# Practical Kernel Development

*It's not an embedded Linux distribution –*
*It creates a custom one for you.*
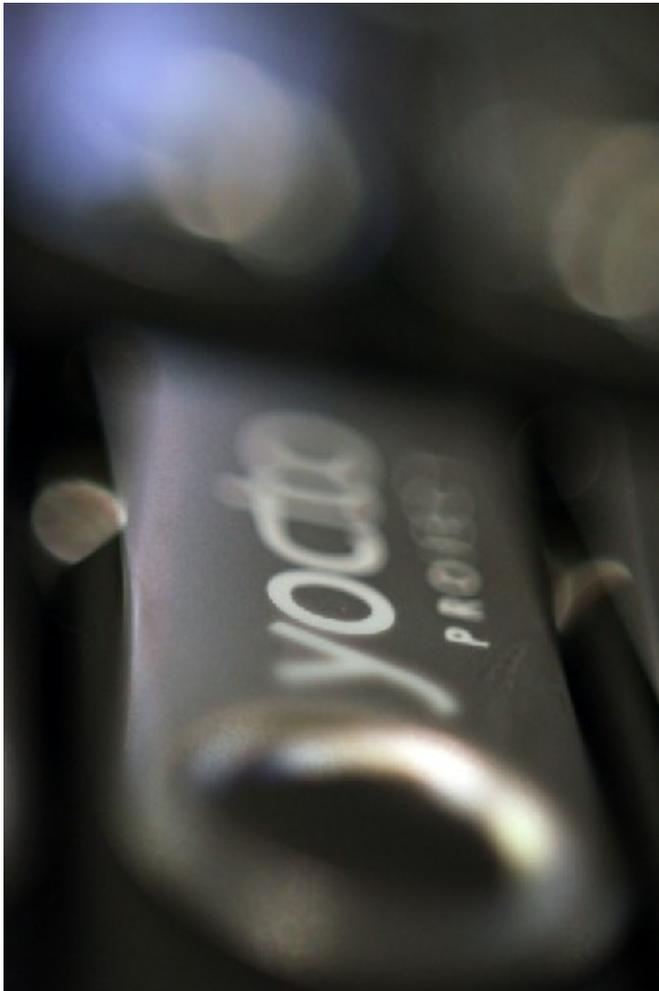
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April 11, 2011

# Agenda

- Kernel Recipes

- Motivation

- Approach

- Live Tutorial

  - Iterative development

  - Recipe-based development

  - In-tree development

# Kernel Recipes

- Linux kernels are recipes

- Kernel recipes inherit kernel.bbclass

- Adding a custom kernel is "easy":

  1) Add a new recipe: linux-2.6_dvhart.bb

  2) Specify the SRC_URI

  3) Provide a machine defconfig

# Complexity

- Security fixes

- Bug fixes

- Whiz-bang features

- New target hardware

- An explosion of linux-*.bb recipes, patch queues, defconfigs, etc.

# Motivation for Consolidation

- Reduce duplication of effort

  - Security fixes

  - Bug fixes

  - Feature ports

- Collaborate on a common core

  - Construct dynamic source trees

  - Support Linux development methods (i.e. 'git bisect')

  - Manage config fragments

- Differentiate where it matters

Yocto Project Kernel Architecture and User Manual

# Approach: Components

- Components
  - Kernel class
    > meta/classes/kernel.bbclass
  - Linux-Yocto recipe
    > meta/recipes-kernel/linux/linux-yocto*bb
  - Linux-Yocto git repository
    > http://git.pokylinux.org/cgit/cgit.cgi/linux-yocto-2.6.37
- Kernel Versions
  - linux-yocto-stable: 2.6.34
  - linux-yocto: 2.6.37
  - *linux-yocto-dev: 2.6.39-rc1 (meta-kernel-dev)*
  - *linux-2.6: current mainline git (meta-kernel-dev)*

summary   refs   log   tree   commit   diff   stats                                                    log msg [⇕] [_____] search

| Branch | Commit message | Author | Age |
|---|---|---|---|
| meta | meta: preempt-rt renames | Bruce Ashfield | 5 days |
| yocto/standard/arm-versatile-926ejs | Merge branch 'yocto/standard/base' into yocto/standard/arm-versatile-926ejs | Bruce Ashfield | 13 days |
| yocto/standard/common pc/base | Merge branch 'yocto/standard/base' into yocto/standard/common pc/base | Bruce Ashfield | 13 days |
| yocto/standard/crownbay | i2c-eg20t: Include slab.h for memory allocations | Wolfram Sang | 11 days |
| yocto/standard/emenlow | Merge branch 'yocto/standard/base' into yocto/standard/emenlow | Bruce Ashfield | 13 days |
| yocto/standard/fsl-mpc8315e-rdb | Merge branch 'yocto/standard/base' into yocto/standard/fsl-mpc8315e-rdb | Bruce Ashfield | 13 days |
| yocto/standard/mti-malta32-be | Merge branch 'yocto/standard/base' into yocto/standard/mti-malta32-be | Bruce Ashfield | 13 days |
| yocto/standard/mti-malta32-le | Merge branch 'yocto/standard/base' into yocto/standard/mti-malta32-le | Bruce Ashfield | 13 days |
| yocto/standard/qemu-ppc32 | Merge branch 'yocto/standard/base' into yocto/standard/qemu-ppc32 | Bruce Ashfield | 13 days |
| yocto/standard/routerstationpro | Merge branch 'yocto/standard/base' into yocto/standard/routerstationpro | Bruce Ashfield | 13 days |
| [...] | | | |

| Tag | Download | Author | Age |
|---|---|---|---|
| v2.6.37.5 | linux-yocto-2.6.37-2.6.37.5.zip  linux-yocto-2.6.37-2.6.37.5.tar.gz  linux-yocto-2.6.37-2.6.37.5.tar.bz2 | Greg Kroah-Hartman | 3 weeks |
| v2.6.37.4 | linux-yocto-2.6.37-2.6.37.4.zip  linux-yocto-2.6.37-2.6.37.4.tar.gz  linux-yocto-2.6.37-2.6.37.4.tar.bz2 | Greg Kroah-Hartman | 4 weeks |
| v2.6.37.3 | linux-yocto-2.6.37-2.6.37.3.zip  linux-yocto-2.6.37-2.6.37.3.tar.gz  linux-yocto-2.6.37-2.6.37.3.tar.bz2 | Greg Kroah-Hartman | 5 weeks |
| v2.6.37.2 | linux-yocto-2.6.37-2.6.37.2.zip  linux-yocto-2.6.37-2.6.37.2.tar.gz  linux-yocto-2.6.37-2.6.37.2.tar.bz2 | Greg Kroah-Hartman | 5 weeks |
| v2.6.37.1 | linux-yocto-2.6.37-2.6.37.1.zip  linux-yocto-2.6.37-2.6.37.1.tar.gz  linux-yocto-2.6.37-2.6.37.1.tar.bz2 | Greg Kroah-Hartman | 7 weeks |
| v2.6.37 | linux-yocto-2.6.37-2.6.37.zip  linux-yocto-2.6.37-2.6.37.tar.gz  linux-yocto-2.6.37-2.6.37.tar.bz2 | Linus Torvalds | 3 months |
| v2.6.37-rc8 | linux-yocto-2.6.37-2.6.37-rc8.zip  linux-yocto-2.6.37-2.6.37-rc8.tar.gz  linux-yocto-2.6.37-2.6.37-rc8.tar.bz2 | Linus Torvalds | 3 months |
| v2.6.37-rc7 | linux-yocto-2.6.37-2.6.37-rc7.zip  linux-yocto-2.6.37-2.6.37-rc7.tar.gz  linux-yocto-2.6.37-2.6.37-rc7.tar.bz2 | Linus Torvalds | 4 months |
| v2.6.37-rc6 | linux-yocto-2.6.37-2.6.37-rc6.zip  linux-yocto-2.6.37-2.6.37-rc6.tar.gz  linux-yocto-2.6.37-2.6.37-rc6.tar.bz2 | Linus Torvalds | 4 months |
| checkpoint-meta | checkpoint-meta.zip  checkpoint-meta.tar.gz  checkpoint-meta.tar.bz2 | Bruce Ashfield | 4 months |
| [...] | | | |

| Age | Commit message | Author | Files | Lines |
|---|---|---|---|---|
| 2011-01-05 | Linux 2.6.37 `HEAD` `v2.6.37` `master` | Linus Torvalds | 1 | -1/+1 |
| 2011-01-04 | Merge git://git.kernel.org/pub/scm/linux/kernel/git/davem/net-2.6 | Linus Torvalds | 14 | -25/+87 |
| 2011-01-04 | ipv4/route c: respect prefsrc for local routes | Joel Sing | 1 | -2/+6 |
| 2011-01-04 | remove trim_fs method from Documentation/filesystems/Locking | Christoph Hellwig | 1 | -2/+0 |
| 2011-01-04 | Merge master.kernel.org:/home/rmk/linux-2.6-arm | Linus Torvalds | 14 | -157/+78 |
| 2011-01-04 | arch/mn10300/kernel/rc.c: fx build | Andrew Morton | 1 | -1/+1 |
| 2011-01-04 | ima: fix add LSM rule bug | Mimi Zohar | 1 | 0/+2 |
| 2011-01-03 | Merge branch 'fix' of git://git.kernel.org/pub/scm/linux/kernel/git/ycmiao/px... | Russell King | 259 | -1598/+2484 |
| 2011-01-03 | bridge: stp: ensure mac header is set | Florian Westphal | 1 | -0/+2 |
| 2011-01-03 | Merge branch 'perf-fixes-for-linus' of git://git.kernel.org/pub/scm/linux/ker... | Linus Torvalds | 4 | -11/+20 |
| [...] | | | | |

# Approach: Branch Hierarchy

## Hierarchical branching structure

```
* master
  meta
  yocto/base
  yocto/standard/arm-versatile-926ejs
  yocto/standard/base
  yocto/standard/beagleboard
  yocto/standard/common-pc-64/base
  yocto/standard/common-pc-64/jasperforest
  yocto/standard/common-pc-64/sugarbay
  yocto/standard/common-pc/atom-pc
  yocto/standard/common-pc/base
  yocto/standard/crownbay
  yocto/standard/emenlow
  yocto/standard/fsl-mpc8315e-rdb
  yocto/standard/mti-malta32-be
  yocto/standard/mti-malta32-le
  yocto/standard/preempt-rt/base
  yocto/standard/preempt-rt/common-pc
  yocto/standard/preempt-rt/common-pc-64
  yocto/standard/qemu-ppc32
  yocto/standard/routerstationpro
```

# Approach: Kernel Types

## Multiple kernel types are supported

```
* master
  meta
  yocto/base
  yocto/standard/arm-versatile-926ejs
  yocto/standard/base
  yocto/standard/beagleboard
  yocto/standard/common-pc-64/base
  yocto/standard/common-pc-64/jasperforest
  yocto/standard/common-pc-64/sugarbay
  yocto/standard/common-pc/atom-pc
  yocto/standard/common-pc/base
  yocto/standard/crownbay
  yocto/standard/emenlow
  yocto/standard/fsl-mpc8315e-rdb
  yocto/standard/mti-malta32-be
  yocto/standard/mti-malta32-le
  yocto/standard/preempt-rt/base
  yocto/standard/preempt-rt/common-pc
  yocto/standard/preempt-rt/common-pc-64
  yocto/standard/qemu-ppc32
  yocto/standard/routerstationpro
```

# Approach: Meta-data

## Meta-data in a separate branch

```
meta/
├── cfg
│   ├── branch_status
│   ├── kernel-cache
│   │   ├── 00-README
│   │   ├── arch
│   │   ├── bsp
│   │   ├── cfg
│   │   ├── features
│   │   ├── ktypes
│   │   ├── kver
│   │   ├── patches
│   │   ├── rr-cache
│   │   ├── scripts
│   │   ├── small
│   │   └── wrs
```
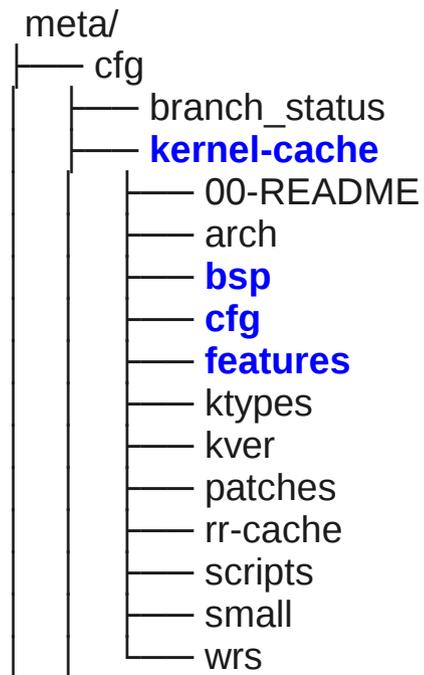
# Local Development

- meta-kernel-dev layer

```
$ git clone git://git.pokylinux.org/poky-extras.git
```

- Local repository

```
$ git clone --bare git://git.pokylinux.org/linux-yocto-2.6.37
```

- meta-elc layer

  - poky-image-elc.bb

  - linux-yocto_git.bbappend

- Configure bblayers.conf

```
KSRC=/home/dvhart/source/linux/linux-yocto-2.6.37-bare.git
BBFILES ?= ""
BBLAYERS = "/home/dvhart/source/poky.git/meta \
            /home/dvhart/source/poky.git/layers/meta-elc \
            /home/dvhart/source/poky.git/layers/poky-extras/meta-kernel-dev"
```

# Tutorial

- Walkthrough

- Mount a vfat image and play an audio file

  - Iterative development

  - Recipe development

  - In-tree development

# Resources

- http://www.yoctoproject.org

- http://www.yoctoproject.org/docs/kernel-manual/kernel-manual.html

- http://www.yoctoproject.org/docs/bsp-guide/bsp-guide.html

# Questions

# Backup

# Recipe Example: linux-yocto

```
inherit kernel
require linux-yocto.inc

KMACHINE = "yocto/standard/base"
KMACHINE_qemux86  = "yocto/standard/common-pc/base"
KMACHINE_mpc8315e-rdb = "yocto/standard/fsl-mpc8315e-rdb"

KBRANCH = ${KMACHINE}
KMETA = meta

LINUX_VERSION ?= "2.6.37"
LINUX_VERSION_EXTENSION ?= "-yocto-${LINUX_KERNEL_TYPE}"
PR = "r16"
PV = "${LINUX_VERSION}+git${SRCPV}"
SRCREV_FORMAT = "meta_machine"

SRC_URI = "git://git.pokylinux.org/linux-yocto-2.6.37;protocol=git;nocheckout=1;branch=$
{KBRANCH},meta;name=machine,meta"

COMPATIBLE_MACHINE = "(qemuarm|mpc8315e-rdb)"

# Functionality flags
KERNEL_REVISION_CHECKING ?= "t"
KERNEL_FEATURES="features/netfilter"
KERNEL_FEATURES_append_qemux86=" cfg/sound"

# extra tasks
addtask kernel_link_vmlinux after do_compile before do_install
addtask validate_branches before do_patch after do_kernel_checkout
addtask kernel_configcheck after do_configure before do_compile

require linux-tools.inc
```

# Append Example: linux-yocto

```
FILESEXTRAPATHS := "${THISDIR}/${PN}"

# Poky-side config fragment
#SRC_URI_append_qemux86 = " file://vfat-elc.cfg"

# linux-yocto built-in config fragment
#KERNEL_FEATURES_append_qemux86 += " cfg/vfat"
```

# Machine Example: qemux86

```
#@TYPE: Machine
#@NAME: common_pc
#@DESCRIPTION: Machine configuration for running a common x86

TARGET_ARCH = "i586"

PREFERRED_PROVIDER_virtual/libgl  = "mesa-dri"
PREFERRED_PROVIDER_virtual/libx11 ?= "libx11-trim"
PREFERRED_PROVIDER_virtual/xserver ?= "xserver-xf86-dri-lite"
PREFERRED_PROVIDER_virtual/xserver-xf86 ?= "xserver-xf86-dri-lite"

require conf/machine/include/qemu.inc

MACHINE_FEATURES += "x86"

KERNEL_IMAGETYPE = "bzImage"

SERIAL_CONSOLE = "115200 ttyS0"

# We bypass swrast but we need it to be present for X to load correctly
XSERVER ?= "xserver-xf86-dri-lite \
           mesa-dri-driver-swrast \
           xf86-input-vmmouse \
           xf86-input-keyboard \
           xf86-input-evdev \
           xf86-video-vmware \
           qemugl"

GLIBC_ADDONS = "nptl"
GLIBC_EXTRA_OECONF = "--with-tls"

MACHINE_ESSENTIAL_EXTRA_RDEPENDS = "v86d"

TARGET_CC_ARCH = "-march=i586"
```

# Image Example: poky-image-elc

```
require recipes-core/images/poky-image-minimal.bb

IMAGE_INSTALL += "dropbear alsa-utils-aplay alsa-utils-alsamixer"
IMAGE_INSTALL_append_qemux86 += " kernel-module-snd-ens1370 kernel-module-snd-rawmidi kernel-
module-loop kernel-module-nls-cp437 kernel-module-nls-iso8859-1 qemux86-audio alsa-utils-amixer"

LICENSE = "MIT"
```