Introduction to the Yocto Project

Developer’s perspective

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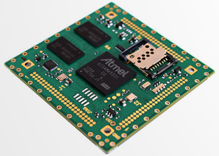


naBerTech

Software Development Company

http://www.nabertech.com/

What is the Yocto Project

- An open source project hosted at The Linux Foundation
- A collection of:
    - embedded projects
    - application development tools

Goals

- Help to build a Linux distribution for embedded systems
- Improving the software development process for embedded Linux distributions

“Is not an Embedded Linux Distribution - It creates a custom one for You!”

Benefits

- Support for all major embedded archs
  - x86, x86-64, ARM, PPC, MIPS
- Start with a validated collection of software
- Access to a collection of application developer tools
- Modular development through the Layer model

Build System: Poky

Poky consist of:

- **Bitbake**: execute and manage all the build steps
- **Metadata**: task definitions:
  - Configuration (.conf): global definition of variables
  - Classes (.bbclass): define the build logic, the packaging ...
  - Recipes (.bb): defines the individual piece of software/image to be build

Recipes

Contains the following metadata:

- Repository or Path of the source code of the packages to build
- Patches to apply
- Dependencies from other recipes or from libraries
- Configuration and compilation options
- Define the packages to create and what files goes into the packages.

Recipes Build Process

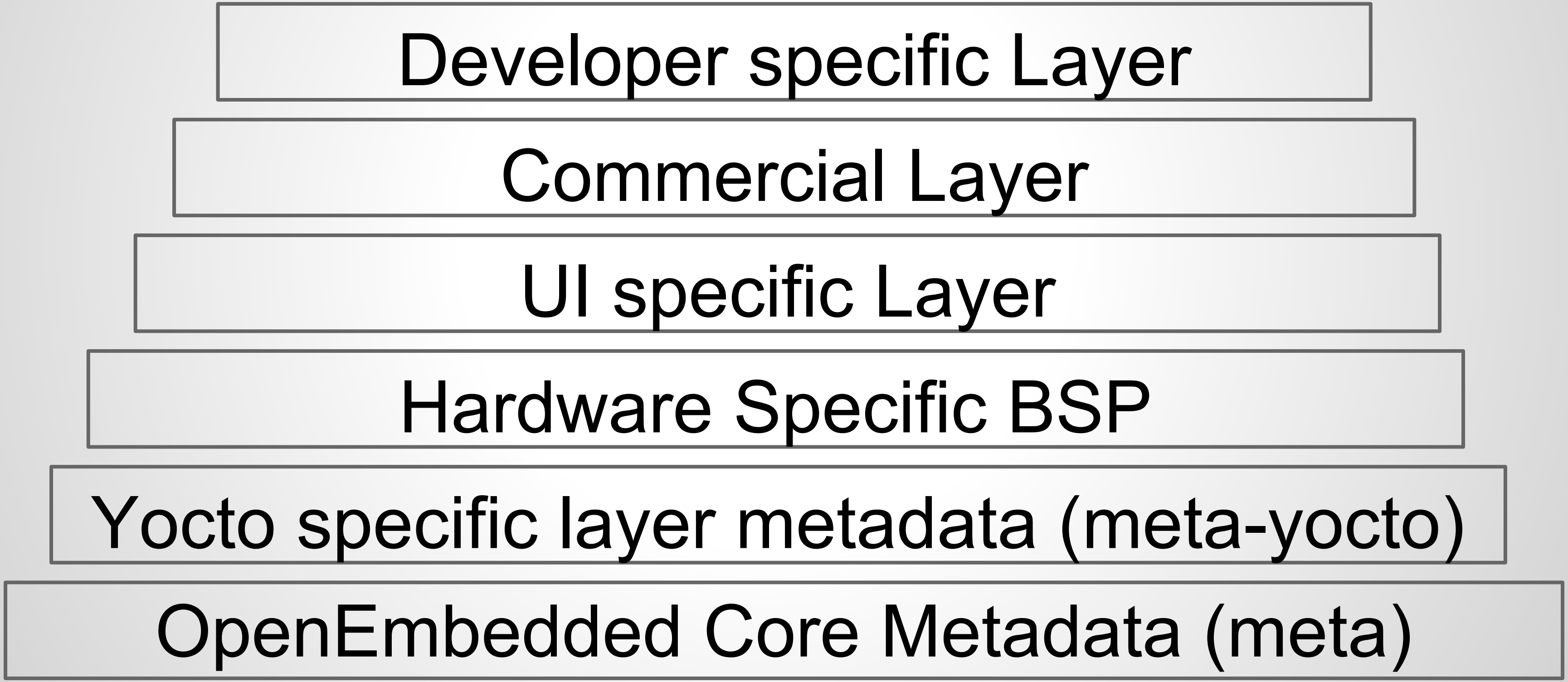
Bitbake build a recipe following this steps:

- fetch and unpack:
    - can get the source files from tarballs, git, svn, etc.
    - the source files are extracted into the work directory
    - and packed into download directory for future builds.
- patch:
    - the extracted source files are then patched

Recipes Build Process (cont)

- configure and install
  - many standard build rules are available as autotools, cmake, gettext
  - put the build into the staging area
- package generation
  - create packages for dev, docs, locales
  - support the formats ipk, Debian, RPM

Layers



Developer specific Layer

Commercial Layer

UI specific Layer

Hardware Specific BSP

Yocto specific layer metadata (meta-yocto)

OpenEmbedded Core Metadata (meta)

Quick Start

Core image for qemux86

Get the Yocto Project:

https://www.yoctoproject.org/downloads

or run:

```
git clone -b daisy git://git.yoctoproject.org/poky.git
```

Init the environment

```
source oe-init-build-env
```

Core image for qemux86 (cont)

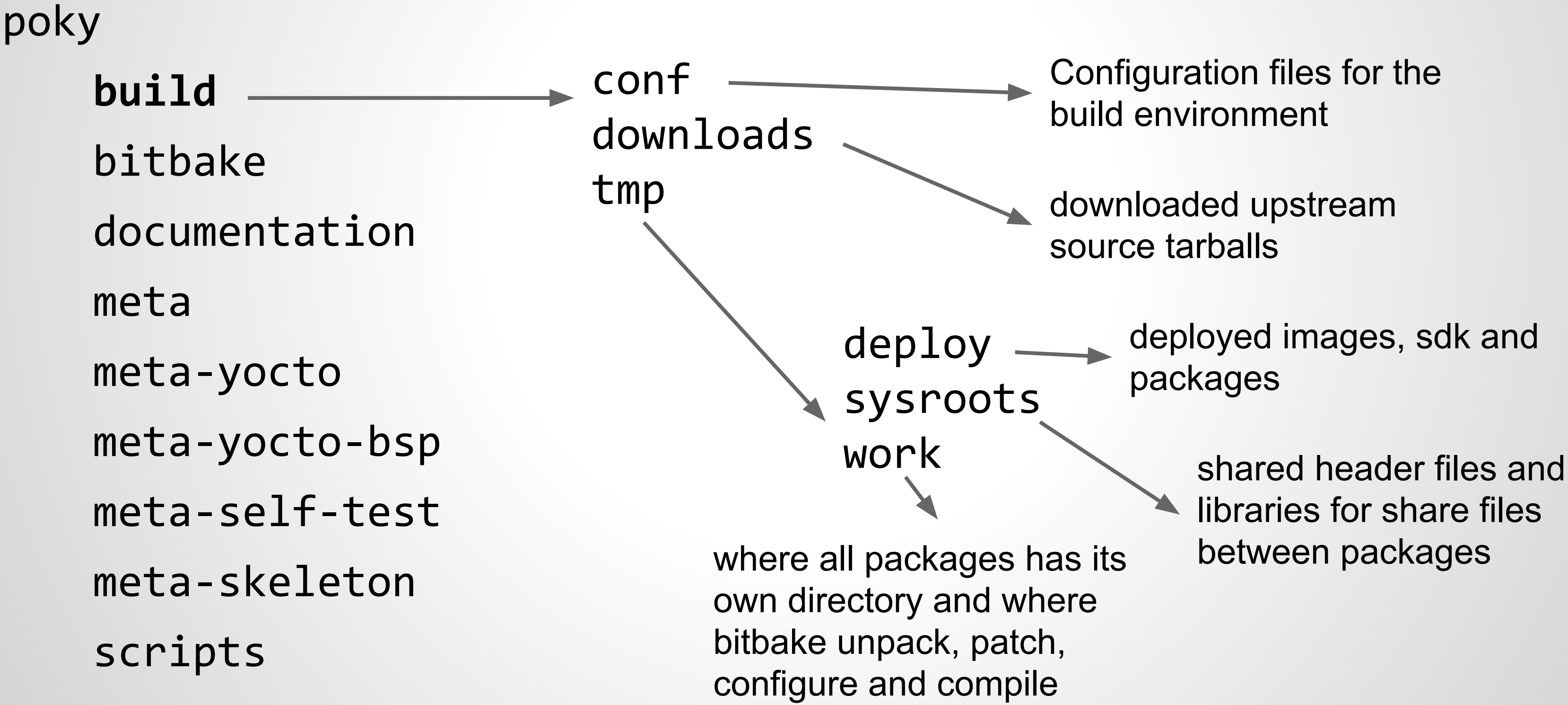
Create the image

```
bitbake core-image-minimal
```

Run emulator

```
runqemu qemux86
```

Poky Folders Overview



poky

- **build**
- bitbake
- documentation
- meta
- meta-yocto
- meta-yocto-bsp
- meta-self-test
- meta-skeleton
- scripts

conf
downloads
tmp

Configuration files for the build environment

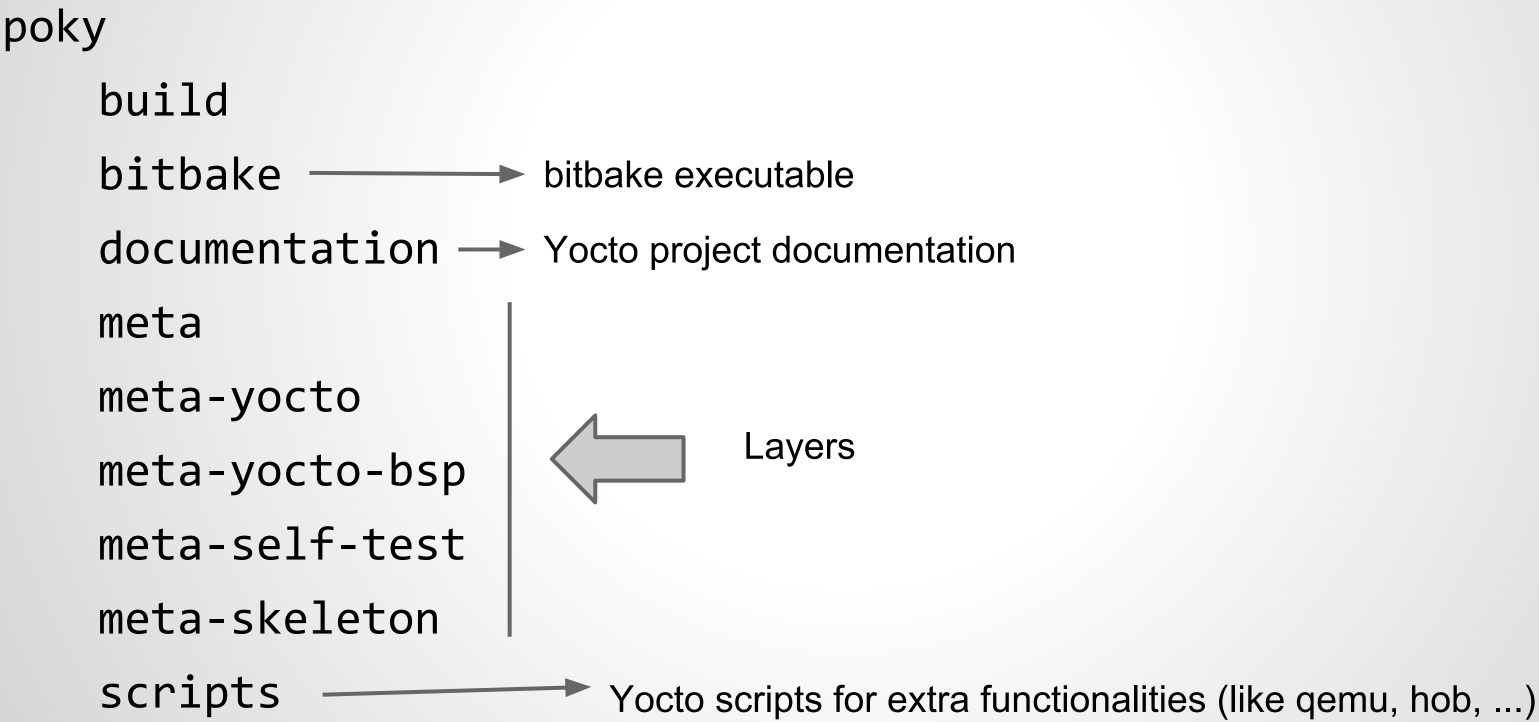
downloaded upstream source tarballs

deploy
sysroots
work

deployed images, sdk and packages

shared header files and libraries for share files between packages

where all packages has its own directory and where bitbake unpack, patch, configure and compile



```
poky
    build
    bitbake
    documentation
    meta
    meta-yocto
    meta-yocto-bsp
    meta-self-test
    meta-skeleton
    scripts
```

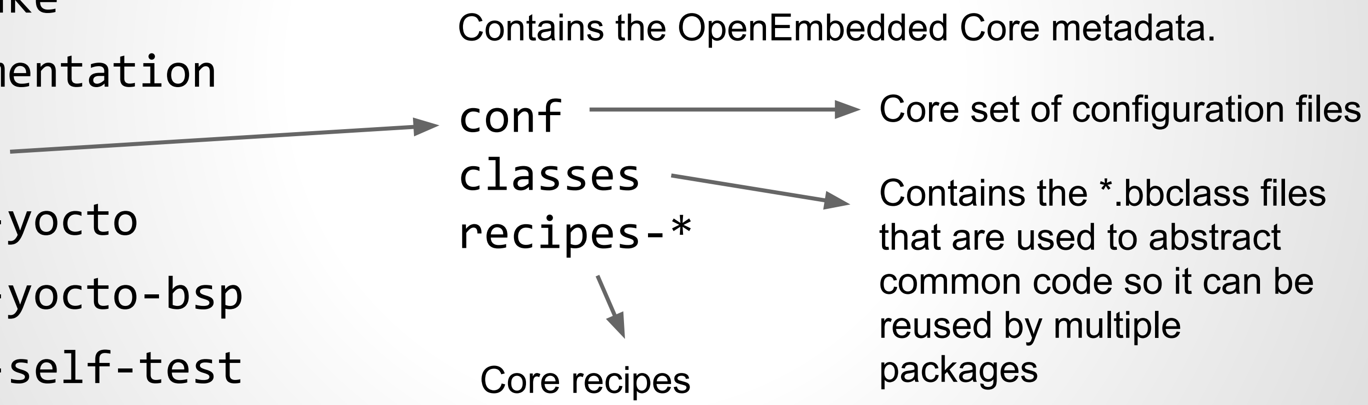
bitbake executable

Yocto project documentation

Layers

Yocto scripts for extra functionalities (like qemu, hob, ...)

```
poky
    build
    bitbake
    documentation
    meta
    meta-yocto
    meta-yocto-bsp
    meta-self-test
    meta-skeleton
    scripts
```



Contains the OpenEmbedded Core metadata.

`conf` → Core set of configuration files

`classes` → Contains the *.bbclass files that are used to abstract common code so it can be reused by multiple packages

`recipes-*` → Core recipes

poky

- build
- bitbake
- documentation
- meta
- **meta-yocto** → Configuration for the poky reference distribution
- **meta-yocto-bsp** → Yocto reference hardware BSP
- **meta-selftest** → Used to verify the behavior of the build system
- **meta-skeleton** → Template recipes for BSP and kernel development
- scripts

Project Example Monitor

Specifications

- Read the status of 8 switches.
- Active 8 Relays accordingly with the switches status
- Show the switches status on a display

Hardware

- **SBC**: Single Board Computer
- **DiDo**: Device that get the status from 8 opto-isolated inputs and set the status to 8 relays. The communication with the host is made through an RS232 serial line
- **Display**: HDMI display

Software

- **Monitor**: application that display the status of switches, based on the GTK+ widget toolkit
- **DiDo Library**: handles the communication with a DiDo device

Test Monitor with qemu

Create a new Layer: meta-monitor

- Create poky subfolder: `meta-monitor`
- add the new layer into `build/conf/bblayers.conf`

```
#[...]
BBLAYERS ?= " \
  /poky-absolute-path/poky/meta \
  /poky-absolute-path/poky/meta-yocto \
  /poky-absolute-path/poky/meta-yocto-bsp \
  /poky-absolute-path/poky/meta-monitor \
  "
#[...]
```

Create DiDo library recipe

Add the new recipe file:

`meta-monitor/recipes-monitor/dido/dido_1.0.0.bb`

```
SUMMARY="Protocol Communication Library for the DiDo devices"
HOMEPAGE="www.example.com/dido"
DEPENDS="boost"
LICENSE="GPLv2+"
LIC_FILES_CHKSUM="file://COPYING;md5=..."
SRCREV="..."
SRC_URI="git://com.example/sw/libdido;protocol=ssh"
S="${WORKDIR}/git"
inherit cmake pkgconfig
```

Package info

Build time recipes dependences

Create DiDo library recipe

Add the new recipe file:

`meta-monitor/recipes-monitor/dido/dido_1.0.0.bb`

```
SUMMARY="Protocol Communication Library for the DiDo devices"
HOMEPAGE="www.example.com/dido"
DEPENDS="boost"
LICENSE="GPLv2+"
LIC_FILES_CHKSUM="file://COPYING;md5=..."
SRCREV="..."
SRC_URI="git://com.example/sw/libdido;protocol=ssh"
S="${WORKDIR}/git"
inherit cmake pkgconfig
```

Source license and Checksums of the license text in the recipe source code.

Create DiDo library recipe

Add the new recipe file:

`meta-monitor/recipes-monitor/dido/dido_1.0.0.bb`

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SUMMARY="Protocol Communication Library for the DiDo devices"
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DEPENDS="boost"
LICENSE="GPLv2+"
LIC_FILES_CHKSUM="file://COPYING;md5=..."
SRCREV="..."
SRC_URI="git://com.example/sw/libdido;protocol=ssh"
S="${WORKDIR}/git"
inherit cmake pkgconfig
```

The revision of the source code used to build the package

How to fetch the source files

Create DiDo library recipe

Add the new recipe file:

`meta-monitor/recipes-monitor/dido/dido_1.0.0.bb`

```
SUMMARY="Protocol Communication Library for the DiDo devices"
HOMEPAGE="www.example.com/dido"
DEPENDS="boost"
LICENSE="GPLv2+"
LIC_FILES_CHKSUM="file://COPYING;md5=..."
SRCREV="..."
SRC_URI="git://com.example/sw/libdido;protocol=ssh"
S="${WORKDIR}/git"
inherit cmake pkgconfig
```

WORKDIR:
`tmp/work/qemux86-poky-linux/dido/1.0.0-r0`

The location in the Build Directory where unpacked recipe source code resides

Create DiDo library recipe

Add the new recipe file:

`meta-monitor/recipes-monitor/dido/dido_1.0.0.bb`

```
SUMMARY="Protocol Communication Library for the DiDo devices"
HOMEPAGE="www.example.com/dido"
DEPENDS="boost"
LICENSE="GPLv2+"
LIC_FILES_CHKSUM="file://COPYING;md5=..."
SRCREV="..."
SRC_URI="git://com.example/sw/libdido;protocol=ssh"
S="${WORKDIR}/git"
inherit cmake pkgconfig
```

Causes the named class to be inherited at this point during parsing.

Create Monitor library recipe

Add the new recipe file:

```
meta-monitor/recipes-monitor/monitor/monitor_1.0.0.bb
```

```
SUMMARY="Monitorize DiDo device"
HOMEPAGE="www.example.com/monitor"
DEPENDS="dido gtk+"
LICENSE="GPLv2+"
LIC_FILES_CHKSUM="file://COPYING;md5=..."
SRCREV="..."
SRC_URI="git://com.example/sw/monitor;protocol=ssh"
S="${WORKDIR}/git"

# continue...
```

Create Monitor library recipe (cont)

`meta-monitor/recipes-monitor/monitor/monitor_1.0.0.bb`

```
FILES_${PN}+=${sysconfdir}/init.d/monitor-boot"

INITSCRIPT_PARAMS = "defaults 99"
INITSCRIPT_NAME = "monitor-boot"

inherit cmake pkgconfig update-rc.d
```

List of directories or files that are placed in the package

The filename of the initialization script as installed to `${sysconfdir}/init.d`

Specifies the name of the script and the options to pass to `update-rc.d`

`inherit update-rc.d.bbclass`

Create Monitor Image recipe

Add the new recipe file:

`meta-monitor/recipes-core/images/monitor-image.bb`

```
IMAGE_FEATURES += "package-management x11-base"
inherit core-image

IMAGE_INSTALL += "dido monitor"
```

Features to include in an image as defined into image.bbclass file.

inherit from `core-image.bbclass`

Specifies the packages to install into the image

Create Monitor layer configuration

Add the new configuration file:

`meta-monitor/conf/layer.conf`

```
BBPATH .= ":${LAYERDIR}"


BBFILES += "${LAYERDIR}/recipes-*/*/*.bb "


BBFILE_COLLECTIONS += "monitorsystem"
BBFILE_PATTERN_monitorsystem := "^${LAYERDIR}/"
BBFILE_PRIORITY_monitorsystem = "5"
```

Add to BBPATH the current layer directory. Used by bitbake to locate . bbclasses and configuration files.

Append all recipes

Append the layer name.
These names are used to find the other BBFILE_* variables

Create Monitor layer configuration

Add the new configuration file:

`meta-monitor/conf/layer.conf`

```
BBPATH .= ":${LAYERDIR}"

BBFILES += "${LAYERDIR}/recipes-*/*/*.bb "

BBFILE_COLLECTIONS += "monitorsystem"
BBFILE_PATTERN_monitorsystem := "^${LAYERDIR}/"
BBFILE_PRIORITY_monitorsystem = "5"
```

Set to a regular expression.
Is used to match files from
BBFILES into a particular layer

Assigns a priority to the layer.
Allows to choose the layer that takes
precedence when the same recipe appear
in multiple layers.

Test Monitor with qemu

Create the image

```
bitbake monitor-image
```

Run emulator

```
runqemu qemux86 monitor-image qemuparams="-usb -usbdevice
serial::/dev/ttyUSB0"
```

Monitor on BeagleBone

Hardware

Processor: AM335x 720MHz ARM Cortex-A8

- 256MB DDR2 RAM
- 3D graphics accelerator
- ARM Cortex-M3 for power management
- 2x PRU 32-bit RISC CPUs

Connectivity

- USB client: power, debug and device
- USB host
- Ethernet
- 2x 46 pin headers

Configure the new machine

Beagle Bone BSP is already contained on meta-yocto-bsp layer:

`meta-yocto-bsp/conf/machine/beaglebone.conf`

Configure the new machine on:

`build/conf/local.conf`

```
#[...]
# Machine Selection
MACHINE ?= "beaglebone"
#[...]
```

Build the image and Deploy (uSD)

Build

```
bitbake monitor-image
```

Create this partitions on uSD:

- FAT32 partition with boot flag, 30MB is enough
- EXT4 partition

```
cp build/tmp/deploy/images/beaglebone/MLO-beaglebone
   path_of_the_first_partition/MLO
cp build/tmp/deploy/images/beaglebone/u-boot-beaglebone.img
   path_of_the_first_partition/u-boot.img
tar -xvf build/tmp/deploy/images/beaglebone/monitor-image.tar.bz2
    -C path_of_the_second_partition
```

Monitor on Seco QuadMo747-X/i.MX6

QuadMo747-X/i.MX6

Freescale™ i.MX6, based on ARM Cortex-A9 processors:

- 4GB DDR3 onboard
- 2D, OpenGL® ES2.0 3D and OpenVG™ accelerators

Connectivity:

- HDMI interface
- eMMC soldered onboard
- MMC/SD/SDIO interface
- 1 x µSD card slot onboard
- Gigabit Ethernet interface
- AC97 Audio Interface
- 1x USB OTG
- 4x USB 2.0 Host

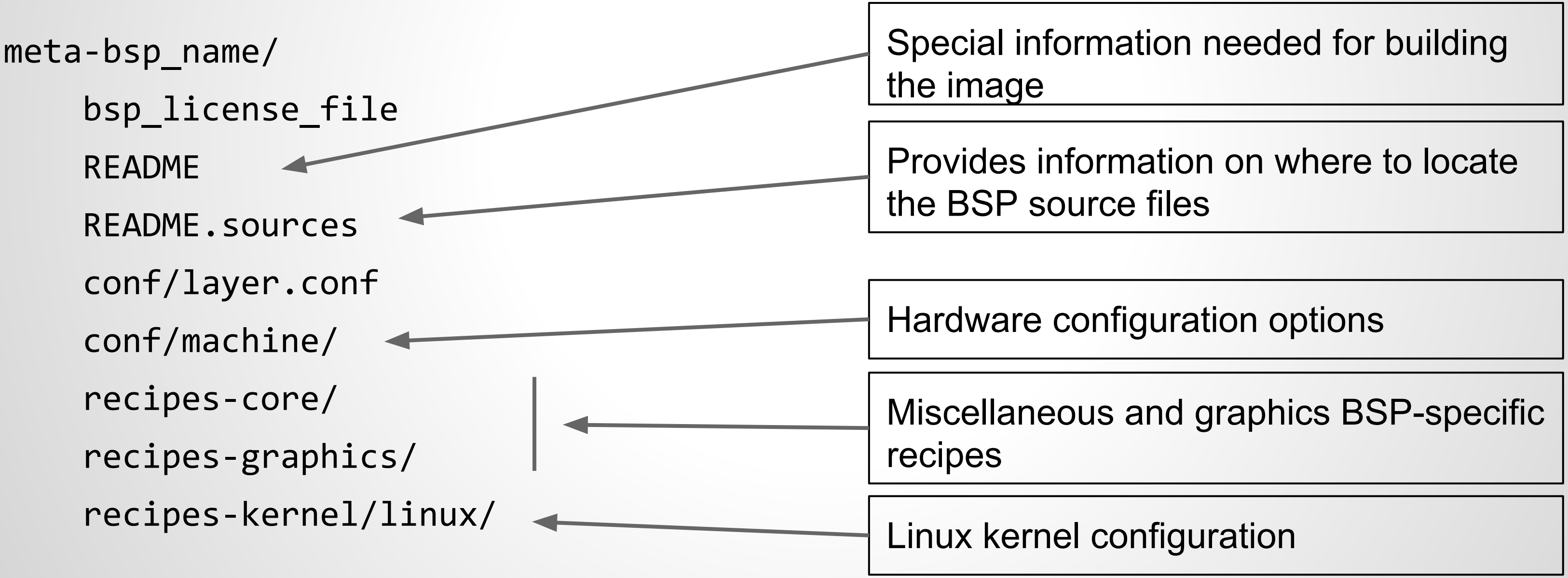
BSP

On https://www.yoctoproject.org/downloads/bsps the QuadMo747-X/i.MX6 is missing.

All that we have is the Kernel Linux from the Seco ufficial site.

Create a custom BSP

Example filesystem layout:



```
meta-bsp_name/
    bsp_license_file
    README
    README.sources
    conf/layer.conf
    conf/machine/
    recipes-core/
    recipes-graphics/
    recipes-kernel/linux/
```

Special information needed for building the image

Provides information on where to locate the BSP source files

Hardware configuration options

Miscellaneous and graphics BSP-specific recipes

Linux kernel configuration

Configure the build

Add the new BSP Layer on

`build/conf/bblayers.conf`

```
#[...]
BBLAYERS ?= " \
  /poky-absolute-path/poky/meta \
  /poky-absolute-path/poky/meta-yocto \
  /poky-absolute-path/poky/meta-yocto-bsp \
  /poky-absolute-path/poky/meta-seco \
  /poky-absolute-path/poky/meta-monitor \
  "
#[...]
```

Configure the build (cont)

Set the new machine on:

`build/conf/local.conf`

```
#[...]
# Machine Selection
MACHINE ?= "quadmo747xiMx6"
#[...]
```

Create BSP layer configuration

Add the new configuration file:

`meta-seco/conf/layer.conf`

```
BBPATH .= ":${LAYERDIR}"

BBFILES += "${LAYERDIR}/recipes-*/*/*.bb"

BBFILE_COLLECTIONS += "seco"
BBFILE_PATTERN_seco := "^${LAYERDIR}/"
BBFILE_PRIORITY_seco = "5"
```

Create New Machine

Add the new machine configuration:

`meta-seco/conf/machine/quadmo747xiMx6.conf`

```
#@TYPE: Machine
#@NAME: quadmo747-x-iMx6 platform
#@DESCRIPTION: quadmo747-x-iMx6 platform configuration

require conf/machine/include/tune-cortexa9.inc

KERNEL_IMAGETYPE = "uImage"

PREFERRED_PROVIDER_virtual/kernel = "linux-quadmo-q7"
```

File to include.
Contains processor params for the compiler

Type of kernel to build

If multiple recipes provide an item, this variable determines which recipe should be given preference.

Kernel package to use

Kernel recipe

Add kernel recipe:

`meta-seco/recipes-kernel/linux/linux-quadmo-q7_3.0.35.bb`

```
DESCRIPTION = "3.0 Linux Development Kernel for quadmo747-x-iMx6 board."
SECTION = "kernel"

LICENSE = "GPLv2"
LIC_FILES_CHKSUM = "file://COPYING;md5=..."

SRCREV = "..."
SRC_URI = "git://com.example/sw/monitor/linux-3.0.35-QUADMO-iMX6;protocol=ssh \
           file://imx6_seco_q7_defconfig.patch \
           file://seco_cpld_h.patch"

S = "${WORKDIR}/git"
```

The name of the section in which packages should be categorized. Can be used by Package management.

Patches

Kernel recipe (cont)

Add kernel recipe:

`meta-seco/recipes-kernel/linux/linux-quadmo-q7_3.0.35.bb`

```
inherit kernel

do_configure() {
        yes '' | oe_runmake imx6_seco_q7_defconfig
}
```

Override bitbake configuration step

Build the image and Deploy (uSD)

Build

```
bitbake monitor-image
```

Create this partition on uSD:

- EXT3 partition

```
tar -xvf build/tmp/deploy/images/quadmo747xiMx6/monitor-image.tar.gz
    -C path_of_the_usd_partition
```

References

https://www.yoctoproject.org/

http://www.yoctoproject.org/docs/1.6.1/mega-manual/mega-manual.html

https://www.yoctoproject.org/downloads/bsps

http://www.yoctoproject.org/docs/1.6/bitbake-user-manual/bitbake-user-manual.html

https://www.youtube.com/watch?v=zNLYanJAQ3s

https://www.yoctoproject.org/sites/default/files/elc-e_2013_devday_introyocto.pdf

https://www.yoctoproject.org/sites/default/files/elc-e_devday_introyocto_2.pdf