Yocto Crash Course

Welcome to the SCaLE 13x Yocto Crash Course – Build Your Own Embedded Linux OS for Fun and Profit

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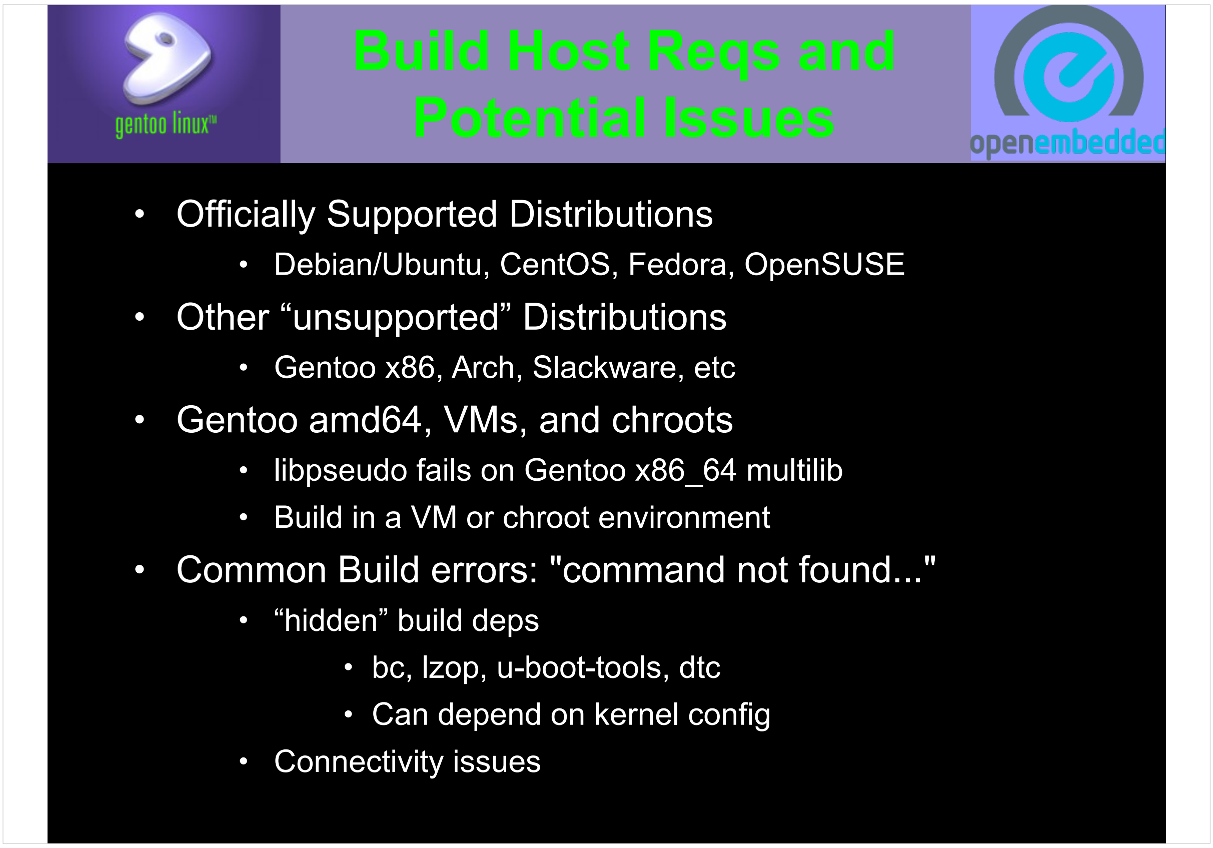
Upstream docs:

Quick Start:
http://tinyurl.com/yocto-1-7
Reference:
https://www.yoctoproject.org/documentation
Project wiki:
http://openembedded.org/wiki/Main_Page
Training:
https://www.yoctoproject.org/training/kernel-lab
Git repos:
https://www.yoctoproject.org/downloads
https://github.com/openembedded/meta-openembedded
Vendors:
http://beagleboard.org/project/yocto-project/
https://community.freescale.com/docs/DOC-1616
Other:
https://github.com/sarnold/meta-alt-desktop-extras
http://www.vctlabs.com/archives.html



Build Host Reqs and Potential Issues

- Officially Supported Distributions
  - Debian/Ubuntu, CentOS, Fedora, OpenSUSE
- Other “unsupported” Distributions
  - Gentoo x86, Arch, Slackware, etc
- Gentoo amd64, VMs, and chroots
  - libpseudo fails on Gentoo x86_64 multilib
  - Build in a VM or chroot environment
- Common Build errors: "command not found..."
  - “hidden” build deps
    - bc, lzop, u-boot-tools, dtc
    - Can depend on kernel config
  - Connectivity issues

See the getting-started guide and wiki for details; essentially you need python, git, tar, and the rest of the “normal” development tools and libraries, plus a few others. For example, a Gentoo x86 system with an ARM cross-compiler and U-boot tools should be almost ready to go:

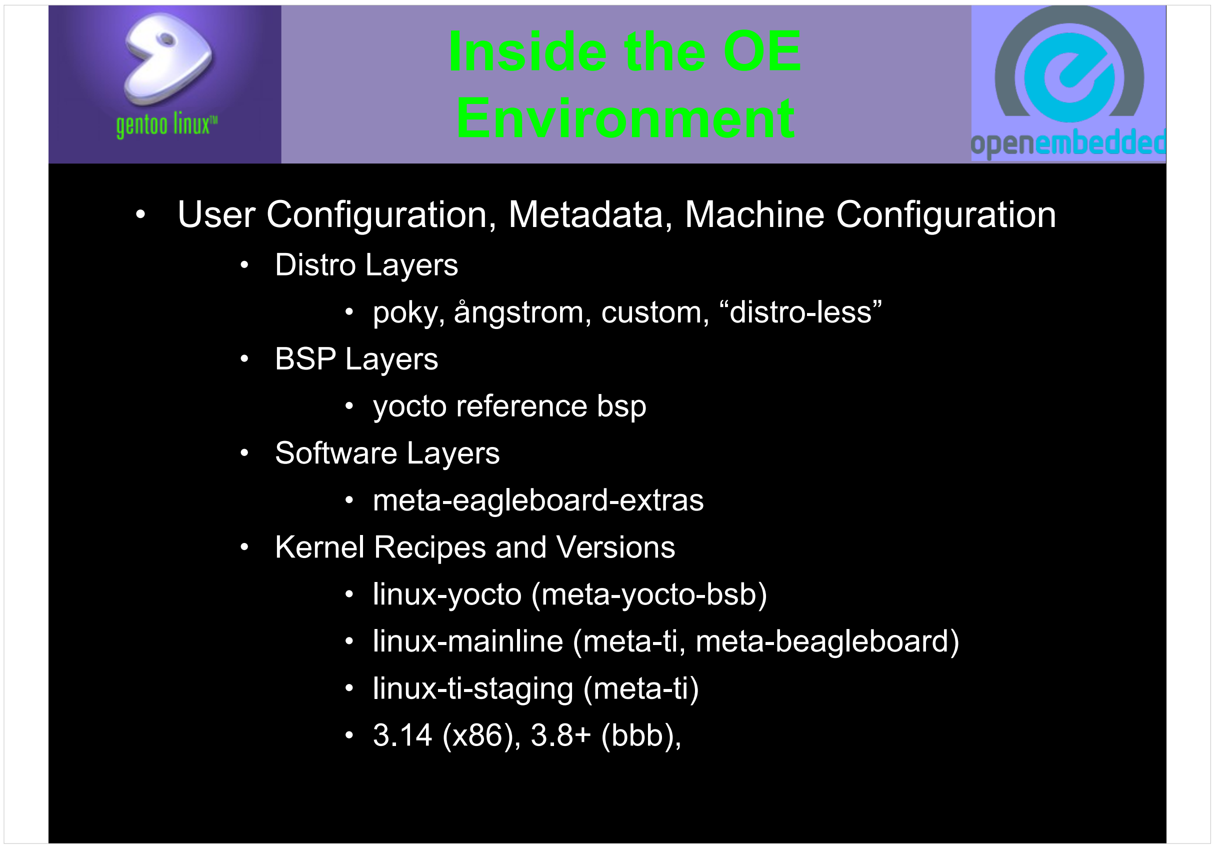
http://tinyurl.com/yocto-1-7

http://www.openembedded.org/wiki/OEandYourDistro

The wiki page above includes details for some of the “unsupported” distributions.

Other general considerations include disk space (you need plenty of it) and VM support (ie, KVM, qemu, libvirt, etc).

Network problems such as dropouts, bad name resolution, etc, can stop a build but you can pre-fetch required source packages and share downloads and cache data between builds.



Inside the OE Environment

- User Configuration, Metadata, Machine Configuration
  - Distro Layers
    - poky, ångstrom, custom, “distro-less”
  - BSP Layers
    - yocto reference bsp
  - Software Layers
    - meta-eagleboard-extras
  - Kernel Recipes and Versions
    - linux-yocto (meta-yocto-bsb)
    - linux-mainline (meta-ti, meta-beagleboard)
    - linux-ti-staging (meta-ti)
    - 3.14 (x86), 3.8+ (bbb),

Typical (manual) directory layout has poky as the top-level directory, with base BSP and additional layers inside.

The default environment script creates local build directories at the same level, however, user-configuration options are provided to specify paths for downloads, build output, and shared cache data (by default each build tree is self-contained).

Sharing downloads and cache data between builds is a good way to both speed up builds/rebuilds and save space.

You can add additional software layers as needed, however only one BSP layer should be enabled for a given build.

The two main local config files are conf/{bblayers.conf,local.conf} and local.conf is probably the easiest place to keep your custom build settings unless you're creating your own BSP or software layer.

Useful config options in local.conf include:

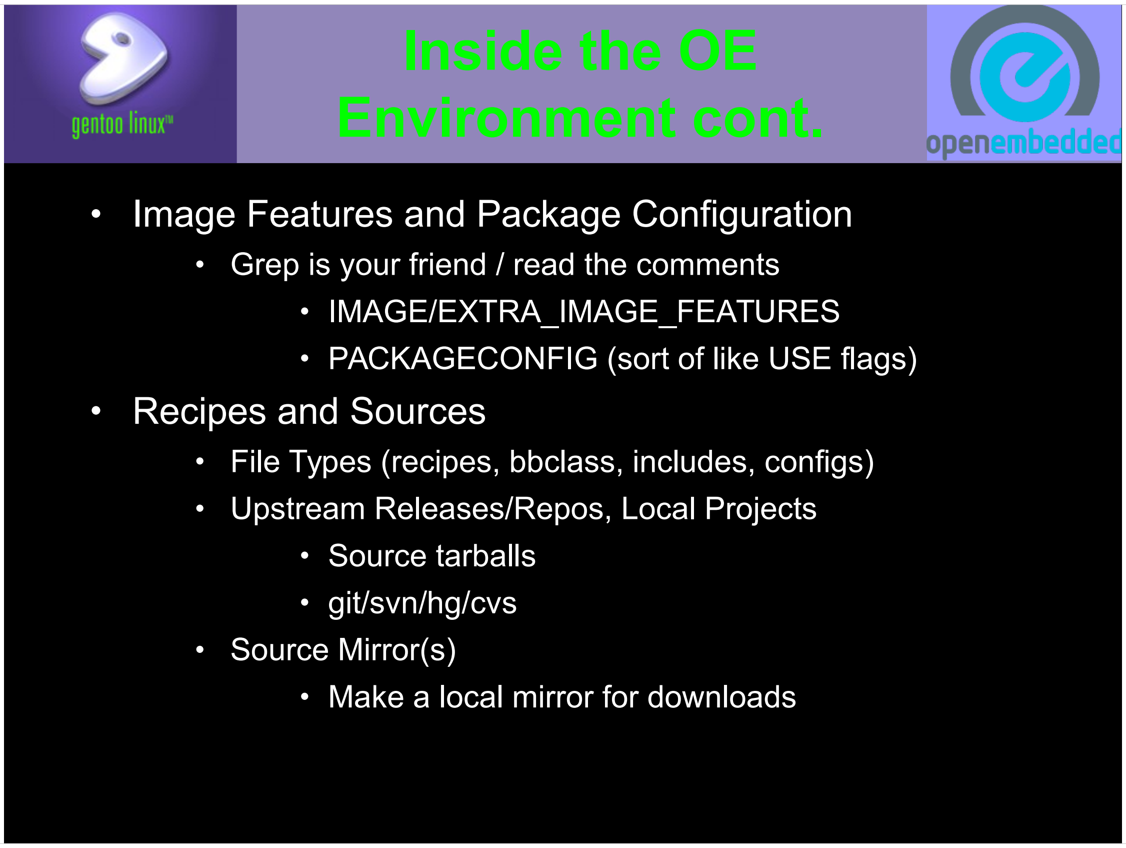
PREFERRED_VERSION

PREFERRED_PROVIDER

DISTRO_FEATURES

IMAGE_FEATURES / EXTRA_IMAGE_FEATURES

PACKAGECONFIG



Inside the OE Environment cont.

- Image Features and Package Configuration
  - Grep is your friend / read the comments
    - IMAGE/EXTRA_IMAGE_FEATURES
    - PACKAGECONFIG (sort of like USE flags)
- Recipes and Sources
  - File Types (recipes, bbclass, includes, configs)
  - Upstream Releases/Repos, Local Projects
    - Source tarballs
    - git/svn/hg/cvs
  - Source Mirror(s)
    - Make a local mirror for downloads

build-foo/conf/bblayers.conf

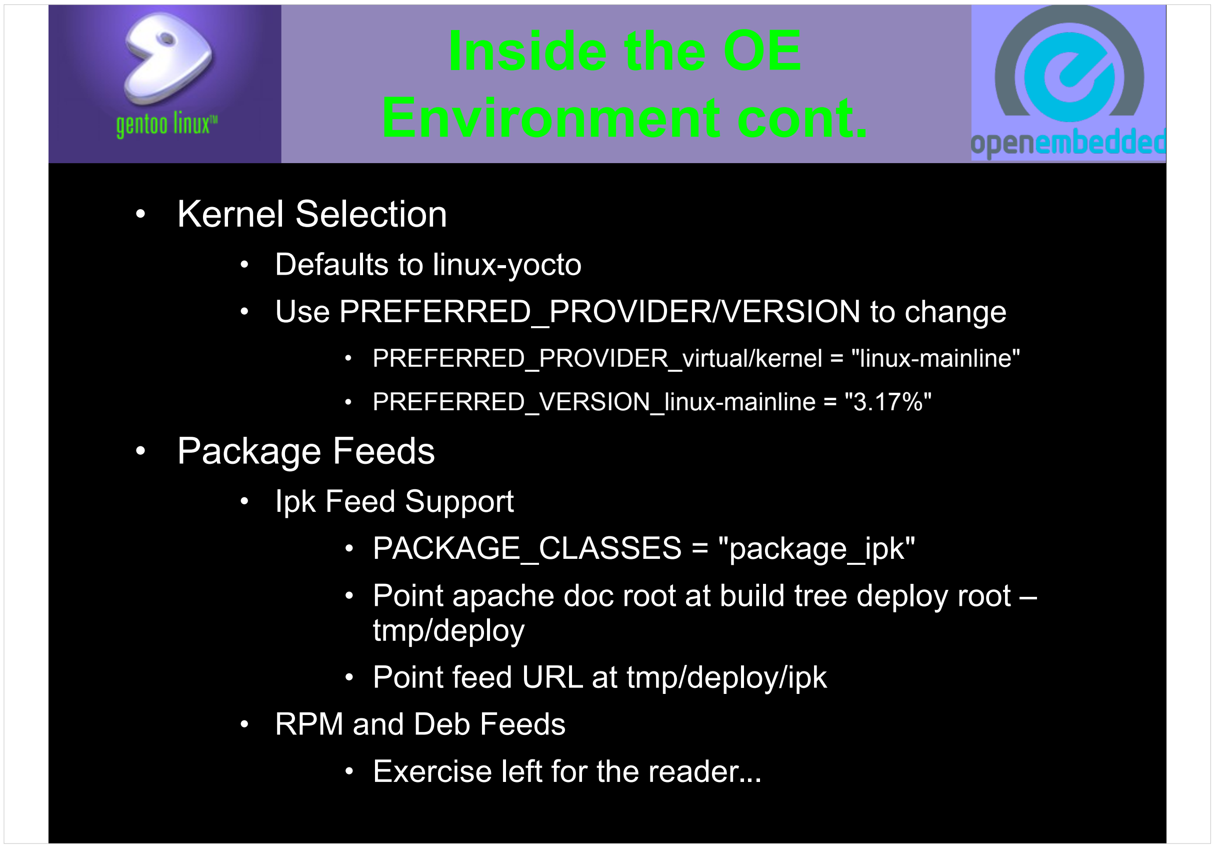
- Enable new metadata (software) layers
- Specify a BSP layer
- Set the full path to poky root

build-foo/conf/local.conf

- Set INHERIT options
- Set PKG_CLASS and PACKAGECONFIG options
- Set LICENSE options
- Set MACHINE and IMAGE options

Metadata file types include package and image recipes (.bb and .bbappend), include files for both recipes and configuration (.inc), configuration files (.conf), and class files (.bbclass). All of them are used to create and extend layers.

Package recipes can include everything from local files to remote git repos in their SRC_URIs (some control over remote fetching is provided via MIRROR settings).



Inside the OE Environment cont.

- Kernel Selection
  - Defaults to linux-yocto
  - Use PREFERRED_PROVIDER/VERSION to change
    - PREFERRED_PROVIDER_virtual/kernel = "linux-mainline"
    - PREFERRED_VERSION_linux-mainline = "3.17%"
- Package Feeds
  - Ipk Feed Support
    - PACKAGE_CLASSES = "package_ipk"
    - Point apache doc root at build tree deploy root – tmp/deploy
    - Point feed URL at tmp/deploy/ipk
  - RPM and Deb Feeds
    - Exercise left for the reader...

References:

http://www.yoctoproject.org/docs/1.7.1/kernel-dev/kernel-dev.html

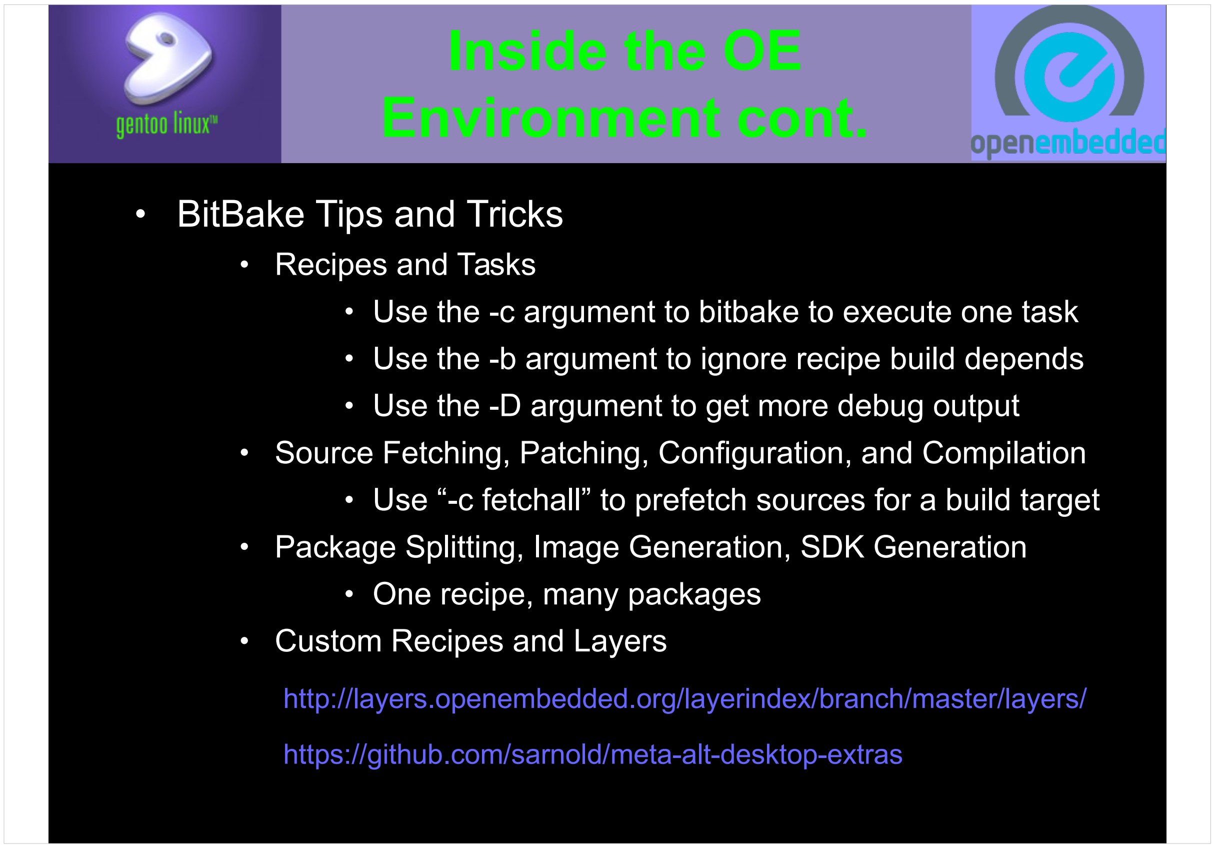
https://www.yoctoproject.org/training/kernel-lab

There are many ways to “skin” the kernel, depending on the specific BSP and kernel recipe:

1) KERNEL_FEATURES (poky-lsb distro config file)
2) Config parameters (linux-raspberrypi/linux.inc)
3) Config “fragment” (kernel recipe/.bbappend SRC_URI)
4) Custom defconfig (kernel recipe/.bbappend SRC_URI)
5) Kernel patches (kernel recipe/.bbappend SRC_URI)
6) Custom recipes or .bbappends (meta-mybsp)

When modifying kernel recipes, adding fragments/patches, etc, bitbake will normally detect the changes and rebuild the recipe. For example, the new kernel can be rebuilt, deployed, and then run with the following commands:

```
$ bitbake virtual/kernel -c deploy
$ runqemu tmp/deploy/images/bzImage-blah.bin \
  tmp/deploy/images/core-image-minimal-blah.ext3
```



Inside the OE Environment cont.

- BitBake Tips and Tricks
  - Recipes and Tasks
    - Use the -c argument to bitbake to execute one task
    - Use the -b argument to ignore recipe build depends
    - Use the -D argument to get more debug output
  - Source Fetching, Patching, Configuration, and Compilation
    - Use "-c fetchall" to prefetch sources for a build target
  - Package Splitting, Image Generation, SDK Generation
    - One recipe, many packages
  - Custom Recipes and Layers

    http://layers.openembedded.org/layerindex/branch/master/layers/

    https://github.com/sarnold/meta-alt-desktop-extras

References:

http://www.openembedded.org/wiki/Bitbake_cheat_sheet
https://community.freescale.com/docs/DOC-94953
http://tinyurl.com/bitbake-1-6

To keep an image build going after non-critical failure:

```
$ bitbake -k <recipe_name>
```

To list the contents of your build environment (can be large):

```
$ bitbake -e core-image-minimal
$ bitbake -e redis-ipc
```

To open a shell in the package source tree with the correct build environment:

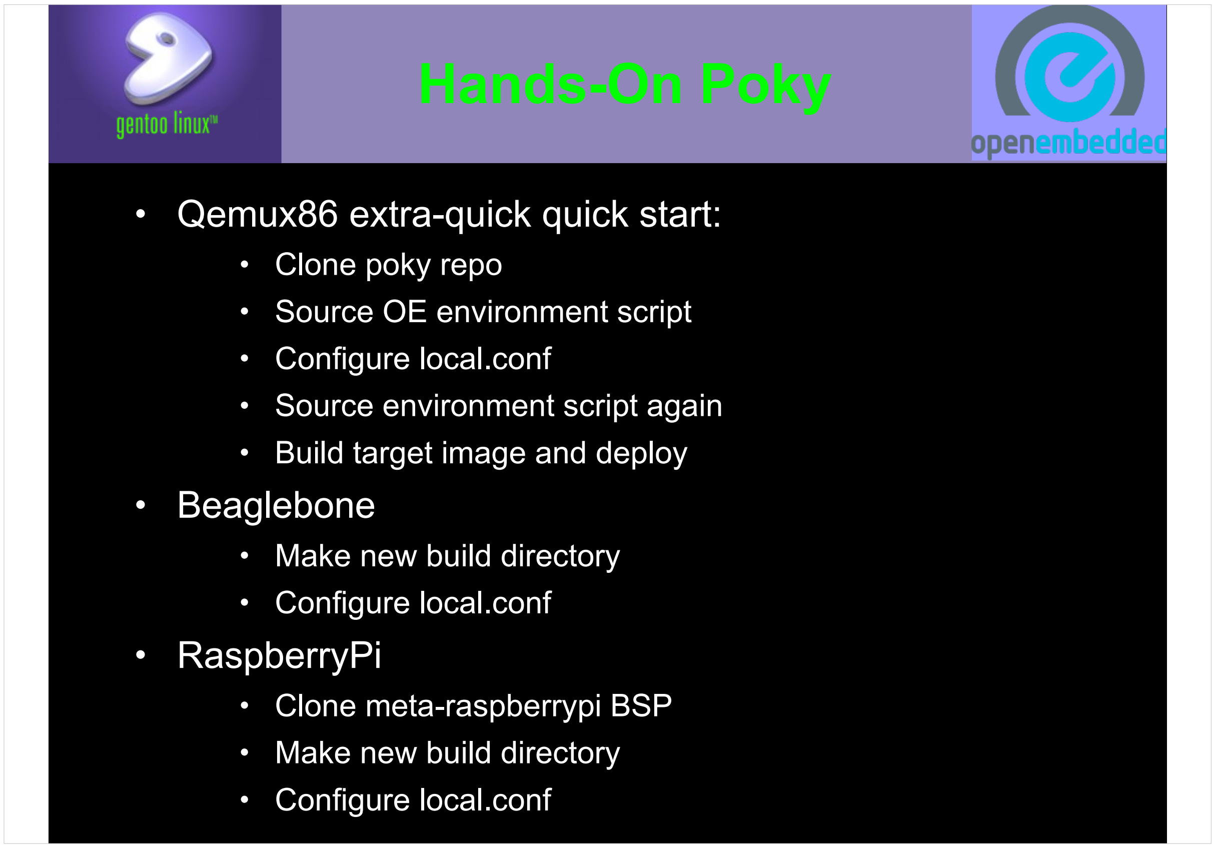
```
$ bitbake <recipe_name> -c devshell
```

To list the available tasks for a given build target:

```
$ bitbake <recipe_name> -c listtasks
```

To generate an SDK specific to a given image target:

```
$ bitbake <image_name> -c populate_sdk
```



Hands-On Poky

- Qemux86 extra-quick quick start:
  - Clone poky repo
  - Source OE environment script
  - Configure local.conf
  - Source environment script again
  - Build target image and deploy
- Beaglebone
  - Make new build directory
  - Configure local.conf
- RaspberryPi
  - Clone meta-raspberrypi BSP
  - Make new build directory
  - Configure local.conf

Clone poky, check out release/master branch

```
$ git clone http://git.yoctoproject.org/git/poky
$ cd <poky-dir> && git checkout master
$ source oe-init-build-env build-x86
```

Changes to <poky-dir>/<build-dir>/conf/local.conf:

```
MACHINE = "qemux86"
DL_DIR ?= "/home/user/downloads"
SSTATE_DIR ?= "/home/user/shared-state/poky-std"
PACKAGE_CLASSES ?= "package_ipk"
INHERIT += "rm_work"
INHERIT += "buildhistory"
INHERIT += "toaster"
DISTRO_FEATURES_append = " pam"
```

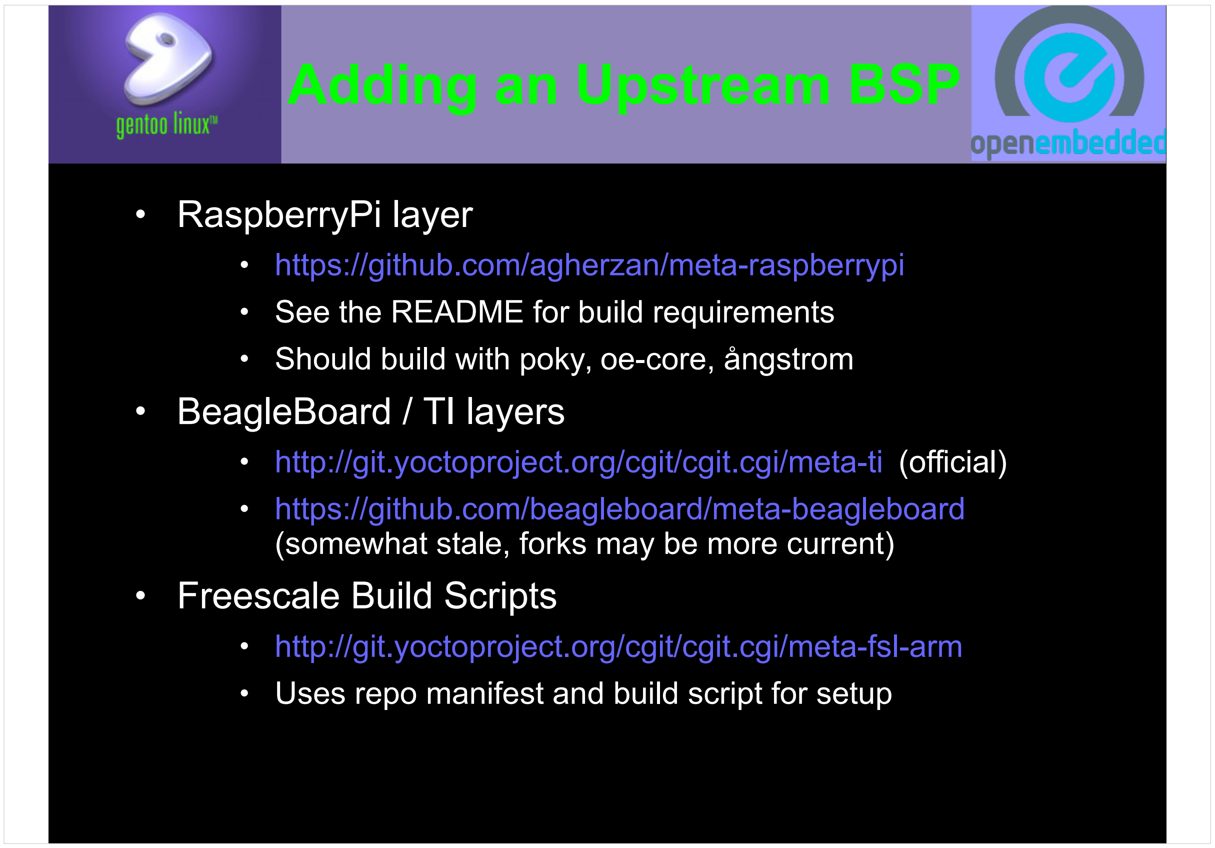
```
$ cd <poky-dir> && source oe-init-build-env build-x86
$ bitbake core-image-minimal
$ runqemu /path/to/kernel.bin /path/to/image.ext3
```

Official Yocto Project Quick Start Guide

http://tinyurl.com/yocto-1-7

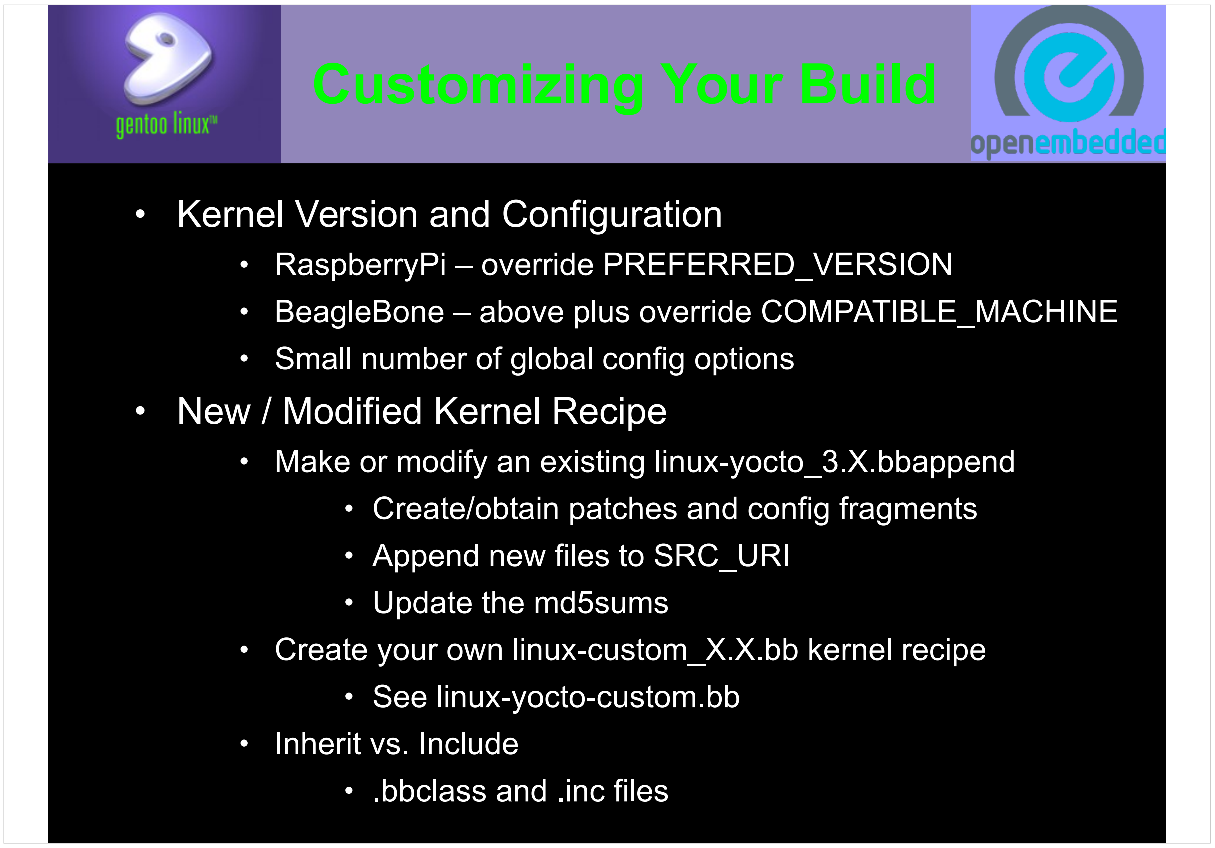
OpenEmbedded OE-Core Quick Start

http://openembedded.org/wiki/OE-Core_Standalone_Setup



Adding an Upstream BSP

- RaspberryPi layer
  - https://github.com/agherzan/meta-raspberrypi
  - See the README for build requirements
  - Should build with poky, oe-core, ångstrom
- BeagleBoard / TI layers
  - http://git.yoctoproject.org/cgit/cgit.cgi/meta-ti (official)
  - https://github.com/beagleboard/meta-beagleboard (somewhat stale, forks may be more current)
- Freescale Build Scripts
  - http://git.yoctoproject.org/cgit/cgit.cgi/meta-fsl-arm
  - Uses repo manifest and build script for setup



Customizing Your Build

- Kernel Version and Configuration
  - RaspberryPi – override PREFERRED_VERSION
  - BeagleBone – above plus override COMPATIBLE_MACHINE
  - Small number of global config options
- New / Modified Kernel Recipe
  - Make or modify an existing linux-yocto_3.X.bbappend
    - Create/obtain patches and config fragments
    - Append new files to SRC_URI
    - Update the md5sums
  - Create your own linux-custom_X.X.bb kernel recipe
    - See linux-yocto-custom.bb
  - Inherit vs. Include
    - .bbclass and .inc files

References:

http://www.yoctoproject.org/docs/latest/kernel-dev/kernel-dev.html
http://www.yoctoproject.org/docs/latest/bsp-guide/bsp-guide.html
http://www.yoctoproject.org/docs/latest/adt-manual/adt-manual.html

Different kernel recipes from various BSPs can take somewhat different approaches to kernel builds and configuration (see the linux-raspberrypi vs. linux-yocto recipes). The following config fragment method is from the latest Yocto Kernel Dev Guide.

1) Complete a kernel build at least through the configuration task:

```
$ bitbake linux-yocto -c kernel_configme -f
```

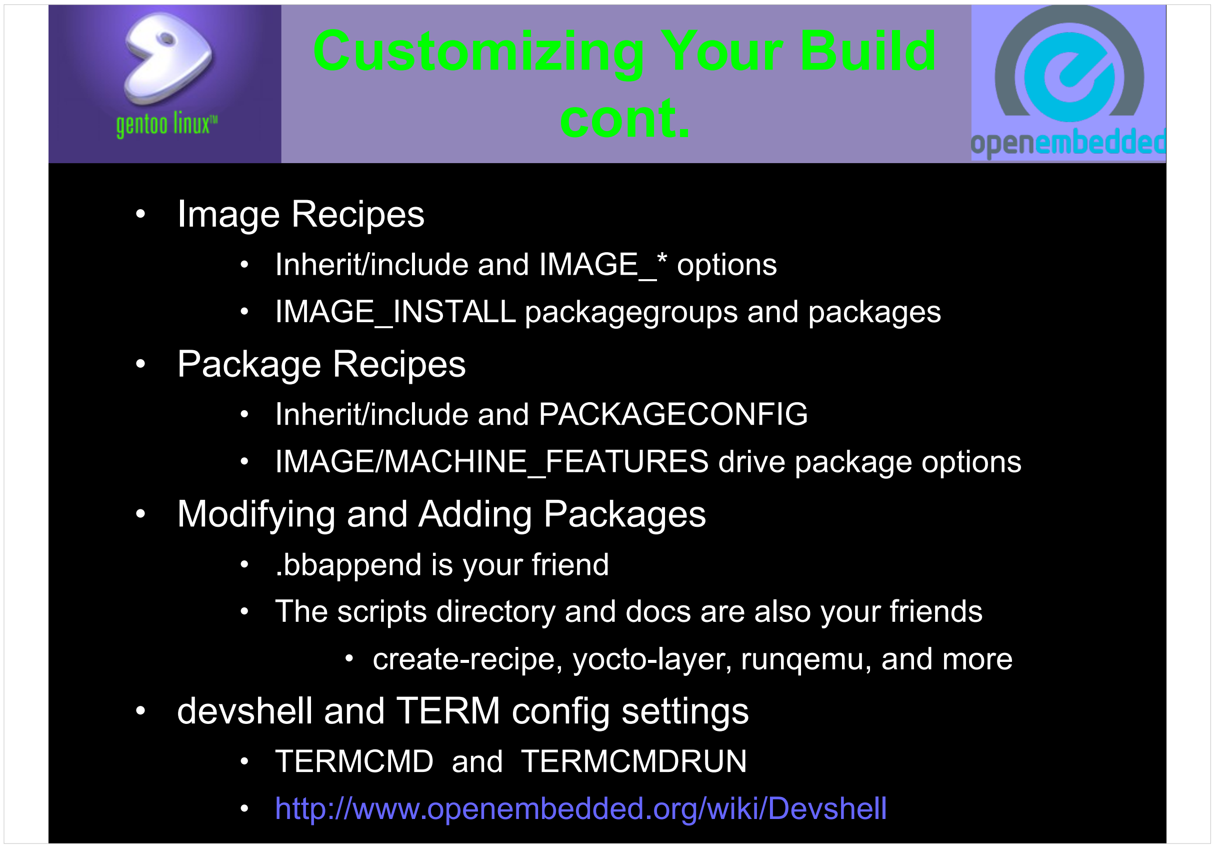
2) Run the menuconfig command:

```
$ bitbake linux-yocto -c menuconfig
```

3) Run the diffconfig command to prepare a configuration fragment. fragment.cfg will be in the ${WORKDIR} directory:

```
$ bitbake linux-yocto -c diffconfig
```

The diffconfig command creates a file that is a list of kernel CONFIG_ assignments.



Customizing Your Build cont.

- Image Recipes
  - Inherit/include and IMAGE_* options
  - IMAGE_INSTALL packagegroups and packages
- Package Recipes
  - Inherit/include and PACKAGECONFIG
  - IMAGE/MACHINE_FEATURES drive package options
- Modifying and Adding Packages
  - .bbappend is your friend
  - The scripts directory and docs are also your friends
    - create-recipe, yocto-layer, runqemu, and more
- devshell and TERM config settings
  - TERMCMD and TERMCMDRUN
  - http://www.openembedded.org/wiki/Devshell

With recipes, less is more. See core-image-minimal.bb vs. core-image-sato.bb

Also be careful with config options (eg, FEATURES) that aren't required, as the build can balloon in size due to dependency resolution.

So what did we do to update the beaglebone kernel?

1) We made changes to local.conf

```
COMPATIBLE_MACHINE_beaglebone = "beaglebone"
PREFERRED_VERSION_linux-yocto = "3.17.%"
```

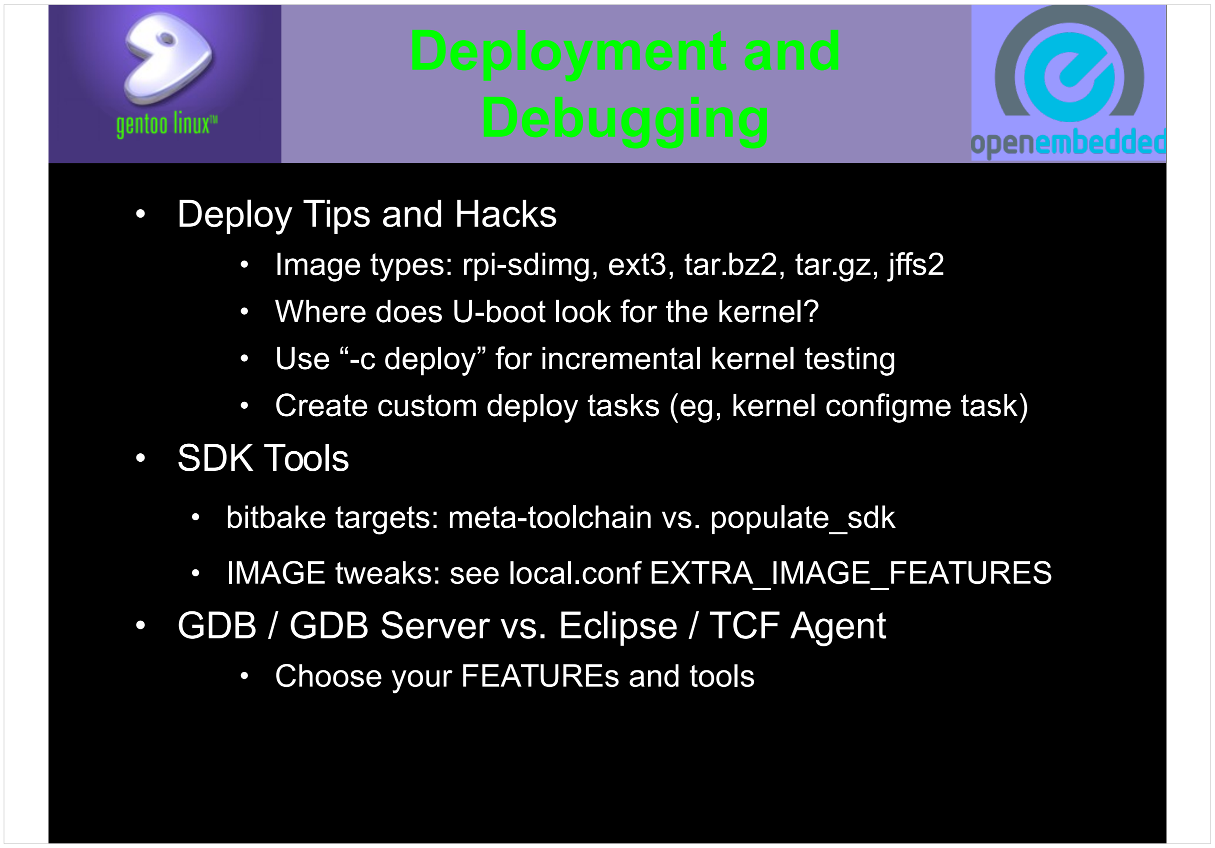
But, the linux-yocto recipe only sets qemu-compatible machines, and we also need to change the kernel configuration, so:

2) We created a new config fragment and .bbappend for linux-yocto_3.17.bb:

```
FILESEXTRAPATHS_prepend := "${THISDIR}/${PN}:"
SRC_URI_append_beaglebone = " file://ohci.cfg "
KBRANCH_beaglebone = "standard/beaglebone"
SRCREV_machine_beaglebone ?= "0409b1fbed221e61212e17b7637fa54f908d83f6"
COMPATIBLE_MACHINE_beaglebone = "beaglebone"
```

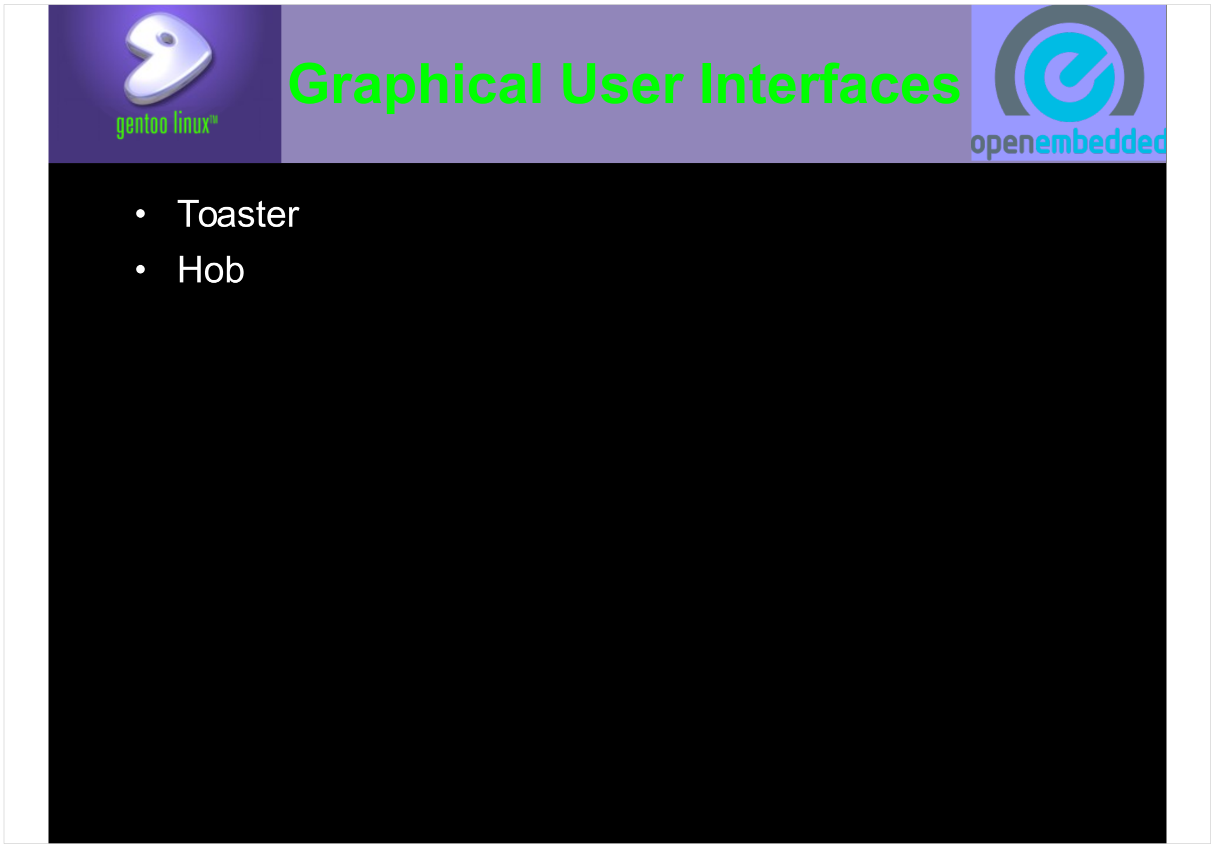
The config fragment in this case simply enables the OHCI OMAP support:

```
CONFIG_USB_OHCI_HCD=y
CONFIG_USB_OHCI_HCD_OMAP3=y
```



Deployment and Debugging

- Deploy Tips and Hacks
    - Image types: rpi-sdimg, ext3, tar.bz2, tar.gz, jffs2
    - Where does U-boot look for the kernel?
    - Use “-c deploy” for incremental kernel testing
    - Create custom deploy tasks (eg, kernel configme task)
- SDK Tools
    - bitbake targets: meta-toolchain vs. populate_sdk
    - IMAGE tweaks: see local.conf EXTRA_IMAGE_FEATURES
- GDB / GDB Server vs. Eclipse / TCF Agent
    - Choose your FEATUREs and tools



Graphical User Interfaces

- Toaster
- Hob