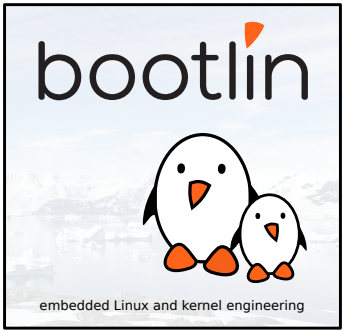
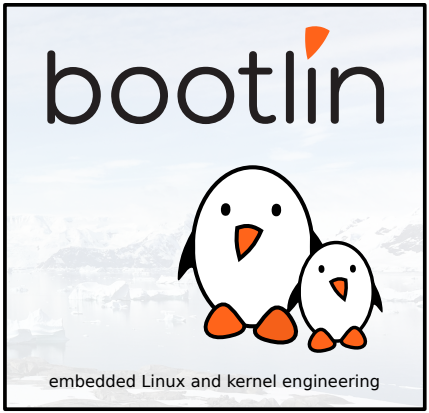
Introduction to the Yocto Project / OpenEmbedded-core

Mylène Josserand
Bootlin
mylene@bootlin.com



Mylène Josserand

- Embedded Linux engineer at Bootlin since 2016
  - Embedded Linux **expertise**
  - **Development**, consulting and training around the Yocto Project
  - One of the authors of Bootlin' **Yocto Project / OpenEmbedded** training materials.
- Kernel contributor: audio driver, touchscreen, RTC and more to come!



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- When you see a ✓, it means it is a **good practice**!

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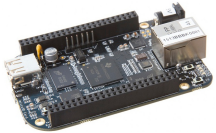

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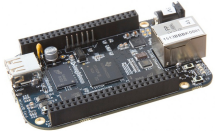

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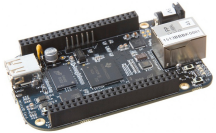

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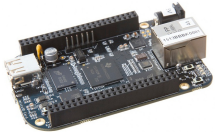

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- **Integration** means packaging applications to create a final image

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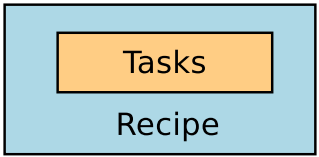

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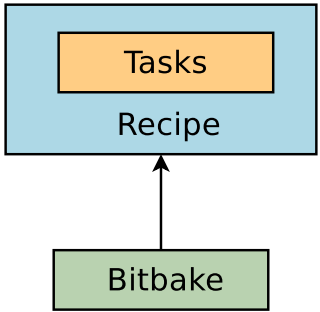

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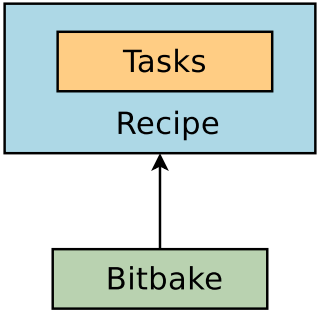

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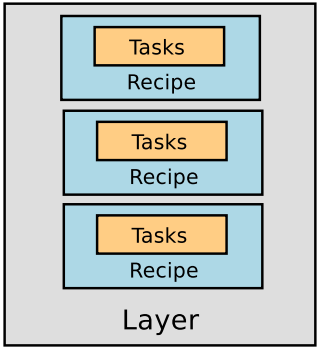

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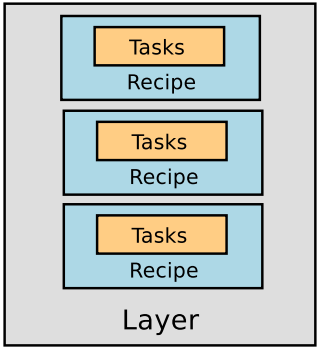

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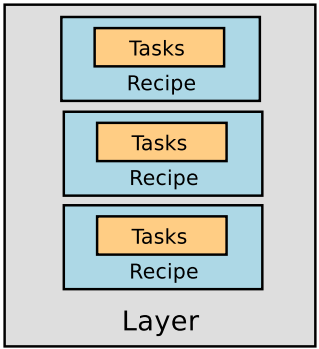

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⇒ This is the aim of the Yocto Project

yocto PROJECT

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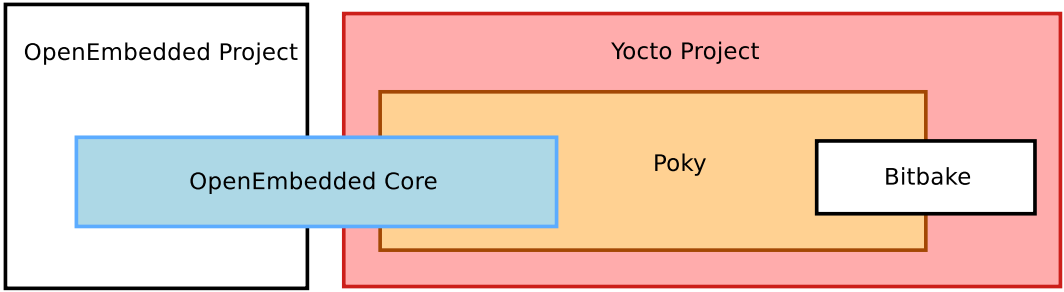
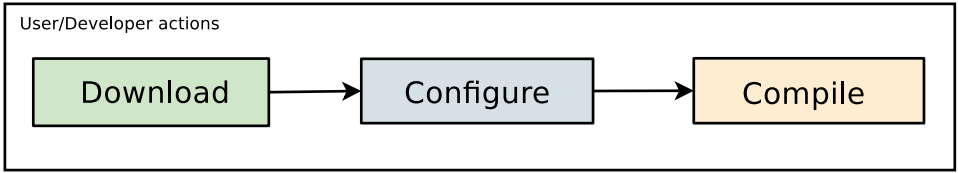
- Also contains some useful tools to ease recipes and layers' creation

The Yocto Project / OpenEmbedded Core / Poky



Workflow - General



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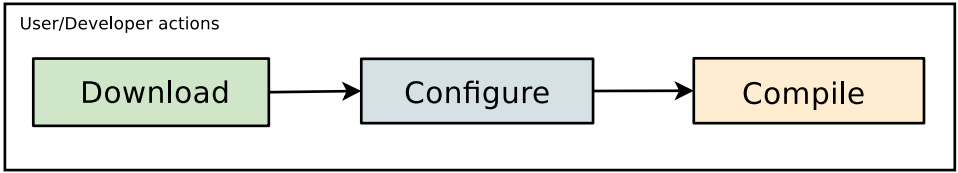

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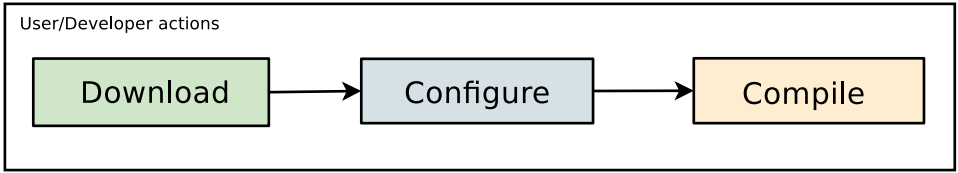
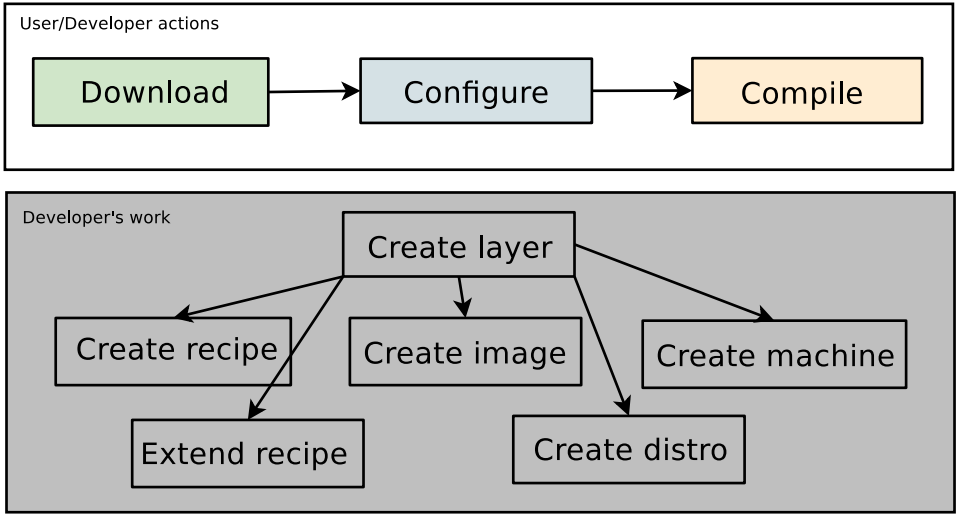


Workflow - Users/Developers actions



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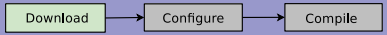

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Figure: `https://wiki.yoctoproject.org/wiki/Releases`

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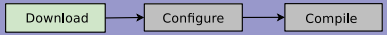

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Workflow - 1. Download

- **Layers** are sets of recipes, matching a common purpose.
  To simplify things, they are just **folders**
- Look at existing layers

Branch: **pyro** | Layers | Recipes | Machines | Distros

Search layers | Filter layers

Layer name	Description	Type	Repository
openembedded-core	Core metadata	Base	git://git.openembedded.org/openembedded-core
meta-oe	Additional shared OE metadata	Base	git://git.openembedded.org/meta-openembedded
meta-96boards	BSP Layer for 96boards platforms	Machine (BSP)	https://github.com/96boards/meta-96boards
meta-aarch64	AArch64 (64-bit ARM) architecture support	Machine (BSP)	git://git.linaro.org/openembedded/meta-linaro.git
meta-acer	Acer machines support	Machine (BSP)	git://github.com/shr-distribution/meta-smartphone.git
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Figure: `http://layers.openembedded.org/layerindex/`

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- **Layers** are sets of recipes, matching a common purpose.
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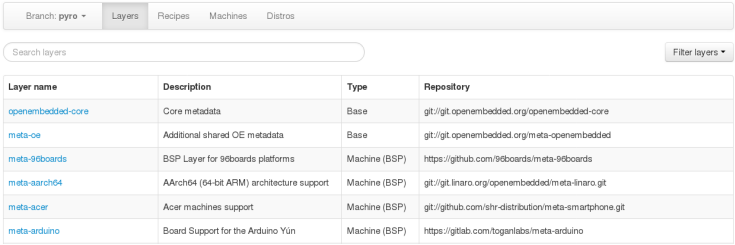

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openembedded-core	Core metadata	Base	git://git.openembedded.org/openembedded-core
meta-oe	Additional shared OE metadata	Base	git://git.openembedded.org/meta-openembedded
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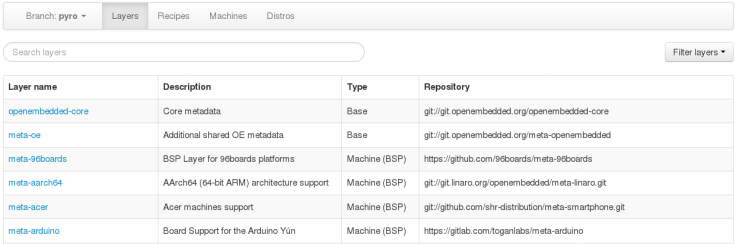

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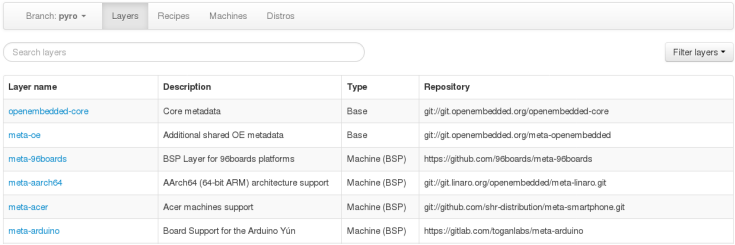

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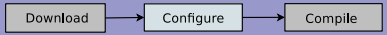

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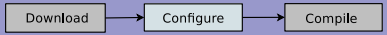

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/home/mylene/yocto/meta-freescale \
/home/mylene/yocto/meta-qt5 \
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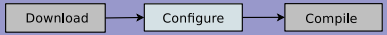

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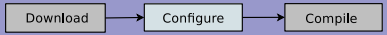

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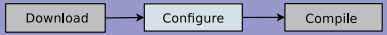

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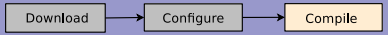

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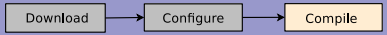

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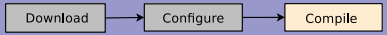

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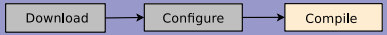

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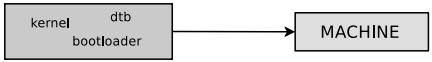

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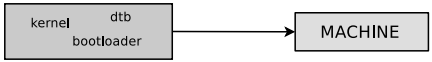

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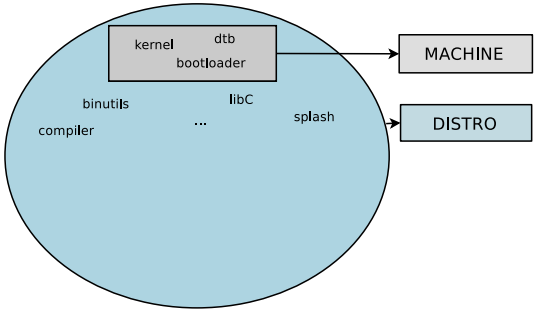

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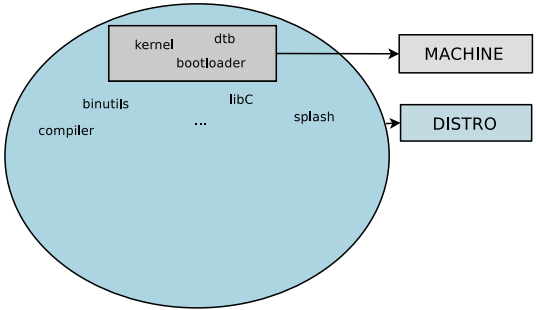

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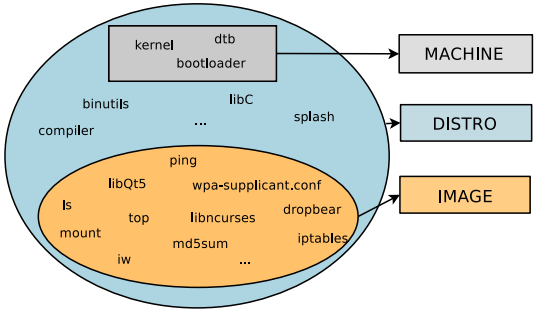
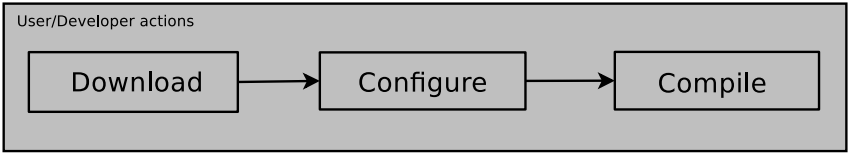
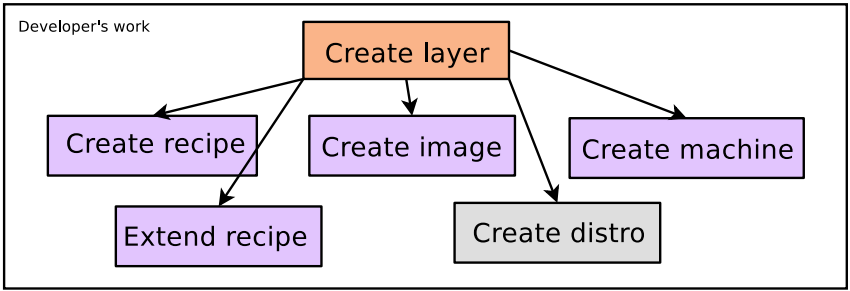
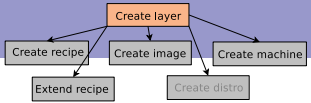


Workflow - Developer





Workflow - 4. Create a layer



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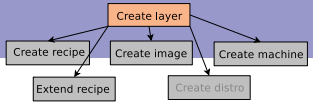

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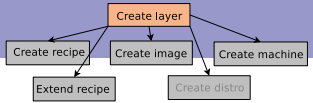

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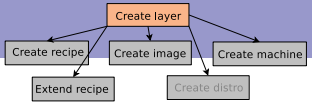

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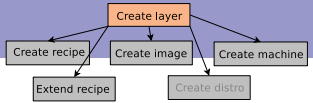

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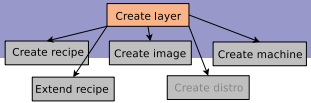

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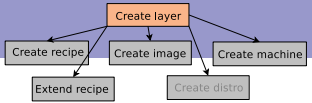

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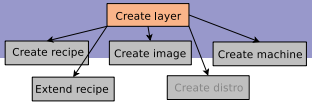
yocto-layer create <layer_name> -o <dest_dir>
```

✓ The layer's name must be `meta-*` (done automatically using `yocto-layer` tool)

Workflow - 4. Create a layer



- You may have **custom hardware**, need to update recipes from upstream layers, integrate your **own application**, etc
- Already said before: DO NOT EDIT POKY/UPSTREAM LAYERS
- To be able to do that, we will create our **own layer** that will host all our modifications/applications
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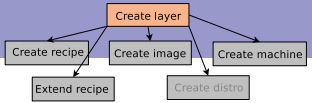

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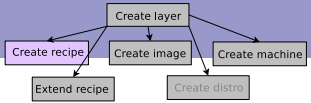
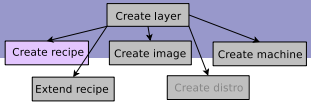
- ✓ If you have different projects with common parts, try to create two layers
  ⇒ Can re-use some parts

Workflow - 5. Create a recipe



Workflow - 5. Create a recipe



- A recipe is a file describing **tasks** for an application to:

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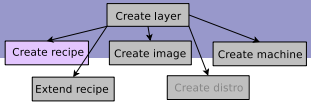

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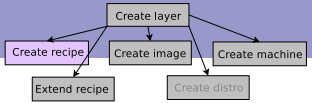

- A recipe is a file describing **tasks** for an application to:
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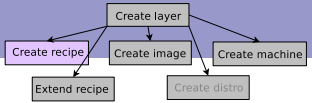
Workflow - 5. Create a recipe



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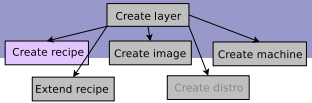

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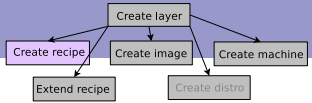

- A recipe is a file describing **tasks** for an application to:
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- It handles all the **dependencies** for you.

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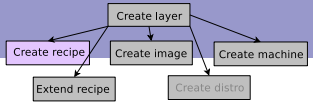

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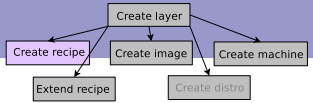

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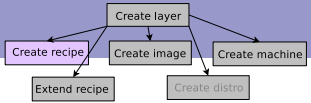
- It handles all the **dependencies** for you.
- Many common **tasks** are already defined by OpenEmbedded-core
- Organized in folders with the same purpose (*recipes-core*, *recipes-bsp*, *recipes-kernel*, *recipes-devtool*, *recipes-support*, ...) and a sub-folder with the application's name

Workflow - 5. Create a recipe



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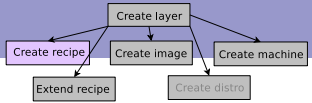

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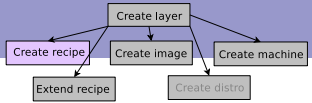

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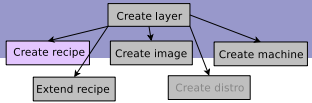

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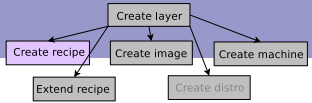

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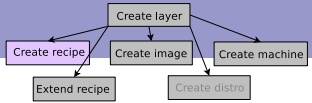

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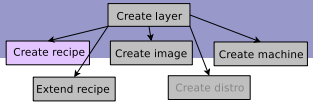

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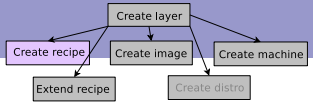
  - The header: what/who. Description of the application
  - The sources: where. Can be tarballs, remote repository, ...
  - The tasks: how. How to proceed with the application's sources
- Classes are available for tasks commonly used: kernel, CMake, autotools, ...

Workflow - 5. Create a recipe



recipes-support/nmon/nmon_13g.bb

```
SUMMARY = "nmon performance monitor"
HOMEPAGE = "http://nmon.sf.net"
SECTION = "console/utils"
LICENSE = "GPLv3"
LIC_FILES_CHKSUM = "file://${WORKDIR}/Documentation.txt;md5=dbb13658cf55d687c4f2ff771a696d4a"
DEPENDS = "ncurses"

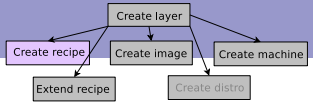
SRC_URI = "${SOURCEFORGE_MIRROR}/nmon/lmon13g.c;name=lmon \
           ${SOURCEFORGE_MIRROR}/nmon/Documentation.txt;name=doc \
"
SRC_URI[lmon.md5sum] = "b1b8e6c0123ad232394991f2d4f40494"
SRC_URI[lmon.sha256sum] = "456ab2a342b31d1a352d0d940af5962fa65a12ae8757ff73e6e73210832ae8b5"
SRC_URI[doc.md5sum] = "dbb13658cf55d687c4f2ff771a696d4a"
SRC_URI[doc.sha256sum] = "1f7f83afe62a7210be5e83cd24157adb854c14599efe0b377a7ecca933869278"

CFLAGS += "-D JFS -D GETUSER -Wall -D LARGEMEM"
LDFLAGS += "-ltinfo -lncursesw"

do_compile() {
   ${CC} ${CFLAGS} ${LDFLAGS} ${WORKDIR}/lmon13g.c -o nmon
}

do_install() {
   install -d ${D}${bindir}
   install -m 0755 nmon ${D}${bindir}
}
```

Workflow - 5. Create a recipe



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          | SRC_URI = "${SOURCEFORGE_MIRROR}/nmon/lmon13g.c;name=lmon \
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          | "
          | SRC_URI[lmon.md5sum] = "b1b8e6c0123ad232394991f2d4f40494"
"Source"  | SRC_URI[lmon.sha256sum] = "456ab2a342b31d1a352d0d940af5962fa65a12ae8757ff73e6e73210832ae8b5"
          | SRC_URI[doc.md5sum] = "dbb13658cf55d687c4f2ff771a696d4a"
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          | CFLAGS += "-D JFS -D GETUSER -Wall -D LARGEMEM"
          | LDFLAGS += "-ltinfo -lncursesw"
          |
          | do_compile() {
          |     ${CC} ${CFLAGS} ${LDFLAGS} ${WORKDIR}/lmon13g.c -o nmon
"Tasks"   | }
          |
          | do_install() {
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          | }
```
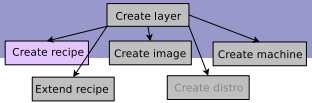
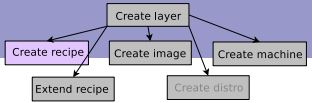

Workflow - 5. Create a recipe



recipes-example/helloworld/helloworld_1.0.bb

```
DESCRIPTION = "Print a friendly, customizable greeting"
HOMEPAGE = "https://www.gnu.org/software/hello/"
PRIORITY = "optional"
SECTION = "examples"
LICENSE = "GPLv3"

SRC_URI = "${GNU_MIRROR}/hello/hello-${PV}.tar.gz"
SRC_URI[md5sum] = "67607d2616a0faaf5bc94c59dca7c3cb"
SRC_URI[sha256sum] = "ecbb7a2214196c57ff9340aa71458e1559abd38f6d8d169666846935df191ea7"
LIC_FILES_CHKSUM = "file://COPYING;md5=d32239bcb673463ab874e80d47fae504"

inherit autotools
```

Workflow - 5. Create a recipe



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          | DESCRIPTION = "Print a friendly, customizable greeting"
          | HOMEPAGE = "https://www.gnu.org/software/hello/"
"Header"  | PRIORITY = "optional"
          | SECTION = "examples"
          | LICENSE = "GPLv3"

          | SRC_URI = "${GNU_MIRROR}/hello/hello-${PV}.tar.gz"
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"Tasks"   | inherit autotools
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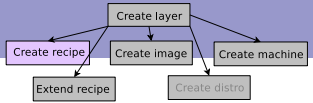

- ✓ Always use **remote repositories** to host your application sources
  ⇒ Makes development quicker + keep history

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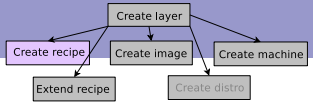

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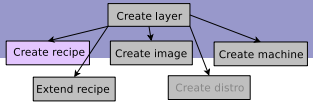

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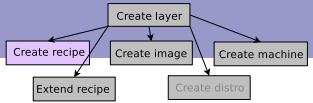

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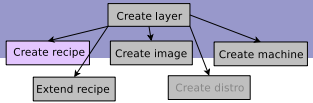

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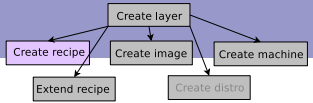

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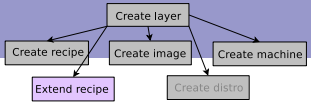
- ✓ Keep the **headers / sources / tasks** organization in the recipe
  ⇒ All the recipes have the same content organization
- ✓ Use/Create **include files** when possible
  ⇒ Can extend other versions easily
- ✓ Know how to **compile** the application **manually** before integrating it in a recipe
  ⇒ Saves you time

Workflow - 6. Extend a recipe



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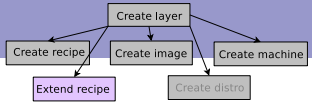

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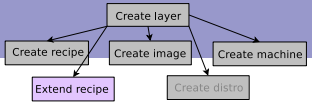

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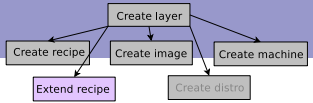

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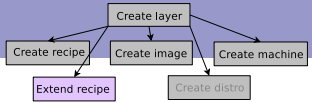
- But it is sometimes useful to modify an existing recipe
- The BitBake *build engine* allows to modify a recipe by **extending** it

Workflow - 6. Extend a recipe



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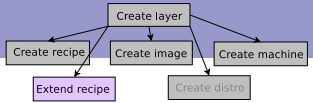

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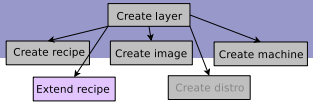

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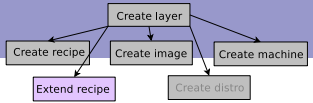
- If adding new files, you must prepend the `FILESEXTRAPATHS` variable with the path to files' directory.

Workflow - 6. Extend a recipe



recipes-support/nmon/nmon_13g.bbappend

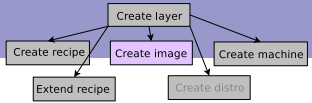
```
FILESEXTRAPATHS_prepend := "${THISDIR}/files:"

SRC_URI += "file://custom-modification-0.patch \
            file://custom-modification-1.patch \
"

do_install_append() {
   # Do something
}
```

```
.
|--- conf
|   |-- layer.conf
|--- recipes-support
    |--- nmon
        |-- files
        |   |-- custom-modification-0.patch
        |   |-- custom-modification-1.patch
        |-- nmon_13g.bbappend
```

Workflow - 7. Create an image



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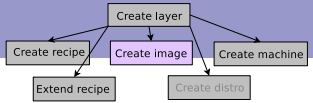

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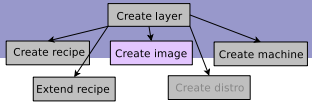

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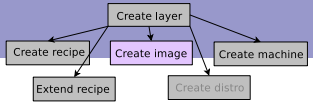

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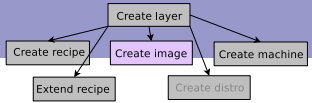

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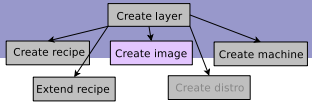

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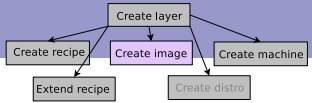

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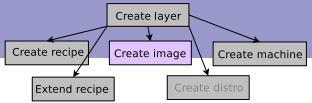

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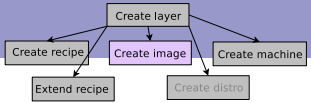
```
mkdir -p recipes-core/images/
touch recipes-core/images/core-image-fe.bb
```

Workflow - 7. Create an image



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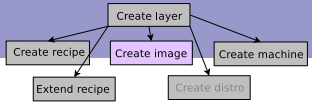

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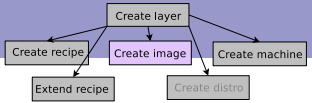

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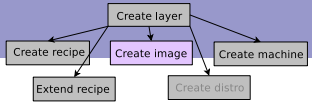

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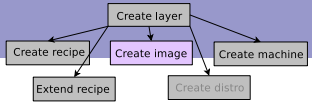

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  ⇒ Allows to have a minimal rootfs

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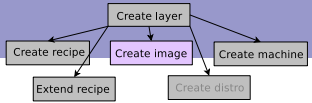

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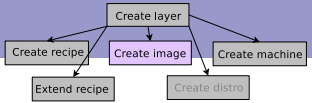
- ✓ Create a **minimal image** to include it in others
  ⇒ Allows to have a minimal rootfs
- ✓ Create different images according to your needs: image-minimal, image-dev, image-x11, image-qt5, etc
  ⇒ Install only what you really need for your board.

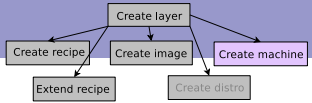
Workflow - 7. Create an image



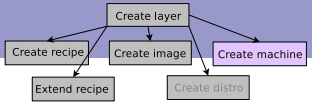
recipes-core/images/core-image-fe.bb

```
inherit core-image

DESCRIPTION = "A small image to boot a device, created for Embedded Recipes"
LICENSE = "MIT"

IMAGE_FSTYPES = "tar.bz2 ext4"
IMAGE_INSTALL = "packagegroup-core-boot \
                 nmon \
                 helloworld \
                 "
```

Workflow - 8. Create a machine

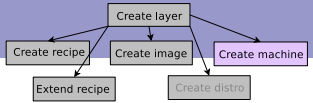


Workflow - 8. Create a machine



- A machine describes your **hardware**

Workflow - 8. Create a machine



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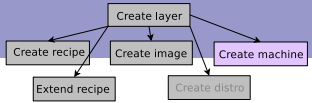

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```
meta-ti/conf/machine/beaglebone.conf
MACHINE = "beaglebone"
```

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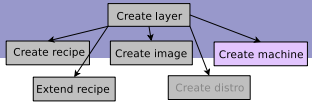

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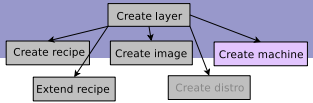

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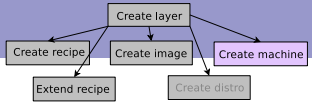

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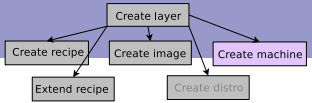

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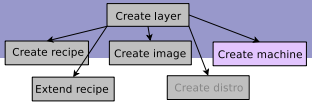
Workflow - 8. Create a machine



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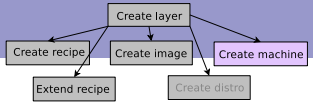

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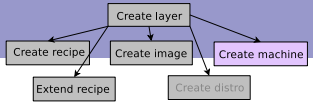
✓ Describe your machine in a `README` file

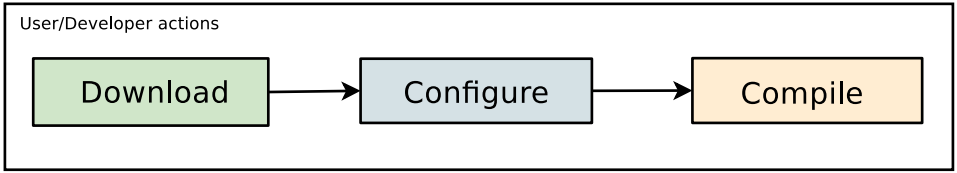
Workflow - 8. Create a machine

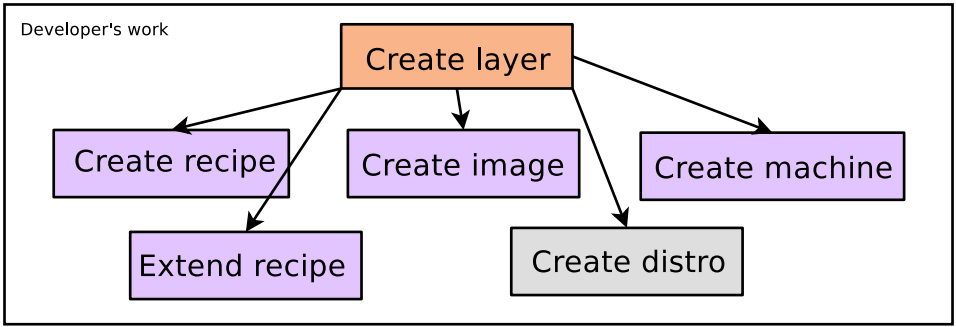


conf/machine/fe-machine.conf

```
require conf/machine/include/soc-family.inc
require conf/machine/include/tune-cortexa5.inc

TARGET_ARCH = "arm"

PREFERRED_PROVIDER_virtual/kernel ?= "linux-at91"
PREFERRED_PROVIDER_virtual/bootloader ?= "u-boot-at91"

KERNEL_IMAGETYPE = "zImage"
KERNEL_DEVICETREE = "at91-sama5d3_xplained.dtb"

SERIAL_CONSOLE ?= "115200 ttyS0"
```

Conclusion


User/Developer actions
Download
Configure
Compile


Developer's work
Create layer
Create recipe
Create image
Create machine
Extend recipe
Create distro

Thank you for listening!

yocto PROJECT

openembedded

Questions? Suggestions? Comments?

Mylène Josserand
mylene@bootlin.com

`http://bootlin.com/pub/conferences/2017/embedded-recipes/josserand-introduction-to-yocto-project/`