

RTAI

Under construction. This page needs a bit of research on my part to complete. Please obtain example code from the [RTAI](#) website for the moment.

Introduction

RTAI is a system that allows your Linux operating system to run so-called 'hard' realtime tasks. By 'hard' we mean that it isn't just 'best effort' it really will do something regularly, to a schedule dictated by you, no matter how heavily loaded the system. RTAI comes in two parts: a set of patches for your kernel and a library you can link your programs against which allows them to become realtime tasks. It may feel like you're running your program under Linux just like any other normal user-mode program, however under the hood you are taking full control of the hardware, and any other processes will only run as the remaining CPU time permits.

The above is a gross over-simplification of what is actually happening and is simply a lay-person's introduction. Please investigate the RTAI documentation for discussion of things like jitter, latency and so on

Getting RTAI

You can download the latest version of RTAI from the website:

```
# wget https://www.rtai.org/userfiles/downloads/RTAI/rtai-5.1.tar.bz2
# tar xvf rtai-5.1.tar.bz2
# cd rtai-5.1
```

Identifying the HAL patch

RTAI requires the application of kernel patches, but carries patches only for certain kernel versions. You can find out which ones like this:

```
# find ./ -name hal\*.patch
./base/arch/x86/patches/hal-linux-3.10.32-x86-8.patch
./base/arch/x86/patches/hal-linux-3.18.20-x86-6.patch
./base/arch/x86/patches/hal-linux-4.4.71-x86-10.patch
./base/arch/x86/patches/hal-linux-4.9.80-x86-4.patch
./base/arch/x86/patches/hal-linux-4.4.115-x86-10.patch
./base/arch/x86/patches/hal-linux-4.1.18-x86-9.patch
./base/arch/x86/patches/hal-linux-3.16.7-x86-5.patch
./base/arch/x86/patches/hal-linux-3.14.44-x86-12.patch
./base/arch/x86/patches/hal-linux-4.9.51-x86-4.patch
```

Now check your own kernel version:

```
# uname -r
```

4.4.14

We can see that the closest kernel with a HAL patch after this is 4.4.71, so that's the one to aim for. For now just copy the patch to the kernel source location:

```
# cp base/arch/x86/patches/hal-linux-4.4.71-x86-10.patch /usr/src
```

Switching Kernel Version

We need to get ourselves on a kernel of the correct version (above) before we do anything else. Start by downloading and uncompressing the new version:

```
# cd /usr/src
# wget https://www.kernel.org/pub/linux/kernel/v4.x/linux-4.4.71.tar.xz
# tar xvf linux-4.4.71.tar.xz
# cd linux-4.4.71
```

Now use the existing configuration as a base and 'make oldconfig'. There may be some new config options that get prompted for, it's likely you can accept the defaults though.

```
# zcat /proc/config.gz > .config
# make oldconfig
```

If you have a more obscure filesystem for your root partition you may now want to 'make menuconfig' to ensure it's compiled into your kernel [*] instead of a module [m], or you may want to investigate using initrds. For anyone using the default EXT4, you're good to just make now:

```
# make
```

And then copy the results to install:

```
# make modules_install
# cp arch/x86_64/boot/bzImage /boot/vmlinuz-rtai
# cd /boot
```

Edit the lilo config:

```
# vi /etc/lilo.conf
```

And ensure there's a section added like this:

```
image = /boot/vmlinuz-rtai
  root = /dev/sda1
  label = Linux-4.4.71
  read-only
```

Leave the other kernel image section in there as a second option in case something goes wrong with the boot, but you want to make the new one the default (the first entry).

Patching the Kernel

When you're sure that new kernel works and your system boots and functions, now's the time to add the RTAI patches:

```
# cd /usr/src/linux-4.4.71
# patch -p1 < /usr/src/hal-linux-4.4.71-x86-10.patch
```

And now you can make the kernel again. This may take some time:

```
# make
```

If there are any prompted questions about the RTAI it's safe to leave them as defaults. Next install the new kernel.

```
# make modules_install
# cp arch/x86_64/boot/bzImage /boot/vmlinuz-rtai
```

You've already configured LILO, so just re-run it to reference the newly copied kernel:

```
# lilo
```

Reboot the machine to ensure that the new kernel works.

Compiling/Installing RTAI

Before compiling RTAI itself we must ensure `/usr/src/linux` points to the new RTAI kernel.

```
# cd /usr/src
# rm linux
# ln -s linux-4.4.71 linux
```

Next just compile in the normal way:

```
# cd rtai-5.1
# ./configure
# make
# make install
```

At this point, some kernel modules should have arrived in `/usr/realtime/modules/` For now you can load them manually, however in the future you can add them to `/etc/rc.d/rc.local`:

```
# /sbin/insmod /usr/realtime/modules/rtai_hal.ko
# /sbin/insmod /usr/realtime/modules/rtai_sched.ko
# /sbin/insmod /usr/realtime/modules/rtai_fifos.ko
```

Check they are there:

```
# lsmod | grep rtai
rtai_fifos          39941  0
rtai_sched         118855  1 rtai_fifos
rtai_hal           1762779  2 rtai_fifos,rtai_sched
```

Now we need to ensure we can link to the libraries:

```
vim /etc/ld.so.conf
```

Add the line:

```
/usr/realtime/lib
```

and then run (as root):

```
# ldconfig
```

Finally, we are ready to write our first RTAI program.

Example Program

Here's an example Makefile to compile a really simple realtime program. It uses the `rtai-config` utility to set everything up:

```
CC = $(shell /usr/realtime/bin/rtai-config --cc)
LXRT_CFLAGS = $(shell /usr/realtime/bin/rtai-config --lxrt-cflags)
LXRT_LDFLAGS = $(shell /usr/realtime/bin/rtai-config --lxrt-ldflags)

all:: rtai-example

rtai-example: rtai-example.c
    $(CC) $(LXRT_CFLAGS) -o $@ $< $(LXRT_LDFLAGS) -llxrt
clean::
    $(RM) -f rtai-example*~
.PHONY: clean
```

And here is the demo program, `rtai-example.c`:

```
TOD0
```

Dedication

This page is dedicated to the memory of `captain@captain.at` whos pages have been a great source of information in kernel and realtime programming. You can still find his stuff in various archives, e.g. [here](#).

RIP Captain.

Sources

* Originally written by [User bifferos](#)

[howtos](#), [rtai](#), [realtime](#)

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