

## Technical Report

# How to install an RTAI extension in Linux 2.6.24 Kernel

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## 1 Introduction

Real-time linux extensions are really useful tools when using general purpose computers in control projects. Sometimes, it's impossible to handle the non-determinism introduced by the operational system during hard real-time control tasks. One way to overcome this issue is to introduce a real-time extension, a software layer that is capable of interrupting the operational systems's tasks for the sake of timing determinism.

There is a well known proprietary Windows real-time extension, Venturcom's RTX. However, it's often preferable to deal with free, open source software. This is the motivation of this tutorial. It tries to describe briefly the steps to install an RTAI real-time extension in a Linux 2.6.24 kernel. This procedure was tested both in single and multi core machines using Ubuntu 8.10 and Kubuntu 8.04. This tutorial is based in [1, 2].

## 2 Preparing the installation

- First, download a default (*vanilla*) 2.6.24 Linux kernel (**linux-2.6.24.tar.bz2**). It can be found at <http://www.kernel.org>. Choose the mirror that best suites you;
- Download the RTAI source (**rtai-3.6-cv.tar.bz2**) at <https://www.rtai.org/>;
- If you have a *gcc* version newer than *gcc-4.1*, download *gcc-4.1* and change the symbolic link at */usr/bin*;
- Move your sources (**linux-2.6.24.tar.bz2** and **rtai-3.6-cv.tar.bz2**) to */usr/src* and unpack them;

```
$ sudo su
# cp rtai-3.6-cv.tar.bz2 /usr/src
# cp linux-2.6.24.tar.bz2 /usr/src
# cd /usr/src
# tar xvj rtai-3.6-cv.tar.bz2
# tar xvj linux-2.6.24.tar.bz2
# mv linux-2.6.24 linux-2.6.24-rtai
```

### 3 Preparing the Linux Kernel

- Once the Linux source is unpacked, create a symbolic link to it in */usr/src*;

```
# ln -s linux-2.6.24-rtai linux
```

- If you prefer, you can create a special *modules* folder and create a symbolic link to RTAI inside it;

```
# cd /usr/src
# mkdir modules
# cd modules
# ln -s ../rtai-3.6-cv rtai
```

- Install the packages associated with Kernel compilation. If you have a Debian based Linux distribution, issue the following command;

```
# apt-get install build-essential kernel-package ncurses-dev
```

- Patch the Linux Kernel to make the RTAI installation possible;

```
# cd /usr/src/linux
# patch -p1 -b < /usr/src/modules/rtai/base/arch/x86/patches/hal-linux-2.6.24-x86-2.0-07.patch
```

### 4 Configuring the Linux Kernel

- Copy your Kernel's current *config* file to the Linux's source directory;

```
# cd /usr/src/linux
# cp /boot/config-$(uname -r) ./config
```

- Configure your new Kernel;

```
# make menuconfig
```

The following fields should be changed

- Loadable module support —> Enable loadable module support —> enabled
- Loadable module support —> Module versioning support —> disabled
- Processor type and features —> Preemption Model —> Preemptible Kernel (Low-Latency Desktop)
- Processor type and features —> Interrupt pipeline —> enabled
- Processor type and features —> High Memory Support —> off
- Power management options (ACPI, APM) —>  
Legacy Power Management API —> disabled
- Power management options (ACPI, APM) —>  
Software Suspend —> disabled
- Power management options (ACPI, APM) —>  
ACPI (Advanced Configuration and Power Interface) Support—> ACPI Support —> disabled
- Power management options (ACPI, APM) —>  
APM (Advanced Power Management) BIOS Support —> APM BIOS Support —> disabled
- Power management options (ACPI, APM) —>  
CPU Frequency scaling —> CPU Frequency scaling —> disabled
- Power management options (ACPI, APM) —>  
Power Management support —> disabled
- For non-SMP systems, disable symmetric multi-processing support;
  - Processor type and features —> Symmetric multi-processing support —> disabled
- Choose the most suitable processor family for your machine. For example, for a Pentium-III processor;
  - Processor type and features —> Processor family —>  
Pentium-III / Celeron(Coppermine) / Pentium-III Xeon
- If you have a dual cores CPU or SMP system, don't choose a processor family which has no TSC (time stamp counter). This means that, for example, you can't choose 586/K5/5x86/6x86/6x86MX as Processor family if you have a dual cores CPU. In conclusion, choose the most suitable processor family for your machine.

## 5 Kernel compilation

- Issue the following commands to compile your new Kernel

```
# make-kpkg clean
# make-kpkg --append-to-version -rtai --initrd kernel_image kernel_headers kernel_source
```
- If everything goes well, the last commands will generate *.deb* files, which should be installed as following

```
# cd /usr/src
# dpkg -i linux-image-2.6.24-rtai.deb
# dpkg -i linux-headers-2.6.24-rtai.deb
```
- Boot with the new Kernel.

## 6 RTAI-Lab

If you want to install RTAI with RTAI-Lab support, you need Mesa and eFLTK libraries. For more details, see [2].

## 7 Compiling RTAI modules

- Change to RTAI's source directory and configure it

```
# cd /usr/src/modules/rtai
# make menuconfig
```
- If you only want to run EMC2, default values are OK. Save, exit and do

```
# make
# make install
# reboot
```

## 8 Testing RTAI

- In order to test RTAI installation, run the tests that follow

```
# cd /usr/realtime/testsuite/user/latency; ./run
# cd /usr/realtime/testsuite/user/preempt; ./run
# cd /usr/realtime/testsuite/user/switches; ./run
# cd /usr/realtime/testsuite/kern/latency; ./run
# cd /usr/realtime/testsuite/kern/preempt; ./run
# cd /usr/realtime/testsuite/kern/switches; ./run
```
- If you have no problems, you RTAI installation is complete.

## References

- [1] Cristóvão Souza. How-to Install RTAI in Ubuntu Hardy. Technical report, 2008. Available at <https://woc.uc.pt/deec/getFile.do?tipo=2&id=5690>.

[2] EMC Documentation Wiki. Debian Etch Compile RTAI. Technical report, 2008. Available at [http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl?Debian\\_Etch\\_Compile\\_RTAI](http://wiki.linuxcnc.org/cgi-bin/emcinfo.pl?Debian_Etch_Compile_RTAI).