NightSim RT User's Guide

Version 3.5

(RedHawk™ Linux®)

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Preface

Scope of Manual

This guide is designed to assist you in getting started with the use of NightSim™. NightSim is a real-time NightStar™ RT tool that provides a graphical user interface to the frequency-based scheduler and performance monitor services.

Structure of Manual

This manual consists of five chapters, four appendixes, a glossary, and an index. A brief description of the chapters and appendixes is presented as follows.

- Chapter 1 introduces you to the concepts and components of NightSim, a real-time tool that is part of the NightStar™ development environment.
- Chapter 2 provides an overview of the primary factors that need to be taken into account prior to running NightSim on RedHawk Linux.
- Chapter 3 explains the procedures for beginning and ending a NightSim session and explains how to get help.
- Chapter 4 describes the frequency-based scheduler and introduces the components of NightSim's Scheduler window.
- Chapter 5 describes the performance monitor and introduces the components of NightSim's Monitor window.
- Appendix A discusses the NightStar License Manager (NSLM) and how to obtain and install licenses. It also discusses approaches for dealing with a firewall either on the system acting as the license server or on a system hosting the NightStar RT tools.
- Appendix B describes the additional functionality and capabilities of the NightStar RT tools when running Concurrent's RedHawk kernel.
- Appendix C discusses the format of configuration files used by NightSim.
- Appendix D presents the configurable X resources, NightStar resources, and widget hierarchy for NightSim.

The glossary contains definitions of technical terms that are important to understanding the concepts presented in this book.

The index contains an alphabetical reference to key terms and concepts and numbers of pages where they occur in the text.

Syntax Notation

The following notation is used throughout this manual:

italic	Books, reference cards, and items that the user must specify appear in *italic* type. Special terms may also appear in *itali*cs.
`list bold`	User input appears in **`list bold`** type and must be entered exactly as shown. Names of directories, files, commands, options and system manual page references also appear in **`list bold`** type.
`list`	Operating system and program output such as prompts and messages and listings of files and programs appear in `list` type.
`[ ]`	Brackets enclose command options and arguments that are optional. You do not type the brackets if you choose to specify such options or arguments

Referenced Publications

The following publications are referenced in this document:

0890514	*NightBench User's Guide*
0891082	*Real-Time Clock and Interrupt Module User's Guide*
0898004	*RedHawk Linux™ User's Guide*
0898008	*NightStar RT Installation Guide*
0898008	*NightStar RT Tutorial*
0898395	*NightView RT User's Guide*
0898398	*NightTrace RT User's Guide*
0898465	*NightProbe RT User's Guide*
0898515	*NightTune RT User's Guide*
0898537	*MAXAda for RedHawk Linux Reference Manual*

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1
Overview

This chapter introduces you to the concepts and components of NightSim, a real-time tool that is part of the NightStar development environment. NightSim provides a graphical user interface to the major functions associated with the *frequency-based scheduler* and the *performance monitor.*

Overview of NightSim

NightSim allows you to perform the entire range of functions associated with frequency-based scheduling. You can perform the major functions of configuring a scheduler, setting up a timing source, scheduling programs, saving and restoring a scheduler configuration, running a simulation, and viewing scheduling data. The principal features of the *frequency-based scheduler* are described in the section that follows.

NightSim also allows you to perform the entire range of functions associated with the *performance monitor.* You can perform the major functions of selecting a scheduler, clearing existing performance monitor values, enabling and disabling performance monitoring, including and excluding interrupt time, and viewing performance monitor values. The principal features of the performance monitor are described in “Overview of the Performance Monitor” (see p. 1-2).

In addition, NightSim supports the use of timing sources, including Distributed Interrupts devices on the RCIM (Real-Time Clock and Interface Module) board. An addition capability is NightSim's ability to configure a frequency-based scheduler on any system in your network, not just the *NightSim host*.

NightSim is also integrated with other NightStar tools. NightSim may be invoked directly from the Tools menu of any NightStar RT tool, and NightSim provides access to every other NightStar RT tool in the same way. NightSim also provides the ability to schedule your programs under the control of the NightView™ Source-Level Debugger, making it easy to gain control of scheduled programs in order to set breakpoints or monitorpoints early on in the execution of the program, before it attaches to the frequency based scheduler.

NightSim’s graphical user interface is based on the X Window System™ and OSF/Motif™.

Overview of the Frequency-Based Scheduler

The *frequency-based scheduler*, or FBS, is a task synchronization mechanism that allows you to run processes at specified frequencies. Frequencies can be based on high-resolution clocks, an external interrupt source, or completion of a cycle. The frequency-based

scheduler provides a mechanism for initiating processes at the specified frequency. The processes are then scheduled via the standard priority-based scheduler.

When used in conjunction with the performance monitor, the FBS can be used to determine the best way of allocating processors to various tasks for a particular application. Chapter 4, "Using the Scheduler Window," fully describes the features and capabilities of the frequency-based scheduler.

Overview of the Performance Monitor

The performance monitor is a mechanism that allows you to monitor use of the CPU by processes that are scheduled on a frequency-based scheduler. The values obtained can help in determining whether processes need to be redistributed among processors for improved load balancing and processing efficiency. You can obtain performance monitor values by process or processor and can specify whether time spent servicing interrupts should be included or excluded from the values. The performance monitor also makes it possible to monitor a processor's *idle time*. By examining the amount of idle time on each processor, you can identify the processors that have the lightest load and determine the additional amount of CPU time that can be used for scheduling real-time processes. Chapter 5, "Using the Monitor Window," fully describes the features and capabilities of the performance monitor.

Overview of the Graphical User Interface

NightSim's graphical user interface has two major windows: the Scheduler window and the Monitor window. The Scheduler window provides access to the key operations associated with frequency-based scheduling. The Monitor window provides access to the key operations associated with performance monitoring. An overview of each window is provided in the sections that follow.

The Scheduler Window

Figure 1-1 presents the Scheduler window. This window allows you to configure a frequency-based scheduler; set up a timing source for it; schedule programs on it; start, stop, and resume a simulation; and view scheduling data.

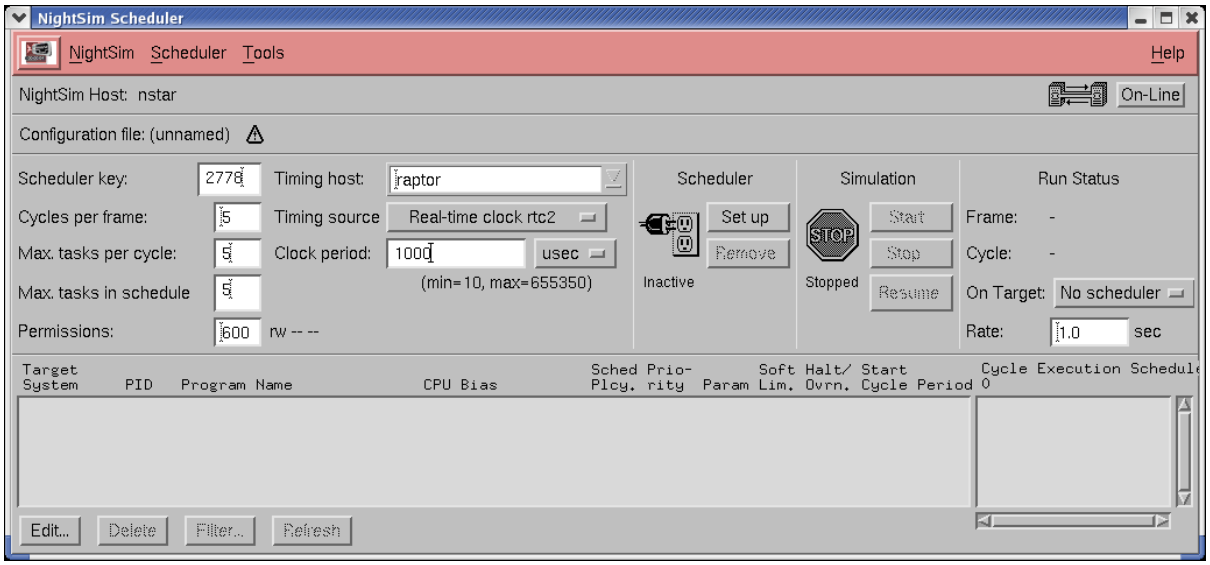


Figure 1-1. Scheduler Window

The Scheduler window also allows you to save a scheduler configuration to a file and to open and save a configuration file that you have previously created. It shows whether the window is active (associated with a scheduler that exists on the system) or inactive (not associated with a scheduler that exists on the system) and whether the selected scheduler is running or stopped. It displays the current *minor cycle* and current *major frame* for the simulation, and it graphically shows the execution cycle for each process that is scheduled on the scheduler.

Chapter 4, “Using the Scheduler Window,” provides a detailed explanation of each area of the Scheduler window and provides reference information for all of the fields and controls in each area.

The Monitor Window

Figure 1-2 presents the Monitor window. This window allows you to monitor the performance of selected FBS-scheduled processes scheduled on one or more processors on a selected scheduler. It allows you to display performance monitor values for selected FBS-scheduled processes, clear performance monitor values for all FBS-scheduled processes scheduled on one or more CPUs, and specify whether or not time spent servicing interrupts is to be included in performance monitor timing values.

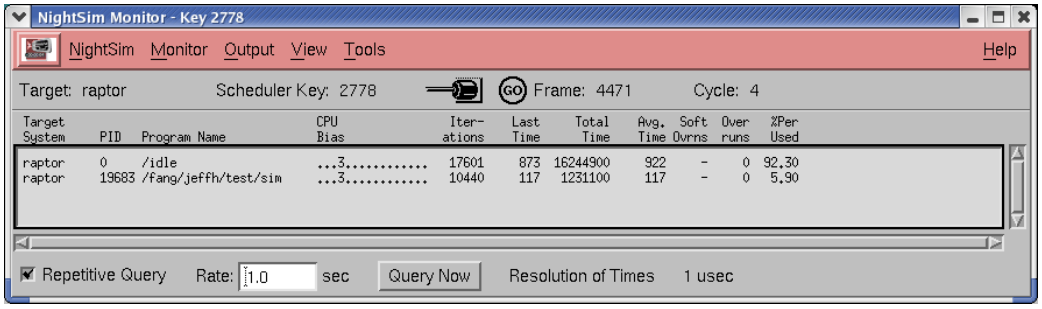


Figure 1-2. Monitor Window

The Monitor window also allows you to specify whether performance monitoring information is to be displayed in the Monitor window or written to a selected file. In either case, you may specify the types of information that are to be reported, the resolution with which performance monitor timing values are displayed (for example, microseconds, tens of microseconds, milliseconds), and the rate at which values are to be updated.

The Monitor window allows you to specify a frequency-based scheduler with which the window is to be associated. It shows whether the scheduler is active or inactive, and it shows whether the simulation is running or stopped. If the scheduler is active, it displays the current *major frame* and current *minor cycle* for the simulation. The Monitor window also shows performance monitor values for selected processes.

Chapter 5, "Using the Monitor Window," provides a detailed explanation of each area of the Monitor window and provides reference information for all of the fields and controls in each area.

Overview of RCIM Support

NightSim supports the Real-Time Clock and Interrupt Module (RCIM). An RCIM is an hardware module attached to a *target system* which contains the following interrupt-generating devices:

- real-time clocks (RTCs)
- edge triggered interrupts (ETIs)
- programmable interrupt generators (PIGs)

Any of these devices may be used as the timing source for an FBS.

RCIMs may be connected via RCIM cables such that interrupts from one RCIM may be distributed to other systems in the RCIM chain.

Each interrupt device on an RCIM may be configured as an *RCIM-distributed* or normal device. By default, each interrupt device is available for use on the attached target system. If the interrupt device is configured as an RCIM-distributed device, interrupts are also distributed between target systems using the RCIM cable.

NightSim provides full support for the creation, control, and performance monitoring of schedulers distributed across multiple SBC's and/or target computers in an RCIM chain utilizing an RCIM-distributed device.

For more information see the *Real-Time Clock and Interrupt Module (RCIM) PCI Form Factor User's Guide (0898007).*

2
Establishing the NightSim Environment

This chapter provides an overview of the primary factors that need to be taken into account prior to running NightSim. These include *system configuration requirements* and *user requirements*.

Configuration Requirements

NightSim requires the Frequency Based Scheduler to be installed on the target sytsem. The FBS comes with the RedHawk Linux distribution.

Typically, the default installation of the FBS is sufficient for NightSim activities. Refer to the *RedHawk Frequency-Based Scheduler (FBS) User's Guide (0898005)* for more information on FBS configuration.

NightSim schedulers that are driven by an interrupt source require an RCIM device; a real-time clock, an edge-triggered interrupt, or a distributed interrupt source.

If you do not have an RCIM device, you can still use NightSim's end-of-process scheduling capability to drive your simulation. See End of Processing Cycle scheduling on page 4-2 for more information.

User Requirements

To use NightSim, you must also ensure that certain user requirements related to remote shell access, environment variables, and capabilities are met. These requirements are described in the sections that follow.

Remote Shell Access

When you configure NightSim to run your scheduled process under an **`xterm(1)`**, NightSim will run the **`xterm`** command on the NightSim host if the target is accessible from the host via **`rsh(1)`**.

Alternatively, if the **`xterm`** command is available on the target system, it is not necessary to enable **`rsh`** access, because NightSim will execute the **`xterm`** command on the target system.

To enable the use of **`rsh(1)`**, ensure that there exists a login on the remote target with the same username as on the NightSim host. In addition, the **`.rhosts`** file in that user's

home directory on the target system must contain an entry for that username and the NightSim host.

Your target system must also be properly configured to accept **rsh** command execution. See your target system documentation for details on how to enable **rsh** access to your target system.

See the **rsh(1)** man page for more details.

Capabilities

Some of the operations associated with the *frequency-based scheduler* and the *performance monitor* require certain capabilities such as CAP_SYS_NICE.

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.

Linux systems should be configured with an fbscheduser role which provides the CAP_SYS_NICE and CAP_DAC_OVERRIDE capabilities.

Edit **/etc/security/capability.conf** and define the fbscheduser role (if it is not already defined) in the "ROLES" section:

```
role fbscheduser CAP_SYS_NICE CAP_DAC_OVERRIDE
```

Additionally, for each NightSim user on the target system, add the following line at the end of the file:

```
user   username     fbscheduser
```

where *username* is the login name of the user.

If the user requires capabilities not defined in the fbscheduser role, add a new role which contains fbscheduser and the additional capabilities needed, and substitute the new role name for fbscheduser in the text above.

In addition to registering your login name in **/etc/security/capability.conf**, certain files under the **/etc/pam.d** directory must also be configured to allow capabilities to be activated.

To activate capabilities, add the following line to the end of selected files in **/etc/pam.d** if it is not already present:

```
session required pam_capability.so
```

The list of files to modify is dependent on the list of methods that will be used to access the system. The following table presents a recommended configuration that will grant capabilities to users of the services most commonly employed in accessing a system.

Table 2-1. Recommended /etc/pam.d Configuration

/etc/pam.d File	Affected Services	Comment
remote	telnet rlogin rsh (when used w/o a command)	Depending on your system, the **remote** file may not exist. Do not create the **remote** file, but edit it if it is present.
login	local login (e.g. console) telnet* rlogin* rsh* (when used w/o a command)	*On some versions of Linux, the presence of the **remote** file limits the scope of the **login** file to local logins. In such cases, the other services listed here with **login** are then affected solely by the **remote** configuration file.
rsh	rsh (when used with a command)	e.g. **rsh system_name a.out**
sshd	ssh	You must also edit **/etc/ssh/sshd_config** and ensure that the following line is present: **UsePrivilegeSeparation no**
gdm	gnome sessions	
kde	kde sessions	

If you modify **/etc/pam.d/sshd** or **/etc/ssh/sshd_config**, you must resetart the **sshd** service for the changes to take effect:

```
service sshd restart
```

In order for the above changes to take effect, the user must log off and log back onto the target system.

NOTE

To verify that you have been granted capabilities, issue the following command:

```
/usr/sbin/getpcaps $$
```

The output from that command will list the roles currently assigned to you.

3
Getting Started

This chapter explains the procedures for beginning and ending a NightSim session. It also explains how to get help and how to use accelerators.

Invoking NightSim

The NightSim tool is available on your system as **`/usr/bin/nsim`**.

The syntax for executing **`nsim`** is as follows:

`nsim` [**`-help`**] [**`-version`**] [**`-offline`**] [**`-s`** [*hostname*[**`,`***key*]|*key*]] [**`-m`** [*hostname*[**`,`***key*]|*key*]] [**`-`***Xoption* ...] [[**`-f`**] *file* ...]

Options are described as follows:

`-help` This option allows you to display the usage information for NightSim and then exit.

`-version` This option allows you to display the version and copyright information for NightSim and then exit.

`-offline` Create Scheduler windows initially in Off-Line mode. See "On-Line/Off-Line Operation" on page 4-6 for more information.

`-s` [*hostname*[,*key*] | *key*]

This option creates a Scheduler window. If the optional *hostname* is present, it causes the window to be associated with an FBS that is active on the designated system. If the *hostname* is not specified, the Scheduler window will be associated with an FBS on the local system where **`nsim`** is invoked.

The optional *key* is an integer value that identifies the scheduler.

This option may be used more than once; a Scheduler window will be created for each occurrence of the option.

`-m` [*hostname*[,*key*] | *key*]

This option creates a Monitor window. If the optional *hostname* is present, it causes the window to be associated with an FBS that is active on the designated system. If the *hostname* is not specified, the Monitor window will be associated with an FBS on the local system where **`nsim`** is invoked.

The optional *key* is an integer value that identifies the scheduler. If

the *key* parameter is omitted and a Scheduler window is specified with a matching *hostname*, the Monitor window will adopt the key of the corresponding Scheduler window, if present.

This option may be used more than once; a Monitor window will be created for each occurrence of the option.

-*Xoption*

You may also specify any standard X Toolkit command-line option. Such options include **-bg** *color* to set the color for the window background; **-fg** *color* to set the color to use for text or graphics; and **-xrm** *resourcestring* to set selected resources. For a complete list of these options, refer to the **X(1)** system manual page.

[**-f**] *file*

This option allows you to specify the name of a file that contains configuration and scheduling data for a selected *frequency-based scheduler.*

To save the configuration and scheduling data entered in a particular Scheduler window to a file, select the Scheduler->Save Config File As menu item from that Scheduler window. Procedures are fully explained in "Save Config File As..." on page 4-17.

You may also use a text editor to create or modify a configuration file, following the format as described in "Configuration Files" on page C-1.

When invoking NightSim, you may specify options in any order; you may specify the **-f**, **-s**, and **-m** options more than once as illustrated by the following example:

```
nsim -s buzzard,4 -s papio,5 -m papio,5 -f config_file
```

In this case, NightSim opens two *active scheduler windows* — one associated with the scheduler identified by key 4 on target **buzzard** and one associated with the scheduler identified by key 5 on target **papio** — a monitor window associated with the scheduler identified by key 5 on target **papio**, and an *inactive scheduler window* associated with the scheduler identified in **config_file**.

You may also invoke NightSim without specifying any options. Doing so allows you to display an inactive Scheduler window. An inactive Scheduler window is one that is not associated with a scheduler that exists on the system.

The steps for invoking NightSim are as follows:

1. Log in to your system.
2. Ensure that the value of your DISPLAY variable is set to the name of your X server (or use the **-display** command-line option to the NightSim command). If using a remote target system, please ensure that your display name is reachable from the target system as well as the GUI host.
3. Type **nsim** and any desired options after the system command prompt, and press the Enter key.

Getting Help

NightSim provides on-line help information through the Help menu which is accessible via the menu bars in the Scheduler window (see “Introduction to the Scheduler Window” on page 4-9) and Monitor window (see “Introduction to the Monitor Window” on page 5-6). Figure 3-1 presents this menu:

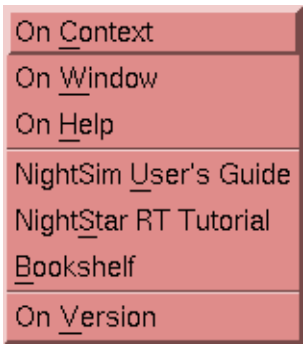


Figure 3-1. Help Menu

The following describe the options on the Help menu:

On Context

Mnemonic: C

Gives context-sensitive help on the various menu options, dialogs, or other parts of the user interface.

Help for a particular item is obtained by first choosing this menu option, then clicking the mouse pointer on the object for which help is desired (the mouse pointer will become a floating question mark when the On Context menu item is selected).

In addition, context-sensitive help may be obtained for the currently highlighted option by pressing the F1 key. HyperHelp™, NightSim’s online help system, will open with the appropriate topic displayed.

On Window

Mnemonic: W

Displays help information for the current window.

On Help

Mnemonic: H

Displays help information about how to use HyperHelp™, NightSim’s online help system.

NightSim User's Guide

Mnemonic: U

Opens the online version of the *NightSim RT User's Guide* in the HyperHelp viewer.

NightStar RT Tutorial

Mnemonic: S

Opens a HyperHelp window containing a tutorial which demonstrates the features of NightSim™, NightProbe™, NightView™, NightTrace™, and NightTune™ in one cohesive example.

Bookshelf

Mnemonic: B

Opens a HyperHelp window that lists all of the currently available HyperHelp publications.

On Version

Mnemonic: V

Displays a short description of the current version of NightSim.

In addition, context-sensitive help may be obtained for the currently highlighted option by pressing the F1 key. The HyperHelp viewer will open with the appropriate-ate topic displayed.

NightSim also provides help information through the Help buttons that appear in other windows. When you click on the Help button in one of these windows, NightSim displays the help information for that window.

Using Accelerators

A set of keyboard accelerators is defined for use within NightSim to provide quick access to certain functions and menu items. Accelerators associated with menu items allow you to access those items whether or not the menu is posted. Table 3-1 contains a list of the accelerators and the resulting actions; where applicable, it indicates the menu items for

which the accelerators provide shortcuts. Note that you can define additional accelerators through the use of X resources (refer to the **X(1)** system manual page.

Table 3-1. Accelerators

Accelerator	Menu Item	Action
<Control> <W>	NightSim->Close Window	Closes the current Scheduler or Monitor window
<Control> <Q>	NightSim->Exit	Exits NightSim
<Control> <N>	Scheduler->New	Clears all information from the current Scheduler window; resets the various areas to blank or default values; and places the window in the inactive state
<Control> <O>	Scheduler->Open Config File	In the current Scheduler window, opens a scheduler configuration file that you have previously saved
<Control> <S>	Scheduler->Save Config File	Saves the configuration and scheduling data entered in the current Scheduler window in the file that is associated with the window
F1		Displays context help for the component that currently has the focus

Exiting NightSim

You may exit NightSim from the Scheduler or Monitor window by using one of the following techniques:

- Select the NightSim->Exit menu item.
- Press <Control> <Q>.

If you have not saved the changes that you have made in any window, you will be asked to confirm that you wish to exit.

4
Using the Scheduler Window

This chapter describes the *frequency-based scheduler* and explains how scheduler frequency is defined and how processes are scheduled. It introduces the components of NightSim's Scheduler window and describes the use of each component.

Understanding the Frequency-Based Scheduler

The *frequency-based scheduler* is a task synchronization mechanism that allows you to run processes at frequencies that you specify. Frequencies can be based on high-resolution clocks, an external interrupt source, or completion of a cycle. The frequency-based scheduler provides a mechanism for initiating processes at the specified frequency.

The frequency–based scheduler provides you with the ability to:

- Define *FBS* frequency in terms of the duration of a *minor cycle* and the number of minor cycles per *major frame*
- Specify the scheduling parameters with which processes are scheduled
- Detect *frame overruns* for all FBS–scheduled processes
- View the status of FBS–scheduled processes
- Remove one or all FBS–scheduled processes from a scheduler
- Reschedule an FBS–scheduled process
- Start, stop, and resume scheduling on a frequency–based scheduler
- Connect a timing source to and disconnect it from a frequency–based scheduler
- Control use of the real–time clock device as the timing source for a frequency–based scheduler
- Configure up to 100 frequency–based schedulers system–wide in a single processor or multiprocessor environment
- Use both frequency–based scheduling and static priority scheduling simultaneously

In addition, NightSim provides the following additional capabilities for your convenience:

- Specify input and output files for scheduled processes
- Specify a working directory for scheduled processes.
- Schedule processes under **`xterm(1)`** terminal windows, providing the option of interactive behavior

- Schedule processes under the NightView debugger

NOTE

Some of these additional features are not available for schedulers started via a saved script.

How Is Scheduler Frequency Defined?

You configure a *frequency–based scheduler*, in part, by defining the number of *minor cycles* that compose a *major frame*. Minor cycles and major frames have associated with them a duration of time that you can define by using a timing source for the scheduler. The timing source can be the end of a minor cycle, a real–time clock, an edge–triggered interrupt, or a user–supplied device.

If you use *end-of-cycle scheduling*, scheduling is triggered when the last process that is scheduled during the current minor cycle of the current major frame completes its processing.

If you use a real–time clock as the timing source, you can specify the period in microseconds or the frequency in hertz.

How Are Processes Scheduled?

You schedule processes to run at a certain frequency by specifying the first *minor cycle* in which the process is to be wakened in each *major frame* (called the *starting base cycle*) and the frequency with which it is to be wakened (called the period).

If, for example, you schedule "Process 1" with a starting base cycle of zero and a *period* of two, the process will be wakened once every two minor cycles, starting with the first minor cycle in the frame.

If you schedule "Process 2" with a starting base cycle of one and a period of four, that process will be wakened once every four minor cycles, starting with the second minor cycle in the frame.

If you then schedule "Process 3" with a starting base cycle of two and a period of two, that process will be wakened once every two minor cycles, starting with the third minor cycle in the frame.

On a *frequency–based scheduler* configured with 100 minor cycles per major frame, these processes will be wakened as illustrated in Table 4-1.

Table 4-1. Process Scheduling

Minor Cycle	Processes Wakened
0	Process 1
1	Process 2
2	Process 1, Process 3
3	
4	Process 1, Process 3
5	Process 2
...	
97	Process 2
98	Process 1, Process 3
99	

The maximum frequency with which you can schedule a process is once per minor cycle (a period of one); the minimum frequency is once per major frame (in the case of the example, a period of 100).

A process runs until it calls an *FBS* library routine that causes it to sleep until the frequency–based scheduler wakes it again. The frequency–based scheduler wakes those sleeping processes that are scheduled to be wakened in the current minor cycle of the current major frame and repeats the process for each minor cycle in the current frame. It continues to repeat the entire process on every major frame until the scheduler is disabled. A scheduler configured with 100 minor cycles per major frame, a minor cycle duration of 10,000 microseconds (0.01 second), and a major frame duration of one second wakes processes as illustrated in Table 4-2.

Table 4-2. Scheduler Operation

Major Frame	Time (sec.)	Minor Cycle	Processes Wakened
0	0	0	Process 1
	0.01	1	Process 2
	0.02	2	Process 1, Process 3
	...		
	0.97	97	Process 2
	0.98	98	Process 1, Process 3
	0.99	99	

Table 4-2. Scheduler Operation (Cont.)

Major Frame	Time (sec.)	Minor Cycle	Processes Wakened
1	1.00	0	Process 1
	1.01	1	Process 2
	1.02	2	Process 1, Process 3
	...		
	1.97	97	Process 2
	1.98	98	Process 1, Process 3
	1.99	99	
	...		
n	n.00	0	Process 1
	n.01	1	Process 2
	n.02	2	Process 1, Process 3
	..		
	n.97	97	Process 2
	n.98	98	Process 1, Process 3
	n.99	99	

As illustrated in Table 4-2:

- When the current major frame is zero and the current minor cycle is zero, the scheduler wakes "Process 1."
- After 0.01 second, it wakes "Process 2"; after 0.02 second, it wakes "Process 1" and "Process 3"; and so on.
- At one second, when the current major frame becomes one, the current minor cycle becomes zero again, and the scheduler wakes "Process 1."
- After .01 second, it wakes "Process 2."
- After .02 second, it wakes "Process 1" and "Process 3"; and so on.
- The scheduler continues repeating this process for as long as it is enabled.

It is important to note that a process may not always run at the frequency that you have specified. A *frame overrun* occurs when a scheduled process does not finish its processing before it is scheduled to run again. Overrun counts are maintained for each process and for each scheduler. You can obtain information on overruns by querying a process in the Monitor window (see Chapter 5, "Using the Monitor Window"). When you schedule a process

on a selected scheduler, you have the option of ensuring that the scheduler is stopped when that process causes a frame overrun.

For additional information on the *frequency-based scheduler*, refer to the *RedHawk Frequency-Based Scheduler (FBS) User's Guide (0898005)*.

On-Line/Off-Line Operation

NightSim provides two modes of operation for a Scheduler, On-Line and Off-Line. You can toggle the current state by pressing the On-Line/Off-Line button on either the NightSim Scheduler window (see "On-Line/Off-Line" on page 4-21) or the Edit Process dialog associated with it (see "On-Line/Off-Line" on page 4-30).

By placing a NightSim Scheduler into an Off-Line state, immediate checking of the information entered in either the NightSim Scheduler window or its associated Edit Process dialog can be avoided. When in Off-Line mode, the NightSim Scheduler will not communicate with any servers on any timing host or target system of the Scheduler.

This is useful when creating a configuration for future use that deals with target systems which may not currently exist or may not be currently accessible. The values entered in a Scheduler while it is Off-Line will be checked when the mode is changed to On-Line.

There are two ways to request a transition to On-Line mode:

1. Press the On-Line/Off-Line button on either the NightSim Scheduler or its associated Edit Process dialog. This toggles the value on the face of the button.
2. Press the Set Up button on the Scheduler window.

In each of these cases, when going from Off-Line to On-Line, the information entered in the Scheduler window and its associated Edit Process dialog is examined for correctness given the current state of the timing host and target systems. NightSim servers are started if necessary, and all scheduled process attributes are checked for correctness.

If errors are found in the configuration, the user will be guided through the list of issues discovered in the examination via the Verify Scheduler dialog.

Verify Scheduler

NightSim provides two modes of operation for a Scheduler, On-Line and Off-Line (see "On-Line/Off-Line Operation" on page 4-6). When going from Off-Line to On-Line, the information entered in the Scheduler window and its associated Edit Process dialog is examined for correctness given the current state of the timing host and target systems.

If errors are found in the configuration, the user will be guided through the list of issues discovered in the examination via the Verify Scheduler dialog. An example of such an error is shown below.

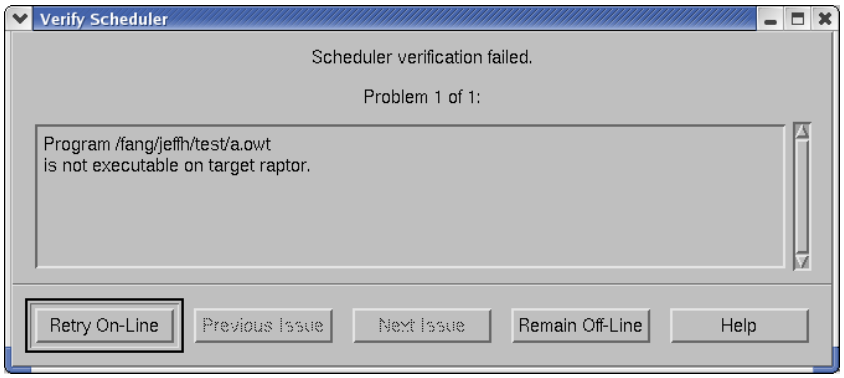


Figure 4-1. Verify Scheduler Dialog

The operation of the buttons in the Verify Scheduler dialog is as follows:

Retry On-Line

If all problems found during the current verification process have been attended to, the user may press this button to re-attempt the transition to On-Line.

Previous Issue

Pressing this button will cycle to the previous issue found during the current verification process. The text describing the problem will be displayed in the Verify Scheduler dialog.

Next Issue

Pressing this button will cycle to the next issue found during the current verification process. The text describing the problem will be displayed in the Verify Scheduler dialog.

Remain Off-Line

This button allows the user to continue to work off-line in lieu of the problems found and attempt to transition to On-Line at a later time.

Help

This button displays appropriate information related to the problem currently displayed in the Verify Scheduler dialog.

For each issue, NightSim will highlight the label associated with the field most likely to be of use in correcting the problem. If that field is on a window that is not visible, NightSim will raise the appropriate window to the top of the display. Below is a portion of the NightSim Scheduler window corresponding to the error listed in Figure 4-1. Note that the Timing host field is highlighted since the host name entered was invalid.

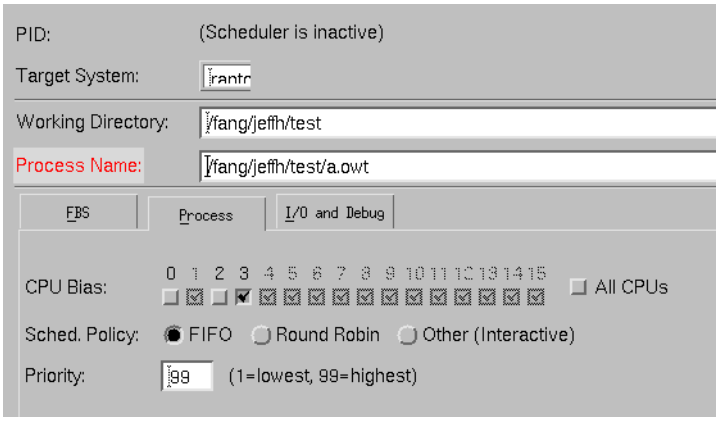


Figure 4-2. Errors found during transition to on-line

After making the appropriate changes, the user may retry the transition to On-Line mode or may choose to remain in Off-Line mode. If new problems are discovered when transitioning to On-Line mode, the Verify Scheduler window will re-appear.

Introduction to the Scheduler Window

The Scheduler window allows you to configure a *frequency-based scheduler*; select a timing source for it; schedule programs on it; start, stop, and resume a simulation; and view scheduling data.

Figure 4-3 is an example of a Scheduler window.

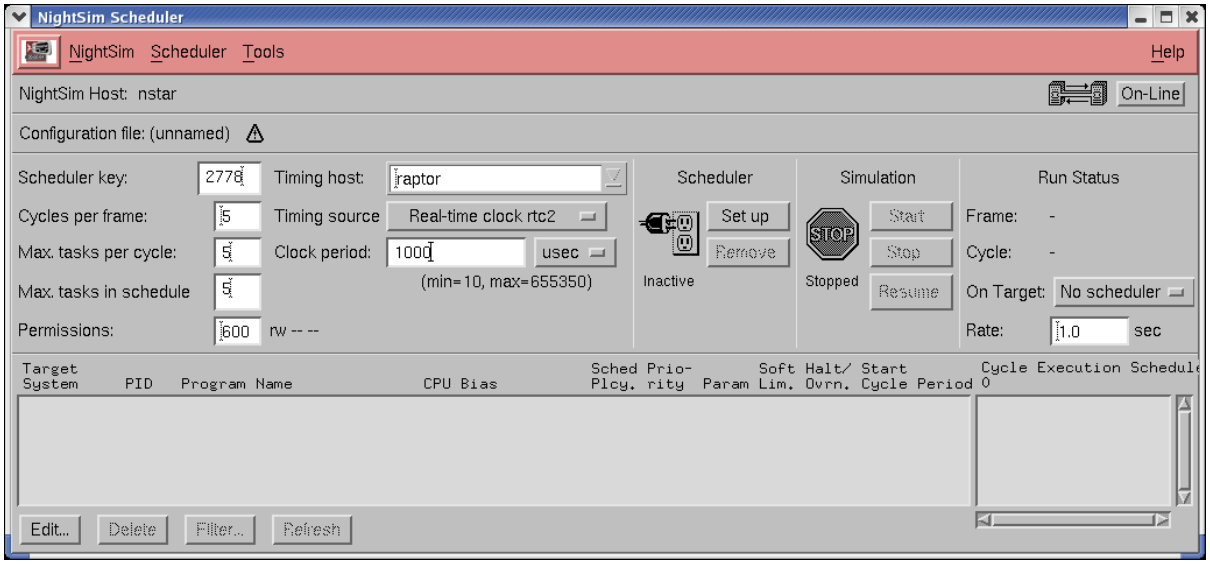


Figure 4-3. Scheduler Window

The Scheduler window consists of the following components:

- Menu Bar (see “Using the Scheduler Window Menu Bar” on page 4-11)
- On-Line/Off-Line Status Area (see “Using the On-Line/Off-Line Status Area” on page 4-21)
- Configuration File Name Area (see “Using the Configuration File Name Area” on page 4-22)
- Scheduler Configuration Area (see “Using the Scheduler Configuration Area” on page 4-23)
- Process Scheduling Area (see “Using the Process Scheduling Area” on page 4-27)
- Scheduler Control Area (see “Using the Scheduler Control Area” on page 4-42)
- Simulation Control Area (see “Using the Simulation Control Area” on page 4-46)
- Run Status Area (see “Using the Run Status Area” on page 4-48)

Procedures for using each component of the Scheduler window are described in the sections that follow.

Using the Scheduler Window Menu Bar

The Scheduler window menu bar is a part of the Scheduler window (see “Introduction to the Scheduler Window” on page 4-9).

The Scheduler window menu bar provides access to the following menus:

- NightSim (see “NightSim” on page 4-12)
- Scheduler (see “Scheduler” on page 4-14)
- Tools (see “Tools” on page 4-19)
- Help (see “Help” on page 4-20)

Each menu is described in the sections that follow.

NightSim

The NightSim menu appears on the Scheduler window menu bar (see "Using the Scheduler Window Menu Bar" on page 4-11).

The NightSim menu on the Scheduler window contains commands related to the global operation of NightSim. Figure 4-4 presents this menu.

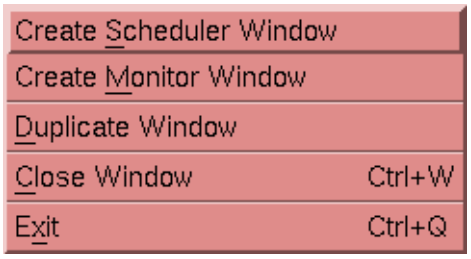


Figure 4-4. NightSim Menu

Descriptions of the options on the NightSim menu follow.

Create Scheduler Window

This option allows you to create a new Scheduler window. The new window is *inactive*—that is, it is not associated with a scheduler that exists on your system. Its text fields contain blanks or default values. You may create any number of Scheduler windows.

Create Monitor Window

This option allows you to create a new Monitor window. If the Scheduler window from which you create the window is associated with an existing scheduler, the *key* and *target* for that scheduler will be displayed in the Status Area of the new Monitor window. In addition, if the scheduler is active, scheduled processes will be listed in the Output Area of the new Monitor window. Use of the Monitor window is fully explained in Chapter 5, "Using the Monitor Window."

Duplicate Window

This option allows you to create a new Scheduler window with the same configuration as that of the Scheduler window from which this option was selected.

Close Window

This option allows you to close the current Scheduler window. If the window is untitled and contains unsaved changes, NightSim displays a warning dialog. If you proceed with the current action without saving, these changes will be lost. If you click on the Yes button to save the changes, NightSim displays a file selection dialog. If you click on the No button, the changes will be discarded. If you click on the Cancel button, the action is aborted.

To select the file in which to save the changes, use the directory text area, file mask area, list of directories, list of files, and file selection text area as appropriate. After making a selection, you may save the changes to the selected file, search for another file, cancel the operation, or display help related to the dialog.

If the Scheduler window is associated with a configuration file name and contains unsaved changes, NightSim displays a warning dialog about saving changes. If you proceed with the current action without saving, these changes will be lost. If you click on the Yes button, the changes are saved in the file associated with the window. If you click on the No button, the changes will be discarded. If you click on the Cancel button, the action is aborted.

If the window from which you select Close Window is the only window that you have open, NightSim displays a confirmation dialog. You may confirm that you wish to exit, continue to keep the window open, or display help related to the dialog.

Exit

This option allows you to exit NightSim. If you have open Scheduler windows that are untitled and contain unsaved changes or if you have an active scheduler, NightSim displays a warning dialog. In each case, you may save the changes, close the window without saving the changes, cancel the close operation, or display help related to the dialog. If you click on the Yes button to save the changes, NightSim displays a file selection dialog.

If you have open a Scheduler window that is associated with a configuration file name and contains unsaved changes, NightSim displays a warning dialog. If you click on the Yes button, the changes are saved in the file associated with the window.

The warning dialogs are displayed for each window that contains unsaved changes.

Scheduler

The Scheduler menu appears on the Scheduler window menu bar (see "Using the Scheduler Window Menu Bar" on page 4-11).

The Scheduler menu contains commands that affect the current Scheduler window. Figure 4-5 presents this menu.

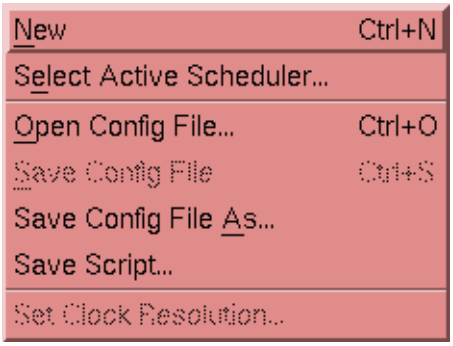


Figure 4-5. Scheduler Menu

Descriptions of the options on the Scheduler menu follow.

New

This option allows you to clear all information from the current Scheduler window; reset the various areas to blank or default values; and place the window in the *inactive* state. The *timing host* is preserved, however.

If the window is untitled and contains unsaved changes, NightSim displays a warning dialog. You may save the changes, clear the window without saving the changes, cancel the operation, or display help related to the dialog. If you click on the Yes button to save the changes, NightSim displays a file selection dialog.

If the window is associated with a configuration file name and contains unsaved changes, NightSim displays a warning dialog. You may save the changes, clear the window without saving the changes, cancel the operation, or display help related to the dialog. If you click on the Yes button, the changes are saved in the file associated with the window.

NOTE

If the window containing the unsaved changes is associated with an active scheduler, the scheduler will continue to run although the window is no longer associated with it.

Select Active Scheduler...

This option allows you to associate the current Scheduler window with a *frequency-based scheduler* active on a given *target system*. When you select this option, NightSim displays Figure 4-6.

If the window from which you select this option is untitled and contains unsaved changes, NightSim displays a warning dialog. You may save the changes, close the window without saving the changes, cancel the operation, or display help related to the dialog. If you click on the Yes button to save the changes, NightSim displays a file selection dialog.

If the window is associated with a configuration file name and contains unsaved changes, NightSim displays a warning dialog. You may save the changes, close the window without saving the changes, cancel the operation, or display help related to the dialog. If you click on the Yes button, the changes are saved in the file associated with the window.

To assist you in selecting a scheduler, NightSim displays the selection dialog that Figure 4-6 presents.

NOTE

NightSim needs to communicate with a target system in order to determine which schedulers are active. This will occur even if the existing Scheduler window is Off-Line. This is to be expected since the existing scheduler will be abandoned when an active scheduler is selected, and because an active scheduler is necessarily On-Line (see “On-Line/Off-Line Operation” on page 4-6).

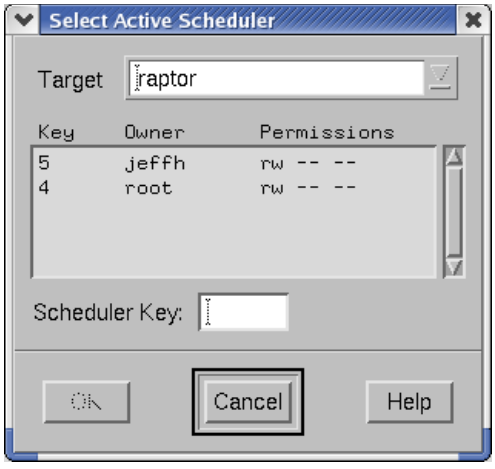


Figure 4-6. Select Active Scheduler Dialog

This dialog provides a list of the *active schedulers* for the system designated by the Target field. The Target defaults to your local host and the list contains the active

schedulers running on that particular system. For instance, Figure 4-6 lists the two schedulers currently running on the host `amber2`.

You may change the `Target` either by using the drop-down list or by typing the name of the *target system* into the text field provided. Entering an item in this field will populate the list with the *active schedulers* on the specified target.

You may select a scheduler from the list that the dialog displays, or you may use the `Scheduler Key` text field to enter the numeric *key* that is associated with the desired scheduler. The key can be any positive integer value. Whether you select from the list or enter a key, the selected scheduler must previously have been configured, and you must have at least read permission for it; otherwise, NightSim reports an error.

If you successfully select an existing scheduler, the Scheduler window becomes an active window associated with that scheduler. Information related to the selected scheduler replaces information that the window contained prior to the operation.

Open Config File...

This option allows you to open a scheduler configuration file that you have previously saved. The file is opened in the current Scheduler window.

If the window from which you select this option is untitled and contains unsaved changes, NightSim displays a warning dialog. You may save the changes, close the window without saving the changes, cancel the operation, or display help related to the dialog. If you click on the `Yes` button to save the changes, NightSim displays a file selection dialog.

If the window is associated with a configuration file name and contains unsaved changes, NightSim displays a warning dialog. You may save the changes, close the window without saving the changes, cancel the operation, or display help related to the dialog. If you click on the `Yes` button, the changes are saved in the file associated with the window.

To assist you in specifying a configuration file to be opened, NightSim displays a file selection dialog. After making a selection, you may open the selected file, search for another file, cancel the operation, or display help related to the dialog. When you open the selected file, the Scheduler window is associated with that file and displays the configuration and scheduling data contained in the file.

NightSim will open the configuration file in `Off-Line` mode. Once the file has been read in, NightSim will make a transition to `On-Line` mode unless the **`-offline`** option was used on the command line, or the `*offline` X resource was set to `True` (see "X Resources" on page D-1). When this transition occurs, the new scheduler will be verified. See "On-Line/Off-Line Operation" on page 4-6 for more information.

Save Config File

This option allows you to save the configuration and scheduling data entered in the current Scheduler window in the file that is associated with the window. If the configuration file name has not yet been specified, this option is disabled; you should use the `Save Config File As...` option. See "Configuration Files" on page C-1

for a description of the format of this file as well as "Configuration File Example" on page C-3 for an example.

Save Config File As...

This option allows you to specify the name of the file in which you wish the configuration and scheduling data entered in the current Scheduler window to be saved.

When you select this option, NightSim displays a file selection dialog. After making a selection, you may save the current configuration and scheduling data in the selected file, search for another file, cancel the operation, or display help related to the dialog.

See "Configuration Files" on page C-1 for a description of the format of this file as well as "Configuration File Example" on page C-3 for an example.

Save Script...

This option allows you to save the current configuration as a shell script containing **`rtcp`** commands. The script may be run from any host in your network as long as it has **`rsh(1)`** access to all the targets, as well as the timing host (see "Remote Shell Access" on page 2-1). This script can then be used to recreate your scheduler configuration without the added overhead of NightSim, allowing your application to start up and run more quickly. This can be extremely useful when dealing with time-critical applications.

The main disadvantage of using this script instead of using NightSim is that you do not get any monitoring capabilities. This may be less important for systems that are typically used in production environments but can be critical to those systems used in a testing/development environment where the monitoring feedback that NightSim provides can be invaluable.

Another disadvantage is that the script does not support starting your processes under NightView or **`xterm(1)`**. For this features, you must use the NightSim scheduler to start your scheduler.

If a scheduler which makes use of **`xterm`** or NightView is saved as a script, NightSim will ignore these points and schedule the processes directly. If File input or output is used, NightSim will honor those filenames, but if the scheduler uses Standard Input Stream or Standard Output Stream, NightSim will forcibly redirect from or to **`/dev/null`** in order to prevent **`rsh`** from hanging while waiting for input or output.

See "Configuration Files" on page C-1 for details on this new format.

Set Clock Resolution...

This option allows you to select the resolution for a real-time clock that you have selected as the timing source for a scheduler. The resolution indicates the duration in microseconds of one clock count.

The duration of a *minor cycle* is defined by specifying the number of clock counts per minor cycle (1 to 65,535) and the number of microseconds per clock count (1,

10, 100, 1000, or 10,000). You determine the duration of a *major frame* by multiplying the duration of a minor cycle by the number of minor cycles per major frame. If, for example, you configure a scheduler with 100 minor cycles per major frame and you use as the timing source a real–time clock with a clock count of 10,000 and a clock count duration of one microsecond, each minor cycle has a duration of 10,000 microseconds, or 0.01 second, and each frame a duration of one second.

When you select this option, NightSim displays the selection dialog that Figure 4-7 presents.

Figure 4-7. Set Clock Resolution Dialog

You select the resolution by clicking on the toggle button and choosing one of the following options: `1`, `10`, `100`, `1000`, or `10000`. You may apply your selection, cancel the operation, or display help related to the dialog.

The resolution of the clock affects the valid range of the clock period. See "Clock period" on page 4-26.

Detailed Scheduler Info...

(Expert mode only)

The dialog associated with this option provides more information about the current *FBS* which may be of interest to some users.

This option appears on the `Scheduler` menu (see "Scheduler" on page 4-14) only when the user is running in *expert mode*. See the `expert` resource under "X Resources" on page D-1 for more details.

Tools

The Tools menu appears on the Scheduler window menu bar (see “Using the Scheduler Window Menu Bar” on page 4-11) as well as on the Monitor window menu bar (see “Using the Monitor Window Menu Bar” on page 5-7).

The Tools menu contains a list of other NightStar tools that can be launched directly from NightSim.

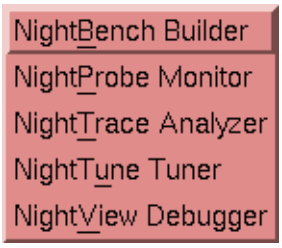


Figure 4-8. Tools Menu

Descriptions of the options on the Tools menu follow.

NightBench Builder

Opens the NightBench™ Program Development Environment.

NightBench is a set of graphical user interface (GUI) tools for developing software with Concurrent’s MAXAda™ compiler.

See the *NightBench User’s Guide* for more information.

NightProbe Monitor

Opens the NightProbe Data Monitoring application.

NightProbe is a real-time graphical tool for monitoring, recording, and altering program data within one or more executing programs without significant intrusion. NightProbe can be used in a development environment as a tool for debugging, or in a production environment to create a “control panel” for program input and output.

See the *NightProbe RT User’s Guide* for more information.

NightTrace Analyzer

Opens the NightTrace Analyzer.

The NightTrace Analyzer is a graphical tool for analyzing the dynamic behavior of multiprocess and/or multiprocessor user applications and operating system activity. NightTrace allows you to control user and kernel trace collection daemons and can

graphically display the interplay between many real-time programs and processes across multiple processors and systems.

See the *NightTrace RT User's Guide* for more information.

NightTune Tuner

Opens the NightTune Performance Tuner.

NightTune is a graphical tool for analyzing the status of the system in terms of processes, interrupts, context switches, interrupt CPU affinity, processor shielding and hyperthreading control as well as network and disk activity. NightTune can adjust the scheduling attributes of individual or groups of processes, including priority, policy, and CPU affinity.

See the *NightTune RT User's Guide* for more information.

NightView Debugger

Opens the NightView Source-Level Debugger.

NightView is a graphical source-level debugging and monitoring tool specifically designed for real-time applications. NightView can monitor, debug, and patch multiple real-time processes running on multiple processors with minimal intrusion.

See the *NightView RT User's Guide* for more information.

Help

The Help menu appears on the Scheduler window menu bar (see "Using the Scheduler Window Menu Bar" on page 4-11) as well as on the Monitor window menu bar (see "Using the Monitor Window Menu Bar" on page 5-7).

The Help menu provides access to the on-line help system. See "Getting Help" on page 3-3 for detailed information about this menu and each of its items.

Using the On-Line/Off-Line Status Area

The On-Line/Off-Line Status Area is a part of the Scheduler window (see “Introduction to the Scheduler Window” on page 4-9).

The On-Line/Off-Line Status Area shows the name of the NightSim host as well as an On-Line/Off-Line toggle button indicating the current state of operation of the Scheduler (see “On-Line/Off-Line Operation” on page 4-6).

Figure 4-9. Scheduler Window - On-Line/Off-Line Status Area

On-Line/Off-Line

NightSim provides two modes of operation for a Scheduler, On-Line and Off-Line (see “On-Line/Off-Line Operation” on page 4-6). You can toggle the current state by pressing the On-Line/Off-Line button on either the NightSim Scheduler window or its associated Edit Process dialog (see “Edit Process” on page 4-29).

By placing a NightSim Scheduler into an Off-Line state, immediate checking of the information entered in either the NightSim Scheduler window or its associated Edit Process dialog can be avoided. When in Off-Line mode, the NightSim Scheduler will not communicate with any servers on any timing host or target system of the Scheduler.

This is useful when creating a configuration for future use that deals with target systems which may not currently exist or may not be currently accessible. The values entered while Off-Line will be checked when the mode is changed to On-Line.

Using the Configuration File Name Area

The Configuration File Name Area is a part of the Scheduler window (see "Introduction to the Scheduler Window" on page 4-9).

The Configuration File Name Area shows the name of the configuration file with which the current Scheduler window is associated.

Figure 4-10. Scheduler Window - Configuration File Name Area

If the window contains unsaved changes, the name is followed by a warning icon as illustrated by Figure 4-10. When the Scheduler window is not associated with a configuration file name, the Configuration File Name Area displays (unnamed) as illustrated by Figure 1-1 (see p. 1-3).

Using the Scheduler Configuration Area

The Scheduler Configuration Area is a part of the Scheduler window (see “Introduction to the Scheduler Window” on page 4-9).

The Scheduler Configuration Area allows you to configure a *frequency-based scheduler*, select the timing source that is to be used for it, and specify the permissions that are to be associated with it.

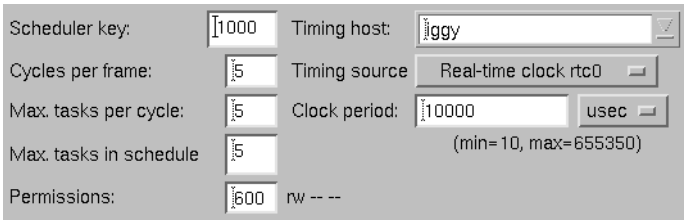


Figure 4-11. Scheduler Window - Configuration Area

Descriptions of the text fields and controls contained in the Configuration Area follow:

Scheduler key

This field allows you to specify a *key* for the frequency–based scheduler that you wish to create. The key is a user–chosen numeric identifier with which the scheduler will be associated. It can be any positive integer value. Note that the number of schedulers that can be configured at one time cannot exceed the value of FBSMNI, which is the maximum number of frequency–based schedulers permitted on your system (see Chapter 2, “Establishing the NightSim Environment,” for a description of system tunable parameters).

Cycles per frame

This field allows you to specify the number of cycles that compose a frame on the specified scheduler.

Max. tasks per cycle

This field allows you to specify the maximum number of processes that can be scheduled to execute during one cycle.

Max. tasks in scheduler

This field allows you to specify the maximum number of processes that can be scheduled on the specified scheduler at one time. The number must be less than or equal to the *product* that is obtained by multiplying the values specified in the Cycles per frame and the Max. tasks per cycle text fields. Enter a number ranging from one to the product of these values.

Permissions

This field allows you to specify the permissions required for operations related to the specified scheduler. Enter three octal digits—the first indicating permissions granted to the owner, the second indicating those granted to the group, and the third indicating those granted to other users. The octal method for setting permissions associated with a scheduler is the same as that used for specifying *mode* with the **`chmod`** command (for assistance in using this method, see the system manual page for **`chmod(1)`**). The default, **600,** grants read and alter (write) permission to the owner only.

Timing host

This field allows you to select the *host* of the timing source for the scheduler. You may enter the name of the host directly in the entry field or choose from the supplied list.

This list contains a list of possible timing hosts. NightSim maintains a list in **`~/.NightSimHosts`** of all hosts you ever used as a timing host. Once selected, the Timing source menu is repopulated with the set of devices available on that host.

This field is empty by default. The user must provide a Timing host name.

NOTE

The timing host cannot be changed while the scheduler is active; you must first remove the scheduler.

Timing source

This option menu allows you to select the timing source for the scheduler. The timing source can be the end of a *minor cycle*, a real-time clock, an edge-triggered interrupt, or a user-supplied device. Figure 4-12 presents an example of the option menu.

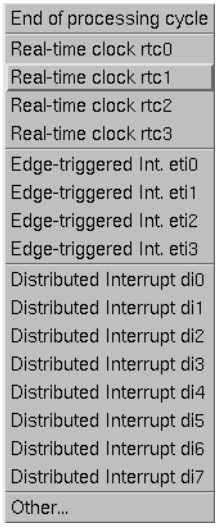


Figure 4-12. Timing Source Option Menu

This list contains the set of devices available on the *timing host*. Note that the options that NightSim displays vary according to the devices that are configured in the system designated as the timing host and may change if the timing host is changed. This list will be initially populated with the devices on the defaut timing host.

If you select the End of processing cycle option from the Timing source option menu, scheduling is triggered when the last process that is scheduled during the current *minor cycle* of the current *major frame* completes its processing.

If you select a real-time clock, the Clock period text field is enabled so that you can specify the information needed to set the clock.

If you select the Other...option, NightSim displays the dialog shown in Figure 4-13. The text input area in this dialog allows you to specify the name of a user-supplied device that you wish to use as the timing source. The Device Pathname must be the name of a device file on the currently selected timing host and that is supported by Concurrent's RedHawk kernel as a FBS timing device. Currently, the only devices supported are those associated with an RCIM.

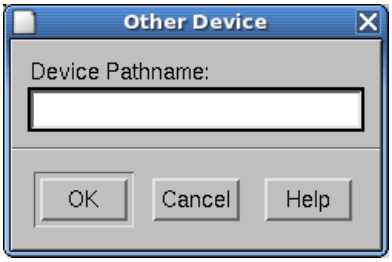


Figure 4-13. Other Device Prompt Dialog

Clock period

If you select a real-time clock as the timing source for the scheduler, this field allows you to specify a value to be used in setting the clock. Otherwise, this field is disabled.

You may specify the period in microseconds, milliseconds, hertz, or kilohertz by clicking on the toggle button and choosing the desired option. Below the field is a label that shows the minimum and maximum values that are permitted. The label changes according to the option you choose. Figure 4-14 presents the options from which you may choose.

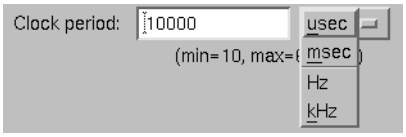


Figure 4-14. Clock Period Options

The valid range of the clock period is determined by multiplying the minimum and maximum clock counts, 1 and 65535, by the clock resolution, which defaults to 10 microsends. By chainging the clock resolution, you can increase or decrease the valid range of the clock period. See "Set Clock Resolution..." on page 4-17 to adjust the number of microseconds per clock count.

Using the Process Scheduling Area

The Process Scheduling Area is a part of the Scheduler window (see “Introduction to the Scheduler Window” on page 4-9).

The Process Scheduling Area allows you to:

- add programs to a *frequency-based scheduler*
- remove *FBS*-scheduled processes from a scheduler
- reschedule FBS-scheduled processes
- view scheduling data for current FBS-scheduled processes
- select the processes for which scheduling data are to be displayed.

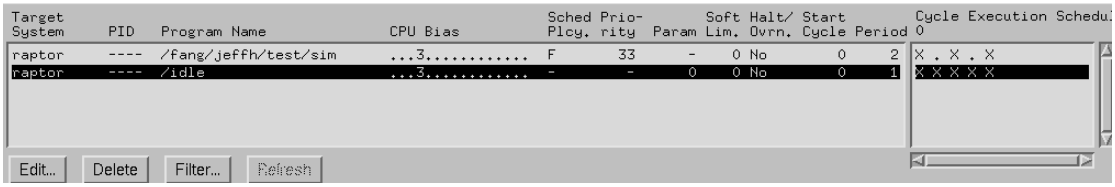


Figure 4-15. Scheduler Window - Process Scheduling Area

The Process Scheduling Area contains a scrolling list of the processes that are currently scheduled on a *frequency-based scheduler* and the parameters with which they have been scheduled (CPU mask, scheduling policy and priority, starting *minor cycle*, and so on). You can select the process or processes that you wish to reschedule or delete by clicking on the respective item(s) in this list.

In addition, the Process Scheduling Area includes a grid that graphically shows the execution cycle for each process in the list. The labels at the top of the grid show the number of the *minor cycle*. The minor cycles in which each process is scheduled to run are denoted by the appearance of the letter X in the appropriate column. You can use the horizontal and vertical scroll bars to scroll the visible contents of the grid.

The Process Scheduling Area contains a row of process controls below the list of FBS-scheduled processes. These controls are explained below:

Edit...

This push button allows you to add a program to a *frequency-based scheduler* or reschedule an *FBS*-scheduled process. When you click on this button, NightSim displays the Edit Process dialog (see “Edit Process” on page 4-29). Note that if you select a process from the list of scheduled processes and then click on this button, the dialog contains the scheduling parameters for the selected process. NightSim also displays the Edit Process dialog if you double click on a line in the list of scheduled processes.

Delete

This button allows you to delete *FBS*-scheduled processes from a scheduler. All processes that are selected in the list will be deleted. When you click on this button, NightSim displays the Delete Processes dialog (see "Delete Processes" on page 4-40).

Filter...

This button allows you to specify the *FBS*-scheduled processes that you wish to be displayed in the Process Scheduling Area of the Scheduler window (see "Using the Process Scheduling Area" on page 4-27). When you click on this button, NightSim displays the Filter Process List dialog (see "Filter Process List" on page 4-41).

Refresh

This button is enabled only when the Scheduler window is active. Clicking on this button updates the scheduler and process information in the window. If a process terminates, for example, it will remain in the process list until the Refresh button is clicked, at which time it will be removed.

Edit Process

The Edit Process dialog allows you to add a program to a *frequency-based scheduler* or reschedule an *FBS*-scheduled process. Note that if you had selected a process from the list of scheduled processes in the Process Scheduling Area (see "Using the Process Scheduling Area" on page 4-27) and then clicked on the Edit button, this dialog will contain the scheduling parameters for the selected process. NightSim also displays the Edit Process dialog if you double click on a line in the list of scheduled processes.

The Edit Process dialog is shown in Figure 4-16:

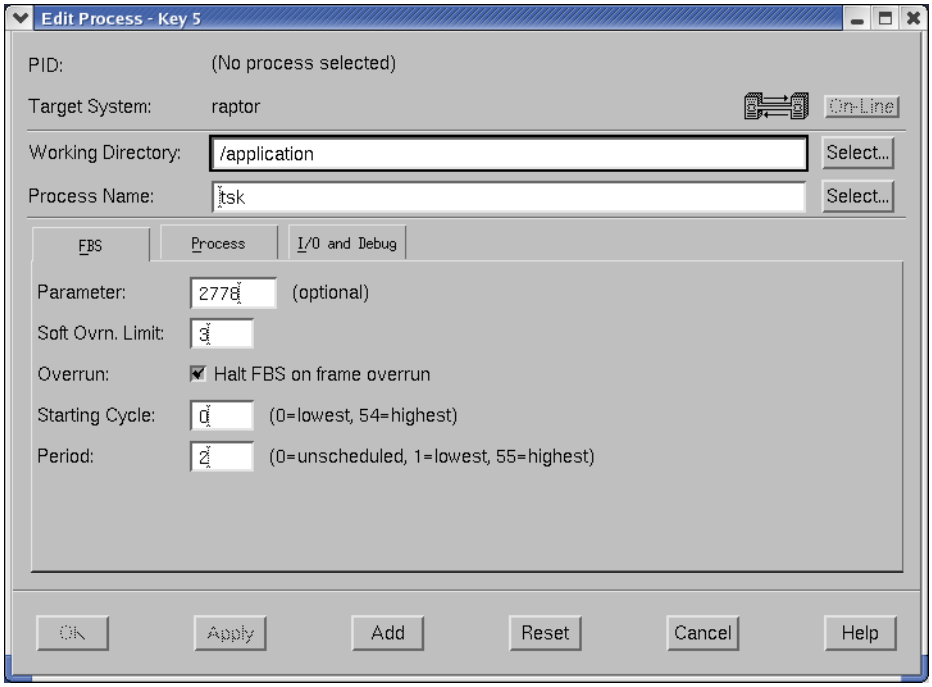


Figure 4-16. Edit Process Dialog

The following fields appear at the top of the Edit Process dialog:

PID

This field specifies the unique *frequency-based scheduler* process identifier that is obtained when a program is scheduled on a scheduler. When a program has not yet been scheduled on the scheduler, this field displays "(Scheduler is inactive)".

Target System

This item indicates the *target system* on which this process is to be scheduled.

On-Line/Off-Line

NightSim provides two modes of operation for a Scheduler, On-Line and Off-Line (see "On-Line/Off-Line Operation" on page 4-6). You can toggle the current state by pressing the On-Line/Off-Line button on either the the NightSim Scheduler window or the Edit Process dialog associated with it (see "Using the On-Line/Off-Line Status Area" on page 4-21).

By placing a NightSim Scheduler into an Off-Line state, immediate checking of the information entered in either the NightSim Scheduler window or its associated Edit Process dialog can be avoided. When in Off-Line mode, the NightSim Scheduler will not communicate with any servers on any timing host or target system of the Scheduler.

This is useful when creating a configuration for future use that deals with target systems which may not currently exist or may not be currently accessible. The values entered while Off-Line will be checked when the mode is changed to On-Line.

Working Directory

You may specify the path to the working directory in which the scheduled process will run. This path must be a valid directory name on the *target system*. If the target system is not available, or if the Scheduler is Off-Line (see "On-Line/Off-Line Operation" on page 4-6), the path must be a valid directory on the target system at the time the program scheduler is created (i.e. when the Set up button is pressed on the Scheduler window).

Select...

You may use the Select button to bring up the Select a Directory dialog to specify the working directory for the program you want to configure under the *FBS*.

Process Name

This field specifies the name of the process that you wish to schedule. Enter a full or relative pathname (see "Pathname Expansion" on page 4-39). The pathname must be valid on the *target system* to which this process is assigned. If you have selected a process from the list of *FBS*-scheduled processes prior to clicking on the Edit button, this field contains the name of the FBS-scheduled process.

NOTE

You cannot change the name of a process while the process is running. You must either stop the scheduler first or add a new process with the desired name.

Select...

You may use the Select button to bring up the Select a Program dialog to choose the program you want to configure under the *FBS*. Note that NightSim

displays files on the selected target system if it is reachable via the network. If the target system is unavailable, NightSim will disable file browsing on the target system. In addition, the Scheduler must be operating in an On-Line state in order to browse on the target file system (see "On-Line/Off-Line Operation" on page 4-6).

The bottom portion of the Edit Process dialog is divided into a number of pages that contain various parameters related to the given process. These pages are:

- FBS (see "FBS" on page 4-32)
- Process (see "Process" on page 4-35)
- I/O and Debug (see "I/O and Debug" on page 4-37)

NOTE

If the Process Name is /idle, then all of the fields which are inappropriate for the /idle pseudo-processes are desensitized. Only the CPU Bias field is valid for /idle.

After you have entered the scheduling parameters for a specified program, you may apply the changes and close the Edit Process dialog, apply the changes without closing the dialog, add another program to the scheduler, reset the contents of the dialog to its initial state, cancel the changes and close the dialog, or display help for the dialog.

FBS

The FBS tab of the Edit Process dialog (see "Edit Process" on page 4-29) allows the user to specify parameters such as the starting cycle, period, and overrun limits for the given process.

The FBS page of the Edit Process dialog is shown in Figure 4-17:

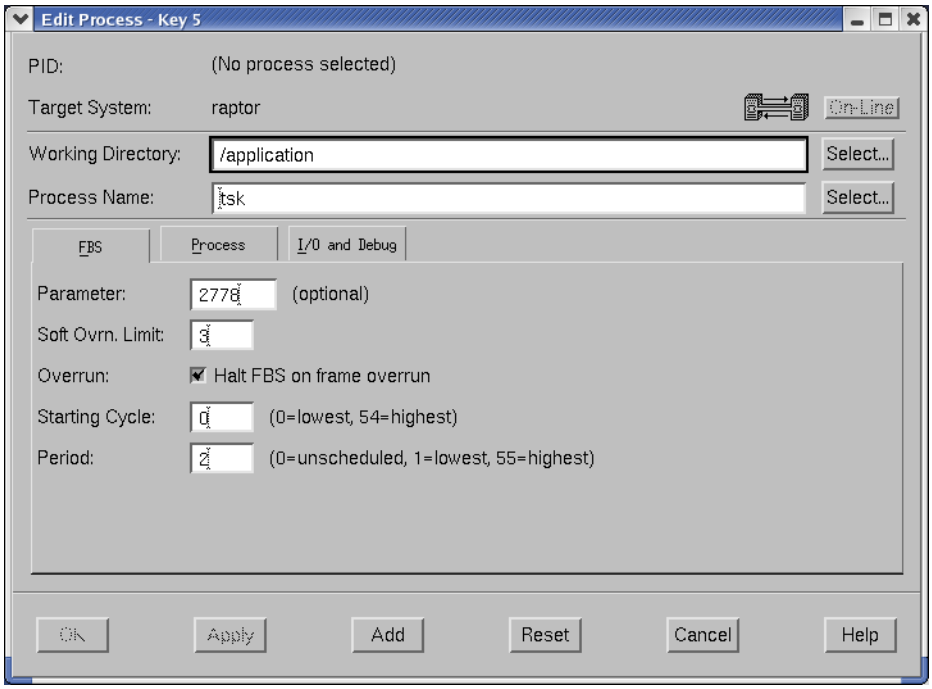


Figure 4-17. Edit Process Dialog - FBS

Parameter

This field allows you to pass an integer value to a process that is scheduled on a frequency–based scheduler. The value must be a 32-bit decimal value. The default is no value. The process can retrieve this value by using the **`sched_fbsqry(3)`** library routine.

Soft Ovrn. Limit

This field allows you to specify a consecutive overrun limit count that this process will tolerate and have processed as soft overruns by the kernel. *Soft overruns* are catastrophic failures only if the process reaches its limit on the number of soft overruns tolerated. This soft overrun limit defaults to 0 for each process.

Overrun

This check button allows you to indicate whether or not the selected scheduler should be stopped in the event that the specified program causes a *frame overrun*. Turn this button on if you wish the scheduler to be stopped.

NOTE

This may useful in conjunction with scheduling a process under the NightView debugger, making it easier to stop a scheduled process at the source of an overrun and determine the activity which caused the overrun to occur.

Starting cycle

This field allows you to specify the first *minor cycle* in which the specified program is to be wakened in each *major frame*. Enter a number ranging from zero to the total number of minor cycles per frame minus one. (The total number of minor cycles per frame is defined when you use the Scheduler Configuration Area to configure a scheduler. See "Using the Scheduler Configuration Area" on page 4-23 for details.)

NightSim displays the range of starting cycle values that you can enter next to the Starting cycle field.

NOTE

You must enter a starting cycle of zero for unscheduled processes (for an explanation of unscheduled processes, see Chapter 5, "Using the Monitor Window," and the section entitled "Monitoring Unscheduled Processes").

Period

This field allows you to establish the frequency with which the specified program is to be wakened in each *major frame*. A period of one indicates that the specified program is to be wakened every *minor cycle*; a period of two indicates that it is to be wakened once every two minor cycles, a period of three once every three minor cycles, and so on. Enter the number of minor cycles representing the frequency with which you wish the program to be wakened. This number can range from zero to the number of minor cycles that compose a frame on the scheduler. (The total number of minor cycles per frame is defined when you use the Scheduler Configuration Area to configure a scheduler. See "Using the Scheduler Configuration Area" on page 4-23 for details.)

NightSim displays the range of period values that you can enter next to the Period field.

NOTE

You must enter a period of zero for unscheduled processes (for an explanation of unscheduled processes, see Chapter 5, "Using the Monitor Window," and the section entitled "Monitoring Unscheduled Processes").

NOTE

If the Period of a process is changed while the scheduler is running, the Monitor window will not reflect the updated value until the next Monitor window update after the process runs again.

Process

The Process tab of the Edit Process dialog (see “Edit Process” on page 4-29) allows the user to specify the CPU bias, scheduling policy, and priority of the given process.

The Process page of the Edit Process dialog is shown in Figure 4-18:

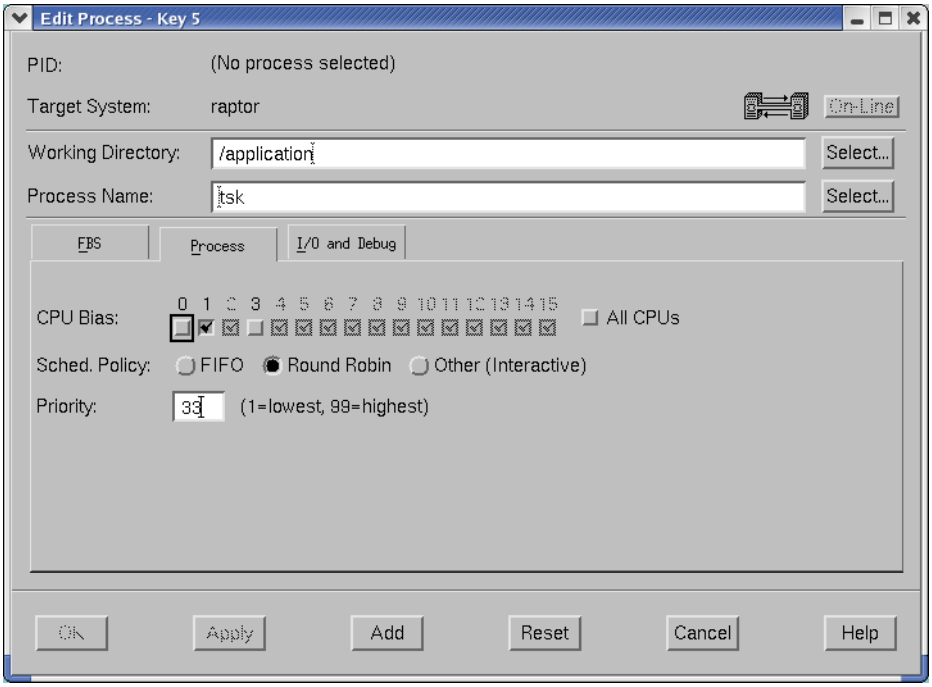


Figure 4-18. Edit Process Dialog - Process

CPU Bias

This panel of check buttons allows you to select the processor or processors on which the program can be scheduled. Click on one or more buttons, where the label 0 represents the first logical CPU, 1 represents the second, and so on. To select all CPUs on your system, click on the All CPUs button.

NOTE

If the CPU Bias of a process is changed while the scheduler is running, the Monitor window will not reflect the updated value until the next Monitor window update after the process runs again.

NOTE

You cannot change the CPU bias of **`/idle`** while the scheduler is active because it is not a real process. You must either add a new process with the desired CPU bias, or make the change while the scheduler is inactive. See "How Is Idle Time Monitored?" on page 5-3 for more information.

Sched Policy

This panel of radio buttons allows you to select the POSIX scheduling policy for the specified program. The options are as follows: the FIFO (first–in–first–out) scheduling policy, the Round Robin scheduling policy, and the Other (interactive) scheduling policy.

Priority

The range of priority values that you can enter is governed by the scheduling policy specified. You can determine the allowable range of priorities associated with each policy (FIFO, Round-Robin, or Other) by invoking the **`run(1)`** command from the shell and not specifying any options or arguments (see the corresponding system manual page for an explanation of this command). Higher numerical values correspond to more favorable scheduling priorities.

NightSim displays the range of priority values that you can enter next to the Priority field.

NOTE

If the Priority of a process is changed while the scheduler is running, the Monitor window will not reflect the updated value until the next Monitor window update after the process runs again.

I/O and Debug

The I/O and Debug tab of the Edit Process dialog (see “Edit Process” on page 4-29) allows the user to specify where to read input from, where to send output, and if the process is to be scheduled within a NightView dialogue or within an **`xterm(1)`** window.

The I/O and Debug page of the Edit Process dialog is shown in Figure 4-19:

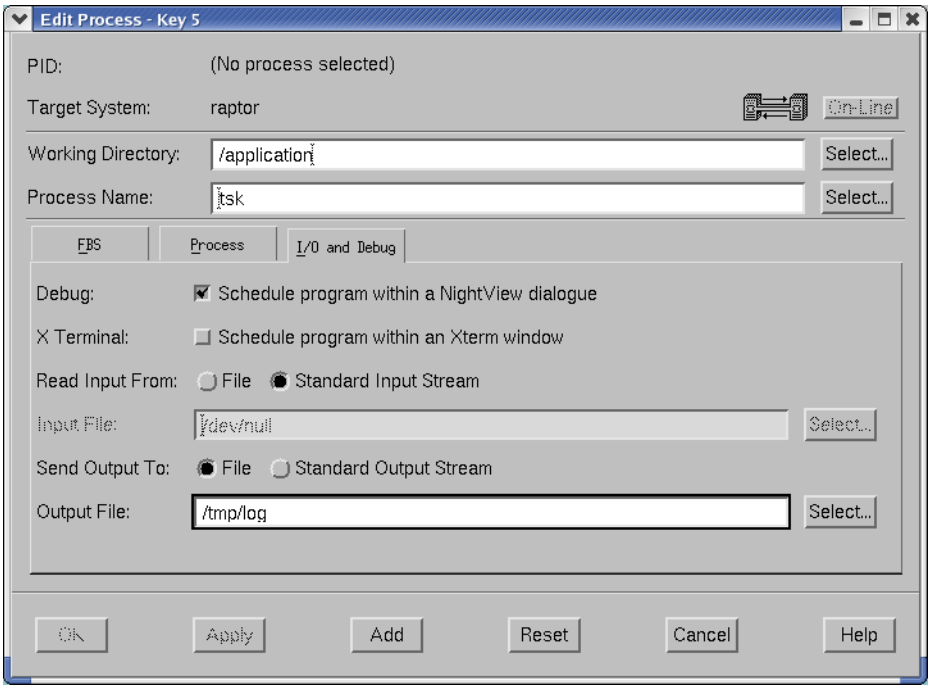


Figure 4-19. Edit Process Dialog - I/O and Debug

Debug

Schedule this process under the NightView debugger. When the Schedule program within a NightView dialogue checkbox is checked, the process will be stopped at the point it begins execution, allowing early intervention for the purpose of setting breakpoints, watchpoints, etc. A **`resume`** command to NightView is required to resume the execution of the scheduled process.

NOTE

Scheduling processes under the FBS requires certain capabilites (see “Capabilities” on page 2-2). It is the responsibiliy of the user to ensure that appropriate capabili are granted to the NightView session.

X Terminal

Schedule the process in an **`xterm(1)`** window. An **`xterm`** window may be used in conjunction with scheduling the process under NightView as well, if so desired (see Debug above). This permits the scheduled process to interact with the terminal services provided by the **`xterm`**.

Read Input From

Select the input source, if any, for the scheduled process. By default, as in previous versions of NightSim, input is taken from the file, **`/dev/null`**. When either the Debug or X Terminal checkboxes are selected, the default is to permit input to come from the Standard Input Stream, but you may choose File input in either case if your scheduled program needs a fixed input stream (see Input File below).

Input File

If File is selected for Read Input From, this field specifies the name of the input file which the scheduled process will use. By default, the file is **`/dev/null`**. See "Pathname Expansion" on page 4-39.

If the NightSim Scheduler is On-Line (see "On-Line/Off-Line Operation" on page 4-6), the pathname given must be a valid file on the target system with sufficient read permissions.

If the NightSim Scheduler is Off-Line, the path must represent a valid readable file at the time the program scheduler is created (i.e. when the NightSim Scheduler transitions to an On-Line mode of operation).

Select...

You may use the Select button to bring up the Select a File dialog to specify the name of the input file which the scheduled process will use.

Send Output To

Select the way to manage output from your scheduled process. If neither the Debug and X Terminal checkboxes are selected, you may select File output, where the default file is **`/dev/null`**. Output may be sent to an actual file specified in the Output File field, if desired. By default, output is sent to the Standard Output Stream of the scheduled process.

Output File

If File is selected for Send Output To, this field specifies the name of the output file to generate. The output file name may be a full pathname or may be a pathname relative to the Working Directory specified for the scheduled process. See "Pathname Expansion" on page 4-39.

Select...

You may use the Select button to bring up the Select a File dialog to specify the name of the output file that will be generated.

Pathname Expansion

When entering the Process Name, Input File, or Output File in the Edit Process dialog (see "Edit Process" on page 4-29), the user can make use of the following conventions:

- if the pathname begins with `/`, it is assumed to be fully rooted
- if the pathname begins with `.`, `..`, or a simple file or directory name, it is assumed to be relative to the path in the Working Directory field
- if the pathname begins with `~`, it is interpreted according to the values of the following environment variables *on the NightSim host*:
  - `~`, `~/`, or `~`*user* (where *user* is the username of the user running NightSim), the login directory of the user is substituted
  - `~`*otheruser* (where *othername* is a user other than the user running NightSim), the login directory of *otheruser* is substituted
  - `~+`, the value of `$PWD` on the NightSim host is substituted.
  - ~-, the value if `$OLDPWD` on the NightSim host is substituted
- if any part of the pathname contains an environment variable reference of the form $*name*, the value of $*name* on the NightSim host is substituted

The pathnames will be expanded and substitutions made at the time the Apply or Add button is pressed.

Delete Processes

The Delete Processes dialog is presented when deleting *FBS*-scheduled processes after pressing the Delete button in the Process Scheduling Area (see "Using the Process Scheduling Area" on page 4-27).

If the scheduler is active when you click on this button, NightSim displays a dialog to confirm killing the selected processes. You may press the Yes button to kill the selected processes after deleting them from the *frequency-based scheduler*. You may also press the No button to delete the processes from the scheduler but allow them to continue executing or press Cancel to abort the action.

If the scheduler is inactive when you click on this button, NightSim displays a dialog to confirm deleting the processes. You may press OK to delete the processes from the scheduler or Cancel to cancel the operation.

Filter Process List

The Filter Process List dialog allows you to specify the *FBS*-scheduled processes that you wish to be displayed in the the Process Scheduling Area (see “Using the Process Scheduling Area” on page 4-27) of the Scheduler window. When you click on this button, NightSim displays the dialog that Figure 4-20 presents.

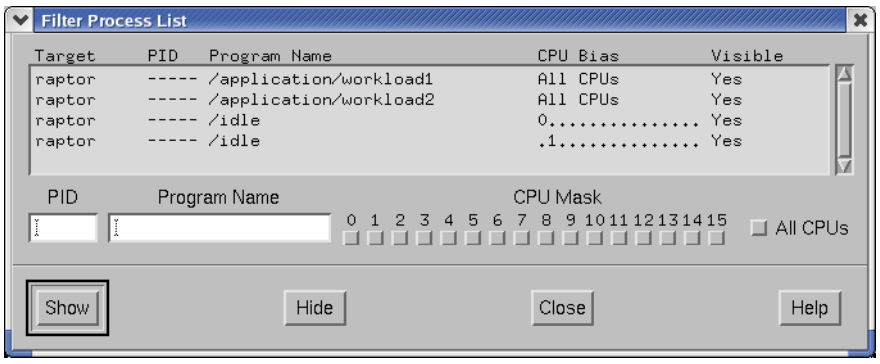


Figure 4-20. Filter Process List Dialog

Filter Process List

This list contains all of the processes that are scheduled on the scheduler and indicates whether or not they are visible in the list presented in the Process Scheduling Area of the Scheduler window (see “Using the Process Scheduling Area” on page 4-27 for details). You may use the mouse to select the process or processes that you wish to show or hide and then click on the Show or Hide button as desired.

You may also use a combination of the following items to specify which processes you wish to show or hide:

FPID

You may specify the unique *frequency-based scheduler* process identifier for a process that you wish to show or hide.

Program Name

You may specify the name of the process that you wish to show or hide. Enter a full or relative pathname. The pathname must be valid on the *target system* to which this process is assigned.

CPU Mask

This panel of check buttons allows you to show or hide processes which are scheduled on the specified processor or processors. Click on one or more buttons, where the label 0 represents the first logical CPU, 1 represents the second, and so on. To select all CPUs on your system, click on the All button.

If an FBS-scheduled process with the specified identifier(s) does not exist, NightSim reports an error. If more than one FBS-scheduled process with the specified identifier(s) exists, all such processes are shown or hidden.

Show

Lists in the Process Scheduling Area (see "Using the Process Scheduling Area" on page 4-27) of the Scheduler window those processes either selected in the Filter Process List or specified using FPID, Program Name, or CPU Mask .

Hide

Removes from the Process Scheduling Area (see "Using the Process Scheduling Area" on page 4-27) of the Scheduler window those processes either selected in the Filter Process List or specified using FPID, Program Name, or CPU Mask.

Using the Scheduler Control Area

The Scheduler Control Area is a part of the Scheduler window (see "Introduction to the Scheduler Window" on page 4-9).

The Scheduler Control Area allows you to create and remove a *frequency-based scheduler*. It contains two push buttons that you use to perform these functions: the Set up button and the Remove button.

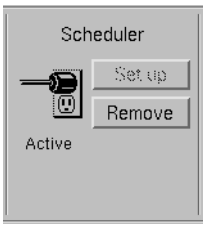


Figure 4-21. Scheduler Window - Scheduler Control Area

The Scheduler Control Area also contains an icon that indicates the current state of the Scheduler window.

	When the window is inactive, NightSim shows an unplugged connection.
	When the window is active, it shows a plugged connection.

The Set up button is enabled only when the window is in the *inactive* state. When you click on the Set up button, NightSim carries out the following actions:

- Transitions the NightSim Scheduler to an On-Line mode of operation, if the NightSim Scheduler is operating in an Off-Line mode (see "On-Line/Off-Line Operation" on page 4-6). The state of the target on which processes are scheduled, the existence and execute permissions of each scheduled program, and the existence and read permissions for any input files required.
- Determines whether there is an existing scheduler that is associated with the same *key* as that entered in the current window.

  If an active scheduler with the same scheduler key as the key you selected already exists on the target systemto which you assigned processes, Night-Sim displays the dialog that Figure 4-22 presents.

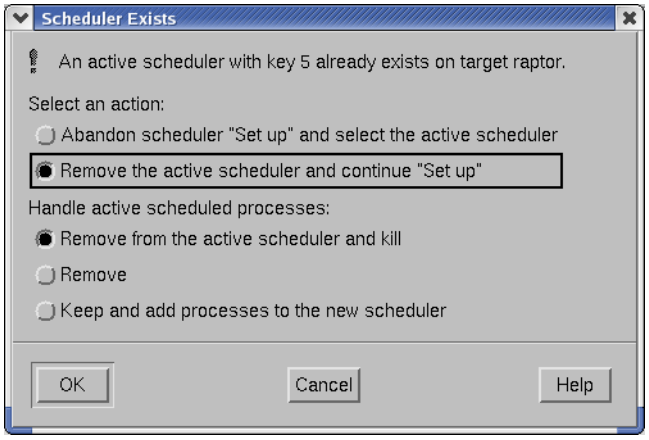


Figure 4-22. Scheduler Exists Dialog

You have two main choices:

- Work with the existing FBS, in which case the active FBS's configuration will appear in the Scheduler window in place of the current configuration.

  or

- Replace the existing FBS with a new scheduler based on the configuration in the window.

  If you decide to replace the existing FBS, you then need to decide what to do with the processes running under the old FBS.

You may also press the Cancel button to abort this action.

- Creates a scheduler that is configured according to the parameters specified in the Scheduler Configuration Area of the window (see "Using the Scheduler Configuration Area" on page 4-23 for details)
- Schedules the processes that are listed in the Process Scheduling Area of the window and starts them running (see "Using the Process Scheduling Area" on page 4-27 for details). Programs will run up to the first **`fbswait`** system call.
- Attaches the timing source to the scheduler
- Enables the Start button in the Simulation Control Area

  Initially, the simulation is stopped. For an explanation of the Simulation Control Area, see "Using the Simulation Control Area" on page 4-46.
- Disables the Set up button and enables the Remove button
- Places the window in the *active* state and changes the state icon and title bar accordingly

The Remove button is enabled only when the window is in the *active* state. When you click on the Remove button, NightSim carries out the following actions:

- Displays a dialog verifying that NightSim should kill the processes running on the scheduler. You may press Yes to kill the processes that are currently scheduled on the scheduler, No to remove the processes from the scheduler but allow them to continue executing, or Cancel to abort the action.
- Stops the simulation if it is running
- If a real-time clock is being used as the timing source, and the scheduler is running, stops the clock.
- Detaches the timing source from the scheduler or disables *end-of-cycle scheduling*
- Removes all processes that are currently scheduled on the scheduler from it and either terminates them or allows them to continue executing in accordance with the selections made in response to the dialog presented.

- Removes the scheduler from the system
- Disables the Start, Stop, and Resume buttons in the Simulation Control Area

  For an explanation of the Simulation Control Area, see "Using the Simulation Control Area" on page 4-46
- Enables the Set up button and disables the Remove button
- Places the window in the *inactive* state and changes the state icon and title bar accordingly

Using the Simulation Control Area

The Simulation Control Area is a part of the Scheduler window (see "Introduction to the Scheduler Window" on page 4-9).

The Simulation Control Area allows you to start, stop, and resume a simulation. It contains three push buttons that you use to perform these functions: the Start button, the Stop button, and the Resume button.

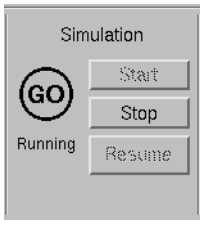


Figure 4-23. Scheduler Window - Simulation Control Area

The Simulation Control Area also contains an icon that indicates whether the simulation is stopped or running.

	When the simulation is stopped, NightSim displays a stop sign.
	When the simulation is running, NightSim displays a circle containing the word GO.

The Start button is enabled only when the simulation is stopped. When you click on the Start button, NightSim carries out the following actions:

- Attaches the timing source to the scheduler if not already attached or if the timing source has been changed
- If a real-time clock is being used as the timing source, sets the clock period in accordance with the value entered in the Clock period field in the Scheduler Configuration Area (see "Clock period" on page 4-26).
- Starts the simulation with the values of the *minor cycle*, *major frame*, and *overrun* counts set to zero

The Stop button is enabled when the simulation is running. When you click on the Stop button, NightSim stops the simulation. When the simulation is stopped, the timing source is not detached from the scheduler, but the Timing source and Clock period fields in the Scheduler Configuration Area of the Scheduler window are enabled (see pp. 4-24 and

4-26, respectively, for information on these fields). You may wish to change the timing source, and, if the timing source is a real-time clock, you may wish to change the clock *period*.

NOTE

If you change the timing source, the previously specified timing source is detached from the scheduler when you click on the Start or Resume button to start or resume the simulation.

While the simulation is stopped, you may also wish to change one or more of the parameters with which you have scheduled a process on the scheduler.

Although you can also change the parameters with which a process has been scheduled while the scheduler is running, it is not recommended that you do so. Rescheduling requires processor time. As a result, other processes that are currently scheduled on the *frequency-based scheduler* may experience *frame overruns*. If you have indicated as such, the scheduler will halt on a frame overrun but can be resumed.

The Resume button is enabled when the simulation has been running but is currently stopped. When you click on the Resume button, NightSim restarts the simulation with the values of the *minor cycle*, *major frame*, and *overrun* counts the same as they were when you stopped the simulation.

Using the Run Status Area

The Run Status Area is a part of the Scheduler window (see "Introduction to the Scheduler Window" on page 4-9).

The Run Status Area shows the number of the current major Frame and the current minor Cycle for the simulation running on the scheduler.

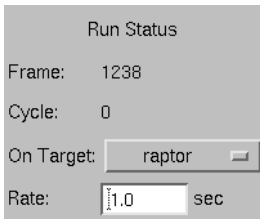


Figure 4-24. Scheduler Window - Run Status Area

This area also contains the following two configurable items:

On Target

This option menu allows you to select which *target system* supplies the frame number and *minor cycle* count. This allows you to see each target's frame and cycle counts and determine if the schedulers are out of sync. It also allows you to assign the work of supplying this information to a target system that may not be as time-critical as other systems.

Rate

This field allows you to specify the frequency with which the frame and cycle counts in the Run Status Area are to be updated. Enter the number of seconds to occur between updates. The minimum value that you may specify is .01 second; the maximum is 100 seconds. The default value is 1.0 second.

5
Using the Monitor Window

This chapter describes the *performance monitor* and explains how to monitor *FBS*-scheduled processes, a processor's *idle time*, and unscheduled processes. It introduces the components of NightSim's Monitor window and describes the use of each component.

Understanding the Performance Monitor

The performance monitor is a mechanism that enables you to monitor *FBS*–scheduled processes' utilization of a CPU.

The performance monitor provides you with the ability to:

- Obtain performance monitor values by process or processor
- Start and stop performance monitoring by process
- Clear performance monitor values by processor

You also have the ability to set the *timing mode* under which the performance monitor is to run. You can select one of two modes: one that includes time spent servicing interrupts in performance monitor timing values and one that excludes time spent servicing interrupts from those values.

When the performance monitor timing mode is set to include interrupt time, a process's user and system times will total the elapsed time that accrues when the process is the currently running process. This elapsed time includes time spent servicing interrupts and performing context switches. Time spent servicing interrupts is added to the process's system time. Time spent switching to a new process is included in the new process's system time.

When the performance monitor timing mode is set to exclude interrupt time, a process's user and system times will total the time that accrues when the process is the currently running process. This time excludes time spent servicing interrupts, but it includes time spent performing context switches. Time spent switching to a new process is included in the new process's system time.

What Values Are Monitored?

The *performance monitor* keeps track of the time that a process spends running from the time that it is wakened by a frequency–based scheduler until it calls **`fbswait`**. Time is measured in microseconds. One instance of a process's being wakened by a scheduler is referred to as an iteration or a cycle. Performance monitor values for *FBS*–scheduled processes are reported both in terms of cycles, or *iterations*, and in terms of *major frames*.

They reflect what has happened since the last time that performance monitor values were cleared and performance monitoring was enabled.

When performance monitoring is enabled for an *FBS*–scheduled process, NightSim maintains the following values for each process:

Process Parameters

Target	The system on which this process is running
FPID	The process's unique *frequency-based scheduler* identifier
PID	The process's process identification number
Name	The process's name
Priority	The process's scheduling priority
Starting Cycle	The number of the first *minor cycle* in which the process is to be wakened in each frame
Period	The frequency with which the process is to be wakened in each *major frame*
CPU Mask	The process's CPU mask
Interrupt Time Inclusion	Indicates whether time spent processing interrupts is included in performance monitor timing values

General Statistics

Total iterations, cycles	The number of times that the process has been wakened by the scheduler
Last time	The amount of time that the process has spent running from the last time that it has been wakened by the scheduler until it has called **`fbswait`**
Total time	The total amount of time that the process has spent running in all cycles
Average time	The average amount of time that the process has spent running in all cycles, or *iterations*. This value is obtained by dividing the value reported in the Total Time column by the value reported in the Iterations column.
Number of overruns	The number of times that the process has caused consecutive "soft" frame overruns, as well as the number of "hard" frame overruns that the process has caused.
Percent of period used	This value is maintained only if the timing source for the *frequency-based scheduler* on which the process is scheduled is a real-time clock. It is obtained by dividing the value reported in the Average Time column by the amount of time that is available to the process. The amount of time

available to the process is calculated from its *period* and the length of a clock cycle.

Minimum Values

Minimum cycle time	The least amount of time that the process has spent running in a cycle
Minimum cycle frame	The number of the *major frame* in which the *minimum cycle time* has occurred
Minimum cycle cycle	The number of the *minor cycle* in which the *minimum cycle time* has occurred
Minimum frame time	The least amount of time that the process has spent running during a *major frame*
Minimum frame frame	The number of the *major frame* in which the *minimum frame time* has occurred

Maximum Values

Maximum cycle time	The greatest amount of time that the process has spent running in a cycle
Maximum cycle frame	The number of the *major frame* in which the *maximum cycle time* has occurred
Maximum cycle cycle	The number of the *minor cycle* in which the *maximum cycle time* has occurred
Maximum frame time	The greatest amount of time that the process has spent running during a *major frame*
Maximum frame frame	The number of the *major frame* in which the *maximum frame time* has occurred

Monitoring Idle Time

The *performance monitor* provides you with the capability of monitoring a processor's idle time. Idle time refers to the time that the CPU is not busy. By monitoring a processor's idle time, you can determine the amount of CPU time that is available to be allocated to additional processes.

Procedures for monitoring idle time is described in "How Is Idle Time Monitored?"

How Is Idle Time Monitored?

You can monitor a particular processor's *idle time* if you add the process **`/idle`** to a frequency–based scheduler and schedule it on the desired processor. You can also monitor idle time for a number of different processors by adding **`/idle`** to a selected *fre-*

quency–based scheduler more than once and scheduling it on a different processor each time. Furthermore, you can add **/idle** to more than one frequency–based scheduler.

NOTE

It is important to note that you can schedule **/idle** on a particular processor for a particular target only once. This is a system-wide restriction. Only one user per processor per target may schedule **/idle**.

To add **/idle** to a frequency–based scheduler, use the Process Scheduling Area of the Scheduler window (see "Using the Process Scheduling Area" on page 4-27 for details). For an explanation of the procedures for adding a program to a scheduler, refer to Chapter 4, "Using the Scheduler Window."

When you use NightSim to add **/idle** to a frequency–based scheduler, the only parameter that you may specify is the CPU mask. The CPU mask for **/idle** must specify only one CPU. The default scheduling priority is zero. The starting base cycle is zero, and the period is one. **/idle** will be scheduled every *minor cycle*, starting with the first minor cycle in each *major frame*.

You can view scheduling information for **/idle** in the same way that you view it for other *FBS*–scheduled processes—in the Process Scheduling Area of the Scheduler window (see "Using the Process Scheduling Area" on page 4-27 for details).

Monitoring Unscheduled Processes

The *performance monitor* provides you with the additional capability of monitoring the performance of unscheduled processes. Unscheduled processes are those that are not wakened by the scheduler and do not call **fbswait**; they are not scheduled to run at a certain frequency. To be able to obtain *performance monitor* values for such processes, you must first add them to a *frequency–based scheduler* and specify a starting base cycle of zero and a *period* of zero. The other scheduling parameters that you must specify include the process's scheduling priority and the CPU on which it is to be scheduled. You can optionally specify a decimal value to be passed to a process that is scheduled on a frequency–based scheduler. The Halt FBS on frame overrun flag does not apply to an unscheduled process (see "Overrun" on page 4-33).

You can add unscheduled processes to a frequency–based scheduler by using the Process Scheduling Area of the Scheduler window (see "Using the Process Scheduling Area" on page 4-27 for details). For an explanation of the procedures for adding a program to a scheduler, refer to Chapter 4, "Using the Scheduler Window."

You can view scheduling information for unscheduled processes in the same way that you view it for other *FBS*–scheduled processes—in the Process Scheduling Area of the Scheduler window (see "Using the Process Scheduling Area" on page 4-27 for details).

The *performance monitor* values that are maintained for unscheduled processes include the following:

- Total time

You can obtain this value if you enable performance monitoring for the processes. Procedures for enabling performance monitoring and retrieving *performance monitor* values are described in detail in “Monitor” on page 5-8.

Introduction to the Monitor Window

The Monitor window allows you to start and stop performance monitoring on *FBS*-scheduled processes scheduled on one or more processors, clear *performance monitor* values for all FBS-scheduled processes scheduled on one or more processors, and display *performance monitor* values for selected FBS-scheduled processes.

Figure 5-1 is an example of a Monitor window.

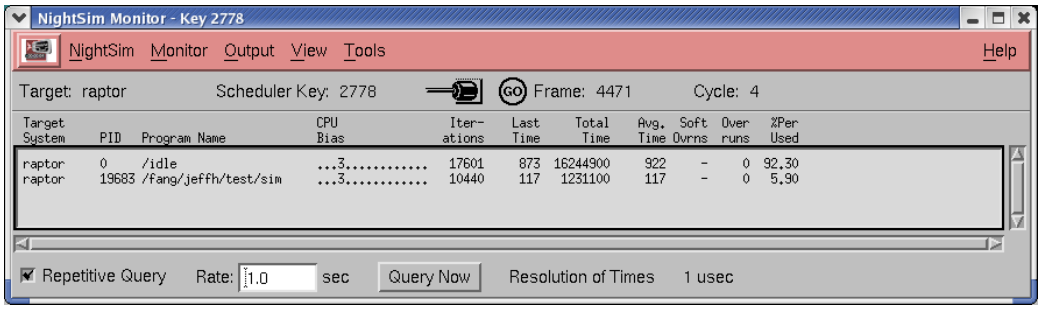


Figure 5-1. Monitor Window

The Monitor window consists of the following components:

- Menu Bar (see "Using the Monitor Window Menu Bar" on page 5-7)
- Status Area (see "Using the Status Area" on page 5-21)
- Output Area (see "Using the Output Area" on page 5-23)
- Output Control Area (see "Using the Output Control Area" on page 5-24)

Procedures for using each component of the Monitor window are described in the sections that follow.

Using the Monitor Window Menu Bar

The Monitor window menu bar is a part of the Monitor window (see “Introduction to the Monitor Window” on page 5-6).

The Monitor window menu bar provides access to the following menus:

- NightSim (see “NightSim” on page 5-7)
- Monitor (see “Monitor” on page 5-8)
- Output (see “Output” on page 5-13)
- View (see “View” on page 5-15)
- Tools (see “Tools” on page 5-21)
- Help (see “Help” on page 5-21)

Each menu is described in the sections that follow.

NightSim

The NightSim menu appears on the Monitor window menu bar (see “Using the Monitor Window Menu Bar” on page 5-7).

The NightSim menu on the Monitor window contains commands related to the global operation of NightSim. Figure 5-2 presents this menu.

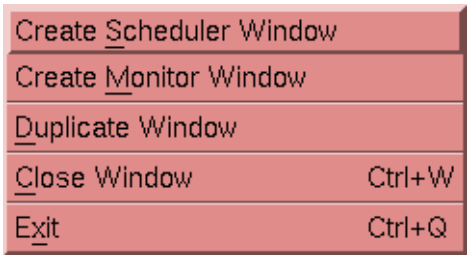


Figure 5-2. NightSim Menu

Descriptions of the options on the NightSim menu follow.

Create Scheduler Window

This option allows you to create a new Scheduler window. If this option is selected from a Monitor window which is associated with an existing scheduler, the new Scheduler window is created as an *active window* and all information associated with the Monitor window, including the *target* and *scheduler key*, is copied to this new Scheduler window.

Create Monitor Window

This option allows you to create a new Monitor window. The new window will not be associated with a particular *frequency-based scheduler.*

Duplicate Window

This option allows you to create a new Monitor window with the same configuration as that of the Monitor window from which this option was selected. Note that if *performance monitor* values are currently being logged to one or more files, the new Monitor window will not be associated with those files.

Close Window

This option allows you to close the current Monitor window.

If *performance monitor* values are being logged to a file, NightSim requires that you close this file before proceeding.

Exit

This option allows you to exit NightSim. If you have open Scheduler windows that are untitled and contain unsaved changes, NightSim displays a warning dialog. In each case, you may save the changes, close the window without saving the changes, cancel the close operation, or display help related to the dialog. If you click on the Yes button to save the changes, NightSim displays a file selection dialog.

If you have open a Scheduler window that is associated with a configuration file name and contains unsaved changes, NightSim displays a warning dialog. If you click on the Yes button, the changes are saved in the file associated with the window.

The warning dialogs are displayed for each window that contains unsaved changes.

If *performance monitor* values are being logged to one or more files, NightSim displays a warning dialog. You may confirm that you wish to stop logging and close the file, continue to keep the window open, or display help related to the dialog.

If a scheduler is currently active, NightSim display a confirmation dialog that allows you to exit and leave the scheduler active, or to cancel the exit action.

Monitor

The Monitor menu appears on the Monitor window menu bar (see "Using the Monitor Window Menu Bar" on page 5-7).

The Monitor menu contains general commands related to performance monitoring. Figure 5-3 presents this menu.

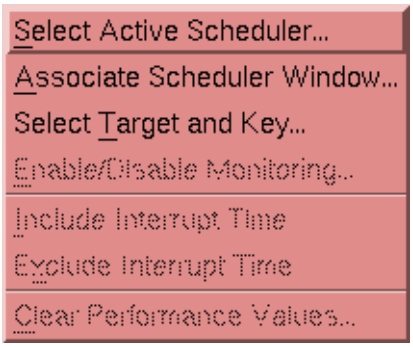


Figure 5-3. Monitor Menu

Descriptions of the options on the Monitor menu follow.

Select Active Scheduler . . .

This option allows you to associate the current Monitor window with a *frequency-based scheduler* active on a given *target system*. When you select this option, NightSim displays Figure 4-6, “Select Active Scheduler Dialog,” (see p. 4-15 of Chapter 4 for an explanation of this dialog).

This dialog provides a list of the active schedulers for the system designated by the Target field. The Target defaults to your local SBC and the list contains the active schedulers running on that particular system. For instance, Figure 4-6 lists the two schedulers currently running on the target `amber2`.

You may change the Target either by using the drop-down list (which lists the targets in your *cluster*) or by typing the name of the *target system* into the text field provided. Entering an item in this field will populate the list with the active schedulers on the specified target.

You may select a scheduler from the list that the dialog displays, or you may use the Scheduler Key text field to enter the numeric *key* that is associated with the desired scheduler. The key can be any positive integer value. Whether you select from the list or enter a key, the selected scheduler must previously have been configured, and you must have at least read permission for it; otherwise, NightSim reports an error.

If you successfully select an existing scheduler, the Monitor window is associated with that scheduler.

If *performance monitor* values are being logged to one or more files, NightSim asks you if you wish to stop the logging and close the files. You may confirm that you wish to stop logging and close the file, continue to keep the window open, or display help related to the dialog. If the window from which you select Select Active Scheduler . . . is the only window that you have open, NightSim displays a warning dialog.

Associate Scheduler Window . . .

This dialog box allows you to associate a Monitor window with an existing scheduler. The dialog lists the *scheduler key* and the *target systems* to which processes are assigned for each Scheduler window in the current NightSim session. Select one of these schedulers by clicking on it and pressing OK, or press Cancel to close the dialog and leave the Monitor window unchanged.

Figure 5-4. Select Associated Scheduler Window Dialog

Select Target and Key . . .

This dialog allows you to associate a Monitor window with a scheduler by specifying the Target System where the scheduler resides and its Scheduler Key. The scheduler need not already exist. If it does not exist but the scheduler is created in this session of NightSim, the Monitor window will automatically start monitoring that scheduler when the scheduler is created and started by NightSim.

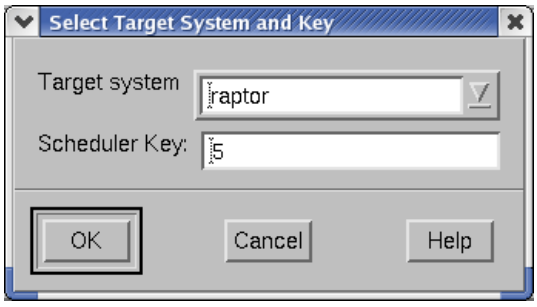


Figure 5-5. Select Target System and Key Dialog

Enable/Disable Monitoring . . .

This option allows you to enable or disable performance monitoring for one or more processes that are scheduled on the selected scheduler. By default, performance monitoring is enabled for all *FBS*-scheduled processes.

When you select this option, NightSim displays the selection dialog that Figure 5-6 presents.

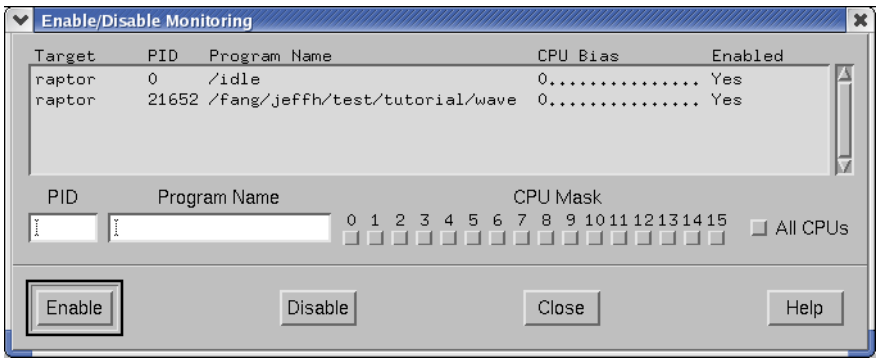


Figure 5-6. Enable/Disable Monitoring Dialog

Enable/Disable Monitoring List

This list contains all of the processes that are scheduled on the scheduler and indicates whether or not performance monitoring is currently enabled for each process. You may use the mouse to select the process or processes for which you wish to enable or disable performance monitoring and then click on the Enable or Disable button as desired.

You may also use a combination of the following items to specify those processes for which you wish performance monitoring enabled or disabled:

FPID:

You may specify the unique *frequency-based scheduler* process identifier of a process for which you wish performance monitoring enabled or disabled.

Program Name:

You may specify the name of the process for which you wish performance monitoring enabled or disabled. Enter a full or relative pathname. The pathname must be valid on the *target system* to which this process is assigned.

CPU Mask:

This panel of check buttons allows you to Enable or Disable performance monitoring for processes that are scheduled on the specified processor or processors.

Click on one or more buttons, where the label 0 represents the first logical CPU, 1 represents the second, and so on. To select all CPUs on your system, click on the All button.

If an FBS-scheduled process with the specified identifier(s) does not exist, NightSim reports an error. If more than one FBS-scheduled process with the specified identifier(s) exists, all such processes are shown or hidden.

Enable

Enables performance monitoring for those processes either selected in the Enable/Disable Monitoring List or specified using FPID, Program Name, or CPU Mask.

Disable

Disables performance monitoring for those processes either selected in the Enable/Disable Monitoring List or specified using FPID, Program Name, or CPU Mask.

Include Interrupt Time

This item allows you set the *timing mode* under which the performance monitor is to run, indicating that time spent processing interrupts is to be **included** in *performance monitor* timing values. This is a system-wide setting that affects all processes on the *target systems* that have processes attached to the specified scheduler.

This status may be displayed by selecting the Interrupt Time Inclusion checkbox in the Custom Display dialog from the View menu (see Figure 5-10 on page 5-15). The Output Area in the Monitor window will then report this status for each process (see "Using the Output Area" on page 5-23 for related information).

Exclude Interrupt Time

This item allows you to set the *timing mode* under which the performance monitor is to run, indicating that time spent processing interrupts is to be **excluded** from *performance monitor* timing values. This is a system-wide setting that affects all processes on the *target systems* that have processes attached to the specified scheduler.

This status may be displayed by selecting the Interrupt Time Inclusion checkbox in the Custom Display dialog from the View menu (see Figure 5-10 on page 5-15). The Output Area in the Monitor window will then report this status for each process (see "Using the Output Area" on page 5-23 for related information).

Clear Performance Values . . .

This option allows you to clear *performance monitor* values for all *FBS*-scheduled processes on one or more processors. Note that values are cleared for selected CPUs on all *target systems* that have processes attached to the specified scheduler.

When you select this option, NightSim displays the dialog that Figure 5-7 presents.

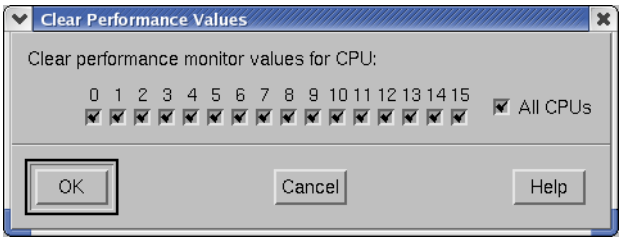


Figure 5-7. Clear Performance Monitor Values Dialog

By default, All CPUs is selected, so that you may conveniently clear all performance monitor values for all CPUs by simply pressing Enter or clicking OK.

You use the panel of check buttons to select the processor or processors for which you wish to clear *performance monitor* values. Click on one or more buttons, where the label 0 represents the first logical CPU, 1 represents the second, and so on. To select all CPUs on your system, click on the All CPUs button. After selecting the processor(s), you may apply your selection, cancel the operation, or display help related to the dialog.

Output

The Output menu appears on the Monitor window menu bar (see "Using the Monitor Window Menu Bar" on page 5-7).

The Output menu controls where performance data is to be sent. Figure 5-8 presents this menu.

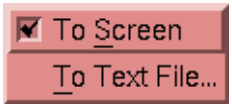


Figure 5-8. Output Menu

A checkmark appears next to an item if it is enabled. The two items can be enabled or disabled independently. Descriptions of these options follow.

To Screen

This toggle button allows you to indicate whether or not performance monitoring values are to be displayed in the Output Area of the Monitor window (see "Using the Output Area" on page 5-23 for related information).

To Text File . . .

This option allows you to (1) specify the name of a text file in which you wish *performance monitor* values to be saved and (2) specify the types of values to be saved. When you select this option, NightSim displays a file selection dialog to specify the

name of the text file.To select the file in which values are to be saved, use the directory text area, file mask area, list of directories, list of files, and file selection text area as appropriate. To specify the types of values to be saved, use the Fields to output option menu that Figure 5-9 presents.

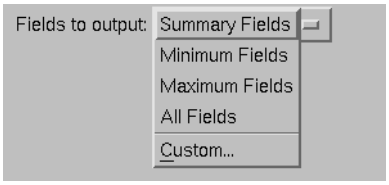


Figure 5-9. Fields to Output Option Menu

Descriptions of the options contained in the Fields to output option menu follow.

Summary Fields

This option specifies the following types of values: *target system*, process parameters (*FPID*, program name, and CPU mask) and general statistics. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

Minimum Fields

This option specifies the following types of values: *target system*, process parameters (*FPID*, program name, and CPU mask), general statistics (*iterations*), and minimum values. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

Maximum Fields

This option specifies the following types of values: *target system*, process parameters (*FPID*, program name, and CPU mask), general statistics (*iterations*), and maximum values. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

All Fields

This option specifies all types of values: *target system*, process scheduling parameters, general statistics, minimum values, and maximum values. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

Custom . . .

This option allows you to select any of the types of values that the *performance monitor* facility maintains.

When you select this option, NightSim displays the dialog that Figure 5-10 presents.

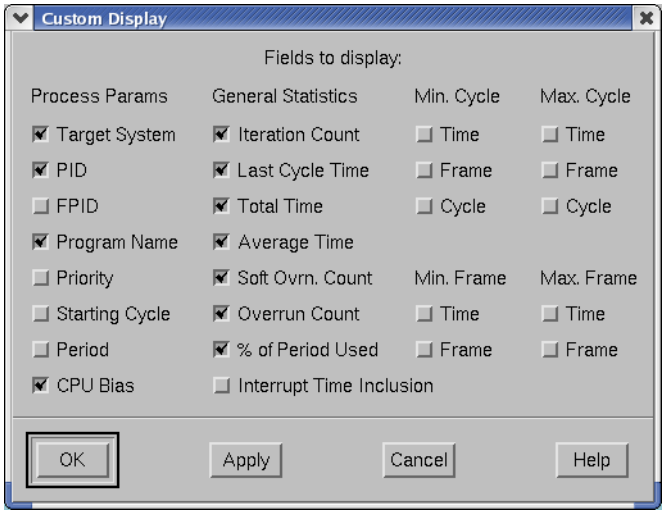


Figure 5-10. Custom Display Dialog Box

You use the panels of check buttons to select the types of *performance monitor* values that you wish to save. Click on one or more buttons as desired. After you have selected the types of values that you wish to save, you may apply the selections and close the Custom Display dialog box, cancel the selections, or display help related to the dialog.

After selecting the file in which values are to be saved and specifying the types of values to be saved, you may save the values in the selected file, search for another file, cancel the operation, or display help related to the dialog.

View

The View menu appears on the Monitor window menu bar (see “Using the Monitor Window Menu Bar” on page 5-7).

The View menu controls output to the Monitor window. Figure 5-11 presents this menu.

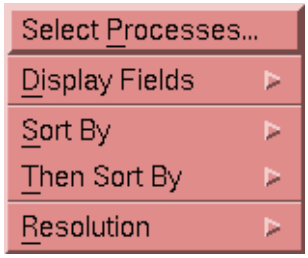


Figure 5-11. View Menu

Descriptions of the options on the View menu follow.

Select Processes. . .

This option allows you to specify the *FBS*-scheduled processes whose *performance monitor* values will be reported.

Depending on the selection under the Output menu (see "Output" on page 5-13), performance monitor values will be displayed in:

- the Output Area of the Monitor window if the "To Screen" option is selected (see "Using the Output Area" on page 5-23 for more information)
- a text file if the "To Text File…" option is selected

Note that performance monitoring must be enabled for a process in order for it to be shown in the Monitor window. Performance monitoring is enabled for all processes by default.

When you choose the Select Processes . . . option, NightSim displays the dialog in Figure 5-12:

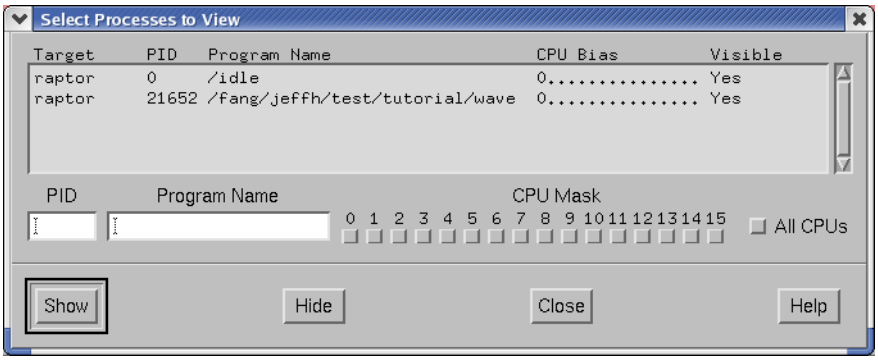


Figure 5-12. Select Processes to View Dialog

Select Processes List

This list contains all of the processes that are scheduled on the scheduler and indicates whether or not their performance values will be reported. You may use the mouse to select the process or processes whose performance values you wish to Show or Hide.

You may also use a combination of the following items to specify which processes you wish to Show or Hide:

FPID:

You may specify the unique *frequency-based scheduler* process identifier for a process whose performance values you wish to Show or Hide.

Program Name:

You may specify the name of the process that you wish to Show or Hide. Enter a full or relative pathname. The pathname must be valid on the *target system* to which this process is assigned.

CPU Mask:

This panel of check buttons allows you to Show or Hide processes which are scheduled on the specified processor or processors. Click on one or more buttons, where the label 0 represents the first logical CPU, 1 represents the second, and so on. To select all CPUs on your system, click on the All button.

If an FBS-scheduled process with the specified identifier(s) does not exist, NightSim reports an error. If more than one FBS-scheduled process with the specified identifier(s) exists, all such processes are shown or hidden.

Show

Reports the performance monitor values for those processes either selected in the Select Processes List or specified using FPID, Program Name, or CPU Mask .

Hide

Refrains from reporting the performance monitor values for those processes either selected in the Select Processes List or specified using FPID, Program Name, or CPU Mask .

Display Fields

This option allows you to specify the types of *performance monitor* values that are to be displayed in the Output Area of the Monitor window (see “Using the Output Area” on page 5-23 for related information). When you select this option, NightSim displays the tear-off menu that Figure 5-13 presents.

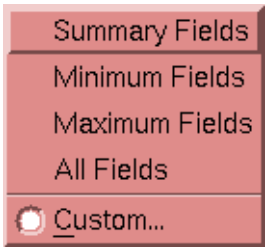


Figure 5-13. Display Fields Tear-Off Menu

Descriptions of the options contained in the Display Fields tear-off menu follow.

Summary Fields

This option specifies the following types of values: *target system*, process parameters (*FPID*, program name, and CPU mask) and general statistics. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

Minimum Fields

This option specifies the following types of values: *target system*, process parameters (*FPID*, program name, and CPU mask), general statistics (*iterations*) and minimum values. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

Maximum Fields

This option specifies the following types of values: *target system*, process parameters (*FPID*, program name, and CPU mask), general statistics (*iterations*) and maximum values. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

All Fields

This option specifies all types of values: *target system*, process scheduling parameters, general statistics, minimum values, and maximum values. Refer to "What Values Are Monitored?" on page 5-1 for a complete description of all types of *performance monitor* values.

Custom . . .

This option allows you to select any of the types of values that the *performance monitor* facility maintains.

When you select this option, NightSim displays the dialog that Figure 5-10 presents.

You use the panels of check buttons to select the types of *performance monitor* values that you wish to display. Click on one or more buttons as desired.

After you have selected the types of values that you wish to display, you may apply the selections and close the Custom Display dialog box, apply the selections without closing the dialog box, cancel the selections, or display help related to the dialog.

Sort By

This option allows you to select the primary sort key used in ordering the *FBS*-scheduled processes and associated *performance monitor* values. (Refer to "Output" on page 5-13 for information on specifying where these values are reported.)

When you select this option, NightSim displays the tear-off menu that Figure 5-14 presents.

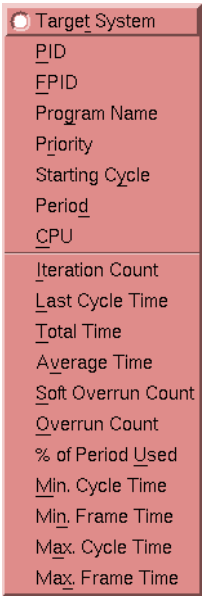


Figure 5-14. Sort By Tear-Off Menu

You specify the type of value to be used as the primary sort key by clicking on the desired radio button. It is important to note that the first seven options are separated from the others. The reason is that with the first seven options, the sort order must be calculated only once. With the other options, the sort order must be recalculated each time you query the values. As a result, the overhead associated with the first seven options is far less than that associated with the others.

The default is Target System.

Then Sort By

This option allows you to indicate the secondary sort key to be used in ordering the *FBS*-scheduled processes and associated *performance monitor* values. (Refer to "Output" on page 5-13 for information on specifying where these values are reported.) The Sort By and Then Sort By options allow you to sort first on a

value such as priority and then sort again within that grouping by a value such as average time.

When you select this option, NightSim displays the tear-off menu that Figure 5-15 presents.

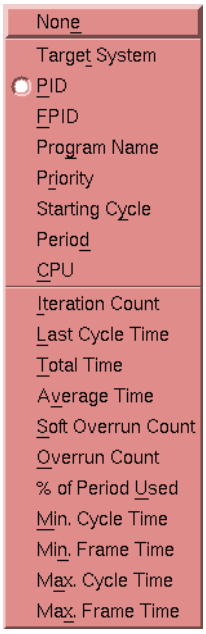


Figure 5-15. Then Sort By Tear-Off Menu

You specify the type of value to be used as the secondary sort key by clicking on the desired radio button or you may choose the first option, None, to have no secondary sort key. It is important to note that the next eight options are separated from the others. The reason is that with those eight options, the sort order must be calculated only once. With the other options, the sort order must be recalculated each time you query the values. As a result, the overhead associated with the eight options is far less than that associated with the other options.

The default is FPID.

Resolution

This option allows you to control the precision with which NightSim reports the *performance monitor* timing values. When you select this option, NightSim displays the tear-off menu that Figure 5-16 presents.

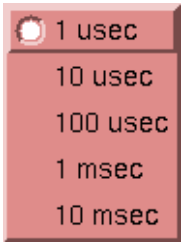


Figure 5-16. Resolution Options

You may specify the precision in microseconds, tens of microseconds, hundreds of microseconds, milliseconds, or tens of milliseconds by clicking on the toggle button and choosing the desired option.

NOTE

As the values of times increase in a long-running simulation, the resolution option value is automatically increased by NightSim in order to avoid overflowing the display.

Tools

The Tools menu appears on the Monitor window menu bar (see “Using the Monitor Window Menu Bar” on page 5-7) as well as on the Scheduler window menu bar (see “Using the Scheduler Window Menu Bar” on page 4-11).

The Tools menu contains a list of other NightStar tools that can be launched directly from NightSim.

See “Tools” on page 4-19 for detailed information about this menu and each of its items.

Help

The Help menu appears on the Monitor window menu bar (see “Using the Monitor Window Menu Bar” on page 5-7) as well as on the Scheduler window menu bar (see “Using the Scheduler Window Menu Bar” on page 4-11).

The Help menu provides access to the on-line help system. See “Getting Help” on page 3-3 for detailed information about this menu and each of its items.

Using the Status Area

The Status Area is a part of the Monitor window (see “Introduction to the Monitor Window” on page 5-6).

The Status Area displays information about the *frequency-based scheduler* with which this Monitor window is associated.

Figure 5-17. Monitor Window - Status Area

It contains the following values:

Target

This field displays the *target system* on which the scheduler associated with this Monitor window resides.

Together with the Scheduler Key, this Target system serves to identify the scheduler to NightSim.

Scheduler Key

This field displays the numeric *key* for the scheduler with which this Monitor window is associated.

If the *frequency-based scheduler* with which the Monitor window is associated is an active scheduler, the Status Area also shows:

Frame

Current *major frame* of the associated *frequency-based scheduler.*

Cycle

Current *minor cycle* of the associated *frequency-based scheduler.*

The Status Area also contains two icons: one that indicates the current state of the scheduler and one that indicates the current state of the simulation.

When the scheduler is inactive, NightSim shows an unplugged connection.

When the scheduler is active, it shows a plugged connection.

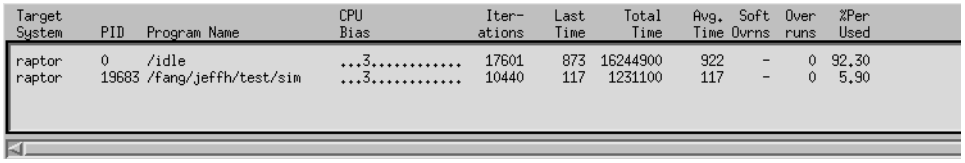
	When the simulation is stopped, NightSim displays a stop sign.
	When the simulation is running, it displays a circle containing the word GO.

Figure 5-17 illustrates the Status Area for a Monitor window that is associated with an active scheduler and a running simulation.

Using the Output Area

The Output Area is a part of the Monitor window (see “Introduction to the Monitor Window” on page 5-6).

The Output Area contains a textual display of *performance monitor* information.



Target System	PID	Program Name	CPU Bias	Iterations	Last Time	Total Time	Avg. Time	Soft Ovrns	Over runs	%Per Used
raptor	0	/idle	...3.....	17601	873	16244900	922	-	0	92.30
raptor	19683	/fang/jeffh/test/sim	...3.....	10440	117	1231100	117	-	0	5.90

Figure 5-18. Monitor Window - Output Area

The Output Area allows you to view *performance monitor* values for selected *FBS*-scheduled processes. It contains a scrolling list of the processes that are currently scheduled on the *frequency-based scheduler* with which the Monitor window is associated and that have been selected for performance monitoring. You can use the horizontal and vertical scroll bars to scroll the visible contents of the area. Although you cannot edit this area of the Monitor window, you can use the mouse to select text in the area and paste it in another window—one in which an editor is running, for example.

NOTE

If the Priority, Period, or CPU Bias mask of a process are changed while the scheduler is running, the Monitor window will not reflect the updated values until the next Monitor window update after the process runs again.

For information on the commands that allow you to control the operation of the *performance monitor*, refer to "Monitor" on page 5-8. For information on the commands that allow you to control the information that is displayed in the Output Area, refer to "View" on page 5-15.

Using the Output Control Area

The Output Control Area is a part of the Monitor window (see "Introduction to the Monitor Window" on page 5-6).

The Output Control Area allows you to specify the frequency and precision with which you wish *performance monitor* values to be updated. Note that the selections that you make in the Output Control Area apply both to the values displayed in the Output Area of the Monitor window (see "Using the Output Area" on page 5-23) and the values saved in a file. See "Output" on page 5-13 for related information.

Figure 5-19. Monitor Window - Output Control Area

The Output Control Area contains the following text field and controls:

Repetitive Query

This check button allows you to indicate that you wish NightSim to repeatedly query *performance monitor* values at a rate that you specify in the Rate text field in the Output Control Area. If this button is activated and the simulation on the *frequency-based scheduler* associated with the Monitor window has not been started, NightSim will query the *target system* (designated in the Target field of the Monitor window) at the specified Rate to detect when the scheduler gets started.

Note that once the scheduler is active, NightSim must query every target system to which processes have been assigned to obtain the complete set of performance data. This may affect the performance of those target systems to some degree.

Rate

This field allows you to specify the frequency with which *performance monitor* values are to be updated. Enter the number of seconds to occur between updates. The minimum value that you may specify is 0.01 second and the maximum is 100 seconds. The default value is 1.0 second.

Query Now

This push button allows you to query *performance monitor* values immediately.

Resolution of Times

This displays the resolution of the times displayed by the *performance monitor.* This resolution is controlled by the Resolution item in the View menu. See “View” on page 5-15 for more information.

A
NightStar Licensing

NightStar RT uses the NightStar License Manager (NSLM) to control access to the NightStar RT tools.

License installation requires a licence key provided by Concurrent.The NightStar RT tools request a licence (see "License Requests" on page A-2) from a license server (see "License Server" on page A-2).

Two license modes are available, fixed and floating, depending on which product option you purchased. Fixed licenses can only be served to NightStar RT users from the local system. Floating licenses may be served to any NightStar RT user on any system on a network.

Tools are licensed per system, per concurrent user. A single license is shared among any or all of the NightStar RT tools for a particular user on a particular system. The intent is to allow *n* developers to fully utilize all the tools at the same time while only requiring *n* licenses. When operating the tools in remote mode, where a tool is launched on a local system but is interacting with a remote system, licenses are required only from the host system.

You can obtain a license report which lists all licenses installed on the local system, current usage, and expiration date for demo licenses (see "License Reports" on page A-3).

The default configuration includes a strict firewall which interferes with floating licenses. See "Firewall Configuration for Floating Licenses" on page A-3 for information on handling such configurations.

See "License Support" on page A-4 for information on contacting Concurrent for additional assistance with licensing issues.

License Keys

Licenses are granted to specific systems to be served to either local or remote clients, depending on the license model, fixed or floating.

License installation requires a license key provided by Concurrent. To obtain a license key, you must provide your system identification code. The system identification code is generated by the **`nslm_admin`** utility:

```
nslm_admin --code
```

System identification codes are dependent on system configurations. Reinstalling Linux on a system or replacing network devices may require you to obtain new license keys.

To obtain a license key, use the following URL:

http://www.ccur.com/NightStarRTKeys

Provide the requested information, including the system identification code. Your license key will be immediately emailed to you.

Install the license key using the following command:

```
nslm_admin --install=xxxx-xxxx-xxxx-xxxx-xxxx
```

where *xxxx-xxxx-xxxx-xxxx-xxxx* is the key included in the license acknowledgment email.

License Requests

By default, the NightStar RT tools request a license from the local system. If no licenses are available, they broadcast a license request on the local subnet associated with the system's hostname.

You can control the license requests for an entire system using the **/etc/nslm.config** configuration file.

By default, the **/etc/nslm.config** file contains a line similar to the following:

```
:server @default
```

The argument @default may be changed to a colon-separated list of system names, system IP addresses, or broadcast IP addresses. Licenses will be requested from each of the entities found in the list, until a license is granted or all entries in the list are exhausted.

For example, the following setting prevents broadcast requests for licenses, by only specifying the local system:

```
:server localhost
```

The following setting requests a license from **server1**, then **server2**, and then a broadcast request if those fail to serve a license:

```
:server server1:server2:192.168.1.0
```

Similarly, you can control the license requests for individual invocations of the tools using the **NSLM_SERVER** environment variable. If set, it must contain a colon-separated list of system names, system IP addresses, or broadcast IP addresses as described above. Use of the **NSLM_SERVER** environment variable takes precedence over settings defined in **/etc/nslm.config**.

License Server

The NSLM license server is automatically installed and configured to run when you install NightStar RT.

The **nslm** service is automatically activated for run levels 2, 3, 4, and 5. You can check on these settings by issuing the following command:

```
/sbin/chkconfig --list nslm
```

In rare instances, you may need to restart the license server via the following command:

```
/sbin/service nslm restart
```

See **nslm(1)** for more information.

License Reports

A license report can be obtained using the **nslm_admin** utility.

```
nslm_admin --list
```

lists all licenses installed on the local system, current usage, and expiration date (for demo licenses). Use of the **--verbose** option also lists individual clients to which licenses are currently granted.

Adding the **--broadcast** option will list this information for all servers that respond to a broadcast request on the local subnet associated with the system's hostname.

See **nslm_admin(1)** for more options and information.

Firewall Configuration for Floating Licenses

RedHawk does not support a firewall configuration by default, because iptables support is disabled. However, it is possible to build a custom kernel with iptables support enabled. If that is done, and floating licenses are used, the iptables firewall rules must be configured to allow the license requests and responses to pass.

If the system with iptables support and firewall rules is serving licenses, then the firewall rules must be arranged to allow license requests on UDP port 25517 and TCP port 25517 from any systems that will make license requests. For example, in a simple firewall, rules like the following, inserted before any DROP or REJECT rules, might work:

```
iptables -A INPUT -p udp -m udp -s subnet/mask --dport 25517 -j ACCEPT
iptables -A INPUT -p tcp -m tcp -s subnet/mask --dport 25517 -j ACCEPT
```

If the system with iptables support and firewall rules is running NightStar RT tools and receiving floating licenses, then the firewall rules must be arranged to allow license responses on UDP port 25517 from any system serving licenses. For example, in a simple firewall, rules like the following, inserted before any DROP or REJECT rules, might work:

```
iptables -A INPUT -p udp -m udp -s subnet/mask --sport 25517 -j ACCEPT
```

License Support

For additional aid with licensing issues, 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://www.ccur.com/isd_support_contact.asp** or by sending an email to **support@ccur.com**.

B
Kernel Dependencies

Concurrent's RedHawk kernel provides features and performance gains that are critical for the full operation of the NightStar RT tools.

The NightStar RT tools can operate in a host-only mode on Red Hat systems without Concurrent's RedHawk kernel, cross-targeting to RedHawk systems. Additionally, the NightStar RT tools can function on Red Hat systems without the RedHawk kernel, but will lack the numerous advantages afforded by running with it.

The following sections describe the additional functionality and capabilities of the NightStar RT tools when running Concurrent's RedHawk kernel.

Advantages for NightView

The following advantages are afforded NightView when Concurrent's RedHawk kernel is running:

- Application speed conditions

  Provides "execution-speed" patches, conditions, and ignore counts.

- Hot operations

  Users of NightView gain the ability to read and write to a particular process without having to stop it. Thus, all eventpoints can be applied and modified during application program execution without stopping the process. User variables also can be read and modified without stopping the process.

- Signal handling

  Allows NightView to pass signals directly to a particular process, avoiding context switching.

NOTE

NightView may not operate at all on older versions of Red Hat without the RedHawk kernel.

Advantages for NightTrace

The following advantage is afforded NightTrace when Concurrent's RedHawk tracing kernel is running:

- Kernel tracing

  Users of NightTrace gain the ability to obtain kernel trace data and combine that with user trace data. Kernel tracing is an incredibly powerful feature that not only provides insight into the operating system kernel but also provides useful information relating to the execution of user applications.

The RedHawk kernel is provided in three flavors:

- Tracing
- Debug
- Plain

The Tracing and Debug flavors provide the features required for NightTrace kernel tracing. These kernels can be selected at boot-time from the boot-loader menu.

Advantages for NightProbe

The following advantages are afforded NightProbe when Concurrent's RedHawk kernel is running:

- Minimal intrusion

  Allows NightProbe to read and write variables without stopping the process for each sample or write operation.

- Sampling performance

  Allows NightProbe to use direct memory fetches for data sampling (as opposed to programmed I/O) which is important for high-rate data acquisition.

- Concurrent debugging/probing

  Allows NightProbe to probe programs already under the control of a debugger or another NightProbe session.

- PCI Device probing

  Allows NightProbe to probe PCI device memory via the Base Address Register (BAR) file system.

Advantages for NightTune

The following advantage is afforded NightTune when Concurrent's RedHawk kernel is running:

- Context switch rate

  Allows NightTune user to display the context switch counts per CPU instead of for the overall system.

- CPU shielding

  Individual CPUs can be shielded from interrupts and processes allowing CPUs to be dedicated solely to specific interrupts and processes that are bound to the CPU.

- CPU sibling interference

  Individual CPUs can be marked down to avoid interfering with hyperthreaded sibling CPUs and dual-core sibling CPUs. Hyperthreaded CPUs share all the resources of their sibling CPU. Dual-core CPUs share the CPU cache and a path to memory with their sibling CPU.

Advantages for NightSim

The following advantage is afforded NightSim when Concurrent's RedHawk kernel is running:

- Scheduling target

  Allows NightSim to schedule processes on the system via Concurrent's Frequency-Based Scheduler.

C
Configuration Files

NightSim allows the user to save the configuration to a file with the following format:

```
Scheduler <key> {
   cycles <n>;                    // cycles per frame
   tasks total <n>;               // total number of tasks allowed in scheduler
   tasks per cycle <n>;           // optional, defaults to total tasks
   permissions owner=<perms>;     // permissions, see below
   distribution <dist_kind>;      // distribution kind, see below

   timing source {
      host "<name>";              // timing-host name
      EOC ;                       // if end-of-cycle timing
      clock "<name>";             // if rtc, simple name of clock
      eti "<name>";               // if eti, simple name of eti
      other "<name>";             // full pathname of device
      clock duration <n>;         // if rtc, clock duration in microseconds
      clock count <n>;            // if rtc, ticks per minor cycle.
   }

   process "<program_name>" on "<target_name>" {
      NightView <boolean> ;       // schedule under NightView, {True | False}
      xterm <boolean> ;           // run under an xterm(1), {True | False}
      dir "<name>" ;              // full pathname of working directory on target
      input <style> ;             // input source, {File | Standard}
      infile "name" ;             // full pathname of input file
      output <style> ;            // output destination, {File | Standard}
      outfile "<name>" ;          // full pathname of output file
      privilege "<privlist>" ;    // working privileges, see below
      policy <p>;                 // scheduling policy, p = {R | O | P}
      priority <n>;               // scheduling priority
      parameter <n>;              // program parameter.  if absent, -1
      soft overruns <n>;          // soft overrun limit.  if absent, no limit
      cpu <mask>;                 // cpu bias mask, see below
      start cycle <n>;            // starting cycle
      period <n>;                 // period
   } ...

}
```

NOTE

The values for <name>, <program_name>, <target_name>, and <privlist> must be enclosed in double quotes (")

The <perms> specification is a sequence of one or more of the following:

```
owner=<permspec>
group=<permspec>
other=<permspec>
```

where <permspec> is either 'r', 'w', or 'rw'.

The <dist_kind> specification is one of the following values:

"None"	target names must match the timing-host name
"Closely Coupled"	targets must be in the same cluster as timing-host

`"RCIM Coupled"`	targets are on the same RCIM chain as timing-host.

The `<boolean>` specifications should have a simple boolean keyword:

`True`	the feature is enabled
`False`	the feature is disabled

The `<style>` specifications should have one of the following values:

`File`	input/output should be redirected from/to a file on the target system. A name must be provided.
`Standard`	I/O should be performed to/from standard I/O streams, Standard Input, or Standard Error.

NOTE

If both `xterm` and `NightView` boolean parameters are `False`, then the `<style>` specifications for `input` and `output` must both be `File`.

The `<privlist>` specification should contain a comma-separated list of simple privilege names. For example:

```
"owner,dev,rtime"
```

See **`intro(2)`** for more information on privileges.

The `<mask>` specification can be a comma-separated list of mask specifiers. Each specifier can be a CPU number (specified as an integer), a range of CPU numbers in the form `<n>-<m>`, or the keyword `active`, indicating all active CPUs on the system.

Configuration File Example

The following is an example of a configuration file.

```
Scheduler 2778 {
   cycles 4;
   tasks total 4;
   tasks per cycle 4;
   permissions owner=rw;
   distribution none;

   timing source {
      host "localhost";
      clock "/dev/rcim/rtc2";
      clock duration 10;
      clock count 10;
   }

   process "./wave"
         on "localhost" {
      NightView False ;
      xterm False ;
      dir "." ;
      input File ;
      infile "/dev/null" ;
      output File ;
      outfile "/dev/null" ;
      privilege "" ;
      policy F;
      priority 1;
      parameter -1;
      soft overruns 0;
      cpu 0;
      start cycle 0;
      period 1;
   }

   process "/idle"
         on "localhost" {
      NightView False ;
      xterm False ;
      dir "/" ;
      input File ;
      infile "/dev/null" ;
      output File ;
      outfile "/dev/null" ;
      privilege "" ;
      policy F;
      priority 99;
      parameter 0;
      soft overruns 0;
      cpu 0;
      start cycle 0;
      period 1;
   }

}
```

D
Resources

This appendix details the X resources, NightStar resources in NightSim.

X Resources

The following X resources are available for configuring the behavior of NightSim:

`*defaultClockRes`

Specifies the default resolution in microseconds that is to be used when configuring a real-time clock. Permissible values are 1, 10, 100, 1000, and 10000. The default value is 10.

`*defaultPermissions`

Specifies the default access permissions to be used when creating a new scheduler. The value is an octal number in the same format used by **`chmod(1)`**. The default value is 600.

`*defaultUpdateRate`

Specifies the default rate in seconds that is to be used for updating the run status fields in the Scheduler window and taking repetitive queries in the Monitor window. Minimum value is 0.01 second; maximum value is 100 seconds; default value is 1.0 second.

`*defaultMonitorRes`

Specifies the default resolution in microseconds of time-based fields in the Monitor window. Permissible values are 1, 10, 100, 1000, and 10000; the default value is 1.

`*displayTitle1 - *displayTitle9`
`*displayFields1 - *displayFields9`

These resources are used to specify the predefined sets of performance monitor fields. Up to 9 sets of fields can be defined. The `displayTitle`*n* resource is a string that defines a name for field set *n*, and the `displayFields`*n* resource is a

list of four-letter codes that specify the fields to be displayed. The codes are as follows:

`targ`	Target system
`fpid`	FPID of the process
`spid`	system PID of the process
`name`	program name
`prio`	program priority
`stcy`	starting cycle
`peri`	period
`cpum`	CPU bias
`itrc`	iteration count
`lcyt`	last cycle time
`tott`	total time
`avgt`	average cycle time
`sorc`	soft overrun count
`ovrc`	overrun count
`prcn`	percent of period used
`mnct`	minimum cycle time
`mncf`	minimum cycle frame
`mncc`	minimum cycle cycle
`mnft`	minimum frame time
`mnff`	minimum frame frame
`mxct`	maximum cycle time
`mxcf`	maximum cycle frame
`mxcc`	maximum cycle cycle
`mxft`	maximum frame time
`mxff`	maximum frame frame
`intr`	inclusion/exclusion of interrupt time

As an example, the following is the default for the first field set:

```
*displayTitle1:   Summary Fields
*displayFields1:  targ fpid name cpum itrc lcyt tott
avgt sorc ovrc prcn
```

`*offline`

Specifies whether new Scheduler windows should be initially Off-Line (`True`) or On-Line (`False`). See "On-Line/Off-Line Operation" on page 4-6 for more information.

`*expert`

Specifies whether the user is running in *expert mode* (`True` or `False`). The default value is `False`.

`*serverStartTimeout`

Specifies the amount of time (in seconds) that NightSim should allow for the NightSim server to start up on a target system. If the server does not start successfully

within this time period, but no error is received, NightSim aborts the operation and displays an error message.

The default value is 15 seconds. You may need to specify a longer time for slow or heavily-loaded networks or target systems.

`*serverMessageTimeout`

Specifies the amount of time (in seconds) that NightSim should allow for the NightSim server to respond to a message. If the server does not respond within this period, NightSim will assume that the server has terminated or that the remote target is inoperative. NightSim will then abort the operation and display an error message.

The default value is 20 seconds. You may need to specify a longer time for slow or heavily-loaded networks or target systems.

`*extendedResponseTimeout`

Specifies the maximum length of time (in seconds) that NightSim should allow for the NightSim server to respond with a longer response to a message. For example, the length of time NightSim should wait for the NightSim server to read a remote directory and return the names of all the files contained within.

If the server does not respond within this time period, NightSim will assume that the server has terminated or that the remote target is inoperative. NightSim will then abort the operation and display an error message.

The default value is 90 seconds. You may need to specify a longer time for slow or heavily-loaded networks or target systems.

NightStar Resources

You may control NightSim's appearance using the NightStar Font Resources and NightStar Color Resources. In most cases, however, the default values for the following resources should be used.

NightStar Font Resources

This section describes the special font resources available for NightStar tools. In addition to these resources, NightStar tools specify an overall *default font* that is used for most of the textual display. NightStar tools use proportional-width fonts except in areas that depend on text alignment; in these instances a fixed-width font is important for readability. If you decide to change fonts, make sure that you choose another fixed-width font for the font resources that have *fixed* in their names.

NightStar font resources include:

`*smallFontList`

Used for areas that require a smaller font.

`*infoFontList`

Used for areas that display informational messages, warnings, errors.

`*fixedFontList`

Used for areas that depend on text alignment.

`*smallFixedFontList`

Used for areas that depend on text alignment but require a smaller font.

The **`/usr/lib/X11/app-defaults/Nsim`** resource file specifies the font values for NightSim.

NightStar Color Resources

This section describes the special color resources available for NightStar tools. In addition to these resources, NightStar tools specify an overall *default color* that is used for most of the window areas. NightStar tools use the same color scheme to indicate that they are part of the same tool set and to provide cues about the usage of different areas in the windows. Each NightStar tool uses a unique color for its menu bars.

The following NightStar color application resources are defined:

```
*outputBackground
*outputForeground
```

Used for the background and foreground colors in output-only areas.

```
*inputBackground
*inputForeground
```

Used for the background and foreground colors in areas that accept user input.

The **`/usr/lib/X11/app-defaults/Nsim-color`** resource file specifies the color values for NightSim.

Glossary

active scheduler window

A Scheduler window that is associated with a scheduler that exists on the system.

end–of–cycle scheduling

A form of frequency–based scheduling in which scheduling is triggered when the last process that is scheduled to execute in the current *minor cycle* of the current *major frame* completes its processing.

expert mode

A mode specified by setting the `expert` X resource to `True`, allowing the user to see more detailed information about the current *FBS* in the Scheduler window.

FBS

Frequency-based scheduler.

FPID

A unique *frequency–based scheduler* process identifier that is returned when a program is scheduled on a frequency–based scheduler.

frame overrun

The condition that occurs when an *FBS*–scheduled process does not finish its processing before it is scheduled to run again.

frequency-based scheduler

A high resolution task synchronization mechanism that enables processes to run at user–specified frequencies.

host system

A system designated by a host name. A host may be a stand-alone computer system or a node in a network of computer system connected by ethernet. See *NightSim host*, *timing host*, *target system*.

idle time

Time during which the CPU is not busy.

inactive scheduler window

A Scheduler window that is not associated with an existing scheduler.

iteration

One instance of a process's being wakened by a *frequency–based scheduler.*

KoalaTalk

The inter-tool communication mechanism used by NightSim to exchange messages among its components. It is provided with the X Window System.

last time

A value returned by the *performance monitor* indicating the amount of time that an *FBS*–scheduled process has spent running from the last time that it has been wakened by the scheduler until it has called **`fbswait`**.

major frame

One pass through all of the *minor cycles* with which a *frequency–based scheduler* is configured. A major frame has associated with it a duration, which is obtained by multiplying the duration of a minor cycle by the number of minor cycles per major frame.

maximum cycle cycle

A value returned by the *performance monitor* indicating the number of the *minor cycle* in which the *maximum cycle time* has occurred.

maximum cycle frame

A value returned by the *performance monitor* indicating the number of the *major frame* in which the *maximum cycle time* has occurred.

maximum cycle time

A value returned by the *performance monitor* indicating the greatest amount of time that an *FBS*–scheduled process has spent running in a cycle.

maximum frame frame

A value returned by the *performance monitor* indicating the number of the *major frame* in which the *maximum frame time* has occurred.

maximum frame time

A value returned by the *performance monitor* indicating the greatest amount of time that an *FBS*–scheduled process has spent running during a *major frame*.

minimum cycle cycle

A value returned by the *performance monitor* indicating the number of the *minor cycle* in which the *minimum cycle time* has occurred.

minimum cycle frame

A value returned by the *performance monitor* indicating the number of the *major frame* in which the *minimum cycle time* has occurred.

minimum cycle time

A value returned by the *performance monitor* indicating the least amount of time that an *FBS*–scheduled process has spent running in a cycle.

minimum frame frame

A value returned by the *performance monitor* indicating the number of the *major frame* in which the *minimum frame time* has occurred.

minimum frame time

A value returned by the *performance monitor* indicating the least amount of time that an *FBS*–scheduled process has spent running during a *major frame*.

minor cycle

The smallest unit of frequency maintained by a *frequency–based scheduler*. A minor cycle has associated with it a duration, which is the time that elapses between interrupts generated by the timing source that is attached to the scheduler. If the timing source is a real–time clock, the minor cycle duration is defined by specifying the number of clock counts per minor cycle and the number of microseconds per clock count.

NightSim host

The system from which NightSim was invoked.

NightSim server

The NightSim server is a program that executes on a *target system* and performs system-level actions on behalf of NightSim. Whenever NightSim needs to perform an operation on a target system, such as creating an *FBS*, scheduling a program on an FBS, or starting or stopping an FBS, NightSim makes a request of the NightSim server on that target system. NightSim automatically takes care of starting up a NightSim server on a target system when needed.

number of overruns

A value returned by the *performance monitor* indicating the number of times that an *FBS*–scheduled process has caused a soft or hard *frame overrun*.

performance monitor

A mechanism that makes it possible to monitor use of the CPU by processes that are scheduled on a *frequency–based scheduler.*

period

A *frequency–based scheduler* scheduling parameter that specifies the frequency with which a specified program is to be wakened in each *major frame*. A period of one indicates that the program is to be wakened every *minor cycle*; a period of two indicates that it is to be wakened once every two minor cycles; and so on.

privilege

A mechanism through which processes are allowed to perform sensitive operations or override system restrictions.

process dispatch latency

The time that elapses from the occurrence of an external event, which is signified by an interrupt, until the process that is waiting for that external event executes its first instruction in user mode.

RCIM

Real-Time Clocks and Interrupt Module - an optional hardware module which provides both real-time clocks and edge-triggered interrupt pins for the *host* to which it is attached, allowing those devices to be used as timing and interrupt sources for that host. RCIMs may be connected, and therefore synchronized, via RCIM cables. RCIM real-time clocks and edge-triggered interrupts may be used locally or as distributed timing devices.

scheduler key

A user–supplied numeric identifier for a *frequency–based scheduler.*

server

See *NightSim server.*

soft overrun

Soft overruns are a type of *frame overrun* which give the scheduled process a chance to recover and return to synchronization. When scheduling a process, you can specify a consecutive soft overrun limit count that this process will tolerate and have processed as soft overruns by the kernel. Soft overruns are catastrophic failures only if the process reaches its limit on the number of soft overruns tolerated. This soft overrun limit defaults to 0 for each process.

starting base cycle

A *frequency–based scheduler* scheduling parameter that specifies the first *minor cycle* in which an *FBS*–scheduled process is to be wakened in each *major frame*.

target system

Any system on which processes will be scheduled.

timing host

The system on which the timing device physically resides.

timing mode

The mode under which the *performance monitor* runs. It specifies whether time spent servicing interrupts is to be included in or excluded from performance monitor timing values.

total iterations

A value returned by the *performance monitor* indicating the number of times that an *FBS*–scheduled process has been wakened by the scheduler.

total time

A value returned by the *performance monitor* indicating the total amount of time that an *FBS*–scheduled process has spent running in all cycles.

unscheduled process

A process that is not wakened by the *frequency–based scheduler* and does not call **fbswait**; it is not scheduled to run at a certain frequency.

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