Concurrent REAL-TIME

Building a Better Embedded Solution

A 360° View of Concurrent Real-Time's High-Performance

RedHawk™ Embedded Linux® Platform

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Abstract

Whether you are building hard real-time embedded applications or just need an easy-to-use/cost-effective embedded platform for development and deployment, a reliable high-performance embedded operating system is just the beginning to a successful project.

In this paper, you will get a full view of Concurrent Real Time's solution for the embedded industry, the RedHawk Embedded Linux platform. You will learn how RedHawk Embedded puts you in control of your embedded software and multi-core system resources with fully integrated tools to "build a better embedded solution." Improved ability to control costs, support and professional services round out the solution.

Introduction

Concurrent has been providing high-performance real-time systems based upon the Linux operating system for nearly ten years. The RedHawk Linux operating system and NightStar™ tools are proven real-time technologies used by the military and aerospace industries, among others. The RedHawk Embedded product for the first time leverages these proven Concurrent technologies into the embedded development space.

RedHawk Embedded is a new product offering that allows the traditional RedHawk native server environment to be customized and tailored for embedded systems. Several embedded target boards are supported, in VME, Compact PCI and Mini-ITX form factors, and support for more boards is constantly being integrated into the product.

RedHawk Embedded is unique in the embedded industry for many reasons, offering several key advantages, ranging from target system generation using the included RedHawk Architect tool, to target application debugging and tuning using the included NightStar tool suite.

RedHawk Architect

RedHawk Embedded provides the RedHawk Architect tool to dramatically simplify target system image generation. Architect is a graphical interface that provides a step-by-step solution for defining, building, configuring, customizing and flashing the target system image.

RedHawk Architect allows the creation of target system images that are built from original Red Hat® packages, the industry standard packages used by the vast majority of deployed non-embedded Linux systems. This leverages the incredible amount of quality assurance work performed by Red Hat and introduces it for the first time into the embedded platform space.

Concurrent has structured the Architect tool so that a user can do package selection using different package views. For example, users who are familiar with the original desktop and server-oriented Red Hat package groups can choose the "Red Hat Package Groups" view to select packages using those same sets of groups.

For users who want a more fine-grained embedded-oriented set of package groups, Concurrent has provided a view into the packages called "Embedded RedHawk Package Groups." Examples of these groups are "Minimal," "Networking," "Web Server," "Web Browser," "Database" and "Graphics."

Architect also includes a "Selected Packages" view which summarizes exactly which packages have been chosen using the various other views. This allows the user to adjust which individual packages have been selected by the chosen higher-level package groups.

For users that want the ultimate control, the "All Packages" view is provided. Every package that is available in the Red Hat distribution can be searched for and selected individually, with dependency resolution automatically performed by the Architect tool.

These different package views provide for rapid target system definition with an easy-to-use and intuitive graphical interface, allowing the user to quickly select just the right packages for the intended target application.

However, selecting Red Hat packages in Architect is just the beginning. Once the user has selected packages and built a target image, they can then configure, customize and flash the target image.

Target image configuration allows the user to control many aspects of the operating system's base configuration, including:

- Set system time zone, root password and default run-level
- Define a serial console and all networking parameters
- Choose to mount the root file-system read-only

Target image customization allows the user to customize many aspects of the run-time environment for the target system application, including:

- Define custom kernel configurations and build custom kernels
- Install additional RPMs and import files
- Remove unneeded resources (man pages, documentation files, locale files, RPM database)
- Launch a virtual shell to further customize the target image

Target image flashing allows the user to "burn" the target image directly onto a bootable CompactFlash device. This device can then be inserted into many target boards, allowing the target board to boot into a fully functioning system, complete with target application, defined exactly to the user's specifications.

Finally, for target boards that do not use a CompactFlash device but are able to PXE boot, the user has the option to perform a network-based remote installation of the target image onto the target board. In addition, the target image can be "diskless" booted on the target board (via NFS-root) allowing the user to boot the target board without even having to perform a flash or installation. This last feature can be extremely valuable and time saving because several iterations of the target image can be evaluated on the target board before the user has invested the time in flashing or remote installing.

RedHawk Kernel

There are many advantages to using the RedHawk Linux kernel over the kernels provided with traditional embedded distributions.

The RedHawk kernel is fully optimized for multi-core applications, and allows the user to specify core affinity for different processes which can be shielded from interrupts and other processes on specific cores. This shielding allows processes to make maximal use of a specific core, ensuring high-performance and real-time response for the process.

All of the target boards supported by RedHawk Embedded are able to make full use of multi-core processors, allowing the entire product range to take advantage of multi-core optimizations for maximum performance.

The RedHawk kernel can be installed into the target system with multiple configurations. If the debug version is installed, the kernel provides an integrated kernel debugger as well as crash dumps over the network, which can be used to debug custom device drivers that are being developed as part of the target application.

As previously mentioned, custom kernel configurations can also be defined and built within the Architect tool, so the user is free to choose exactly the kernel options that are required for the target application.

NightStar Tools

RedHawk Embedded includes the NightStar Tools, which are a fully integrated suite of tools for remote application debugging and tuning. Each of the NightStar Tools can be run on a host machine and used to debug and tune applications running on the target hardware.

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.

The NightView™ Source Level Debugger provides:

- Multi-system, multi-process and multi-thread debugging via a single interface
- Hot patches including breakpoints, patchpoints, monitorpoints and watchpoints
- Application speed conditions and ignore counts
- Dynamic memory (heap) debugging
- Modification and display of variables during execution

The NightTrace™ Event Analyzer provides:

- Synchronized graphical or text display of all system activity
- User-defined event logging
- OS event logging including system calls, interrupts and exceptions
- Precision time-stamping of all events
- Powerful data analysis API
- Function call and parameter tracing

The NightProbe™ Data Monitor provides:

- Unintrusive sampling and recording of program data
- Synchronous and asynchronous data capture
- Flexible data display features
- Program data modification
- Sampling, recording and replaying of APIs

The NightTune™ Performance Tuner provides:

- Dynamic display of system and application performance
- Monitoring of CPU use, memory utilization and network operation
- Interactive control of CPUs, priorities, policies, shielding and interrupts
- Dynamic CPU affinity control for processes, threads and interrupts
- Detailed process and thread information

The NightStar Tools can debug, analyze and tune applications written in C, C++, Ada and FORTRAN. Together these tools provide a proven solution for development and tuning and dramatically enhance the development and deployment process of creating embedded applications.

Professional Services

Concurrent also enhances RedHawk Embedded's value via hardware integration, custom engineering services, maintenance contracts and extensive end-user documentation. Training at all levels, from beginning Linux programming to advanced real-time programming techniques on RedHawk, is available at the home office or at the customer's site.

Future Direction

The current RedHawk Embedded product provides a robust environment for target system development. Future versions of the product will include 64-bit architecture support, support for non-x86 architectures, and, as always, support for new target boards.

About Concurrent Real-Time

Concurrent Real-Time is a global leader in innovative solutions serving aerospace and defense and automotive and process control industries. Concurrent Real-Time is one of the industry's foremost providers of high-performance real-time computer systems, solutions, and software for commercial and government markets, focusing on areas that include hardware-in-the-loop and man-in-the-loop simulation, data acquisition, industrial systems and software. Operating worldwide, Concurrent provides sales and support from offices throughout North America, Europe, Asia and Australia. For more information, please visit Concurrent Real-Time Linux Solutions at http://www.concurrent-rt.com or call (954) 974-1700.