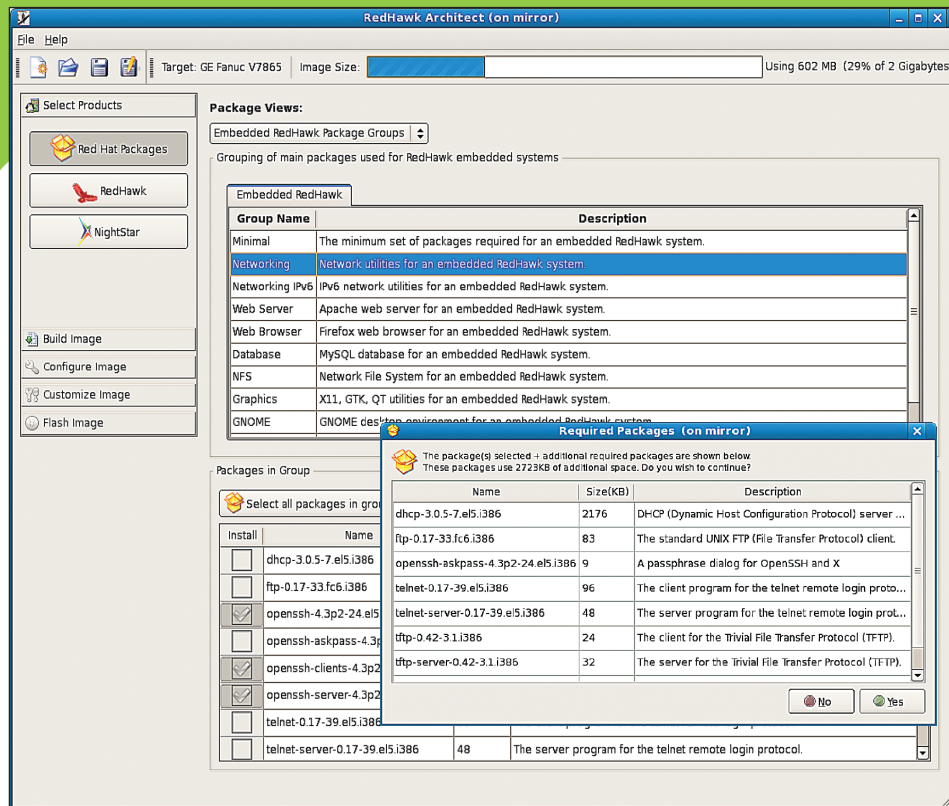


# RedHawk Embedded Linux

Development Environment for  
Single-Board Computers

## Features

- RedHawk Embedded™ Linux® kernel
  - ◆ Open-source kernel based on kernel.org
  - ◆ Support for single and multi-core x86 SBCs
  - ◆ Advanced kernel features
    - Guaranteed <15 usec event response on certified platforms
    - Enhanced multi-core shielding
    - User-level preemption control
    - Lockless kernel trace
    - Preemptive, multithreaded, reentrant kernel
    - Priority inheritance
    - User-level I/O (UIO)
  - ◆ Industry Standards
    - Linux Standard Base (LSB)
    - POSIX 1003.13 Profile 54
    - POSIX 1003.1 real-time and threads
    - RHEL compatibility
    - Eclipse IDE interoperable
- RedHawk Architect™ GUI configuration tool
  - ◆ Chooses desired user packages and modules
  - ◆ Selects a target-specific kernel
  - ◆ Builds the complete root file system
  - ◆ Flashes the file system image
  - ◆ Reconfigures images as needed
- NightStar™ debugging and analysis tools
  - ◆ NightView™ source-level debugger
  - ◆ NightTrace™ event analyzer
  - ◆ NightProbe™ data monitor
  - ◆ NightTune™ system and application tuner
- Customer services
  - ◆ Telephone support, on-line updates, releases
  - ◆ Custom SBC support
  - ◆ I/O device driver development
  - ◆ Application rehosting
  - ◆ Consulting services



## Overview

Concurrent's RedHawk Embedded is an advanced Linux development environment for a wide range of industry applications. Designed for businesses that need to reduce cost, improve time to market, increase system reliability and overall quality of service of their embedded systems, RedHawk Embedded offers field-proven, contemporary open-source Linux technology, advanced GUI debugging and analysis tools, multi-core architecture support and award winning customer service. RedHawk Embedded is ideal for use in telecommunications, manufacturing, process control, aerospace, defense, automotive and other embedded platform solutions.

RedHawk Embedded provides a single, easy-to-use GUI interface for configuring, building and flashing embedded solutions. RedHawk Embedded is fully compatible with the Red Hat user environment and supports all the features of Red Hat Enterprise Linux. Embedded developers can conveniently choose the desired components to be included in their application's target environment.

RedHawk's NightStar debugging and analysis tool kit offers superior functionality

over other tool chains especially in multi-core applications. NightStar supports hot patching and can provide a complete graphical view of multithreaded applications and their interaction with the Linux kernel. NightStar tools can be launched from the popular Eclipse IDE.

RedHawk Embedded is also the ideal solution for applications that need hard real-time performance. RedHawk Embedded features the same Linux kernel as RedHawk Server delivered on Concurrent iHawk real-time computer systems. Both RedHawk editions provide the same high level of guaranteed real-time response, reliability and determinism.

RedHawk Embedded board support is available for Intel and AMD x86-based COTS SBCs in wide range of form factors including VME, CompactPCI, AdvancedTCA, MicroTCA, PC104 and Mini-ITX.

## RedHawk Architect Tool

RedHawk Architect is an easy-to-use GUI that lets a developer choose the Linux and application modules that will be installed with the RedHawk kernel. For example, users can select networking, web server, web browser, database, X server, minimal



or all packages. RedHawk Architect allows the Linux filesystem to be customized and minimized for diskless applications using flash memories as small as 2 GB.

RedHawk Architect creates and processes a configuration file based upon the user's selections and performs actual RPM package installation. The tool prompts the user to insert the necessary RedHawk, Red Hat and NightStar media depending upon the features selected. RedHawk Architect will allow customization of the RedHawk kernel itself and provides a flashing tool for burning RedHawk and the user's application image onto a CPU board's non-volatile memory.

## Single Kernel Solution

RedHawk Embedded is a complete Linux distribution designed to fully support embedded applications. It is a single-kernel programming environment that directly controls all system operation, not a micro-kernel add-on. Complex time-critical applications often require that I/O, networking and graphics be performed deterministically together with real-time task scheduling. Only RedHawk's single-kernel design ensures determinism and high-speed performance of all these features.

## Scalable Processor Shielding

On multi-core SBCs, RedHawk Embedded allows individual CPUs and cores to be shielded from local timers, interrupts, daemons, bottom halves and other Linux tasks. RedHawk's comprehensive processor shielding features provide a highly deterministic execution environment where interrupt response is guaranteed. Unlike other distributions, RedHawk offers a field-proven, easy-to-use shielding API with both command-line and graphical tool user interfaces.

## Multithreading and Preemption

RedHawk Embedded allows multiple processes to execute in the kernel simultaneously. The kernel protects key data structures and critical sections of code with semaphores and spinlocks to preserve system integrity.

Processes executing in the RedHawk kernel can be preempted, i.e. forced to relinquish a CPU involuntarily. The RedHawk kernel can transfer control from a lower-priority process to a higher-priority process

except when the lower priority process is executing in a critical kernel section. To provide deterministic response, many critical sections of the kernel have been tuned and optimized to dramatically shorten non-preemptable conditions. These changes are key to allowing a high-priority process to respond immediately to an external event, even when the CPU is currently in use.

Semaphores internal to RedHawk Linux also support priority inheritance to prevent priority inversion when multiple threads of an application are competing for operating system resources.

## NightStar Application Development Tools

Concurrent's NightStar is a powerful, integrated tool set for developing embedded Linux applications. NightStar tools run with minimal intrusion, thus preserving application execution behavior and determinism. Users can quickly and easily debug, monitor, schedule, analyze and tune applications in real-time.

NightStar tools provide superior functionality over the standard Linux gdb debugger and other tool sets especially in multi-core applications. NightStar GUI-based tools reduce test time, increase productivity and lower development costs. Embedded applications require debugging tools that can handle the complexities of multiple processors and cores, multitask interaction and multithreading. NightStar's advanced features enable system builders to solve difficult problems quickly. All NightStar tools include complete on-line documentation.

**NightView** is a source-level debugger that allows users to simultaneously debug multiple, time-critical processes. With NightView patchpoints, a programmer can change program execution and modify or display data without stopping or interrupting the program. Event conditions, such as hit and ignore counts, are patched directly into an application and execute at full application speed. NightView includes an interactive memory debugger that helps find and eliminate heap memory leaks.

**NightTrace** is an event analyzer that displays and analyzes the dynamic behavior of applications, the RedHawk kernel and the interaction between them. NightTrace can log events from multiple processes executing simultaneously on multiple cores. NightTrace

can also combine user-defined application events with kernel events to present a synchronized view of the entire system. RedHawk's lockless kernel trace eliminates any contention when multiple cores log trace points simultaneously. NightTrace allows users to zoom, search, filter and analyze events. Tracing analysis can be live or post-execution.

NightTrace's powerful application illumination GUI allows programmers to automatically trace application function calls and examine the values of parameters passed and returned. Function call tracing is fully customizable and can provide a complete view of glibc activities.

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

**NightTune** is a GUI for monitoring and tuning application and system performance. Users can monitor and change the priority, scheduling policy, CPU assignment and CPU usage of user applications. NightTune also monitors system CPU usage, context switches, interrupts, memory utilization and network activity. NightTune can be used to shield cores and adjust interrupt and process affinity.

## Customer Support

Customer service support for all embedded needs is directly provided by Concurrent. Standard RedHawk Embedded services included telephone support, problem reporting and resolution, on-line software updates and new releases. Consulting services are also available for special hardware and software support needs.

Since the turn of the millennium, Concurrent has deployed and supported thousands of proven Linux solutions in a range of technical industries. Concurrent Linux expertise and support has been a key factor in the success of many critical government and commercial applications.

