USER GUIDE

SNFv5.3.2.11 User Guide

Version 5.3.2.11

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aria CYBERSECURITY SOLUTIONS

ARIA Cybersecurity Solutions, which includes ARIA SDS, Myricom network adapters, and nVoy security appliances, are designed and manufactured by the High Performance Products Division of CSP Inc.

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PREFACE

The SNFv5.3.2.11 User Guide describes the run-time SNFv5.3.2.11 software package for the CSPi - Myricom ARC Series E-class of network adapters.

Intended Audience

The document is intended for system and networking architects looking for a tailored solution with a focus on packet capture and reduced CPU usage. In this context, the SNFv5.3.2.11 product provides a deployable solution by using a combination of advanced software stacks and 1- and 10-Gigabit network adapters. The document assumes that readers are familiar with C programming language, GNU development tools, and general computer maintenance.

Software developers interested in directly utilizing the advanced features of CSPi Myricom products through the SNF interfaces, should refer to the *SNFv5.3.2.11 API Reference Manual.*

A Note on Handling Network Adapters

Follow industry-standard ESD anti-static procedures when handling network adapters to avoid accidently damaging integrated circuits.

For more information on ESD anti-static procedures, go to: https://www.esda.org/about-esd/esd-fundamentals/part-3-basic-esd-control-procedures-and-materials/

Notices

The following notices are used in this document:

Notice	***Refers to:***
NOTE:	These notices provide important tips, guidance, or advice.
ATTENTION:	These notices indicate potential damage to programs, devices, or data.

Nomenclature

The following terms can be used interchangeably in the SNFv5.3.2.11 User Guide document, unless otherwise noted.

Common terms	***Refers to:***
Sniffer, Sniffer 5.3.2.11, SNF, SNFv5.3.2.11, SNF version 5.3.2.11	SNFv5.3.2.11
NIC, adapter, card, network adapter, network card, device, Ethernet card, quad-port, dual-port. (10G-PCIE3-8E-2S) (10G-PCIE3-8E-4S)	ARC Series E-Class network adapter Dual-port network adapter Quad-port network adapter

Typographic Conventions

This section describes typographic conventions used in this document.

Convention	***Explanation***
Boldface type	Emphasizes heading levels, column headings, and the following literals when writing procedures: Names of options and elements that appear on screens. Keyboard keys. Menu choice(s) and command selection(s). User input for procedures. Notes and attentions.
Italic type	Accentuates words and phrases that have special meaning or are being defined. Chapter titles: Chapter 1 "*Introduction"* Section titles: Section 1.4 "*SNFv5.3.2.11 Components"*
Italic underline type	Emphasizes a term, feature, or action: Example: SNFv5.3.2.11 does *not* support Windows…
`Boldface Courier type`	Coding format: **`$ /opt/snf/bin/tests/snf_simple_recv -p 0 -v`**
Hyperlink	Provides quick and easy access to web pages and cross-referenced topics. Hyperlinks are highlighted in blue and may be underlined.

Technical Support

SNFv5.3.2.11 software documentation, technical support, and downloads are available from the CSPi website, as follows:

CSPi website
https://www.cspi.com/network-adapters

Contact **CSPi Technical Support** via the CSPi Customer Portal
https://www.cspi.com/cybersecurity-products/support/

CSPi email support address
support@cspi.com

1 Table of Contents

1.1 Introduction

The ARIA™ Cybersecurity Solutions-Myricom® Sniffer version 5.3.2.11 software, or **SNFv5.3.2.11**, powers the ARC Series E-class of network adapters to deliver pure packet capture, with the flexibility to configure advanced functions, leaving the vast majority of server cycles available for your application requirements.

SNFv5.3.2.11 is a tightly-integrated combination of FPGA firmware and user-level software libraries to enable sustained capture with merging of *1- and 10-Gigabit Ethernet traffic.*

This chapter describes the following topics:

- SNFv5.3.2.11 Components
- SNFv5.3.2.11 Benefits
- What's New in SNFv5.3.2.11 Software
- SNFv5.3.2.11 and the ARC Series E Network Adapter
- Support for Open-Source Software
- SNFv5.3.2.11 Chapter Summaries

1.2 SNFv5.3.2.11 Components

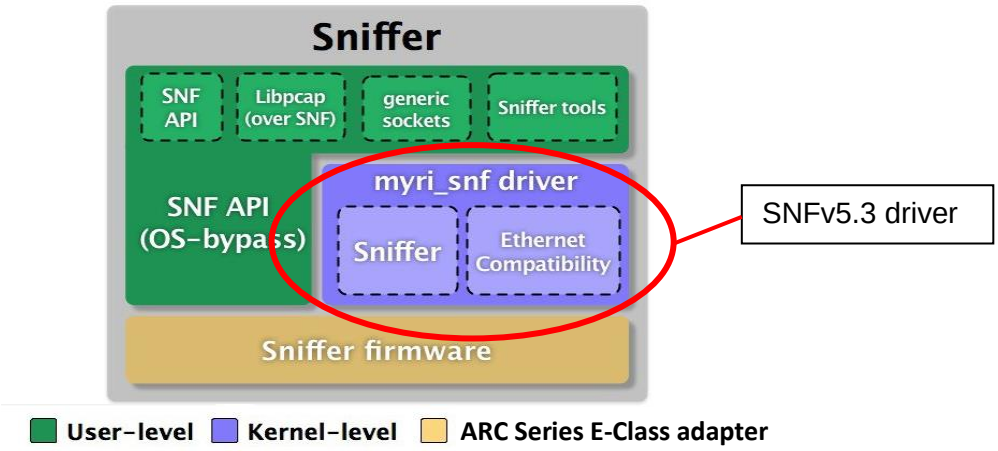


Figure 1. SNFv5.3.2.11 components

The SNFv5.3.2.11 driver contains two components:

1. **SNFv5.3.2.11** or **"Sniffer"** refers to driver features and privileged operations that are necessary to allow an application to directly receive packets into user space. The driver includes optional interrupt generation as well (Figure 1.).

NOTE:	The SNFv5.3.2.11 components are only active when the device is opened for capture through SNF API, or indirectly from **libpcap/SNF**.

2. **Ethernet compatibility** refers to the driver-level functionality required to run an ARC Series E network adapter. At a minimum, it allows familiar OS-provided tools, such as **ethtool**, to interact with the capture device to receive packets on port 0 until it is enabled for SNFv5.3.2.11 capture (Figure 1).

   The enabled SNFv5.3.2.11 capture device receives all incoming packets – with no duplication possible – to the Ethernet driver until the capture device is closed. In other words, tools and utilities that tap into the OS stack to extract information will not see any traffic.

   To that end, SNFv5.3.2.11 includes its own set of tools and counters to analyze packets as they are being captured. In special cases, the driver's send functionality is available while the underlying SNF capture device is enabled, permitting the use of RAW sockets for sending packets.

Libpcap

SNFv5.3.2.11 packet capture capabilities can be leveraged through the **libpcap** library or through the SNFv5.3.2.11 API, as a set of C programming language functions. With a SNFv5.3.2.11-aware **libpcap**, users can reference an ARC Series E network adapter through its Ethernet interface name and run **libpcap**-dependent applications via the **libpcap** portable interface.

At extremely high packet rates, a single system call on every packet could cause packet drops. SNFv5.3.2.11 significantly reduces packet drops by bypassing the kernel altogether, thus offering unrestricted network traffic access to user space applications. With direct (SNFv5.3.2.11 API) and indirect (**libpcap/SNFv5.3.2.11**) access, applications gain full user space access to all incoming packets without any OS intervention—an important consideration when comparing SNFv5.3.2.11 to other packet capture solutions.

> For more information on **libpcap**, go to the *libpcap and SNFv5.3.2.11* section of *Libpcap, and PF_RING Packet Capture*

1.3 SNFv5.3.2.11 Benefits

By using our shared library, **libpcap** users can leverage SNFv5.3.2.11, gaining benefits for packet capture applications. To simplify implementations, the SNFv5.3.2.11-capable **libpcap** library is included in the SNFv5.3.2.11 software distribution. Application benefits include:

- Reduced CPU usage – SNFv5.3.2.11 seamlessly sends all packets to the application, completely bypassing the OS kernel and freeing up CPU cycles.
- Lossless packet capture – With SNFv5.3.2.11 user-definable ring sizes, applications can target a memory queue of any size. This flexibility eliminates packet drops typically caused by rate-matching challenges between hardware and software.
- Applications running in parallel – You can run multiple copies of **libpcap** against a single packet capture stream. This translates into multiple applications running simultaneously against the same packets, with zero copying in the background.
- Exact time stamps – ARC Series E network adapters running SNFv5.3.2.11 provide timestamps with up to ± 3 nanosecond accuracy, using high-quality time signals attached via standard coax inputs.
- Low overhead – SNFv5.3.2.11 efficiency allows you to capture four, 1- and 10-Gigabit Ethernet ports into a single server with zero drops, at maximum packet rate, and still have enough CPU cycles available to run significant applications against these streams.
- SNFv5.3.2.11 software supports Linux operating systems.

  The SNFv5.3.2.11-capable **libpcap** library is an open-source enhancement developed by the ARIA Cybersecurity Solutions Product Development Team and is part of the standard source trees. Both source and compiled versions of these software modules are provided, all interfacing seamlessly with SNFv5.3.2.11.
- Large FPGA supports a stream of future enhancements from the ARIA Cybersecurity Solutions Product Development Team.

NOTE:	SNFv5.3.2.11 does *not* support Windows in this current release.

1.4 What's New in SNFv5.3.2.11 Software

- SNF version 5.3.2.11 is the GA release of the Linux SNFv5.3.2.11 software.
- SNFv5.3.2.11 software supports *1- and 10-Gigabit Ethernet* network adapter environments.
- Supports ARC Series E network adapter dual-port and four-port models in SFP or SFP+ module configurations.
- Exact time stamps: ARC Series E network adapters with SNFv5.3.2.11 drivers provide timestamps with up to ± 3 nanosecond accuracy, using high-quality time signals supplied via standard coax inputs.

1.4.1 Enhancements

- The driver now recognizes firmware up to version 2.1.5.
- Added hardware RSS hash. Removed the **`-a`** parameter from the test programs **snf_simple_recv** and **snf_multi_recv**.
- Added the **`-D`** parameter to **snf_simple_recv** to verify injection pacing.

NOTE:	The **`-D`** parameter applies to every packet. Use only with controlled input streams.

- Added transmit hardware injection pacing. Added new API function calls **snf_inject_sched()** and **snf_inject_sched_v()**.
- Added a new API call, **snf_get_injection_speed()**. The **snf_pktgen** program now uses this function to determine link speed.
- Added support for software transmit timestamps.
- Added acceleration support for port pair merging. Acceleration is adapter-specific and offers a significant improvement over the ARC 8C- and ARC 8B-type adapters, which all do SW port merging only. The new acceleration mode can port merge two ports of sustained 60B traffic with no packet drops and only 50 percent CPU usage. Port merge acceleration is restricted to the following two-port pair configurations: 0 and 1, or 2 and 3. Both port pairs can run concurrently. Other port merging combinations (including across multiple adapters) is supported but with reduced performance.

1.5 SNFv5.3.2.11 and the ARC Series E Network Adapter

SNFv5.3.2.11 software introduces SNF support for the latest generation of Myricom ARC Series E network adapters. SNFv5.3.2.11 software is only compatible with the following hardware platforms:

- ARC Series E network adapter – dual-port (10G-PCIE3-8E-2S)
- ARC Series E network adapter – dual-port (1G-PCIE3-8E-2S)
- ARC Series E network adapter – quad-port (10G-PCIE3-8E-4S)
- ARC Series E network adapter – quad-port (1G-PCIE3-8E-4S)
- ARC Series E network adapter – quad-port (1G/10G-PCIE3-8E-4S)

DISCLAIMER: If you have any other adapter you wish to use, contact ARIA Support.

1.6 Support for Open-Source Software

SNFv5.3.2.11 is compatible with industry-standard open-source packet capture application tools. Examples of tested applications include:

- **tcpdump** (standard Linux utility)
- **tcpreplay** (standard Linux utility)
- **Suricata** network intrusion detection and security monitoring
- **Wireshark** network protocol analyzer
- **Bro** network Intrusion Detection System (IDS)
- **Snort** intrusion prevention systems
- PF_RING packet capture network socket, ported to run above the SNF API

  SNFv5.3.2.11 can accommodate the multi-process **Bro,** multi-threaded **Suricata,** and **tcpdump** packet capture tools running in parallel - each tool collecting and splitting network traffic among their respective application threads.

1.7 SNFv5.3.2.11 Chapter Summaries

The SNFv5.3.2.11 User Guide contains the following chapters:

Chapter 1	*Introduction to SNFv5.3.2.11 software*
Chapter 2	*Installing the ARC Series E Adapter Hardware.* Provides detailed adapter hardware installation instructions for ARC Series E network adapters.
Chapter 3	*Testing the ARC Series E Network Adapter Hardware* Describes testing procedures for dual- and quad-port ARC Series E network adapters.
Chapter 4	*Installing SNFv5.3.2.11 Software in Linux* Provides detailed instructions for downloading and installing SNFv5.3.2.11 RPM and TGZ drivers for Linux OS.
Chapter 5	*Installing SNFv5.3.2.11 Software with VMware Client* This chapter describes the steps necessary to install SNFv5.3.2.11 software and ARC Series E network adapters in VMware ESXi Virtual Machines (VMs).
Chapter 6	*Verifying SNFv5.3.2.11 Software Installation* Verifies proper SNFv5.3.2.11 software installation, network adapter hardware connectivity, and packet rate.
Chapter 7	*PHX-TOOLS Network Adapter Toolkit* The PHX-TOOLS network adapter toolkit allows users to run diagnostics on ARC Series E network adapter operation and flash memory FPGA firmware programming.
Chapter 8	*Testing SNFv5.3.2.11 Software* Describes SNFv5.3.2.11 software test programs that serve to familiarize the user with its basic operation.
Chapter 9	*Running SNFv5.3.2.11 Diagnostic Tool Programs* Describes essential SNFv5.3.2.11 diagnostic tools for error reporting purposes.
Chapter 10	*Configuring SNFv5.3.2.11* Provides instructions on configuring and debugging SNFv5.3.2.11 with an assortment of environment variables. Includes load balancing and port merge features.

Chapter 11	*Load Balancing and Port Merging Features* Describes variables responsible for port merging and load balancing across multiple application processes.
Chapter 12	*Libpcap and PF_RING Packet Capture Applications* Describes how SNFv5.3.2.11 improves packet capture performance with **libpcap** and PF_RING.
Chapter 13	*Open-Source Packet Capture Tools* Describes SNFv5.3.2.11 compatibilities with industry-standard open-source packet capture application tools.
Chapter 14	*Linux PTP Host Clock Synchronization* Describes system clock synchronization to the ARC Series E Adapter Clock.
Chapter 15	*SNFv5.3.2.11 Timestamping Support* Describes SNFv5.3.2.11 timestamping variables. Offers ways to view time source status. SNFv5.3.2.11 does *not* support Arista timestamping in this release.
Chapter 16	*Tuning SNFv5.3.2.11 Software* Identifies and resolves certain issues that may affect packet rate.
Chapter 17	*Troubleshooting* Addresses issues pertaining to hardware and software installation, system configuration, and performance.
Appendix 1	*SNFv5.3.2.11 Counters*
Appendix 2	*Operating Systems & Hardware Support*
Appendix 3	*SNFv5.3.2.11 Driver Restrictions and Limitations*
Appendix 4	*SNFv5.3.2.11 Firmware*
Appendix 5	*SNFv5.3.2.11 Supported 1G and 10G Transceivers*
Appendix 6:	*Network Adapter Toolkit – v. 1.40*

2 Installing the ARC Series E Adapter Hardware

This chapter describes the following tasks for installing the ARC Series E-Class network adapter hardware (10G-PCIE3-8E-2S and 10G-PCIE3-8E-4S):

- Checking Expansion Card Slot Configuration
- Installing the ARC Series E Network Adapter

Myricom network hardware products are designed to be compatible with prevailing industry standards and typically install quickly without significant user effort. Nonetheless, it is beyond the scope of this manual to address all hardware installation issues specific to your networking site. For all issues regarding installing and configuring your hardware, contact:

- **ARIA Technical Support** through the ARIA Customer Portal to https://www.ariacybersecurity.com/support/downloads/ or
- Email **ARIA Technical Support** at ARIA_support@ariacybersecurity.com

2.1 Checking Expansion Card Slot Configuration

The ARC Series E network adapter has been qualified with PCIe server expansion slots with a minimum of x8-lanes. It is recommended that a PCIe Gen3 x8 expansion slot be located closest to the CPU to achieve best performance. See Table 1. to determine which expansion card slots can accommodate the network adapter hardware.

Expansion card slot	***Compatibility***	***Comments***
Gen3 x16 PCIe slot	Supports x8 card	Check motherboard specifications. Check mechanical fit to guarantee a secure electrical connection.
Gen3 x8 PCIe slot		
Gen1 PCIe slot	Not supported.	
Gen2 PCIe slot	Not supported.	

Table 1. PCIe expansion card slot characteristics

2.2 Installing the ARC Series E Network Adapter

Install the ARC Series E network adapter as follows:

1. Close all active applications and shut down the operating system.
2. Turn off the computer and disconnect the power cord.
3. Open the computer case and locate the PCIe expansion card slots on the motherboard. Do not disturb the legacy PCI card slots, which are different in size and electrical specifications.

NOTE:	For optimal performance, install the ARC Series E network adapter in a PCIe Gen3 x8 slot on the server. Minimal testing on PCIe Gen2 has been performed and is not recommended. Servers with PCIe Gen1 slots are not supported.

4. Check for a free slot, then remove the mounting screw from the protective bracket plate covering the selected slot, and set aside the plate. If there are no free slots then it may be necessary to remove a surplus adapter to make room for the network adapter.

5. Carefully remove the ARC Series E network adapter from its sealed protective sleeve without touching the gold PCIe connectors (Figures 2 and 3).

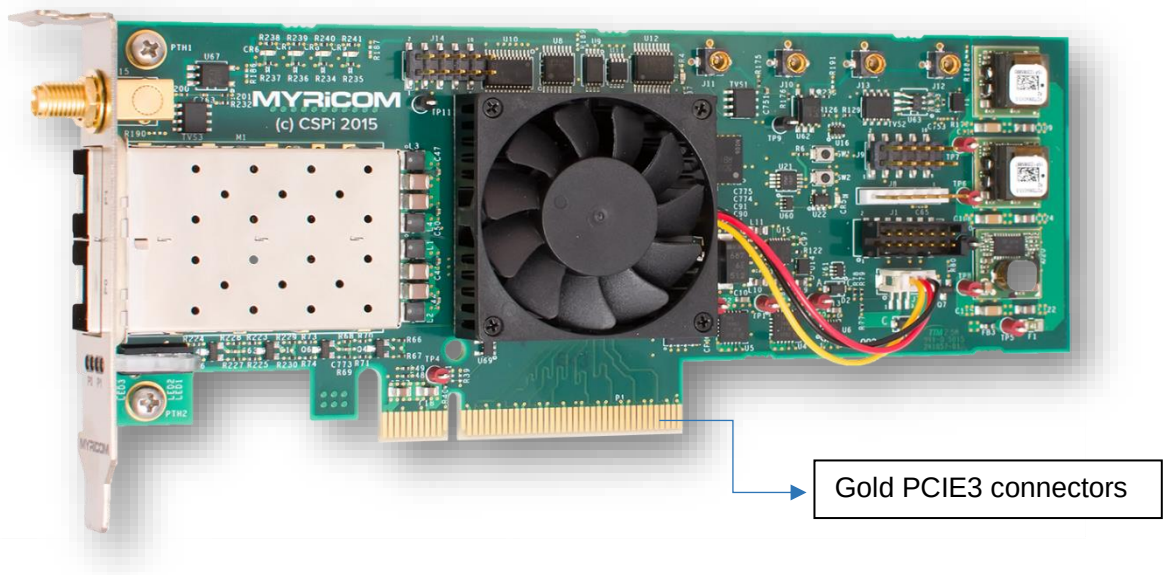


Figure 2. ARC Series E dual-port network adapter (10G-PCIE3-8E-2S)

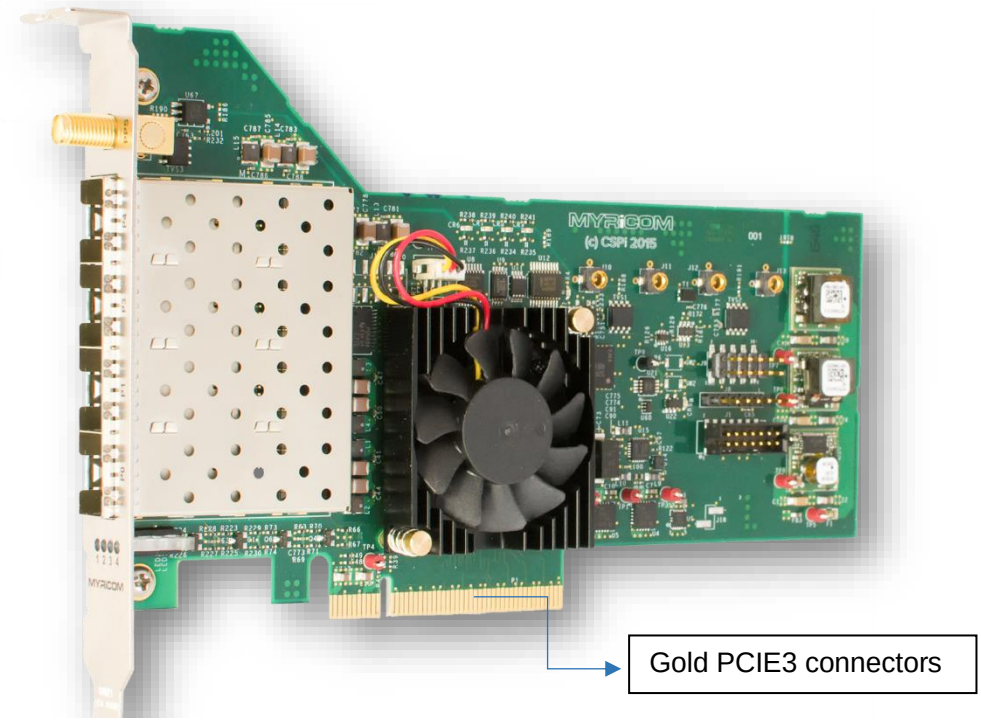


Figure 3. ARC Series E quad-port network adapter (10G-PCIE3-8E-4S)

6. Line up the gold PCIe connectors and indexing tab with the empty PCIe Gen3 slot, ensuring that the ports and mounting bracket are facing the back panel of the computer.

NOTE:	Place the ARC Series E adapter as close as possible to the CPU to achieve best performance.

7. Seat the network adapter firmly into the PCIe expansion slot until the card “clicks” into place.
8. Secure the network adapter to the computer chassis with a screw.
9. Close the computer case and re-connect the power plug.
10. Insert cabled transceivers in the network adapter ports. Do not kink the cables.

The ARC Series E network adapter is now installed.

ATTENTION:	When swapping 1G transceivers, insert the transceiver first and reload the SNFv5.3.2.11 driver, running **myri_start_stop** to detect the link.

For more information on SNFv5.3.2.11 supported 1G and 10G transceivers, refer to *Appendix 5: SNFV5.3.2.11 Supported 1G and 10G Transceivers*

3 Testing the ARC Series E Adapter Hardware

This chapter describes the following topics:

- Testing the ARC Series E-Class Network Adapter – Dual-Port
- Testing the ARC Series E-Class Network Adapter – Quad-Port
- Running a Test Script

> For more information on test programs, go to the *Sample Test Programs* section of *Testing SNFv5.3.2.11 Software*

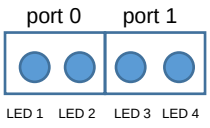
3.1 Testing the ARC Series E Network Adapter – Dual-Port

Once you have installed the dual-port ARC Series E adapter (10G-PCIE3-8E-2S) into the PCIe expansion slot, we recommend testing the card and acquainting yourself with the following:

- Identifying network card port LEDs – dual-port
- Testing the network card
- Running network card diagnostics

3.1.1 Identifying network card port LEDs – dual-port

The network adapter (10G-PCIE3-8E-2S) has two ports: port 0 and port 1. Each port has corresponding LEDs, identified as LED 1, 2, 3, and 4.



- LED 1 represents the first port transmit. It is referenced in SNFv5.3.2.11 software and counters as ‘port 0’.
- LED 2 represents the first port receive. It is referenced in SNFv5.3.2.11 software and counters as ‘port 0’.
- LED 3 represents the second port transmit. It is referenced in SNFv5.3.2.11 software and counters as ‘port 1’.
- LED 4 represents the second port receive. It is referenced in SNFv5.3.2.11 software and counters as ‘port 1’.

3.1.2 Testing the network card

Preparing the network card for testing

1. Prepare the card for testing by connecting port 0 to port 1 in loopback.
2. Insert SFP+ modules into port 0 and port1 and insert a cable between the modules.

   The corresponding port LEDs turn green.

Running the test

Testing requires two terminal windows. One window receives data on port 0 and the other sends data on port 1.

1. Run **snf_simple_recv** in the first window (port 0):

   ```
   $ /opt/snf/bin/tests/snf_simple_recv -p 0 -v
   ```

2. Run **snf_pktgen** in the second window (port 1):

   ```
   $ /opt/snf/bin/tests/snf_pktgen -p 1:1 -v -r 1.0
   ```

   The `-p` option specifies the port assigned to send the data.

   The output for the **snf_simple_recv** command is as follows:

   Output:

```
$ /opt/snf/bin/tests/snf_simple_recv -p 0 -v
pkt: 10000, len: 60, ts_hw: 1460582457723094899 ts_host: 1460582457723432378
ts_diff:337479
pkt: 20000, len: 60, ts_hw: 1460582457727899449 ts_host: 1460582457728224074
ts_diff:324625
pkt: 30000, len: 60, ts_hw: 1460582457732705989 ts_host: 1460582457733025483
ts_diff:319494
pkt: 40000, len: 60, ts_hw: 1460582457737507879 ts_host: 1460582457737826826
ts_diff:318947
pkt: 50000, len: 60, ts_hw: 1460582457742313319 ts_host: 1460582457742627269
ts_diff:313950
pkt: 60000, len: 60, ts_hw: 1460582457747118579 ts_host: 1460582457747428999
ts_diff:310420
pkt: 70000, len: 60, ts_hw: 1460582457751923409 ts_host: 1460582457752229809
ts_diff:306400
pkt: 80000, len: 60, ts_hw: 1460582457756729069 ts_host: 1460582457757032338
ts_diff:303269
pkt: 90000, len: 60, ts_hw: 1460582457761532689 ts_host: 1460582457761832804
ts_diff:300115
```

   The **snf_simple_recv** and **snf_pktgen** commands will run continuously until you exit the programs.

3. Enter **CTRL-C** to exit the programs:

   The **snf_pktgen** command generates no output.

   The **snf_simple_recv** command generates the following output:

   Output:

```
pkt: 90000, len: 60, ts_hw: 1460582457761532689 ts_host: 1460582457761832804
ts_diff:300115
Packets received   in HW:        10348661
Packets reinjected,    app:        0
Packets reflected to netdev:       0
Total bytes received,  app:        620919660 (592 MB)
Total bytes received + HW aligned: 496735728 (473 MB)

Average Packet Length:    60 bytes
Dropped, NIC overflow:    0
Dropped, ring overflow:   0
Dropped, bad:             0
```

   The corresponding port LEDs turn orange while the tests are running.

3.1.3 Running network card diagnostics:

The **myri_nic_info** command provides adapter information such as the hardware serial number, MAC address, firmware version, and so on.

Command line:

```
$ sudo /opt/snf/bin/myri_nic_info
```

Output:

```
# Serial  MAC               ProductCode     Driver   Version     License
0 491942  00:60:dd:43:48:b3 10G-PCIE3-8E-2S myri_snf-5.3.2.11.54367 Valid
1 491943  00:60:dd:43:48:b4 10G-PCIE3-8E-2S myri_snf-5.3.2.11.54367 Valid
```

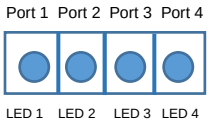
3.2 Testing the ARC Series E Network Adapter – Quad-Port

Once you have installed the quad-port ARC Series E adapter (10G-PCIE3-8E-4S) into the PCIe expansion slot, we recommend testing the card and acquainting yourself with the following:

- Identifying network card port LEDs – quad-port
- Testing the network card
- Running network card diagnostics

3.2.1 Identifying network card port LEDs – quad-port

The network adapter (10G-PCIE3-8E-4S) has four ports: ports 0, 1, 2, and 3. Each port has corresponding LEDs, identified (from left to right) as LED 0, 1, 2, and 3.



- LED 0 represents the first port. It is referenced in SNFv5.3.2.11 software and counters as ‘port 0’.
- LED 1 represents the second port. It is referenced in SNFv5.3.2.11 software and counters as ‘port 1’.
- LED 2 represents the third port. It is referenced in SNFv5.3.2.11 software and counters as ‘port 2’.
- LED 3 represents the fourth port. It is referenced in SNFv5.3.2.11 software and counters as ‘port 3’.

3.2.2 Testing the network card

Preparing the network card for testing

1. Prepare the card for testing by connecting port 0 to port 1, and port 2 to port 3 in loopback.
2. Insert cables into the loopbacks.

   The corresponding port LEDs turn green.

Running the test

Testing requires four terminal windows. Two windows receive data on ports 0 and 2, and two windows send data on ports 1 and 3.

1. Run **snf_simple_recv** in the first window (port 0):

   ```
   $ sudo /opt/snf/bin/tests/snf_simple_recv -p 0 -v
   ```

2. Run **snf_simple_recv** in the second window (port 2):

   ```
   $ sudo /opt/snf/bin/tests/snf_simple_recv -p 2 -v
   ```

3. Run **snf_pktgen** in the third window (port 1):

   `$ sudo /opt/snf/bin/tests/snf_pktgen -p 1:1 -r 1.0`

   The **`-p`** option specifies the port assigned to send the data.

   In this example the command is sending the data out of port 1.

4. Run **snf_pktgen** in the fourth window (port 3):

   `$ sudo /opt/snf/bin/tests/snf_pktgen -p 3:1 -r 1.0`

   The output for the **snf_simple_recv** command is as follows:

   Output:

```
$> /opt/snf/bin/tests/snf_simple_recv -p 0 -v

pkt: 10000, len: 60, ts_hw: 1460582457723094899 ts_host: 1460582457723432378
ts_diff:337479

pkt: 20000, len: 60, ts_hw: 1460582457727899449 ts_host: 1460582457728224074
ts_diff:324625

pkt: 30000, len: 60, ts_hw: 1460582457732705989 ts_host: 1460582457733025483
ts_diff:319494

pkt: 40000, len: 60, ts_hw: 1460582457737507879 ts_host: 1460582457737826826
ts_diff:318947

pkt: 50000, len: 60, ts_hw: 1460582457742313319 ts_host: 1460582457742627269
ts_diff:313950

pkt: 60000, len: 60, ts_hw: 1460582457747118579 ts_host: 1460582457747428999
ts_diff:310420

pkt: 70000, len: 60, ts_hw: 1460582457751923409 ts_host: 1460582457752229809
ts_diff:306400

pkt: 80000, len: 60, ts_hw: 1460582457756729069 ts_host: 1460582457757032338
ts_diff:303269

pkt: 90000, len: 60, ts_hw: 1460582457761532689 ts_host: 1460582457761832804
ts_diff:300115
```

5. Enter **CTRL-C** to exit the programs:

   The **snf_pktgen** command generates no output.

The **snf_simple_recv** command generates the following output:

Output:

```
pkt: 90000, len: 60, ts_hw: 1460582457761532689 ts_host: 1460582457761832804
ts_diff:300115
Packets received   in HW:        10348661
Packets reinjected,    app:        0
Packets reflected to netdev:       0
Total bytes received,  app:        620919660 (592 MB)
Total bytes received + HW aligned: 496735728 (473 MB)
Average Packet Length:    60 bytes
Dropped, NIC overflow:    0
Dropped, ring overflow:   0
Dropped, bad:             0
```

The corresponding port LEDs turn orange while the tests are running.

3.2.3 Running network card diagnostics

The **myri_nic_info** command provides adapter information such as the hardware serial number, MAC address, firmware version, and so on.

Command line:

```
$ sudo /opt/snf/bin/myri_nic_info -B
```

Output:

```
$ sudo /opt/snf/bin/myri_nic_info -B
# Serial  MAC               ProductCode     Driver   Version     License
0 491942  00:60:dd:43:48:b3 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
1 491943  00:60:dd:43:48:b4 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
2 491944  00:60:dd:43:48:b5 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
3 491945  00:60:dd:43:48:b6 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
```

3.3 Running a Test Script

You can run a dual-port or quad-port ARC Series E adapter test from a script. The script launches four terminal windows by default, and initiates send and receive in each.

The quad-port adapter test script launches all four terminal windows and runs the test. The dual-port adapter test script closes two terminal windows (with an error message indicating that the ports do not exist) and runs the test.

Test script:

Command line:

```
$ cat test_script
```

Output:

```
#!/bin/bash
  /usr/bin/xterm -e "/opt/snf/bin/tests/snf_simple_recv -p 0 -v" &
  /usr/bin/xterm -e "/opt/snf/bin/tests/snf_simple_recv -p 2 -v" &
  /usr/bin/xterm -e "/opt/snf/bin/tests/snf_pktgen -p1:1 -v -r1.0" &
  /usr/bin/xterm -e "/opt/snf/bin/tests/snf_pktgen -p3:1 -v -r1.0" &
```

> To run diagnostics on ARC Series E network adapter operations and FPGA firmware programming, go to *PHX-TOOLS Network Adapter Toolkit*

4 Installing SNFv5.3.2.11 Software in Linux

This chapter describes the following topics:

- Downloading SNFv5.3.2.11 RPM or TGZ Drivers
- Installing the SNFv5.3.2.11 RPM Software Package for Linux
- Installing the SNFv5.3.2.11 TGZ Driver for Linux
- Rebuilding after OS/Kernel Update

Linux file formats

The downloaded file format may be either **`.rpm`** or **`.tgz`** for Linux. A different installation process is required for each format and is described in detail in this chapter.

Software package contents

SNFv5.3.2.11 software is a single package file containing:

- A special network adapter driver to replace the normal Ethernet driver
- A dynamic library of software modules
- Test programs to demonstrate SNFv5.3.2.11 functionality

4.1 Downloading SNFv5.3.2.11 RPM or TGZ Drivers

To download a copy of the SNFv5.3.2.11 RPM or SNFv5.3.2.11 TGZ driver, either download the file from https://www.ariacybersecurity.com/support/downloads/ or contact ARIA support (ARIA_support@ariacybersecurity.com). Then save the file to your designated system directory.

4.2 Installing the SNFv5.3.2.11 RPM Software Package for Linux

NOTE:	The RPM package can be used with Fedora based distributions including RHEL and CentOS.

Example:

To install the SNFv5.3.2.11 software package to your Linux operating system, follow these steps:

1. Enter the following command to uninstall any previous versions of Myricom software:

   ```
   $ sudo yum remove myri_snf
   ```

   All previous versions of Myricom software are deleted.

2. Verify that the operating system detects the presence of the network adapter.

   ```
   $ sudo lspci -d 1c09:
   ```

   The output displays a list of network adapter device versions.

   Output:

   ```
   01:00.0 Ethernet controller: CSP, Inc. Device 4260 (rev 01)
   ```

3. Install the SNFv5.3.2.11 driver.

   For CentOS 7.7, 7.8, & 8.0 & RHEL 7 Distributions:

   ```
   $ sudo yum -y install ./myri_snf-<version_info>*.x86_64.rpm
   ```

   Output:

   ```
   kernel      = 3.10.0-327.36.1.el7.x86_64
   destination = /opt/snf/sbin
     *** myri_snf.ko ... ok
   Created symlink from
   /etc/systemd/system/default.target.wants/myri_start_stop.service to
   /etc/systemd/system/myri_start_stop.service.
   ```

4. Enter the following command to confirm that the driver is loaded:

   $ lsmod |grep myri

   Console output while the driver is loading.

   Output:

```
myri_snf              177214  0
```

   OR

   Enter the following command if the driver does *not* load:

   $ sudo /opt/snf/sbin/myri_start_stop restart

5. Enter the following command to confirm that the SNF driver detects the network adapter and the Gen3 x8 or the Gen3 x16 expansion slot.

   $ sudo /opt/snf/sbin/myri_info

The output confirms that the SNF driver detects the network adapter.

Output:

```
pci-dev at 01:00.0 vendor:product(rev)=1c09:4260(01)
        behind bridge root-port: 00:01.0 8086:0c01 (x8.3/x16.3)
Myri-10G-PCIE-8E -- Link x8
   EEPROM String-spec:
        MAC=00:60:dd:43:2d:e8
        SN=495892
        PC=10G-PCIE3-8E-4S
        PN=09-04680
        BOM=A

   Firmware:
      Version: 2.1.5
      Type   : SNF
      Config : 4 Port x 10 Gb
      SHA1   : 2d13f73ad9fe4bd4bda8d7b50dd0ad0b

   External Inputs:
      PPS: Enabled, No Input
           Front Panel PPS: No Input
           Card Edge PPS:   No Input
       10Mhz Clock: Disabled
      100Mhz Clock Locked:  Locked
```

6. Enter the following command to track the interface names assigned to each port:

   $ sudo ip link show | grep -iB 1 00:60:dd

   Example:

   In this example, the interface name is **"enp1s0f0"** and the MAC network adapter addresses begin with **"00:60:dd:"**

   Output:

```
30: enp1s0f0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode
DEFAULT qlen 1000
    link/ether 00:60:dd:43:e8:b0 brd ff:ff:ff:ff:ff:ff
```

7. Enter the following commands to manually assign an IP address and a subnet to port 0 of the adapter. You can only assign an IP address to port 0. Ports 1, 2, and 3 are only available to SNF API. (You can also create **ifcfg** files in the **/etc/sysconfig/network-scripts** directory).

```
$ sudo systemctl stop NetworkManager.service
$ sudo systemctl disable NetworkManager.service
$ sudo ip address add 10.0.0.1/24 dev enp1s0f0
```

8. Enter the following command to confirm that each link is functioning:

```
$ sudo ip address show up
```

The output confirms the link is functioning.

Output:

```
27: enp1s0f0:
<BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc pfifo_fast state UNKNOWN qlen
1000
     link/ether 00:60:dd:43:52:f0 brd ff:ff:ff:ff:ff:ff
     inet 10.0.0.1/24 brd 10.0.0.255 scope global p1p1
       valid_lft forever preferred_lft forever
    inet6 fe80::260:ddff:fe43:52f0/64 scope link
       valid_lft forever preferred_lft forever
```

9. Enter the following commands to verify contact with the remote host:

```
$ sudo ping 10.0.0.2
```

The SNFv5.3.2.11 RPM software installation is now complete.

> To test your SNF software, go to *Testing SNFv5.3.2.11 Software*

4.2.1 Uninstalling the SNFv5.3.2.11 Binary RPM driver

To uninstall the SNFv5.3.2.11 Binary RPM driver, enter the following commands:

```
$ sudo /opt/snf/sbin/myri_start_stop stop
$ sudo yum remove myri_snf
```

The SNFv5.3.2.11 RPM driver is removed from the system.

4.2.2 Listing module load-time variables

To list module load-time variables, enter the following command:

```
$ sudo modinfo /opt/snf/sbin/myri_snf.ko
```

4.2.3 Controlling kernel module behavior (optional)

To manually stop or start the kernel module, enter the following command with the **myri_start_stop** script:

```
$ sudo /opt/snf/sbin/myri_start_stop start
```

4.3 Installing the SNFv5.3.2.11 TGZ Driver for Linux

Non-Fedora-based Linux distributions with Tarball TGZ (**.tgz**) drivers, offering support up to Linux kernel version 5.5, are provided. The TGZ package can be used with Debian-based distributions including Ubuntu.

NOTE:	This procedure involves uninstalling any previous versions of Myricom software, which depends on the manner in which it was installed. For example, if a package manager was used to install Myricom software (e.g. rpm or yum), then software should be removed using that method.

Install the SNFv5.3.2.11 TGZ driver for Linux as follows:

1. To uninstall any previous versions of Myricom software, enter the following command:

   ```
   $ sudo rm -r /opt/snf
   ```

   All previous versions of Myricom software are deleted.

2. Verify that the operating system detects the presence of the network adapter.

   ```
   $ sudo lspci -d 1c09:
   ```

   The output displays a list of device versions.

   Output:

   ```
   01:00.0 Ethernet controller: CSP, Inc. Device 4260 (rev 01)
   ```

3. Enter the following commands to install the SNFv5.3.2.11 TGZ driver:

   Debian Distributions (Ubuntu):

   ```
   $ cd /opt
   $ sudo tar xzvf ./myri_snf-<version_info>*.x86_64.tgz
   $ mv myri_snf-<version_info>*.x86_64 snf
   $ cd /opt/snf
   $ sudo sbin/rebuild.sh
   ```

   ```
   kernel      = 3.19.0-25-generic
   destination = /opt/snf/sbin
     *** myri_snf.ko ... ok
   ```

For Ubuntu servers that use systemd (15.04+) you can also perform the following steps to start the driver automatically.

```
$ sudo cp /opt/snf/sbin/myri_start_stop.service
/etc/systemd/system
```

```
$ sudo systemctl enable myri_start_stop.service
```

```
$ sudo systemctl start myri_start_stop.service
```

4. Enter the following command to confirm that the driver is loaded:

   ```
   $ sudo lsmod |grep myri
   ```

   The output confirms the driver is loading.

   Output:

   ```
   myri_snf             177214  0
   ```

   OR

   Enter the following command if the driver *does not* load:

   ```
   $ sudo /opt/snf/sbin/myri_start_stop restart
   ```

   The output confirms the driver is loaded.

5. Enter the following command to confirm that the SNFv5.3.2.11 driver detects the network adapter and the Gen3 x8 or the Gen3 x16 expansion slot:

   ```
   $ sudo /opt/snf/sbin/myri_info
   ```

The output detects the network adapter and the expansion slot.

Output:

```
pci-dev at 01:00.0 vendor:product(rev)=1c09:4260(01)
        behind bridge root-port: 00:01.0 8086:0c01 (x8.3/x16.3)
Myri-10G-PCIE-8E -- Link x8
   EEPROM String-spec:
        MAC=00:60:dd:43:2d:e8
        SN=495892
        PC=10G-PCIE3-8E-4S
        PN=09-04680
        BOM=A

   Firmware:
      Version: 2.1.5
      Type   : SNF
      Config : 4 Port x 10 Gb
      SHA1   : 2d13f73ad9fe4bd4bda8d7b50dd0ad0b

   External Inputs:
      PPS: Enabled, No Input
           Front Panel PPS: No Input
           Card Edge PPS:   No Input
       10Mhz Clock: Disabled
      100Mhz Clock Locked:  Locked
```

6. Enter the following command to track the interface names assigned to each port:

   $ sudo ip link show | grep -iB 1 00:60:dd

   Example:

   In this example, the interface name is **"enp1s0f0"** and **"enp1s0f1".** The MAC network adapter addresses begin with **"00:60:dd:"**

   Output:

```
30: enp1s0f0: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode
DEFAULT qlen 1000
    link/ether 00:60:dd:43:e8:b0 brd ff:ff:ff:ff:ff:ff
31: enp1s0f1: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode
DEFAULT qlen 1000
    link/ether 00:60:dd:43:e8:b1 brd ff:ff:ff:ff:ff:ff
```

7. Enter the following commands to manually assign an IP address and a subnet to each network adapter port. (You can also create **ifcfg** files in the **/etc/sysconfig/network-scripts** directory).

```
$ sudo systemctl stop NetworkManager.service
$ sudo systemctl disable NetworkManager.service
$ sudo ip address add 10.0.0.1/24 dev enp1s0f0
$ sudo ip link set dev enp1s0f0 up
$ sudo ip address add 10.1.0.1/24 dev enp1s0f1
$ sudo ip link set dev enp1s0f1 up
```

8. Enter the following command to confirm that each link is functioning:

```
$ sudo ip address show up
```

The output confirms each link is functioning.

Output:

```
27: enp1s0f0:
<BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9000 qdisc pfifo_fast state UNKNOWN qlen
1000
     link/ether 00:60:dd:43:52:f0 brd ff:ff:ff:ff:ff:ff
     inet 10.0.0.1/24 brd 10.0.0.255 scope global p1p1
       valid_lft forever preferred_lft forever
    inet6 fe80::260:ddff:fe43:52f0/64 scope link
       valid_lft forever preferred_lft forever
```

9. Enter the following commands to verify you can contact the remote host:

```
$ sudo ping 10.0.0.2
$ sudo ping 10.1.0.2
```

> To test your software, go to *Testing SNFv5.3.2.11 Software*

4.3.1 Uninstalling the SNFv5.3.2.11 Tarball TGZ driver

This section describes how to uninstall the SNFv5.3.2.11 Tarball TGZ driver.

To uninstall the SNFv5.3.2.11 Tarball TGZ driver, enter the following commands:

```
$ sudo /etc/init.d/myri_start_stop stop
$ sudo rm -rf /opt/snf/
$ sudo rm -f /etc/init.d/myri_start_stop
```

The SNFv5.3.2.11 TGZ driver is removed from the system.

4.3.2 Listing module load-time variables

To list module load-time variables, enter the following command:

```
$ sudo modinfo /opt/snf/sbin/myri_snf.ko
```

4.4 Rebuilding after OS/Kernel Update

Updating the kernel on CentOS, Fedora, or Ubuntu Linux is a straightforward process. You update the kernel first and then rebuild after the kernel update.

4.4.1 Updating the kernel

There are several ways to update the kernel on, Fedora, Ubuntu, or CentOS.

Option 1:

Command line (Fedora):

```
$ sudo dnf upgrade
```

Option 2:

Command line (Ubuntu):

```
$ sudo apt-get update
```

Option 3:

Command line (CentOS):

```
$ sudo yum update
```

4.4.2 Rebuilding after kernel update

Following the kernel update, you update, or rebuild, the drivers.

To rebuild after kernel update, enter the following commands:

```
$ cd /opt/snf
$ sudo sbin/rebuild.sh
```

5 Installing SNFv5.3.2.11 Software in VMware Client

This chapter describes the steps necessary to install SNFv5.3.2.11 software and ARC Series E-Class network adapters in VMware ESXi Virtual Machines (VMs).

VMware ESXi VMs allow a guest operating system on a virtual machine to directly access PCIe devices connected to a host. Each virtual machine can connect to as many as six PCI devices at a time.

The chapter includes the following topics:

- References and Terminology
- Prerequisites
- Installing the ARC Series E Adapter to the VMware Server
- Preparing the Adapter Hardware for Pass-through Mode
- Adding Pass-through Hardware to the vSphere Client
- Installing the SNFv5.3.2.11 Software to the VMware Server
- Flashing ARC Series E Adapter Hardware

5.1 Terminology

Terminology used throughout this chapter is as follows:

- **Server**: VMware ESXi server version 6.0.0 3029758
- **Client**: vSphere Client version 6.0.0 3562874
- **Virtual Machine (VM)**: CentOS 7.5 x86_64

5.2 Prerequisites

Note the following prerequisites before you proceed:

- To enable DirectPath I/O, verify that the server has Intel Virtualization Technology for Directed I/O (VT-d) or AMD I/O Virtualization Technology (IOV) enabled in the BIOS.
- Verify that the virtual machine is running CentOS software version 7.7 or later.
- Verify that the ARC Series E adapters are connected to the host and marked as available for pass-through.

NOTE:	If the ESXi host is configured to boot from a USB device, disabling the USB controller for pass-through is recommended. VMware does not support USB controller pass-through for ESXi hosts that boot from USB devices or SD cards connected through USB channels. For more information, go to https://kb.vmware.com/s/article/2068645.

5.3 Installing the ARC Series E Adapter to the VMware Server

Install the network adapter hardware to the VMware server as follows:

NOTE:	The ARC Series E-Class network adapter (10G-PCIE3 -8E-2S) described in this example is Device 4260 and Vendor 1C09, running in VM server location 0000:07:00:0

1. Turn off the server.
2. Insert an ARC Series E network adapter into one of the PCIe Gen3 x8 expansion slots on the server. For more information on installing the ARC Series E adapter, go to *Installing the ARC Series E Adapter Hardware*
3. Turn on the server.
4. Configure the BIOS system virtualization settings to ensure that the VMs accept the network adapter in pass-through mode.
5. Save your settings and reboot.

NOTE:	These options will vary from one BIOS system or motherboard type to another. Nonetheless the following options, relevant to virtualization, must be enabled: Intel I Virtualization, and Intel I VT-d Directed I/O

5.4 Preparing the Adapter Hardware for Pass-through Mode

To prepare the ARC Series E network adapter for pass-through mode, follow this procedure:

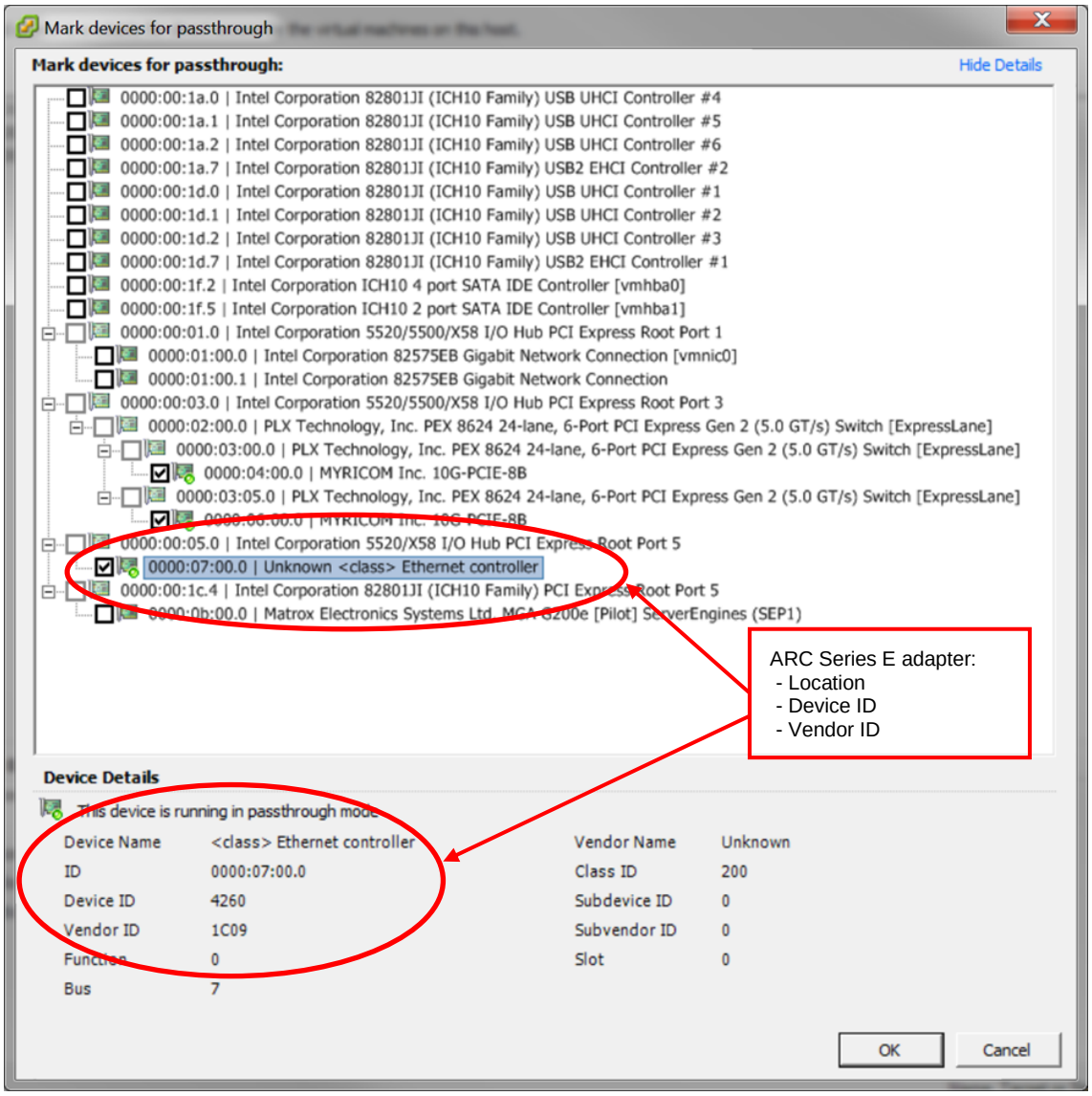
1. Log on to the vSphere client server and click the **Configuration** tab.
2. Select **Hardware > Advanced Settings**.

   The **DirectPath I/O Configuration** window appears, displaying all devices selected for pass-through mode. Note that the device list may be empty.

3. Click **Edit**.

   The **Mark devices for pass-through:** window appears.

   In this example, the ARC Series E adapter lists as "**0000:07:00.0 | Unknown <class> Ethernet controller**".



4. Check the box corresponding to the "**0000:07:00.0 | Unknown <class> Ethernet controller**" device that will pass through to the Guest Virtual Machine.

   The **Device Details** section lists the Device ID and Vendor ID attributes as **"4260"** and **"1C09"** respectively that correlate with the ARC Series E network adapter hardware.

5. Click **OK** to close the dialog window.

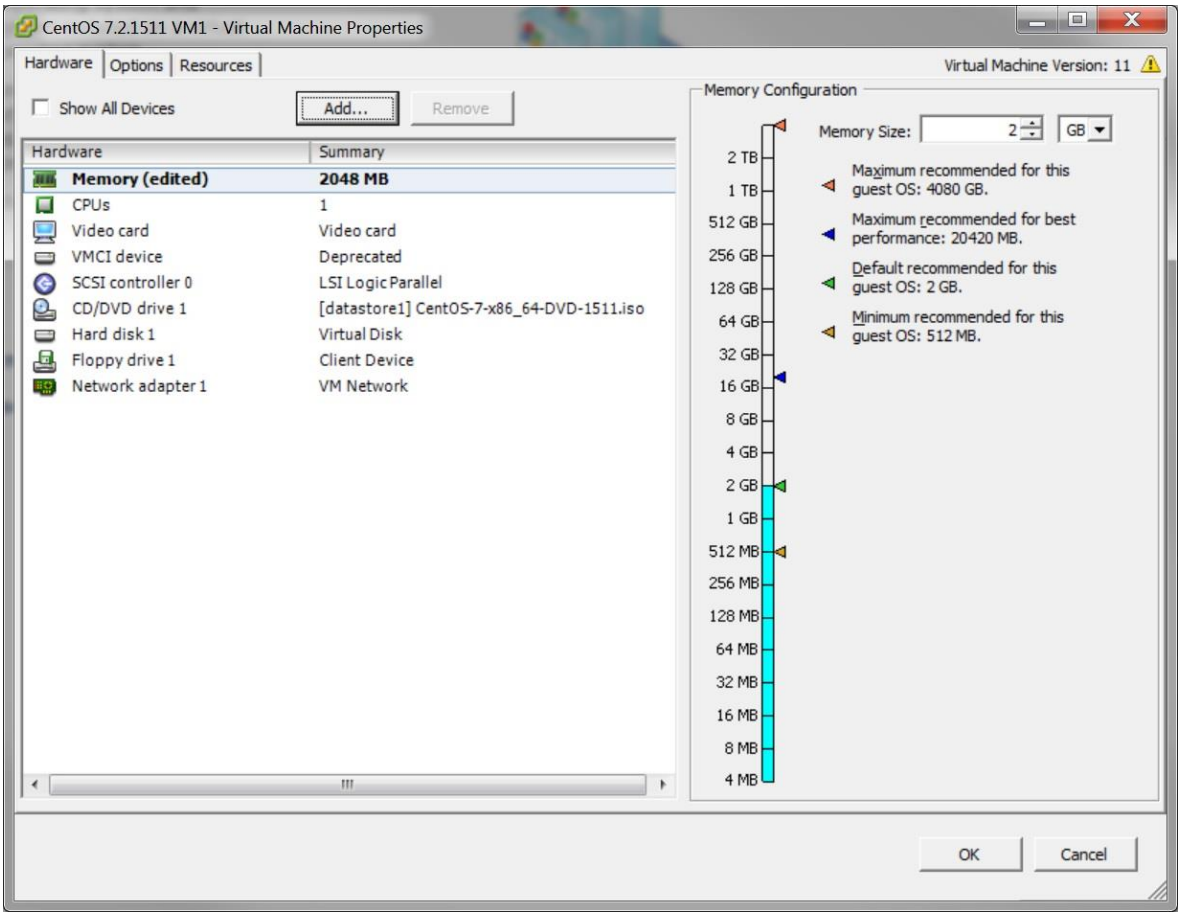
   The ARC Series E network adapter is now ready for pass-through mode and appears in the **DirectPath I/O Configuration** window.

5.5 Adding Pass-through Hardware to the Virtual Machine

To add the ARC Series E-Class adapter pass-through hardware to the VM, follow this procedure:

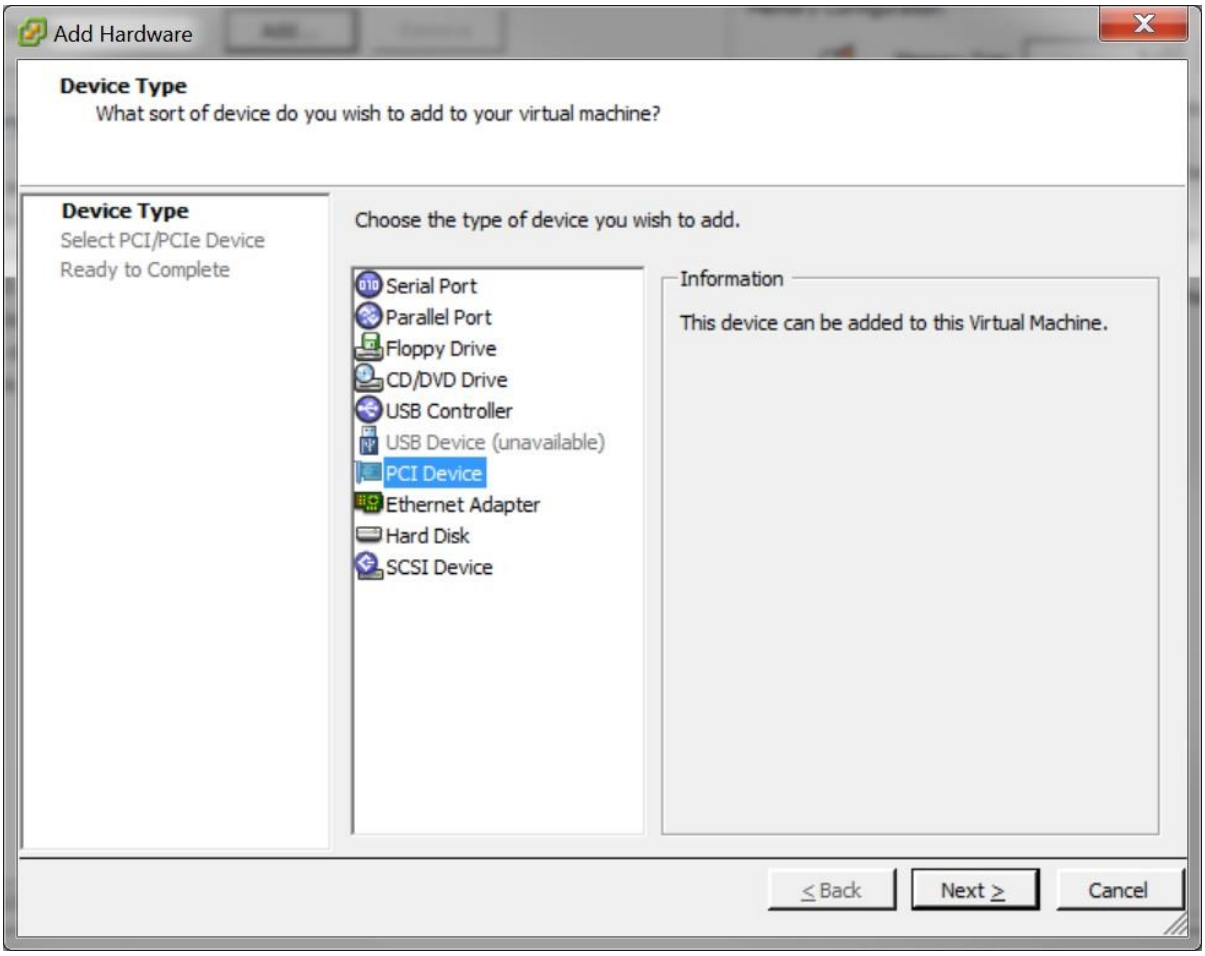
1. Log on to the VMWare server from the vSphere Client.
2. Double-click **Create a New Virtual Machine** to generate the new virtual machine.
3. Select the **Getting Started** tab and click **Edit virtual machine settings**.

   The **<VM Name> - Virtual Machine Properties** window appears.



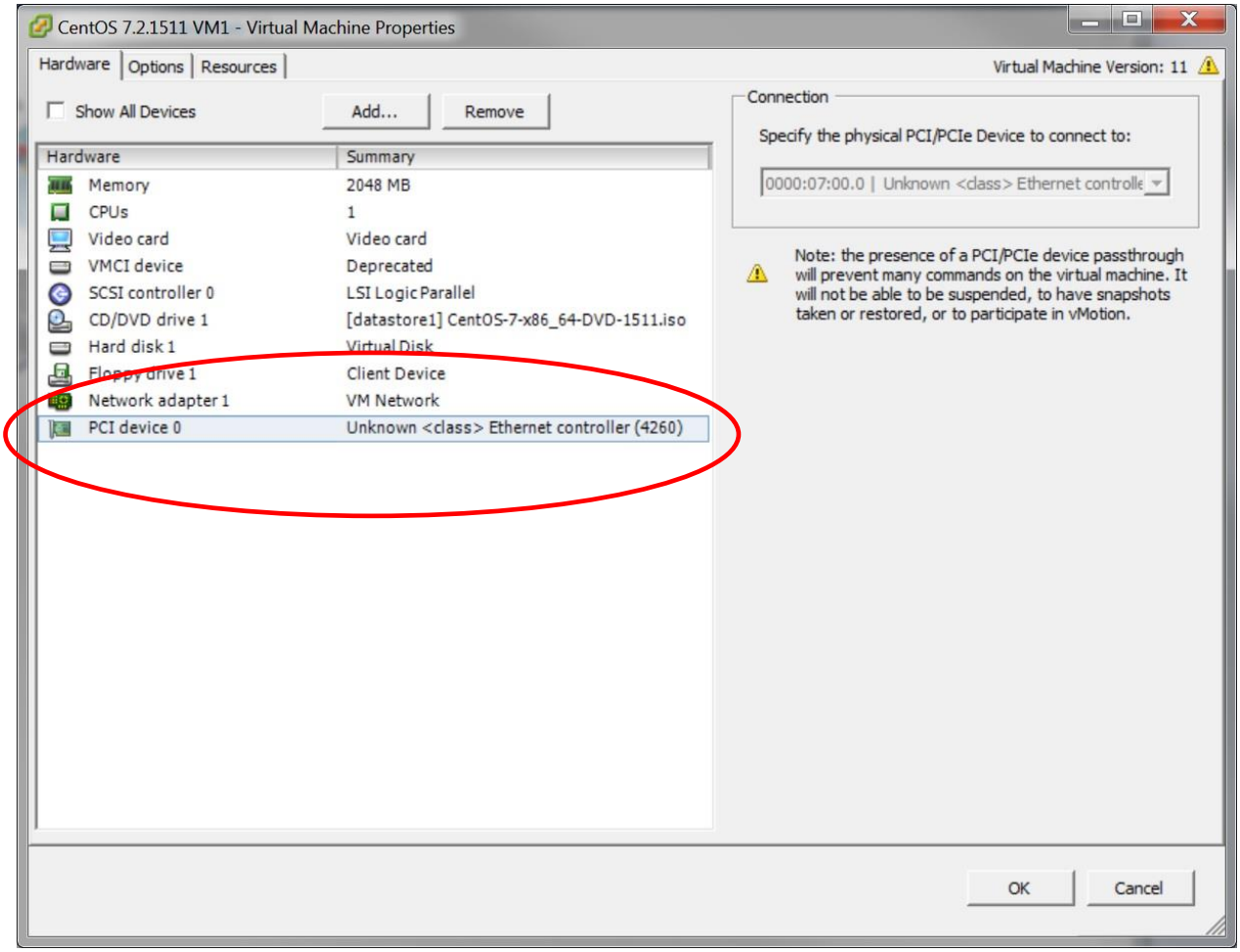
4. Click the **Add...** button.

   The **Add Hardware** window appears.



5. Click **PCI Device** to select the desired ARC Series E adapter hardware.
6. Click **Next**.
7. Select the pass-through ARC Series E adapter to connect to the virtual machine from the drop-down list.
8. Click **Next**.
9. Click **Finish**.
10. Click **Getting Started > Edit virtual machine settings** to confirm that the adapter is connected to the VM.

    The **<VM name> - Virtual Machine Properties** window appears, confirming ARC Series E adapter pass-through to the VM.



5.6 Installing the SNFv5.3.2.11 Software to the VMware Server

Once the ARC Series E network adapter is installed and recognized in VM, install the SNFv5.3.2.11 software package as described in the *Installing the SNFv5.3.2.11 RPM Software Package for Linux* section of *Installing SNFv5.3.2.11 Software in Linux.*

5.7 Flashing ARC Series E Adapter Hardware

ATTENTION:	It is possible to flash the ARC Series E adapter once it is installed in the VM server. However, we do not recommend this procedure. Proceed with caution.

To flash the ARC Series E adapter once it is installed in the VM server, follow the steps:

1. Power-cycle the VM server once flashing is completed. Rebooting the VM is not sufficient.
2. Delete the adapter from the list of devices available for pass-through mode on the VM server operating system.
3. Add the adapter back to the list of devices available for pass-through mode on the VM server operating system.
4. Remove the adapter from the PCIe expansion slot.
5. Reinstall the adapter in the PCIe expansion slot.

> For more information on installing the adapter, refer to the *Installing the ARC Series E Network Adapter* section of *Installing the ARC Series E Adapter Hardware*

6 Verifying SNFv5.3.2.11 Software Installation

SNFv5.3.2.11 software installation test programs are available from:

- **/opt/snf/bin/tests** of the install directory in binary form
- **/opt/snf/share/examples**

6.1 Basic Test

To verify that the SNFv5.3.2.11 software is properly installed, run **snf_simple_recv** to generate the packets for injection followed by **snf_pktgen** to receive the packets. This test is sufficient to verify proper software installation, network adapter hardware connectivity, and the expected packet rate for the SNFv5.3.2.11 software.

6.1.1 Before you start

This test assumes the following:

- The **/opt/snf/bin/tests/** directory has been added to the current **$PATH** variable.
- An ARC Series E network adapter has been installed.
- SNFv5.3.2.11 software has been loaded on both a “server” host and a “client” host.
- The default adapter port on the server is physically connected (via a cable) to the default adapter port on the client. In other words, the server host and the client host are connected in a point-to-point (switchless) configuration.
- If both the server adapter and the client adapter have two physical ports, the default adapter port is port 0 (the port closest to the PCI connector and also the port with the lower MAC address), and it is assumed that port 0 of the server adapter is physically connected to port 0 of the client adapter.
- Run the **snf_simple_recv** process on the client first before running the packet generator **snf_pktgen** on the server.
- Exit the **snf_pktgen** packet generator on the server first before exiting the **snf_simple_recv** process on the client.

NOTE:	Reversing the process causes the overflow counter to increase. With no SNFv5.3.2.11 program to consume packets through SNF API, the packets are delivered instead to the Ethernet portion of the driver. The driver attempts to drop them as fast as possible, but cannot sustain the packet rate.

6.1.2 Running the test

To test that the SNFv5.3.2.11 software is properly installed, enter the following:

1. On the server host system, open a command window.
2. Enter the following command to generate one billion 60-byte packets:

   ```
   $ sudo snf_pktgen -s 60 -n 1000000000
   ```

3. On the client host system, open a command window.
4. Enter the following command:

   ```
   $ sudo snf_simple_recv -t
   ```

   The following output appears.

   Output:

```
14843291 pkts (890597460B) in 1.001 secs (14827884 pps), Avg
Pkt: 60, BW (Gbps): 7.117

14843663 pkts (890619780B) in 1.001 secs (14828242 pps), Avg
Pkt: 60, BW (Gbps): 7.118

14841101 pkts (890466060B) in 1.001 secs (14825697 pps), Avg
Pkt: 60, BW (Gbps): 7.116

14845703 pkts (890742180B) in 1.001 secs (14830250 pps), Avg
Pkt: 60, BW (Gbps): 7.119

14842322 pkts (890539320B) in 1.001 secs (14826946 pps), Avg
Pkt: 60, BW (Gbps): 7.117

14842292 pkts (890537520B) in 1.001 secs (14826902 pps), Avg
Pkt: 60, BW (Gbps): 7.117

14843007 pkts (890580420B) in 1.001 secs (14827601 pps), Avg
Pkt: 60, BW (Gbps): 7.117

14842392 pkts (890543520B) in 1.001 secs (14826942 pps), Avg
Pkt: 60, BW (Gbps): 7.117
```

The test output generates the packet rate per second (pps). The expected packet rate is 14.8 Mpps, on a 60-byte packet line rate.

> To test your SNF software, go to *Testing SNFv5.3.2.11 Software*

7 PHX-TOOLS Network Adapter Toolkit

This chapter includes the following topics:

- PHX-TOOLS Description
- Features and Enhancements
- General Information on the ARC Series E Network Adapter
- Upgrading FPGA Firmware in Linux
- Tracking Environmental Diagnostics on ARC Series E Network Adapters
- Tracking SFP+ Diagnostics on ARC Series E Network Adapters

The Linux diagnostic tools packages is listed as the **Toolkit – Phoenix Group** or PHX-TOOLS (phx-tools-1.40.tar.gz) in the ARIA Customer Portal. It is similar to the **myri-tools.tar.gz** packages in previous hardware generations (**Myri-10G**) except under different tool names. Various tool options and outputs have also changed to reflect ARC Series E network adapter requirements.

7.1 PHX-TOOLS Description

The PHX-TOOLS network adapter toolkit allows users to run diagnostics on ARC Series E network adapter operation and flash memory FPGA firmware programming.

The PHX-TOOLS toolkit contains the following command-line tools:

MYRI_INFO	Displays ARC series E adapter diagnostic information
PHX-REPLACE-EEPROM -	Programs the FPGA firmware into flash memory
PHX-SCAN -	Tracks and records environmental diagnostics from ARC Series E network adapters
MYRI_PHX_MDIO	Retrieves SFP+ transceiver modules diagnostics from ARC Series E network adapters

The toolkit currently supports the following network card format:

- 10G-PCIE3-8E-2S with two SFP+ cages
- 10G-PCIE3-8E-4S with four SFP+ cages

7.2 Features and Enhancements

The PHX-TOOLS version 1.40 release describes the toolkit's individual features, bug fixes, and limitations. For a full description, refer to *Appendix 6: Network Adapter Toolkit - v. 1.40*

We recommend that users migrate to this release at their earliest convenience.

7.3 Network Adapter Diagnostic Information (myri_info)

The **myri_info** command displays 10G-PCIE3-8E-2S and 10G-PCIE3-8E-4S diagnostic information such as product code, serial number, MAC address, FPGA flash image version, and so on.

Linux

Command line:

```
$ sudo ./myri_info
```

Output:

```
pci-dev at 01:00.0 vendor:product(rev)=1c09:4260(01)
        behind bridge root-port: 00:01.0 8086:0c01 (x8.3/x16.3)
Myri-10G-PCIE-8E -- Link x8
   EEPROM String-spec:
        MAC=00:60:dd:43:2d:e8
        SN=495892
        PC=10G-PCIE3-8E-4S
        PN=09-04680
        BOM=A

   Firmware:
      Version: 2.1.5
      Type   : SNF
      Config : 4 Port x 10 Gb
      SHA1   : 2d13f73ad9fe4bd4bda8d7b50dd0ad0b

   External Inputs:
      PPS: Enabled, No Input
           Front Panel PPS: No Input
           Card Edge PPS:   No Input
       10Mhz Clock: Disabled
      100Mhz Clock Locked:  Locked
```

7.4 Upgrading FPGA Firmware in Linux

SNF-5.3.2.11 supports a variety of firmware downloads for 1Gbit and 10Gbit adapter speeds. Run **lspci** to view all available firmware modules from the PHX-TOOLS package by adapter speed and configuration.

Every network adapter format has a different firmware image, which is not interchangeable. For example, a firmware image for the dual-port 10G-PCIE3-8E-2S network adapter is **fw-8E-2S-SNF_10G-2.1.5.bin** and **fw-8E-4S-SNF_10G-2.1.5.bin** for the quad-port 10G-PCIE3-8E-4S network adapter.

> For a comprehensive list of 1G and 10G firmware modules, go to *Appendix 4: SNF-5.3.2.11 Firmware*

7.4.1 Upgrading FPGA firmware (phx-replace-eeprom)

NOTE:	Before you upgrade the FPGA firmware in Linux, verify that the SNFv5.3.2.11 driver is *not* loaded, otherwise the FPGA firmware will not program.

1. To prevent the SNFv5.3.2.11 software driver from loading, enter the following command:

   ```
   $ sudo /etc/init.d/myri_start_stop stop
   ```

2. Enter the following command to program the FPGA firmware into flash memory:

   ```
   $ sudo ./bin/phx-replace-eeprom ./fw-8E-4S-SNF_10G-2.1.5.bin
   ```

   A progress bar appears displaying the programming and verification pass status.

   Output:

```
Preparing to reprogram firmware on unit 0 (129:0.0)

Programming EEPROM with fpga image contained in ./fw-8E-4S-SNF_10G-2.1.5.bin
16006908

Please do not turn off power while flash is being programmed.

Do you want to continue (enter yes)?yes

   Loading.... ##################################################|
100%

   Verifying.. ##################################################|
100%

   Flash verification succeeded!

   Power cycle the system to enable the new firmware.
```

3. Power-cycle the machine to load the new firmware. A reboot/restart is not sufficient.
4. In the event there are repeated programming or verification errors, run the command again,

   OR

   Power-cycle the machine and run the command again.
5. Enter the following command to confirm that the new firmware is running:

   $ sudo ./bin/myri_info

   Output:

```
Version: 2.1.5
Type   : SNF
Config : 4 Port x 10 Gb
SHA1   : 2d13f73ad9fe4bd4bda8d7b50dd0ad0b
```

7.5 Tracking Environmental Diagnostics on ARC Series E Network Adapters (phx-scan)

Enter the following command line to track and record environmental diagnostics from ARC Series E network adapters:

Command line:

$ sudo ./phx-scan

Output: FPGA Revisions

```
K35 FPGA Revisions:
Rev: 0x00350001
Branch: 0x00010010
```

Output: Sensor Records

```
K35 Sensor Records:
Sensor 0: FPGA Core Temperature
Sensor 1: FPGA Local Temperature
Sensor 2: Over Temperature Alert
Sensor 3: Fan Speed Percentage
Sensor 4: Fan RPMs
Sensor 5: Power Management Good
Sensor 6: Power Management Alert
```

Output: Sensor Readings:

```
Sensor Readings:
FPGA Core Temperature: VALUE=32.31 degrees C, STATE=OK
FPGA Local Temperature: VALUE=32.00 degrees C, STATE=OK
Over Temperature Alert: VALUE=1, STATE=OK
Fan Speed Percentage: VALUE=100% STATE=OK
Fan RPMs: VALUE=6064 STATE=OK
Power Management Good: VALUE=0, STATE=OK
Power Management Alert: VALUE=4, STATE=OK
```

The ARC Series E adapters have two temperature sensors: a FPGA Core Temperature sensor and a FPGA Local Temperature sensor.

The FPGA Local Temperature sensor default setting is 80 °C with a hysteresis of -5 °C. When the temperature exceeds 80 °C the sensor readings output is **`STATE=NOT OK`**. ARC Series E adapter functionality is not interrupted or affected when the temperature exceeds the desired range.

7.6 Tracking SFP+ Diagnostics on ARC Series E Network Adapters (myri_phx_mdio)

The MYRI_PHX_MDIO command retrieves SFP+ transceiver modules diagnostics from the 10G-PCIE3-8E-2S and 10G-PCIE3-8E-4S adapters.

Linux

Command line:

```
$ sudo ./bin/myri_phx_mdio -s
```

Output:

```
pci-dev at 05:00.0 vendor:product(rev)=1c09:4264(01) port 0

Reading SFP 0
SFP+ info:
        Type = SFP (0x3)
        Connector = LC (0x7)
        Compliance = 10GBASE-SR (0x10)
        Wavelength = 850 nm
        Vendor = [vendor name]
        PN = [part number]
        SN = [serial number]
        Date = 2016/03/28 (  )
        Current status:

        Temp = 28.5586 Celsius
        Vcc = 3.3306 V
        TX bias = 8.734 mA
        TX power = 0.5674 mW
        RX power = 0.6599 mW

10GBASE-R PHY Link Status UP for port 0.
```

8 Testing SNFv5.3.2.11 Software

After you have successfully installed SNFv5.3.2.11 software to your operating system, best practices recommend that you subject the SNFv5.3.2.11 software to a testing regimen. To that end, SNFv5.3.2.11 software offers several test programs to ensure optimum SNFv5.3.2.11 packet capture performance.

This chapter contains the following topics:

- Summary of Test Program Commands
- SNFv5.3.2.11 Test Program Requirements
- Sample Test Programs

8.1 Summary of Test Program Commands

- snf_basic_diags
- snf_simple_recv
- snf_multi_recv
- snf_bridge
- snf_pktgen
- snf_replay

8.2 SNFv5.3.2.11 Test Program Requirements

Review the following requirements to take full advantage of the SNFv5.3.2.11 test program features.

8.2.1 Adapter port nomenclature

Many SNFv5.3.2.11 example test programs require a **-p <port>** as a command line argument. The port number refers to the physical connector port on the network adapter.

All ARC Series E network adapter ports are numbered, beginning at zero. If the network adapter has two physical ports, the port closest to the PCI connector is assigned “port 0” and the second port is assigned “port 1”. Port 0 also corresponds to the lower MAC address of a dual-port adapter. Quad-port ARC Series E network adapters have four physical ports: “port 0”, “port 1”, “port 2”, and “port 3”, respectively.

> For more information on port numbering, go to *Testing the ARC Series E Adapter Hardware*

For multiple network adapters installed on the server, the adapter port numbers are assigned in the order in which they are detected by the BIOS. Refer to the output of **myri_nic_info -B** to determine the port numbering sequence, as described in the *Summary of Diagnostic Tool Programs* section of *Running SNFv5.3.2.11 Diagnostic Tool Programs*

8.3 Sample Test Programs

The SNFv5.3.2.11 sample test programs can be found in the **/opt/snf/bin/tests/** directory.

Summary of SNFv5.3.2.11 test program commands

- snf_basic_diags
- snf_simple_recv
- snf_multi_recv
- snf_bridge
- snf_pktgen
- snf_replay

8.3.1 snf_basic_diags

A nice adapter smoke test. The program is not as detailed as **phx_bug_report**, which delves more into system information.

Definition:

`snf_basic_diags`

Usage:

```
./snf_basic_diags [options]
```

Command line [options]:

```
enp2s0       portnum=0 mac_addr=00:60:dd:43:2e:04 maxrings=32 maxinject=0
link_speed 10 Gbps

enp2s0-snf1  portnum=1 mac_addr=00:60:dd:43:2e:05 maxrings=32 maxinject=0
link_speed 10 Gbps

test_getifaddrs() found 2 devices

snf_open test: First port                      portnum =       0 successful

snf_open test: First port                      portnum =       0
snf_ring_open() successful

snf_open test: All valid ports                 portmask=     0x3 successful

snf_open test: All valid ports                 portmask=     0x3
snf_ring_open() successful

snf_open test: All ports with a link up        Skipping since no ports are UP
```

```
snf_open test: Invalid port request           portnum =      31 failure=11:
Resource temporarily unavailable

snf_open test: Invalid port request           portnum =      31 does NOT have
to pass

port=0, link status is down timesource is local host (no external)

port=1, link status is down timesource is local host (no external)

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 500 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

snf timeout test on port 0 passed

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 500 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 500 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 500 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 500 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

test_recv_timeout for 500 msecs returned 11 after 499 msecs

snf timeout test on port mask 0x3 passed

test_inject@0 host sent 2 packets (wait for stats update)

test_inject@0 NIC  sent 2 packets was a SUCCESS

test_inject@1 host sent 2 packets (wait for stats update)

test_inject@1 NIC  sent 2 packets was a SUCCESS

test_cancel_recv via pthread_kill started over 4 rings and threads

test_cancel_recv via pthread_kill started over 4 rings and threads was a
SUCCESS

test_cancel_recv via pthread_kill started over 8 rings and threads

test_cancel_recv via pthread_kill started over 8 rings and threads was a
SUCCESS
```

8.3.2 snf_simple_recv

The snf_simple_recv test program demonstrates usage of **snf_ring_recv().**

Definition:

`snf_simple_recv`

Usage:

```
./snf_simple_recv [-v] [-t]  [-p <port number>] [-p] [-n <num pkts>] [-d <ring
sz>] [-S <snap len>] [-m <pkts>]
```

Command line [options]:

```
    -v: verbose
    -t: print periodic statistics, -t -t: also print timestamp mode
    -p <port number>: Myri10G port number to use.
    -T <timeout>: Wait for at most <timeout> milliseconds between calls, 0
never blocks
    -n <num pkts>: number of packet to receive (default: 0 - infinite)
    -d <ring sz>: size if the recieve ring in bytes
    -S <snap len>: display first <snap len> bytes of each packet
    -D: display nanosecond delta from timestamp of prior packet
    -R <port number>: reinject every received packet on port <portnum>
    -N: pass every received packet to netdev
    -O: do not check out-of-order packet timestamps
    -m <pkts>: print verbose output every <pkts> packets (need -v)
   --help: Display this help, and exit
```

8.3.3 snf_multi_recv

The test program snf_multi_recv demonstrates **snf_ring_recv_many()** and **snf_ring_recv()** function call usage.

Definition:

`snf_multi_recv`

Usage:

```
 ./snf_multi_recv -w <num_workers> [options]
```

Command line [options]:

```
options:
    -p <port number>: Myri10G port number to use.
    -n <num pkts>: number of packet to receive (default: 0 - infinite)
    -t: show periodic stats, every second
    -V: validate incoming packets
    -v: verbose, or -vv very verbose
    -d <ring sz>: size of the receive ring in bytes, or megabyte
    -D <nanosecs>: add <nanosecs> of synthetic processing delay in packet
handling
    -W <msecs>: timeout of <msecs> in blocking receive calls
    -S <snap len>: display first <snap len> bytes of each packet
    -R <port number>: reinject every received packet on port <portnum>
    -A <app_id>: set application ID
    -q <core>[,<core>]: thread ID to which assign the respective workers.
Should match <num_workers>
    -O: do not check out-of-order packet timestamps
   --help: Display this help, and exit.
```

8.3.4 snf_bridge

A test program that creates a transparent bridge to analyze traffic on one device and to replay it on another.

Definition:

`snf_bridge`

Usage:

```
./snf_bridge [options] -b <...> [ -b <...> ... ]
```

Command line [options]:

```
options:
    -b <board_source>:<board_dest>:<num_rings>[:<0xcpumask>]
     <board_source> is where to capture packets
     <board_dest>   is where to forward packets
     <num_rings>    is the number of rings/workers to dedicate to capture
     <cpumask>      is an optional binding cpumask in hexadecimal

    -n <num_packets>: Number of packets to forward before exiting
    -N <tx_try_again>: Number of times to try injecting before dropping packet
    -W <tx_wait_msecs>: Number of milliseconds to wait in snf_inject_send
     R: Reflect non UDP and TCP packets to network device
   --help: Display this help, and exit.
```

8.3.5 snf_pktgen

A test program that generates packets for injection.

Definition:

`snf_pktgen`

Usage:

```
./snf_pktgen [options]
```

Command line [options]:

```
 -v: Print verbose output
 -p <config>: Configure threads (max: 8), where
    <config> = <board>[:<nthreads>[:<cpumask>]] (default: 0:1)
 -q <coreID>: CPU ID to assign respective workers
 -n <count>: Number of packets to send per thread (default: infinite)
 -r <x.y>: Replay at x.y Gbits/s (per thread, not aggregate)
 -c <climb_spec>: Replay starting at x.y Gbits/s (per thread, not aggregate),
                  <climb_spec> = <x.y>:[climb_sec] (climb_sec defaults to 3sec)
                  then increment by x.y Gbits after climb_sec expired
 -C <climb_spec>: Same as -c except that bandwidth starts decreasing once it
hits 10Gbps
                   When it reaches the starting bandwidth, it increases again
                   then increment by x.y Gbits after climb_sec expired
 -f <sec>: Replay at random [0.1-10.0] Gbits/s (per thread, not aggregate)
           Bandwidth changes every <sec> seconds
 -F <x.y>:<max_sec>: Same as -C except that bandwidth periods vary randomly
                     <x.y> is the starting bandwidth, and the period is random
[1, <max_sec>]
 -R <x.y>: Replay at x.y Mpps (per thread, not aggregate)
 -d <delay_ns>: Delay in nanoseconds between start of each packet
 -W: Wait instead of busy-poll when injecting packets
 -E <src mac>-<dst mac>: Source-destination MAC address
 -I <src ip>-<dst ip>: Source-destination IP address
 -s <size>: Packet size (default: 60)
 -S <src port>: Source port
 -D <dst port>: Destination port (-s/S/D only)
    For rand/seq ranges, specify <min value>-<max value>:{R,S}
--help: Display this help, and exit
```

8.3.6 snf_replay

A test program that uses SNF-level injection to replay a **libpcap** file.

NOTE:	You must have enough available memory to accommodate the **libpcap** file you are attempting to replay.

Definition:

`snf_replay`

Usage:

```
./snf_replay [options] <file.pcap>
```

Command line [options]:

```
            -v: Print verbose output
     -p <port>: Myri10G port number to use
    -n <count>: Maximum number of packets to send from pcap file
  -t <nthreads>: Number of threads to concurrently send (max: 16)
    -i <iters>: Number of times to replay the file on each thread
   -T <vlan_id>: Insert a vlan tag for packets without VLAN tags
      -r <x.y>: Replay at x.y Gbits/s (per thread, not aggregate)
      -R <x.y>: Replay at x.y Mpps (per thread, not aggregate)
            -z: Replay according to packet timestamp
            -Z: Use injection pacing according to packet timestamp
            -N: Packets are stored with nanosecond precision
            -F: Disable setting thread affinity
            -m: Read pcap file into memory first
                Note - Make sure your pcap file fits in available memory
  -e <trace_id>: Generate a packet trace and send per timestamp
                 <trace_id> (0, 1, ...) specifies a trace.
                 0 = one 60B packet every 100nsec
                 1 = one 60B packet every 500nsec
                 2 = one 60B packet every 1usec
                 3 = one 60B packet every 2usec
                 4 = one 60B packet every 5usec
                 5 = one 60B packet every 10usec
  -E <trace_id>: Receive and compare timestamps against the generated trace
        --help: Display this help, and exit
```

The [**-m**] command line option reads the **libpcap** file into memory, and then replays it from memory instead of from a disk. This option allows it to achieve line rate (if your machine/memory is fast enough) for small packets.

The [**-Z**] flag calculates the deltas between packets in the **libpcap** file and passes them to the **snf_inject_sched()** call.

The **[-z]** flag uses an alternate delay method to pass zero to the **DELAY_NS** parameter.

The [**-N**] flag detects the nanosecond timestamp in **libpcap** files and opens them in **PCAP_STAMP_PRECISION_NANO**.

9 Running SNFv5.3.2.11 Diagnostic Tool Programs

The SNFv5.3.2.11 software package includes diagnostic tool programs, found in the **sbin/** and **bin/** directories. Some tools may be required to run as root.

Most of the diagnostic tools generate diagnostic information for error reporting.

NOTE:	The SNFv5.3.2.11 diagnostic tool programs contain different arguments and outputs than in previous hardware generations. For example, the **myri_counters** and **myri_endpoint_info** outputs are noticeably different, which are described in this chapter.

9.1 Summary of diagnostic tool programs

- sbin/phx_bug_report
- sbin/myri_info
- bin/myri_counters
- bin/myri_endpoint_info
- bin/myri_nic_info

9.1.1 sbin/phx_bug_report (Linux only)

Run the **sbin/phx_bug_report** diagnostic bug report as root. Creates output as a compressed file.

Description:

sbin/phx_bug_report

Command Line:

$ sudo /opt/snf/sbin/phx_bug_report

Sample output from **phx_bug_report**.

Output:

```
Will collect system info in file:
     bugreport.test9-2016-08-16_160853.txt.gz

     Gathering diagnostic information...

    bugreport.test9-2016-08-16_160853.txt.gz created
    Please send it to ARIA Technical Support via the case you have opened
    https://www.ariacybersecurity.com/support/downloads/
    or ARIA support@ariacybersecurity.com
    and include a description of your problem.
```

9.1.2 sbin/myri_info

Provides network adapter information, such as hardware serial number, MAC address, firmware version, and so on.

Description:

sbin/myri_info

Command line [options]:

$ sudo /opt/snf/sbin/myri_info [options]

Usage:

```
-b <board_num>   -- only print info about a card instance <board_num>
                    <board_num> is rank if decimal, or pci_bus if hex
-v               -- verbose: more details about the card(s)
-vv              -- very verbose: even more details
-x               -- select only LX-based card (D, E, F)
-z               -- select only LZ-based 10G cards
-s <spec_file>   -- save the string_specs into file <spec_file>
-c               -- on z-cards, checks the MCP(s) CRCs
-n               -- don't try to use MMIO (to be used when MMIO fails)
-h               -- show this help screen
```

9.1.3 bin/myri_counters

Generates output for low-level network adapter counters.

Description:

bin/myri_counters

Command line [Help]

$ sudo /opt/snf/bin/myri_counters -h

Usage:

```
Usage: myri_counters [args]
-p N - Port number or Ethernet MAC
-b N - Port number or Ethernet MAC
-c   - clear the counters
-q   - quiet: show only nonzero counters
-i   - show host interrupt counters
-x   - expert: show all counters
-o   - show register offset
-r   - raw: show register contents
-e N - show counters for specified endpoint [0]
-a   - show counters for all endpoints
-v   - show all counters
-F   - show filter state including all registered filters
-M   - show MAC filters, if available
-h   - help
```

Resetting the counters

To clear counters on a specific port of the network adapter, enter the following command line:

Command line:

```
$ sudo /opt/snf/bin/myri_counters -p <port_num> -c
```

Resetting counters requires root privileges.

> For more information on **myri_counters**, go to *Appendix 1: SNFv5.3.2.11 Counters*

9.1.4 bin/myri_endpoint_info

Identifies which processes consume adapter-level resources, such as endpoints. It also tracks which process IDs are in use.

Description:

```
$ sudo bin/myri_endpoint_info
```

Command line [options]:

```
$ sudo /opt/snf/bin/myri_endpoint_info [options]
```

Usage:

```
-b - Board mac or number [0]
-h - help
```

9.1.5 bin/myri_nic_info

Provides diagnostic information on the number of adapters installed, which driver is loaded, and the status of the software license(s) for each network adapter.

Description:

```
$ sudo bin/myri_nic_info
```

Command line [options]:

```
$ sudo /opt/snf/bin/myri_nic_info [options]
```

Usage:

```
--machine : Comma separated output (for machine parsing)
--all     : Print all known nics. (may need root privileges)
--license : Print license state details
--help    : Print this help message
```

10 Configuring SNFv5.3.2.11

This chapter describes the following topics:

- Debug Variable
- Ring Management Variables
- RSS Hashing/Load Balancing Variables
- Port Aggregation and Merging Variables
- Traffic Management Variable
- Kernel Ethernet Interfaces

This chapter describes the SNFv5.3.2.11 environment variables available to configure advanced functions so that they match application needs and perform efficiently. The following SNFv5.3.2.11 environment variable categories are described as follows:

Debug variable

SNF_DEBUG_MASK

Ring management variables

SNF_RING_ID

SNF_NUM_RINGS

SNF_DATARING_SIZE

SNF_DESCRING_SIZE

RSS hashing/load balancing variable

SNF_RSS_FLAGS

Port aggregation and merging variable

SNF_FLAGS

Traffic management variable

SNF_APP_ID

10.1 Debug Variable (SNF_DEBUG_MASK)

The debug environment variable enables the SNFv5.3.2.11 library to print various debug information, including configurations, to the console.

Example 1:

To verify that a SNF-compatible **libpcap** library is correctly linked to the application, set **SNF_DEBUG_MASK** to **0x3** and open the **snfX** device, as follows:

```
$ SNF_DEBUG_MASK=0x3 /path/to/tcpdump -i snf0
```

Setting the **SNF_DEBUG_MASK** variable causes the SNF API to display SNFv5.3.2.11 configuration information when **libpcap** opens **snfX**.

If no output appears, the application may be linked to a version of **libpcap** that is not compatible with SNF. Monitor **myri_counters** to verify that traffic is being received.

Example 2:

Similarly, you can run **SNF_DEBUG_MASK=0x3** with RSS hashing flags to ensure that the SNFv5.3.2.11 application is correctly linked to the SNF library.

```
$ SNF_DEBUG_MASK=0x3 SNF_RSS_FLAGS=0x1 ./snf_simple_recv
```

Output:

```
snf.0.0 P (userset) SNF_PORTNUM = 0
snf.0.0 P (default) SNF_RING_ID = -1 (0xffffffff)
snf.0.0 P (default) SNF_NUM_RINGS = 1 (0x1)
snf.0.0 P (default) SNF_RSS_FLAGS = 1 (0x1)
snf.0.0 P (default) SNF_DATARING_SIZE = 268435456 (0x10000000) (256.0 MiB)
snf.0.0 P (default) SNF_DESCRING_SIZE = 67108864 (0x4000000) (64.0 MiB)
snf.0.0 P (default) SNF_FLAGS = 0
snf.0.0 P (environ) SNF_DEBUG_MASK = 3 (0x3)
snf.0.0 P (default) SNF_DEBUG_FILENAME = stderr
...
```

> For more information on **snfX** numbering and how it corresponds to host network adapters, go to the *Numbering of snfX Interfaces* section in *Troubleshooting*

10.2 Ring Management Variables

The ring management variables are:

- SNF_RING_ID
- SNF_NUM_RINGS
- SNF_DATARING_SIZE
- SNF_DESCRING_SIZE

To view the RING management variable settings, run the SNF API application with the environment variable **SNF_DEBUG_MASK=3**. The **snf_open()** function call displays the current variable settings and how they were set (hard-coded by the application or the default value).

Example:

Command line:

```
$ SNF_DEBUG_MASK=3 ./snf_simple_recv
```

Output:

```
snf.0.-1 P (userset)              SNF_PORTNUM = 0
snf.0.-1 P (default)              SNF_RING_ID = -1 (0xffffffff)
snf.0.-1 P (default)            SNF_NUM_RINGS = 1 (0x1)
snf.0.-1 P (environ)            SNF_RSS_FLAGS = 1 (0x1)
snf.0.-1 P (default)    SNF_DATARING_SIZE = 16777216 (0x1000000) (16.0 MiB)
snf.0.-1 P (default)    SNF_DESCRING_SIZE = 4194304 (0x400000) (4.0 MiB)
snf.0.-1 P (default)                SNF_FLAGS = 0
snf.0.-1 P (environ)           SNF_DEBUG_MASK = 3 (0x3)
snf.0.-1 P (default)       SNF_DEBUG_FILENAME = stderr
```

10.2.1 SNF_RING_ID

When running multiple rings, each program can either open the next available ring, or a specific ring. By default **SNF_RING_ID=-1**, opens the next available ring. In a particular instance where an application wants to open a specific ring, SNF_RING_ID is set to a value between **0** and **SNF_NUM_RINGS - 1**.

For example, if we set **SNF_NUM_RINGS=4**, we would expect to run four instances of an application, such as **Bro** or **tcpdump**; each one getting roughly one-quarter of the packets. By specifying **SNF_RING_ID=-1**, the first application will open the first ring (ring **0**), the second application will open the second ring (ring **1**), the third application will open the third ring (ring **2**), and the fourth application will open the last ring (ring **3**).

By specifying which ring to open, the application selects the ring in question, as opposed to the next available ring.

Example:

Specifying which ring to open:

```
$ SNF_RING_ID=0 tcpdump -i snf0 &
$ SNF_RING_ID=1 tcpdump -i snf0 &
$ SNF_RING_ID=2 tcpdump -i snf0 &
$ SNF_RING_ID=3 tcpdump -i snf0 &
```

If one of these applications should die, you can restart the correct ring to continue.

10.2.2 SNF_NUM_RINGS

SNF_NUM_RINGS represents the number of rings the SNFv5.3.2.11 application supports. The maximum number of rings that SNFv5.3.2.11 can support per adapter port is 32. While the SNF_NUM_RINGS ranges from 1 to 32, the SNF_RING_ID ranges from 0 to 31. By default, **SNF_NUM_RINGS=1**.

Command line (Default):

```
SNF_NUM_RINGS=1
```

Assigning more than 32 rings per adapter port prompts the following **`myri_snf WARN:`** message.

Output [WARN]:

```
myri_snf WARN: eth2: endpt XX, early enable failed
```

In Linux, the user may utilize **`taskset`** to explicitly bind ring threads to different processors.

10.2.3 SNF_DATARING_SIZE

The SNF_DATARING_SIZE variable represents the total available memory to store incoming packet data. If the value is set to zero or less than zero, the library opts for a practical default unless SNF_DATARING_SIZE is set in the environment. The library may also adjust the user's request to satisfy alignment requirements (typically 2MB boundaries). By default, **SNF_DATARING_SIZE=16MB**. The value may be specified in megabytes or in bytes, depending on size.

Command line (Default):

```
SNF_DATARING_SIZE=16MB
```

Increasing the SNF_DATARING_SIZE (and its corresponding SNF_DESCRING_SIZE variable) allows the application to buffer a greater number of packets. It may be useful to handle bursty traffic while avoiding packet losses.

NOTE:	Increasing the data ring size also increases process start-up time. For maximum performance limit the aggregate ring size for data and descriptor rings to the L3 cache size.

For more information on L3 cache size, go to the *L3 Cache Awareness* section in *Tuning SNFv5.3.2.11 Software*

10.2.4 SNF_DESCRING_SIZE

The SNF_DESCRING_SIZE variable sets the size of the descriptor ring. The ring stores packet metadata such as timestamp and length in main memory. The descriptor ring is typically sized to be a quarter the size of the data ring, and allows for small packets (60 bytes). In most cases the descriptor ring will fill up before the data ring.

For example, if a user increases the size of the data ring to 32MB, we recommend adjusting the descriptor ring size to a quarter of 32MB or 8MB.

Command line (Default):

```
SNF_DESCRING_SIZE=4MB
```

NOTE:	The maximum permissible level of configured memory assigned to all rings is 80 percent of physical memory. For maximum performance, limit the aggregate ring size for data and descriptor rings to the L3 cache size.

For more information on L3 cache size, go to the *L3 Cache Awareness* section in *Tuning SNFv5.3.2.11 Software*

10.3 RSS Hashing/Load Balancing Variables (SNF_RSS_FLAGS)

RSS hashing flags are set via the environment variable SNF_RSS_FLAGS.

To view SNF_RSS_FLAGS variable settings, run the SNF API application with the environment variable **SNF_DEBUG_MASK=3**. The **snf_open()** function call displays the current variable settings and how they were set (hard-coded by the application or by the default value).

Example:

```
$ SNF_DEBUG_MASK=3 SNF_RSS_FLAGS=0x1 ./snf_simple_recv
```

Output:

```
snf.0.-1 P (userset)              SNF_PORTNUM = 0
snf.0.-1 P (default)              SNF_RING_ID = -1 (0xffffffff)
snf.0.-1 P (default)            SNF_NUM_RINGS = 1 (0x1)
snf.0.-1 P (environ)            SNF_RSS_FLAGS = 1 (0x1)
snf.0.-1 P (default)    SNF_DATARING_SIZE = 16777216 (0x1000000) (16.0 MiB)
snf.0.-1 P (default)    SNF_DESCRING_SIZE = 4194304 (0x400000) (4.0 MiB)
snf.0.-1 P (default)               SNF_FLAGS = 0
snf.0.-1 P (environ)           SNF_DEBUG_MASK = 3 (0x3)
snf.0.-1 P (default)       SNF_DEBUG_FILENAME = stderr
```

10.3.1 SNF_RSS_FLAGS default settings

By default, **SNF_RSS_FLAGS=0x31**. It tells the SNF library to generate RSS hash values based on IP addresses and TCP/UDP ports.

Command line (Default):

```
SNF_RSS_FLAGS=0x31.
```

The SNF_RSS_FLAGS definitions are found in the **/opt/snf/include/snf.h** header file. See Table 3 for the various RSS variable settings.

Output:

```
enum snf_rss_mode_flags {
SNF_RSS_IP = 0x01, /**< Include IP (v4 or v6) SRC/DST addr in hash */
SNF_RSS_SRC_PORT = 0x10, /**< Include TCP/UDP/SCTP SRC port in hash */
SNF_RSS_DST_PORT = 0x20, /**< Include TCP/UDP/SCTP DST port in hash */
SNF_RSS_GTP = 0x40, /**< Include GTP TEID in hash */
SNF_RSS_GRE = 0x80, /**< Include GRE contents in hash */
};
```

Output description:

SNF_RSS_IP - IP address

SNF_RSS_SRC_PORT - Source port

SNF_RSS_DST_PORT - Destination port

SNF_RSS_GTP - GPRS Tunneling Protocol

SNF_RSS_GRE - Generic Routing Encapsulation

To include GTP TEID in calculated hash:

Environment variable setting:

```
SNF_RSS_FLAGS=0x71
```

To include GRE in calculated hash:

Environment variable setting:

```
SNF_RSS_FLAGS=0xB1
```

Packet type	***Select RSS variable settings***	***Comments***
IP packets	SNF_RSS_IP	
IP packets (UDP, TCP or SCTP)	SNF_RSS_SRC_PORT SNF_RSS_DST_PORT	
Traffic tunneled through the GTP protocol	SNF_RSS_GTP	Assigns a Tunnel Endpoint Identifier (TEID) to the hash when the first payload byte indicates the packet is GTP version 1 or GTP version 2.
Traffic tunneled through the GRE protocol	SNF_RSS_GRE	Assigns the encapsulated GRE IP payload packet headers to the hash.
Ethernet frames bearing “non-hashable” traffic (MPLS or non-supported traffic)	No variable setting. Distributed to ring 0.	Distributed to ring 0.

Table 3. RSS variable settings.

Special Considerations

- RSS implementation works well for standard Ethernet traffic. However, if SNF-provided hashes do not perform well for the given network traffic, you can write a custom hash function in C language to direct the SNF library to compute hash values.
- You can also take advantage of the RSS multi-ring capabilities of load balancing across your application for network traffic types that are not handled well by the variables shown in Table 3.
- No packets are dropped regardless of packet type. Packet drops may indicate a bad cyclic redundancy check (CRC32) or an overflow, where either the adapter and/or the application cannot sustain the packet rate.

10.4 Port Aggregation (Merging) Variables (SNF_FLAGS)

The SNF_FLAGS environment variable controls process-sharing (0x1), port merging (0x2), and packet duplication (0x300). The following flags are found in the **/opt/snf/include/snf.h** header file:

- SNF_F_PSHARED 0x1
- SNF_F_AGGREGATE_PORTMASK 0x2
- SNF_F_RX_DUPLICATE 0x300

When port merging is enabled, SNFv5.3.2.11 merges traffic into a single logical receiver from:

- Two or more ports.
- From the same or different set of ARC Series E adapters.

10.4.1 SNF_F_PSHARED 0x1

The **SNF_FLAGS=1** environment variable allows multiple independent processes to share rings on the capturing device. This option may be used to design a custom capture solution, but it can also be used in **libpcap** when multiple rings are requested. In this scenario, each **libpcap** application sees a fraction of the traffic if multiple rings are used unless the SNF_F_RX_DUPLICATE option is used, in which case each **libpcap** application sees the same incoming packets.

Definition:

```
#define SNF_F_PSHARED 0x1
```

10.4.2 SNF_F_AGGREGATE_PORTMASK 0x2

ARC Series E adapters are amenable to port aggregation (merging). For example, if you set the SNF_FLAGS environment variable to two, (**SNF_FLAGS=2**), the portnum variable in **snf_ring_open()** call is interpreted as a bitmask, with a value of **1** assigned to port 0, **2** to port 1, and **3** to the merging of ports 0 and 1. The SNFv5.3.2 library then attempts to open every port specified in order to merge the incoming data from multiple ports. Subsequent calls to **snf_ring_open()** return a ring handle that internally opens a ring on all underlying ports.

Definition:

```
#define SNF_F_AGGREGATE_PORTMASK 0x2
```

Dual-port ARC Series E adapters:

The dual-port ARC Series E adapter has ports 0 and 1. When using **libpcap**, these ports are named **snf0** and **snf1**. With aggregation turned on, **libpcap** shows three devices: **snf1** (port 0), **snf2** (port 1), and **snf3** (port 0 and 1).

Quad-port ARC Series E adapters:

The quad-port ARC Series E adapter has ports 0, 1, 2, and 3. When using **libpcap**, these ports are named **snf0**, **snf1**, **snf2**, and **snf3** respectively. When port merging is enabled, the number represents a bitmask of ports. For example, **snf12** represents merging of ports 2 and 3.

10.4.3 SNF_F_RX_DUPLICATE 0x300

The SNF device can duplicate packets to multiple rings instead of applying RSS in order to split incoming packets across rings. Users should be aware that with '**n**' rings opened, '**n**' times the host processing power is necessary to process incoming packets without drops.

The duplication occurs in the host rather than the SNF device, so while only up to 10Gbps per port of traffic crosses the PCIe, '**n**' times that bandwidth is necessary on the host.

When duplication is enabled, RSS options are ignored since every packet is delivered to every ring.

Definition:

```
#define SNF_F_RX_DUPLICATE 0x300
```

10.5 Application ID Variable (SNF_APP_ID)

SNFv5.3.2.11 enables multiple independent applications to run in parallel, each receiving all the traffic and internally splitting the traffic among its application threads. For example, the user may run **Bro**, **Suricata**, and **tcpdump** at the same time.

The SNF_APP_ID environment variable assigns a unique application ID to each independent application to be run. With each application ID set, SNFv5.3.2.11 can then duplicate receive packets to multiple applications, with each application having a different number of rings. If the application has one process with multiple rings and threads, all rings share the same ID. If the application consists of multiple processes, these processes share the same application ID.

10.5.1 Running SNF_APP_ID with third-party tools

ATTENTION:	This feature has the unfortunate side effect of overriding anything you set in the SNF_NUM_RINGS and SNF_FLAGS variables. Proceed with caution.

The following example uses the SNF_APP_ID variable with **Bro** and **tcpdump**.

1. Ensure SNFv5.3.2.11 has been installed and LD_LIBRARY_PATH has been set correctly so that both **Bro** and **tcpdump** are linked to **libpcap** with SNFv5.3.2.11 support.
2. Set SNF_APP_ID to identify which processes are working together:

- Set **Bro** to run **SNF_APP_ID=1**
- Set **tcpdump** to run **SNF_APP_ID=2**

3. Run **Bro**.
4. Ensure that the **node.cfg** file is defined as follows:

File contents:

```
[worker-1]
type=worker
host=localhost
interface=snf0
lb_method=69inuxpt
lb_procs=6
pin_cpus=3,4,5,6,7,8
env_vars=SNF_APP_ID=1
```

Bro creates six processes to consume packets and sets the SNF_NUM_RINGS and SNF_FLAGS variables appropriately.

NOTE:	To allow another application to obtain a copy of the packets, export **SNF_APP_ID=1** before starting **Bro**.

5. With the **node.cfg** file set as above, run the following command:

```
$ sudo broctl
```

Output:

```
Welcome to BroControl 1.2

Type "help" for help.

BroControl] > start
```

6. Run two instances of **tcpdump**.

```
$ sudo SNF_APP_ID=2 SNF_NUM_RINGS=2 SNF_FLAGS=0x1 \
tcpdump -i snf0 -w /mnt/ramdisk/cap1
```

```
$ sudo SNF_APP_ID=2 SNF_NUM_RINGS=2 SNF_FLAGS=0x1 \
tcpdump -i snf0 -w /mnt/ramdisk/cap2
```

7. Run **myri_endpoint_info** to view the open endpoints:

```
$ sudo ./myri_endpoint_info
```

Output:

```
The myri_snf driver is configured to support a maximum of:
160 endpoints per NIC, 32 NICs per host
Board 00:60:dd:45:4f:5c
Endpoint     PID         Command                 Info
None                     none
32           3292           tcpdump           dup_ma rx handle (2 rings)
33           3302           tcpdump           dup_ma rx handle (2 rings)
34           3433           bro               dup_ma rx handle (6 rings)
35           3431           bro               dup_ma rx handle (6 rings)
36           3434           bro               dup_ma rx handle (6 rings)
37           3430           bro               dup_ma rx handle (6 rings)
38           3432           bro               dup_ma rx handle (6 rings)
39           3429           bro               dup_ma rx handle (6 rings)
64           3292           tcpdump           rx ring 0
65           3302           tcpdump           rx ring 1
66           3434           bro               rx ring 2
67           3433           bro               rx ring 3
68           3431           bro               rx ring 4
69           3430           bro               rx ring 5
70           3432           bro               rx ring 6
71           3429           bro               rx ring 7
```

10.6 Kernel Ethernet Interfaces

SNFv5.3.2.11 creates a kernel Ethernet interface for port 0. It appears when you run **ip addr** or **ifconfig -a** as one interface with a SNF MAC address. The other ports (1, 2, and 3) are not visible to the kernel, and do not appear in the kernel's interface list.

Normally, the port 0 kernel interface remains down, and it cannot send or receive packets through the interface. But the user may configure it and use it for various purposes, such as administration.

When the user starts a SNF application on port 0, it takes over the port. All packets go to the SNF application, and the kernel interface becomes a black hole while the application is running. When the SNF application terminates, the kernel Ethernet interface takes back the port and can send and receive traffic.

11 Load Balancing and Port Merge Features

Two environment variables are used to invoke port merging and load balancing across many cores (RSS hashing):

- export **SNF_NUM_RINGS=2**
- export **SNF_FLAGS=3**

11.1 SNF_NUM_RINGS

The SNF_NUM_RINGS variable enables RSS Hashing. RSS Hashing does not deploy if only one ring is in use.

SNF_RSS_FLAGS specifies hash types. By default, SNF calculates hashes using IP addresses and TCP/UDP ports.

Output:

```
Default hash value =

          mumur_hash(min(src_ip, dst_ip), max(src_ip, dst_ip),
src_port+dst_port)
```

> For more information on hashing, refer to the *RSS Hashing/Load Balancing Variables* section of *Configuring SNFv5.3.2.11 Software*

The user deploys a custom RSS Hashing function and instructs SNFv5.3.2.11 to run the function (the **custom_hash** is defined in **snf.h**, where you pass a function pointer).

This feature is not available in off-the-shelf **libpcap** applications, as there is no way to provide a function pointer (unless you modify the initialization code to provide the custom hash function). Because the custom hash feature is invoked by a procedure call, the additional CPU overhead on every packet by the driver is significant, under high packet-per-second loads.

11.2 SNF_FLAGS

The variable **SNF_FLAGS** is a bitmask with the following properties:

- Sharing between applications is 0x01
- Port merging is 0x02
- Sharing and merging is 0x03

11.2.1 Running multiple instances

There are two ways to run multiple instances of your application:

Method 1:

Running a single process and creating multiple threads, with each thread tied to a specific CPU core and assigned 1/nth of the traffic, where "**n**" is the number of rings created.

Method 2:

Running multiple Instances (processes), with "**n**" processes tied to a specific CPU core, and assigned 1/nth of the traffic, where "**n**" is the number of rings created.

11.2.2 Sharing/Load balancing

The sharing flag allows multiple copies of an application to open a port or **libpcap** device. Each open port receives 1/nth of the traffic flow, based on a pre-defined RSS Hashing. If you do not enable the sharing flag, any subsequent application's attempt to open the port returns an error message.

Before the SNFv5.3.2.11 application runs and opens a SNF port, the port behaves as a standard Ethernet adapter, and the packets pass to a kernel stack. No environment variables are used.

Once the first application opens a port or **libpcap** device in SNFv5.3.2.11 mode, the first instance of the application's environment variables is invoked. When sharing is enabled, this allows more than one process to open the same SNFv5.3.2.11 device, for example, SNF port 0 (**snf0**). These processes have the potential to set different SNFv5.3.2.11 environment variable values.

For example, you could set the environment variable SNF_NUM_RINGS to 4 in one instance, and not specify a value in another, in which case the SNF_NUM_RINGS value in the non-specified instance is set to default.

Where SNF_APP_ID values are identical

In the case where the SNF_APP_ID values are identical for two application processes (that open the same **snf0**), the first application process configuration variable opens the SNFv5.3.2.11 device, with the second application process using the same configuration variable values as the first, to open the SNFv5.3.2.11 device.

This concept is important, particularly if the processes do not always start in a prescribed manner. For example, process A sometimes opens **snf0** first, or process B sometimes opens **snf0** first. Whichever process is the first to open **snf0** determines the values to be assigned to both process A and process B.

Where SNF_APP_ID values are different

In the case where the SNF_APP_ID values are different for two application processes (that open the same **snf0**), the first application process configuration variable opens **snf0** for each SNF_APP_ID. Accordingly SNF_APP_ID 1 may have different variables than SNF_APP_ID 2.

Setting different environment variables

When invoking a second instance of the application with different environment variable values such as SNF_NUM_RINGS or SNF_DATARING_SIZE**,** those values are ignored, as only the values specified by the first open are used to open **snf0**.

Anything that can be done with SNF API applies to **libpcap** as well:

- You can use RSS hashing to distribute packets to several **libpcap** applications that open the same SNFv5.3.2.11 interface.
- You can also distribute the entire ring to two or more **libpcap** applications running SNF_APP_ID.
- You can also mix **libpcap** applications with SNFv5.3.2.11 API applications.

11.2.3 Port Listening on libpcap

With a dual-port adapter, the **libpcap** devices are named **snf0**, corresponding to port 0, and **snf1**, corresponding to port 1.

Example:

```
SNF_FLAGS=1 SNF_NUM_RINGS=2 tcpdump -i snf0 >/tmp/ring1 &
SNF_FLAGS=1 SNF_NUM_RINGS=2 tcpdump -i snf0 >/tmp/ring2 &
```

By setting the sharing bit in the SNF_FLAGS variable, multiple applications can open the same interface. Because there is more than one ring, each instance of the application gets its own virtual ring of packets.

Ring Descriptions

The packets are distributed among the following rings using RSS Hashing:

- There is only one physical ring per port, so the size of the ring, specified by SNF_DATARING_SIZE, is only used for one ring per port.
- The packet descriptors are stored in a separate ring, defined by SNF_DESCRING_SIZE, which is typically one quarter the size of SNF_DATARING_SIZE, to accommodate bursts of 60-byte packets.

11.2.4 Hardware assisted port merging

With port merging enabled, the **libpcap** device name number becomes a bitmask of the ports you wish to merge. For example, a dual-port ARC Series E adapter, the valid interfaces are:

Example:

- **snf1** – all the packets on port 0
- **snf2** – all the packets on port 1
- **snf3** – all the packets on ports 0 and 1 in timestamp order

Hardware accelerated port merging

The dual- and quad-port ARC Series E adapters support hardware acceleration for port merging. The SNF host library automatically runs hardware accelerated port merging depending upon the applications.

The ARC Series E adapters can only support port merging in specific pairs of ports. If the application chooses ports outside of these supported combinations, the SNF host library implements software port merging, with lower performance than hardware acceleration.

Dual-port support

The supported port combinations for hardware accelerated port merging for the dual-port ARC Series E adapter are:

- ports 0 and 1

Quad-port support

The supported port combinations for hardware accelerated port merging for the quad-port ARC Series E adapter are:

- ports 0 and 1
- ports 2 and 3

Merging ports between multiple ARC Series E adapters

The SNF host library does not support port merging among multiple ARC Series E adapters. In this case, and in this case it will use software as not hardware acceleration is supported in this case.

Merging ports and adding rings

To merge ports and add multiple rings, specify **SNF_NUM_RINGS>1**, and **SNF_FLAGS=3** (sharing and merging):

Example:

```
SNF_FLAGS=3 SNF_NUM_RINGS=2 tcpdump -i snf3 >/tmp/ring1 &
SNF_FLAGS=3 SNF_NUM_RINGS=2 tcpdump -i snf3 >/tmp/ring2 &
```

The example demonstrates port merging with the **snf3** interface, by running two instances of the application.

12 Libpcap, and PF_RING Packet Capture

This chapter describes the following topics:

- **libpcap** and SNF
- PF_RING and SNFv5.3.2.11
- Demonstrating PF_RING Functionality

12.1 libpcap and SNFv5.3.2.11

Libpcap provides a packet-capture application API (pcap) and filtering engine for many open-source and commercial network tools, including protocol analyzers (packet sniffers), network monitors, network intrusion detection systems (NIDS), traffic-generators, and network-testers.

Libpcap version

The **libpcap** library distributed as part of the SNFv5.3.2.11 software package is version 1.7.4.

12.1.1 Preamble

SNFv5.3.2.11 software interfaces with the **libpcap** library, (or directly through the SNF API) to capture packets travelling over a network. With a SNF-aware **libpcap** library, users reference the ARC Series E network adapter through its Ethernet interface name to run existing **libpcap**-dependent applications.

When **libpcap** encounters a SNF-capable device, it enables the SNF API to obtain user-level, zero-copy packets instead of the usual kernel-based approach.

SNFv5.3.2.11 improves packet capture performance in two ways:

- SNFv5.3.2.11 exerts more control over user-level receive mechanisms by bypassing the kernel.
- By re-linking existing **libpcap** applications to SNF-capable **libpcap** libraries.

12.1.2 Verifying the libpcap link to SNFv5.3.2.11

To ensure that a SNF-aware **libpcap** library is linked to the application, set the SNF_DEBUG_MASK variable to **3**:

Command line:

```
SNF_DEBUG_MASK=3
```

Setting this variable triggers SNF API to output information when **libpcap** interfaces with the SNFv5.3.2.11 device.

12.2 PF_RING and SNFv5.3.2.11

PF_RING is an alternative network socket that dramatically improves packet capture speed and efficiency, thereby preserving CPU cycles.

Linux

PF_RING is available for Linux and provides support to the ARC Series E class of network adapters.

12.2.1 Installing PF_RING from Linux RPM

1. Enter the following command line to install PF_RING on CentOS as root user:

   Command line:

   `$ sudo rpm -ivh pfring-dkms-6.5.0-718.noarch.rpm`

   Output:

```
warning: pfring-dkms-6.5.0-718.noarch.rpm: Header V4 RSA/SHA1 Signature, key
ID d1eb60be: NOKEY

Preparing...
################################# [100%]

Updating / installing...   1:pfring-dkms-6.5.0-718
################################# [100%]

WARNING: /usr/lib64/dkms/common.postinst does not exist.

Loading new pfring-6.5.0 DKMS files...

Building for 3.10.0-327.4.5.el7.x86_64

Building initial module for 3.10.0-327.4.5.el7.x86_64

Done.


Pf_ring:

Running module version sanity check.

 - Original module

   - No original module exists within this kernel

 - Installation

   - Installing to /lib/modules/3.10.0-327.4.5.el7.x86_64/extra/

Adding any weak-modules


depmod...


DKMS: install completed.
```

2. Enter the following command line:

   Command line:

```
$ sudo rpm -ivh pfring-6.5.0-718.x86_64.rpm
```

Output:

```
warning: pfring-6.5.0-718.x86_64.rpm: Header V4 RSA/SHA1 Signature, key ID
d1eb60be: NOKEY

Preparing...
################################# [100%]

Updating / installing...   1:pfring-6.5.0-718
################################# [100%]
```

NOTE:	By default, PF_RING installs test applications to the **/usr/local/bin** directory

12.2.2 Installing PF_RING from source (ntop)

PF_RING contains the following components:

- The PF_RING user-space SDK.
- An enhanced version of the **libpcap** library that transparently takes advantage of PF_RING if installed, or falls back to the standard behavior if not installed.
- The PF_RING kernel module.
- PF_RING-aware drivers for different chips from various vendors.

For more information on installing PF_RING from source, go to: http://www.ntop.org/get-started/download/#PF_RING

Download and install PF_RING by GIT or Ubuntu/CentOS repositories by entering the following:

```
git clone https://github.com/ntop/PF_RING.git
cd PF_RING/kernel
make
sudo insmod ./pf_ring.ko
cd ../userland
make
```

You can compile the entire tree typing make (as normal, non-root, user) from the main directory.

12.2.3 Configuring the PF_RING library with SNFv5.3.2.11

Configure the PF_RING library by entering the following commands:

```
$ cd /opt/snf
$ sudo ./sbin/rebuild.sh
$ sudo ./sbin/myri_start_stop start
$ sudo echo < "/opt/snf/lib" > /etc/ld.so.conf.d/snf.conf
$ sudo ldconfig


$ cd PF_RING/kernel
$ make
$ sudo insmod pf_ring.ko
$ cd ../userland/lib
$ sudo ./configure
$ make
$ cd ../libpcap
```

```
$ sudo ./configure
$ make
$ cd ../examples
$ make
$ sudo ./pfcount -i myri:0
```

NOTE:	Specify `myri:0` in order to open port 0

12.3 Demonstrating Multi-Process PF_RING Functionality

The PF_RING distribution provides examples that can be used to demonstrate functionality, including:

- Multi-process traffic duplication
- Multi-process traffic sharing (RSS)
- Ports aggregation example
- PF_RING over SNF example

By default, PF_RING applications are installed in the **/usr/local/bin** directory. To access the SNFv5.3.2.11 devices, run the PF_RING program with root privileges.

12.3.1 Multi-process traffic duplication example

The “classic” PF_RING is synonymous with the concept of cluster, which serves to balance ingress packets coming from one or more ingress interfaces.

For example, take the **pfcount** application that receives and counts ingress packets, and suppose you want to balance traffic coming from port 0 to two **pfcount** applications. To do this, enter the following commands:

Example:

```
$ SNF_APP_ID=1 ./pfcount -i myri:0
$ SNF_APP_ID=2 ./pfcount -i myri:0
```

OR

```
$ sudo./pfcount -i myri:A1P0
$ sudo ./pfcount -i myri:A2P0
```

Where **`A1`** refers to **`SNF_APP_ID=1`** and **`P0`** refers to port 0.

> For more information on the **pfcount** application, go to: http://www.ntop.org/pf_ring/how-to-balance-mobile-traffic-across-applications-using-pf_ring/

12.3.2 Multi-process traffic sharing (RSS) example

The PF_RING distribution can also scale applications to work on multiple cores (RSS) as seen in Figure 4.

- Supports multicore processor scalability, where the ARC Series E devices distribute incoming packets among “virtual rings”. **Bro**, for example, built its scaling strategy around this concept.
- Configures one virtual ring for every CPU core that an application leverages.
- Sends all the packets in a single TCP flow to the same virtual ring.

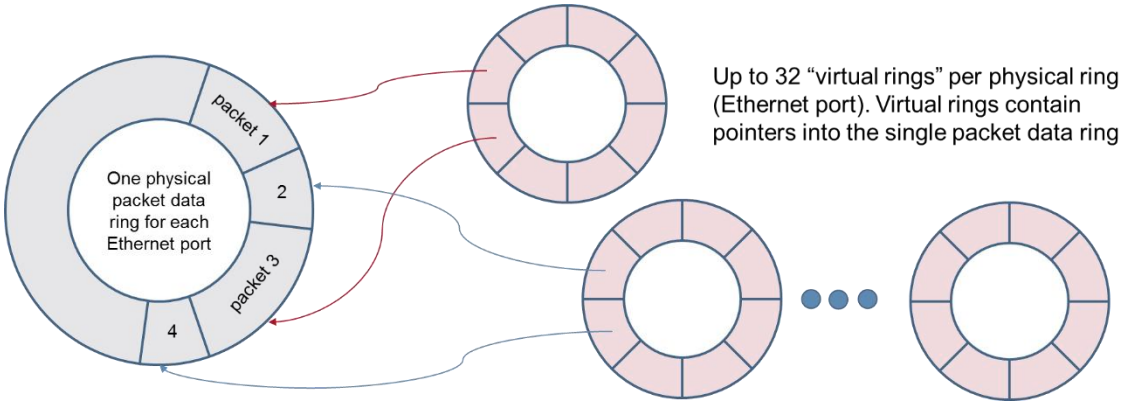


Figure 4. Myricom multicore scaling (RSS)

To performs multicore scaling (RSS) with a PF_RING distribution, enter the following command lines:

Example:

```
$ SNF_APP_ID=1 SNF_NUM_RINGS=2 SNF_RING_ID=0 ./pfcount -i myri:0

$ SNF_APP_ID=1 SNF_NUM_RINGS=2 SNF_RING_ID=1 ./pfcount -i myri:0
```

OR

```
$ sudo ./pfcount -i myri:A1R2P0@0

$ sudo./pfcount -i myri:A1R2P0@1
```

Where **A1** refers to **SNF_APP_ID=1**, **R2** refers to RSS with two rings, **P0** refers to port 0, and **@0** refers to Ring 0.

12.3.3 Ports aggregation example

To allow **pfcount** to capture traffic on more than one port, a comma-separated list of ports needs to be given.

To merge two ports into one, enter the following command:

```
$ SNF_FLAGS=0x2 ./pfcount -i myri:0,1
```

12.3.4 PF_RING over SNF example

In this example, packets are being received from port 1 by a single instance of **pfcount** pinned to a single CPU as chosen by **pfcount**.

NOTE:	The user should refer to PF_RING documentation for further information on PF_RING command line options at http://www.ntop.org/products/packet-capture/pf_ring/

1. Enter the following command line:

   ```
   $ sudo /usr/local/bin/pfcount -i myri:1
   ```

   (Note the license error, shown corrected below).

   Output:

```
# ERROR: You do not seem to have a valid PF_RING-Myricom 6.3.0.160304
# license for port 1 [00:60:DD:20:16:02]
# ERROR: Please get one at http://shop.ntop.org/.
# We're now working in demo mode with packet capture and
# transmission limited to 5 minutes
Using PF_RING v.6.5.0
Capturing from myri:1 [mac: unknown][if_index: 1][speed: 0Mb/s]
# Device RX channels: 1
# Polling threads:    1
Dumping statistics on /proc/net/pf_ring/stats/18261-none.37
Absolute Stats: [0 pkts total][0 pkts dropped][0.0% dropped]
[0 pkts rcvd][0 bytes rcvd]
=========================
```

2. Start a packet generator, such as **pfsend** or **snf_pkgen**, on another system.

   Packets total count starts increasing.

   Output:

```
=========================

Absolute Stats: [772’784 pkts total][0 pkts dropped][0.0% dropped]

[772’784 pkts rcvd][64’913’856 bytes rcvd][193’164.32 pkt/sec][129.81
Mbit/sec]

Actual Stats: [772’784 pkts rcvd][1’000.15 ms][772’665.78 pps][0.52 Gbps]

=========================
```

   Packet sender at full line rate.

   Output:

```
=========================

Absolute Stats: [90’074’559 pkts total][0 pkts dropped][0.0% dropped]

[90’074’559 pkts rcvd][7’566’262’956 bytes rcvd][9’005’887.07
pkt/sec][6’051.95 Mbit/sec]

Actual Stats: [14’883’823 pkts rcvd][1’000.17 ms][14’881’144.39 pps][10.00
Gbps]

=========================
```

   Packet sender ends, rate decreases steadily to zero.

   Output:

```
=========================

Absolute Stats: [100’000’000 pkts total][0 pkts dropped][0.0% dropped]

[100’000’000 pkts rcvd][8’400’000’000 bytes rcvd][9’089’301.11
pkt/sec][6’108.01 Mbit/sec]

Actual Stats: [9’925’441 pkts rcvd][1’000.20 ms][9’923’416.62 pps][6.67 Gbps]

Absolute Stats: [100’000’000 pkts total][0 pkts dropped][0.0% dropped]

[100’000’000 pkts rcvd][8’400’000’000 bytes rcvd][8’331’859.28
pkt/sec][5’599.00 Mbit/sec]

Actual Stats: [0 pkts rcvd][1’000.17 ms][0.00 pps][0.00 Gbps]

=========================
```

   Packet sender has finished.

3. Enter **CTRL-C** to close the PF_RING receiver application.
4. Verify that all packets sent were received.

   Once the license file has been created in **/etc/pf_ring/<MAC_ADDRESS>** the error and time limitation are no longer an issue.

5. Enter the following command line:

```
$ sudo /usr/local/bin/pfcount -i myri:1
```

Output:

```
Using PF_RING v.6.5.0
Capturing from myri:1 [mac: unknown][if_index: 1][speed: 0Mb/s]
# Device RX channels: 1
# Polling threads:    1
Dumping statistics on /proc/net/pf_ring/stats/19417-none.39
```

6. Enter the following command line to start a traffic generator on a remote connected system. There is no need to run as root.

```
Hostname:anypath> /opt/snf/bin/tests/snf_pktgen -b 1 -n
100000000 -S 80-8000:R -D 80-8000:R
```

Output:

```
open_tx_endpoint: board_type=K35SNF
Final flush: packets=1279
Draining packets. Inflight=69808
Draining packets. Inflight=55536
Draining packets. Inflight=40645
Draining packets. Inflight=24265
Draining packets. Inflight=7879
[0] Size     Mbps    Mpps  Efficiency
      60  7140.07  14.875      99.96%
```

13 Open-Source Packet Capture Tools

SNFv5.3.2.11 is compatible with industry-standard open-source packet capture application tools. Examples of tested applications include:

- Standard Linux utility **tcpdump**
- Standard Linux utility **tcpreplay**
- **Suricata** network intrusion detection and security monitoring
- **Bro** IDS network intrusion detection system
- **Wireshark** network protocol analyzer
- **Snort** intrusion prevention systems

NOTE:	SNFv5.3.2.11 can accommodate the multi-process **Bro,** multi-threaded **Suricata,** and **tcpdump** packet capture tools running in parallel; each tool collecting and splitting the network traffic among their respective application threads.

Figure 5. describes the various open-source application tools and their relationship to **libpcap**.

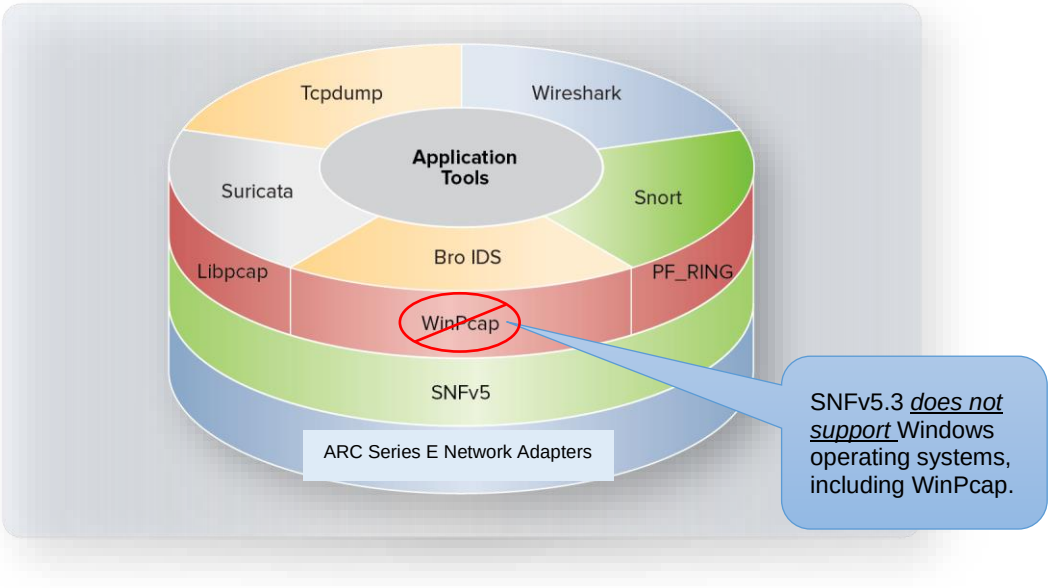


Figure 5. Industry Standard Packet Capture Software

13.1 Running tcpdump with SNFv5.3.2.11

You can run **tcpdump** a number of ways:

- Running tcpdump with no recompiling
- Building a new tcpdump tool with recompilation
- Running the tcpdump tool with LD_LIBRARY_PATH

13.1.1 Running tcpdump with no recompiling

Run **tcpdump** as follows:

1. Verify that **tcpdump** has a dynamically linked **libpcap.**

   ```
   $ sudo ldd `which tcpdump` | grep pcap
   ```

2. When **tcpdump** statically links **libpcap**, there is no output. Proceed to the following *Building a new tcpdump with recompilation* section.

   OR

   When **tcpdump** does *not* statically link to **libpcap,** output is generated. Proceed to the *Running the tcpdump tool with LD_LIBRARY_PATH* section.

   Output:

   ```
   libpcap.so.0.9.4 => /usr/lib64/libpcap.so.0.9.4
   (0x00000034c1400000)
   ```

13.1.2 Building a new tcpdump tool with recompilation

NOTE:	While **libpcap** remains binary-compatible between versions 0.9.x to 1.1.x, we recommend recompiling **tcpdump** against the newest version of **libpcap**.

To build a new **tcpdump** with recompilation, enter the following:

1. Enter the following command to install **libpcap-devel.**

   ```
   $ sudo yum install libpcap-devel
   ```

2. Download and build **tcpdump**.

   ```
   $ wget http://www.tcpdump.org/release/tcpdump-4.7.4.tar.gz
   $ tar xzf tcpdump-4.7.4.tar.gz
   $ cd tcpdump-4.7.4
   $ ./configure
   $ make
   ```

13.1.3 Running the tcpdump tool with LD_LIBRARY_PATH

To run **tcpdump** with LD_LIBRARY_PATH, enter the following:

1. Verify that **tcpdump** has a dynamically linked **libpcap.**

   $ sudo ldd tcpdump | grep pcap

   Output:

   ```
   $ ldd tcpdump | grep pcap
   libpcap.so.1 => /lib64/libpcap.so.1 (0x00007ffa48cc8000)
   ```

2. Set LD_LIBRARY_PATH to the SNF-compatible **libpcap.**

   Csh/tcsh:

   $ sudo setenv LD_LIBRARY_PATH /opt/snf/lib

   bash:

   $ sudo export LD_LIBRARY_PATH=/opt/snf/lib

3. Verify that **ldd** is pointing to **/opt/snf/lib/libpcap…**

   $ sudo ldd tcpdump | grep pcap

   Output:

   ```
   libpcap.so.1 => /opt/snf/lib/libpcap.so.1 (0x00007f5b6e577000)
   ```

4. Set **SNF_DEBUG_MASK=3** to verify that incoming packets are going through SNFv5.3.2.11.

   Csh/tcsh:

   $ sudo setenv SNF_DEBUG_MASK 3

   bash:

   $ sudo export SNF_DEBUG_MASK=3

5. Run **tcpdump** on the **eth18** interface.

   $ sudo tcpdump -i eth18

Output:

```
 5273 snf.0.-1 P (userset)              SNF_PORTNUM = 0
 5273 snf.0.-1 P (default)              SNF_RING_ID = -1 (0xffffffff)
 5273 snf.0.-1 P (default)            SNF_NUM_RINGS = 1 (0x1)
 5273 snf.0.-1 P (default)            SNF_RSS_FLAGS = 49 (0x31)
 5273 snf.0.-1 P (default) SNF_DATARING_SIZE = 16777216 (0x1000000) (16.0 MiB)
 5273 snf.0.-1 P (default) SNF_DESCRING_SIZE = 4194304 (0x400000) (4.0 MiB)
...
tcpdump: WARNING: eth18: no Ipv4 address assigned
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth18, link-type EN10MB (Ethernet), capture size 65535 bytes
```

NOTE 1:	Be aware that **tcpdump** prints to output or to file, which may severely limit achievable packet rates to a couple of gigabits per second.

NOTE 2:	The SNFv5.3.2.11 packet sniffer interface diverts all traffic from the Ethernet interface to the SNFv5.3.2.11 application and may cause host interface response failures.

13.1.4 Available tcpdump interfaces

Run the **`tcpdump -D`** argument to display the available SNF port interfaces.

Command line:

```
$ sudo tcpdump -D
```

Output:

```
15.eth18 (Myricom snf0)
16.eth18-snf1 (Myricom snf1)
17.eth18-snf2 (Myricom snf2)
18.eth18-snf3 (Myricom snf3)
```

Table 4 describes the available SNF port interfaces.

Ethernet interface	***SNF Port***
eth18 (or snf0)	corresponds to SNF port0
eth18-snf1 (or snf1)	corresponds to SNF port1
eth18-snf2 (or snf2)	corresponds to SNF port2
eth18-snf3 (or snf3)	corresponds to SNF port3

Table 4. Available SNF port interfaces.

13.2 Running tcpreplay with SNFv5.3.2.11

tcpreplay is an open source tool that reads and replays (send) previously captured packets in **libpcap**. The tool supports a number of methods to send packets. By default, it supports PF_PACKET, by sending packets through the kernel.

For more information on **tcpreplay**, go to:
http://tcpreplay.appneta.com/wiki/installation.html#download-source

13.2.1 Building tcpreplay

In order to sustain low overhead SNFv5.3.2.11 packet injection, build **tcpreplay** and run it with SNFv5.3.2.11 **libpcap** as follows:

Command lines:

```
$ git clone https://github.com/appneta/tcpreplay
$ cd tcpreplay
$ ./autogen.sh
$ LD_LIBRARY_PATH=/opt/snf/lib ./configure \
--prefix=/path/to/install-dir \
--with-libpcap=/opt/snf \
--enable-force-inject
$ LD_LIBRARY_PATH=/opt/snf/lib make
$ make install
```

The `-enable-force-inject` command line argument forces **tcpreplay** to run the PCAP_INJECT method with SNFv5.3.2.11 **libpcap**. In this fashion you are running a SNFv5.3.2.11 packet injection method.

13.2.2 Listing available SNF packet injection interfaces

In this example, enter the following command line to list which interfaces are available for injection:

Command line:

```
$ LD_LIBRARY_PATH=/opt/snf/lib tcpreplay --listnics
```

Output:

```
p2p1
p2p1-snf1
p2p1-snf2
p2p1-snf3
```

A quad-port ARC Series E adapter shows four SNF port interfaces. The p2p1 interface is exposed to the kernel and appears in '**ip link**', whereas the remaining interfaces are not exposed to the kernel and do not appear in '**ip link**' (See Table 5).

Ethernet interface	*SNF Port*	*Ip link*
p2p1	corresponds to SNF port 0	Appears in ip link
p2p1-snf1	corresponds to SNF port1	Does not appear
p2p1-snf2	corresponds to SNF port2	Does not appear
p2p1-snf3	corresponds to SNF port3	Does not appear

Table 5. Available SNF port interfaces.

13.2.3 Running tcpreplay through a specific port

To replay through a specific port, run **`tcpreplay -i`** with an interface name from Table 5 (**p2p1-snf1**):

Command line:

```
$ LD_LIBRARY_PATH=/opt/snf/lib tcpreplay -i p2p1-snf1 <pcap-file>
```

tcpreplay replays through port 1.

13.3 Running Suricata with SNFv5.3.2.11

Suricata (http://www.suricata-ids.org/) is an open-source-based Intrusion Detection System (IDS) that interfaces with SNFv5.3.2.11 through **libpcap**.

NOTE:	**Suricata** is usually built with **libpcap**. It is not necessary to rebuild **Suricata** once it is installed on your machine.

Suricata resources

Go the following **Suricata** project Wiki page to build and run **Suricata** with SNFv5.3.2.11:

https://redmine.openinfosecfoundation.org/projects/suricata/wiki/Myricom

To build **Suricata** from source on CentOS, go to:

https://redmine.openinfosecfoundation.org/projects/suricata/wiki/CentOS_Installation

13.3.1 Configuring and building Suricata with libpcap

In order to run **Suricata**, you must first configure **Suricata libpcap** settings.

Example:

We are configuring four SNF ARC Series E adapter ports, where **eth18** corresponds to port 0, and **eth18-snf1**, **eth18-snf2**, and **eth18-snf3** correspond to ports 1, 2, and 3, respectively (Table 6).

Command line:

```
$ sudo./configure -with-libpcap-includes=/opt/snf/include/ --
with-libpcap-libraries=/opt/snf/lib/ --prefix=/usr -
sysconfdir=/etc -localstatedir=/var

$ make

$ make install
```

Output:

```
pcap:
  - interface: eth18
    threads: 8
    checksum-checks: no
    snaplen: 9018

  - interface: eth18-snf1
    threads: 8
    checksum-checks: no
    snaplen: 9018

  - interface: eth18-snf2
    threads: 8
    checksum-checks: no
    snaplen: 9018

  - interface: eth18-snf3
    threads: 8
    checksum-checks: no
    snaplen: 9018
```

NOTE:	Enable **snaplen** for **Suricata** to retrieve maximum transmission unit (MTU) information from SNF interfaces.

The **`threads: 8`** setting creates eight reader threads for **`eth18`**. The Myricom driver ensures each thread is attached to its own ring buffer.

Ethernet interface	***SNF Port***
eth18 (or snf0)	corresponds to SNF port 0
eth18-snf1 (or snf1)	corresponds to SNF port1
eth18-snf2 (or snf2)	corresponds to SNF port2
eth18-snf3 (or snf3)	corresponds to SNF port3

Table 6. Available SNF port interfaces.

13.3.2 Running Suricata with libpcap

To run **Suricata**, enter the following:

Example:

Command line:

```
SNF_FLAGS=1 SNF_NUM_RINGS=8 LD_LIBRARY_PATH\
=/opt/snf/lib 97inuxptp -c /etc/Suricata\
/97inuxptp.yaml -pcap=eth18 -runmode=workers
```

You will need to use **-pcap** to specify the SNF ports.

The command runs **-pcap=eth18** on SNF port 0. To run it on SNF port 1, specify **-pcap=eth18-snf1**, and so on, as described in Table 7.

Ethernet interface	*SNF Port*
pcap=eth18	corresponds to SNF port 0
pcap=eth18-snf1	corresponds to SNF port1
pcap=eth18-snf2	corresponds to SNF port2
pcap=eth18-snf3	corresponds to SNF port3

Table 7. Available SNF port interfaces.

13.3.3 Known issue

Running **Suricata** on ports other than port 0 displays the following timestamped error messages:

Output [Error]:

```
21/7/2016 - 15:05:48 - <Warning> - [ERRCODE: SC_ERR_SYSCALL(50)] - Failure
when trying to get feature via ioctl for 'eth18-snf1': No such device (19)

21/7/2016 - 15:05:48 - <Warning> - [ERRCODE: SC_ERR_SYSCALL(50)] - Failure
when trying to get MTU via ioctl for 'eth18-snf1': No such device (19)
```

Explanation:

SNFv5.3.2.11 exposes only port 0 as a kernel interface, such as **eth18**. The remaining ports are hidden from the kernel. On ports 1 through 3, **Suricata** cannot query the interface MTU or offload capabilities through system calls, thus prompting the error messages. These are expected and do not disrupt normal **Suricata** operations.

13.4 Running Bro with SNFv5.3.2.11

Bro (http://www.bro.org/), which is now referred to as Zeek, is an open-source-based IDS package that interfaces with SNFv5.3.2.11 through **libpcap**.

13.4.1 Configuring Bro

1. To configure **Bro** to run with SNFv5.3.2.11, enter the following command:

   ```
   $ sudo ./configure -with-pcap=/opt/snf
   ```

2. Configure any worker using SNFv5.3.2.11 in the **node.cfg** file by entering the following command lines:

   ```
   [worker1]
   type=worker
   host=1.2.3.4
   interface=snf1
   lb_method=98inuxpt
   lb_procs=8
   pin_cpus=3,4,5,6,7,8,9,10
   ```

   Flow-based load balancing is automatically enabled. It is important to pin the processing to specific cores to maximize performance.

   SNFv5.3.2.11 can accommodate the multi-process **Bro,** multi-threaded **Suricata,** and **tcpdump** packet capture tools running in parallel; each tool collecting and splitting the network traffic among their respective application threads.

NOTE:	If **Bro** was previously configured, compiled, and dynamically linked with **libpcap**, there is no need to reconfigure. You can instead reset LD_LIBRARY_PATH as described in the following section.

13.4.2 Running Bro with LD_LIBRARY_PATH

NOTE:	If **Bro** is built with SNF **libpcap** (**--with-pcap=/opt/snf**), setting LD_LIBRARY_PATH is not necessary as the executable file explicitly links to **/opt/snf/lib/libpcap.so**. If **Bro** is built with the generic **libpcap**, set LD_LIBRARY_PATH so that **Bro** dynamically links with SNF **libpcap**.

To run **Bro** using the environment variable LD_LIBRARY_PATH, enter the following:

1. Verify that **Bro** has a dynamically linked **libpcap.**

   ```
   $ sudo ldd `which bro` | grep pcap
   ```

2. When **Bro** statically links **libpcap**, there is no output.

   OR

   When **Bro** does *not* statically link to **libpcap,** the following output is generated.

   Output:

   ```
   libpcap.so.0.9.4 => /usr/lib64/libpcap.so.0.9.4
   (0x00000034c1400000)
   ```

3. Create a **symlink** between **Bro** and **libpcap** in the **/opt/snf/lib** directory.

   ```
   $ sudo ln -s /opt/snf/lib/libpcap.so
   /opt/snf/lib/libpcap.so.0.9.4
   ```

4. Set LD_LIBRARY_PATH to the SNF-compatible **libpcap**:

   csh/tcsh:

   ```
   $ setenv LD_LIBARY_PATH /opt/snf/lib
   ```

   bash:

   ```
   $ export LD_LIBRARY_PATH=/opt/snf/lib
   ```

13.5 Running Wireshark with SNFv5.3.2.11

Wireshark version 2.0.5 (http://www.wireshark.org/) shares many characteristics with **tcpdump**, except that it supports a graphical user interface (GUI). **Wireshark** interfaces with SNFv5.3.2.11 software through **libpcap**.

13.5.1 Running Wireshark in Linux

NOTE:	These examples are specifically for the Wireshark application; however, the procedure is similar for any application running **libpcap**.

To run **Wireshark** in Linux, follow these instructions:

1. Download **Wireshark** from http://www.wireshark.org/
2. Create a link from **`pcap.h`** to **`pcap/pcap.h`** in the **/opt/snf/include** directory.

```
$ cd /opt/snf/include; sudo ln -sf pcap/pcap.h pcap.h
$ sudo yum install bison flex gtk2 gtk2-devel
$ sudo tar jxf wireshark-1.2.5.tar.bz2
$ cd wireshark-1.2.5
```

3. Configure **Wireshark** using the **`-with-pcap=/opt/snf`** option.

```
$ sudo ./configure -prefix=/opt/wireshark -with-pcap=/opt/snf
$ make
$ make install
```

13.5.2 Alternate approach to running Wireshark in Linux

While recompiling is the preferred and safest way to make use of SNFv5.3.2.11 functionality, the following approach also works:

1. Install the **Wireshark** and **Wireshark-gnome** packages on RHEL 5.4.
2. Run **`ldd`** to verify that **Wireshark** has a dynamically linked **libpcap.**

```
$ sudo ldd /usr/sbin/wireshark | grep pcap
```

3. Once you install SNFv5.3.2.11 RPM, then symlink the **libpcap** library to the SNFv5.3.2.11 RPM distribution and change LD_LIBRARY_PATH.

```
$ cd /opt/snf/lib
$ sudo ln -s libpcap.so.1 libpcap.so.0.9.4
$ sudo LD_LIBRARY_PATH=/opt/snf/lib /usr/sbin/wireshark
```

4. Rerun **`ldd`** to verify that the correct **`libpcap.so`** and **`libsnf.so`** have been selected.

```
$ sudo LD_LIBRARY_PATH=/opt/snf/lib ldd /usr/sbin/wireshark |
grep pcap
```

NOTE:	While SNFv5.3.2.11 supports up to 14.8Mpps per port, **Wireshark** scrolls output to the screen, which may severely limit achievable packet rates.

13.6 Running Snort with SNFv5.3.2.11 (Parallel Snort)

While **libpcap** is not thread-safe, it is possible to run multiple processes that use **libpcap/SNF** in parallel. Under this configuration, if multiple **libpcap** processes wish to process incoming data from a single device, they simply need to agree on the total number of rings by exporting the number of desired rings in the environment. This approach effectively translates the number of rings into an equal amount of “virtual” capture devices (Figure 6.).

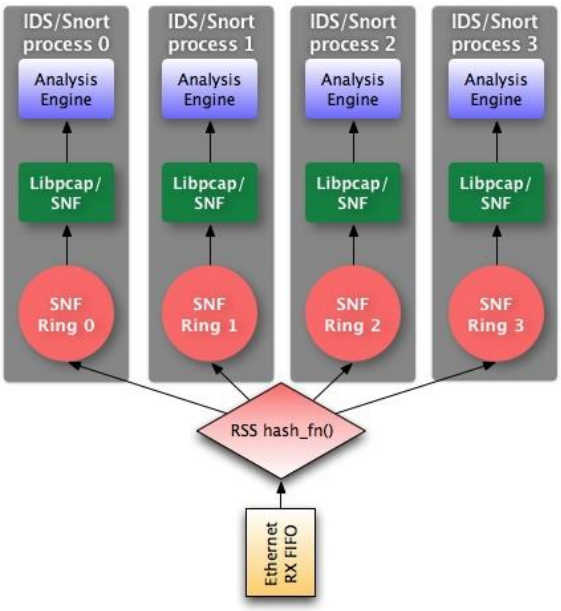


Figure 6. Multi-Process **Snort** over **libpcap/SNF**

NOTE:	**libpcap** is not thread-safe to the extent that multiple threads cannot make calls to the same **pcap_t** and expect correct behavior. The goal is to have each thread open and access its own **pcap_t.**

13.6.1 Running Multi-Process Snort over libpcap/SNF

As an example, start eight parallel instances of **Snort** each bound to different cores, all using the same configuration file and the **snf0** interface, as follows:

1. Start eight parallel instances of **Snort**.

```
$ export SNF_NUM_RINGS=8
```

2. Duplicate incoming data to multiple **Snort** instances.

```
SNF_F_RX_DUPLICATE=0x300 and SNF_F_PSHARED=0x1 flags

$ export SNF_FLAGS=0x301
$ i=0
$ while [ $i -lt $SNF_NUM_RINGS ]; do
        /opt/snort/snort -c /opt/snort/snort.conf \
        -i snf0 &
        sleep 2
        let "i = i + 1"
    done
```

14 Linux PTP Host Clock Synchronization

This chapter contains the following topics:

- Verifying Adapter Clock Functionality
- Synchronizing the System Clock to the ARC Series E Adapter Clock
- Synchronizing the ARC Series E Clock

14.1 Verifying Adapter Clock Functionality

The ARC Series E network adapter clock displays as a **PTP Hardware Clock**, compatible with Linux kernel version 4.6 and later.

To verify adapter clock functionality, refer to the following procedure:

1. Download **linuxptp** from the Sourceforge website at http://linuxptp.sourceforge.net/

   OR

   Install through a package manager such as Yum, by entering the following command:

   ```
   $ sudo yum install linuxptp
   ```

2. Reference the hardware clock by its PTP device name (**/dev/ptpN**) or by its network name.

   All ports on a single network adapter share a single PTP clock. While there may be two or four network interfaces, there will only be one PTP clock. Access to the clock through different network devices references the same physical clock.

NOTE:	Make clock adjustments carefully as all timestamps originate from the interface.

14.1.1 Reading the clock by PTP device name:

Command line:

```
$ sudo phc_ctl /dev/ptp0 get
```

14.1.2 Reading the clock by network name:

Command line:

```
$ sudo phc_ctl enp2s0f0 get
```

14.1.3 Setting adapter clock to host time:

Command line:

```
$ sudo phc_ctl /dev/ptp0 set
```

14.1.4 Synchronizing the system clock with the network adapter clock (phc2sys):

The **linuxptp** package synchronizes the system clock to the adapter clock on the network.

Command line:

```
$ sudo phc2sys -s /dev/ptp0 -O 0 -m
```

14.1.5 Maintaining clock synchronization (ptp4l):

Linuxptp prompts the PTP daemon to send out periodic messages on the interface. To stop messages from affecting adapter speed, switch to a system interface that supports PTP.

The SNF interface is limited to SW TX Timestamps, and requires a two-step process to synchronize the SNF PTP device over PTP.

1. PTP must first be set up on the SNF interface, using TX Timestamps to update CLOCK_REALTIME.

   Command line:

   ```
   $ sudo ptp4l -i eth0 -p /dev/ptp1 -m -s -S
   ```

   Command descriptions:

- The **`eth0`** interface connected to the **`/dev/ptp1`** device supports PTP.
- The **`-m`** option instructs the application to direct output to the console.
- The **`-s`** option forces the PTP daemon to run as a slave.
- The **`-S`** option forces PTP to use SW TX Timestamps.
- Omitting the **`-m`** option prevents **`ptp4l`** from directing output to the console if running as a daemon.
- Omitting the **`-s`** option allows the daemon to assume the role of Grand Master if the **linuxptp** algorithm determines that it is the most accurate clock.

2. Synchronize the SNF PTP device to the CLOCK_REALTIME.

Command line:

```
$ sudo phc2sys -s CLOCK_REALTIME -c /dev/ptp1 -O 0 -m
```

Command descriptions:

- The **-s** option indicates the source clock
- The clock being used as the source is CLOCK_REALTIME.
- The **-c** option indicates the clock that will be changed.
- The SNF clock is **/dev/ptp1**
- The **-O** option indicates the offset from CLOCK_REALTIME.
- The **-m** option instructs the application to direct output to the console,
- Omitting the **-m** option prevents **ptp4l** from directing output to the console if running as a daemon.

NOTE:	PTP coordinates with the IAC (International Atomic Clock), which as of June 30, 2015, has a positive 36-second offset from UTC (Coordinated Universal Time). It may be necessary to specify this offset from the **CLOCK_REALTIME** when synchronizing the ARC Series E adapter PTP device.

14.2 Synchronizing the ARC Series E Clock to Another Clock

Synchronize the SNF PTP device to the CLOCK_REALTIME.

Command line:

```
$ sudo phc2sys -s CLOCK_REALTIME -c /dev/ptp1 -O 0 -m
```

Command descriptions:

- The **-s** option indicates the source clock
- The clock being used as the source is **CLOCK_REALTIME**
- The **-c** option indicates the clock that will be changed.
- The SNF clock is **/dev/ptp1**
- The **-O** option indicates the offset from **CLOCK_REALTIME**
- The **-m** option instructs the application to direct output to the console,
- Omitting the **-m** option prevents **ptp4l** from directing output to the console if running as a daemon.

NOTE:	PTP coordinates with the IAC (International Atomic Clock), which as of June 30, 2015, has a positive 36-second offset from UTC (Coordinated Universal Time). It may be necessary to specify this offset from the **CLOCK_REALTIME** when synchronizing the ARC Series E adapter PTP device.

15 SNFv5.3.2.11 Timestamping Support

This chapter contains the following topics:

- Timestamping Module Variables
- Viewing the Time Source Status

SNFv5.3.2.11 in API mode supports SW TX, SW RX, and HW RX timestamping by default.

> For more information on implementing timestamping, refer to the *Network Adapter Timestamps* section in *Troubleshooting*

15.1 Timestamping Module Variables

The SNFv5.3.2.11 driver has three timestamping module variables to specify the time source.

- MYRI_CLK_ENABLE_PPS
- MYRI_CLK_ENABLE_10MHZ
- MYRI_CLK_INVERT_PPS

Default support settings (disabled):

By default, we assume that there is nothing connected to the packets-per-second (PPS) input connector on the front of the card.

The driver sets both MYRI_CLK_ENABLE_PPS and MYRI_CLK_ENABLE_10MHZ to zero, which disables the PPS and 10MHZ inputs.

Command lines (Disabled):

```
myri_clk_enable_pps=0
myri_clk_enable_10mhz=0
```

Enabling PPS support:

To enable PPS support, set the MYRI_CLK_ENABLE_PPS module variable to **1** in **/opt/snf/sbin/myri_start_stop** and restart the driver.

Command line (Enabled):

```
myri_clk_enable_pps=1
```

Enabling 10MHz support:

To enable 10 MHz support, set the MYRI_CLK_ENABLE_10MHZ module variable to **1** in **/opt/snf/sbin/myri_start_stop** and restart the driver.

Command line (Enabled):

```
myri_clk_enable_10mhz=1
```

15.2 Viewing the Time Source Status

There are two ways to view the time source status.

- **`dmesg`** command
- **`myri_info`** command

15.2.1 dmesg

Enter the **dmesg** command.

Output [example]:

```
...
[   40.660764] myri_snf INFO: Disabling 10Mhz input
[   40.660766] myri_snf INFO: Disabling PPS input
[   40.660768] myri_snf INFO: PPS is inactive: wrote the time to the adapter
ts=1471521123.635242000
...
```

15.2.2 myri_info

The **myri_info** command displays one set of external time source connections per network adapter. Likewise, two network adapters create a duplicate output for each function.

NOTE:	Do not select the MYRI_CLK_ENABLE_10MHZ variable if it is not connected to an external 10MHz time source. Disable the variable first before disconnecting the 10MHz time source.

Command line:

$ sudo ./myri_info -b 0

Output [example]:

```
pci-dev at 01:00.0 vendor:product(rev)=1c09:4260(01)
        behind bridge root-port: 00:01.0 8086:0c01 (x8.3/x16.3)
Myri-10G-PCIE-8E -- Link x8
   EEPROM String-spec:
        MAC=00:60:dd:43:2d:e8
        SN=495892
        PC=10G-PCIE3-8E-4S
        PN=09-04680
        BOM=A

   Firmware:
      Version: 2.1.5
      Type   : SNF
      Config : 4 Port x 10 Gb
      SHA1   : 2d13f73ad9fe4bd4bda8d7b50dd0ad0b

   External Inputs:
      PPS: Enabled, No Input
           Front Panel PPS: No Input
           Card Edge PPS:   No Input
       10Mhz Clock: Disabled
      100Mhz Clock Locked:  Locked
```

16 Tuning SNFv5.3.2.11 Software

This chapter contains the following topics:

- Ring Performance
- Tuning Check List

Myricom high-speed, packet-capture networking solutions in real customer environments vary depending upon the particular details of the network configuration, end-user applications, and transaction workloads.

Critical applications often have internal measurements of effective transaction rates. To that end, we recommend running performance tests before and after installing the ARC Series E network adapter hardware to compare performance results.

Ideally one should use reliable and recurring workload data. If that is not possible, sample enough daily traffic to establish typical performance metrics. If there is no noticeable improvement after installing the hardware, verify that the network adapters and software are properly installed.

> For a detailed description of SNFv5.3.2.11 software test packet performance rates, go to the *Sample Test Programs* section of the *Testing SNFv5.3.2.11 Software* chapter.

Contact **ARIA Technical Support at** https://www.ariacybersecurity.com/support/downloads/ for further assistance if performance results are below expectations.

16.1 Ring Performance

Single-ring Performance

Whereas most Internet traffic is usually bimodal in the distribution of packet sizes, SNFv5.3.2.11 has been designed to support a worst case scenario where all packets are at the minimum 10-Gigabit Ethernet packet size of 64 bytes.

When including the 8-byte preamble, the start byte, and the 12-byte inter-packet gap, a minimum-size packet of 64 bytes requires 84 byte times on the wire. Under a constant stream of minimum packet sizes, a packet arrives at every 67.2 nanosecond intervals, corresponding to a maximum packet rate of 14.88 Mpps.

On our reference platform, a Xeon X5570 at 2.93GHz, running SNFv5.3.2.11 in a single ring configuration demonstrates a library overhead of about 32 nanoseconds per packet on average for 64-byte packets. Minimizing library overhead is necessary to achieve high packet rate capture.

Multi-ring performance

The primary goal of using multiple rings is to leverage multiple cores in the packet analysis by effectively reducing the number of packets each ring has to process.

For example, if we assume that the incoming traffic can be fairly well balanced across eight cores, each core is responsible for processing one-eighth of a potential peak of 14.88 Mpps, for a worst case scenario of one packet every 537.6 nanoseconds. With the aforementioned library overhead, this leaves roughly 500 nanoseconds of analysis per core under a worst case scenario.

16.2 SNFv5.3.2.11 Tuning Check List

SNFv5.3.2.11 is a kernel-bypass driver. As such, it does not require much tuning; however, it helps to be aware of the following issues which may affect latency/packet rate.

In addition to these tuning suggestions, there are also a number of environment variables available in the SNFv5.3.2.11 software for debugging and for customizing the software configuration to the requirements of the application.

> For more information on environment variables, go to *Configuring SNFv5.3.2.11*

Tuning is recommended to help reduce the performance hit that takes place when the SNFv5.3.2.11 application alerts the adapter (through a kernel call) that the ring memory has been freed. The SNFv5.3.2.11 application can be preempted by the OS when this call takes place. Tuning also helps reduce packet loss due to a drop in the number of RX data pages available or drops due to PCI backpressure (indicating there is no free memory available in the L3 cache).

> For more information on the RX Data Pages Available Min counter, go to *Appendix 1. SNFv5.3.2.11 Counters*

16.2.1 Setting the system performance profile

We recommend setting the system performance profile to **`network-latency`** as described below:

```
sudo tuned-adm profile network-latency
```

This profile is chosen because it specifies appropriate scheduler, memory, and system energy consumption parameters. In addition, **`network-latency`** prevents the kernel from balancing processes across NUMA nodes. This recommendation refers to distribution Red Hat Enterprise Linux (RHEL) and its derivative, CentOS.

16.2.2 PCIe expansion slot seating

Verify that the ARC Series E network adapter is seated properly into a PCI-Express Gen3 expansion slot that is compatible with the correct PCI-Express link width (x8).

Run the **myri_info** command (included in SNFv5.3.2.11 in **/opt/snf/sbin/** directory or the PHX-TOOLS package) to verify that the negotiated PCI-Express link is the correct x8 width.

> For more information, refer to the *Hardware Installation/Performance Issues* section in *Troubleshooting*

16.2.3 Interrupts and IRQ Affinity (Linux)

An Interrupt Request (IRQ) is a hardware signal sent to the processor that temporarily stops a running program and allows a special program, an interrupt handler, to run instead. You can send IRQs by a dedicated hardware signal or across a hardware bus as a Message Signaled Interrupt (MSI) information packet. When interrupts are enabled, receipt of an IRQ prompts a switch to interrupt context.

Kernel interrupt dispatch code retrieves the IRQ number and its associated list of registered Interrupt Service Routines (ISRs), and calls each ISR in turn. The ISR acknowledges the interrupt and ignores redundant interrupts from the same IRQ, then queues a deferred handler to finish processing the interrupt and stop the ISR from ignoring future interrupts.

IRQ Affinity

The affinity of an interrupt request (IRQ Affinity) is defined as the set of CPU cores that can service that interrupt.

> For more information on IRQ affinity go to:
> https://community.mellanox.com/docs/DOC-2123

Finding the interrupt number of the device

Command line:

```
grep myriC0-ep01 /proc/interrupts
```

Usage:

```
144:          0
```

Checking the current affinity:

Command line:

```
sudo cat /proc/irq/144/smp_affinity
```

Usage:

```
00000000,00000000,00000000,00000200
```

16.2.4 Irqbalance

Irqbalance is a Linux daemon that balances the CPU load generated by interrupts across all CPUs. The irqbalance daemon identifies the highest volume interrupt sources and isolates them to a single CPU, spreading the load as much as possible over an entire processor set, and minimizing cache hit rates for IRQ handlers.

Irqbalance is enabled by default.

The **/proc/interrupts** file includes the following:

- the number of interrupts per CPU per I/O device
- IRQ number
- the interrupt number handled by each CPU core
- interrupt type
- a comma-delimited list (CSV) of drivers that are registered to receive that interrupt.

Disabling irqbalance

By disabling irqbalance, you avoid hardware interrupts in your threads. In real-time deployments, applications are typically dedicated and bound to specific CPUs, so the irqbalance daemon is not required.

Example:

In this example, enter the following commands to disable irqbalance:

Command lines:

```
$ sudo systemctl stop  irqbalance.service
$ sudo cat /proc/interrupts | grep myri | grep ke
```

Usage:

```
      CPU0       CPU1       CPU2       CPU3
69:   9506696    768107     5662150    10696648   PCI-MSI-edge     myriB0-ke00
94:   7554013    13139806   11239993   5735786    PCI-MSI-edge     myriB1-ke08
```

Disabling irqbalance loads each interrupt to a separate CPU core, as follows:

Command line:

```
$ sudo cat /proc/irq/69/smp_affinity
```

Usage:

```
8
```

That gives us CPU core 3 (bit 3 set).

Command line:

```
$ sudo cat /proc/irq/94/smp_affinity
```

Usage:

```
4
```

That's CPU core 2 (bit 2 set).

When all bits are set, the interrupt can run on any core even after rebooting the driver (irqbalance still disabled).

Command line:

```
$ sudo cat /proc/irq/69/smp_affinity
```

Usage:

```
f
```

The following forces the interrupts to two specific cores.

Command lines:

```
$ sudo echo 1 | sudo tee /proc/irq/69/smp_affinity
$ sudo echo 2 | sudo tee /proc/irq/94/smp_affinity
```

We can check that each interrupt is going to the specified core.

Command line:

```
$ sudo cat /proc/interrupts | grep myri
```

Usage:

```
           CPU0       CPU1       CPU2       CPU3
 69:   23827111          0          0          0   PCI-MSI-edge      myriC0-
ep01
 94:         35     458887          0          0   PCI-MSI-edge      myriC0-
ep02
```

Using irqbalance, we can also remove specific cores from the set of cores that receive interrupts.

For more information on disabling irqbalance, go to: https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_MRG/1.3/html/Realtime_Tuning_Guide/sect-Realtime_Tuning_Guide-General_System_Tuning-Interrupt_and_Process_Binding.html

16.2.5 Interrupt Balancing

In some situations, performance may be impacted negatively by interrupt balancing. Disabling IRQ balancing (daemon irqbalance on RHEL), manually assigning the IRQ to a specific CPU, and then binding the tasks to a specific CPU (via **`taskset`** or **`numactl`**) may improve performance (see CPU Binding below).

16.2.6 CPU Frequency Scaling

In some cases, dynamic CPU frequency scaling may run CPUs at low frequencies. If so, disable dynamic scaling and always run CPUs at highest speeds.

16.2.7 CPU Binding

CPU binding (e.g., using **`taskset`** or **`numactl`** on Linux) can be very useful for optimizing performance for SNFv5.3.2.11.

On hosts with multiple CPU sockets, some CPUs are physically closer to the adapter and/or memory and perform better than others.

Some systems have multiple PCI-Express root ports. For example, multi-socket machines and some PCI Express slots can connect to one root port and are more easily accessible from one CPU socket, while another PCI-Express slot will be connected to another root port and are more easily accessible from another CPU socket.

16.2.8 PCI Bridging

Some PCIe slots on a machine may have deeper PCI bridging than others. Extra bridge chips between the CPU and the adapter will result in higher latency. If there seem to be lots of bridge chips, trying a different PCI-Express slot may improve performance for SNFv5.3.2.11. Run the **/opt/snf/sbin/myri_info** tool to detect the bridges between the CPU and adapter.

16.2.9 Hyperthreading

We do not recommend using more than one SNF receive thread (or process) on each physical core. Enable hyperthreading as long as the processes/threads are mapped correctly (see *CPU Binding* above).

16.2.10 NUMA Awareness

Execute the **snf_open()** function on the socket “closest” to the PCIe slot containing the ARC Series E adapter. Assign the **snf_ring_open()** function for each process/thread to its own core, preferably on the socket closest to the adapter. Latencies and contention across the QPI bridges between the sockets may arise in some cases.

> For more information on NUMA zones, go to the *L3 Cache Awareness* section of this chapter.

16.2.11 L3 Cache Awareness

For optimal performance we recommend that the aggregate Rx data and descriptor ring size be smaller than the L3 cache. Ring sizes larger than the L3 cache can lead to L3 misses, which in turn can lead to stalls, writes to RAM instead of cache, and slower performance. Slower performance is more likely to lead to dropped packets when operating at line rate.

> For more information on default data and descriptor ring sizes, go to the *Ring Management Variables* section of *Configuring SNFv5.3.2.11*

Running a single interface

When running a single interface, we recommend the application that executes **snf_open()** be opened in the NUMA zone closest to the adapter PCIe slot.

Running multiple interfaces

When running multiple interfaces, executing **snf_open()** for each interface in its own NUMA zone would be preferred.

Running in separate NUMA zones

Running the application in separate NUMA zones is more efficient for memory usage; however, the drawback is that DMA over QPI is slower than the L3 cache, but still more efficient than SW (the packets are written directly into RAM).

When running multiple interfaces in separate NUMA zones, the application with slower packet processing power may compete for the same NUMA zone as the adapter.

While it is acceptable to run SNFv5.3.2.11 applications outside the NUMA zone that the PCIe slot is in, we recommend running the SNFv5.3.2.11 threads on the same NUMA zone as the **snf_open()** call, otherwise performance will be degraded as the QPI read penalty will be larger.. Three possible scenarios for application handling of packets are:

1. Fast packet processing - In this scenario, packets are read quickly out of the ring and immediately processed. This scenario would take advantage of the ring sizes fitting into the L3 cache size as there would be less probability of the rings getting full.
2. Hold packets - In this scenario, a larger ring size is preferred as the packets would be held in the ring longer as each application does other processing. Care must be taken to ensure that the rings don't fill to capacity, resulting in packet drops.

3. Hold packets with copy - In this scenario, the application would process the packets quickly, as in the Fast packet processing scenario; however, the packets would simply be copied out of the ring to allow other workers to process the data.

16.2.12 CPU isolation

We recommend running the SNFv5.3.2.11 application on a CPU that has been isolated from the kernel scheduler, otherwise the application may be preempted by other OS services, causing a loss of performance.

Isolating the specific CPU from the kernel scheduler binds the SNFv5.3.2.11 application to that CPU.

Benefits

- Prevents OS scheduling policy issues.
- Reduces host-based back pressure caused by packet drops (due to a lack of available data or descriptor pages).

For Grub based Linux systems the **isolcpu** option can be used to accomplish CPU isolation.

CPU isolation is especially important for smaller data and descriptor ring sizes.

> For more information, go to the *CPU Binding* section in this chapter.

16.2.13 Process Priority

When the SNFv5.3.2.11 application cannot be run on a CPU that has been isolated from the kernel scheduler, setting the process to a higher priority can help limit host-based back pressure and give the SNFv5.3.2.11 application more run-time. Run the Linux **`nice`** or **`renice`** programs to adjust application priorities.

16.2.14 Blocking Mode

We recommend running the SNFv5.3.2.11 API in non-blocking mode whenever possible. In non-block mode, the application calling the SNFv5.3.2.11 API must poll the interface for the next packet. Calling the SNFv5.3.2.11 API with a receive timeout of zero enters non-blocking mode, thus increasing performance and reducing packet drops.

If you cannot execute the application in non-blocking mode, run the CPU isolation and/or Process Priority tuning steps.

> For more information, go to the *CPU isolation* and/or *Process Priority* sections in this chapter.

We also recommend that you review the IRQ affinity steps to prevent the IRQs from running on a separate CPU socket from the SNFv5.3.2.11 application

> For more information on IRQ affinity, go to the *Interrupts and IRQ Affinity (Linux)* section in this chapter.

17 Troubleshooting

This chapter describes the following topics:

- Hardware Issues
- Software Installation & System Configuration Issues

Hardware

The defective operation of a network adapter is usually easily determined. When this situation occurs, contact **ARIA Technical Support** to initiate the RMA (Return Merchandise Authorization) process to obtain a replacement for the defective network adapter.

Software/System

If the network appears to be functioning correctly but application transaction rates have not significantly improved after installation of the 10-Gigabit Ethernet Network Adapters and SNFv5.3.2.11 software, it is possible that the proprietary software features are not properly enabled. Only those hosts with valid SNFv5.3.2.11 licenses loaded will demonstrate accelerated performance. It may be necessary to repeat the activation process on all suspect host machines using the latest customer site license file to insure proper status of all network adapters.

17.1 Hardware Installation and Performance Issues

The ARC Series E network adapter is a PCIe Gen3 x8 10-Gigabit Ethernet network adapter. For optimal performance, properly seat the adapter in a PCIe Gen3 x8 expansion slot on the server. The ARC Series E adapter auto-negotiates operation in the widest available mode (x8, x4, x2, or x1) supported by the expansion slot into which it is installed, and at the highest data rate (8, 5, or 2.5 GT/s).

For optimal performance, verify that the adapter reports Gen3 x8 (8 GT/s) PCIe link speed, once it is seated in the PCIe expansion slot on the server.

Two ways to check if the network adapter is properly seated in a Gen3 PCI Express slot:

- Sample **lspci -vvv** output
- Sample **myri_info** output

17.1.1 Sample lspci -vvv output

For operating systems with the **lspci** command, examine the **lspci -vvv** output to check link speed (**Lnk Sta**).

Description:

`lspci -vvv`

Command Line:

`$ sudo lspci -vvv`

Output:

```
LnkSta: Speed 8GT/s, Width x8, TrErr- Train- SlotClk+ DLActive- BWMgmt-
ABWMgmt-
```

17.1.2 Sample myri_info output

Description:

`myri_info`

Command Line:

`$ sudo ./myri_info -b 0`

Output:

```
$ sudo ./myri_info -b 0
pci-dev at 01:00.0 vendor:product(rev)=1c09:4260(01)
        behind bridge root-port: 00:01.0 8086:0c01 (x8.3/x16.3)
Myri-10G-PCIE-8E -- Link x8
   EEPROM String-spec:
        MAC=00:60:dd:43:2d:e8
        SN=495892
        PC=10G-PCIE3-8E-4S
        PN=09-04680
        BOM=A

   Firmware:
      Version: 2.1.5
      Type   : SNF
      Config : 4 Port x 10 Gb
      SHA1   : 2d13f73ad9fe4bd4bda8d7b50dd0ad0b

   External Inputs:
      PPS: Enabled, No Input
           Front Panel PPS: No Input
           Card Edge PPS:   No Input
       10Mhz Clock: Disabled
      100Mhz Clock Locked:  Locked
```

pci-dev output results:

- The "**.3**" notation from **(x8.3/x16.3)** refers to a PCIe 3.0 Gen3 slot.
- "**behind the bridge root-port: 00:01.0 8086:0c01 (x8.3/x16.3)**" indicates that the adapter is running at Gen3 x8 speed (maximum capability).
- The motherboard PCIe slot is x16-capable.
- "**Myri-10G-PCIE-8E - Link x8**" indicates that the ARC Series E network adapter is running optimally at x8 speed.

17.1.3 LED Issues

Link LED behaviors are not well defined when ARC Series E adapters are disabled or when SNFv5.3.2.11 software is uninstalled. In addition, the adapter may not correctly process remote signal loss which may not reflect the true state of the Link.

After software installation, it is strongly recommended to ping the SNFv5.3.2.11 device before proceeding with testing.

> For more information on LED behavior, go to *Testing the ARC Series E Adapter Hardware*

17.2 Software Installation & System Configuration Issues

Should you encounter problems with SNFv5.3.2.11 software installation, usage, or performance, send the bug report script to **ARIA Technical Support**. The script output contains the vital information we need to quickly resolve your software issues.

NOTE:	It is very important that you retrieve the bug report script from the **/opt/snf/sbin** directory, otherwise important diagnostic information may not be collected.

17.2.1 Bug report scripts

Linux

The **/opt/snf/sbin/phx_bug_report** is a diagnostic script included in the Linux SNFv5.3.2.11 software distribution. The script collects diagnostic information about a customer's system configuration, such as **uname** output, processor files such as **cpuinfo** and interrupts, **lspci**, kernel messages, **ethtool**, **myri_counters**, and so on. The script must be run as root.

17.2.2 Linux RPM-TGZ installation failures

Linux RPM

If you encounter errors during the Linux RPM installation process, send the complete output from the RPM command, the kernel log output, and the **/tmp/myri_snf.log** log to **ARIA Technical Support**.

Linux TGZ

If you encounter errors during the Linux TGZ installation, send the complete output from the **sbin/rebuild.sh** log to **ARIA Technical Support**.

NOTE:	To build a SNFv5.3.2.11 kernel module, configure the source kernel tree to match the running kernel. **RedHat example:** You must install the **kernel-devel** package and the **kernel-headers** package from the RedHat distribution to build the SNFv5.3.2.11 kernel module.

17.2.3 Software Counters (myri_counters)

The **myri_counters** tool provides low-level SNFv5.3.2.11 hardware and software counters for traffic passing through the network adapter.

Command line:

```
$ sudo /opt/snf/bin/myri_counters
```

For Dual port adapters

By default, the **myri_counters** output only displays on dual-port adapters on port 0.

For Quad-port adapters

myri_counters output on quad-port adapters depends upon the port in question. If you have a quad-port network adapter installed in the host, you must specify the command line argument **-p <port_num>** to obtain the counters output for each port.

The environment variable **port_num** is an integer value from `0` to `n-1`, where "`n`" represents the number of network adapters installed in the host and running the SNFv5.3.2.11 driver, as follows:

Command lines:

```
$ sudo /opt/snf/bin/myri_counters -p 0
$ sudo /opt/snf/bin/myri_counters -p 1
```

The space between the "`p`" and the number is optional.

If a host has two quad-port adapters, use **-p0**, **-p1**, **-p2**, **-p3** to see the ports of the first adapter, and **-p4**, **-p5**, **-p6**, **-p7** to see the ports of the second adapter.

Clearing the counters

To clear and reset the counters on a specific port of a network adapter, enter the following:

Command line:

```
$ sudo /opt/snf/bin/myri_counters -p <port_num> -c
```

> For a detailed list of command line arguments to **myri_counters,** go to the *bin/myri_counters* section of *Running SNFv5.3.2.11 Diagnostic Tool Programs*

17.2.4 Numbering of snfX interfaces

If you have multiple quad-port network adapters per server, run the **myri_nic_info** utility to monitor the numbering and assigning of **snfX** interfaces to the installed adapters. The utility also lists the **snfX** interfaces' corresponding MAC addresses.

Refer to the following **myri_nic_info** output, where the board number corresponds to the **snfX** interface number. For example, adapter 4 is **snf4** in **libpcap**.

Command lines:

```
$ sudo /opt/snf/bin/myri_nic_info -B
$ sudo /opt/snf/bin/myri_nic_info
```

Output:

```
# Serial MAC               ProductCode     Driver   Version          License
0 495604 00:60:dd:43:2f:f8 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
1 495604 00:60:dd:43:2f:f9 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
2 495604 00:60:dd:43:2f:fa 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
3 495604 00:60:dd:43:2f:fb 10G-PCIE3-8E-4S myri_snf-5.3.2.11.54367 Valid
```

17.2.5 Performance Tuning and Packet Drops

If the network adapter has insufficient receive buffers on the host, all subsequent packets will be dropped until the application can provide more host buffers. SNFv5.3.2.11 supports very large receive rings but these large buffers are useful only if the application can, on average, sustain the incoming packet rate. While the network adapter can support a worst-case scenario of 14.88 Mpps, it can also be the source of dropped packets in some less common cases. The following points may help to address the issue.

The libpcap library is not SNF-aware

Ensure that the SNFv5.3.2.11 software is being used by setting **SNF_DEBUG_MASK=0x3** and opening the **snfX** device when invoking the application. This option causes the SNFv5.3.2.11 library to dump memory mapping information when the device is open. If no information outputs to the screen, it is likely that your application is linked against a version of **libpcap** that is not SNF-aware.

PCIe expansion slot issues

Verify that the network adapter is installed into a PCIe expansion slot that can sustain 10Gbit/s traffic.

Traffic issues

Monitor **myri_counters** to verify that traffic is in fact being received. For each network adapter, check the runtime counter values as follows:

1. First, examine the **Packets Received (all ports)** and **Packets Rx (this port)** counter values to verify that traffic is going directly to a consumer that uses the SNF API. If this count is zero, packets are probably being passed to the regular (much slower) kernel stack. Check to see if **libpcap** is SNF-aware with the **SNF_DEBUG_MASK=0x3** debugging option noted above.
2. Next, examine the **XMAC RX pktsAbort, XMAC RX pktsDropped**, **XMAC RX pktsNoMeta**, **XMAC RX pktsNoOutCtrl**, **XMAC RX pktsDropAbort**, and **PCIE FIFO *** values for traffic the network adapter and stack cannot sustain. Use **myri_counters -x** to see these low-level, detailed counters. These counters are zero in normal operation. If a non-zero value is reported for any of these counters, contact **ARIA Technical Support**.

17.2.6 Network Adapter Timestamps

SNFv5.3.2.11 supports socket timestamps on ARC Series E network adapters.

The timestamp is made available through the socket interface. The socket interface, running the SO_TIMESTAMP[NS] socket option, is a high-precision clock synchronized at startup to system host time (returned by the **gettimeofday()** function call). The timestamp automatically attaches to the packet upon arrival.

Linux users can access the clock as a POSIX clock or through the PTP protocol.

ATTENTION:	Use caution when running NTP services (that rely on network time protocols) on the POSIX clock. NTP services cause variations in system host times that may exceed inter-packet arrival times.

17.2.7 Synchronization

There are different levels of timestamp synchronization.

- Network Adapter-to-host synchronization (local sync)
- Host-to-host synchronization (global sync)

Network adapter-to-host synchronization (local sync)

Use the **phc2sys** Linux tool to run Network Adapter-to-host synchronization. Set the ARC Series E network adapter to “Master” clock, for higher resolution and accuracy (recommended).

Host-to-host synchronization (global sync)

Most systems use **NTPD** to run host-to-host synchronization (global sync). More precise options to **NTPD** exist; however, it only raises the accuracy level from milliseconds to tens of microseconds. Since both protocols are not typically run on dedicated networks and because there is typically a lot of host overhead in processing the protocol, the time can only be so accurate.

The ARC Series E network adapters connect externally to a PPS or a 10MHz input to improve adapter clock accuracy. When loading the driver, set the module variable inputs as follows:

```
“myri_clk_enable_pps=1"
"myri_clk_enable_10mhz=1”
```

Appendix 1. SNFv5.3.2.11 Counters

To download SNFv5.3.2.11 hardware and software counter values from the time the driver was loaded (or since the counters were reset), use the **myri_counters** tool.

Definition:

myri_counters

Command line [Linux]:

$ sudo /opt/snf/bin/myri_counters

Multi-port adapters appear in **myri_counters** as different ports. If you have a dual-port or quad port network adapter installed in the host, you must specify the command line argument **-p <port_num>** to obtain the counters output for only one port.

Example:

$ sudo /opt/snf/bin/myri_counters -p 0

$ sudo /opt/snf/bin/myri_counters -p 1

The space between the "**p**" and the number is optional.

Command line [Help]:

$ sudo /opt/snf/bin/myri_counters -h

Usage:

```
Usage: myri_counters [args]
-p N - Port number or Ethernet MAC
-b N - Port number or Ethernet MAC
-c   - clear the counters
-q   - quiet: show only nonzero counters
-i   - show host interrupt counters
-x   - expert: show all counters
-o   - show register offset
-r   - raw: show register contents
-e N - show counters for specified endpoint [0]
-a   - show counters for all endpoints
-v   - show all counters
-F   - show filter state including all registered filters
-M   - show MAC filters, if available
-h   - help
```

Clearing counters

To clear the counters on a specific port of a network adapter, enter the following command line:

Command line:

```
$ sudo /opt/snf/bin/myri_counters -p <port_num> -c
```

To clear and/or reset the counters requires root privileges.

List of SNFv5.3.2.11 Counters

The following is a detailed list of SNFv5.3.2.11 software and hardware counters.

Cycle Count

The FPGA cycle count from the time the SNFv5.3.2.11 driver was loaded

Packets Received

The number of packets received by the FPGA and transferred to the host memory.

Bytes Received

The number of bytes in the packets received by the FPGA and transferred to the host memory.

Packets Finalized

The number of packets received by the FPGA and the FPGA has transferred the descriptor to the host.

PCIE FIFO empty

The number of clock cycles for which the Rx PCIe FIFO was empty.

PCIE FIFO < ¼

The number of clock cycles for which the Rx PCIe FIFO was less than one quarter full.

PCIE FIFO ¼ - ½

The number of clock cycles for which the Rx PCIe FIFO was between one quarter and one half full.

PCIE FIFO ½ - ¾

The number of clock cycles for which the Rx PCIe FIFO was between one half and three quarters full.

PCIE FIFO > ¾

The number of clock cycles for which the Rx PCIe FIFO was between three quarters and full.

PCIE FIFO full

The number of clock cycles for which the Rx PCIe FIFO was full. These are cycles for which PCIe is blocking Rx.

RX Time Limit

The number of cycles that the RX hardware will wait for more packets to arrive before sending up partial TLP transactions.

APU version

Developer use only.

APU configuration

Developer use only.

RX Cycle Count

Continuous running count of cycles.

RX Data Pages

Number of pages in the receive data buffer.

RX Desc Pages

Number of pages in the receive descriptor buffer.

RX Data Pages Available

Number of free pages in the receive data buffer.

RX Desc Pages Available

Number of free pages in the receive data buffer.

RX Data Pages Available Min

RX Desc Pages Available Min

Indicates the minimum number of available data and descriptor pages. The lower these page values are, the more likely the adapter hardware will exhibit transmission problems.

RX Data Consumer Position

Host position in the receive data buffer.

RX Data Producer Position

FPGA position in the receive data buffer.

RX Desc Consumer Position

Host position in the receive descriptor buffer.

RX Desc Producer Position

FPGA position in the receive descriptor buffer.

RX Descriptors Created

Descriptors that have been processed by the host.

RX Wake Request

Used for interrupt generation.

RX Data TLP Q1

RX Data TLP Q2

RX Data TLP Q3

RX Data TLP Q4

RX Data TLP Full

Histogram of Rx Data DMA performance.

RX Desc TLP Q1

RX Desc TLP Q2

RX Desc TLP Q3

RX Desc TLP Q4

RX Desc TLP Full

Histogram of Rx Descriptor DMA performance.

RX Data MWr/s Min

RX Data MWr/s Max

RX Data Full MWr/s Min

RX Data Full MWr/s Max

RX Data MWr DW/s Min

RX Data MWr DW/s Max

RX Data MWr PLDW/s Min

RX Data MWr PLDW/s Max

Read Data buffer performance min/max statistics.

RX Desc MWr/s Min

RX Desc MWr/s Max

RX Desc Full MWr/s Min

RX Desc Full MWr/s Max

RX Desc MWr DW/s Min

RX Desc MWr DW/s Max

RX Desc MWr PLDW/s Min

RX Desc MWr PLDW/s Max

Read Descriptor buffer performance min/max statistics.

TX Time Limit

The number of cycles that the TX hardware will wait for more packets to be queued for sending, before starting partially full PCIe transactions.

TX Byte Count

The number of bytes in the packets sent by the FPGA.

TX Packet Count

The number of packets sent by the FPGA.

TX Completion Page LSW

TX Completion Page MSW

The two registers contain the page DMA address used for flow control on the TX portion of the SNF hardware.

TX Completion Count

Used to handshake with the hardware regarding TX completions.

TX Completion Count ACK

Used to handshake with the hardware regarding TX completions.

TX Data MRd Q1

TX Data MRd Q2

TX Data MRd Q3

TX Data MRd Q4

TX Data MRd Full

Histogram of TX Data DMA performance.

TX Desc MRd Q1

TX Desc MRd Q2

TX Desc MRd Q3

TX Desc MRd Q4

TX Desc MRd Full

Histogram of TX Descriptor DMA performance.

TX Data CplD Q1

TX Data CplD Q2

TX Data CplD Q3

TX Data CplD Q4

TX Data CplD Full

Histogram of TX Data Completion ID performance.

TX Desc CplD Q1

TX Desc CplD Q2

TX Desc CplD Q3

TX Desc CplD Q4

TX Desc CplD Full

Histogram of TX Descriptor Completion ID performance.

TX Data MRd/s Min

TX Data MRd/s Max

TX Data Full MRd/s Min

TX Data Full MRd/s Max

TX Data MRd DW/s Min

TX Data MRd DW/s Max

TX Data read performance min/max information.

TX Desc MRd/s Min

TX Desc MRd/s Max

TX Desc Full MRd/s Min

TX Desc Full MRd/s Max

TX Desc MRd DW/s Min

TX Desc MRd DW/s Max

TX Descriptor read performance min/max information.

TX Data CplD/s Min

TX Data CplD/s Max

TX Data Full CplD/s Min

TX Data Full CplD/s Max

TX Data CplD DW/s Min

TX Data CplD DW/s Max

TX Data completion read performance min/max information.

TX Desc CplD/s Min

TX Desc CplD/s Max

TX Desc Full CplD/s Min

TX Desc Full CplD/s Max

TX Desc CplD DW/s Min

TX Desc CplD DW/s Max

TX Descriptor completion read performance min/max information.

TX Data Ring Size (4 KB Pages)

The number of 4 KB pages for the host Transmit Data ring.

TX Data Ring ConsR Position

The position in the Data ring where the FPGA is pulling data.

TX Desc Ring Size (Descriptors)

The number of descriptors that can be held in the descriptor ring buffer.

TX Desc Ring ProdW Position

The descriptor index that is being written by the host.

TX Desc Ring ConsR Position

The descriptor index that is being read by the FPGA.

XMAC RX pktsRcvd

Incoming packet count at the XMAC RX core.

XMAC RX pktsAbort

Packets that get aborted in the XMAC RX core

XMAC RX pktsDropped

A count of receive packets dropped by the MAC.

XMAC RX pktsNoMeta

Packets dropped by XMAC RX due to no meta data.

XMAC RX pktsNoOutCtrl

Packets dropped by XMAC RX due to no output control.

XMAC RX pktsDropAbort

Packets dropped by XMAC RX due to other reasons.

XMAC RX pktsSent

Packets forwarded by the XMAC Rx core.

XMAC RX bytesSent

Bytes in packets forwarded by the XMAC Rx core.

XMAC RX SendDup

Should always be 0.

XMAC RX SentWithErr

Should always be 0.

XMAC RX ExtraMeta

Should always be 0.

XMAC RX CtrlDropped

Packets dropped due to control metadata FIFO full.

XMAC RX Discarded

Should always be 0.

XMAC RX Bytes

XMAC TX Bytes

The number of bytes in valid frames seen at the MAC.

XMAC RX Frames

XMAC TX Frames

The number of valid frames seen at the MAC.

XMAC RX Undersized Frames

Frames that were less than 64 bytes.

XMAC TX Fragmented Frames

Frames that were transmitted as runts due to underrun.

XMAC RX 64B Frames

XMAC RX 65-127B Frames

XMAC RX 128-255B Frames

XMAC RX 256-511B Frames

XMAC RX 512-1023B Frames

XMAC RX 1024-Max Frames

XMAC RX Oversized Frames

The number of received frames in various sizes as seen at the MAC.

XMAC TX 64B Frames

XMAC TX 65-127B Frames

XMAC TX 128-255B Frames

XMAC TX 256-511B Frames

XMAC TX 512-1023B Frames

XMAC TX 1024-Max Frames

XMAC TX Oversized Frames

The number of transmitted frames in various sizes as seen at the MAC.

XMAC RX FCS Errors

The count of frames received with FCS errors

XMAC RX Broadcast Frames

The count of correctly received broadcast frames

XMAC RX Multicast Frames

The count of correctly received multicast frames

XMAC RX MAC CTRL Frames

The count of correctly received MAC control frames

XMAC RX Length/Type Range Error

A count of error-free frames received that were at least 64 bytes in length where the length/type field contained a length value that did not match the number of MAC client data bytes received.

The counter also increments for frames in which the length/type field indicated that the frame contained padding but where the number of MAC client data bytes received was greater than 64 bytes

XMAC RX VLAN Frames

The count of correctly received VLAN frames

XMAC RX Pause Frames

The count of correctly received MAC control PAUSE frames

XMAC RX MAC Unsupported Frames

The count of correctly received MAC control frames that were not PAUSE frames

XMAC TX Broadcast Frames

The count of correctly transmitted broadcast frames

XMAC TX Multicast Frames

The count of correctly transmitted multicast frames

XMAC TX Underrun Frames

The count of transmitted frames where there was an underrun error at the MAC

RSS Mode

RSS Mask

These counters display the register setup values that control RSS distribution of packets to rings.

RSS Rx Packets

The number of packets that have arrived at the RSS core.

RSS Rx Bytes

The number of bytes in the packets that have arrived at the RSS core.

RSS Dropped Packets

The number of packets that have been dropped by the RSS core. Packets are dropped because they are arriving faster than the host is reading packets from the adapter.

RSS Dropped Bytes

The number of bytes in the packets that have been dropped by the RSS core.

RSS Error Packets

The number of packets that have errors and arrive at the RSS core. Packets are deemed to have errors if they are flagged by the MAC as having an FCS error. These packets are received and discarded by the SNF library.

RSS Error Bytes

The number of bytes in the packets that the RSS core has determined to have errors.

RSS Dispatcher Dropped Packets

The number of packets dropped out of the RSS before being dispatched to the next ring.

RSS Dispatcher Forwarded Packets

The number of packets forwarded out of the RSS to the next available ring, or distributed to different rings by way of FPGA port merging.

Appendix 2. Operating Systems and Hardware Support

Software Support

Linux support

- CentOS 8.0 is recommended.
- CentOS 7.7 and 7.8 are supported.
- For non-RPM-based Linux distributions, a `.tgz` driver is provided and supported up to Linux kernel version 5.5.

Hardware Support

Network Adapters:

ARC Series E (10G-PCIE3-8E-2S) network adapter

Part number: 09-04669

ARC Series E (10G-PCIE3-8E-4S) network adapter

Part number: 09-06480

Processors:

- Intel Haswell-E processors are recommended.
- Testing has been performed on i7-4790K, i7-5960X, i7-6700K, E5-2603, E5-2658, E5-2699, and E5-3699 processors.

Motherboards

- The following motherboards are compatible:
    - Asus Z97-Deluxe
    - Asus X99-WS/IPMI
    - Dell PowerEdgeR630
    - HP 2440 motherboards.
- Other HP Servers that are not recommended:
    - HP Z840 Workstation
    - HP G7 ProLiant servers
    - HP ProLiant Gen9 servers

Appendix 3. SNFv5.3.2.11 Driver Restrictions and Limitations

The SNFv5.3.2.11 driver restrictions and limitations are as follows:

- The SNFv5.3.2.11 release does ***not*** support Windows.
- SNF: Port merge combinations: Port merging is only permitted between two ports. You can merge ports 0 & 1, or ports 2 & 3. You cannot merge other port combinations such as ports 1 & 2.
- NUMA awareness: For best performance, all receive operations should be assigned to the single NUMA zone closest to the PCIe slot where the adapter is installed. Accessing from a socket CPU across QPI to a different NUMA zone may incur higher CPU utilization and dropped packets. The application must insure it runs from the NUMA zone CPUs where the rings/buffers are allocated to ensure no packet drops.
- The ARC Series E adapters only support DAC cables three meters in length or less. Fiber cabling and SFP+ transceivers are recommended for cables measuring more than three meters.
- Running **tcpdump -D** (lists available network devices) may not display the **snf0** device when **SNF_DEBUG_MASK=0**, even though the device is operational and can be referenced. Setting **SNF_DEBUG_MASK=3** does not display any devices, yet all are operational and can be referenced.
- SNFv5.3.2.11 FPGA firmware must match up to the proper 1G/10G transceiver. There are instances where 1G firmware may work with 10G transceivers but this practice is neither recommended nor supported. Run **myri_info** to verify firmware type and support. Refer to *Appendix 4: SNFv5.3.2.11 Firmware* of the *SNFv5.3.2.11 User Guide* for more information.
- The **snf/bin/tests/sniffex** test program is not supported. It will be removed in a future release.

Known Issues

- (ID# 174) PF_RING port aggregation is using only one CPU and may drop packets.
- (ID# 147, 153) Arista switch timestamping is not yet supported. There is no support for keyframes or timestamped packets.
- (ID# 181) **myri_endpoint_info** does not display the physical receive endpoint in use by the current port. It only displays physical endpoints in use by other ports.
- (ID# 387) FCS errors may occur on an adapter with 1G firmware when you **Ctrl-C** a receiving application.
- (ID# 388) The **snf_basic_diags** utility may intermittently fail due to port merging timing issues.
- (ID# 375) Entering **Ctrl-C** to terminate a Tx transmit application (**snf_inject_open()** function) may cause a server hang, with the warning, "**myri_snf WARN: SnifferTx still not flushed after 30 msec**". Reboot or power-cycle the server if the hang persists. We also suggest invoking **snf_inject_close** in the case of repeated lockups.
- (ID# 442) Port merging, on a quad-port card with 1G/10G firmware, fails for larger-sized packets (over 1500 bytes) and drops packets. Terminating the Rx receiver application prompts the warning, **"myri_snf WARN: SnifferTX still not flushed after 30 msec"**, in **dmesg** or /var/log/messages. Reboot the server if the hang persists.
- (ID# 444) A segmentation fault may occur when port merging between multiple adapters on the same server.
- (ID# 374) **`snf_replay -Z -N`** (playback software pacing) runs slow (in microseconds). These two flags should not be used together.

Appendix 4: SNFv5.3.2.11 Firmware

There are a variety of SNF-5.3.2.11 firmware downloads that support 1Gbit and 10Gbit speeds (Table 8).

Firmware Prefix	*Supported HW*	*Port 0 speed*	*Port 1 speed*	*Port 2 speed*	*Port 3 speed*	*Vendor Info*
fw-8E-2S-SNF_1G-<x.x.x.>	10G-PCIE3-8E-2S	1 Gbit/sec	1 Gbit/sec	N/A	N/A	1c09:4265
fw-8E-2S-SNF_10G-<x.x.x.>	10G-PCIE3-8E-2S	10 Gbit/sec	10 Gbit/sec	N/A	N/A	1c09:4264
fw-8E-4S-SNF_1G-<x.x.x.>	10G-PCIE3-8E-4S	1 Gbit/sec	1 Gbit/sec	1 Gbit/sec	1 Gbit/sec	1c09:4263
fw-8E-4S-SNF_1G10G-<x.x.x.>	10G-PCIE3-8E-4S	1 Gbit/sec	1 Gbit/sec	10 Gbit/sec	10 Gbit/sec	1c09:4262
fw-8E-4S-SNF_10G1G-<x.x.x.>	10G-PCIE3-8E-4S	10 Gbit/sec	10 Gbit/sec	1 Gbit/sec	1 Gbit/sec	1c09:4261
fw-8E-4S-SNF_10G-<x.x.x.>	10G-PCIE3-8E-4S	10 Gbit/sec	10 Gbit/sec	10 Gbit/sec	10 Gbit/sec	1c09:4260

Table 8: SNFv5.3.2.11 firmware prefixes by adapter port configuration and speed.

Legend:

fw: firmware

8E: ARC Series E network adapter class

2S/4S: dual-port or quad-port configuration

SNF: product class

1G: port speed in Gbit/sec

10G: port speed in 10Gbit/sec

<x.x.x.>: firmware version appended to the prefix

Appendix 5: SNFv5.3.2.11 Supported 1G and 10G Transceivers

The following 1G and 10G transceivers have been tested and are supported to run with ARC Series E (10G-PCIE3-8E-4S and 10G-PCIE3-8E-2S) network adapters.

Supported 1G transceiver modules

Model Number	***Speed***	***Connector***	***Notes***
FTLX8574D3BCV	1G & 10G	MM Fiber (fiber optic cable)	Can run at 1 Gb or 10 Gb
FTLF8519P3BNL	1G	MM Fiber (fiber optic cable)	1000Base-SX
FCLF8521P2BTL	1G	TXRX Copper SFP	1000BASE-T 100M
FCLF8522P2BTL	1G	TXRX Copper SFP	1000BASE-T
FTLF1318P2BTL	1G	SM Fiber (fiber optic cable)	1000BASE-LX Not tested.
ABCU-5730RZ	1G	TXRX RJ45 Copper SFP	Does not advertise connector type
ABCU-5740RZ	1G	TXRX RJ45 Copper SFP	Does not advertise connector type
FCLF-8520-3	1G	TXRX Copper SFP	Does not advertise connector type

Table 9: Supported 1G transceiver modules by speed and connector type.

Supported 10G transceiver modules

CSPi Model Number:	*Description:*	*Software Releases verified in:*
10G-SFP-SR	Optical-Fiber SFP+ transceiver for 10GBase-SR (850nm wavelength).	SNF Release Versions 2, 3, and 5
10G-SFP-LR	Optical-Fiber SFP+ transceiver for 10GBase-LR (1310nm wavelength)	SNF Release Versions 2, 3, and 5
10G-XFP-SR	Optical-Fiber XFP transceiver for 10GBase-SR (850nm wavelength)	SNF Release Versions 2, 3, and 5
10G-XFP-LR	Optical-Fiber XFP transceiver for 10GBase-LR (1310nm wavelength)	SNF Release Versions 2, 3, and 5

Table 10: Supported 10G transceiver modules.

Appendix 6: Network Adapter Toolkit - v. 1.40

The PHX-TOOLS Network Adapter Toolkit release (version 1.40) allows users to run diagnostics on ARC Series E network adapter operation and flash memory FPGA firmware programming.

The PHX-TOOLS toolkit version 1.40 describes the individual features, bug fixes, and limitations. We recommend that users migrate to this release at their earliest convenience.

Hardware Support

1. Refer to the README file in the PHX-TOOLS Network Adapter Toolkit for installation and configuration instructions.
2. The toolkit currently supports the following network adapter format:

- 10G-PCIE3-8E-2S with two SFP+ cages
- 10G-PCIE3-8E-4S with four SFP+ cages

3. The firmware must match the adapter model and transceiver type. For more information, refer to *Appendix 4: SNFv5.3.2.11 Firmware*.
4. Several models of 1G and 10G transceivers are supported. For more information, refer to *Appendix 5: SNFv5.3.2.11 Supported 1G and 10G Transceivers.*
5. The toolkit is compatible with Windows Server 2008R2 and later, and most Linux distributions.

New Features and Enhancements

1. (ID# 369) SNF: Release of firmware version 2.1.5 for ARC Series E adapters.
2. (ID# 74) SNF: ARC Series E- adapters have been updated with an improved oscillator and resistor. These hardware updates reduce FCS errors and improve timestamp accuracy. The updates also improve performance when using 1 Gb firmware/transceivers.
3. (ID# 166) SNF: Transmit injection pacing is now supported.
4. (ID# 282) SNF: Interrupts are now generated to detect the insertion or removal of SFP+ transceivers.
5. (ID# 211) SNF: Improved packet type coverage for RSS hash.
    a. (ID# 239) Packets are now spread among rings when using a varying destination port with a fixed source port.
    b. (ID# 248) GRE packets with fixed IPs and ports now land in one ring.

c. (ID# 249) GTP-U packets with varying TEIDs & fixed IPs and ports are now spread among rings.

6. (ID# 397) Added acceleration support for port pair merging. For more information, go to the *Port Merging* section of *Load Balancing and Port Merging Features*

Bug Fixes

1. (ID# 332) SNF: **myri_info -v** will now display the correct firmware build date.
2. (ID# 345) SNF: Fixed hang that occurred when entering **CTRL-C** while an application was transmitting data.
3. (ID# 257) SNF: **myri_info -h** will now display the correct version number of the toolkit release.
4. (ID# 364) SNF: Fixed slow throughput that occurred with quad-port 1G firmware.
5. (ID# 305) SNF: Fixed a case where drops would occur when receiving successive packets that were sequentially sized.

   Example: Receiving packet sizes: 64, 65, 66...
6. (ID# 379) SNF: Fixed problem that caused TX traffic on port 0 to stop when a cable was removed from port 1.
7. (ID# 380) SNF: Fixed problem that caused the first packet received to be dropped following a reboot or power-cycle.

Limitations

None

Known issues

1. (ID# 437) ARC Series E adapters running 1G firmware may run into a situation where they cannot receive packets, prompting the following **`dmesg`** error log: **`"myri_snf WARN: RX endpoint is not flushed"`**. You must reboot to correct the problem.

Technical Support:

If there are any problems installing or using ARIA Cybersecurity Solutions products, or if any bugs or possible enhancements are noticed, do not hesitate to contact ARIA Technical Support.

Contact Technical Support via the ARIA Customer Portal *
https://www.ariacybersecurity.com/support/downloads/

ARIA Cybersecurity Solutions website:
https://www.ariacybersecurity.com/network-adapters/

ARIA email support at ARIA_support@ariacybersecurity.com

Before you contact our technical support staff, have the following information available:

- Your name, title, company name, phone number, and email address
- Operating system and version number
- Product name and release version
- Problem description

* Follow the instructions on the ARIA Customer Portal website to register for an ARIA Customer Support account

Glossary

Bro	An open source based Intrusion Detection System (IDS) package that interfaces with SNFv5.3.2.11 through **libpcap**.
CentOS	A third-party Linux distribution.
Descriptor ring	Stores packet metadata such as timestamp and length in main memory.
DMA	Direct memory access.
DST	Destination address.
Dual-port	An adapter with two ports.
EEPROM	Electrically erasable programmable read-only memory
Endpoint	A connection point where HTML files or active server pages are exposed. An example of an endpoint is a PC.
ESD	Electrostatic Discharge.
Fedora	A third-party Linux distribution.
Firmware	Permanent software programmed into a read-only memory.
FPGA	Field Programmable Gate Array
Gen2	A second generation of PCIe standard.
Gen3 x16	A third generation of PCIe standard with 16 lanes.
Gen3 x8	A third generation of PCIe standard with 8 lanes.
GNU	Generally Not Unix

GPRS Tunneling Protocol	GPRS Tunneling Protocol (GTP) is a group of IP-based communications protocols used to carry General Packet Radio Service (GPRS) within cellular networks.
GRE Protocol	Generic Routing Encapsulation protocol, used to encapsulate packets of one network layer protocol over another network layer protocol.
HW	Hardware
IDS	Intrusion Detection System
ifcfg	A configuration file that defines parameters used to configure a network adapter.
isolcpus	Isolate CPUs from the kernel scheduler.
IRQ	Interrupt Request
IRQ Affinity	Defined as the set of CPU cores that can service an interrupt request.
Irqbalance	A Linux daemon that balances the CPU load generated by interrupts across all CPUs.
ISR	Interrupt Service Routine
ldd	List Dynamic Dependencies
LED	Light Emitting Diode
Libpcap	Library used by programs to perform packet capture.
Linuxptp	Implementation of Precision Time Protocol on Linux.
MAC	A network adapter Media Access Controller address.
MPLS	Multi-Protocol Label Switching

MSI	Message Signaled Interrupt
NTP	Network Time Protocol
Ntpd	Network Time Protocol daemon. A program which uses Network Time Protocol (NTP) to keep system time synchronized with time servers.
NUMA	Non Uniform Memory Architecture
Numactl	A program used to monitor memory usage policy.
PATH	An environment variable used by a system to access programs without having to specify their path
Pcap	Packet capture
PCIe	Peripheral Component Interconnect (Express)
phc2sys	A Linux program used to run adapter-to-host synchronization.
PHX-TOOLS	A toolkit that runs diagnostics on ARC Series E network adapter operation and flash memory FPGA firmware programming.
POSIX clock	POSIX function used to determine CPU time consumed by a process
PPS	Pulse Per Second
PTP Hardware Clock	The ARC Series E network adapter clock.
PTP Protocol	Point-To-Point protocol
QPI	QuickPath Interconnect
Quad port	An adapter with four ports.

RHEL	Red Hat Enterprise Linux (RHEL) is a Linux distribution developed by Red Hat.
RMA	Return Merchandise Authorization
RPM	RedHat Package Manager
RSS	Receive Side Scaling
SDK	Software Development Kit
SFP+	Small Form-Factor Pluggable transceiver, “+” symbol indicates 10Gb.
Snort	An open source network intrusion prevention system, capable of performing real-time traffic analysis and packet logging on IP networks.
SRC	Source address
Suricata	An open source-based Intrusion Detection System (IDS) that interfaces with SNFv5.3.2.11 through libpcap
SW	Software
Taskset	A program used to set or retrieve a task’s CPU affinity
TCP	Transmission Control Protocol
Tcpdump	An open source packet analyzer that runs under the command line. It allows the user to display TCP/IP and other packets being transmitted or received over a network to which the computer is attached.
Tcpreplay	An open source utility that edits and replays previously captured network traffic. Tcpreplay was originally designed to replay malicious traffic patterns to Intrusion Detection/Prevention Systems.

UDP	User Datagram Protocol
Ubuntu	An open source operating system based on the Debian Linux distribution.
VM	Virtual Machine
Wireshark	An open source packet analyzer, used for network troubleshooting, analysis, software and communications protocol development. Similar to **tcpdump** except that it supports a Graphical User Interface (GUI).