



KVM-RT™

Version 1.6 Release Notes

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Disclaimer

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1.0. Introduction

This document provides release information and installation instructions for Concurrent Real-Time's RedHawk KVM-RT™ Version 1.6.

1.1 Product Description

RedHawk KVM-RT is a Real-Time Hypervisor solution that utilizes QEMU/KVM and RedHawk real-time features to extend RedHawk's real-time determinism to guest RedHawk virtual machines.

It supports multiple guests, both real-time and non real-time, running in virtual machines on a host system.

1.2 The KVM-RT Product

At this time, Concurrent has pre-qualified the KVM-RT product to achieve real-time performance with a specific hardware and software configuration.

Pre-qualification ensures that all of Concurrent's real-time benchmarking and validation software has been extensively run, both natively and inside virtual machines, with all results indicating acceptable real-time performance. Latencies under 100us were measured in all cases, including real-time scenarios utilizing PCI passthrough, with latencies in most cases measuring under 30us.

The pre-qualified configuration should be suitable for most customers to utilize real-time virtualization without any additional services needed from Concurrent. However, Customers utilizing uncommon or custom PCI Express devices with both open source and proprietary drivers may still need to contact Concurrent for KVM-RT tuning assistance and or driver consultation.

1.2.1 KVM-RT Product Specifications

The KVM-RT product requires specific hardware and software. The following two products have been pre-qualified:

Hardware:

- Supermicro M12SWA-TF AMD Ryzen Threadripper PRO 5975WX
- Supermicro M12SWA-TF AMD Ryzen Threadripper PRO 5965WX

Host Firmware:	UEFI only, revision 2.1
Host OS:	RedHawk 8.4.11 on Rocky/RHEL 8.4 or Ubuntu 20.04 RedHawk 9.2.3 on Rocky/RHEL/Oracle 9.2.x or Ubuntu 22.04
RT guest Firmware:	UEFI or Legacy
RT guest OS:	RedHawk 7.5 or newer
Non-RT guest Firmware:	UEFI or Legacy
Non-RT guest OS:	Any OS

1.3 Related Publications

The following table lists Concurrent Real-Time documentation. Depending upon the document, they are available online on RedHawk Linux systems or from the Concurrent Real-Time documentation web site at <http://redhawk.concurrent-rt.com/docs>

RedHawk KVM-RT	Pub. Number
<i>RedHawk KVM-RT Release Notes</i>	0898603
<i>RedHawk KVM-RT User's Guide</i>	0898604
RedHawk Architect	
<i>RedHawk Architect Release Notes</i>	0898600
<i>RedHawk Architect User's Guide</i>	0898601
RedHawk Linux	
<i>RedHawk Linux Release Notes</i>	0898003
<i>RedHawk Linux User's Guide</i>	0898004
NightStar RT Development Tools	
<i>NightView User's Guide</i>	0898395
<i>NightTrace User's Guide</i>	0898398
<i>NightProbe User's Guide</i>	0898465
<i>NightTune User's Guide</i>	0898515

1.4 Syntax Notation

The following notation is used throughout this document:

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

2.0. Prerequisites

This section describes the hardware, firmware and software considerations in KVM-RT.

Note that the pre-qualified KVM-RT product has specific firmware and software requirements differing from those listed below. It also requires specific hardware. Refer to the "The KVM-RT Product" on page 1.

2.1 Host Hardware Considerations

Concurrent Real-Time recommends KVM-RT applications use the latest available Intel or AMD CPUs that support x86 virtualization technology.

The CPUs on the host must support Virtual Machine Extensions (VMX). Different providers have different names for the virtualization technology; on Intel CPUs look for VT-x and on AMD CPUs look for AMD V.

The CPU must also support I/O MMU virtualization. This support is necessary for virtual machines to directly use IO devices such as PCI Express (PCIe) cards, network interface cards (NIC), and hard disk drives (HDD) controllers. This support is provided on Intel's VT-d and AMD's AMD-Vi.

It is also highly recommended the CPUs support Interrupt virtualization with either Intel's APICv or AMD's AVIC.

2.2 Firmware Configuration

UEFI firmware on the host is required for PCI passthrough of NVIDIA graphics cards.

Virtualization extensions must be enabled on the host. Enable all VMX capabilities supported by your processors and PCI subsystem. Once booted, the **lscpu(1)** command can be used to verify that the vmx flag is set.

Guest firmware may be configured as UEFI or Legacy.

Host Firmware: UEFI (required for passthrough) or Legacy
Guest Firmware: UEFI or Legacy

2.3 Software Requirements

KVM-RT requires the host system to be running the RedHawk operating system 8.4 or newer, while a real-time guest VM requires 7.0 or newer. Any operating system can be run in a non real-time guest VM.

Host OS: RedHawk 8.4 or newer
RT Guest OS: RedHawk 7.0 or newer
Non-RT guest OS: Any OS

3.0. Changes in this Release

This section describes enhancements and other changes to KVM-RT in this release and previous releases in the RedHawk 9.x. timeline.

3.1 Changes in KVM-RT Version 1.6

- Changes to the KVM-RT configuration file `/etc/kvmrt.cfg`:
 - a new attribute, `pcidevs`, used to configure and validate PCI device passthrough to VMs.
 - a new value option, **auto**, for the existing `nr_vcpus` attribute. When this attribute is set to **auto**, `nr_vcpus` will be automatically set to all the CPUs specified in the attribute `cpuset` minus 1.
- Additions to the KVM-RT User's Guide:
 - new chapter: "I/O Device Utilization in Virtual Environment"
 - new appendices: "SR-IOV Setup" and "PCI Passthrough Boot Parameters"
- New commands added to the RedHawk Real-time tools package (**ccur-rttools**). Added since the last release of KVM-RT:
 - **cpi(1)** Displays per-CPU interrupt counts of IRQs.
 - **cpus(1)** Displays or changes the state of CPUs.
 - **irqs(1)** Displays information about IRQs on the system.
 - **pci(1)** Displays PCI device information.
 - **tasks(1)** Displays information about tasks (threads) on the system.
- New man pages for tools; for both the RedHawk Real-time and the KVM-RT tools.
- Miscellaneous bug fixes and enhancements to tools and library.

3.2 Changes in KVM-RT Version 1.5

- Support for RedHawk 9.2 as both host and guest.
- Support for RedHawk 9.2 on the KVM-RT qualified Threadripper Pro platforms. See section "The KVM-RT Product" on page 1 for information on the KVM-RT product.
- Support for Oracle 9.2 as a supported base for the KVM-RT product.
- The latest version of the RedHawk real-time tools package, **ccur-rttools**, is now included with KVM-RT.
- New appendix in the KVM-RT User's Guide describes the NUMA node mappings for the motherboard I/O controllers and PCIe slots on the qualified Threadripper Pro platforms.
- Miscellaneous bug fixes.

4.0. Known Issues

Special consideration should be given to the following areas:

Graphics intensive programs

If a graphics intensive VM does not use dedicated GPU hardware, emulated graphics or any graphics intensive programs can cause VMs to affect the real-time performance of other virtual machines. The onboard graphics of a CPU rely on the memory controllers on the chip for accessing VRAM memory for the host and the VMs. If the memory controllers are overloaded with graphical accesses, the real-time VMs can suffer from performance hits. For this reason, you should not run the VM in graphical mode but instead in multi-user mode whenever possible.

Real-time VMs running RedHawk 7.0-7.3

In RedHawk releases 7.0 through 7.3, the default kernel idle algorithm is to spin and poll. This can cause a VM to busy-spin idle virtual CPUs, and therefore the physical CPUs on the host. On VMs configured for real-time, the QEMU threads on the host spin at a high FIFO priority and when the VM is configured to use an entire host NUMA node this could result in the *host* system to become sluggish or even lock up.

To fix this problem we recommend using the following kernel boot options in real-time VMs running RedHawk 7.0-7.3:

```
idle=halt
idle.forcespin=shielded
```

VMs running the Windows operating system

There is a "per socket" license for Windows operating systems that will dramatically reduce the performance of a Windows virtual machine if you use the default libvirt CPU topology settings. The user should adjust the *cpu_topology* setting in the KVM-RT configuration to be many cores/threads on a single socket. It is recommended that the *cpu_topology* parameter be set to **auto** for VMs running Windows. If the CPU topology setting is not adjusted, the Windows VM will act like it is a single CPU system and system performance will be slow.

UEFI booting

UEFI booting is supported if OVMF software is installed on the system. Some distributions, like Red Hat 7.x releases do not provide OVMF natively.

IRQs that cannot be migrated

In some architectures, IRQs may be bound to the first CPU in each socket and cannot be migrated to another CPU. These IRQs may affect the performance of real-time VMs running on those CPUs. If such IRQs exist, it is recommended that those CPUs not be allocated to a real-time VM.

5.0. Installation & Upgrade Procedures

Perform the following installation steps as the root user to both install and upgrade KVM-RT. Note that step 7 is only applicable to Upgrades.

1. Insert the installation CD in the CD-ROM drive.
2. The CD should normally be automatically mounted under the `/run/media/root` directory. If it does not mount automatically, create a mount point directory and invoke the `mount` command as follows:
mount /dev/cdrom /media/cdrom

NOTE

`/media/cdrom` is used in the examples in this section, however any other unique mount point directory can be used instead.

NOTE

On Ubuntu systems you may encounter a directory access problem. To work around it, execute the following command after inserting the DVD:
sudo setfacl -m g::5,0::5 /media/*

3. Change the current working directory to the directory containing the installation script:
cd /media/cdrom
4. Invoke the installation script. When prompted, you must accept EULA to continue.
/install-kvmrt
5. When installation is complete, change the current working directory outside of `/media/cdrom`:
cd /
6. Unmount the CD-ROM device (may be required to remove the installation CD from the CD-ROM device):
umount /media/cdrom
7. If upgrading, force re-synchronization of any existing KVM-RT configurations you may have as follows:
kvmrt-sync-config --force

6.0. Software Removal

Should you desire to uninstall RedHawk KVM-RT, perform the following steps as the root user:

1. Insert the installation CD in the CD-ROM drive.
2. Mount the CD-ROM drive.

```
mount /dev/cdrom /media/cdrom
```

NOTE

/media/cdrom is used in the examples in this section, however any other unique mount point directory can be used instead.

NOTE

On Ubuntu systems you may encounter a directory access problem. To work around it, execute the following command after inserting the DVD:

```
sudo setfacl -m g::5,o::5 /media/*
```

3. Change the current working directory to the directory containing the installation script:

```
cd /media/cdrom
```
4. Invoke the uninstall script:

```
./uninstall-kvmrt
```
5. When the uninstall is complete, change the current working directory outside of **/media/cdrom**:

```
cd /
```
6. Unmount the CD-ROM device (may be required to remove the installation CD from the CD-ROM device):

```
umount /media/cdrom
```

7.0. Software Updates and Support

7.1 Direct Software Support

Software support is available from a central source. If you need assistance or information about your system, please contact the Concurrent Real-Time 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.

Calling the Software Support Center gives you immediate access to a broad range of skilled personnel and guarantees you a prompt response from the person most qualified to assist you. If you have a question requiring on-site assistance or consultation, the Software Support Center staff will arrange for a field analyst to return your call and schedule a visit.

You may also submit a request for assistance at any time by using the Concurrent Real-Time, Inc. web site at <http://concurrent-rt.com/support>.

7.2 Software Updates

Updates to Concurrent Real-Time RedHawk software can be obtained via Concurrent Real-Time's Software Portal. There are three ways of installing product updates:

- Using the Network Update Utility (NUU) installed on your RedHawk system
- Manual installation after browsing and downloading individual RPMs from Concurrent Real-Time's software repositories
- Building a customized Update disc using Concurrent Real-Time's web site for immediate download

7.2.1 Updating via NUU

NUU supports installation and updating of software products from Concurrent Real-Time software repositories over a network. NUU utilizes Yum and the RPM subsystems to install and update software.

NUU is installed automatically with RedHawk, however, you should configure it to include all of the Concurrent Real-Time software products installed on your system.

Clicking on the "Updates (NUU)" icon on your desktop launches NUU to check to see if Concurrent Real-Time updates are available for your system.

NOTE

It is recommended that all CentOS repositories should be disabled when checking for Concurrent Real-Time updates. In NUU, select the **Repositories -> Edit Configuration** menu item and ensure that the *base*, *updates* and *extras* repositories are disabled.

Instructions for configuring NUU can be found in the QuickStart.pdf document available when you click on the NUU link on the redhawk.concurrent-rt.com website or directly via this link <http://redhawk.concurrent-rt.com/network/QuickStart.pdf>

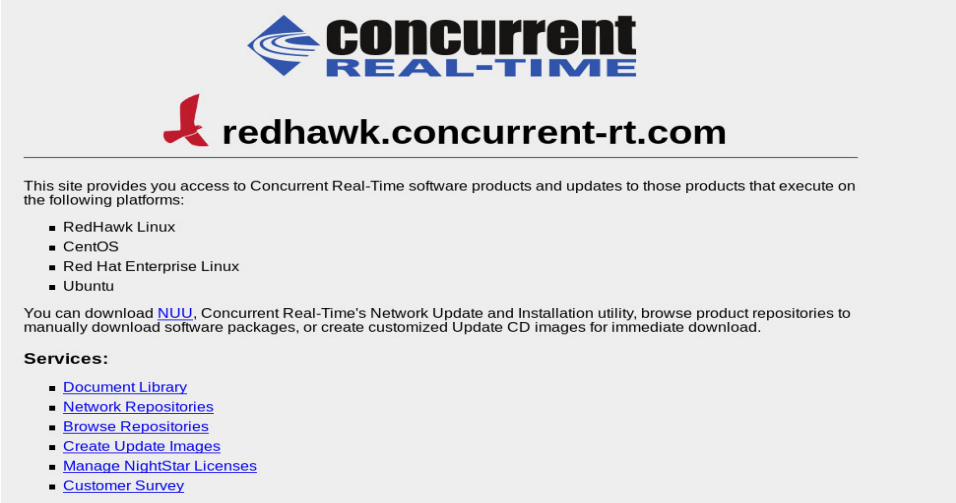
The first time you invoke NUU you will need to specify your redhawk.concurrent-rt.com Login ID and Password that were provided in the shipping documents accompanying your system.

Before using NUU to install any updated software modules, check for NUU updates separately. Apply any NUU updates and then restart NUU before applying any other updates.

7.2.2 Installing Manually Downloaded RPMs

You can browse Concurrent's software repositories to locate updated RPMs and download them for manual installation.

Access the RedHawk Updates web site (<http://redhawk.concurrent-rt.com/>) by clicking on the "Concurrent Real-Time Software Portal" icon on the desktop. Below is the top half of the screen displayed when you access this web site.



The screenshot shows the top half of the Concurrent Real-Time website. At the top center is the logo for "concurrent REAL-TIME" in blue and black. Below the logo is a red stylized bird icon followed by the text "redhawk.concurrent-rt.com". A horizontal line separates the header from the main content. The main content area contains the following text:

This site provides you access to Concurrent Real-Time software products and updates to those products that execute on the following platforms:

- RedHawk Linux
- CentOS
- Red Hat Enterprise Linux
- Ubuntu

You can download [NUU](#), Concurrent Real-Time's Network Update and Installation utility, browse product repositories to manually download software packages, or create customized Update CD images for immediate download.

Services:

- [Document Library](#)
- [Network Repositories](#)
- [Browse Repositories](#)
- [Create Update Images](#)
- [Manage NightStar Licenses](#)
- [Customer Survey](#)

Clicking on the Browse Repositories link takes you to an authentication page.

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Browse Software Repositories

The preferred mechanism for network installation and update on CentOS and RHEL systems is to use [NUU](#). Concurrent Real-Time's Network Update and installation Utility, NUU analyzes the software installed on your system, contacts Concurrent's software repositories via the Internet, and allows you to install and update software.

For Ubuntu-based systems, there is a similar mechanism using standard Ubuntu utilities. See [APT Repositories](#) for more information.

For customers who lack network connections to Concurrent's software repositories from their secured systems, web-based browsing is made available. You can locate software updates for your products and download them for subsequent transport to secured systems.

Enter your redhawk.concurrent-rt.com Login and Password and press the browse button to proceed:

Login:

Password:

Enter your redhawk.concurrent-rt.com Login ID and Password and click the **Browse** button.

Select the products of interest and architecture from the following pages to see the list of RPMs in the product software repository.

Index of /home/repos/RedHawk/7.5

Name	Last modified	Size	Description
Parent Directory/		-	
i386/	29-May-2018 16:37	-	
i505/	22-Jan-2018 15:49	-	
x86_64/	24-Jan-2018 10:45	-	

To locate the latest RPMs in the repository, click on the **Last modified** column header to sort by date. You may need to click twice to set the sort order to newest-to-oldest.

After locating the RPMs of interest and downloading them to your system, you can manually install them.

To install newly downloaded packages, follow these steps:

1. Log in as root and take the system down to single-user mode:
 - a. Right click on the desktop and select **Open Terminal**.
 - b. At the system prompt, type **init 1**.
2. Change directory to the location of the updates and issue the following command:

rpm -Uvh *.rpm

The time it takes to install will vary depending on the number of updates being installed.

3. When complete, exit single-user mode (Ctrl-D).

NOTE

If you have installed an update containing new RedHawk kernels on a system that has post-installation loadable modules present, those modules must be recompiled for the new kernel; for example, an NVIDIA driver that is a later version than the one included with RedHawk or any third party package that uses loadable modules.

7.2.3 Customized Update Discs

You can use Concurrent Real-Time's Software Portal to create a customized Update Disc for your system which you can then download and burn onto physical media, or simply mount as an ISO9660 image.

Update discs have customized copies of product software repositories and a simple graphical interface for selecting packages for update and installation. These discs use NUU (described above) to talk to the disc to obtain packages -- no network access is required during installation via Update Discs.

Access the RedHawk Updates web site (<http://redhawk.concurrent-rt.com>) by clicking on the "Concurrent Real-Time Software Portal" icon on the desktop, then click on **Create Update Images**.

You will need to enter your redhawk.concurrent-rt.com Login ID and Password and then you can select the products to update. A disc image is built as part of the web session. At the end of the session, you can immediately download it for subsequent installation.

7.3 Documentation Updates

For the latest documents, including updated Release Notes and User Guides, go to Concurrent Real-Time's documentation web site at <http://redhawk.concurrent-rt.com/docs>.

