NightStar LX Installation Guide

Version 4.5-SR1

CentOS
Debian
Fedora
Red Hat
Ubuntu
RedHawk

Contents

1.0.   Introduction

NightStar LX Version 4.5-SR1 is a production release of the NightStar Tools running under RedHawk Linux.

This release includes enhancements and corrections to NightStar and further support for NVIDIA's Jetson TX1 development kit. It is all inclusive, insomuch as it contains the original NightStar LX 4.5 content plus all changes to date.

NightStar LX 4.5 is required for use with modern Linux distributions; i.e. older NightStar LX CDs may not even install due to changes in YUM file sharing rules by the underlying Linux distribution.

1.1.   What is NightStar LX?

NightStar LX consists of the NightProbe data monitor, NightTrace event analyzer, NightTune system and application tuner, and NightView source-level debugger.

If you haven't used NightStar LX since version 3.2 you'll notice a new look and feel to the graphical interface components. Read "NightStar LX GUI Features" on page 15 to get an overview of the new interface.

2.0.   New in NightStar LX 4.5

Apart from bug fixes and minor enhancements, the original 4.5 released added aarch64 (aka ARM64) to the family of supported NightStar architectures.

NightStar 4.5-SR1 includes the following additional features on aarch64 targets.

- CUDA 7.0 support is now available for Tegra on NVIDIA's Jetson TX1 board. It includes:
    - NightTune CUDA Configuration and Usage panels
    - NightView CUDA debugging
    - NightTrace CUDA user trace events in GPU-executed code
    - NightTrace CUDA Application Illuminator
- CUDA 8.0 support
    - Support is under development
    - NightTrace CUDA features have passed unit testing on CUDA 8.0 and have been included in this service release.
    - NightView CUDA (GPU) debugging is not recommended on CUDA 8.0 at this time.
    - Full support will be added in NightStar 4.5-SR2.
- General Application Illumination (AI) support was added for all supported aarch64 targets. It includes the following predefined illuminators:
    - main
    - glibc
    - pthread
    - ccur_rt
    - cuda (for the Jetson TX1)

2.1.   Changes in NightView

2.1.1.   New Features

NightView 7.6, a component of NightStar LX 4.5, includes the following new features.

- Reduced disk, memory, and CPU footprint for target systems
- Reduced package dependencies for target systems
- Debugging of aarch64 systems, including cross debugging from x86_64
- Unrestricted debugging of 32-bit x86 applications on x86_64 systems

2.1.2.   Remote Debugging ssh Connections

When remote debugging, NightView uses **ssh** to connect to the target system. Multiple connection are required - up to three for each remote session. As such, NightView may prompt you multiple times for authentication information for the same target system. The best way to avoid multiple authentication requests is to use an **ssh** agent (see **ssh-agent(1)**) with pre-loaded authentication keys. If properly configured, NightView would then only prompt you for authentication information if the target system rejects your agent-supplied keys.

An alternative is to use **ssh** control path forwarding. This provides for port forwarding across an active **ssh** connection. Currently NightView uses this feature sparingly, because some recent Linux distributions have problems setting up port forwarding when using control path forwarding; e.g. an initial ssh connection such as **ssh -M -o file** *target*, and subsequent **ssh** port forwarding commands referencing the connection master.

You can fully enable this feature in NightView by setting a debug flag in your NightView session:

```
set-debug use-control-path-forwarding=1
```

When fully enabled, attempts to create the second or third **ssh** connection to the target system may hang. Our experience is that if they do not hang and actually do connect, they operate correctly.

To completely disable control path forwarding, use the following NightView command:

```
set-debug no_ssh_port_forwarding=0
```

We recommend that you use an ssh agent (**ssh-agent(1)**) with pre-loaded authentication keys. If set up properly, you can avoid having to interactively provide authentication information, regardless of the port forwarding scheme in use.

2.1.3.   Package Reorganization

NightView 7.6 changed the names of NightView packages from previous releases.   The old packages:

- **ccur-NightView**
- **ccur-Nviewp**
- **ccur-Nview-ptrace**
- **ccur-NightView-docs-rt**

will be replaced during the installation or update of NightView 7.6 by the following new packages:

- **ccur-nview**
- **ccur-nview-target**
- **ccur-nview-${arch-tag}-support**
- **ccur-nview-docs-rt**

Each NightView installation will include its native architecture support package. This allows it to debug native architecture programs locally as well as being able to debug same-architecture programs running on target systems. We call the later "remote debugging". Remote debugging requires that an ssh connection can be made by NightView from the host system to the target system.

For situations where you have constraints on the target system's resources, the only NightStar packages required are `ccur-nview-target` and `ccur-nstar-fs`. Such "server" or "target" packages are available for each of the four tools.

2.1.4. Cross Debugging

We use the term cross-debugging for the case of a remote debugging session between a host and target system with differing architectures. Cross-debugging requires the installation of additional `ccur-nview-*-support` packages on the host system.

NightView on i386 supports cross-debugging to x86_64 and aarch64 target systems. To use the cross-debugging features, the host system requires the installation of the `ccur-nview-amd64-support` or `ccur-nview-aarch64-support` package, respectively.

Similarly, NightView 7.6 on x86_64 supports cross-debugging to i386 and aarch64 target systems. This requires that `ccur-nview-i386-support` or `ccur-nview-aarch64-support` be installed on the host, respectively. Further, since x86_64 program can execute i386 programs directly, NightView 7.6 supports debugging i386 programs directly on the host as well. The previous NightView restriction of requiring a separate 32-bit shell for i386 debugging has been lifted. You can now even debug i386 programs that are exec'd (see `exec(2)`) from x86_64 programs, and vice versa. This mixed-architecture debugging requires the installation of `ccur-nview-i386-support` on the host x86_64 system.

At the current time, NightView 7.6 on aarch64 systems does not support cross-debugging to i386 or x86_64 targets. However, you can still do remote debugging from an aarch64 host to an aarch64 target system.

2.2. Changes in NightTrace

NightTrace 7.5, a component of NightStar LX 4.5, includes the following new and improved features:

2.2.1. Support for aarch64

NightTrace can now operate on user data or kernel data logged on aarch64 systems.

You can analyze the data with the exact same techniques and session files as the same user interface is provided; the addition of aarch64 was completed without changes to the user interface.

2.2.2. Improved PID Tracking for Kernel and User Trace Data

The ability to provide a program name along with a process ID greatly enhances the readability of trace data.

In the past, process names were available for a majority of trace events, but there were many cases where only the PID was available. Such cases included processes seen at the start of kernel tracing before any context switching had occurred as well as processes that were started after kernel tracing started but exited before kernel tracing stopped.

With this release, NightTrace has enhanced process name determination. Most all events now have process names as well as PID values. This includes user events when accompanied by kernel events.

However, there are some limitations. Much of process name determination happens retroactively, as more trace data is consumed.

While using ntrace to view trace data from files, you should encounter few events without process names.

However, when streaming trace events, there will be times initially where the process name may not be available, but those will subsequently be identified as more trace data is consumed.

The NightTrace Analysis API has a similar limitation. Full process name determination cannot be completed until data from the end of a trace is consumed. Thus if you want to ensure that all process names are determined, you should use code similar to the following:

```
#include <ntrace_analysis.h>
...
tr t = tr_init()
...
-- Ensure the end of trace data has been seen
while (tr_next_event(t)!=TR_EOF){}
tr_seek(t,0);
...
-- Now install your conditions and states and callback
-- functions and start processing for real.
...
```

While this is wasteful in terms of processing, it is effective. A more elegant solution is being considered for the future.

2.3. Changes in NightTune

2.3.1. New Features

NightTune 3.7, a component of NightStar LX 4.5, has the following new features.

- Support of CUDA 7.5 on x86_64 systems (with NightStar LX 4.5-SR1). In order to utilize the NightStar-built CUDA illuminator, please request a copy from Concurrent Software Support (see "Direct Software Support" on page 33).

- Addition of a PCI Panel which graphically shows the layout of PCI devices, ports, bridges, and buses. You can easily see devices which share IRQs by simply selecting a device in the panel -- those that share an IRQ will be highlighted in red. The panel also provides users insight into how a specific PCI device might be affected by other PCI traffic.

2.3.2. Package Renaming

NightTune 3.7 renamed a few of its packages, making the previous names obsolete. packages **ccur-ntuneserv** and **ccur-ntunecommon** have been replaced with **ccur-ntune-server** and **ccur-ntune-common**, respectively.

During installation the old packages will be replaced with the new packages.

2.4. Changes in NightProbe

2.4.1. Maintenance Release

NightProbe 4.3 did not change significantly from their previous versions. The new releases contain bug fixes and adjusted package dependencies.

3.0. Software Installation

Follow the instructions under "Installing NightStar LX" on page 7 to install NightStar LX on your system.

Then take a look at "NightStar LX GUI Features" on page 15 to learn about the new graphical interface of the NightStar LX tools.

3.1. Prerequisites

Prerequisites for NightStar LX Version 4.5-SR1 for both the host system and target system are as follows.

3.1.1. Host System

Any of the following distributions:

- Concurrent RedHawk 4 - 7.2
- Red Hat Enterprise 4-7
- CentOS 5-7
- Ubuntu 14.04 - 16.04
- Fedora 20-24
- Debian 7-8

3.1.2. Target System

For x86 and x86_64 systems, all the distributions above are supported.

For aarch64 systems, there are two currently supported userland distributions:

- For the X-C1^{TM} platform from Applied Micro Circuits Corporation
  - CentOS 7.2
- For the Jetson TX1 from NVIDIA Corporation
  - Ubuntu 14.04 (NVIDIA L4T r24.1 / JetPack 2.2)
  - Ubuntu 16.04 (NVIDIA L4T r24.2 / JetPack 2.3)

3.2. Installing NightStar LX

There are three methods of installing NightStar LX.

- Network Installation for CentOS and Red Hat
- Network Installation for Ubuntu
- CD Installation

Network installation is highly recommended as an alternative to using the CD image, because it includes configuration of a repository for NightStar LX and allows you to keep your system up to date with updates. Further, NightStar may require packages which are not yet installed on your system -- such packages may be automatically installed when using **yum** or **apt-get** for installation.

If you have NightStar icons on your desktop, remove them before proceeding with the installation. After installation is complete, reinstall the icons using the following command when logged in as your normal user:

> **/usr/lib/NightStar/bin/install_icons**

3.2.1. Network Installation for CentOS and Red Hat

Network installation is accomplished via YUM repositories hosted on redhawk.ccur.com using the **nuu** or **yum** command. **nuu** is Concurrent's Network Update and installation Utility.

Network installation requires your **redhawk.ccur.com** *login/password* information. If you do not have this information, please contact Concurrent Software Support; see the Direct Software Support section at the end of this document.

IMPORTANT

> **Before** actual installation, it is highly recommended that you read the entirety of which ever network installation method you have selected as well as short section that follows entitled *Additional Network Installation Issues*.

Use of **nuu** is preferred because it manages your **redhawk.ccur.com** login and password required to access the repositories.

If you do not have NUU installed on your system, visit the following URL and follow the instructions on installing and configuring NUU and installing this release:

> **http://redhawk.ccur.com/updates**

Once NUU is installed, you can install or upgrade to this release by invoking NUU as follows:

> **/usr/bin/nuu --enablerepo=ccur-nstar-lx**

If you have not yet used NUU to install or update from Concurrent product repositories, you will be prompted for your login and passwd information.

If NightStar LX is not already installed you will need to change NUU's mode to *Installable*, as it defaults to *Updateable*. This setting can be selected from a drop-down menu located in the upper right quadrant of the main window. Once set, you should be able to locate ccur-NightStar-LX in the list of packages. Select that package for installation and click the **Apply** button. It's dependencies will cause the entire NightStar LX to be installed.

If NightStar LX is already installed on your system any out of date packages will be in the updateable list on the screen. Select them for update and click the **Apply** button.

IMPORTANT

> When updating be careful. Make sure you are not unknown-
> inly updated your entire system unless that is your intention.
> After hitting **Apply** NUU will pop up a dialog which will
> show you exactly which packages will be updated. Carefully
> examine that list before proceeding. All Concurrent packages
> start with a ccur- prefix.

The QuickStart.pdf document included in the NUU download kit obtained from the URL above explains how to use NUU in more detail.

Installation via YUM

Add a yum repository definition file to the **/etc/yum.repos.d** directory; the filename must end in **.repo**

The URL for the NightStar LX repository is customized with your **redhawk.ccur.com** login information. The contents of the **ccur-nstar-lx.repo** file should be as follows:

```
[ccur-nstar-lx]
name=NightStar LX
baseurl=https://redhawk.ccur.com/buffet?Login=login&Password=passwd
&path=NightStar/LX/CentOS/$basearch
gpgcheck=0
```

where you replace *login* and *passwd* with your actual authentication values.

The **baseurl** setting must be on a single line without intervening spaces.

The string **$basearch** in the URL should be exactly those characters. Yum will replace that sub-string with the current architecture during yum's execution.

To install NightStar LX for the first time, use the following command:
```
yum --enablerepo=ccur-nstar-lx install ccur-NightStar-LX
```

To update NightStar LX, use the following command:

```
yum --enablerepo=ccur-nstar-lx update 'ccur-n*'
```

Additional Network Installation Issues

Do not attempt to update or install the following obsolete packages:

- ccur-NightView, ccur-NightView-docs-rt, ccur-Nviewp, ccur-Nview-ptrace

- ccur-ntunecommon, ccur-ntuneserv

- ccur-ntracelog, ccur-ntraceapi

- ccur-nprobeserv

NightStar LX 4.5 replaces those packages with new ones with different names. Normally, all these obsoleted packages will be removed during a CD installation or yum/nuu update in favor of the

newly required packages so you should not have to deal with them. If you have trouble in this area try forcing the removal of these packages manually via:

```
rpm -e --nodepends problematic-obsolete-package-list
```

and then retry the install.

If the installation fails because **libstdc++.so.5** is not available, install the **compat-lib-stdc++-33** RPM which is readily available with CentOS and exists in an optional repository for Red Hat Enterprise users. You may also be able to locate the RPM from an older Linux system or distribution media.

The NightStar LX installation CD contains a version that may or may not be compatible with your system.

If you experience any problems during the update or installation process, please contact Concurrent support (see "Direct Software Support" on page 33).

After installation, you can keep your system up to date interactively using NUU or even install a **cron** job to update your system nightly; e.g.:

```
1 0 * * * /usr/bin/yum -y --disablerepo=* --enablerepo=ccur-nstar-lx
update
```

3.2.2.   Network Installation for Ubuntu

Installation of NightStar LX on Ubuntu and Debian systems is accomplished using APT -- the standard installation method for those distributions.

- Concurrent's public key should be obtained from Concurrent and added via the **apt-key** command as shown below:

```
wget http://redhawk.ccur.com/debian/ccur-public-key
apt-key add ccur-public-key
```

- The following line should be appended to **/etc/apt/sources.list**:

```
deb http://redhawk.ccur.com/debian/nightstar 4.5 lx
```

- Force the APT system to reread the repository source list. Issue the following command (do not be concerned about the word update, **apt-get** will not change any packages as part of this step):

```
apt-get update
```

- Install the entire NightStar LX product via the following command:

```
apt-get install ccur-nightstar-lx
```

NOTE

The URL used for obtaining NightStar LX is subject to change.

3.2.3.   CD Image Installation

To install NightStar LX using the NightStar LX *Installation CD*:

- Insert the *NightStar LX Installation CD* in the CD-ROM drive; on newer
systems it will automatically mount at one of the following locations:

  - **`/media/NightStar-LX-4.5-SR1`**

  - **`/run/media/{user-name}/NightStar-LX-4.5-SR1`**

- If the CD does not auto-mount, mount the CD-ROM drive in a manner similar to
the following:

  ```
  [ -d /mnt/cdrom ] || mkdir /mnt/cdrom;
  mount -t iso9660 -o ro /dev/sr0 /mnt/cdrom
  ```

  Your CD device may be something other than **`/dev/sr0`**.

- Double-click on the CD icon including the notation NightStar LX 4.5-SR1 on
your desktop.

- Double-click on the icon labeled Launch Install Script.

NOTE

If you are not using a file browser to access the CD or the icon fails to appear on your desktop,
change the current working directory to the directory where the CD is mounted and invoke the fol-
lowing script:

`./install-nstar.`

IMPORTANT

If attempts to invoke **`./install-nstar`** are unsuccessful and generate a message similar to

```
unable to exec...
```

or if the Launch Install Script immediately exits without useful information, it may be that your
system has been configured to prevent execution of scripts from mounted CDs. If this is the case,
the mount options would have included the **`noexec`** option. You can correct this problem by exe-
cuting a command similar to the following:

`mount -o exec,remount` *mountpoint*

NOTE

If the installation fails due to an unmet dependency, retry the installation with an additional option
by running the following command while positioned in the directory where the CD is mounted:

`./install-nstar --no-disable`

By default, the installation instructs yum to ignore all RPM repositories except the one included
natively on the CD.

The **`--no-disable`** option, as shown above, allows (enabled) network repositories to participate
in meeting RPM requirements.

If the install still fails due to an unmet dependency on **libstdc++.so.5**, install the **compat-libstdc++-33** RPM which is readily available from CentOS installation media or network repositories and exists in an optional repository with Red Hat Enterprise. For Debian and Ubuntu, the package is named libstdc++-5. You may also be able to locate the packages from an older Linux distribution to which you have access.

A version of this package exists on the CD -- it may or may not be compatible with your system.

If you experience any problems during the update or installation process, please contact Concurrent support (see "Direct Software Support" on page 33).

- Double-click on the icon labeled Install Desktop Icons.

NOTE

Since you are running as root, these icons will only be installed on root's desktop. To install these on your normal user's desktop, run the following script when logged on as your normal user:

/usr/lib/NightStar/bin/install_icons

3.3. Know Installation Issues

The following sections describe known complexities for installing NightStar LX.

3.3.1. Missing libstdc++.so.5

On X86 systems, NightStar still requires **libstdc++.so.5**. On CentOS and Fedora systems, packages that supply that library are readily available, assuming you have a network link to their respective repositories. This applies to Ubuntu and Debian systems as well.

On CentOS-like systems, you can find **libstdc++.so.5** in the following RPMs:

- **compat-libstdc++-33**

On Ubuntu-like systems, you can find the shared library in the following DEB packages:

- **libstdc++5**

The following files are included on the NightStar Installation disc and are members of their corresponding repositories on the CD:

- **deb/dists/4.5/rt/binary-amd64/libstdc++5_3.3.6-17ubuntu1_amd64.deb**
- **deb/dists/4.5/rt/binary-i386/libstdc++5_3.3.6-17ubuntu1_i386.deb**
- **rpm/x86_64/compat-libstdc++-33-3.2.3-61.x86_64.rpm**
- **rpm/i386/compat-libstdc++-33-3.2.3-61.i386.rpm**

On Red Hat systems, you may have to mount your original Red Hat media to locate RPMs that satisfy the **libstdc++.so.5** dependency.   Alternatively, use of additional channels with your Red Hat subscription may give you access to the library.

On aarch64, **libstdc++.so.5** is not required -- **libstdc++.so.6** is required instead and is available on both CentOS 7.2 and Ubuntu 16.10 systems.

3.3.2. 32-bit library dependency

Currently, on x86_64 systems, the NightView server package, ccur-nview-target.x86_64 has requirements on the 32-bit glibc. Typically on CentOS or Fedora systems these packages are readily available. On Red Hat, you may need to manually install such packages to satisfy the requirements.

3.4. Removing NightStar LX

To remove NightStar LX, mount the CD or ISO image as described in "CD Image Installation" on page 10 and execute the following command as root:

```
./remove-nstar
```

4.0.   Documentation

The following table lists the NightStar LX 4.5 documentation available from Concurrent.

NightStar LX Version 4.5-SR1 Documentation

Manual Name	Pub. Number
NightStar LX *Installation Guide (Version 4.5-SR1)*	0897008-4.5-SR1
NightStar LX *Tutorial (Version 4.5)*	0897009-100
NightProbe User's Guide (Version 4.2)	0898465-108
NightSim User's Guide (Version 4.3)	0898480-075
NightTrace User's Guide (Version 7.4)	0898398-190
NightTune User's Guide (Version 3.6)	0898515-044
NightView User's Guide (Version 7.5)	0898395-360

Additionally, the manuals are available:

- in PDF format in the **documentation** directory of the *NightStar LX Installation CD*

- from the Concurrent Software Library *online* at http://redhawk.ccur.com/docs

- using the NightStar integrated HTML viewer **/usr/bin/nhelp**

- in PDF format in the directory **/usr/share/doc/NightStar/pdf**

- in HTML format in the directory **/usr/share/doc/NightStar/html**

5.0.   NightStar LX GUI Features

Some of the common features of the NightStar LX Tools graphical user interface include:

- movable and resizable panels
- tabbed pages
- context menus

5.1.   Movable and Resizable Panels

The NightStar LX Tools allow the user flexibility in configuring the graphical user interface to suit their needs through the use of resizable and movable panels.

For instance, consider the default configuration for NightTune. When NightTune is invoked, the graphical user interface looks similar to the following figure:
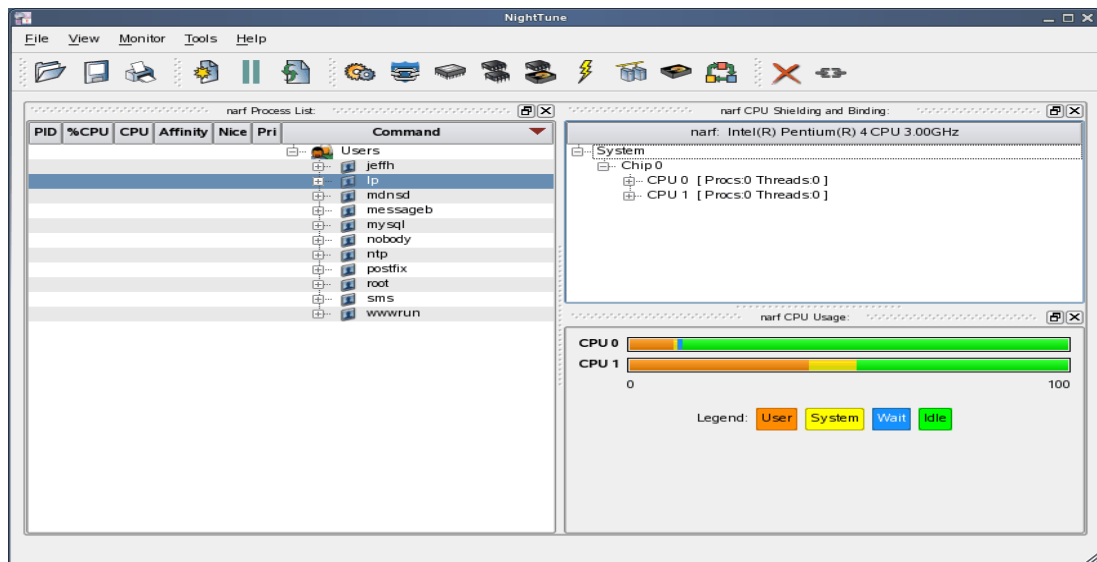

To move one of the panels in the current page, left-click on the title bar for the panel you wish to move and begin to drag the panel to the desired location. The application will respond by creating space on the page based on where you move the panel while resizing and moving the other panels accordingly.

For instance, to move the CPU Usage panel above the Process List panel, left-click on the title bar of the CPU Usage panel and begin to drag it up and to the left. NightTune will respond by creating space above the Process List panel as shown in the figure below:
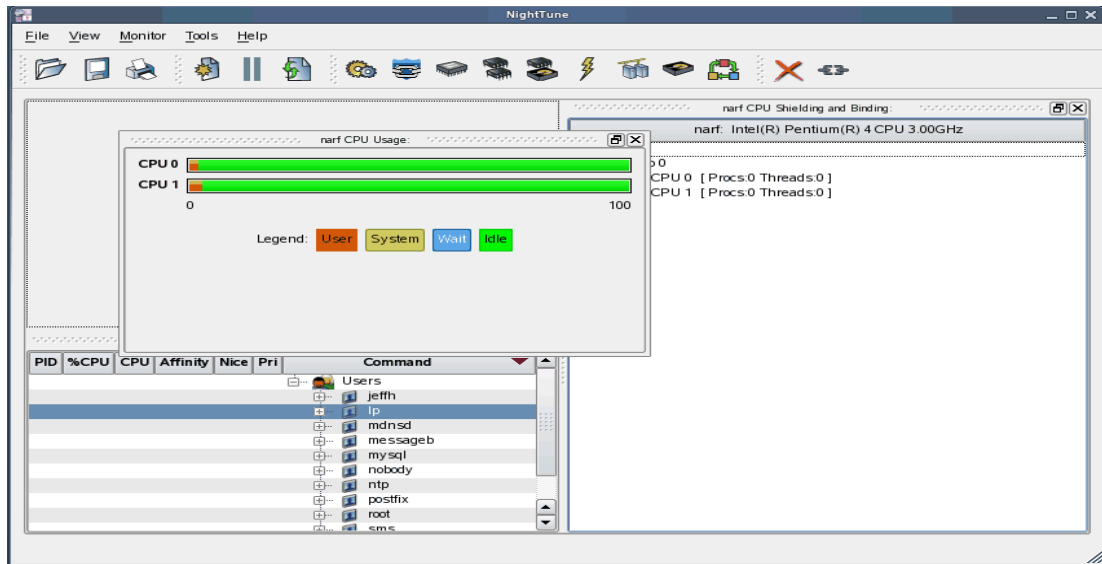

Release the mouse button when NightTune has opened a space where you desire and NightTune will place the panel in that location. The CPU Usage panel now resides in the upper left corner of the NightTune display.
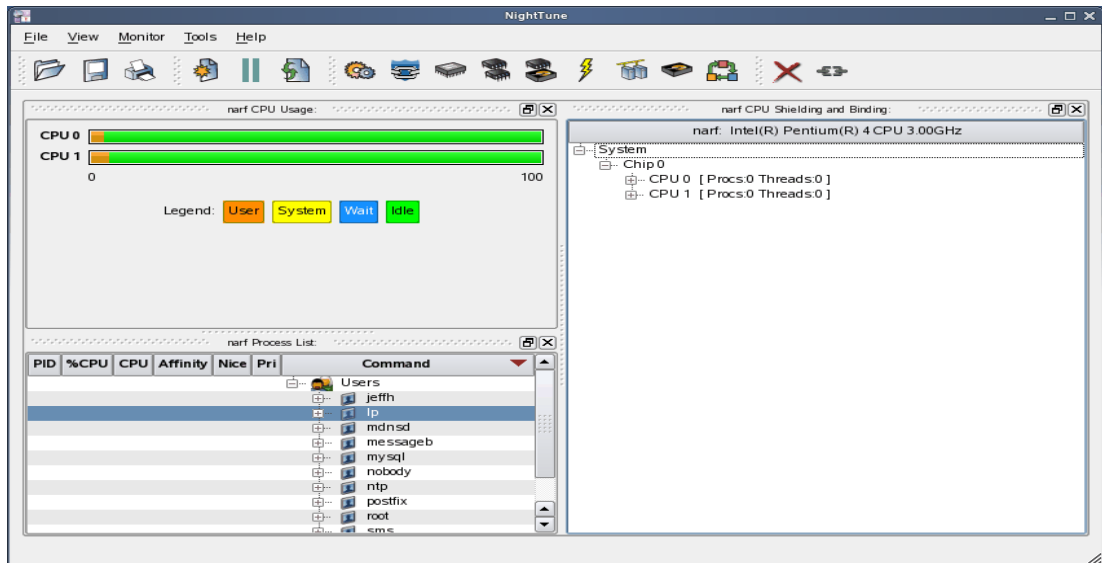

If an empty space does not appear where you desire it, try increasing the size of the main window, decreasing the size of the undocked panel, and moving an alternative edge of the undocked panel near where you want to place it.

Panels can be resized by left-clicking on the separator between the panels and dragging it to the desired size. For instance, to increase the height of the Process List panel (and thereby decrease the height of the CPU Usage panel), left-click on the separator between the two panels (the cursor will become a double-headed arrow) and drag the separator until the panels are the desired size.
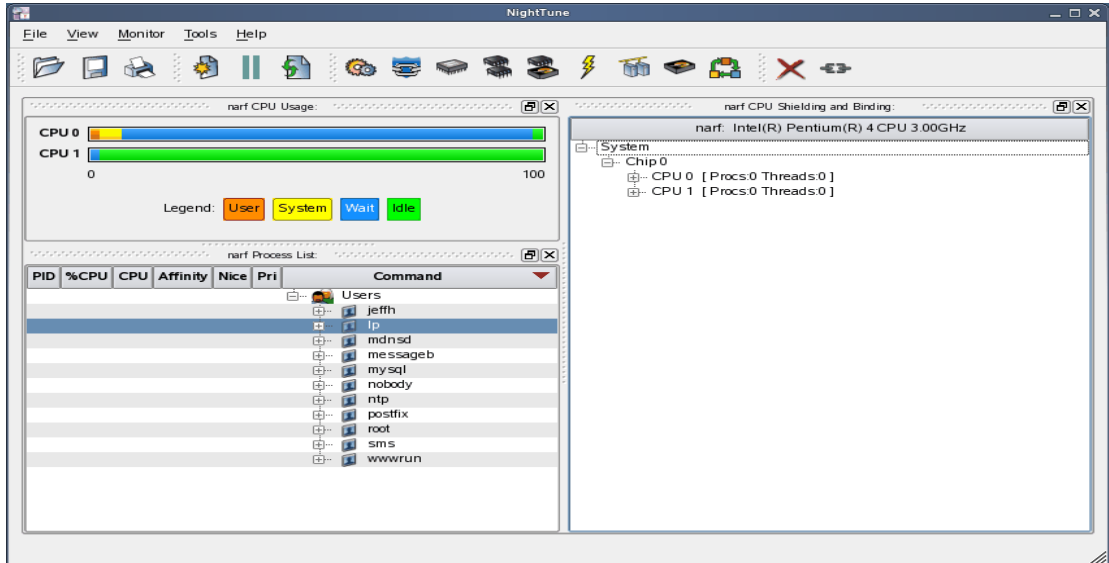
Another feature of the NightStar LX Tools graphical user interface is the use of tabbed panels. Tabbed panels allow you to maximize your GUI real estate by placing two or more panels in the same location. You can then switch between the panels using the tabs created.

In our example, we can configure NightTune so that the CPU Shielding and Binding panel and the CPU Usage panel share the same space. Left-click on the title bar of the CPU Shielding and Binding panel and drag it beneath the CPU Usage panel until you see a tab labeled "CPU Usage" created at the bottom of the CPU Usage panel as shown in the figure below.
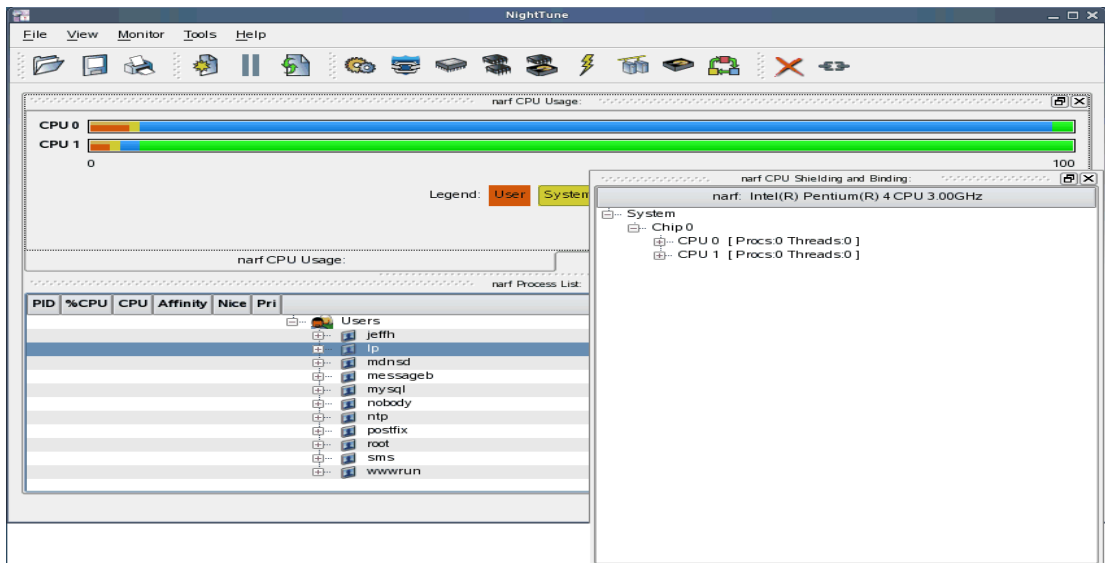
Release the mouse button and NightTune places the CPU Shielding and Binding panel in the same location as the CPU Usage panel and creates two tabs underneath enabling you to switch back and forth between the two.
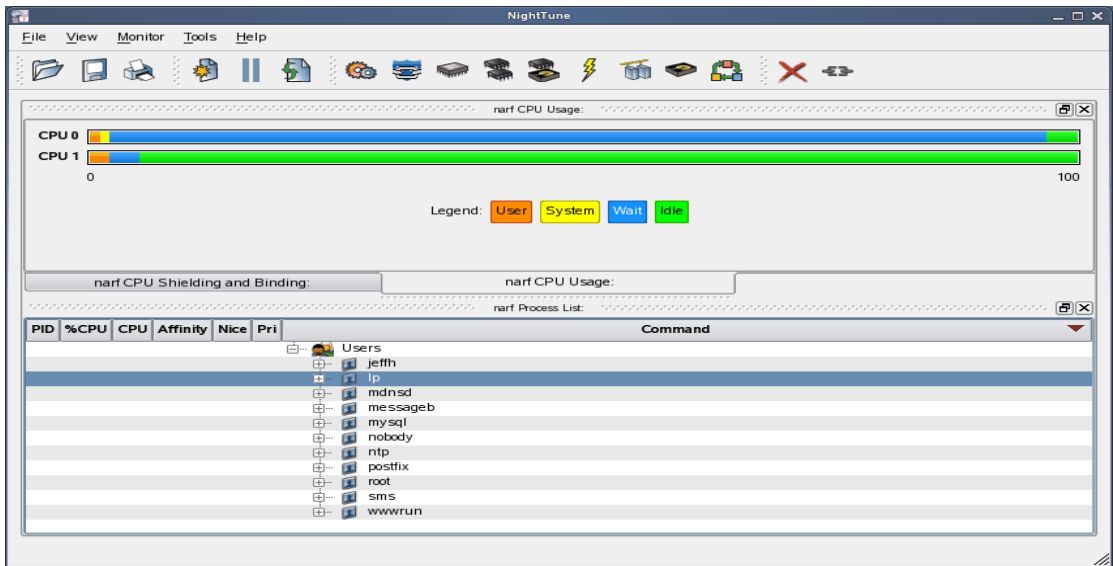
5.2. Tabbed Pages

The NightStar LX Tools allow the user to maintain multiple views of data and the mechanisms that manipulate that data within each application through the use of tabbed pages. By default, only one page is displayed when the tool is invoked.

In our NightTune example from the previous section, we can create another page in which to display a different set of data. For instance, perhaps we would like to monitor disk activity, interrupt activity, and memory activity but do not want to clutter up our original page.

Select Add Page from the View menu. NightTune will create two tabbed pages; our original page is placed under the first tab and a new empty page will be presented under the second.
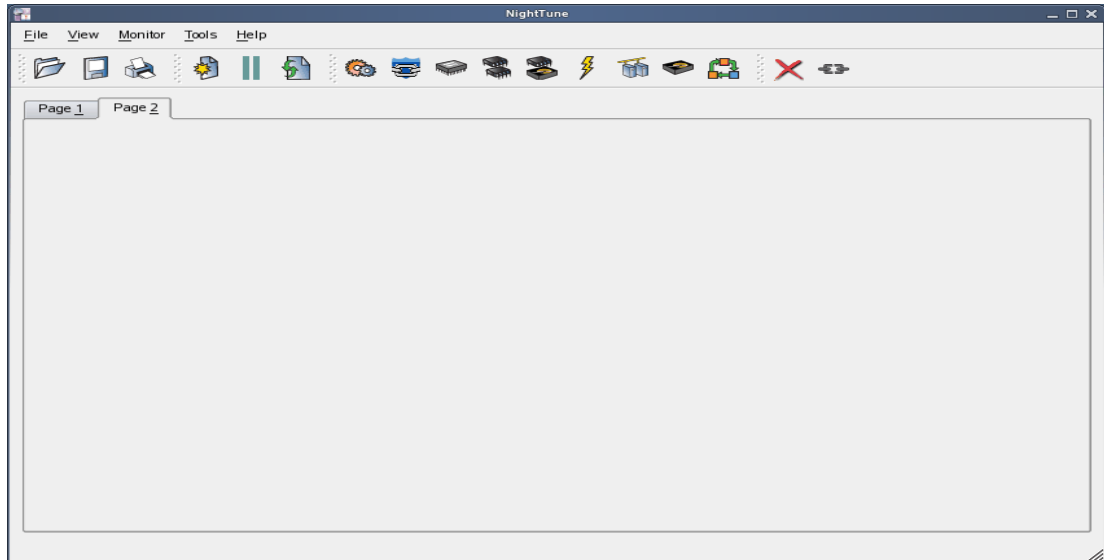
To add the desired NightTune panels, click on the Monitor menu item. You will be presented with a menu of panels to choose from. Select the Disk Activity menu item and then select Bar graph pane from the sub-menu. The Disk Activity panel displaying the information in bar graph format is added to our new page.
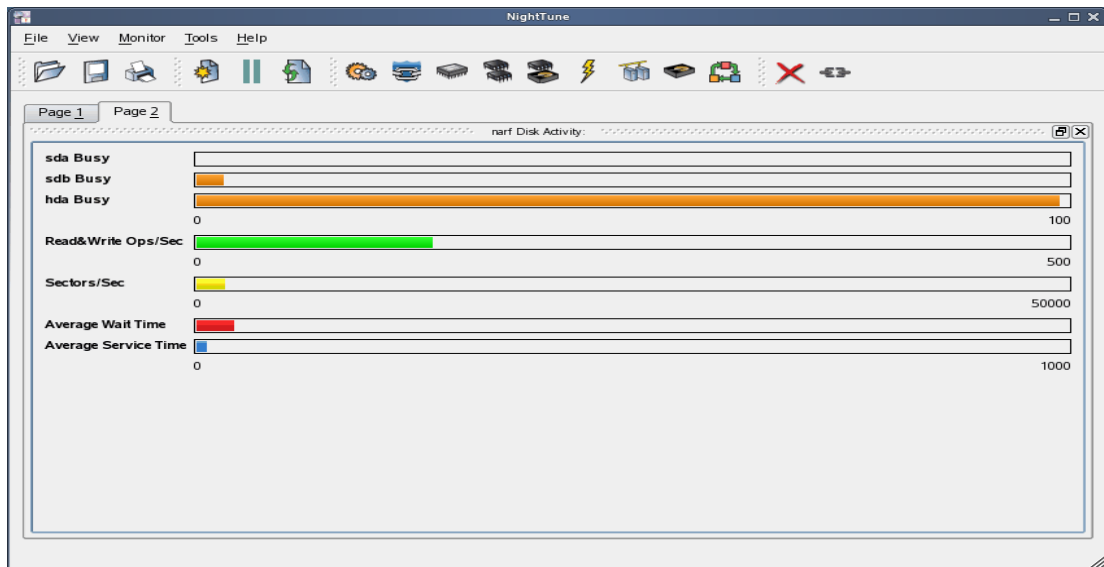
Select Bar graph pane from the Interrupt Activity sub-menu. The Interrupt Activity panel is added to the page.
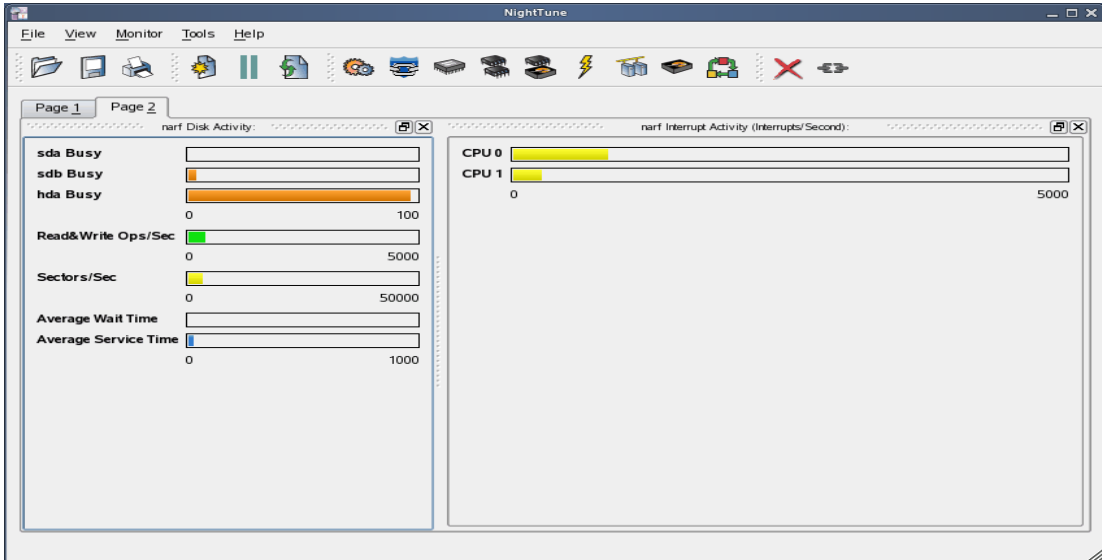
Select Bar graph pane from the Memory: Physical sub-menu. The Memory Physical panel is added to the page.
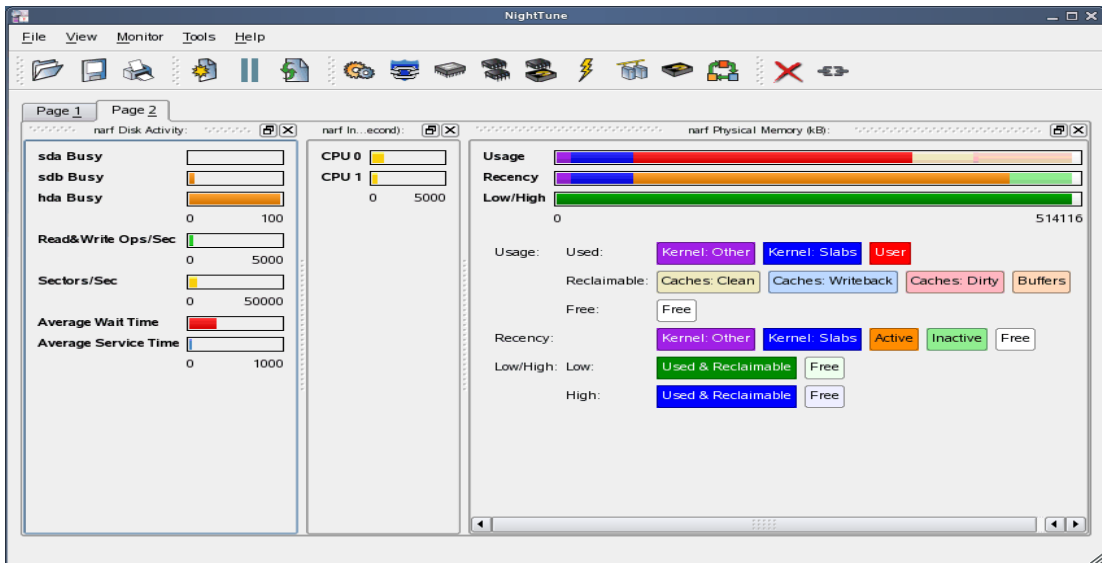
Our new page now contains the Disk Activity, Interrupt Activity, and Memory Physical panels all displaying their information in bar graph format. We can switch back to our first page by clicking on the tab labeled "Page 1" and return to our new page by clicking on the tab labeled "Page 2".

5.3. Context Menus

The NightStar LX Tools provide extensive use of context menus. Right-clicking in any of the NightStar LX Tools will provide the user with a menu containing items related to the location of the mouse in the tool.

We can demonstrate this feature using our NightTune example. For instance, perhaps we would like to give our new page that we created in "Tabbed Pages" on page 18 a more meaningful name.

Right-click on the tab labeled "Page 2". We are presented with a context menu with the menu items Delete Current Page, Rename Current Page…, and Move Current Page….
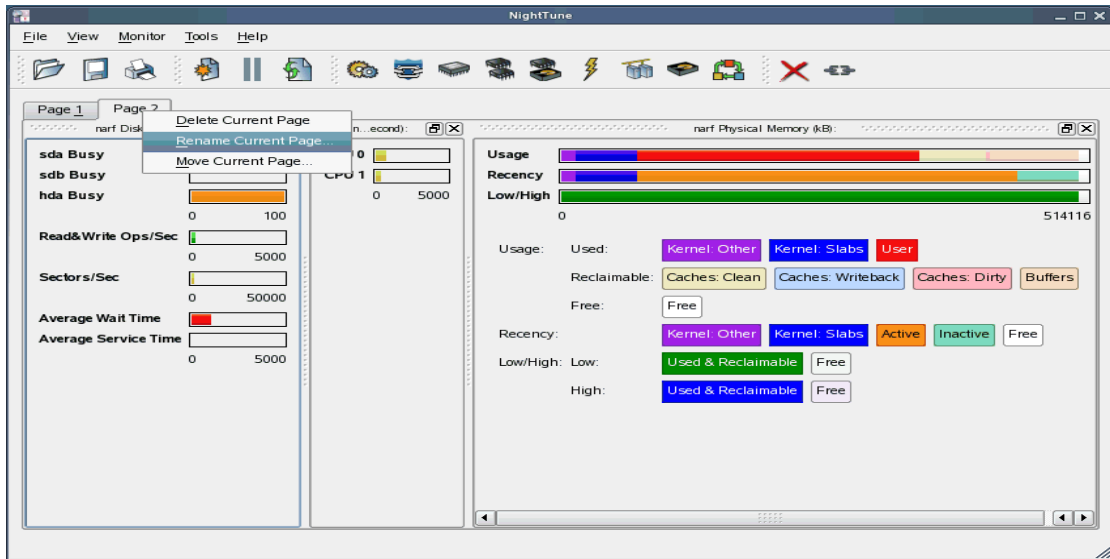
Select Rename Current Page… from the context menu. The Rename Page dialog is presented.
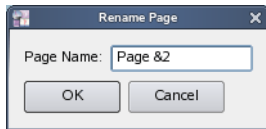
Change the Page Name to "&Activity".

NOTE

An ampersand (&) before a particular character creates an accelerator for that page. The user can then switch to a particular page by holding down the Alt key and pressing the accelerator for that page. The accelerator is indicated on the tab by an underline.

Press **Alt-1** to switch to our original page; press **Alt-A** to return to our **Activity** page.

6.0.   Overview of NightStar LX

The following sections describe the basic features of each of the NightStar LX tools.

- NightProbe
- NightTrace
- NightTune
- NightView

6.1.   NightProbe

The features of the NightProbe data monitor include:

- Non-intrusive sampling and recording of program data

- Synchronous and asynchronous data capture

- Flexible data display features

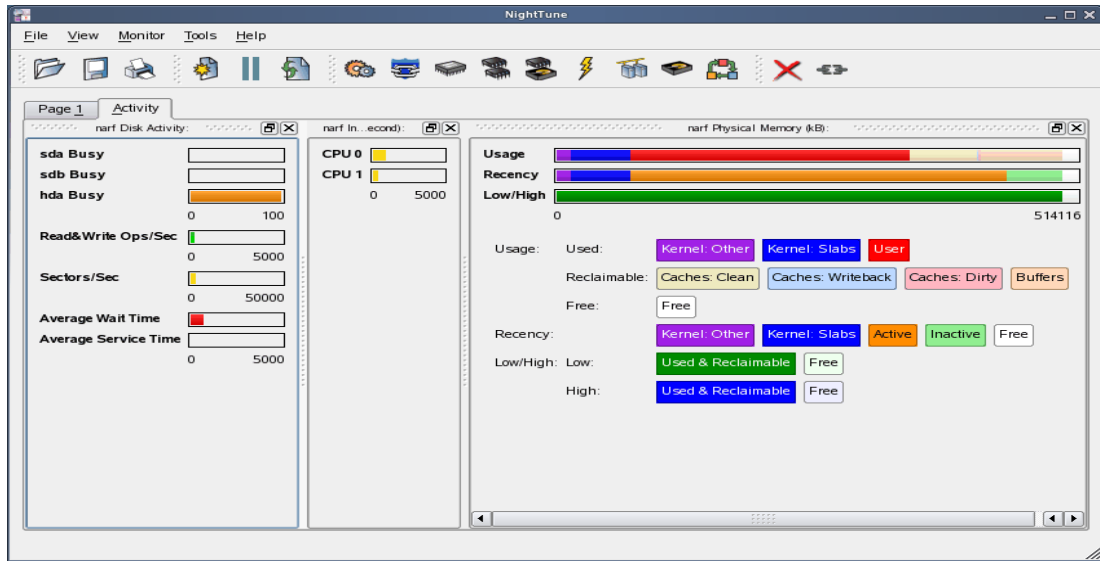- Sampling, recording and replay APIs

- Time stamping of acquired data

NightProbe is a tool for independently monitoring, modifying and recording data values from multiple application resources, including programs, shared memory segments, and memory mapped files. NightProbe can be used in a development environment for debugging, analysis, prototyping and fault injection, or in a production environment to create a GUI control panel for program input and output.

NightProbe utilizes a non-intrusive technique of mapping the target resource's address space into its own. Subsequent direct memory reads and writes by NightProbe allow it to sample and modify data without interrupting or otherwise affecting resources.

Synchronized and Asynchronous Logging

NightProbe can perform synchronous logging of data via a simple API. Asynchronous logging can be performed via on-demand sampling or a cyclic clock rate.

NightProbe provides for logging data items using tracepoints for simultaneous analysis by the NightTrace event analyzer. Sampled data can be combined with kernel trace and additional user trace data to obtain a synchronized picture of application and operating system behavior. NightProbe can record data to disk files or provide data directly to the NightTrace tool.

Interactive Sampling and Modification

NightProbe provides a flexible spreadsheet display for on-demand or cyclic sampling of data at user-specified refresh rates. Direct modification of user data is accomplished by typing in new values for data items into the spreadsheet. NightProbe provides colorized notification of violations of user-defined data thresholds for individual data items. NightProbe allows sampled data to be timestamped and passed off to user applications written with the NightProbe API for subsequent analysis, recording or customized display.

NightProbe supports scalar and structured data types in C/C++ and Fortran that have statically-determined addresses and shapes. NightProbe scans the symbol table and debug information of user programs allowing the user to browse for data items or specifically enter the names of data items to be monitored. Any application that contains symbol table and debug information may be used with NightProbe. No application source code changes are required.

6.2. NightTrace

The features of the NightTrace event analyzer include:

- Synchronized graphical or text display of system application activity

- User-defined event logging in single or multi-threaded applications

- Kernel event logging including system calls, interrupts and exceptions

- Data analysis API

- Automated instrumentation of user code

NightTrace is a tool for displaying and analyzing the dynamic behavior of applications, the Linux operating system and the interaction between them. NightTrace can log events from multiple processes executing simultaneously on multiple CPUs or systems. NightTrace can also combine user-defined application events with kernel events to present a synchronized view of the entire system. NightTrace then creates a graphical time-based view of all logged events. NightTrace allows users to zoom, search, filter, summarize and analyze events. Tracing analysis can be performed live or post execution.

NightTrace was specifically designed to meet the most stringent requirements of time-critical applications. Using synchronized, fast-access hardware clocks and kernel-free primitives, NightTrace tracepoints are logged with minimal overhead. Tracepoints can be inserted into device drivers, interrupt level code and any user application. Tracepoints can be left in production-quality applications even when not collecting trace data.

NightTrace's Illumination tool (nlight) automatically instruments user code (executable images or .o files) with trace points for the entry and return of every function (the user has control over which functions to illuminate). It does this without modifying the executable images or .o files outright. NightTrace provides a description of the function call, including the values of all arguments, and the return value.

Graphical and Interactive

NightTrace graphically displays requested events and states along a timeline graph or event log to clearly show the relative timing of events and provide an overall picture of application and operating system activity. NightTrace can locate specific events and zoom in on them with a fine degree of granularity for precise timing observation. The NightTrace graphical display is completely user-configurable for customized viewing. Configurations can be saved and later recalled, and multiple configurations can be viewed simultaneously.

Kernel Trace Support

By combining system event information such as interrupts, exceptions, context switches, Linux system calls and device accesses together with event information from user applications, NightTrace provides a clear picture of the interaction between the kernel and user applications at any point during the application's run.

NightTrace provides statistical performance data about events and states, including frequency, time of occurrence, duration, gap and minimum and maximum times. Users can create state definitions and qualify events by specifying the applicable process, thread, CPU, system and event content. Conditional tracing can be expressed using C expression syntax. Displays can be customized to yield insight into operating system and application performance and behavior patterns.

NightTrace generates source code using an Analysis API that allows users to easily create custom applications that monitor or analyze application or system activity.

IMPORTANT

Kernel tracing is only supported on Concurrent's RedHawk Linux product.

6.3.   NightTune

The features of the NightTune system and application tuner include:

- Dynamic display of system and application performance

- Monitoring of CPU use, memory paging and network operation

- Interactive control of processes, priorities, policies and interrupts

- Dynamic CPU affinity control for processes, threads and interrupts

NightTune provides a graphical interface to system facilities for monitoring and tuning application and system performance. Users can monitor the priority, scheduling policy, CPU assignment and CPU usage of user applications. NightTune also monitors system CPU usage, context switches, interrupts, memory paging and network activity.

NightTune can monitor processes individually or in groups determined by user or by CPU. NightTune also displays information about individual threads or tasks within a process. Multiple frames and windows are used to display information allowing users to customize their display.

Application Tuning

NightTune allows users to change the process attributes of an individual thread, task, process or group of processes as a whole using pop-up dialogs and drag-and-drop actions. For example, dragging a process icon to a CPU icon binds the process to that processor. The user then instantly sees the results of the tuning effort both graphically and as text.

System Tuning

NightTune allows users to change the CPU assignment of interrupts using pop-ups or drag-and-drop actions. NightTune optionally provides a textual log of all application and system tuning actions taking during a NightTune session.

6.4. NightView

The features of the NightView source-level debugger include:

- Multi-system, multi-processor, multi-process, multi-thread debugging via single interface

- Hot patches including breakpoints, monitorpoints and watchpoints

- Application speed conditions

- Dynamic memory "heap" debugging

- Modification and display of variables during execution

NightView allows users to simultaneously debug multiple, time-critical processes. With NightView, a programmer can change program execution and modify or display data without stopping or interrupting the program. Eventpoint conditions, such as hit and ignore counts, are patched directly into an application and can execute at full application speed. NightView provides fine-grained control without adversely affecting application timing.

NightView monitorpoints can display expressions at user-selected locations without stopping a process, thus providing data displays that are synchronized with the application's algorithms. Watchpoints utilize hardware address trap features that cause an application to stop when user-specified variables or memory locations are selectively read or modified.

Language-sensitive Debugging

NightView supports the debugging of multiple applications written in any combination of C/C++ and Fortran. All variables and expressions in each program are referenced in the appropriate language. NightView is also integrated with the NightTrace event analyzer. NightView can insert tracepoints at user-specified locations for concurrent or post execution analysis by NightTrace.

More Powerful Than The Gnu Debugger

NightView offers many features not available in the gnu debugger (`gdb`). Advantages of NightView include the ability for users to debug multiple processes from a single session and processes started from scripts. With NightView, patched-in code runs at full speed. While a process is executing, hot patching can modify variables or add eventpoints. Monitorpoints can display expressions and stack variables, and signals can be sent directly to the process, bypassing the debugger.

Dynamic Memory Debugging

NightView includes an interactive memory debugger that helps find and eliminate memory problems during the debug process without code recompilation. NightView watches for heap memory leaks, monitors the amount of memory an application uses, and tracks how it allocates and frees memory. With its memory debugger enabled, NightView lets users track heap allocations and deallocations in real-time, thus allowing for more efficient debugging than post-run analysis. Programmers can stop execution, check for problems, test patches and then continue debugging. NightView can detect double-frees, dangling pointers, heap area overruns, and other common user application bugs.

7.0.   Getting Started

The NightStar LX *Tutorial* is ***highly recommended*** as an introduction to the NightStar LX product. This tutorial integrates all of the NightStar LX tools into one cohesive example incorporating various scenarios which demonstrate their extensive functionality.

The tutorial is available in PDF format in the **documentation** directory of the *NightStar LX Installation CD* as well as in **/usr/share/doc/NightStar/pdf** after installation.

The online version of the tutorial can be accessed by double-clicking on the NightStar LX Documentation icon installed on the desktop and selecting the NightStar LX Tutorial from the Bookshelf.

In addition, the tutorial can be launched from the Help menu of any NightStar LX tool or can be started by issuing the following command:

> **nhelp**

from the command line.

7.1.   Capabilities

Most operations with NightStar LX do not require any special privileges. However, if you wish to take full advantage of NightStar LX capabilities without running as the root user, additional configuration steps are required.

Linux provides a means to grant otherwise unprivileged users the authority to perform certain privileged operations. The Pluggable Authentication Module (see **pam_capability(8)**) is used to manage sets of capabilities, called *roles*, required for various activities.

The following table lists the advantages granted to non-root users with the capabilities suggested for use with NightStar LX:

Capabilities and their Effects

Capability	Advantage
CAP_IPC_LOCK	Allows NightTrace to lock critical pages into memory related to User Trace event buffers.
CAP_SYS_RAWIO	Allows NightProbe to gain access to PCI devices and memory mapped system files, such as **/dev/mem**.
CAP_SYS_NICE	Allows the NightStar LX tools to set the scheduling policy, scheduling priority, and CPU affinity of processes. Allows NightTune to set the CPU affinity of interrupts and to shield CPUs from process, interrupts. and hyper-threading interference.

Configuring capabilities on systems not running RedHawk Linux is problemantic. Consult your system administrator if you wish to use the features above without being the root user.

7.1.1. Allowing NightView to Attach to Your Processes

By default, some recent distributions of Linux restrict prevent you from attaching a debugger to your running process, even if you invoke the debugger with the same uid and gid as the process which you want to debug.

You can remove this restriction by using the `sysctl` command to change the value of the variable which controls the restriction. To remove the restriction, enter the following command from a shell:

```
sysctl -w kernel.yama.ptrace_scope=0
```

Once you have issued that command, log out and log in again and the restriction will be lifted. However, the setting is only effective until the next reboot. You may want to put the command above in `/etc/rc.local` (sometimes `/etc/rc.d/rc.local`) so that is applied every time the system boots.

8.0. Architecture Interoperability

The NightStar LX tools were designed to be used in a self-hosted environment as well as remotely, separating the host processing from the time-critical target system.

8.1. X86 32 and 64 bit Interoperability

This section describes the interoperability of each tool between 32-bit x86 and 64-bit x86.

NightProbe

No limitations.

NightTune

No limitations.

NightTrace

Limitations

- NightTrace cannot control remote system tracing unless the host and target system have the same bit-size for addresses. Thus you cannot connect NightTrace to a 32-bit system from a 64-bit system, and vice versa.

- NightTrace on a 32-bit system cannot analyze data from a 64-bit system.

Inter-architecture Capabilities in NightStar LX 4.5

- 32-bit applications can use the NightTrace Logging API and execute on a 64-bit system. The 64-bit NightTrace can capture and analyze data from such programs via **ntraceud** and **ntrace**. The 32-bit applications must be linked with the version of NightTrace Logging API from this release (or newer).

- NightTrace running on a 64-bit system can analyze data files generated on a 32-bit system; both user and kernel data. The 32-bit applications must be linked with the version of the NightTrace Logging API from this release (or newer).

- 64-bit applications using the NightTrace Analysis API can analyze data, either in stream or file mode, generated from 32-bit applications (or 32-bit kernel data).

User Responsibility

- When analyzing 32-bit data on a 64-bit system, be aware that NightTrace will evaluate expression types as they would be evaluated on the 64-bit system. Thus, explicitly specifying arg_long() in a NightTrace expression will result in 8 bytes of data being extracted from the trace event, even though only 4 bytes were logged. The data types of concern are long and all pointer types.

NOTE

NightTrace automatically prints the arguments in Timelines and Event panels with the correct data type.

- When unpacking block arguments generated on a 32-bit system within NightTrace, you must unpack them as a 32-bit compiler would have laid out the structure. In addition to the differing sizes of long, long double, and all pointer types, 64-bit compilers pad structures differently. Use care. This includes using the information generated from a 32-bit Application Illumination session; references to long will extract 8 bytes even though it expects only 4.

NOTE

In reality, there is no problem using arg_long_dbl() in a 64-bit NightTrace session when the actual long double item was generated from a 32-bit program. Even though there are 4 extra bytes of data at the end of a long double on 64-bit systems, those extra bytes are completely ignored (currently) by the instructions that operation on such values.

NightView

Limitations

Obviously, NightView running on a 32-bit system cannot debug 64-bit programs on that system (since they can't execute!). Similarly, since x86 (32-bit or 64-bit) systems cannot execute aarch64 programs, NightView cannot debug them directly on the x86 system.

In previous versions, NightView required the --arch=i386 option in order debug 32-bit applications on a 64-bit machine. That restriction has been lifted. The --arch=i386 option has no effect in this release -- it is silently ignored. You can debug 32-bit x86 programs on 64-bit x86 systems freely, even intermixing such programs that exec (see **exec(2)**) such programs; this includes 32-bit programs launched from a 64-bit shell.

In this release, NightView supports cross-debugging from x86 systems to aarch64 systems. See "Changes in NightView" on page 2 for more information.

8.2.   Intel and ARM64 Interoperability

NightTrace

Binary NightTrace data files may be analyzed from either x86_64 or aarch64 systems. The limitations described in the *X86 32 and 64 bit Interoperability* NightTrace section apply as well.

NightProbe

No limitations.

NightTrace

Binary NightTrace data captured on x86_64 or aarch64 system files may be analyzed from either x86_64 or aarch64 systems. The limitations described in the *X86 32 and 64 bit Interoperability* NightTrace section apply as well.

NightTune

No limitations.

NightView

Since X86 and ARM64 are incompatible architectures you cannot run an x86 executable program on an aarch64 system, nor vice versa.

However, NightView can "cross-debug" from x86 (32-bit or 64-bit) to an aarch64 target system. This requires that you have the **ccur-nview-arm64-support** package installed on the x86 host and the **ccur-nview-target** package installed on the aarch64 target.

For full cross debugging support (e.g. patching, conditional eventpoints, etc.), the GNU x86/aarch64 cross development packages should be installed on the host system as well.   The minimal set of packages include:

- gcc-aarch64-linux-gnu

- binutils-aarch64-linux-gnu

These packages are generally available for CentOS-like and Ubuntu-like systems.

If you intend on building your full user application using the GNU cross development environment you will likely require additional packages. General cross development is outside the scope of this document.

9.0. Known Problems

The following sub-sections list known issues with NightStar.

9.1. Problem: Unable to attach to the target system

Several NightStar tools need to talk to their server processes in order to operate.

By default, they will attempt to locate their server processes on the local system using the value returned by the following command:

```
hostname
```

If there is no mapping to the hostname, these tools will fail.

Solution:

Ensure that **/etc/hosts** contains a mapping of the hostname to a valid IP address or that the mapping is made available by DNS or other means.

9.2. Problem: Unable to debug on VirtualBox Systems

VirtualBox incorrectly manages the debug registers of the underlying chip. This causes NightView to fail when starting to debug a process. This bug in Virtual Box has been reported for several years, and still exist.

Solution:

Concurrent recommends KVM as an alternative solution to VirtualBox.

10.0. Direct Software Support

Software support is available from a central source. If you need assistance or information about your system, please contact the Concurrent Software Support Center at our toll free number 1-800-245-6453. For calls outside the continental United States, the number is 1-954-283-1822. The Software Support Center operates Monday through Friday from 8 a.m. to 5 p.m., Eastern Standard Time.

You may also submit a request for assistance at any time by using the Concurrent Computer Corporation web site at **http://real-time.ccur.com/support** or by sending an email to **support@ccur.com**.