. Change the unicast MAC address for non-privileged functions on this port. This is a global option and applies to all physical ports on the NIC.</td>
</tr>
<tr>
<td>default</td>
<td>enabled</td>
</tr>
<tr>
<td>event-merge-timeout=</td>
<td>Specifies the timeout in nanoseconds for RX event merging.</td>
</tr>
<tr>
<td>&lt;timeout in nanoseconds&gt;</td>
<td>A timeout of 0 means that event merging is disabled.</td>
</tr>
</tbody>
</table>
The following per-adapter parameters in Table 65 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

Table 65: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| link-speed=auto|10g|1g|100m | Specifies the network link speed of the adapter used by the Boot ROM. The default is auto. On the 10GBASE-T adapters, auto instructs the adapter to negotiate the highest speed supported in common with its link partner. On SFP+ adapters, auto instructs the adapter to use the highest link speed supported by the inserted SFP+ module. On 10GBASE-T and SFP+ adapters, any other value specified will fix the link at that speed, regardless of the capabilities of the link partner, which may result in an inability to establish the link.  
  auto  Auto-negotiate link speed (default)  
  10G  10G bit/sec  
  1G  1G bit/sec  
  100M  100M bit/sec |
| linkup-delay= | Specifies the delay (in seconds) the adapter defers its first connection attempt after booting, allowing time for the network to come up following a power failure or other restart. This can be used to wait for spanning tree protocol on a connected switch to unblock the switch port after the physical network link is established. The default is 5 seconds.  
  <delay time in seconds> |
| banner-delay= | Specifies the wait period for Ctrl-B to be pressed to enter adapter configuration tool.  
  <delay time in seconds>= 0-256 |
| bootskip-delay= | Specifies the time allowed for Esc to be pressed to skip adapter booting.  
  <delay time in seconds>= 0-256 |
| boot-type=pxe|uefi|disabled | Sets the adapter boot type – effective on next boot.  
  pxe – PXE (Preboot eXecution Environment) booting  
  disabled – Disable adapter booting |
### Table 65: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>pf-count=&lt;pf count&gt;</code></td>
<td>This is the number of available PCIe PFs per physical network port. This setting is applied to all ports on the adapter. Changes to this setting with <code>sfboot</code> require a cold reboot to become effective. MAC address assignments may change after altering this setting.</td>
</tr>
<tr>
<td><code>msix-limit=</code></td>
<td>Specifies the maximum number of MSI-X interrupts that each PF will use. The default is 32. Note: Using the incorrect setting can impact the performance of the adapter. Contact Solarflare technical support before changing this setting.</td>
</tr>
<tr>
<td>`8</td>
<td>16</td>
</tr>
<tr>
<td>`sriov=enabled</td>
<td>disabled`</td>
</tr>
<tr>
<td><code>vf-count=&lt;vf count&gt;</code></td>
<td>The number of virtual functions (VF) advertised to the operating system for each Physical Function on this physical network port. SFN7000 and SFN8000 series adapters have a total limit of 2048 interrupts. Earlier adapters support a total limit of 127 virtual functions per port and a total of 1024 interrupts. Depending on the values of <code>msix-limit</code> and <code>vf-msix-limit</code>, some of these virtual functions may not be configured. Enabling all 127 VFs per port with more than one MSI-X interrupt per VF may not be supported by the host BIOS - in which case you may get 127 VFs on one port and none on others. Contact your BIOS vendor or reduce the VF count. The <code>sriov</code> parameter is implied if <code>vf-count</code> is greater than zero. Changes to this setting with <code>sfboot</code> require a cold reboot to become effective.</td>
</tr>
<tr>
<td><code>vf-msix-limit=</code></td>
<td>The maximum number of interrupts a virtual function may use.</td>
</tr>
<tr>
<td>`1</td>
<td>2</td>
</tr>
</tbody>
</table>
Sfboot: Examples

- Show the current boot configuration for all adapters:
  ```
  sfboot
  ```

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pf-vlans=&lt;tag&gt;[,&lt;tag&gt;]</td>
<td>Comma separated list of VLAN tags for each PF in the range 0-4094 - see sfboot --help for details.</td>
</tr>
<tr>
<td></td>
<td>Setting pf-vlans=none will clear all VLAN tags on the port.</td>
</tr>
<tr>
<td></td>
<td>pf-vlans should be included after the pf-count option on the sfboot command line.</td>
</tr>
<tr>
<td></td>
<td>If the number of PFs is changed then the VLAN tags will be cleared.</td>
</tr>
<tr>
<td>switch-mode=</td>
<td>Specifies the mode of operation that the port will be used in:</td>
</tr>
<tr>
<td>default</td>
<td>sriov</td>
</tr>
<tr>
<td></td>
<td>default - single PF created, zero VFs created.</td>
</tr>
<tr>
<td></td>
<td>sriov - SR-IOV enabled, single PF created, VFs configured with vf-count.</td>
</tr>
<tr>
<td></td>
<td>partitioning - PFs configured with pf-count, VFs configured with vf-count. See NIC Partitioning for details.</td>
</tr>
<tr>
<td></td>
<td>partitioning-with-sriov - SR-IOV enabled, PFs configured with pf-count, VFs configured with vf-count. See NIC Partitioning for details.</td>
</tr>
<tr>
<td></td>
<td>pfiov - PFIOV enabled, PFs configured with pf-count, VFs not supported.</td>
</tr>
<tr>
<td></td>
<td>Changes to this setting with sfboot require a cold reboot to become effective.</td>
</tr>
</tbody>
</table>

Table 65: Sfboot Per-adapter Parameters
5.9 Upgrading Adapter Firmware with sfupdate

- Sfupdate: Command Usage on page 276
- Sfupdate: Command Line Options on page 276
- Sfupdate: Examples on page 278

Sfupdate is a command line utility used to manage and upgrade the Solarflare adapter Boot ROM, Phy and adapter firmware. Embedded within the sfupdate executable is firmware images for various Solarflare adapters - the exact updates available via sfupdate are therefore depend on your adapter.

**Sfupdate: Command Usage**

Log in to the VMware Service Console as root, and enter the following command:

```
sfupdate [-adapter=vmnicX] [options]
```

where:

- `vmnicX` is the interface name of the Solarflare adapter you want to upgrade. Specifying the adapter is optional - if it is not included the command is applied to all Solarflare adapters in the machine.
- `option` is one of the command options listed in Table 66.

The format for the options are:

```
<option>=<parameter>
```

Running the command sfupdate with no additional parameters will show the current firmware version for all Solarflare adapters and whether the firmware within sfupdate is more up to date. To update the firmware for all Solarflare adapters run the command sfupdate --write

Solarflare recommend that you use sfupdate in the following way:

1. Run sfupdate to check that the firmware on all your adapters are up to date.
2. Run sfupdate --write to update the firmware on all adapters.

**Sfupdate: Command Line Options**

Table 66 lists the options for sfupdate.
### Table 66: Sfupdate Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-h, --help</td>
<td>Shows help for the available options and command line syntax.</td>
</tr>
<tr>
<td>-v, --verbose</td>
<td>Verbose output mode.</td>
</tr>
<tr>
<td>-s, --silent</td>
<td>Suppress all output except errors. Useful for scripting.</td>
</tr>
<tr>
<td>-V, --version</td>
<td>Display version number information and exit.</td>
</tr>
<tr>
<td>-i, --adapter=vmnicX</td>
<td>Specifies the target adapter when more than one adapter is installed in the local host. vmnicX = Adapter interface name or MAC address (as obtained with --list).</td>
</tr>
<tr>
<td>--list</td>
<td>Shows the adapter ID, adapter name and MAC address of each adapter installed in the local host, or on the target when --computer is specified.</td>
</tr>
<tr>
<td>--write</td>
<td>Writes the firmware from the images embedded in sfupdate. To use an external image, specify --image=&lt;filename&gt; in the command. --write fails if the embedded image is the same or a previous version to that in the adapter. To force a write in this case, specify --force in the command.</td>
</tr>
<tr>
<td>--force</td>
<td>Force update of all firmware, even if the installed firmware version is the same or more recent. If required, use this option with --write.</td>
</tr>
<tr>
<td>--image=&lt;filename&gt;</td>
<td>Specifies a specific firmware image. This option is not normally required and is only necessary if you need to provide writing the sfupdate embedded image file.</td>
</tr>
<tr>
<td>--ipxe-image=&lt;filename&gt;</td>
<td>Install an iPXE image from the given file, replacing the Solarflare boot ROM image. sfupdate will not automatically replace the iPXE image in subsequent flash updates unless the --restore-bootrom option is used.</td>
</tr>
<tr>
<td>--restore-bootrom</td>
<td>Replace an iPXE image in flash with the standard Solarflare Boot Manager PXE image included in sfupdate.</td>
</tr>
<tr>
<td>-y, --yes</td>
<td>Prompts for user confirmation before writing the firmware.</td>
</tr>
</tbody>
</table>
Sfupdate: Examples

- List all Solarflare adapters installed on the host with the installed firmware:
  
  ```
  sfupdate
  ```

  **Solarflare firmware update utility [v3.0.3]**
  Copyright Solarflare Communications 2006-2010, Level 5 Networks 2002-2005

<table>
<thead>
<tr>
<th>Interface</th>
<th>MAC Address</th>
<th>Firmware Version</th>
<th>PHY Type</th>
<th>PHY Version</th>
<th>Controller Type</th>
<th>Controller Version</th>
<th>boot ROM Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>eth1</td>
<td>00-0F-53-01-39-70</td>
<td>v3.0.3</td>
<td>QT2025C</td>
<td>v2.0.2.5</td>
<td>Solarflare SFC4000</td>
<td>v3.0.3.2127</td>
<td>v3.0.3.2127</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eth2</td>
<td>00-0F-53-01-39-71</td>
<td>v3.0.2</td>
<td>QT2025C</td>
<td>v2.0.2.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

  The PHY firmware is up to date
  The boot ROM firmware is up to date
  The controller firmware is up to date

5.10 Performance Tuning on VMware

- Introduction on page 278
- Tuning Settings on page 279
- Other Considerations on page 283

**Introduction**

The Solarflare family of network adapters are designed for high-performance network applications. The adapter driver is pre-configured with default performance settings that have been designed to give good performance across a broad class of applications. In many cases, application performance can be improved by tuning these settings to best suit the application.

There are three metrics that should be considered when tuning an adapter:

- Throughput
- Latency
- CPU utilization

Different applications may be more or less affected by improvements in these three metrics. For example, transactional (request-response) network applications can be very sensitive to latency whereas bulk data transfer applications are likely to be more dependent on throughput.
The purpose of this section is to highlight adapter driver settings that affect the performance metrics described. This guide covers the tuning of all members of the Solarflare family of adapters. Performance between adapters should be identical, with the exception of latency measurements.

Latency will be affected by the type of physical medium used: CX4, XFP, 10GBase-T or SFP+. This is because the physical media interface chip (PHY) used on the adapter can introduce additional latency.

Tuning Settings

Install VMware Tools in the Guest Platform

Installing VMware tools will give greatly improved networking performance in the guest. If VMware Tools are not installed, ESX emulates a PC-Lance device in the guest. If VMware Tools are installed, the guest will see a virtual adapter of type vmxnet.

To check that VMware Tools are installed:

1. From the **VMware Infrastructure Client**, power on the virtual machine and click the **Summary** tab.
2. In the **General** panel, check the status of **VMware Tools**.

To install VMware Tools:

1. Power on the virtual machine
2. From the **Inventory > Virtual Machine** menu, select **Install/Upgrade VMware Tools**.

   This will mount a virtual CD-ROM in the guest OS. If the guest OS is Windows, it can autorun the CD and install tools (if not, navigate to the CD-ROM device and run the setup program yourself). If the guest is a Linux OS, you must mount the CD, install the tools, and configure them. For example, if the guest is Red Hat:

   ```
   # mount /dev/cdrom /mnt
   # rpm -i /mnt/VMwareTools*.rpm
   # vmware-tools-config.pl
   ```

VMware ESX NetQueue

Solarflare adapters supports VMware’s NetQueue technology, which accelerates network performance in 10 Gigabit Ethernet virtualized environments. NetQueue is enabled by default in VMware versions. There is usually no reason not to enable NetQueue.

**NOTE:** VMware NetQueue accelerates both receive and transmit traffic.
**Binding NetQueue queues and Virtual Machines to CPUs**

Depending on the workload, NetQueue can show improved performance if each of the queues’ associated interrupt and the virtual machine are pinned to the same CPU. This is particularly true of workloads where sustained high bandwidth is evenly distributed across multiple virtual machines (such as you might do when benchmarking). To pin a Virtual Machine to one or more CPUs:

1. Log in to the VMware Infrastructure Client.
2. Expand the host and select the virtual machine to pin from the inventory panel.
3. Select the Summary tab for that virtual machine.
4. Click Edit Settings.
5. From the resulting dialog box select the Resources tab
6. Click Advanced CPU on the left.
7. Select the CPU(s) to which the virtual machine is to be bound (on the right hand side of the dialog box).

To bind a queue’s interrupt to a CPU, from the VMware ESX console OS enter:

```
# echo move $IRQVEC $CPU > /proc/vmware/intr-tracker
```

(Where $IRQVEC is the interrupt vector in hex, and $CPU is the CPU number in decimal.)

To determine the value for $IRQVEC enter:

```
# cat /proc/vmware/interrupts
```

Locate the interrupts associated with the Solarflare adapter (e.g. vmnic2). Interrupts are listed in order: the first interrupt will be for the default queue, the second interrupt for the queue dedicated to the first virtual machine to have been started, the third interrupt for the queue dedicated to the second virtual machine to have been started, and so on.

If there are more virtual machine's than CPUs on the host, optimal performance is obtained by pinning each virtual machine and associated interrupt to the same CPU. If there are fewer virtual machines than CPUs, optimal results are obtained by pinning the virtual machine and associated interrupt respectively to two cores which share an L2 cache.

**Adapter MTU (Maximum Transmission Unit)**

The default MTU of 1500 bytes ensures that the adapter is compatible with legacy 10/100Mbps Ethernet endpoints. However if a larger MTU is used, adapter throughput and CPU utilization can be improved. CPU utilization is improved because it takes fewer packets to send and receive the same amount of data. Solarflare adapters support frame sizes up to 9216 bytes (this does not include the Ethernet preamble or frame-CRC).
Since the MTU should ideally be matched across all endpoints in the same LAN (VLAN), and since the LAN switch infrastructure must be able to forward such packets, the decision to deploy a larger than default MTU requires careful consideration. It is recommended that experimentation with MTU be done in a controlled test environment.

To change the MTU of the vSwitch, from the VMware Console OS enter:

```
# esxcfg-vswitch --mtu <size> <vSwitch>
```

To verify the MTU settings, as well as obtaining a list of vSwitches installed on the host, enter:

```
# esxcfg-vswitch --list
```

The change in MTU size of the vSwitch will persist across reboots of the VMware ESX host.

**Interrupt Moderation (Interrupt Coalescing)**

Interrupt moderation controls the number of interrupts generated by the adapter by adjusting the extent to which receive packet processing events are coalesced. Interrupt moderation may coalesce more than one packet-reception or transmit-completion event into a single interrupt.

By default, adaptive moderation is enabled. Adaptive moderation means that the network driver software adapts the interrupt moderation setting according to the traffic and workloads it sees.

Alternatively, you can set the moderation interval manually. You would normally only do this if you are interested in reducing latency. To do this you must first disable adaptive moderation with the following command, where vmnicX is the interface name.

```
ethtool -C <vmnicX> adaptive-rx off
```

**NOTE:** adaptive-rx may already have been disabled. Consult your VMware documentation for details.

Interrupt moderation can be changed using ethtool, where vmnicX is the interface name and interval is the moderation setting in microseconds (\(\mu s\)). Specifying 0 as the interval parameter will turn interrupt moderation off:

```
ethtool -C <vmnicX> rx-usecs-irq <interval>
```

Verification of the moderation settings may be performed by running ethtool –c

This parameter is critical for tuning adapter latency. Increasing the moderation value will increase latency, but reduce CPU utilization and improve peak throughput, if the CPU is fully utilized. Decreasing the moderation value or turning it off will decrease latency at the expense of CPU utilization and peak throughput. However, for many transaction request-response type network applications, the benefit of reduced latency to overall application performance can be considerable. Such benefits may outweigh the cost of increased CPU utilization.
NOTE: The interrupt moderation time dictates the minimum gap between two consecutive interrupts. It does not mandate a delay on the triggering of an interrupt on the reception of every packet. For example, an interrupt moderation setting of 30µs will not delay the reception of the first packet received, but the interrupt for any following packets will be delayed until 30µs after the reception of that first packet.

TCP/IP Checksum Offload

Checksum offload moves calculation and verification of IP Header, TCP and UDP packet checksums to the adapter. The driver by default has all checksum offload features enabled. Therefore, there is no opportunity to improve performance from the default.

Checksum offload is controlled using ethtool:

Receive Checksum:
```
# /sbin/ethtool -K <vmnicX> rx <on|off>
```

Transmit Checksum:
```
# /sbin/ethtool -K <vmnicX> tx <on|off>
```

Verification of the checksum settings may be performed by running ethtool with the –k option. Solarflare recommend you do not disable checksum offload.

For advice on configuring checksum offload in the guest, consult the relevant Solarflare section for that guest, or the documentation for the guest operating system.

TCP Segmentation Offload (TSO)

TCP Segmentation offload (TSO) offloads the splitting of outgoing TCP data into packets to the adapter. TCP segmentation offload benefits applications using TCP. Non TCP protocol applications will not benefit (but will not suffer) from TSO.

Enabling TCP segmentation offload will reduce CPU utilization on the transmit side of a TCP connection, and so improve peak throughput, if the CPU is fully utilized. Since TSO has no effect on latency, it can be enabled at all times. The driver has TSO enabled by default. Therefore, there is no opportunity to improve performance from the default.

NOTE: TSO cannot be controlled via the host on VMware ESX. It can only be controlled via the guest Operating System.

TCP Large Receive Offload (LRO)

TCP Large Receive Offload (LRO) is a feature whereby the adapter coalesces multiple packets received on a TCP connection into a single call to the operating system TCP Stack. This reduces CPU utilization, and so improves peak throughput when the CPU is fully utilized.
LRO should not be enabled if you are using the host to forward packets from one interface to another; for example if the host is performing IP routing or acting as a layer2 bridge.

LRO is supported, and enabled by default, on VMware versions later than ESX 3.5.

**TCP Protocol Tuning**

TCP Performance can also be improved by tuning kernel TCP settings. Settings include adjusting send and receive buffer sizes, connection backlog, congestion control, etc.

Typically it is sufficient to tune just the max buffer value. It defines the largest size the buffer can grow to. Suggested alternate values are max=500000 (1/2 Mbyte). Factors such as link latency, packet loss and CPU cache size all influence the affect of the max buffer size values. The minimum and default values can be left at their defaults minimum=4096 and default=87380.

For advice on tuning the guest TCP stack consult the documentation for the guest operating system.

**Receive Side Scaling (RSS)**

Solarflare adapters support Receive Side Scaling (RSS). RSS enables packet receive-processing to scale with the number of available CPU cores. RSS requires a platform that supports MSI-X interrupts. RSS is enabled by default.

When RSS is enabled the controller uses multiple receive queues into which to deliver incoming packets. The receive queue selected for an incoming packet is chosen in such a way as to ensure that packets within a TCP stream are all sent to the same receive queue – this ensures that packet-ordering within each stream is maintained. Each receive queue has its own dedicated MSI-X interrupt which ideally should be tied to a dedicated CPU core. This allows the receive side TCP processing to be distributed amongst the available CPU cores, providing a considerable performance advantage over a conventional adapter architecture in which all received packets for a given interface are processed by just one CPU core.

RSS will be enabled whenever NetQueue is not and Solarflare recommend using NetQueue on VMware ESX hosts.

**Other Considerations**

**PCI Express Lane Configurations**

The PCI Express (PCIe) interface used to connect the adapter to the server can function at different widths. This is independent of the physical slot size used to connect the adapter. The possible widths are multiples x1, x2, x4, x8 and x16 lanes of (2.5Gbps for PCIe Gen. 1, 5.0 Gbps for PCIe Gen. 2) in each direction. Solarflare Adapters are designed for x8 lane operation.
On some server motherboards, choice of PCIe slot is important. This is because some slots (including ones that are physically x8 or x16 lanes) may only electrically support x4 lanes. In x4 lane slots, Solarflare PCIe adapters will continue to operate, but not at full speed. The Solarflare driver will warn you if it detects the adapter is plugged into a PCIe slot which electrically has fewer than x8 lanes.

For SFN5000 series adapters, which require a PCIe Gen. 2 slot for optimal operation, a warning will be given if they are installed in a PCIe Gen. 1 slot. Warning messages can be viewed in dmesg from /var/log/messages.

**Memory bandwidth**

Many chipsets/CPUs use multiple channels to access main system memory. Maximum memory performance is only achieved when the server can make use of all channels simultaneously. This should be taken into account when selecting the number of DIMMs to populate in the server. Consult your motherboard documentation for details.

**Intel® QuickData**

Intel® QuickData Technology allows VMware ESX to data copy by the chipset instead of the CPU, to move data more efficiently through the server and provide fast, scalable, and reliable throughput.

I/O AT can be enabled on the host and on guest operating systems. For advice on enabling I/OAT in the guest, consult the relevant Solarflare section for that guest, or the documentation for the guest operating system. I/OAT must be enabled on the host if it is to be used in the guests.

**To enable I/OAT on the VMware ESX host:**

On some systems the hardware associated with I/OAT must first be enabled in the BIOS

Log in to the ConsoleOS on the VMware ESX host, and enter:

```
# esxcfg-advcfg -s 1 /Net/TcpipUseIoat
```

Reboot the VMware ESX host

To verify I/OAT is enabled, from the ConsoleOS enter:

```
# vmkload_mod -l | grep -i ioat
```

**NOTE:** The following VMware KB article should be read when enabling I/OAT:

Server Motherboard, Server BIOS, Chipset Drivers

Tuning or enabling other system capabilities may further enhance adapter performance. Readers should consult their server user guide. Possible opportunities include tuning PCIe memory controller (PCIe Latency Timer setting available in some BIOS versions).
6 Solarflare Adapters on FreeBSD

This chapter covers the following topics on the FreeBSD platform:

- System Requirements on page 286
- FreeBSD Platform Feature Set on page 287
- Installing Solarflare Drivers on page 287
- Unattended Installation on page 289
- Configuring the Solarflare Adapter on page 291
- Setting Up VLANs on page 292
- FreeBSD Utilities Package on page 293
- Configuring the Boot ROM with sfboot on page 294
- Upgrading Adapter Firmware with sfupdate on page 300
- Performance Tuning on FreeBSD on page 302
- Module Parameters on page 312
- Kernel and Network Adapter Statistics on page 314

6.1 System Requirements

Refer to Software Driver Support on page 16 for details of supported FreeBSD distributions.

NOTE: FreeBSD includes a previous version of the Solarflare adapter driver that does not support all features of this version. To update the supplied driver, see Installing Solarflare Drivers on page 287.
6.2 FreeBSD Platform Feature Set

Table 67 lists the features supported by Solarflare adapters on FreeBSD.

<table>
<thead>
<tr>
<th>Feature Set</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumbo frames</td>
<td>Support for MTUs (Maximum Transmission Units) to 9000 bytes.</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Jumbo Frames on page 292</td>
</tr>
<tr>
<td>Task offloads</td>
<td>Support for TCP Segmentation Offload (TSO), Large Receive Offload (LRO), and TCP/UDP/IP checksum offload for improved adapter performance and reduced CPU processing requirements.</td>
</tr>
<tr>
<td></td>
<td>• See Configuring Task Offloading on page 292</td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Support for RSS multi-core load distribution technology.</td>
</tr>
<tr>
<td></td>
<td>• See Receive Side Scaling (RSS) on page 307</td>
</tr>
<tr>
<td>Virtual LANs (VLANs)</td>
<td>Support for multiple VLANs per adapter.</td>
</tr>
<tr>
<td></td>
<td>• See Setting Up VLANs on page 292</td>
</tr>
<tr>
<td>PXE and booting</td>
<td>Support for diskless booting to a target operating system via PXE or UEFI boot.</td>
</tr>
<tr>
<td></td>
<td>• See Configuring the Boot ROM with sfboot on page 294</td>
</tr>
<tr>
<td></td>
<td>• See Solarflare Boot Manager on page 371</td>
</tr>
<tr>
<td>Firmware updates</td>
<td>Support for Boot ROM, PHY transceiver and adapter firmware upgrades.</td>
</tr>
<tr>
<td></td>
<td>• See Upgrading Adapter Firmware with sfupdate on page 300</td>
</tr>
</tbody>
</table>

6.3 Installing Solarflare Drivers

The FreeBSD drivers for Solarflare are available in a source package.

- A package is available for FreeBSD 10.0 and 10.1:
  - this package might perform correctly with other FreeBSD kernels, but has not been tested with them
  - for further details see the Release Notes.

**NOTE:** The Solarflare adapter should be physically installed in the host computer before you attempt to install drivers. You must have root permissions to install the adapter drivers.
This source can be used:

- To compile and install a driver on a development machine.
  The development machine must have the following installed:
  - development tools
  - the ports system, and its Makefiles
  - the kernel source.

- To create a binary driver package, for installing on other target machines.
  A target machine:
  - must have the same kernel and architecture as the development machine
  - that built the package
  - does not require any of the development tools or source.

To install the driver, use pkg add or pkg_add.

The following instructions assume that the source package has been downloaded to the /tmp directory.

1. Ensure you are the root user. If not:
   su -

2. To avoid using the previous driver that is distributed with the OS, rename it:
   mv /boot/kernel/sfxge.ko /boot/kernel/sfxge.ko_default
   - If desired, it can instead be removed:
     rm /boot/kernel/sfxge.ko

3. Unpack the downloaded source:
   cd /tmp
   tar xvf sfxge-freebsd-<version_no>.txz
   For example:
   cd /tmp
   tar xvf sfxge-freebsd-4.5.3.1002.txz

4. Change directory into the source:
   cd sfxge-freebsd-<version_no>
   For example:
   cd sfxge-freebsd-4.5.3.1002

5. Build the package:
   make package
   - If you do not have the ports system installed you will see this error:
     The ports system must be installed first.
   - You can install the ports system by running:
     portsnap fetch extract
6  Install the package:
   make install
   - the driver (for use on this machine) is installed in /boot/modules/
     sfxge.ko
   - the binary driver package (for use on other machines) is installed in the
     build directory in work/package/sfxge-kmod-<version_no>.txz, and in
     /usr/ports/packages/All/sfxge-kmod-<version_no>.txz

7  Load the driver:
   kldload /boot/modules/sfxge.ko

For information on configuring this network interface see Configuring the Solarflare
Adapter on page 291.

6.4 Unattended Installation

Unattended installations of FreeBSD can be performed by PXE booting over the
network, and using the bsdinstall command. Set this up as follows:

• Ensure that DHCP is available, with PXE boot options.
• Ensure that a TFTP server is available.
• Ensure that a FreeBSD server is available.

This is required only to generate the FreeBSD PXE boot image:
   - Download the mfsbsd utility (available from http://mfsbsd.vx.sk/).
     Install it on the FreeBSD server.¹
   - Download the ISO image for the required FreeBSD release.
     Mount this boot image on the FreeBSD server.
   - Configure and customize the boot image.
     Change any PXE boot settings as necessary.
     Modify the /etc/installerconfig file in the boot image to add any
     post-install tasks.
   - Use the mfsbsd utility to build the PXE boot image, using the modified
     boot image as source.
• Copy the PXE boot image to the TFTP server
   Add a FreeBSD option to its pxelinux boot menu.
• PXE boot the target server and select the FreeBSD image.
• The FreeBSD server that was used to generate the FreeBSD PXE boot image can
  now be re-used.

¹ The mfsbsd utility runs only under FreeBSD.
FreeBSD install and booting is documented as follows:

- For information on booting a FreeBSD system over the network, see:
  https://www.freebsd.org/cgi/man.cgi?query=diskless&sektion=8
- For general information on using bsdinstall, see:
  https://www.freebsd.org/doc/handbook/bsdinstall.html
- For a reference description of the bsdinstall command, see:
  https://www.freebsd.org/cgi/man.cgi?query=bsdinstall&sektion=8 especially the SCRIPTING section.

Table 68 shows an example time line for an unattended installation.

<table>
<thead>
<tr>
<th>In Control</th>
<th>Stages of Boot</th>
<th>Setup needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOS</td>
<td>PXE code on the adapter runs.</td>
<td>Adapter must be in PXE boot mode. See Solarflare Boot Manager on page 371.</td>
</tr>
<tr>
<td>SF Boot ROM (PXE)</td>
<td>DHCP request from PXE (SF Boot ROM).</td>
<td>DHCP server filename and next-server options.</td>
</tr>
<tr>
<td>SF Boot ROM (PXE)</td>
<td>TFTP request for filename to next-server, e.g. pxelinux.0</td>
<td>TFTP server.</td>
</tr>
<tr>
<td>pxelinux</td>
<td>TFTP retrieval of pxelinux configuration.</td>
<td>pxelinux configuration on TFTP server.</td>
</tr>
<tr>
<td>pxelinux</td>
<td>TFTP menu retrieval of FreeBSD kernel image.</td>
<td>pxelinux configuration Kernel, kernel command</td>
</tr>
<tr>
<td>FreeBSD kernel/ installer</td>
<td>Installer retrieves configuration.</td>
<td>FreeBSD image</td>
</tr>
<tr>
<td>Installation occurs</td>
<td>Machine reboots</td>
<td>/etc/installerconfig file</td>
</tr>
<tr>
<td>Target FreeBSD kernel</td>
<td>kernel reconfigures network adapters.</td>
<td>DHCP server.</td>
</tr>
</tbody>
</table>
6.5 Configuring the Solarflare Adapter

The drivers will be loaded as part of the as part of the installation. However the adapter will not be configured (adding IP address and netmask).

Each Solarflare network adapter interface will be named sfxge<n> where <n> is a unique identifier. There will be one interface per physical port on the Solarflare adapter.

To configure the interface and bring it up to allow data to pass, enter the following:

```
ifconfig sfxge<n> inet <IPv4 address> netmask <netmask> up
```

This configures the interface and initializes it with the up command.

NOTE: This method of configuring is temporary. If you reboot your computer the settings will be lost. To make these settings permanent, create entries in the configuration file as described below.

Using IPv6

To configure using IPv6, create an IPv6 interface sfxge<n> interface with a link local IPv6 address by entering:

```
ifconfig sfxge<n> inet6 <IPv6 address> prefixlen <IPv6 prefix length>
```

This uses automatic link-local address configuration, which is enabled by default in FreeBSD. It will give an IPv6 interface name of sfxge<n>:1

Using a Configuration File with IPv4

Configuration is set in the /etc/rc.conf file. There are three options with IPv4:

- Using a static IPv4 address. To use this option, add:
  
  ```
  ifconfig_sfxge<n>="inet <IPv4 address> netmask <netmask>"
  ```

- Using a hostname. To use this option, add:
  
  ```
  ifconfig_sfxge<n>="inet <hostname>"
  ```
  and modify /etc/hosts and /etc/netmasks

- Using DHCP. To use this option, add:
  
  ```
  ifconfig_sfxge<n>="DHCP"
  ```

Using Configuration files with IPv6

Configuration is set in the /etc/rc.conf file:

- For automatic configuration by StateLess Address AutoConfiguration (SLAAC), add:
  
  ```
  ifconfig_sfxge<n>_ipv6="inet6 accept_rtadv"
  ```
Configuring Task Offloading

Solarflare adapters support transmit (Tx) and receive (Rx) checksum offload, as well as TCP segmentation offload. To ensure maximum performance from the adapter, all task offloads should be enabled, which is the default setting on the adapter. For more information, see Performance Tuning on FreeBSD on page 302.

Configuring Jumbo Frames

Solarflare adapters support a frame size (MTU) from 1500 bytes to 9000 bytes. The default maximum driver MTU size is 1500 bytes. For example, to set a new frame size (MTU) of 9000 bytes, enter the following command:

```
ifconfig sfxge<n> inet mtu 9000
```

To view the current MTU, enter:

```
# ifconfig sfxge<n>
sfxge0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> metric 0 mtu 1500
...
```

If you want to have an MTU configured when the interface is brought up, add an `mtu` parameter to the single line of interface configuration data in the `/etc/rc.conf` file. For example:

```
ifconfig_sfxge<n>="inet <IPv4 address> netmask <netmask> mtu <MTU size>"
```

### 6.6 Setting Up VLANs

VLANs offer a method of dividing one physical network into multiple broadcast domains. In enterprise networks, these broadcast domains usually match with IP subnet boundaries, so that each subnet has its own VLAN. The advantages of VLANs include:

- Performance
- Ease of management
- Security
- Trunks
- You don’t have to configure any hardware device, when physically moving your server to another location.

To have a single interface exist on multiple VLANs (if the port on the connected switch is set to “trunked” mode) see the following documentation:

http://people.freebsd.org/~arved/vlan/vlan_en.html
6.7 FreeBSD Utilities Package

The Solarflare FreeBSD Utilities package is supplied as a source package or a 64 bit binary package, and is available from https://support.solarflare.com/. It contains the following utilities:

<table>
<thead>
<tr>
<th>Utility File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sfupdate</td>
<td>A command line utility that contains an adapter firmware version which can update Solarflare adapter firmware.</td>
</tr>
<tr>
<td>sfboot</td>
<td>A command line utility for configuring Solarflare adapter Boot ROM options, including PXE and UEFI booting.</td>
</tr>
<tr>
<td>sfreport</td>
<td>A command line utility that generates a diagnostic log file providing diagnostic data about the server and Solarflare adapters.</td>
</tr>
</tbody>
</table>

By default, sfboot and sfupdate are installed to /usr/local/sbin, and sfreport is installed to /usr/local/bin.

Building and installing the source package

To build and install the source package:

1. Unpack the source package:
   ```
   tar -xf <source package name>
   ```
2. Go to its directory:
   ```
   cd <source package dir>
   ```
3. Build and install a binary package from the source:
   ```
   make install
   ```
   Alternatively, to build and install in separate steps:
   a) Build a binary package from the source:
      ```
      make package
      ```
   b) Install the resulting binary package:
      ```
      pkg install ./work/pkg/sfutils-<version>.txz
      ```

Installing the 64 bit binary package

1. Install the binary package:
   ```
   pkg install <path to package file>
   ```
6.8 Configuring the Boot ROM with sfboot

- Sfboot: Command Usage on page 294
- Sfboot: Command Line Options on page 294
- Sfboot: Examples on page 300

Sfboot is a command line utility for configuring Solarflare adapter Boot ROM options, including PXE and UEFI booting. Using sfboot is an alternative to using Ctrl + B to access the Boot Rom agent during server startup.

See Solarflare Boot Manager on page 371 for more information on the Boot Rom agent.

Sfboot: Command Usage

The general usage for sfboot is as follows (as root):
```
sfboot [‐‐adapter=sfxge<n>] [options] [parameters]
```

Note that without --adapter, the sfboot command applies to all adapters that are present in the target host.

The format for the parameters are:
```
<parameter>=<value>
```

Sfboot: Command Line Options

Table 70 lists the options for sfboot, Table 71 lists the available global parameters, and Table 72 lists the available per-adapter parameters.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-h, --help</td>
<td>Displays command line syntax and provides a description of each sfboot option.</td>
</tr>
<tr>
<td>-V, --version</td>
<td>Shows detailed version information and exits.</td>
</tr>
<tr>
<td>-v, --verbose</td>
<td>Shows extended output information for the command entered.</td>
</tr>
<tr>
<td>-s, --silent</td>
<td>Suppresses all output, including warnings and errors; no user interaction. You should query the completion code to determine the outcome of commands when operating silently.</td>
</tr>
<tr>
<td>--log &lt;filename&gt;</td>
<td>Logs output to the specified file in the current folder or an existing folder. Specify --silent to suppress simultaneous output to screen, if required.</td>
</tr>
<tr>
<td>--computer &lt;computer_name&gt;</td>
<td>Performs the operation on a specified remote computer. Administrator rights on the remote computer is required.</td>
</tr>
</tbody>
</table>
Table 70: Sfboot Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>--list</td>
<td>Lists all available Solarflare adapters. This option shows the adapter’s ID number, ifname and MAC address.</td>
</tr>
<tr>
<td></td>
<td>Note: this option may not be used in conjunction with any other option. If this option is used with configuration parameters, those parameters will be silently ignored.</td>
</tr>
<tr>
<td>-d, --adapter=&lt;sfxge&lt;n&gt;&gt;</td>
<td>Performs the action on the identified Solarflare network adapter. The adapter identifier sfxge can be the adapter ID number, ifname or MAC address, as output by the --list option. If --adapter is not included, the action will apply to all installed Solarflare adapters.</td>
</tr>
<tr>
<td>--clear</td>
<td>Resets all options to their default values. If an adapter is specified, options for the given adapter are reset, but global options (shown in Table 71) are not reset. Note that --clear can also be used with parameters, allowing you to reset to default values, and then apply the parameters specified.</td>
</tr>
</tbody>
</table>

The following global parameters in Table 71 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

Table 71: Sfboot Global Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>boot-image=all</td>
<td>optionrom</td>
</tr>
<tr>
<td>port-mode=default</td>
<td>1x10G</td>
</tr>
<tr>
<td></td>
<td>• SFN8542: 4x10G, 2x40G (default)</td>
</tr>
<tr>
<td></td>
<td>• SFN8522: 2x10G (default)</td>
</tr>
<tr>
<td></td>
<td>• SFN7xx4F: 2x10G, 4x10G (default)</td>
</tr>
<tr>
<td></td>
<td>• SFN7xx2Q: 2x10G, 4x10G, 2x40G (default)</td>
</tr>
<tr>
<td></td>
<td>• SFN7xx2F: 1x10G, 2x10G (default)</td>
</tr>
<tr>
<td></td>
<td>Changes to this setting with sfbboot require a cold reboot to become effective. MAC address assignments may change after altering this setting.</td>
</tr>
</tbody>
</table>
**Table 71: Sfboot Global Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>firmware-variant=</strong> full-feature</td>
<td>ultra-low-latency</td>
</tr>
<tr>
<td></td>
<td>• the SFN7002F adapter is factory set to full-feature</td>
</tr>
<tr>
<td></td>
<td>• all other adapters are factory set to auto.</td>
</tr>
<tr>
<td></td>
<td><strong>Default value = auto</strong> - means the driver will select a variant that meets its needs:</td>
</tr>
<tr>
<td></td>
<td>• the VMware driver always uses full-feature</td>
</tr>
<tr>
<td></td>
<td>• otherwise, ultra-low-latency is used.</td>
</tr>
<tr>
<td></td>
<td><strong>The ultra-low-latency variant produces best latency without support for TX VLAN insertion or RX VLAN stripping (not currently used features). It is recommended that Onload customers use the ultra-low-latency variant.</strong></td>
</tr>
<tr>
<td><strong>insecure-filters=</strong> enabled</td>
<td>disabled</td>
</tr>
<tr>
<td><strong>mac-spoofing=</strong> enabled</td>
<td>disabled</td>
</tr>
<tr>
<td><strong>rx-dc-size=</strong> 8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>• 16 if the port-mode supports the maximum number of connectors for the adapter.</td>
</tr>
<tr>
<td></td>
<td>• 32 if the port-mode supports a reduced number of connectors.</td>
</tr>
</tbody>
</table>
The following per-adapter parameters in Table 72 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

Table 72: Sfboot Global Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| tx-dc-size=8|16|32|64 | Specifies the size of the descriptor cache for each transmit queue. This is for SFN7000 and SFN8000 series adapters only. The default is: 
• 32 if the port-mode supports the maximum number of connectors for the adapter. 
• 64 if the port-mode supports a reduced number of connectors. |
| vi-count=<vi count> | Sets the total number of virtual interfaces that will be available on the NIC. |
| event-merge-timeout= <timeout in nanoseconds> | Specifies the timeout in nanoseconds for RX event merging. A timeout of 0 means that event merging is disabled. |

The following per-adapter parameters in Table 72 are used to control the configurable parameters for the Boot ROM driver when running prior to the operating system booting.

Table 72: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| link-speed=auto|10g|1g|100m | Specifies the network link speed of the adapter used by the Boot ROM. The default is auto. On the 10GBASE-T adapters, auto instructs the adapter to negotiate the highest speed supported in common with its link partner. On SFP+ adapters, auto instructs the adapter to use the highest link speed supported by the inserted SFP+ module. On 10GBASE-T and SFP+ adapters, any other value specified will fix the link at that speed, regardless of the capabilities of the link partner, which may result in an inability to establish the link. 
auto  Auto-negotiate link speed (default) 
10G  10G bit/sec 
1G  1G bit/sec 
100M  100M bit/sec |
**Table 72: Sfboot Per-adapter Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>linkup-delay=&lt;delay time in seconds&gt;</td>
<td>Specifies the delay (in seconds) the adapter defers its first connection attempt after booting, allowing time for the network to come up following a power failure or other restart. This can be used to wait for spanning tree protocol on a connected switch to unblock the switch port after the physical network link is established. The default is 5 seconds.</td>
</tr>
</tbody>
</table>
| banner-delay=<delay time in seconds> | Specifies the wait period for Ctrl-B to be pressed to enter adapter configuration tool.  
<delay time in seconds> = 0-256 |
| bootskip-delay=<delay time in seconds> | Specifies the time allowed for Esc to be pressed to skip adapter booting.  
<delay time in seconds> = 0-256 |
| boot-type=pxe|uefi|disabled | Sets the adapter boot type – effective on next boot.  
pxe – PXE (Preboot eXecution Environment) booting  
disabled – Disable adapter booting |
| pf-count=<pf count> | This is the number of available PCIe PFs per physical network port. This setting is applied to all ports on the adapter.  
Changes to this setting with sfboot require a cold reboot to become effective. MAC address assignments may change after altering this setting. |
| msix-limit=8|16|32|64|128|256|512|1024 | Specifies the maximum number of MSI-X interrupts that each PF will use. The default is 32.  
Note: Using the incorrect setting can impact the performance of the adapter. Contact Solarflare technical support before changing this setting. |
| sriov=enabled|disabled | Enable SR-IOV support for operating systems that support this. Not required on SFN7000 or SFN8000 series adapters. |
The number of virtual functions (VF) advertised to the operating system for each Physical Function on this physical network port. SFN7000 and SFN8000 series adapters have a total limit of 2048 interrupts. Earlier adapters support a total limit of 127 virtual functions per port and a total of 1024 interrupts.

Depending on the values of msix-limit and vf-msix-limit, some of these virtual functions may not be configured.

Enabling all 127 VFs per port with more than one MSI-X interrupt per VF may not be supported by the host BIOS - in which case you may get 127 VFs on one port and none on others. Contact your BIOS vendor or reduce the VF count.

The sriov parameter is implied if vf-count is greater than zero.

Changes to this setting with sfboot require a cold reboot to become effective.

Table 72: Sfboot Per-adapter Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vf-count=&lt;vf count&gt;</td>
<td>The number of virtual functions (VF) advertised to the operating system for each Physical Function on this physical network port. SFN7000 and SFN8000 series adapters have a total limit of 2048 interrupts. Earlier adapters support a total limit of 127 virtual functions per port and a total of 1024 interrupts. Depending on the values of msix-limit and vf-msix-limit, some of these virtual functions may not be configured. Enabling all 127 VFs per port with more than one MSI-X interrupt per VF may not be supported by the host BIOS - in which case you may get 127 VFs on one port and none on others. Contact your BIOS vendor or reduce the VF count. The sriov parameter is implied if vf-count is greater than zero. Changes to this setting with sfboot require a cold reboot to become effective.</td>
</tr>
<tr>
<td>vf-msix-limit=</td>
<td>The maximum number of interrupts a virtual function may use.</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>pf-vlans=&lt;tag&gt;[,&lt;tag&gt;[,...]]</td>
<td>none</td>
</tr>
<tr>
<td>switch-mode=</td>
<td>Specifies the mode of operation that the port will be used in:</td>
</tr>
<tr>
<td>default</td>
<td>sriov</td>
</tr>
</tbody>
</table>
Sfboot: Examples

- Show the current boot configuration for all adapters:
  
  sfboot

  Solarflare boot configuration utility [v3.0.5]
  Copyright Solarflare Communications 2006-2010, Level 5 Networks 2002-2005

  sfxge0:
  Boot image Disabled
  MSI-X interrupt limit 32

  sfxge1:
  Boot image Disabled
  MSI-X interrupt limit 32

- List all Solarflare adapters installed on the localhost:
  
  sfboot --list

  Solarflare boot configuration utility [v3.0.5]
  Copyright Solarflare Communications 2006-2010, Level 5 Networks 2002-2005
  sfxge0 - 00-0F-53-01-38-40
  sfxge1 - 00-0F-53-01-38-41

6.9 Upgrading Adapter Firmware with sfupdate

To Update Adapter Firmware

Reinstall the sfutils package, as described in FreeBSD Utilities Package on page 293.

Sfupdate: Command Usage

The general usage for sfupdate is as follows (as root):

  sfupdate [--adapter=sfxge<n>] [options]

where:

- sfxge<n> is the interface name of the Solarflare adapter you want to upgrade.
- option is one of the command options listed in Table 73.

The format for the options are:

  --<option>=<parameter>

Running the command sfupdate with no additional parameters will show the current firmware version for all Solarflare adapters and whether the firmware within sfupdate is more up to date. To update the firmware for all Solarflare adapters run the command sfupdate --write

Solarflare recommend that you use sfupdate in the following way:

1. Run sfupdate to check that the firmware on all your adapters are up to date.
2 Run `sfupdate --write` to update the firmware on all adapters.

**Sfupdate: Command Line Options**

Table 73 lists the options for `sfupdate`.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-h, --help</code></td>
<td>Shows help for the available options and command line syntax.</td>
</tr>
<tr>
<td><code>-v, --verbose</code></td>
<td>Enable verbose output mode.</td>
</tr>
<tr>
<td><code>-s, --silent</code></td>
<td>Suppress all output except for errors. Useful for scripts.</td>
</tr>
<tr>
<td><code>-V, --version</code></td>
<td>Display version information and exit.</td>
</tr>
<tr>
<td><code>-i, --adapter=sfxge&lt;n&gt;</code></td>
<td>Specifies the target adapter when more than one adapter is installed in the machine.</td>
</tr>
<tr>
<td></td>
<td><code>sfxge&lt;n&gt;</code> = Adapter ifname or MAC address (as obtained with <code>--list</code>).</td>
</tr>
<tr>
<td><code>--list</code></td>
<td>Shows the adapter ID, adapter name and MAC address of each adapter installed in the machine.</td>
</tr>
<tr>
<td><code>--write</code></td>
<td>Re-writes the firmware from the images embedded in the <code>sfupdate</code> tool.</td>
</tr>
<tr>
<td></td>
<td>To re-write using an external image, specify <code>--image=&lt;filename&gt;</code> in the command.</td>
</tr>
<tr>
<td></td>
<td><code>--write</code> fails if the embedded image is the same or a previous version. To force a write in this case, specify the option <code>--force</code>.</td>
</tr>
<tr>
<td><code>--force</code></td>
<td>Force update of all firmware, even if the installed firmware version is the same or more recent than the images embedded in the utility.</td>
</tr>
<tr>
<td><code>--image=(filename)</code></td>
<td>Update the firmware using the image contained in the specified file, rather than the image embedded in the utility. Use with the <code>--write</code> and, if needed, <code>--force</code> options.</td>
</tr>
<tr>
<td><code>-y, --yes</code></td>
<td>Prompts for user confirmation before re-writing the firmware.</td>
</tr>
</tbody>
</table>

**Sfupdate: Examples**

- Display firmware versions for all adapters:

  ```
  sfupdate
  sfupdate: Solarflare Firmware Update Utility [v3.0.5.2164]
  Copyright Solarflare Communications 2006-2010, Level 5 Networks 2002-2005
  Network adapter driver version: v3.0.5.2163
  sfxge0 - MAC: 00:0F:53:01:38:90
  Firmware version: v3.0.5
  Boot ROM version: v3.0.5.2163
  ```
6.10 Performance Tuning on FreeBSD

- Introduction on page 302
- Tuning settings on page 303
- Other Considerations on page 308

Introduction

The Solarflare family of network adapters are designed for high-performance network applications. The adapter driver is pre-configured with default performance settings that have been designed to give good performance across a broad class of applications. Occasionally, application performance can be improved by tuning these settings to best suit the application.

There are three metrics that should be considered when tuning an adapter:

- Throughput
- Latency
- CPU utilization

Different applications may be more or less affected by improvements in these three metrics. For example, transactional (request-response) network applications can be very sensitive to latency whereas bulk data transfer applications are likely to be more dependent on throughput.

The purpose of this section is to highlight adapter driver settings that affect the performance metrics described. This section covers the tuning of all Solarflare adapters.
Latency will be affected by the type of physical medium used: 10GBase-T, twinaxial (direct-attach), fiber or KX4. This is because the physical media interface chip (PHY) used on the adapter can introduce additional latency. Likewise, latency can also be affected by the type of SFP/SFP+/QSFP module fitted.

In addition, you may need to consider other issues influencing performance, such as application settings, server motherboard chipset, CPU speed, cache size, RAM size, additional software installed on the system, such as a firewall, and the specification and configuration of the LAN. Consideration of such issues is not within the scope of this guide.

**Tuning settings**

**Port mode**

The selected port mode for SFN7000 and SFN8000 series adapters should correspond to the speed and number of connectors in use, after using any splitter cables. If a restricted set of connectors is configured, the driver can then transfer resources from the unused connectors to those configured, potentially improving performance.

**Adapter MTU (Maximum Transmission Unit)**

The default MTU of 1500 bytes ensures that the adapter is compatible with legacy 10/100Mbps Ethernet endpoints. However if a larger MTU is used, adapter throughput and CPU utilization can be improved. CPU utilization is improved, because it takes fewer packets to send and receive the same amount of data. Solarflare adapters support an MTU of up to 9216 bytes (this does not include the Ethernet preamble or frame-CRC).

Since the MTU should ideally be matched across all endpoints in the same LAN (VLAN), and since the LAN switch infrastructure must be able to forward such packets, the decision to deploy a larger than default MTU requires careful consideration. It is recommended that experimentation with MTU be done in a controlled test environment.

The MTU is changed dynamically using ifconfig, where sfxge<n> is the interface name and <size> is the MTU size in bytes:

```
# ifconfig sfxge<n> mtu <size>
```

Verification of the MTU setting may be performed by running ifconfig with no options and checking the MTU value associated with the interface. The change in MTU size can be made to persist across reboots by editing the /etc/rc.conf file and adding an mtu parameter to the single line of interface configuration data. For example:

```
ifconfig_sfxge<n>="inet <IPv4 address> netmask <netmask> mtu <size>"
```
Interrupt Moderation (Interrupt Coalescing)

Interrupt moderation reduces the number of interrupts generated by the adapter by coalescing multiple received packet events and/or transmit completion events together into a single interrupt.

The interrupt moderation interval sets the minimum time (in microseconds) between two consecutive interrupts. Coalescing occurs only during this interval:

- When the driver generates an interrupt, it starts timing the moderation interval.
- Any events that occur before the moderation interval expires are coalesced together into a single interrupt, that is raised only when the interval expires. A new moderation interval then starts, during which no interrupt is raised.
- An event that occurs after the moderation interval has expired gets its own dedicated interrupt, that is raised immediately. A new moderation interval then starts, during which no interrupt is raised.

Interrupt moderation settings are **critical for tuning adapter latency**:

- Increasing the interrupt moderation interval will:
  - generate less interrupts
  - reduce CPU utilization (because there are less interrupts to process)
  - increase latency
  - improve peak throughput.

- Decreasing the interrupt moderation interval will:
  - generate more interrupts
  - increase CPU utilization (because there are more interrupts to process)
  - decrease latency
  - reduce peak throughput.

- Turning off interrupt moderation will:
  - generate the most interrupts
  - give the highest CPU utilization
  - give the lowest latency
  - give the biggest reduction in peak throughput.

For many transaction request-response type network applications, the benefit of reduced latency to overall application performance can be considerable. Such benefits typically outweigh the cost of increased CPU utilization. It is recommended that:

- Interrupt moderation is disabled for applications that require best latency and jitter performance, such as market data handling.
- Interrupt moderation is enabled for high throughput single (or few) connection TCP streaming applications, such as iSCSI.
Interrupt moderation is changed dynamically using `sysctl`. To set the interrupt moderation, where `sfxge<n>` is the interface name, and the `<interval>` is in microseconds (μs):

```bash
sysctl dev.sfxge.<n>.int_mod=<interval>
```

To turn off interrupt moderation, set an interval of zero (0):

```bash
sysctl dev.sfxge.<n>.int_mod=0
```

The change in interrupt moderation can be made to persist across reboots by editing the file `/etc/sysctl.conf` and adding `dev.sfxge.<n>.int_mod=<interval>` on a new line.

**NOTE:** The performance benefits of TCP Large Receive Offload are limited if interrupt moderation is disabled. See TCP Large Receive Offload (LRO) on page 306.

### TCP/IP Checksum Offload

Checksum offload moves calculation and verification of IP Header, TCP and UDP packet checksums to the adapter. The driver has all checksum offload features enabled by default. Therefore, there is no opportunity to improve performance from the default.

Checksum offload is changed dynamically using `ifconfig`, with the following parameters:

- `rxsum, txsum, rxsum6, txsum6`
  Enable Rx and Tx checksum offload for IPv4 and IPv6
- `-rxsum, -txsum, -rxsum6, -txsum6`
  Disable Rx and Tx checksum offload for IPv4 and IPv6

To enable checksum offload, where `sfxge<n>` is the interface name:

```bash
# ifconfig sfxge<n> rxsum txsum rxsum6 txsum6
```

To disable checksum offload:

```bash
# ifconfig sfxge<n> -rxsum -txsum -rxsum6 -txsum6
```

Verification of the checksum offload setting may be performed by running `ifconfig` with no options and checking the checksum offload value associated with the interface. The change in checksum offload can be made to persist across reboots by editing the `/etc/rc.conf` file and adding the appropriate parameters to the single line of interface configuration data. For example:

```bash
ifconfig_sfxge<n>="inet <IPv4 address> netmask <netmask> rxsum txsum rxsum6 txsum6"
```

**NOTE:** Solarflare recommend you do not disable checksum offload.

### TCP Segmentation Offload (TSO)

TCP Segmentation Offload (TSO) offloads the splitting of outgoing TCP data into packets to the adapter. TSO benefits applications using TCP. Applications using protocols other than TCP will not be affected by TSO.
The FreeBSD TCP/IP stack provides a large TCP segment to the driver, which splits the data into MSS size, each with adjusted sequence space and a hardware calculated checksum.

Enabling TSO will reduce CPU utilization on the transmit side of a TCP connection and improve peak throughput, if the CPU is fully utilized. Since TSO has no effect on latency, it can be enabled at all times. The driver has TSO enabled by default. Therefore, there is no opportunity to improve performance from the default.

TSO is changed dynamically using `ifconfig`.
To enable TSO, where `sfxge<n>` is the interface name:

```
# ifconfig sfxge<n> tso
```

To disable TSO:

```
# ifconfig sfxge<n> -tso
```

Verification of the TSO setting may be performed by running `ifconfig` with no options and checking the TSO value associated with the interface. The change in TSO can be made to persist across reboots by editing the `/etc/rc.conf` file and adding the appropriate parameter to the single line of interface configuration data. For example:

```
ifconfig_sfxge<n>="inet <IPv4 address> netmask <netmask> tso"
```

TCP and IP checksum offloads must be enabled for TSO to work.

**NOTE:** Solarflare recommend that you do not disable this setting.

**TCP Large Receive Offload (LRO)**

TCP Large Receive Offload (LRO) is a feature whereby the adapter coalesces multiple packets received on a TCP connection into a single larger packet before passing this onto the network stack for receive processing. This reduces CPU utilization and improves peak throughput when the CPU is fully utilized. The effectiveness of LRO is bounded by the interrupt moderation delay, and is limited if interrupt moderation is disabled (see Interrupt Moderation (Interrupt Coalescing) on page 304). Enabling LRO does not itself negatively impact latency.

The Solarflare network adapter driver enables LRO by default.

LRO is changed dynamically using `ifconfig`.
To enable LRO, where `sfxge<n>` is the interface name:

```
# ifconfig sfxge<n> lro
```

To disable LRO:

```
# ifconfig sfxge<n> -lro
```

Verification of the LRO setting may be performed by running `ifconfig` with no options and checking the LRO value associated with the interface. The change in LRO can be made to persist across reboots by editing the `/etc/rc.conf` file and adding the appropriate parameter to the single line of interface configuration data. For example:
TCP Protocol Tuning

TCP Performance can also be improved by tuning kernel TCP settings. Settings include adjusting send and receive buffer sizes, connection backlog, congestion control, etc.

Initial buffering settings should provide good performance. However for certain applications, tuning buffer settings can significantly benefit throughput. To change buffer settings, adjust the tcp_rmem and tcp_wmem using the `sysctl` command:

- Receive buffering:
  ```bash
  sysctl net.ipv4.tcp_rmem="<min> <default> <max>"
  ```
- Transmit buffering:
  ```bash
  sysctl net.ipv4.tcp_wmem="<min> <default> <max>"
  ```

(tcp_rmem and tcp_wmem can also be adjusted for IPv6 and globally with the `net.ipv6` and `net.core` variable prefixes respectively).

Typically it is sufficient to tune just the max buffer value. It defines the largest size the buffer can grow to. Suggested alternate values are max=500000 (1/2 Mbyte). Factors such as link latency, packet loss and CPU cache size all influence the affect of the max buffer size values. The minimum and default values can be left at their defaults minimum=4096 and default=87380.

See https://wiki.freebsd.org/NetworkPerformanceTuning for more details.

Receive Side Scaling (RSS)

Solarflare adapters support Receive Side Scaling (RSS). RSS enables packet receive-processing to scale with the number of available CPU cores. RSS requires a platform that supports MSI-X interrupts.

When RSS is enabled the controller uses multiple receive queues to deliver incoming packets. The receive queue selected for an incoming packet is chosen to ensure that packets within a TCP stream are all sent to the same receive queue – this ensures that packet-ordering within each stream is maintained. Each receive queue has its own dedicated MSI-X interrupt which ideally should be tied to a dedicated CPU core. This allows the receive side TCP processing to be distributed amongst the available CPU cores, providing a considerable performance advantage over a conventional adapter architecture in which all received packets for a given interface are processed by just one CPU core.

By default the driver enables RSS and configures one RSS Receive queue per CPU core. The number of RSS Receive queues is changed using `kenv` to modify the kernel environment variable `hw.sfxge.<n>.max_rss_channels`. The driver must be reloaded after the change using the `kldload` command.

NOTE: LRO should NOT be enabled when using the host to forward packets from one interface to another. For example, if the host is performing IP routing.
To set `<m>` RSS Receive queues, where `sfxge<n>` is the interface name:

```bash
kenv hw.sfxge.<n>.max_rss_channels=<m>
kldload /boot/modules/sfxge.ko
```

Sometimes, it can be desirable to disable RSS when running single stream applications, since all interface processing may benefit from taking place on a single CPU. To do so, set a single RSS Receive queue:

```bash
kenv hw.sfxge.<n>.max_rss_channels=1
kldload /boot/modules/sfxge.ko
```

The change in RSS Receive queues can be made to persist across reboots by editing the file `/boot/loader.conf` and adding `hw.sfxge.<n>.max_rss_channels=<m>` on a new line.

If no MSI/MSI-X interrupts are available then the driver will fall-back to use a single legacy interrupt. RSS will be unavailable for that port.

**NOTE:** RSS also works for UDP packets. For UDP traffic the Solarflare adapter will select the Receive CPU based on IP source and destination addresses. Solarflare adapters support IPv4 and IPv6 RSS.

**Other Considerations**

**PCI Express Lane Configurations**

The PCI Express (PCIe) interface used to connect the adapter to the server can function at different speeds and widths. This is independent of the physical slot size used to connect the adapter. The possible widths are multiples x1, x2, x4, x8 and x16 lanes of (2.5Gbps for PCIe Gen 1, 5.0 Gbps for PCIe Gen 2 and 8.0Gbps for PCIe Gen 3) in each direction. **Solarflare adapters are designed for x8 or x16 lane operation.**

On some server motherboards, choice of PCIe slot is important. This is because some slots (including those that are physically x8 or x16 lanes) may only electrically support x4 lanes. In x4 lane slots, Solarflare PCIe adapters will continue to operate, but not at full speed. The Solarflare driver will warn if it detects that the adapter is plugged into a PCIe slot which electrically has fewer than x8 lanes.

Solarflare SFN5000 and SFN6000 series adapters require a PCIe Gen 2 x8 slot for optimal operation. Solarflare SFN7000 and SFN8000 series adapters require a PCIe Gen 3 x8 or x16 slot for optimal performance. The Solarflare driver will warn if it detects that the adapter is placed in a sub-optimal slot.

In addition, the latency of communications between the host CPUs, system memory and the Solarflare PCIe adapter may be PCIe slot dependent. Some slots may be “closer” to the CPU, and therefore have lower latency and higher throughput. If possible, install the adapter in a slot which is local to the desired NUMA node.

Please consult your server user guide for more information.
CPU Power Management

The powerd service controls the CPU clock speed dynamically according to current processing demand. For latency sensitive applications, where the application switches between having packets to process and having periods of idle time waiting to receive a packet, dynamic clock speed control may increase packet latency. Solarflare recommend disabling the powerd service if minimum latency is the main consideration.

To stop powerd, type:
/etc/rc.d/powerd stop

To disable powerd across reboots, ensure this setting is present in /etc/rc.conf:
powerd_enable="NO"

Memory bandwidth

Many chipsets use multiple channels to access main system memory. Maximum memory performance is only achieved when the chipset can make use of all channels simultaneously. This should be taken into account when selecting the number of memory modules (DIMMs) to populate in the server. For optimal memory bandwidth in the system, it is likely that:

- all DIMM slots should be populated
- all NUMA nodes should have memory installed.

Please consult the motherboard documentation for details.

Server Motherboard, Server BIOS, Chipset Drivers

Tuning or enabling other system capabilities may further enhance adapter performance. Readers should consult their server user guide. Possible opportunities include tuning PCIe memory controller (PCIe Latency Timer setting available in some BIOS versions).

Tuning Recommendations

The following tables provide recommendations for tuning settings for different applications.

Throughput - Table 74
Latency - Table 75
Forwarding - Table 76
Recommended Throughput Tuning

Table 74 shows recommended tuning settings for throughput:

**Table 74: Throughput Tuning Settings**

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU Size</td>
<td>Configure to maximum supported by network:</td>
</tr>
<tr>
<td></td>
<td><code>ifconfig sfxge&lt;n&gt; mtu &lt;size&gt;</code></td>
</tr>
<tr>
<td>Interrupt moderation</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Segmentation Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Large Receive Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default</td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Application dependent</td>
</tr>
<tr>
<td>Buffer Allocation Method</td>
<td>Leave at default. Some applications may benefit from specific setting.</td>
</tr>
<tr>
<td>PCI Express Lane Configuration</td>
<td>Ensure the adapter is in an x8 slot (2.0 or later), and that current speed (not the supported speed) reads back as “x8 and 5GT/s”, “x8 and 8GT/s”, or “x8 and Unknown”.</td>
</tr>
<tr>
<td>CPU Power Management</td>
<td>Leave enabled</td>
</tr>
<tr>
<td>Memory bandwidth</td>
<td>Ensure memory utilizes all memory channels on system motherboard</td>
</tr>
</tbody>
</table>

Recommended Latency Tuning

Table 75 shows recommended tuning settings for latency:

**Table 75: Latency Tuning Settings**

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU Size</td>
<td>Configure to maximum supported by network:</td>
</tr>
<tr>
<td></td>
<td><code>ifconfig sfxge&lt;n&gt; mtu &lt;size&gt;</code></td>
</tr>
<tr>
<td>Interrupt moderation</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td><code>sysctl dev.sfxge.&lt;n&gt;.int_mod=0</code></td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Segmentation Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
</tbody>
</table>
Table 75: Latency Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP Large Receive Offload</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td><code>ifconfig sfxge&lt;n&gt; -lro</code></td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default, but changing does not impact latency</td>
</tr>
<tr>
<td>Receive Side Scaling</td>
<td>Application dependent</td>
</tr>
<tr>
<td>Buffer Allocation Method</td>
<td>Leave at default. Some applications may benefit from specific setting.</td>
</tr>
<tr>
<td>PCI Express Lane Configuration</td>
<td>Ensure the adapter is in an x8 slot (2.0 or later), and that current speed (not the supported speed) reads back as “x8 and 5GT/s”, or “x8 and 8GT/s”, or “x8 and Unknown”.</td>
</tr>
<tr>
<td>CPU Power Management</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td><code>/etc/rc.d/powerd stop</code></td>
</tr>
<tr>
<td>Memory bandwidth</td>
<td>Ensure memory utilizes all memory channels on system motherboard</td>
</tr>
</tbody>
</table>

**Recommended Forwarding Tuning**

Table 76 shows recommended tuning settings for forwarding:

Table 76: Forwarding Tuning Settings

<table>
<thead>
<tr>
<th>Tuning Parameter</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTU Size</td>
<td>Configure to maximum supported by network:</td>
</tr>
<tr>
<td></td>
<td><code>ifconfig sfxge&lt;n&gt; mtu &lt;size&gt;</code></td>
</tr>
<tr>
<td>Interrupt moderation</td>
<td>Configure an explicit interrupt moderation interval with:</td>
</tr>
<tr>
<td></td>
<td><code>sysctl dev.sfxge.&lt;n&gt;.int_mod=150</code></td>
</tr>
<tr>
<td>TCP/IP Checksum Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Segmentation Offload</td>
<td>Leave at default (Enabled).</td>
</tr>
<tr>
<td>TCP Large Receive Offload</td>
<td>Disable with:</td>
</tr>
<tr>
<td></td>
<td><code>ifconfig sfxge&lt;n&gt; -lro</code></td>
</tr>
<tr>
<td>TCP Protocol Tuning</td>
<td>Leave at default</td>
</tr>
<tr>
<td>Receive Side Scaling (RSS)</td>
<td>Leave at default</td>
</tr>
</tbody>
</table>
6.11 Module Parameters

Table 77 lists the available parameters in the Solarflare FreeBSD driver module:

- all parameters have a hw.sfxge. prefix
- for example, the full name of the parameter shown as rx_ring is hw.sfxge.rx_ring:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Possible Value</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx_ring</td>
<td>Size of Rx and Tx rings (maximum number of descriptors) per queue.</td>
<td>512, 1024, 2048, 4096</td>
<td>1024</td>
</tr>
<tr>
<td></td>
<td>Values used by the driver (default or specified when module is loaded) can be obtained using the same sysctl.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tx_ring</td>
<td>Size of Rx and Tx rings (maximum number of descriptors) per queue.</td>
<td>512, 1024, 2048</td>
<td>1024</td>
</tr>
<tr>
<td></td>
<td>Values used by the driver (default or specified when module is loaded) can be obtained using the same sysctl.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lro.table_size</td>
<td>Size of the LRO hash table. Must be a power of 2.</td>
<td>uint</td>
<td>128</td>
</tr>
<tr>
<td>lro.chain_max</td>
<td>Maximum length of chains in the LRO hash table.</td>
<td>uint</td>
<td>20</td>
</tr>
<tr>
<td>lro.idle_ticks</td>
<td>Time (in jiffies) after which an idle connection's LRO state is discarded.</td>
<td>uint</td>
<td>101</td>
</tr>
</tbody>
</table>
### Table 77: Driver Module Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Possible Value</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lro.slow_start_packets</td>
<td>Number of packets that must pass in-order before starting LRO.</td>
<td>uint</td>
<td>20000</td>
</tr>
<tr>
<td>lro.loss_packets</td>
<td>Number of packets that must pass in-order following loss before restarting LRO.</td>
<td>uint</td>
<td>20</td>
</tr>
<tr>
<td>tx_dpl_get_max</td>
<td>Maximum number of packets queued in the software get-list for a transmit queue.</td>
<td>uint</td>
<td>65536</td>
</tr>
<tr>
<td></td>
<td>The get-list is used to get packets to be put onto the Tx ring. It should be big enough to avoid drops of locally generated TCP packets when many (1000+) streams are running in parallel. Accessing this list requires the transmit queue lock. If a packet is dropped because this limit has been exceeded, the sender gets an ENOBUFS error, and the tx_get_overflow counter grows.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tx_dpl_get_non_tcp_max</td>
<td>Maximum number of non-TCP packets queued in the software get-list for a transmit queue.</td>
<td>uint</td>
<td>1024</td>
</tr>
<tr>
<td></td>
<td>This parameter can restrict utilizing the queue for non-TCP (e.g. UDP) packets, which can easily overflow any queue because there is no back-pressure. If a packet is dropped because this limit has been exceeded, the sender gets an ENOBUFS error, and the tx_get_non_tcp_overflow counter grows.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tx_dpl_put_max</td>
<td>Maximum number of packets queued in the software put-list for a transmit queue.</td>
<td>uint</td>
<td>1024</td>
</tr>
<tr>
<td></td>
<td>The put-list is used to put packets temporarily when the transmit queue lock cannot be obtained. The packets are moved to the get-list as soon as the transmit queue lock is acquired and the queue is served. If a packet is dropped because this limit has been exceeded, the sender gets an ENOBUFS error, and the tx_put_overflow counter grows.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6.12 Kernel and Network Adapter Statistics

The Linux command `sysctl` will display an extensive range of statistics originated from the MAC on the Solarflare network adapter. To display statistics use the following command:

```bash
sysctl dev.sfxge.<n>.stats
```

where `sfxge<n>` is the interface name.

Tables below list the complete output from the `sysctl dev.sfxge.<n>.stats` command. See:

- Table 78 on page 314
- Table 79 on page 317
- Table 80 on page 318.

Per port statistics (Table 80 on page 318) are from the physical adapter port. Other statistics are from the specified PCIe function.

**NOTE:** `sysctl dev.sfxge.<n>.stats` output depends on the features supported by the adapter type.

#### Table 77: Driver Module Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Possible Value</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>tso_fw_assisted</td>
<td>Whether to assist TSO using the firmware. Applicable to SFN7000 and SFN8000 series adapters only.</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>&lt;n&gt;.max_rss_channels</td>
<td>The number of RSS Receive queues for interface sfxge&lt;n&gt;. See Receive Side Scaling (RSS) on page 307. The actual number may be lower due to availability of MSI-X interrupts. There is a maximum of 32 MSI-X interrupts across all network devices. If no value is set (the default), the number is limited only by the number of CPUs and MSI-X interrupts.</td>
<td>unit</td>
<td>—</td>
</tr>
</tbody>
</table>

#### Table 78: Event queue statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ev_all</td>
<td>Total number of events.</td>
</tr>
<tr>
<td>ev_rx</td>
<td>Number of packets received by driver.</td>
</tr>
<tr>
<td>ev_rx_ok</td>
<td>Number of received packets not discarded.</td>
</tr>
</tbody>
</table>
### Table 78: Event queue statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>evRxRecovery</td>
<td>Not supported.</td>
</tr>
<tr>
<td>evRxFrmTrunc</td>
<td>Number of packets truncated because an internal FIFO is full. As a packet is received it is fed by the MAC into a 128K FIFO. If for any reason the PCI interface cannot keep pace and is unable to empty the FIFO at a sufficient rate, the MAC will be unable to feed more of the packet to the FIFO. In this event the MAC will truncate the packet marking it as such, and discard the remainder. The driver on seeing a 'partial' packet which has been truncated will discard it.</td>
</tr>
<tr>
<td>evRxTobeDisc</td>
<td>Number of packets marked by the adapter to be discarded because of one of the following:</td>
</tr>
<tr>
<td></td>
<td>• mismatched unicast address and unicast promiscuous mode is not enabled</td>
</tr>
<tr>
<td></td>
<td>• packet is a pause frame</td>
</tr>
<tr>
<td></td>
<td>• packet has length discrepancy</td>
</tr>
<tr>
<td></td>
<td>• internal FIFO overflow condition</td>
</tr>
<tr>
<td></td>
<td>• length &lt; 60 bytes.</td>
</tr>
<tr>
<td>evRxPauseFrmErr</td>
<td>Number of pause packets received.</td>
</tr>
<tr>
<td>evRxBufOwnerIdErr</td>
<td>Event caused by internal driver error.</td>
</tr>
<tr>
<td>evRxIpv4HdrChksumErr</td>
<td>Number of packets received with IP header checksum error.</td>
</tr>
<tr>
<td>evRxTcpUdpChksumErr</td>
<td>Number of packets received with TCP/UDP checksum error.</td>
</tr>
<tr>
<td>evRxEthCrcErr</td>
<td>Number of packets received whose CRC did not match the internally generated CRC value.</td>
</tr>
<tr>
<td>evRxIpFragErr</td>
<td>Number of IP fragments received (note this is not an error).</td>
</tr>
<tr>
<td>evRxMcastPkt</td>
<td>Number of IP multicast packets received.</td>
</tr>
<tr>
<td>evRxMcastHashMatch</td>
<td>Number of IP multicast packets received which have matched the IP multicast match filter.</td>
</tr>
<tr>
<td>evRxTcpIpv4</td>
<td>Number of TCP/IPv4 packets received.</td>
</tr>
</tbody>
</table>
### Field Description

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ev_rx_tcp_ipv6</td>
<td>Number of TCP/IPv6 packets received.</td>
</tr>
<tr>
<td>ev_rx_udp_ipv4</td>
<td>Number of UDP/IPv4 packets received.</td>
</tr>
<tr>
<td>ev_rx_udp_ipv6</td>
<td>Number of UDP/IPv6 packets received.</td>
</tr>
<tr>
<td>ev_rx_other_ipv4</td>
<td>Number of IPv4 packets received which are not TCP or UDP.</td>
</tr>
<tr>
<td>ev_rx_other_ipv6</td>
<td>Number of IPv6 packets received which are not TCP or UDP.</td>
</tr>
<tr>
<td>ev_rx_non_ip</td>
<td>Number of packets received which are not IP.</td>
</tr>
<tr>
<td>ev_rx_overrun</td>
<td>Number of received packets dropped by receiver because of FIFO overrun.</td>
</tr>
<tr>
<td>ev_tx</td>
<td>Number of transmitted packets.</td>
</tr>
<tr>
<td>ev_tx_wq_ff_full</td>
<td>Number of transmitted packets dropped because of FIFO overrun.</td>
</tr>
<tr>
<td>ev_tx_pkt_err</td>
<td>Number of transmitted packets dropped because of driver error.</td>
</tr>
<tr>
<td>ev_tx_pkt_too_big</td>
<td>Number of transmitted packets dropped because of driver error.</td>
</tr>
<tr>
<td>ev_tx_unexpected</td>
<td>Number of transmitted packets dropped because of driver error.</td>
</tr>
<tr>
<td>ev_global</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_global_phy</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_global_mnt</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_global_rx_recovery</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver_srm_upd_done</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver_tx_descq_fls_done</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver_rx_descq_fls_done</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver_rx_descq_fls_failed</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver_rx_dsc_error</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_driver_tx_dsc_error</td>
<td>Internal driver event.</td>
</tr>
</tbody>
</table>
### Table 78: Event queue statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ev_drv_gen</td>
<td>Internal driver event.</td>
</tr>
<tr>
<td>ev_mcdi_response</td>
<td>Internal driver event.</td>
</tr>
</tbody>
</table>

### Table 79: Driver statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lro_merges</td>
<td>Number of packets absorbed by LRO.</td>
</tr>
<tr>
<td>lro_bursts</td>
<td>Number of bursts spotted by LRO.</td>
</tr>
<tr>
<td>lro_slow_start</td>
<td>Number of packets not merged because connection may be in slow-start.</td>
</tr>
<tr>
<td>lro_misorder</td>
<td>Number of out-of-order packets seen in tracked streams.</td>
</tr>
<tr>
<td>lro_too_many</td>
<td>Incremented when the driver is trying to track too many streams.</td>
</tr>
<tr>
<td>lro_new_stream</td>
<td>Number of distinct streams the driver has tracked.</td>
</tr>
<tr>
<td>lro_drop_idle</td>
<td>Number of streams discarded because they went idle.</td>
</tr>
<tr>
<td>lro_drop_closed</td>
<td>Number of streams that have seen a FIN or RST.</td>
</tr>
<tr>
<td>tso_bursts</td>
<td>Number of times TSO transmit invoked by the kernel.</td>
</tr>
<tr>
<td>tso_packets</td>
<td>Number of packets sent via the TSO transmit path.</td>
</tr>
<tr>
<td>tso_long_headers</td>
<td>Number of packets with headers too long for standard blocks.</td>
</tr>
<tr>
<td>tx_collapses</td>
<td>Number of packets with too many fragments collapsed.</td>
</tr>
<tr>
<td>tx_drops</td>
<td>Number of packets dropped by the driver because of:</td>
</tr>
<tr>
<td></td>
<td>• transmit queue in inappropriate state</td>
</tr>
<tr>
<td></td>
<td>• memory allocation or DMA mapping failures required to handle packet with</td>
</tr>
<tr>
<td></td>
<td>long header by TSO</td>
</tr>
<tr>
<td></td>
<td>• mbuf collapse failure.</td>
</tr>
</tbody>
</table>
Table 79: Driver statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tx_get_overflow</td>
<td>Number of packets early dropped by the driver because of software transmit queue overflow (see hw.sfxge.tx_dpl_get_max and hw.sfxge.tx_dpl_put_max in Table 77 on page 312).</td>
</tr>
<tr>
<td>tx_put_overflow</td>
<td>Number of packets early dropped by the driver because of software transmit queue overflow (see hw.sfxge.tx_dpl_get_max and hw.sfxge.tx_dpl_put_max in Table 77 on page 312).</td>
</tr>
<tr>
<td>tx_get_non_tcp_overflow</td>
<td>Number of non-TCP packets early dropped by the driver because of software transmit queue limit for non-TCP packets (see hw.sfxge.tx_dpl_get_non_tcp_max in Table 77 on page 312).</td>
</tr>
<tr>
<td>tx_netdown_drops</td>
<td>Number of packets early dropped by the driver because of link is down.</td>
</tr>
<tr>
<td>tso_pdrop_too_many</td>
<td>Number of TSO packets partially dropped by the driver because TSO generates too many segments (most likely because of tiny MSS).</td>
</tr>
<tr>
<td>tso_pdrop_no_rsrc</td>
<td>Number of TSO packets partially dropped by the driver because the packet header is too big and requires per-segment memory allocation and DMA mapping which failed.</td>
</tr>
</tbody>
</table>

Table 80: Port statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx_octets</td>
<td>Number of bytes received. Not include collided bytes.</td>
</tr>
<tr>
<td>rx_pkts</td>
<td>Number of packets received.</td>
</tr>
<tr>
<td>rx_unicst_pkts</td>
<td>Number of unicast packets received.</td>
</tr>
<tr>
<td>rx_multicast_pkts</td>
<td>Number of multicast packets received.</td>
</tr>
<tr>
<td>rx_brdcast_pkts</td>
<td>Number of broadcasted packets received.</td>
</tr>
<tr>
<td>rx_pause_pkts</td>
<td>Number of pause frames received with valid pause op_code.</td>
</tr>
</tbody>
</table>
### Table 80: Port statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx_le_64_pkts</td>
<td>Number of packets received where the length is less than or equal to 64 bytes.</td>
</tr>
<tr>
<td>rx_65_to_127_pkts</td>
<td>Number of packets received where the length is between 65 and 127 bytes.</td>
</tr>
<tr>
<td>rx_128_to_255_pkts</td>
<td>Number of packets received where the length is between 128 and 255 bytes.</td>
</tr>
<tr>
<td>rx_256_to_511_pkts</td>
<td>Number of packets received where the length is between 256 and 511 bytes.</td>
</tr>
<tr>
<td>rx_512_to_1023_pkts</td>
<td>Number of packets received where the length is between 512 and 1023 bytes.</td>
</tr>
<tr>
<td>rx_1024_to_15xx_pkts</td>
<td>Number of packets received where the length is between 1024 and 1518 bytes (1522 with VLAN tag).</td>
</tr>
<tr>
<td>rx_ge_15xx_pkts</td>
<td>Number of packets received where the length is between 1518 bytes (1522 with VLAN tag) and 9000 bytes.</td>
</tr>
<tr>
<td>rx_errors</td>
<td>Number of packets received with errors.</td>
</tr>
<tr>
<td>rx_fcs_errors</td>
<td>Number of packets received with FCS errors.</td>
</tr>
<tr>
<td>rx_drop_events</td>
<td>Number of packets dropped by receiver.</td>
</tr>
<tr>
<td>rx_false_carrier_errors</td>
<td>Count of the instances of false carrier detected. False carrier is activity on the receive channel that does not result in a packet receive attempt being made.</td>
</tr>
<tr>
<td>rx_symbol_errors</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_align_errors</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_internal_errors</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_jabber_pkts</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane0_char_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane1_char_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane2_char_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane3_char_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane0_disp_err</td>
<td>Port error condition.</td>
</tr>
</tbody>
</table>
Table 80: Port statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx_lane1_disp_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane2_disp_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_lane3_disp_err</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>rx_match_fault</td>
<td>Number of packets received which did not match any filter.</td>
</tr>
</tbody>
</table>
| rx_nodesc_drop_cnt  | Number of packets dropped by the network adapter because of a lack of RX descriptors in the RX queue. Packets can be dropped by the NIC when there are insufficient RX descriptors in the RX queue to allocate to the packet. This problem occurs if the receive rate is very high and the network adapter receive cycle process has insufficient time between processing to refill the queue with new descriptors. A number of different steps can be tried to resolve this issue:  
  - Disable the irqbalance daemon in the OS  
  - Distribute the traffic load across the available CPU/cores by setting rss_cpus=cores. Refer to Receive Side Scaling section  
  - Increase receive queue size using ethtool. |
| tx_octets           | Number of bytes transmitted.                                                |
| tx_pkts             | Number of packets transmitted.                                              |
| tx_unicst_pkts      | Number of unicast packets transmitted. Includes flow control packets.       |
| tx_multicst_pkts    | Number of multicast packets transmitted.                                    |
| tx_brdcst_pkts      | Number of broadcast packets transmitted.                                    |
| tx_pause_pkts       | Number of pause frames transmitted with valid pause op_code.               |
| tx_le_64_pkts       | Number of frames transmitted where the length is less than or equal to 64 bytes. |
| tx_65_to_127_pkts   | Number of frames transmitted where the length is between 65 and 127 bytes.  |
Table 80: Port statistics

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tx_128_to_255_pkts</td>
<td>Number of frames transmitted where the length is between 128 and 255 bytes</td>
</tr>
<tr>
<td>tx_256_to_511_pkts</td>
<td>Number of frames transmitted where the length is between 256 and 511 bytes</td>
</tr>
<tr>
<td>tx_512_to_1023_pkts</td>
<td>Number of frames transmitted where length is between 512 and 1023 bytes</td>
</tr>
<tr>
<td>tx_1024_to_15xx_pkts</td>
<td>Number of frames transmitted where the length is between 1024 and 1518 bytes (1522 with VLAN tag).</td>
</tr>
<tr>
<td>tx_ge_15xx_pkts</td>
<td>Number of frames transmitted where length is between 1518 bytes (1522 with VLAN tag) and 9000 bytes.</td>
</tr>
<tr>
<td>tx_errors</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>tx_sgl_col_pkts</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>tx_mult_col_pkts</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>tx_ex_col_pkts</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>tx_late_col_pkts</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>tx_def_pkts</td>
<td>Port error condition.</td>
</tr>
<tr>
<td>tx_ex_def_pkts</td>
<td>Port error condition.</td>
</tr>
</tbody>
</table>
Netstat statistics

The Linux command `netstat` also displays some of these statistics. They are periodically updated from the port and driver statistics. See Table 81:

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lpkts</td>
<td>rx_packets</td>
</tr>
<tr>
<td>lerrs</td>
<td>rx_errors</td>
</tr>
<tr>
<td>ldrop</td>
<td>0</td>
</tr>
<tr>
<td>lbytes</td>
<td>rx_octets</td>
</tr>
<tr>
<td>opkts</td>
<td>tx_packets</td>
</tr>
<tr>
<td>oerrs</td>
<td>tx_errors + tx_drops + get_overflow + get_non_tcp_overflow + put_overflow + netdown_drops + tso_pdrop_too_many + tso_pdrop_no_rsrc</td>
</tr>
<tr>
<td>obytes</td>
<td>tx_octets</td>
</tr>
<tr>
<td>coll</td>
<td>tx_sgl_col_pkts + tx_mult_col_pkts + tx_ex_col_pkts + tx_late_col_pkts</td>
</tr>
</tbody>
</table>
7 SR-IOV Virtualization Using KVM

7.1 Introduction

This chapter describes SR-IOV and virtualization using Linux KVM and Solarflare SFN7000 or SFN8000 series adapters.

SR-IOV enabled on Solarflare adapters provides accelerated cut-through performance and is fully compatible with hypervisor based services and management tools. The advanced design of Solarflare SFN7000 and SFN8000 series adapters incorporates a number of features to support SR-IOV. These features can be summarized as follows:

- **PCIe Virtual Functions (VF).**
  A PCIe physical function, PF, can support a configurable number of PCIe virtual functions. In total 240 VFs can be allocated between the PFs. The adapter can also support a total of 2048 MSI-X interrupts.

- **Layer 2 Switching Capability.**
  A layer 2 switch configured in firmware supports the transport of network packets between PCI physical functions (PF), Virtual functions (VF) and the external network. This allows received packets to be replicated across multiple PFs/VFs and allows packets transmitted from one PF to be received on another PF or VF.

![Figure 48: Per Adapter - Configuration Options](image-url)
Supported Platforms

Host
- Red Hat Enterprise Linux 6.5 - 7.0 KVM

Guest VM
- Red Hat Enterprise Linux 5.x, 6.x and 7.x

Acceleration of guest Virtual Machines (VM) running other (non-Linux) operating systems are not currently supported, however other schemes, for example, a KVM direct bridged configuration using the Windows virtio-net driver could be used.

Driver/Firmware

Features described in the chapter require the following (minimum) Solarflare driver and firmware versions.

```
# ethtool -i eth<N>
driver: sfc
version: 4.4.1.1017
firmware-version: 4.4.2.1011
```

The adapter must be using the `full-feature` firmware variant which can be selected using the `sfboot` utility and confirmed with `rx0 tx0` appearing after the version number in the output from ethtool as shown above.

The firmware update utility (`sfupdate`) and boot ROM configuration tool (`sfboot`) are available in the Solarflare Linux Utilities package (SF-107601-LS issue 28 or later).

Platform support - SR-IOV

BIOS

To use SR-IOV modes, SR-IOV must be enabled in the platform BIOS where the actual BIOS setting can differ between machines, but may be identified as SR-IOV, IOMMU or VT-d and VT-x on an Intel platform.

The following links identify Linux Red Hat documentation for SR-IOV BIOS settings.


There may be other BIOS options which should be enabled to support SR-IOV, for example on DELL servers the following BIOS option must also be enabled:

Integrated Devices, SR-IOV Global Enable
Users are advised to consult the server vendor BIOS options documentation.

Kernel Configuration

On an Intel platform, the IOMMU must be explicitly enabled by appending `intel_iommu=on` to the kernel line in the `/boot/grub/grub.conf` file. The equivalent setting on an AMD system is `amd_iommu=on`.

Solarflare recommends that users also enable the `pci=realloc` kernel parameter in the `/boot/grub/grub.conf` file. This allows the kernel to reassign addresses to PCIe apertures (i.e. bridges, ports) in the system when the BIOS does not allow enough PCIe apertures for the maximum number of supported VFs.

KVM - Interrupt Re-Mapping

To use PCIe VF passthrough, the server must support interrupt re-mapping. If the target server does not support interrupt re-mapping it is necessary to set the following option in a user created file e.g. `kvm_iommu_map_guest.conf` in the `/etc/modprobe.d` directory:

[RHEL 6] options kvm allow_unsafe_assigned_interrupts=1
[RHEL 7] options vfio_iommu_type1 allow_unsafe_assigned_interrupts=1

Alternative Routing-ID Interpretation (ARI)

The ARI extension to the PCI Express Base Specification extends the capacity of a PCIe endpoint by increasing the number of accessible functions (PF+VF) from 8, up to 256. Without ARI support - which is a feature of the server hardware and BIOS, a server hosting a virtualized environment will be limited to 8 functions. Solarflare SFN7000 and SFN8000 series adapters can expose up to 16 PFs and 240 VFs per adapter.

Users should consult the appropriate server vendor documentation to ensure that the host server supports ARI.

Supported Adapters

All Solarflare SFN7000 and SFN8000 series adapters fully support SR-IOV. Features described in this chapter are not supported by Solarflare SFN5000 or SFN6000 series adapters which support a limited SR-IOV implementation.

The sfboot utility allows the user to configure:

• The number of PFs exposed to host and/or Virtual Machine (VM).
• The number VFs exposed to host and/or Virtual Machine (VM).
• The number of MSI-X interrupts assigned to each PF or VF.

The Solarflare implementation uses a single driver (sfc.ko) that binds to both PFs and VFs.
sfboot - Configuration Options

Adapter configuration options are set using the sfboot utility v4.5.0 or later from the Solarflare Linux Utilities package (SF-107601-LS issue 28 or later). The firmware variant must be set to full-feature / Virtualization.

# sfboot firmware-variant=full-feature

To check the current adapter configuration run the sfboot command:

# sfboot

Solarflare boot configuration utility [v4.5.0]
Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

eth5:
  Boot image: Option ROM only
  Link speed: Negotiated automatically
  Link-up delay time: 5 seconds
  Banner delay time: 2 seconds
  Boot skip delay time: 5 seconds
  Boot type: Disabled
  Physical Functions per port: 1
  MSI-X interrupt limit: 32
  Number of Virtual Functions: 2
  VF MSI-X interrupt limit: 8
  **Firmware variant**: full feature / virtualization
  Insecure filters: Disabled
  MAC spoofing: Disabled
  VLAN tags: None
  Switch mode: SRIOV

For some configuration option changes using sfboot, the server must be power cycled (power off/power on) before the changes are effective. sfboot will display a warning when this is required.

Table 82 identifies sfboot SR-IOV configurable options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pf-count=&lt;n&gt;</td>
<td>1</td>
<td>Number of PCIe PFs per physical port. MAC address assignments may change, after next reboot, following changes with this option.</td>
</tr>
<tr>
<td>pf-vlans</td>
<td>None</td>
<td>A comma separated list of VLAN tags for each PF. sfboot pf-vlans=0,100,110,120 The first tag is assigned to the first PF, thereafter tags are assigned to PFs in (lowest) MAC address order.</td>
</tr>
</tbody>
</table>
mac-spoofing | disabled | If enabled, non-privileged functions may create unicast filters for MAC addresses that are not associated with themselves. This should be used when using bonded interfaces where a bond slave inherits the bond master hardware address.

msix-limit=<n> | 32 | Number of MSI-X interrupts assigned to each PF. The adapter supports a maximum 2048 interrupts. The specified value for a PF must be a power of 2.

switch-mode=<mode> | default | Specifies the mode of operation that the port will be used in:

default - single PF created, zero VFs created.
sriov - SR-IOV enabled, single PF created, VFs configured with vf-count.
partitioning - PFs configured with pf-count, VFs configured with vf-count. See NIC Partitioning on page 71 for details.
partitioning-with-sriov - SR-IOV enabled, PFs configured with pf-count, VFs configured with vf-count. See NIC Partitioning on page 71 for details.
pfiov - PFIOV enabled, PFs configured with pf-count, VFs not supported. Layer 2 switching between PFS.

vf-count=<n> | 240 | Number of virtual functions per PF.
7.2 SR-IOV

In the simplest of SR-IOV supported configurations each physical port is exposed as a single PF (adapter default) and up to 240 VFs.

The Solarflare net driver (sfc.ko) will detect that PF/VFs are present from the sfboot configuration and automatically configure the virtual adapters and virtual ports as required.

Adapter firmware will also configure the firmware switching functions allowing packets to pass between PF and VFs or from VF to VF.

Table 82: sfboot - SR-IOV options

<table>
<thead>
<tr>
<th>Option</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>vf-msix-limit=&lt;n&gt;</td>
<td>8</td>
<td>Number of MSI-X interrupts per VF. The adapter supports a maximum 2048 interrupts. The specified value for a PF must be a power of 2.</td>
</tr>
<tr>
<td>insecure_filters</td>
<td>disabled</td>
<td>When enabled, a function (PF or VF) can insert filters not qualified by its own permanent MAC address.</td>
</tr>
</tbody>
</table>

Figure 49: SR-IOV - Single PF, Multiple VFs
With no VLAN configuration, the PFs and VFs are in the same Ethernet layer 2 broadcast domain i.e. a packet broadcast from the PF would be received by all VFs. VLAN tags can optionally be assigned to VFs using standard libvirt commands.

The L2 switch supports replication of received/transmitted broadcast packets to all functions.

The L2 switch will replicate received/transmitted multicast packets to all functions that have subscribed.

The MUXER function is a firmware enabled layer2 switching function for transmit and receive traffic.

In the example above there are no virtual machines (VM) created. Network interfaces for the PF and each VF will appear in the host. An sfc NIC driver loaded in the host will identify the PF and each VF as individual network interfaces.

**SR-IOV Configuration**

Ensure SR-IOV and the IOMMU are enabled on the host server kernel command line - Refer to Platform support - SR-IOV on page 324.

1. The example configures 1 PF per port (default), 2 VFs per PF:
   
   ```
   sfboot switch-mode=sriov pf-count=1 vf-count=2
   ```

   Solarflare boot configuration utility [v4.5.0]
   Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

   eth8:
   Boot image: Option ROM only
   Link speed: Negotiated automatically
   Link-up delay time: 5 seconds
   Banner delay time: 2 seconds
   Boot skip delay time: 5 seconds
   Boot type: Disabled

   Physical Functions per port: 1
   MSI-X interrupt limit: 32
   Number of Virtual Functions: 2
   VF MSI-X interrupt limit: 8
   Firmware variant: full feature / virtualization
   Insecure filters: Disabled
   MAC spoofing: Disabled
   VLAN tags: None
   Switch mode: SRIOV

2. Create VFs - see Enabling Virtual Functions on page 345.

3. The server should be cold rebooted following changes using sfboot. Following the reboot, The PF and VFs will be visible in the host using the `ifconfig` command and `lspci` (the output below is from a dual-port adapter. VFs are shown in bold text):

   ```
   # lspci -d 1924:
   03:00.0 Ethernet controller: Solarflare Communications SFC9120 (rev 01)
   03:00.1 Ethernet controller: Solarflare Communications SFC9120 (rev 01)
   ```
03:00.2 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
03:00.3 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
03:00.4 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
03:00.5 Ethernet controller: Solarflare Communications Device 1903 (rev 01)

4 To identify which physical port a given network interface is using:

```bash
# cat /sys/class/net/eth<N>/device/physical_port
```

5 To identify which PF a given VF is associated with use the following command (in this example there are 4 VFs assigned to PF eth4):

```bash
# ip link show
```

```
19: eth4: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc mq state DOWN qlen 1000
link/ether 00:0f:53:21:00:61 brd ff:ff:ff:ff:ff:ff
vf 0 MAC 76:c1:36:0a:be:2b vf 1 MAC 1e:b8:a8:ea:c7:fb
```

MAC addresses beginning 00:0f:53 are Solarflare designated hardware addresses. MAC addresses assigned to VFs in the above example output have been randomly generated by the host. MAC addresses visible to the host will be replaced by libvirt-generated MAC addresses in a VM.

### 7.3 KVM Network Architectures

This section identifies SR-IOV and the Linux KVM virtualization infrastructure configurations to consume adapter port Physical Functions (PF) and Virtual Functions (VF).

- **KVM libvirt Bridged** on page 330
- **KVM Direct Bridged** on page 334
- **KVM Libvirt Direct Passthrough** on page 337
- **KVM Libvirt Network Hostdev** on page 340
- **General Configuration** on page 345
- **Enabling Virtual Functions** on page 345

When migration is not a consideration, Solarflare recommends the network-hostdev configuration for highest throughput and lowest latency performance.

#### KVM libvirt Bridged

The traditional method of configuring networking in KVM virtualized environments uses the para-virtualized (PV) driver, virtio-net, in the virtual machine and the standard Linux bridge in the host.

The bridge emulates a layer 2 learning switch to replicate multicast and broadcast packets in software and supports the transport of network traffic between VMs and the physical port.
This configuration uses standard Linux tools for configuration and needs only a virtualized environment and guest operating system.

Performance (latency/throughput) will not be as good as a network-hostdev configuration because network traffic must pass via the host kernel.

![Figure 50: KVM - libvirt bridged](image)

**KVM libvirt bridged - Configuration**

1. Ensure the Solarflare adapter driver (sfc.ko) is installed on the host.

2. In the host, configure the PF:

   ```bash
   # sfboot switch-mode=default pf-count=1
   ```

   The sfboot settings shown above are the default (shipping state) settings for the SFN7000 series adapter. A cold reboot of the server is only required when changes are made using sfboot.

3. Create virtual machines:

   VMs can be created from the standard Linux virt-manager GUI interface or the equivalent virsh command line tool. As root, run the command virt-manager from a terminal to start the GUI interface. A VM can also be created from an existing VM XML file.

   *The following procedure assumes the VM is created.* The example procedure will create a bridge ‘br1’ and network ‘host-network’ to connect the VM to the Solarflare adapter via the bridge.

4. Define a bridge in `/etc/sysconfig/network-scripts/ifcfg-br1`

   ```bash
   DEVICE=br1
   TYPE=Bridge
   BOOTPROTO=None
   ONBOOT=yes
   DELAY=0
   NM_CONTROLLED=no
   ```
Associate the bridge with the required Solarflare PF (HWADDR) in a config file in 
/etc/sysconfig/network-scripts/ifcfg-eth4 (this example uses eth4):

```bash
DEVICE=eth4
TYPE=Ethernet
HWADDR=00:0f:53:21:00:60
BOOTPROTO=none
ONBOOT=yes
BRIDGE=br1
```

Bring up the bridge:

```
# service network restart
```

The bridge will be visible in the host using the ifconfig command:

```
# ifconfig -a
br1 Link encap:Ethernet  HWaddr 00:0f:53:21:00:60
inet6 addr: fe80::20f:53ff:fe21:60/64 Scope:Link
   UP BROADCAST RUNNING MULTICAST  MTU:1500 Metric:1
   RX packets:170 errors:0 dropped:0 overruns:0 frame:0
   TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
   collisions:0 txqueuelen:0
   RX bytes:55760 (54.4 KiB) TX bytes:468 (468.0 b)
```

Define a network in an XML file i.e. host-network.xml:

```xml
<network>
    <name>host-network</name>
    <forward mode='bridge'/>
    <bridge name='br1'/>
</network>
```

Define and start the network using virsh net-<option> commands:

```
# virsh net-define host-network.xml
Network host-network defined from host-network.xml
# virsh net-start host-network
Network host-network started
# virsh net-autostart host-network
Network host-network marked as autostarted
# virsh net-list --all
```

On the host machine, edit the VM XML file:

```
# virsh edit <vmname>
```

Add the network component to the VM XML file:

```xml
<interface type='network'>
    <source network='host-network'/>
    <model type='virtio'/>
</interface>
```

Restart the VM after editing the XML file.

```
# virsh start <vmname>
```
13 The bridged interface is visible in the VM when viewed from the GUI Virtual Machine Manager:

![Image of Virtual Machine Manager showing the network/bridged interface]

**Figure 51: Virtual Machine Manager - Showing the network/bridged interface**

**XML Description**

The following extract is from the VM XML file after the configuration procedure has been applied (line numbers have been added for ease of description):

1. `<interface type='bridge'>`
2. `<mac address='52:54:00:96:0a:8a'/>
3. `<source bridge='br1'/>`
4. `<model type='virtio'/>`
5. `<address type='pci' domain='0x0000' bus='0x00' slot='0x07' function='0x0'/>`
6. `</interface>`

1. Interface type must be specified by the user as ‘bridge’.
2. The MAC address. If not specified by the user this will be automatically assigned a random MAC address by libvirt.
3. The source bridge as created in configuration step 4 above.
4. Model type must be specified by the user as ‘virtio’.
5. The PF PCIe address (as known by the guest) will be added automatically by libvirt.

For further information about the direct bridged configuration and XML formats, refer to the following links: [http://libvirt.org/formatdomain.html#elementsNICSBridge](http://libvirt.org/formatdomain.html#elementsNICSBridge)
KVM Direct Bridged

In this configuration multiple macvtap interfaces are bound over the same PF. For each VM created, libvirt will automatically instantiate a macvtap driver instance and the macvtap interfaces will be visible on the host.

Where the KVM libvirt bridged configuration uses the standard Linux bridge, a direct bridged configuration bypasses this providing an internal bridging function and increasing performance.

When using macvtap there is no link state propagation to the guest which is unable to identify if a physical link is up or down.

Macvtap does not currently forward multicast joins from the guests to the underlying network driver with the result that all multicast traffic received by the physical port is forwarded to all guests. Due to this limitation this configuration is not recommended for deployments that use a non-trivial amount of multicast traffic.

Guest migration is fully supported as there is no physical hardware state in the VM guests. A guest can be migrated to a host using a different VF or a host without an SR-IOV capable adapter.

![Diagram of KVM Direct Bridged Configuration]

Figure 52: KVM - direct bridged
KVM direct Bridged - Configuration

1. Ensure the Solarflare adapter driver (sfc.ko) is installed on the host.

2. In the host, configure the PF.
   
   ```bash
   # sfboot switch-mode=default pf-count=1
   ```

   The sfboot settings shown above are the default (shipping state) settings for the SFN7000 series adapter. A cold reboot of the server is only required when changes are made using sfboot.

3. Create virtual machines:

   VMs can be created from the standard Linux virt-manager GUI interface or the equivalent virsh command line tool. As root, run the command virt-manager from a terminal to start the GUI interface. A VM can also be created from an existing VM XML file.

   The following procedure assumes the VM is created. The example procedure will create an interface configuration file and connect the VM directly to the Solarflare adapter.

4. Create a configuration file for the required Solarflare PF (HWADDR) in a config file in /etc/sysconfig/network-scripts/ifcfg-eth4 (this example uses eth4):

   ```
   DEVICE=eth4
   TYPE=Ethernet
   HWADDR=00:0F:53:21:00:60
   BOOTPROTO=none
   ONBOOT=yes
   ```

5. Bring up the interface:

   ```bash
   # service network restart
   ```

6. On the host machine, edit the VM XML file:

   ```bash
   # virsh edit <vmname>
   ```

7. Add the interface component to the VM XML file:

   ```xml
   <interface type='direct'>
     <source dev='eth4' mode='bridge'/>
     <model type='virtio'/>
   </interface>
   ```

8. Restart the VM after editing the XML file.

   ```bash
   # virsh start <vmname>
   ```

9. The bridged interface is visible when viewed from the GUI Virtual Machine Manager:
XML Description

The following extract is from the VM XML file after the configuration procedure has been applied (line numbers have been added for ease of description):

```xml
1. <interface type='direct'>
2.   <mac address='52:54:00:db:ab:ca'/>
3.   <source dev='eth4' mode='bridge'/>
4.   <model type='virtio'/>
5.   <address type='pci' domain='0x0000' bus='0x00' slot='0x07' function='0x0'/>
6. </interface>
```

1. Interface type must be specified by the user as ‘direct’.
2. The MAC address. If not specified by the user this will be automatically assigned a random MAC address by libvirt.
3. The source dev is the interface identifier from the host - added by the user. The user should also specify the mode which must be ‘bridge’.
4. If not specified by the user, the model type will be automatically assigned by libvirt when the guest is started. Use virtio for best performance.
5. The PF PCIe address (as known by the guest) will be added automatically by libvirt

For further information about the direct bridged configuration and XML formats, refer to the following link:

http://libvirt.org/formatdomain.html#elementsNICSBridge
KVM Libvirt Direct Passthrough

Using a libvirt direct-passthrough configuration, VFs are used in the host OS to provide network acceleration for guest VMs. The guest continues to use a paravirtualized driver and is unaware this is backed with a VF from the network adapter.

Figure 54: SR-IOV VFs used in the host OS

- The Solarflare net driver is bound over the top of each VF.
- Each macvtap interface is implicitly created by libvirt over a single VF network interface and is not visible to the host OS.
- Each macvtap instance builds over a different network interface - so there is no implicit macvtap bridge.
- Macvtap does not currently forward multicast joins from the guests to the underlying network driver with the result that all multicast traffic received by the physical port is forwarded to all guests. Due to this limitation this configuration is not recommended for deployments that use a non-trivial amount of multicast traffic.
- Guest migration is fully supported as there is no physical hardware state in the VM guests. A guest can be reconfigured to a host using a different VF or a host without an SR-IOV capable adapter.
- The MAC address from the VF is passed through to the para-virtualized driver.
• Because there is no VF present in a VM, Onload and other Solarflare applications such as SolarCapture cannot be used in the VM.

KVM Libvirt Direct Passthrough - Configuration

1. Ensure the Solarflare adapter driver (sfc.ko) is installed on the host.
2. In the host, configure the switch-mode, PF and VFs:
   
   ```
   # sfboot switch-mode=sriov pf-count=1 vf-count=4
   ```
   
   A cold reboot of the server is required when changes are made using sfboot.
3. Create VFs in the host (example uses PF eth4):
   
   ```
   echo 2 > /sys/class/net/eth4/device/sriov_numvfs
   cat /sys/class/net/eth4/device/sriov_totalvfs
   ```
   
   For Linux versions earlier than RHEL6.5 see Enabling Virtual Functions on page 345.
4. PFs and VFs will be visible using the lspci command (VFs in **bold**):
   
   ```
   # lspci -D -d1924:
   0000:03:00.0 Ethernet controller: Solarflare Communications SFC9120
   0000:03:00.1 Ethernet controller: Solarflare Communications SFC9120
   0000:03:00.2 Ethernet controller: Solarflare Communications Device 1903
   0000:03:00.3 Ethernet controller: Solarflare Communications Device 1903
   0000:03:00.4 Ethernet controller: Solarflare Communications Device 1903
   0000:03:00.5 Ethernet controller: Solarflare Communications Device 1903
   ```

   VFs will also be listed using the ifconfig command (abbreviated output below, from a dual port adapter, shows 2 x PF and 4 x VF, (pf-count=1 vf-count=2). VFs are shown in **bold**).

   ```
   eth4 Link encap:Ethernet HWaddr 00:0F:53:21:00:60
   eth5 Link encap:Ethernet HWaddr 00:0F:53:21:00:61
   eth7 Link encap:Ethernet HWaddr 86:B4:C8:9E:27:D6
   eth8 Link encap:Ethernet HWaddr 72:0B:C7:21:E1:59
   eth9 Link encap:Ethernet HWaddr D2:B7:68:54:35:A5
   ```

5. Create virtual machines:

   VMs can be created from the standard Linux virt-manager GUI interface or the equivalent virsh command line tool. As root, run the command virt-manager from a terminal to start the GUI interface. A VM can also be created from an existing VM XML file.

   The following procedure assumes the VM is created. The example procedure will create an interface configuration file for each VF to be passed through to the VM.

6. For each VF to be passed through to a VM, create a configuration file in the `/etc/sysconfig/network-scripts` directory i.e. `ifcfg-eth6`:

   ```
   DEVICE=eth6
   TYPE=Ethernet
   BOOTPROTO=none
   ONBOOT=yes
   ```
The above example is the file ifcfg-eth6 and identifies the MAC address assigned to the VF. One file is required for each VF.

7 On the host machine, edit the VM XML file:
   # virsh edit <vmname>

8 Add the interface component to the VM XML file e.g:
   <interface type='direct'>
     <source dev='eth6' mode='passthrough'/>
     <model type='virtio'/>
   </interface>

One interface type component is required for each VF.

9 Restart the VM after editing the XML file.
   # virsh start <vmname>

The passed through VF interface is visible when viewed from the GUI Virtual Machine Manager.

![Virtual Machine Manager - Showing the passthrough interface](image)

**XML Description**

The following (example) extract is from the VM XML file after aVF has been passed through to the guest using the procedure above (line numbers have been added for ease of description):

1. <interface type='direct'>
2. <mac address='52:54:00:96:40:28'/>
3. <source dev='eth6' mode='passthrough'/>
4. <model type='virtio'/>
5. <address type='pci' domain='0x0000' bus='0x00' slot='0x07' function='0x0'/>
1. A description of how the VF interface is managed - added by the user.
2. The MAC address. If not specified by the user this will be automatically assigned a random MAC address by the guest OS. The user can specify a MAC address when editing the XML file.
3. The source dev is the VF interface identifier - added by the user. The user should also specify the mode which must be ‘passthrough’.
4. If not specified by the user, the model type will be automatically assigned by libvirt when the guest is started.
5. The VF PCIe address (as known by the guest) will be added automatically by libvirt.

For further information about the direct passthrough configuration and XML formats, refer to the following link: http://libvirt.org/formatdomain.html#elementsNICSDirect

**KVM Libvirt Network Hostdev**

Network Hostdev exposes VFs directly into guest VMs allowing the data path to fully bypass the host OS and therefore provides maximum acceleration for network traffic.

![Diagram of KVM Libvirt Network Hostdev](image)

**Figure 56: SR-IOV VFs passed to guests**

- The hostdev configuration delivers the highest throughput and lowest latency performance. Because the guest is directly linked to the virtual function therefore directly connected to the underlying hardware.
• Migration is not supported in this configuration because the VM has knowledge of the network adapter hardware (VF) present in the server.
• The VF is visible in the guest. This allows applications using the VF interface to be accelerated using OpenOnload or to use other Solarflare applications such as SolarCapture.
• The Solarflare net driver (sfc.ko) needs to be installed in the guest.

KVM Libvirt network hostdev - Configuration
1 Create the VM from the Linux virt-manager GUI interface or the virsh command line tool.
2 Install Solarflare network driver (sfc.ko) in the guest and host.
3 Create the required number of VFs:
   # sfboot switch-mode=sriov vf-count=4
   A cold reboot of the server is required for this to be effective.
4 For the selected PF - configure the required number of VFs e.g:
   # echo 4 > /sys/class/net/eth8/device/sriov_numvfs
5 VFs will now be visible in the host - use ifconfig and the lscpi command to identify the Ethernet interfaces and PCIe addresses (VFs shown below in bold text):
   # lscpi -D -d1924:
   0000:03:00.0 Ethernet controller: Solarflare Communications SFC9120 (rev 01)
   0000:03:00.1 Ethernet controller: Solarflare Communications SFC9120 (rev 01)
   0000:03:00.2 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
   0000:03:00.3 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
   0000:03:00.4 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
   0000:03:00.5 Ethernet controller: Solarflare Communications Device 1903 (rev 01)
6 Using the PCIe address, unbind the VFs to be passed through to the guest from the host sfc driver e.g.:
   # echo 0000:03:00.5 > /sys/bus/pci/devices/0000\:03\:00.5/driver/unbind
7 Check that the required VF interface is no longer visible in the host using ifconfig.
8 On the host, stop the virtual machine:
   # virsh shutdown <vmname>
9 On the host, edit the virtual machine XML file:
   # virsh edit <vmname>
10 For each VF that is to be passed to the guest, add the following <interface type> section to the file identifying the VF PCIe address (use lscpi to identify PCIe address):
   <interface type='hostdev' managed='yes'>
     <source>
     <address type='pci' domain='0x0000' bus='0x03' slot='0x00' function='0x5'/>
     </source>
   </interface>
Restart the virtual machine in the host and VF interfaces will be visible in the guest:

```
# virsh start <vmname>
```

The following (example) extract is from the VM XML file after a VF has been passed through to the guest using the procedure above (line numbers have been added for ease of description):

```xml
1. <interface type='hostdev' managed='yes'>
2.  <mac address='52:54:00:d1:ec:85'/>
3.  <source>
4.  <alias name='hostdev0'/>
5.  <address type='pci' domain='0x0000' bus='0x00' slot='0x07' function='0x0'/>
</interface>
```

**XML Description**

1. A description of how the VF interface is managed - added by user.
   When `managed=yes`, the VF is detached from the host before being passed to the guest and the VF will be automatically reattached to the host after the guest exits.
   If `managed=no`, the user must call `virNodeDeviceDetach` (or use the command `virsh nodetev-detach`) before starting the guest or hot-plugging the device and call `virNodeDeviceReAttach` (or use command `virsh nodetev-reattach`) after hot-unplug or after stopping the guest.

2. The VF MAC address. If not specified by the user this will be automatically assigned a random MAC address by libvirt The user can specify a MAC address when editing the XML file.

3. The VF PCIe address, this is the address of the VF interface as it is identified in the host. This should be entered by the user when editing the XML file.

4. If not specified by the user the alias name will be automatically assigned by libvirt The user can supply an alias when editing the XML file.

5. The VF PCIe address (as known by the guest) will be added automatically by libvirt.

For further information about the hostdev configuration and XML formats, refer to the following link:

[http://libvirt.org/formatdomain.html#elementsNICSHostdev](http://libvirt.org/formatdomain.html#elementsNICSHostdev)
7.4 PF-IOV

Physical Function I/O Virtualization allows PFs to be passed to a VM. Although this configuration is not widely used, it is included here for completeness. This mode provides no advantage over “Network Hostdev” and therefore Solarflare recommends that customers deploy “Network hostdev instead of PF-IOV. PF-IOV does not use SR-IOV and does not require SR-IOV hardware support.

Each physical port is partitioned into a number of PFs with each PF passed to a different Virtual Machine (VM). Each VM supports a TCP/IP stack and Solarflare adapter driver (sfc.ko).

This mode allows switching between PFs via the Layer 2 switch function configured in firmware.

Figure 57: PFIOV

- Up to 16 PFs and 16 MAC addresses are supported per adapter.
- With no VLAN configuration, all PFs are in the same Ethernet layer 2 broadcast domain i.e. a packet broadcast from any one PF would be received by all other PFs.
- PF VLAN tags can optionally be assigned when creating PFs using the sfboot utility.
- The layer 2 switch supports replication of received/transmitted broadcast packets to all PFs and to the external network.
- The layer 2 switch supports replication of received/transmitted multicast packets to all subscribers.
- VFs are not supported in this mode.
PF-IOV Configuration

The sfboot utility from the Solarflare Linux Utilities package (SF-107601-LS) is used to partition physical interfaces to the required number of PFs.

- Up to 16 PFs and 16 MAC addresses are supported per PFs.
- The PF setting applies to all physical ports. Ports cannot be configured individually.
- vf-count must be zero.

1. To partition all ports (example configures 4 PFs per port):

   ```bash
   # sfboot switch-mode=pfiov pf-count=4
   ```

   Solarflare boot configuration utility [v4.3.1]
   Copyright Solarflare Communications 2006-2014, Level 5 Networks 2002-2005

   eth5:
   - Boot image: Option ROM only
   - Link speed: Negotiated automatically
   - Link-up delay time: 5 seconds
   - Banner delay time: 2 seconds
   - Boot skip delay time: 5 seconds
   - Boot type: Disabled
   - Physical Functions per port: 4
   - MSI-X interrupt limit: 32
   - Number of Virtual Functions: 0
   - VF MSI-X interrupt limit: 8
   - Firmware variant: full feature / virtualization
   - Insecure filters: Disabled
   - VLAN tags: None
   - Switch mode: PFIOV

2. A reboot of the server is required for the changes to be effective.

3. Following reboot the PFs will be visible using the ifconfig or ip commands - each PF will have a unique MAC address. The lspci command will also identify the PFs:

   ```bash
   # lspci -d 1924:
   07:00.0 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.1 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.2 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.3 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.4 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.5 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.6 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   07:00.7 Ethernet controller: Solarflare Communications Device 0903 (rev 01)
   ```
7.5 General Configuration

Enabling Physical Functions

Use the sfboot utility from the Solarflare Linux Utilities package to create PFs. Up to 16 PF and 16 MAC addresses are supported per adapter.

```
sfboot pf-count=<N>
```

PF VLAN tags can also be assigned using sfboot.

```
sfboot pf-count=4, pf-vlan=100,110,200,210
```

The first VLAN tag is assigned to the first function, thereafter the tags are applied to PFs in MAC address order.

Enabling Virtual Functions

On RHEL6.5 and later versions, VF creation is controlled through sysfs. Use the following commands (example) to create and view created VFs.

```
echo 2 > /sys/class/net/eth8/device/sriov_numvfs
cat /sys/class/net/eth8/device/sriov_totalvfs
```

On kernels not having this control via sysfs the Solarflare net driver module option `max_vfs` can be used to enable VFs. The `max_vfs` value applies to all adapters and can be set to a single integer i.e. all adapter physical functions will have the same number of VFs, or can be set to a comma separated list to have different numbers of VFs per PF.

The driver module parameter should be enabled in a user-created file (e.g. `sfc.conf`) in the `/etc/modprobe.d` directory and the sfc driver must be reloaded following changes.

```
options sfc max_vfs=4
options sfc max_vfs=2,4,8
```

When specified as a comma separated list, the first VF count is assigned to the PF with the lowest index i.e. the lowest MAC address, then the PF with the next highest MAC address etc. If the sfc driver option is used to create VFs, reload the driver:

```
modprobe -r sfc
modprobe sfc
```

VLAN tags can be dynamically assigned to VFs using `libvirt` commands, or using the `ip` command:

```
ip link vf NUM [mac LLADDR] [vlan VLANID]
```

To ensure VLAN tags persist after reboot, these can be configured in the VM XML file.
Using OpenOnload in a Virtual Machine

Onload users should refer to the Onload User Guide (SF-104474-CD) for further information about using Onload in a KVM.

When Onload and the sfc net driver have been installed in the guest, the sfc driver module option num_vis is used to allocate the required number of virtual interfaces. One VI is needed for each Onload stack using a VF.

Driver module options should be enabled in a user created file (e.g. sfc.conf) in the /etc/modprobe.d directory.

options sfc num_vis=<num>

Reload the driver after setting/changing this value:

# onload_tool reload

7.6 Feature Summary

Table 83: Feature Summary

<table>
<thead>
<tr>
<th>Default</th>
<th>SRIOV</th>
<th>Partitioning</th>
<th>Partitioning + SRIOV</th>
<th>PFIOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of PFs (per adapter)</td>
<td>num ports</td>
<td>num ports</td>
<td>≥num ports ≤16</td>
<td>≥num ports ≤16</td>
</tr>
<tr>
<td>All PFs (per port) must be on unique VLANS</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Num VFs (per adapter)</td>
<td>0</td>
<td>&gt;0, ≤240</td>
<td>0</td>
<td>&gt;0, ≤240</td>
</tr>
<tr>
<td>Mode suitable for PF PCIe passthrough</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Mode suitable for VF PCIe passthrough</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>sfboot settings</td>
<td>switch-mode=default</td>
<td>switch-mode=sriov</td>
<td>switch-mode=partitioning</td>
<td>switch-mode=partitioning-with-sriov</td>
</tr>
<tr>
<td>pf-count=1</td>
<td>pf-count=1</td>
<td>pf-count&gt;1</td>
<td>pf-count&gt;1</td>
<td>pf-count&gt;1</td>
</tr>
<tr>
<td>vf-count=0</td>
<td>vf-count&gt;0</td>
<td>vf-count=0</td>
<td>vf-count&gt;0</td>
<td>vf-count=0</td>
</tr>
<tr>
<td>L2 switching between PF and associated VFs</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>L2 switching between PFs on the same physical port</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
7.7 Limitations

Users are advised to refer to the Solarflare net driver release notes for details of all limitations.

**Per Port Configuration**

For initial releases, all PFs on a physical port have the same expansion ROM configuration where PXE/UEFI settings are stored. This means that all PFs will PXE boot or none will attempt to PXE boot. Users should ensure that a DHCP server responds to the first MAC address.

The PF (pf-count) configuration is a global setting and applies to all physical ports on an adapter. It is not currently possible to configure ports individually.

**PTP**

PTP can only run on the primary physical function of each physical port and is not supported on VF interfaces.
8 SR-IOV Virtualization Using ESXi

This chapter includes procedures for installation and configuration of Solarflare adapters for SR-IOV and Virtualization deployment using VMware® ESXi. For details of installation and configuration on VMware® platforms refer to Solarflare Adapters on VMware on page 261.

8.1 Introduction

This chapter describes SR-IOV and DirectPath I/O using the VMware ESXi hypervisor and Solarflare SFN7000 and SFN8000 series adapters.

SR-IOV enabled on Solarflare adapters provides accelerated cut-through performance and is compatible with hypervisor based services and management tools. The advanced design of Solarflare SFN7000 and SFN8000 series adapters incorporates a number of specific features when deploying the adapter into virtualized environments.

- PCIe Physical Functions (PF)
  By partitioning the NIC, each physical network port can be exposed to the host as up to 16 PCIe Physical Functions (PF) with each having a unique interface name and unique MAC address.

- PCIe Virtual Functions (VF)
  A PCIe physical function, PF, can support a configurable number of PCIe virtual functions. In total 240 VFs can be allocated between the PFs. The adapter can also support a total of 2048 MSI-X interrupts.

![Figure 58: Per Adapter - Configuration Options](image-url)
Features Supported

On ESXi Solarflare adapters support the following deployments:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Guest OS</th>
</tr>
</thead>
<tbody>
<tr>
<td>VF Passthrough</td>
<td>Linux 6.5 to 7.x</td>
</tr>
<tr>
<td>PF Passthrough (DirectPath I/O)</td>
<td>Linux 6.5 to 7.x</td>
</tr>
<tr>
<td></td>
<td>Windows Server 2012 R2</td>
</tr>
</tbody>
</table>

Recommended Reading

The instructions in this chapter follow the procedures for VF and PF passthrough as documented in the VMware Networking User Guide for ESXi 5.5.

Platform Compatibility

SR-IOV and DirectPath I/O are not supported on all server platforms and users are advised to check server compatibility.

DirectPath I/O - PF Passthrough does not require platform SR-IOV support.

- Check for SR-IOV support in the VMware compatibility web page: http://www.vmware.com/resources/compatibility/search.php
- Ensure the BIOS has all SR-IOV/Virtualization options enabled.
- On a server with SR-IOV correctly configured, identify if Virtual Functions (VF) can be exposed to the host OS. Refer to sfboot options below for the procedure to configure VFs on the Solarflare adapter.

BIOS

To use SR-IOV modes, SR-IOV must be enabled in the platform BIOS where the actual BIOS setting can differ between machines, but may be identified as SR-IOV, IOMMU or VT-d and VT-x on an Intel platform.

There may be other BIOS options which should be enabled to support SR-IOV, for example on DELL servers the following BIOS option must also be enabled:

Integrated Devices, SR-IOV Global Enable

Users are advised to consult the server vendor BIOS options documentation.
Supported Platform OS

Host

- VMware ESXi 5.5 and 6.0
- Solarflare v4.7 (or later) net drivers

Guest VM

- Red Hat Enterprise Linux 6.5 to 7.x
- Windows Server 2012 R2
- Solarflare v4.5 (or later) net drivers

Acceleration of Virtual Machines (VM) running guest operating systems not listed above are not currently supported.

Supported Adapters

All Solarflare SFN7000 and SFN8000 series adapters fully support SR-IOV. Features described in this chapter are not supported by Solarflare SFN5000 or SFN6000 series adapters.

Solarflare Driver/Firmware

Features described in the chapter require the following (minimum) Solarflare driver and firmware versions.

```
# ethtool -i vmnic<N>
driver: sfc
version: 4.7.0.1031
firmware-version: 4.7.0.1020 rx0 tx0
```

The adapter must be using the full-feature firmware variant which can be selected using the sfboot utility and confirmed with `rx0 tx0` appearing after the version number in the output from ethtool as shown above.

The firmware update utility (sfupdate) and boot ROM configuration tool (sfboot) are available in the Solarflare Linux Utilities package (SF-107601-LS issue 36 or later).
8.2 Configuration Procedure - SR-IOV

Use the following procedure to configure the adapter and server for SR-IOV.

- Install the Solarflare Driver on the ESXi host on page 351
- Install Solarflare Utilities on the ESXi host on page 352
- Install Solarflare Drivers in the Guest on page 351
- Configure VFs on the Host/Adapter on page 354
- Virtual Machine on page 355
- vSwitch and Port Group Configuration on page 357
- VF Passthrough on page 361

8.3 Configuration Procedure - DirectPath I/O

Use the following procedure to configure the adapter and server for PF passthrough.

- Install the Solarflare Driver on the ESXi host on page 351
- Install Solarflare Utilities on the ESXi host on page 352
- Install Solarflare Drivers in the Guest on page 351
- Partition the Adapter on page 367
- Virtual Machine on page 355
- Make PF Passthrough Devices available to the Guest on page 368
- Assign PF Passthrough Devices to the VM on page 369
- Listing Devices in a Windows Guest on page 370

8.4 Install Solarflare Drivers in the Guest

For both VF and PF passthrough configurations, the Solarflare adapter driver must be installed in the virtual machine guest OS.

Drivers are available from the Solarflare download site for Linux and Windows guests: https://support.solarflare.com/.

Driver installation procedures on a guest are the same as installation for a host.

8.5 Install the Solarflare Driver on the ESXi host

Solarflare VMware ESXi drivers are available from: https://support.solarflare.com/.

Refer to Installing Solarflare Drivers and Utilities on VMware on page 263 for instructions to install VIB driver packages through the CLI.
8.6 Install Solarflare Utilities on the ESXi host

Solarflare utilities - including sfboot, sfupdate and sfkey are distributed in the Solarflare Linux Utilities package (SF-107601-LS issue 36 or later) from:

https://support.solarflare.com/.

Refer to Solarflare Utilities Package on page 267 for instructions to install the utilities on the ESXi host server.

**NOTE:** The Solarflare driver must be installed before using sfboot or any of the utilities.

**sfboot - Configuration Options**

The sfboot utility allows the user to configure:

- The number of PFs exposed per port to host and/or Virtual Machine (VM).
- The number VFs exposed per port to host and/or Virtual Machine (VM).
- The number of MSI-X interrupts assigned to each PF or VF.
- Firmware Variant and switch mode.

To check the current adapter configuration run the sfboot command:

```
# sfboot
```

Solarflare boot configuration utility [v4.7.0]
Copyright Solarflare Communications 2006-2015, Level 5 Networks 2002-2005

vmnic6:
- Boot image: Disabled
- Physical Functions on this port: 1
- PF MSI-X interrupt limit: 32
- Virtual Functions on each PF: 4
- VF MSI-X interrupt limit: 16
- Port mode: 2x10G
- Firmware variant: Full feature / virtualization
- Insecure filters: Enabled
- MAC spoofing: Disabled
- VLAN tags: None
- Switch mode: SR-IOV
- RX descriptor cache size: 32
- TX descriptor cache size: 16
- Total number of VIs: 2048
- Rate limits: None
- Event merge timeout: 8740 nanoseconds

An alternative bootable ISO image of the Solarflare Utilities is available from the Solarflare download site under Downloads > Linux > Misc.
Firmware Variant

The firmware variant must be set to full-feature / virtualization.

```
# sfboot --adapter=vmnic6 firmware-variant=full-feature
```

SR-IOV (VF Passthrough) sfboot Settings

The following example creates 4 VFs for each physical port.

```
# sfboot switch-mode=sriov pf-count=1 vf-count=4
```

When used without the --adapter option, the command applies to all adapters.

DirectPath I/O (PF Passthrough) sfboot Settings

The following example partitions the NIC so that each physical port is exposed as 4 PCIe PFs.

```
# sfboot switch-mode=partitioning pf-count=4 vf-count=0
```

*For some configuration option changes using sfboot, the server must be power cycled (power off/power on) before the changes are effective. sfboot will display a warning when this is required.*
8.7 Configure VFs on the Host/Adapter

The following host procedure is used to expose VFs from the Solarflare adapter.

1. Set the sfc driver module parameter for the required number of VFs:
   ```
esxcli system module parameters set -m sfc -p max_vfs=4
esxcli system module parameters list -m sfc
   ```

2. Use sfboot to create VFs on the adapter:
   ```
sfboot switch-mode=sriov vf-count=4
   ```
   The server must be restarted (power off/power on) for these changes to take effect.

3. Following restart - list VFs exposed in the host:
   ```
   # lspci | grep Solarflare
   0000:04:00.0 Network controller: Solarflare SFC9120 [vmnic6]
   0000:04:00.1 Network controller: Solarflare SFC9120 [vmnic7]
   0000:04:00.2 Network controller: Solarflare [PF_0.4.0_VF_0]
   0000:04:00.3 Network controller: Solarflare [PF_0.4.0_VF_1]
   0000:04:00.4 Network controller: Solarflare [PF_0.4.0_VF_2]
   0000:04:00.5 Network controller: Solarflare [PF_0.4.0_VF_3]
   0000:04:00.6 Network controller: Solarflare [PF_0.4.1_VF_0]
   0000:04:00.7 Network controller: Solarflare [PF_0.4.1_VF_1]
   0000:04:01.0 Network controller: Solarflare [PF_0.4.1_VF_2]
   0000:04:01.1 Network controller: Solarflare [PF_0.4.1_VF_3]
   ```
   The example above is a dual-port adapter. Each physical port is exposed as 1 PF and 4 VFs (PFs are shown in bold text).
8.8 Virtual Machine

The procedures in the Chapter assume the VM has already been created. Users should consult the VMware documentation to create the VM. The recommended method is to use the VMware vSphere Web Client:

The VM must be compatible with version 10 (or later).

VM Compatibility

The VM must be compatible with ESXi 5.5 (or later). When the VM is not compatible, the following procedure via the vSphere Web Client will upgrade compatibility:

- Locate the VM from the listed hosts in the Web Client.
- Right click the VM > Edit Settings
- Under the Virtual Hardware tab > Upgrade
- Check the “Schedule VM Compatibility Upgrade” check box
- Select ESXi 5.5 and later from the drop down list
- Click OK to close the dialog
- Shutdown and restart the guest

After the VM has been shutdown and restarted, the compatibility will be displayed under the Settings tab:

![VM Hardware](image)

- CPU: 1 CPU(s), 0 MHz used
- Memory: 2048 MB, 0 MB used
- Hard disk 1: 10.00 GB
- Network adapter 1: VM Network (disconnected)
- CD/DVD drive 1: Power on VM to connect
- Floppy drive 1: Power on VM to connect
- Video card: 8.00 MB
- Other: Additional Hardware
- Compatibility: ESXi 5.5 and later (VM version 10) (upgrade succeeded)
8.9 List Adapters - Web Client

To list available adapters.

Navigate to the Host > Networking > Physical Adapters

<table>
<thead>
<tr>
<th>Device</th>
<th>SR-IOV Status</th>
<th>Number of VFs</th>
<th>Switch</th>
<th>Actual Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>vmnic2</td>
<td>Not supported</td>
<td>--</td>
<td>--</td>
<td>Down</td>
</tr>
<tr>
<td>vmnic3</td>
<td>Not supported</td>
<td>--</td>
<td>--</td>
<td>Down</td>
</tr>
</tbody>
</table>

Solarflare SFC9120

<table>
<thead>
<tr>
<th>Device</th>
<th>SR-IOV Status</th>
<th>Number of VFs</th>
<th>Switch</th>
<th>Actual Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>vmnic6</td>
<td>Enabled</td>
<td>8 (4 currently available)</td>
<td>vSwitch1</td>
<td>10000 Mb</td>
</tr>
<tr>
<td>vmnic7</td>
<td>Disabled</td>
<td>--</td>
<td>--</td>
<td>10000 Mb</td>
</tr>
</tbody>
</table>

Selecting an adapter and clicking the edit (pencil) icon allows adapter settings to be edited.
8.10 vSwitch and Port Group Configuration

Using the vSphere Web Client, navigate to the host.

Right click and select All vCenter Actions > Add Networking to display the Add Networking wizard.

Select Virtual Machine Port Group for a Standard Switch, click Next.

In Select target device - select an existing standard switch or create a new switch, click Next.
When creating a new standard switch, click the + icon under Assigned adapters.

Select the required physical adapter(s) which, as uplinks, will connect the vswitch with a network.
Label the portgroup and assign a network label and VLAN ID if required. VFs will later be assigned to the same portgroup and will be able to send/receive traffic through the uplink adapter(s).

Review settings and click Finish to complete.
The vSwitch and associated uplink adapter(s) topology can be viewed as follows:
Select the host > Manage tab > Networking > Virtual switches
8.11 VF Passthrough

The following procedure uses the VMware vSphere Web Client to configure SR-IOV VF passthrough.

The procedure is documented in the VMware Networking User Guide for ESXi 5.5.

Assumptions

The procedure assumes the following tasks are complete:

• A VM has been created and the guest OS installed.
• A Solarflare SFN7000 or SFN8000 series adapter is physically installed on the host.
• The Solarflare VMware net driver package is installed on the host.
• A Solarflare net driver is installed in the VM.
• The Solarflare adapter exposes VFs to the host OS.
• On the host a vswitch has been created and the PF(s) from the Solarflare adapter are selected as uplinks.

Enable SR-IOV on the Host Adapter

1. In the vSphere Web Client, navigate to the host.
2. Select the Manage tab > Networking > Physical Adapters to list all available host adapters.
3. Select the required Solarflare adapter, then select the pencil (edit) icon.

<table>
<thead>
<tr>
<th>Physical adapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Solarflare SFC9120</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Solarflare SFC9140</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
4 From the adapter **Edit Settings** dialog enable SRIOV and specify the number of VFs which can be used by the VM.

![Image of Edit Settings dialog]

**NOTE:** The number of virtual functions should not exceed the value set by the max-vfs Solarflare driver option.

5 **The host must be restarted following adapter settings changes.** Select and right click the host in the Web Client window for reboot options.
Assign a VF as a SR-IOV Passthrough adapter to the VM

1. In the vSphere Web Client, navigate to the VM.
2. Power OFF the VM.
3. Select the Manage tab > Settings > VM Hardware, then click the Edit button to display the VM - Edit Settings window.

4. To add a VF, select Network from the New device drop down list and click the Add button.

5. Expand the New Network section:

6. Connect the VM to a port group identifying the network the VF is to connect to. If there is no uplink associated with the portgroup, VFs attached to the same portgroup can sent between themselves, but not to any network.
7 Select Adapter Type as **SR-IOV passthrough**.
8 Select the physical adapter associated with the port group and which will back the passthrough virtual machine adapter. ESXi will select an unused VF associated with this adapter.
9 From the Edit Settings window, expand the Memory section and check the Reserve all guest memory (All locked) check box.
Reserving all memory is required for both SR-IOV and DirectPath configurations because the adapter PF/VF must be able to DMA to the guest memory which needs to be present in physical RAM.

10 From the Edit Settings window, click the OK button to close.
With the VM selected, click the **Manage** tab and the **VM Hardware** option to view hardware configuration. The Solarflare adapter PF and VF are listed in this window.

### Listing Passthrough Devices in a Linux Guest

When the VM has been restarted the passed through VF devices are visible in the Linux guest using both `lspci` and the `ifconfig` commands.

```
[root@localhost ~]# lspci | grep Solarflare
0b:00.0 Ethernet controller: Solarflare Communications Device 1983
13:00.0 Ethernet controller: Solarflare Communications Device 1983
[root@localhost ~]#`
```
8.12 DirectPath I/O

DirectPath I/O allows a VM access to PF on platforms having an IOMMU. Platform support for SR-IOV is not required.

Solarflare SFN7000 and SFN8000 series adapters can be partitioned into multiple PCIe PFs, supporting up to 16 PCIe physical functions.

For details of NIC Partitioning see NIC Partitioning on page 71.

Partition the Adapter

The Solarflare NIC can be partitioned to expose up to 16 PFs using the sfboot command from the ESXi host command line interface:

```
# sfboot --adapter=vmnic6 vf-count=0 pf-count=4 switch-mode=partitioning
```

**The server must be cold-power cycled.** When the server restarts, PFs will be visible in the host:

```
# lspci -vvv | grep Solarflare

0000:07:00.0 Ethernet controller Network controller: Solarflare SFC9148 [vmnic8]
0000:07:00.1 Ethernet controller Network controller: Solarflare SFC9148 [vmnic9]
0000:07:00.2 Ethernet controller Network controller: Solarflare SFC9148 [vmnic4]
0000:07:00.3 Ethernet controller Network controller: Solarflare SFC9148 [vmnic5]
0000:07:00.4 Ethernet controller Network controller: Solarflare SFC9148 [vmnic10]
0000:07:00.5 Ethernet controller Network controller: Solarflare SFC9148 [vmnic11]
0000:07:00.6 Ethernet controller Network controller: Solarflare SFC9148 [vmnic12]
0000:07:00.7 Ethernet controller Network controller: Solarflare SFC9148 [vmnic13]
```

In the above example a dual-port adapter is partitioned to expose 4 PFs per physical port.
Make PF Passthrough Devices available to the Guest

This procedure uses the vSphere Web Client and follows the procedure from the vmware documentation for DirectPath I/O:

**VMware Networking User Guide for ESXi 5.5**

1. Navigate to the host. Select the **Manage** tab > **Settings** option.
2. Under the **Hardware** section, select **PCI Devices**.

3. Right click any device listed and select **Edit** from the pop-up menu. Or click the edit (pencil) icon.
4. From the **All PCI Devices** window, tick the check-box of the required PF devices:
CAUTION: The Primary PF from each physical port cannot be passed through to a guest. PF0, having configuration privileges, is used by the sfc driver in the hypervisor and should not be passed to a VM.

NOTE: When selecting new devices these will be marked as “Available (pending)”. The host must be restarted to effect the changes.

Assign PF Passthrough Devices to the VM

1. Locate and select the VM in the vSphere Web Client.
2. Power OFF the VM.
3. Select the Manage tab, select Settings then VM Hardware, then click the Edit button to open the VM Edit Settings window.
4. Select the Virtual Hardware tab and then the Memory option:

   ![VM Settings](image)

   For the Memory option, set the Limit to “Unlimited”.

5. Next, select PCI Device from the New device drop-down list, then click the Add button.

6. Select the required Solarflare PF device to be passed through.
8 Repeat - selecting **New Device** then **Add** for each PF to be passed through.
9 Click the **OK** button when done.
10 Power ON the VM.

**Listing Devices in a Windows Guest**

Start the Solarflare Adapter Manager GUI by selecting **Start > select arrow icon >** from the desktop and select the **Configure adapters on this PC**.

This will start SAM, after a refresh, Selected PFs will be visible as Solarflare adapters.
9 Solarflare Boot Manager

9.1 Introduction

Solarflare adapters support the following Preboot Execution Environment (PXE) options enabling diskless systems to boot from a remote target operating system:

- Solarflare Boot Manager (based on gPXE) - the default PXE client installed on all Solarflare adapters.
- UEFI network boot.
- iPXE - supported on Solarflare XtremeScale™ SFN8000 (and later series) adapters.

The Solarflare Boot Manager complies with the PXE 2.1 specification.

Boot Manager Exposed

Solarflare adapters are shipped with boot ROM support ‘exposed’, that is the Boot Manager runs during the machine bootup stage allowing the user to enter the setup screens (via Ctrl+B) and enable PXE support when this is required.

The Boot Manager can also be invoked using the Solarflare supplied sfboot utility. For instructions on the sfboot method refer to the sfboot commands in the relevant OS specific sections of this user guide.

Using the sfboot utility, the boot-image options identify which boot images are exposed on the adapter during boot time. The boot-image=uefi option allows the Solarflare UEFI driver to be loaded by the UEFI platform which can be configured to PXE boot from the Solarflare adapter.

The boot-type options allows the user to select PXE boot or to disable PXE boot. This is effective on the next reboot.

**NOTE:** If network booting is not required, startup time can be decreased when the boot-image option is ‘disabled’ so that the CTRL-B option is not exposed during system startup.

PXE Enabled

Some Solarflare distributors are able to ship Solarflare adapters with PXE boot enabled. Customers should contact their distributor for further information.

Solarflare SFN8000 series adapters are shipped with the PXE boot enabled and set to PXE boot.
NOTE: PXE, UEFI network boot is not supported for Solarflare adapters on IBM System p servers.

Firmware Upgrade - Recommended

Before configuring the Solarflare Boot Manager, it is recommended that servers are running the latest adapter firmware which can be updated as follows:

- From a Windows environment use the supplied Command Line Tool sfupdate.exe. See Sfupdate: Firmware Update Tool on page 195 for more details.
- From a Linux or VMware environment update the firmware via sfupdate. See OS specific sections of this document for sfupdate commands.

This section covers the following subjects.

- Solarflare Boot Manager on page 372
- iPXE Support on page 373
- sfupdate Options for PXE upgrade/downgrade on page 373
- Starting PXE Boot on page 375
- iPXE Image Create on page 379
- Multiple PF - PXE Boot on page 381

9.2 Solarflare Boot Manager

The standard Solarflare Boot Manager, based on gPXE, is supported on all Solarflare adapters.

The boot ROM agent, pre-programmed into the adapter’s flash image, runs during the machine bootup stage and, if enabled, supports PXE booting the server.

The Boot Manager can be configured using its embedded setup screens (entered via Ctrl+B during system boot) or via the Solarflare-supplied sfboot utility.

The boot ROM agent firmware version can be upgraded using the Solarflare-supplied sfupdate utility. Refer to the OS specific sections of this document for details of sfupdate commands.

The use of the Solarflare Boot Manager is fully supported by Solarflare (including meeting any SLA agreements in place for prioritised and out-of-hours support).
9.3 iPXÉ Support

iPXÉ boot is supported on Solarflare XtremeScale™ SFN8000 series (and later adapters).

An iPXÉ boot image can be programmed into the adapter’s flash via the Solarflare-supplied sfupdate utility.

iPXÉ is an alternative open-source network boot firmware providing both PXE support and additional features such as HTTP and iSCSI boot. Solarflare have integrated, maintain and support iPXÉ drivers for the SFN8000 series adapters in the iPXÉ open source code base.

Users can use iPXÉ features not provided within the gPXÉ based Solarflare Boot ROM agent. However, iPXÉ is an open source project with its own development and test process not under the direct control of the Solarflare engineering team. Solarflare will monitor the iPXÉ development mailing lists and participate to ensure the iPXÉ driver for Solarflare adapters operates correctly.

**NOTE:** It is recommended that customers having support questions on the iPXÉ feature set work directly with the iPXÉ open source community.

9.4 sfupdate Options for PXE upgrade/downgrade

This section describes sfupdate when used to install/upgrade/downgrade PXE images. Refer to sfupdate in OS specific sections of this document for a complete list of sfupdate options.

Each version of sfupdate contains a firmware image and Solarflare Boot Manager image.

**Current Versions**

Run the sfupdate command to identify current image versions:

```bash
enp5s0f0 - MAC: 00-0F-53-41-C7-00sf
Firmware version: v6.3.0
Controller type: Solarflare SFC9200 family
Controller version: v6.2.5.1000
Boot ROM version: v5.0.3.1002
UEFI ROM version: v2.4.3.1
```

When an iPXÉ image has been flashed over the Solarflare Boot Manager:

```bash
enp5s0f0 - MAC: 00-0F-53-41-C7-00
Controller type: Solarflare SFC9200 family
Controller version: v6.2.5.1000
Boot ROM version: iPXÉ
UEFI ROM version: v2.4.3.1
```
NOTE: sfupdate is not able to display version numbers for iPXE images.

**sfupdate - Solarflare Boot Manager image**

- To install the firmware image and Solarflare, gPXE based, Boot Manager image:

  ```
  # sfupdate [--adapter=] --write [--force] [--backup]
  ```

- To reinstall firmware and Solarflare Boot Manager image from sfupdate:

  ```
  # sfupdate [--adapter=] --write --restore-bootrom
  ```

- To reinstall only a Solarflare Boot Manager image from backup:

  ```
  # sfupdate [--adapter=] --write --img=<image.dat>
  ```

  Use the `--force` option when downgrading. Use the `--backup` option to create a backup image (.dat) file of the current firmware and Solarflare Boot Manager image.

**sfupdate - iPXE image**

- To install the iPXE image, but keep current firmware:

  ```
  # sfupdate [--adapter=] --write [--backup] --ipxe-image=<image.mrom>
  ```

  Use the `--backup` option to create a backup of the existing firmware and PXE boot ROM image.

- To upgrade firmware and retain the iPXE image:

  ```
  # sfupdate [--adapter=] --write [--force]
  ```

  Using the `--force` option allows firmware to be downgraded but keeps the current iPXE image.

**CAUTION:** sfupdate does not do version checking for iPXE therefore it is possible to downgrade the image without any displayed warning and without using the `--force` option.
9.5 Starting PXE Boot

The Boot Manager can be configured using any of the following methods:

• On server startup, press **Ctrl+B** when prompted during the boot sequence. This starts the Solarflare Boot Manager GUI.

• From a Windows Environment, you can:
  - Use SAM. See Using SAM for Boot ROM Configuration on page 178.
  - Use the supplied `sfboot` command line tool. See Sfboot: Boot ROM Configuration Tool on page 187.

• From a Linux environment, you can use the `sfboot` utility. See Configuring the Boot Manager with sfboot on page 85.

• From a VMware environment, you can use the `sfboot` utility. See Solarflare Utilities Package on page 267.

`sfboot` is a command line utility program from the Solarflare Linux Utilities RPM package (SF-107601-LS) available from support@solarflare.com.

PXE requires DHCP and TFTP Servers, the configuration of these servers depends on the deployment service used.

**Linux**

See Unattended Installation - Red Hat Enterprise Linux on page 65 and Unattended Installation - SUSE Linux Enterprise Server on page 67 for more details of unattended installation on Linux.
Configuring the Boot Manager for PXE

This section describes configuring the adapter via the Ctrl+B option during server startup.

**NOTE:** If the BIOS supports console redirection, and you enable it, then Solarflare recommends that you enable ANSI terminal emulation on both the BIOS and your terminal. Some BIOSs are known to not render the Solarflare Boot Manager properly when using vt100 terminal emulation.

1. On starting or re-starting the server, press Ctrl+B when prompted. The Solarflare Boot Manager is displayed.

```
Solarflare Boot Manager (v5.0.3.1000)
Select Adapter
Base MAC address  PCI    Boot image
: 00-0f-53-21-9b-b8  04:00.0  OptionROM
: 00-0f-53-41-c7-00  06:00.0  OptionROM & UEFI

Controller: Solarflare Flareon Ultra 8000 Series 100 Adapter
```

The initial Select Adapter page lists the available adapters. In the above example, that are two adapters, on PCI bus 04 and PCI bus 05.

2. Use the arrow keys to highlight the adapter you want to boot via PXE and press Enter. The Adapter Menu is displayed.

```
Solarflare Boot Manager (v5.0.3.1000)
Adapter Menu
> Global adapter options 9
Reset to Defaults 3
FF MAC  PCI   Boot type  Link speed
00-0f-53-41-c7-00  05:00.0  PXE  Auto
10-0f-53-41-c7-01  06:00.1  PXE  Auto
```

---

1. On starting or re-starting the server, press Ctrl+B when prompted. The Solarflare Boot Manager is displayed.

```
Solarflare Boot Manager (v5.0.3.1000)
Select Adapter
Base MAC address  PCI    Boot image
: 00-0f-53-21-9b-b8  04:00.0  OptionROM
: 00-0f-53-41-c7-00  06:00.0  OptionROM & UEFI

Controller: Solarflare Flareon Ultra 8000 Series 100 Adapter
```

The initial Select Adapter page lists the available adapters. In the above example, that are two adapters, on PCI bus 04 and PCI bus 05.

2. Use the arrow keys to highlight the adapter you want to boot via PXE and press Enter. The Adapter Menu is displayed.

```
Solarflare Boot Manager (v5.0.3.1000)
Adapter Menu
> Global adapter options 9
Reset to Defaults 3
FF MAC  PCI   Boot type  Link speed
00-0f-53-41-c7-00  05:00.0  PXE  Auto
10-0f-53-41-c7-01  06:00.1  PXE  Auto
```

---
3. Use the arrow keys to highlight the **Global adapter Options** and press **Enter**. The **Global Adapter Options** menu is displayed.

4. Select the required boot image:
   
   **a)** Use the arrow keys to highlight the **Boot Image**.
   
   **b)** Use the space bar to choose the required image.
   
   **c)** Press the **Esc** key to exit the **Global Adapter Options**.
   
   The **Adapter Menu** is again displayed.

5. Use the arrow keys to highlight the PF you want to boot via PXE and press **Enter**.

The **PF Options** menu is displayed.
6 Set the PF to use PXE boot:

   ![Solarflare Boot Manager Screenshot](image)

   a) Use the arrow keys to highlight the **Boot Type**.
   b) Use the space bar to select **PXE**.

   Solarflare recommend leaving other settings at their default values. For details on the default values for the various adapter settings, see Table 9.8 on page 384.

7 Press the Esc key repeatedly until the Solarflare Boot Manager exits.

8 Choose **Save Changes and exit**.
9.6 iPXE Image Create

Solarflare do not provide pre-built iPXE images.

The Solarflare iPXE boot ROM image can be generated from the rom-o-matic iPXE web builder wizard available from:

https://rom-o-matic.eu/

1 Select the Advanced option:

2 Select an Output format:
3 Enter NIC Details:

**Generating iPXE build image version 17887**

This wizard will guide you through the customized iPXE image generation.
- Standard, for most common use
- Advanced, for experienced users

**Choose an output format:**

Help me choose
- ROM binary (flashable) for larger ROM images (.mrom)

**Enter NIC device details:**

You have chosen Binary ROM image as your output format. To match the image to your NIC device, please enter its PCI VENDOR CODE and PCI DEVICE CODE.

Information on how to determine NIC PCl OIDs:

<table>
<thead>
<tr>
<th>PCI VENDOR CODE</th>
<th>1924</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI DEVICE CODE</td>
<td>0a03</td>
</tr>
</tbody>
</table>

iPXE does not support all possible PCI IDs for supported NICs.

**Embedded script:**

Read about embedded scripts

Paste your script

Or import your script

Or drop your script:

Drop your script here

**Which revision?**

Read about GIT revision

Default master (recommended) master

**Ready to build?**

| Proceed >> | Save buildcfg |

- **a)** Enter the Solarflare PCI vendor identifier: 1924.
- **b)** Enter the SFN8000 PCI Device Code: 0a03
- **c)** Select the GIT version (master is recommended).

4 Generate the image file.

Click the Proceed button to start image generation then download the created image file to the target server.

5 Apply the image to the Solarflare adapter using sfupdate:

```
# sfupdate [--adapter=] --write --ipxe-image=<filename.mrom>
```
9.7 Multiple PF - PXE Boot

Using the sfboot command line utility v4.5.0 (or later version) it is possible to PXE boot when multiple Physical Functions have been enabled. The primary function on each port (PF0/PF1) is a privileged function and can be selected for configuration. Other PFs inherit from their privileged function- so, for example, with two physical ports and 2 PFs per port:

- PF0 and PF2 will have the same boot-type
- PF1 and PF3 will have the same boot-type

Configuration of non-privileged functions is not currently supported.

In the following example 2 PFs (and 2 VFs) are enabled for each physical interface.

# sfboot
Solarflare boot configuration utility [v4.5.0]

eth2:
  Boot image: Option ROM only
  Link speed: Negotiated automatically
  Link-up delay time: 5 seconds
  Banner delay time: 2 seconds
  Boot skip delay time: 5 seconds
  Boot type: Disabled
  Physical Functions per port: 2
  MSI-X interrupt limit: 32
  Number of Virtual Functions: 2
  VF MSI-X interrupt limit: 8
  Firmware variant: full feature / virtualization
  Insecure filters: Disabled
  MAC spoofing: Disabled
  VLAN tags: 100,110
  Switch mode: Partitioning with SRIOV

eth3:
  Boot image: Option ROM only
  Link speed: Negotiated automatically
  Link-up delay time: 5 seconds
  Banner delay time: 2 seconds
  Boot skip delay time: 5 seconds
  Boot type: Disabled
  Physical Functions per port: 2
  MSI-X interrupt limit: 32
  Number of Virtual Functions: 2
  VF MSI-X interrupt limit: 8
  Firmware variant: full feature / virtualization
  Insecure filters: Disabled
  MAC spoofing: Disabled
  VLAN tags: 100,110
Switch mode

Partitioning with SRIOV

eth4:
Interface-specific boot options are not available. Adapter-wide options are available via eth2 (00-0F-53-25-39-90).

eth5:
Interface-specific boot options are not available. Adapter-wide options are available via eth2 (00-0F-53-25-39-90).

Using the Boot Manager

When multiple Physical Functions have been enabled, the Solarflare Boot Manager GUI utility (CTRL-B) will list them:

![Solarflare Boot Manager GUI](image)

**Figure 59: Boot Manager lists multiple PFs**
However, the settings for each PF are read-only, and the only supported action is to **Flash LEDs** on the port being used.

![Solarflare Boot Manager](image)

**Figure 60: Read-only settings for multiple PFs**

### Recovery from incorrect settings

Certain settings must be correct for successful PXE booting, such as:

- port mode
- VLAN tagging.

If these settings become incorrect, for example because a server is moved to a different part of the network. PXE booting will then fail.

To correct these settings, you must use the Solarflare Boot Manager GUI utility. (You cannot use the `sfboot` command line utility, because there is no OS to host it.) This is possible only in single Physical Function mode.

If multiple Physical Functions have been enabled, the incorrect settings are read-only. In such cases, you must reset the adapter to its default settings (see Default Adapter Settings on page 384). This returns the adapter to a single Physical Function mode, and removes all VLAN tags. You can then use the Boot Manager to make the settings that you require.
9.8 Default Adapter Settings

Resetting an adapter does not change the boot ROM image. To reset an adapter to its default settings:

1. Start or re-start the server and when prompted, press Ctrl+B. The Solarflare Boot Manager is displayed.

2. Use the arrow keys to highlight the adapter you want to restore and press Enter. The Adapter Menu is displayed.
3 Use the arrow keys to highlight **Reset to Defaults** and press Enter. The **Reset to Defaults** confirmation is displayed.

![Solarflare Boot Manager]

4 Use the arrow keys to highlight **OK** and press Enter. The settings are reset to the defaults.

**NOTE:** Under Windows, you can also reset the settings by clicking **Default** from SAM.

Table 9.8 lists the various adapter settings and their default values.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boot Image</td>
<td>OptionROM &amp; UEFI</td>
</tr>
<tr>
<td>Link speed</td>
<td>Auto</td>
</tr>
<tr>
<td>Link up delay</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Banner delay</td>
<td>2 seconds</td>
</tr>
<tr>
<td>Boot skip delay</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Boot Type</td>
<td>PXE</td>
</tr>
<tr>
<td>Initiator DHCP</td>
<td></td>
</tr>
<tr>
<td>Initiator-IQN-DHCP</td>
<td></td>
</tr>
<tr>
<td>LUN busy retry count</td>
<td></td>
</tr>
<tr>
<td>Target-DHCP</td>
<td></td>
</tr>
<tr>
<td>TCP port</td>
<td></td>
</tr>
<tr>
<td>Boot LUN</td>
<td></td>
</tr>
</tbody>
</table>
### Table 85: Default Adapter Settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DHCP Vendor</td>
<td></td>
</tr>
<tr>
<td>MPIO attempts</td>
<td></td>
</tr>
<tr>
<td>MSIX Limit</td>
<td>32</td>
</tr>
</tbody>
</table>
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