Notes on PREEPT_RT and Xenomai installation

Real-Time Industrial Systems

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Outline

- Kernel download
- Kernel patch
- Configuration
- Build & Install

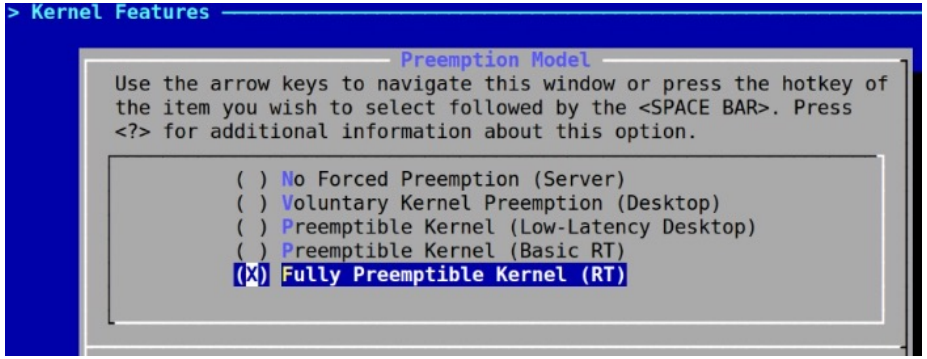
Kernel download

- First of all, we need a vanilla Linux kernel
  - Download it at https://cdn.kernel.org/pub/linux/kernel/
  - Check also for suitable versions for patch
  - Extract the archive (e.g. to /home/)
- Choose a version not too far away from your running kernel
  - Your distro could not support it

The **kernel** is the core of the OS, providing privileged services, different from
the **distro**, that is basically everything is built on top of the kernel, like a IDE, applications and so on.
At boot time, for each partition there is a distro that could have installed more than one kernel, that can be selected

Kernel patch - PREEMPT-RT

- Download a suitable patch
  - https://wiki.linuxfoundation.org/realtime/start
  - https://wiki.linuxfoundation.org/realtime/preempt_rt_versions for more versions
  - Choose **EXACTLY** your kernel version and subversion
- Next steps:
  - Extract the patch (e.g. into /home/)
  - cd into your linux build tree (e.g cd /home/linux-5.4.77)
  - apply the patch (patch -p1 < ../patch-5.4.77-rt14.patch)
  - Under “General setup” go to “preemption model”
  - Set to Fully Preemptible Kernel
- Skip to configuration slide



Complete steps @ https://wiki.linuxfoundation.org/realtime/documentation/howto/applications/preemptrt_setup

Kernel “patch” - low-latency

- Nice one, no patch is needed! :)
- As a basic RT support is already native nowadays in vanilla kernels!

ANYWAY

- Make sure to configure your kernel to be preemptible
  - Under “General setup” go to “preemption model”
  - Set to preemptible kernel, that’s all you need!
- Skip to configuration slide

Kernel patch - Xenomai

- You need to download one or two patches, depending on the single kernel or dual kernel configuration
- Let's assume a cobalt (dual kernel) configuration
  - Download ipipe patch @ https://xenomai.org/downloads/ipipe/
  - Choose **EXACTLY** your kernel version and subversion
  - https://source.denx.de/Xenomai/xenomai to download the real time core (clone it or download it via zip, versioning is independent from Linux)
- Next steps:
  - Extract the patch (e.g. into /home/) and cobalt
  - cd into Cobalt source tree and use scripts/prepare-kernel.sh, details @ https://source.denx.de/Xenomai/xenomai/-/wikis/Installing_Xenomai_3
- Skip to configuration slide

Complete steps @ https://source.denx.de/Xenomai/xenomai/-/wikis/Setting_Up

Configuration - warnings

- Install a few needed libs:
  - sudo apt install build-essential libncurses-dev bison flex libssl-dev libelf-dev xz-utils fakeroot
- A few parameters depend on what you are installing
- There is no “correct configuration”
- Anyway there are a few common guidelines
- The final aim is to remove the “latency killers” and **every** bit of useless code

Configuration - a little more

- cd into your linux build tree (e.g. cd /home/linux-5.4.77) and
  - make xconfig or make menuconfig
- When measuring system latency all kernel debug options should be turned off. They require much overhead and distort the measurement result.
  - (e.g. DEBUG_PREEMPT, DEBUG_OBJECTS, Lock debbugging)
- Disable (in order) * More at https://source.denx.de/Xenomai/xenomai/-/wikis/Configuring_For_X86_Based_Dual_Kernels *
  - CONFIG_SCHED_MC_PRIO (-> Processor type and features -> Multi-core scheduler support)
  - CONFIG_CPU_FREQ (-> Power management and ACPI options -> CPU Frequency scaling
  - CONFIG_CPU_IDLE (same)
  - CONFIG_APM (-> Power management and ACPI options)
  - CONFIG_ACPI_PROCCESSOR (-> Power management and ACPI options -> ACPI (Adv Configuration and Power Interface))
  - CONFIG_STACKPROTECTOR
  - Simultaneous Multi-threading (if supported)
- Anyway x86-64 architectures still present unpredictable features like SMI

For Xenomai check out the official installation guide

Configuration - endless

- There may be conflicts between several parameters
  - e.g. preempt-rt clashes with rt-cgroups parameters
- Under “processor type and features” fine tune on your hardware
- By default the .config file for the first time is read from the running system config file
  - If coming from a general purpose distro, it could be very bloated! Keep attention!
- lsmod and make defconfig can be useful to create a small .config file
- Save the configuration
- **Software** configuration is not enough, reboot and into the UEFI wizard fine tune **hardware** settings, depending on your hardware:
  - For example, disable Intel SpeedStep technology
  - Disabled TurboBoost
  - Disabled Intel c-state
  - Fine tuned some power optimization configs

Build and install

- cd into linux build tree
- make -j9 (or make -j9 modules modules_install bzImage), where 9 is the number of your logical cores +1
- If there are more modules than needed we need to strip them:
  - cd into modules folder (e.g. /lib/modules/5.4.77-name)
  - sudo find ./ -iname "*.ko" -exec strip --strip-unneeded {} \;
  - otherwise the initial RAM disk will be huge and system won’t boot
- cd into linux build-tree and make install
- check if everything is fine under /boot
- reboot and choose the selected kernel