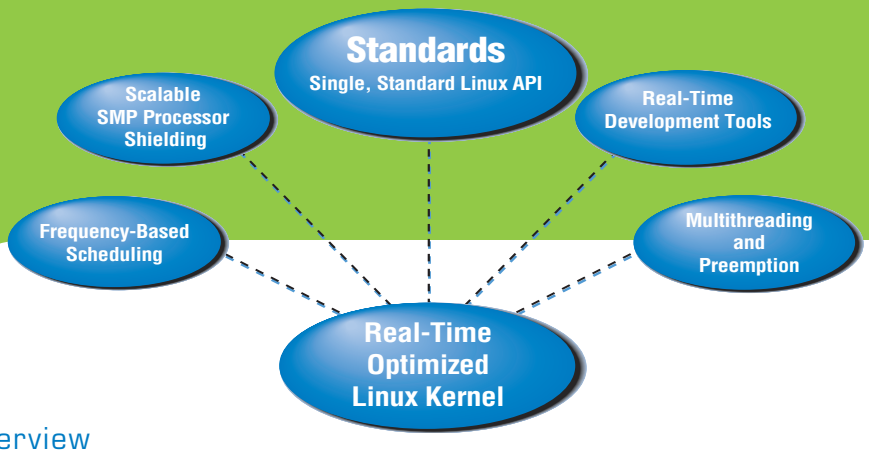
RedHawk Linux Server
Real-Time Software Environment

Features

- Real-time Linux® operating system for Intel® and AMD-based systems
- Field-proven Value-add Performance
  - Guaranteed event response times
  - Advanced shielding features
    - Processor, interrupt and local timer
    - Easy-to-use shielding API and GUI
  - NUMA performance optimization
  - User-level I/O
  - Frequency-based scheduling
  - Lockless kernel trace
  - Optimized graphics I/O
  - Cluster management
  - Preemptive, multithreaded, reentrant kernel
  - Priority inheritance
  - User-level preemption control
  - Post/Wait services
  - Minimal dispatch latencies
  - Dynamic and static load balancing
- Industry Standards
  - Linux Standard Base (LSB)
  - POSIX 1003.13 Profile 54
  - POSIX 1003.1 real-time and threads
    - Semaphores
    - Signals
    - Shared memory
    - Message queues
    - Memory locking
    - Asynchronous I/O
    - Synchronous I/O
    - Execution scheduling
    - High-resolution clocks and timers
- Single-vendor Support for All Linux Needs
  - Software maintenance services
  - Custom I/O drivers
  - Application rehosting
  - Consulting services



Overview

Concurrent's RedHawk™ Linux® Server is an industry-standard, real-time version of the open source Linux operating system for Intel and AMD-based systems. RedHawk Linux provides the guaranteed performance needed in time-critical and hard real-time environments. RedHawk is the ideal Linux solution for a broad range of deterministic applications such as modeling, simulation, data acquisition, industrial control and medical imaging systems. RedHawk guarantees that a user-level application can respond to an external event in less than 15 microseconds on a shielded processor.

RedHawk Linux includes all the features of Red Hat Enterprise Linux. The user-level commands, utilities and system administration are compatible with standard Red Hat. RedHawk achieves its superior real-time performance by providing the latest official release from kernel.org that includes key open source patches and kernel enhancements developed by Concurrent. RedHawk user libraries provide access to value-add features that are not part of other Linux offerings. RedHawk is fully compatible with standard Linux user-level APIs, thus Linux applications written for other Linux distributions will run on RedHawk without modification.

Complete Development Environment

RedHawk Linux offers a full set of tools for efficient development of time-critical applications. Concurrent's powerful NightStar application development tool set provides a robust graphic interface for non-intrusive control, monitoring, analysis and debugging of multi-threaded and multi-core applications. NightStar offers advanced debugging features such as lockless kernel trace. In addition to the GNU C, C++, and Fortran compilers, Concurrent's MAXAda 95 language environment is optionally available. RedHawk also supports the popular Intel C/C++ and Fortran compilers.

Scalable SMP and Processor Shielding

In tightly-coupled symmetric multiprocessing systems, RedHawk Linux 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 Linux 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.

Single Kernel Environment

RedHawk is a complete Linux distribution designed to fully support time-critical applications. RedHawk provides a true

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single-kernel programming environment that directly controls all system operation. Complex time-critical applications often require that high-speed file 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.

Frequency-Based Scheduler

RedHawk's Frequency-Based Scheduler (FBS) is a high-resolution task scheduler that enables the user to run processes in cyclical execution patterns. FBS controls the periodic execution of multiple, coordinated processes utilizing major and minor cycles with overrun detection. A performance monitor is also provided to view CPU utilization during each scheduled execution frame.

RCIM Support

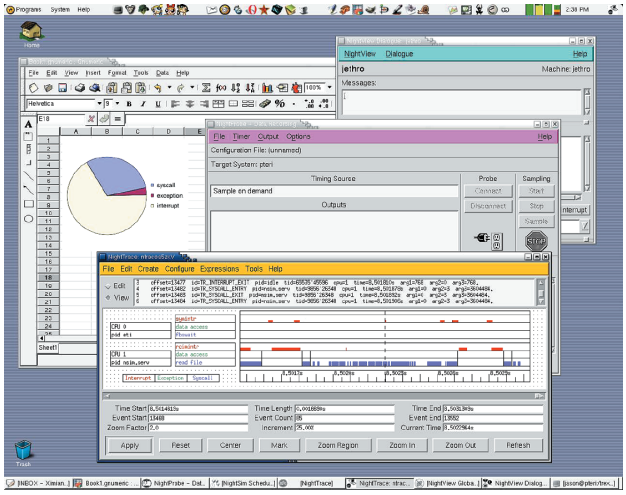
On Concurrent iHawk real-time multiprocessors, RedHawk supports the Real-Time Clock & Interrupt Module (RCIM), a multifunction card designed for time-critical applications that require rapid response to external events. Eight programmable timers and twelve input and output external interrupt lines are available. Any interrupt source can be distributed to other iHawks for synchronizing multi-system applications. The RCIM includes a high-resolution synchronized clock to provide a common time base across multiple systems. On-the-wire time stamps allow RedHawk to provide for high-resolution NTP synchronization. RCIM options include a GPS module for synchronizing with GPS standard time and high-stability crystal oscillators to provide for accurate time keeping without an external time source.

I/O Enhancements

RedHawk supports Linux user-level (UIO) device drivers. RedHawk's UIO facility provides a kernel driver stub that can be used with user code to develop a user-space driver for almost any type of hardware. RedHawk also includes the latest available NVIDIA graphics drivers specially optimized for real-time performance by Concurrent. The enhanced graphics driver allows applications to achieve maximum determinism during image rendering.

Non-Uniform Memory Access (NUMA) Optimization

The standard Linux NUMA implementation does not offer a mechanism to ensure that all pages of a real-time process are local to a given NUMA node and ensure that no other process' pages are using that same node. RedHawk's NUMA optimization features dramatically improve the determinism of real-time process memory access on NUMA architectures. RedHawk can automatically duplicate libraries and other modules as needed and hold them simultaneously in multiple nodes to maximize performance.



RedHawk Cluster Management Software

RedHawk's cluster manager software allows users to install and configure systems as highly-integrated, high-performance computing clusters. Cluster manager includes a mechanism for network booting multiple nodes with the same version of RedHawk. Cluster management software products also include Global File System, High-Availability NFS and OpenFabrics Enterprise Distribution packages.

NightStar Application Development Tools

Concurrent's NightStar is a powerful, integrated tool set for developing time-critical 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 GUI-based tools reduce test time, increase productivity and lower development costs. Time-critical applications require debugging tools that can handle the complexities of multiple processors and cores, multitask interaction and multi-threading. NightStar's advanced features enable system builders to solve difficult problems quickly. All NightStar tools include complete on-line documentation. Help is available by simply clicking on the tool feature being used.

NightView is a source-level debugger that allows users to simultaneously debug multiple, time-critical processes. With NightView, a programmer can change program execution and modify or display data without stopping or interrupting the program. Eventpoint conditions, such as hit and ignore counts, are patched directly into an application and 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 CPUs or systems. 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.

NightSim is a tool for scheduling time-critical applications that require predictable, cyclic process execution. Ideal for simulation applications, NightSim allows developers to dynamically adjust the execution of multiple, coordinated processes, their priorities, scheduling policies and CPU assignments. Users can monitor the performance of applications by displaying period execution times, minimums and maximums, and optionally pause execution when a process overruns its allocated frame.

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 the priority, scheduling policy, CPU assignment and CPU usage of user applications. NightTune also monitors system CPU usage, context switches, interrupts, memory utilization, and disk and network activity.

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