AGL AMM

Building AGL with the Yocto Project
- A Crashcourse -

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/me

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Embedded Systems, Selinux, Robotics,
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Trainer for the Linux Foundation
AGL Build Infrastructure / Test / Release

Schedule

Yocto ~ 50 min
AGL Specifics ~ 30 min
Demo/Hands-on ~ 30 min

- I'll talk fast, questions in-between chapters

- Hands-on/Demo deferred to the end

During the middle break:

- We will hand out USB drives
- copy the data from the USB drives
- we need it at the end!

The Yocto Project

- Crashcouse on the Yocto Project
  - The Project, the components
  - bitbake, metadata, layers
  - poky, recipes, operators
  - „when things go wrong“
  - building a filesystem image

Building and Developing for AGL

and the specifics on-top of the Yocto Project:

- Where is the AGL code
- What layers are used
- How to clone and build AGL
- How to set up your (Platform-) Development environment

Demo/Hands-on

- Building AGL for the porter board

  and/or qemux86
- We will use a VM of Ubuntu 15.10
  - **Either** make sure you have VirtualBox installed **AND** the .ova imported
  - **OR** make sure you have Ubuntu 15.10 on your laptop **AND** the tarballs provided by the speaker
  - **YOU NEED at least 50GB of free space.**
  - **We have *no time to debug*, in case just team-up with your neighbour and go on!**

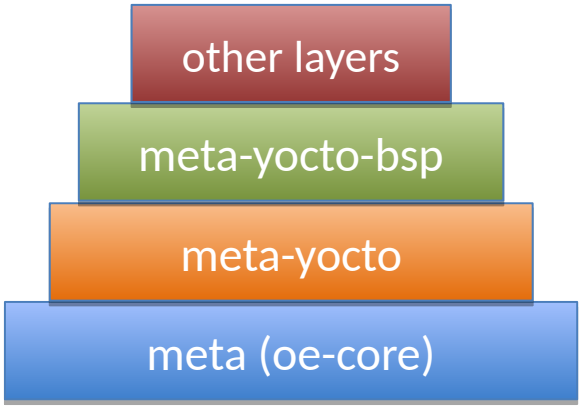
- Let's go ...

Creating a Custom Embedded Linux Distribution for Any Embedded Device Using the Yocto Project

Jan-Simon Moeller
The Linux Foundation
Feb 2016

Yocto Project Overview

- **Collection of tools and methods enabling**
  - Rapid evaluation of embedded Linux on many popular off-the-shelf boards
  - Easy customization of distribution characteristics
- **Supports x86, ARM, MIPS, Power**
- **Based on technology from the OpenEmbedded Project**
- **Layer architecture allows for easy re-use of code**



What is the Yocto Project?

- Umbrella organization under Linux Foundation
- Backed by many companies interested in making Embedded Linux easier for the industry
- Co-maintains OpenEmbedded Core and other tools (including opkg)
- The Linux Foundation provides also a Yocto Project related training:
  - see LFD405 on training.linuxfoundation.org

Yocto Project Governance

- Organized under the Linux Foundation
- Split governance model
- Technical Leadership Team
- Advisory Board made up of participating organizations

Yocto Project Overview

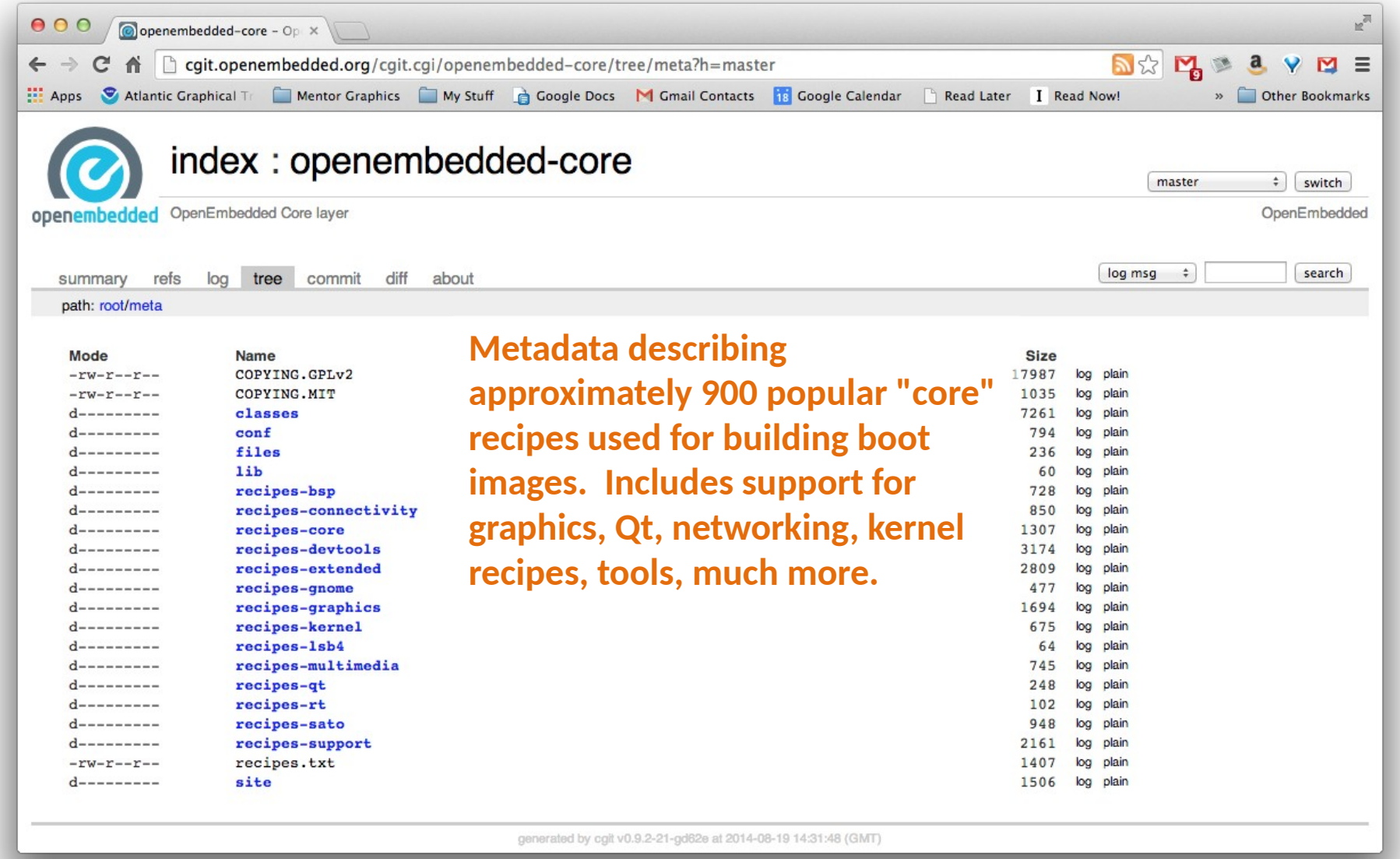
- YP builds packages - then uses these packages to build bootable images
- Supports use of popular package formats including:
  - rpm, deb, ipk
- Releases on a 6-month cadence
- Latest (stable) kernel, toolchain and packages, documentation
- App Development Tools including Eclipse plugin, SDK, toaster

Yocto Project Release Versions

Major Version Releases

Name	Revision	Poky	Release Date
Bernard	1.0	5.0	Apr 5, 2011
Edison	1.1	6.0	Oct 17, 2011
Denzil	1.2	7.0	Apr 30, 2012
Danny	1.3	8.0	Oct 24, 2012
Dylan	1.4	9.0	Apr 26, 2013
Dora	1.5	10.0	Oct 19, 2013
Daisy	1.6	11.0	Apr 24, 2014
Dizzy	1.7	12.0	Oct 31, 2014
Fido	1.8	13.0	April 22, 2015
Jethro	2.0	14.0	Oct 31, 2015

Yocto is based on OpenEmbedded-core



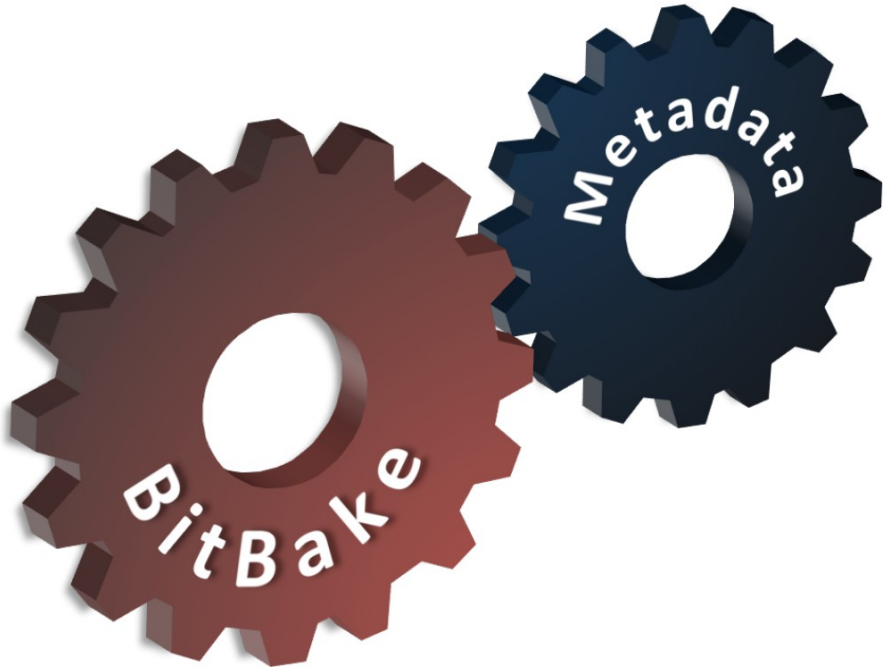
Metadata describing approximately 900 popular "core" recipes used for building boot images. Includes support for graphics, Qt, networking, kernel recipes, tools, much more.

Intro to OpenEmbedded

- **The OpenEmbedded Project co-maintains OE-core build system:**
  - bitbake build tool and scripts
  - Metadata and configuration
- **Provides a central point for new metadata** (see the OE Layer index)

What is Bitbake?

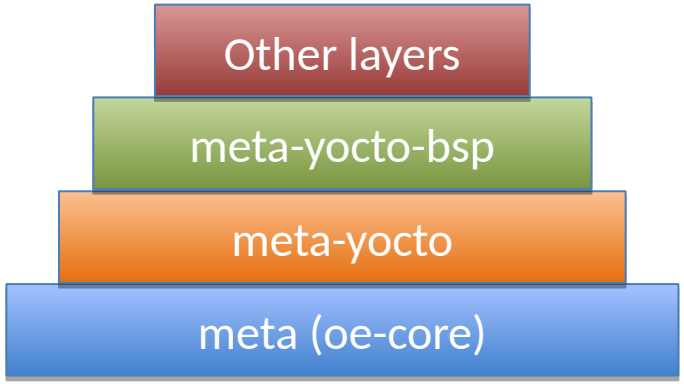
- **Bitbake**
  - Powerful and flexible build engine (Python)
  - Reads metadata…
  - …determines dependencies and schedules tasks



Metadata – a structured collection of "recipes" which tell BitBake what to build, organized in layers

OK, so what is Poky?

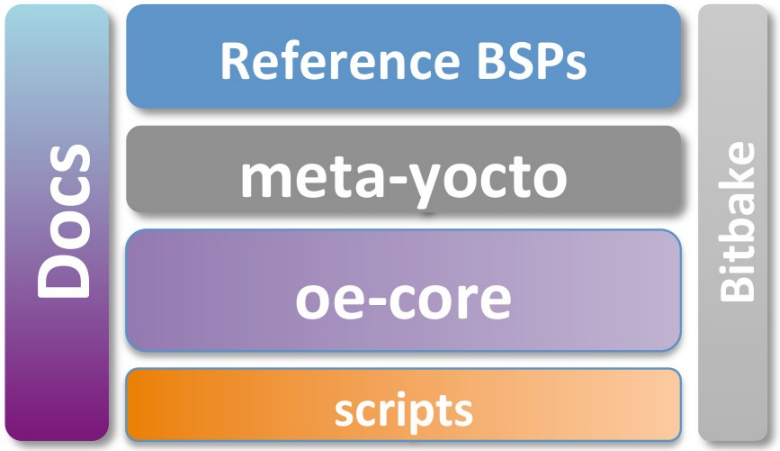
- **Poky is a reference distribution**
- **Poky has its own git repo**
  - git clone git://git.yoctoproject.org/poky
- **Primary Poky layers**
  - oe-core (poky/meta)
  - meta-yocto
  - meta-yocto-bsp



- **Poky is the starting point for building things with yocto**

Poky in Detail

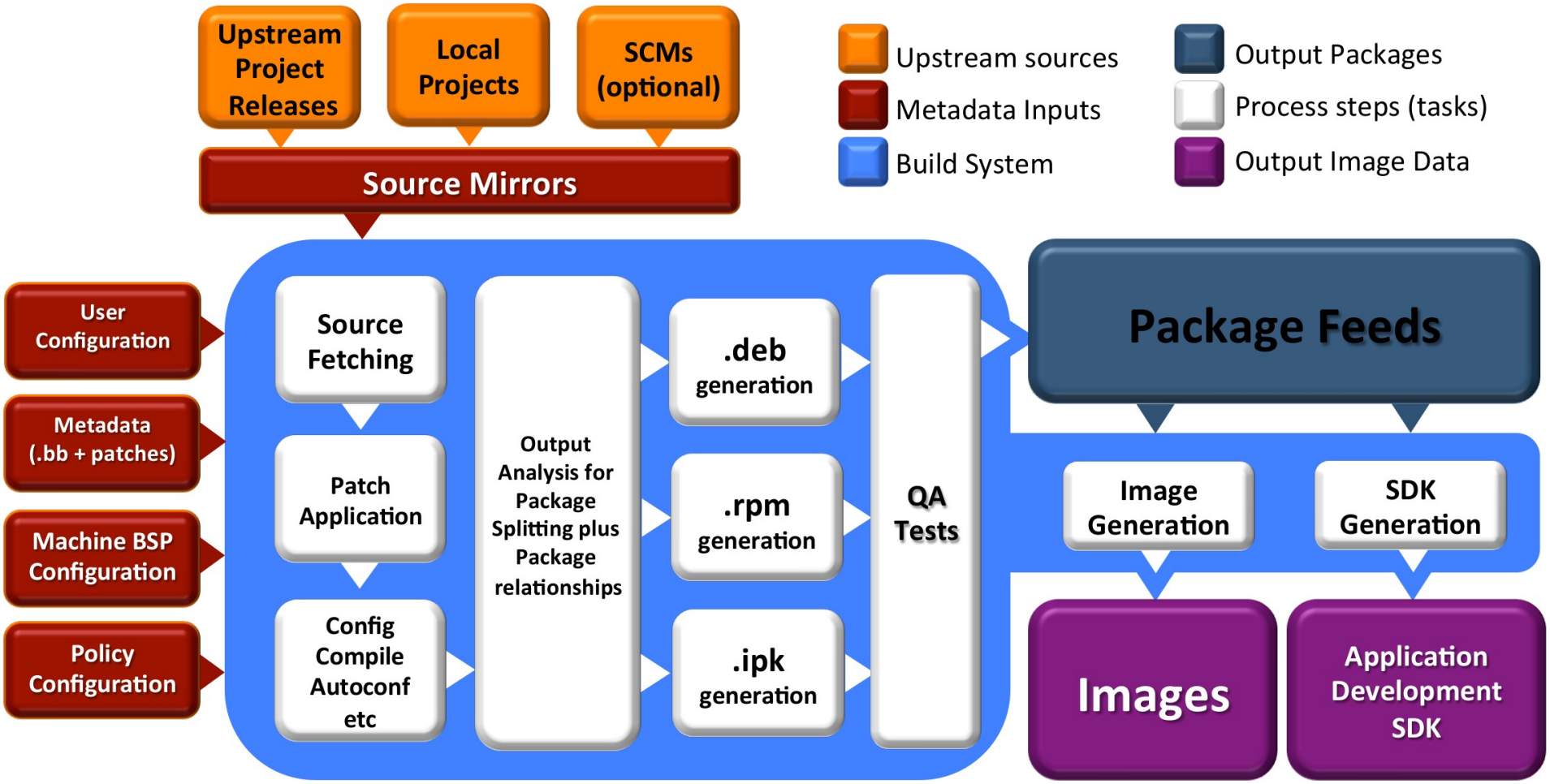
- **Contains core components**
  - Bitbake tool: A python-based build engine
  - Build scripts (infrastructure)
  - Foundation package recipes (**oe-core**)
  - Meta-yocto (Contains distribution policy)
  - Reference BSPs
  - Yocto Project documentation



Putting It All Together

- **Yocto Project** is a large collaboration ('meta-' or 'umbrella-' project)
- **OpenEmbedded** is the build system
- **Bitbake** is the built tool
- **Poky** is the Yocto Project's reference distribution
  - Poky contains a version of bitbake and oe-core from which you can start your project

Build System Workflow

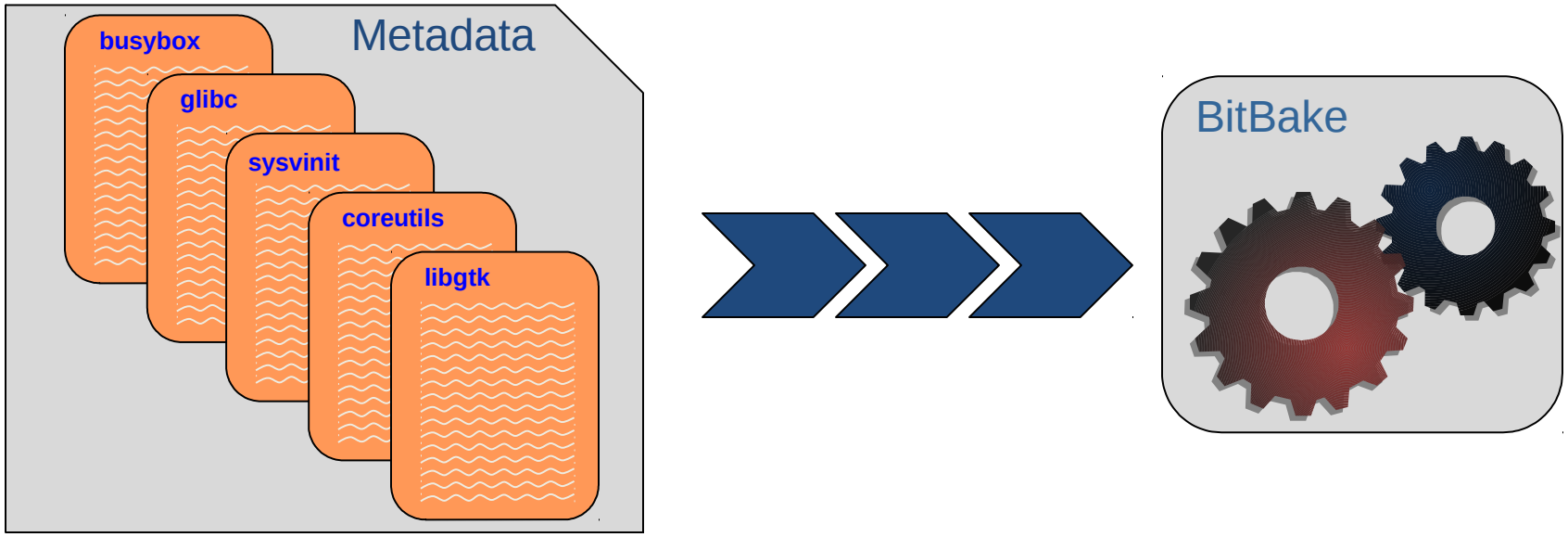


BITBAKE

This section will introduce the concept of the bitbake build tool and how it can be used to build recipes

Metadata and bitbake

- Most common form of metadata: The Recipe
- A *Recipe* provides a "list of ingredients" and "cooking instructions"
- Defines settings and a set of tasks used by bitbake to build binary packages



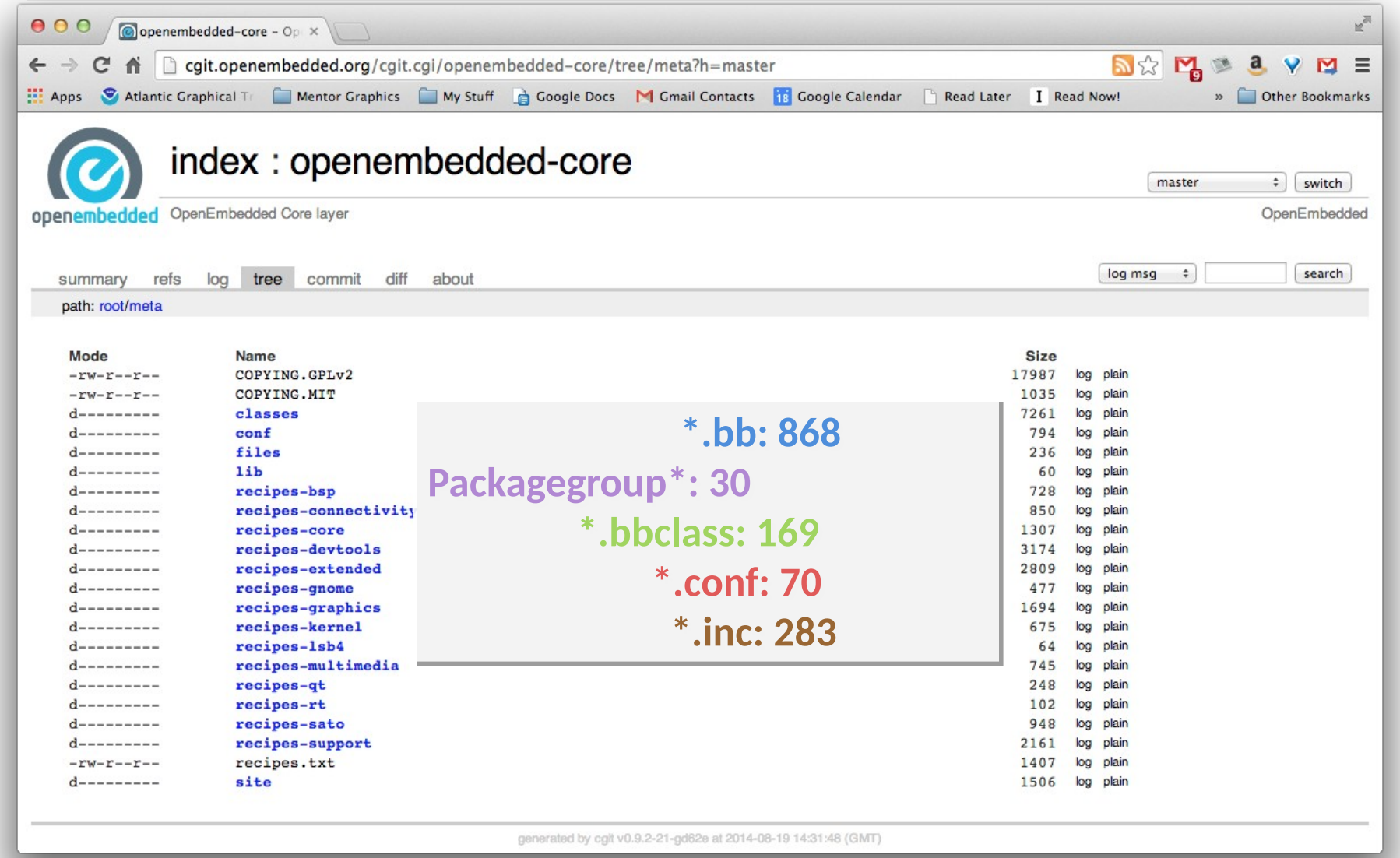
What is Metadata?

- **Metadata exists in four general categories:**
- **Recipes (*.bb)**
  - Usually describe build instructions for a single package
- **PackageGroups (special *.bb)**
  - Often used to group packages together for a FS image
- **Classes (*.bbclass)**
  - Inheritance mechanism for common functionality
- **Configuration (*.conf)**
  - Drives the overall behavior of the build process

Other Metadata

- **Append files (*.bbappend)**
  - Define additional metadata for a similarly named .bb file
  - Can add or override previously set values
- **Include files (*.inc)**
  - Files which are used with the *`include`* directive
  - Include files are typical found via the `BBPATH` variable

OE-CORE Breakdown



yocto PROJECT

THE LINUX FOUNDATION

Introduction to Bitbake

- ***Bitbake* is a task executor and scheduler**
- **By default the *build* task for the specified recipe is executed**

  $ bitbake myrecipe

- **You can indicate which task you want run**

  $ bitbake -c clean myrecipe

- **You can get a list of tasks with**

  $ bitbake -c listtasks myrecipe

Building Recipes

- **By default the highest version of a recipe is built (can be overriden with `DEFAULT_PREFERENCE` or `PREFERRED_VERSION` metadata)**

  $ bitbake myrecipe

- **You can specify the version of the package you want built (version of upstream source)**

  $ bitbake myrecipe-1.0

- **You can also build a particular revision of the package metadata**

  $ bitbake myrecipe-1.0-r0

- **Or you can provide a recipe file to build**

  $ bitbake -b mydir/myrecip.bb

Running bitbake for the First Time

- **When you do a really big build, running with *--continue* (*-k*) means bitbake will proceed as far as possible after finding an error**

  $ bitbake -k core-image-minimal

  - **When running a long build (e.g. overnight) you want as much of the build done as possible before debugging issues**

- **Running bitbake normally will stop on the first error found**

  $ bitbake core-image-minimal

- ***We'll look at debugging recipe issue later...***

Bitbake is a Task Scheduler

- Bitbake builds recipes by scheduling build tasks in parallel

  $ bitbake recipe
- This looks for `recipe.bb` in `BBFILES`
- Each recipe defines build tasks, each which can depend on other tasks
- Recipes can also depend on other recipes, meaning more than one recipe may be built
- Tasks from more than one recipe are often executed in parallel at once on multi-cpu build machines

Recipe Basics – Default Tasks*

`do_fetch`	**Locate and download source code**
`do_unpack`	**Unpack source into working directory**
`do_patch`	**Apply any patches**
`do_configure`	**Perform any necessary pre-build configuration**
`do_compile`	**Compile the source code**
`do_install`	**Installation of resulting build artifacts in WORKDIR**
`do_populate_sysroot`	**Copy artifacts to sysroot**
`do_package_*`	**Create binary package(s)**

Note: to see the list of all possible tasks for a recipe, do this:

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

*Simplified for illustration

Simple recipe task list*

chris — sleep — 117×32 — ⌘5

```
$ bitbake hello
NOTE: Running task 337 of 379 (ID: 4, hello_1.0.0.bb, do_fetch)
NOTE: Running task 368 of 379 (ID: 0, hello_1.0.0.bb, do_unpack)
NOTE: Running task 369 of 379 (ID: 1, hello_1.0.0.bb, do_patch)
NOTE: Running task 370 of 379 (ID: 5, hello_1.0.0.bb, do_configure)
NOTE: Running task 371 of 379 (ID: 7, hello_1.0.0.bb, do_populate_lic)
NOTE: Running task 372 of 379 (ID: 6, hello_1.0.0.bb, do_compile)
NOTE: Running task 373 of 379 (ID: 2, hello_1.0.0.bb, do_install)
NOTE: Running task 374 of 379 (ID: 11, hello_1.0.0.bb, do_package)
NOTE: Running task 375 of 379 (ID: 3, hello_1.0.0.bb, do_populate_sysroot)
NOTE: Running task 376 of 379 (ID: 8, hello_1.0.0.bb, do_packagedata)
NOTE: Running task 377 of 379 (ID: 12, hello_1.0.0.bb, do_package_write_ipk)
NOTE: Running task 378 of 379 (ID: 9, hello_1.0.0.bb, do_package_qa)
```

*Output has been formatted to fit this slide.

*Simplified for illustration

SSTATE CACHE

- **Several bitbake tasks can use past versions of build artefacts if there have been no changes since the last time you built them**

do_packagedata	Creates package metadata used by the build system to generate the final packages
do_package	Analyzes the content of the holding area and splits it into subsets based on available packages and files
do_package_write_rpm	Creates the actual RPM packages and places them in the Package Feed area
do_populate_lic	Writes license information for the recipe that is collected later when the image is constructed
do_populate_sysroot	Copies a subset of files installed by do_install into the sysroot in order to make them available to other recipes

Simple recipe build from sstate cache*

chris — sleep — 117×32 — ⌘5

```
$ bitbake -c clean hello
$ bitbake hello
NOTE: Running setscene task 69 of 74 (hello_1.0.0.bb, do_populate_sysroot_setscene)
NOTE: Running setscene task 70 of 74 (hello_1.0.0.bb, do_populate_lic_setscene)
NOTE: Running setscene task 71 of 74 (hello_1.0.0.bb, do_package_qa_setscene)
NOTE: Running setscene task 72 of 74 (hello_1.0.0.bb, do_package_write_ipk_setscene)
NOTE: Running setscene task 73 of 74 (hello_1.0.0.bb, do_packagedata_setscene)
```

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RECIPES

This section will introduce the concept of metadata and recipes and how they can be used to automate the building of packages

What is a Recipe?

- **A recipe is a set of instructions for building packages, including:**
  - Where to obtain the upstream sources and which patches to apply (this is called "*fetching*")
    - `SRC_URI`
  - Dependencies (on libraries or other recipes)
    - `DEPENDS, RDEPENDS`
  - Configuration/compilation options
    - `EXTRA_OECONF, EXTRA_OEMAKE`
  - Define which files go into what output packages
    - `FILES_*`

Example Recipe – ethtool_3.15.bb

chris — ssh — 80×24

```
SUMMARY = "Display or change ethernet card settings"
DESCRIPTION = "A small utility for examining and tuning the settings of your eth
ernet-based network interfaces."
HOMEPAGE = "http://www.kernel.org/pub/software/network/ethtool/"
SECTION = "console/network"
LICENSE = "GPLv2+"
LIC_FILES_CHKSUM = "file://COPYING;md5=b234ee4d69f5fce4486a80fdaf4a4263 \
                    file://ethtool.c;beginline=4;endline=17;md5=c19b30548c582577
fc6b443626fc1216"

SRC_URI = "${KERNELORG_MIRROR}/software/network/ethtool/ethtool-${PV}.tar.gz \
           file://run-ptest \
           file://avoid_parallel_tests.patch \
           file://ethtool-uint.patch \
           "

SRC_URI[md5sum] = "7e94dd958bcd639aad2e5a752e108b24"
SRC_URI[sha256sum] = "562e3cc675cf5b1ac655cd060f032943a2502d4d59e5f278f02aae9256
2ba261"

inherit autotools ptest
RDEPENDS_${PN}-ptest += "make"

                                                              1,1           Top
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                                                              1,1           Top
```

What can a Recipe Do?

- **Build one or more packages from source code**
  - Host tools, compiler, utilities
  - Bootloader, Kernel, etc
  - Libraries, interpretors, etc
  - Userspace applications
- **Package Groups**
- **Full System Images**

Recipe Operators

A = “foo” (late assignment)

B ?= “0t” (default value)

C ??= “abc” (late default)

D := “xyz” (Immediate assignment)

A .= “bar” “foobar” (append)

B =. “WO” “WO0t” (prepend)

C += “def” “abc def” (append)

D =+ “uvw” “uvw xyz” (prepend)

More Recipe Operators

A = “foo”

A_append = “bar” → “foobar”

B = “0t”

B_prepend = “WO” → “WO0t”

OVERRIDES = “os:arch:machine”

A = “abc”

A_os = “ABC” (Override)

A_append_arch = “def” (Conditional append)

A_prepend_os = “XYZ” (Conditional prepend)

Bitbake Variables/Metadata

- **These are set automatically by bitbake**
  - `TOPDIR` – The build directory
  - `LAYERDIR` – Current layer directory
  - `FILE` – Path and filename of file being processed
- **Policy variables control the build**
  - `BUILD_ARCH` – Host machine architecture
  - `TARGET_ARCH` – Target architecture
  - And many others…

Build Time Metadata

- **PN – Pakage name (“myrecipe”)**
- **PV – Package version (1.0)**
- **PR – Package Release (r0)**
- **P = “${PN}-${PV}”**
- **PF = “${PN}-${PV}-${PR}”**
- **FILE_DIRNAME** – Directory for FILE
- **FILESPATH** = "${FILE_DIRNAME}/${PF}:\
  ${FILE_DIRNAME}/${P}:\
  ${FILE_DIRNAME}/${PN}:\
  ${FILE_DIRNAME}/files:${FILE_DIRNAME}

Build Time Metadata

- **TOPDIR - The build directory**
- **TMPDIR** = "${TOPDIR}/tmp"
- **WORKDIR** = ${TMPDIR}/work/${PF}"
- **S** = "${WORKDIR}/${P}" (Source dir)
- **B** = "${S}" (Build dir)
- **D** = "${WORKDIR}/${image}" (Destination dir)
- **DEPLOY_DIR** = "${TMPDIR}/deploy"
- **DEPLOY_DIR_IMAGE** = "${DEPLOY_DIR}/images"

Dependency Metadata

- **Build time package variables**
  - `DEPENDS` – Build time package dependencies
  - `PROVIDES = "${P} ${PF} ${PN}"`
- **Runtime package variables**
  - `RDEPENDS` – Runtime package dependencies
  - `RRECOMMENDS` – Runtime recommended packages
  - `RSUGGESTS` – Runtime suggested packages
  - `RPROVIDES` – Runtime provides
  - `RCONFLICTS` – Runtime package conflicts
  - `RREPLACES` – Runtime package replaces

Common Metadata

- **Variables you commonly set**
  - `SUMMARY` – Short description of package/recipe
  - `HOMEPAGE` – Upstream web page
  - `LICENSE` – Licenses of included source code
  - `LIC_FILES_CHKSUM` – Checksums of license files at time of packaging (checked for change by build)
  - `SRC_URI` – URI of source code, patches and extra files to be used to build packages. Uses different fetchers based on the URI.
  - `FILES` – Files to be included in binary packages

Examining Recipes: bc

- **Look at 'bc' recipe:**
- **Found in**

  poky/meta/recipes-extended/bc/bc_1.06.bb
  - Uses LIC_FILES_CHKSUM and SRC_URI checksums
  - Note the DEPENDS build dependency declaration indicating that this package depends on `flex` to build

Examining Recipes: bc.bb

```
SUMMARY = "Arbitrary precision calculator language"
HOMEPAGE = "http://www.gnu.org/software/bc/bc.html"

LICENSE = "GPLv2+ & LGPLv2.1"
LIC_FILES_CHKSUM = "file://COPYING;md5=94d55d512a9ba36caa9b7df079bae19f \
                    file://COPYING.LIB;md5=d8045f3b8f929c1cb29a1e3fd737b499 \

file://bc/bcdefs.h;endline=31;md5=46dffdaf10a99728dd8ce358e45d46d8 \

file://dc/dc.h;endline=25;md5=2f9c558cdd80e31b4d904e48c2374328 \

file://lib/number.c;endline=31;md5=99434a0898abca7784acfd36b8191199"

SECTION = "base"
DEPENDS = "flex"
PR = "r3"

SRC_URI = "${GNU_MIRROR}/bc/bc-${PV}.tar.gz \
           file://fix-segment-fault.patch "

SRC_URI[md5sum] = "d44b5dddebd8a7a7309aea6c36fda117"
SRC_URI[sha256sum] =
"4ef6d9f17c3c0d92d8798e35666175ecd3d8efac4009d6457b5c99cea72c0e33"

inherit autotools texinfo update-alternatives

ALTERNATIVE_${PN} = "dc"
ALTERNATIVE_PRIORITY = "100"
```

Building upon bbclass

- **Use inheritance for common design patterns**
- **Provide a class file (.bbclass) which is then inherited by other recipes (.bb files)**

```
inherit autotools
```

  - Bitbake will include the *autotools.bbclass* file
  - Found in a *classes* directory via the `BBPATH`

Examining Recipes: flac

- **Look at 'flac' recipe**
- **Found in**

  `poky/meta/recipes-multimedia/flac/flac_1.3.1.bb`

  - Inherits from both *autotools* and *gettext*
  - Customizes autoconf configure options (`EXTRA_OECONF`) based on "TUNE" features
  - Breaks up output into multiple binary packages
    - See `PACKAGES` var. This recipe produces additional packages with those names, while the FILES_* vars specify which files go into these additional packages

Examining Recipes: flac.bb

```
SUMMARY = "Free Lossless Audio Codec"
DESCRIPTION = "FLAC stands for Free Lossless Audio Codec, a lossless audio compression format."
HOMEPAGE = "https://xiph.org/flac/"
BUGTRACKER = "http://sourceforge.net/p/flac/bugs/"
SECTION = "libs"
LICENSE = "GFDL-1.2 & GPLv2+ & LGPLv2.1+ & BSD"
LIC_FILES_CHKSUM = "file://COPYING.FDL;md5=ad1419ecc56e060eccf8184a87c4285f \
    file://src/Makefile.am;beginline=1;endline=17;md5=0a853b81d9d43d8aad3b53b05cfcc37e  \
    file://COPYING.GPL;md5=b234ee4d69f5fce4486a80fdaf4a4263 \
    file://src/flac/main.c;beginline=1;endline=18;md5=d03a766558d233f9cc3ac5dfafd49deb \
    file://COPYING.LGPL;md5=fbc093901857fcd118f065f900982c24 \
    file://src/plugin_common/all.h;beginline=1;endline=18;md5=7c8a3b9e1e66ed0aba765bc6f35da85d \
    file://COPYING.Xiph;md5=a2c4b71c0198682376d483eb5bcc9197 \
    file://include/FLAC/all.h;beginline=65;endline=70;md5=64474f2b22e9e77b28d8b8b25c983a48"
DEPENDS = "libogg"

SRC_URI = "http://downloads.xiph.org/releases/flac/${BP}.tar.xz"

SRC_URI[md5sum] = "b9922c9a0378c88d3e901b234f852698"
SRC_URI[sha256sum] = "4773c0099dba767d963fd92143263be338c48702172e8754b9bc5103efe1c56c"
```

(con't next page)

Examining Recipes: flac.bb (con't)

(con't from previous page)

```
inherit autotools gettext

EXTRA_OECONF = "--disable-oggtest \
                --with-ogg-libraries=${STAGING_LIBDIR} \
                --with-ogg-includes=${STAGING_INCDIR} \
                --disable-xmms-plugin \
                --without-libiconv-prefix \
                ac_cv_prog_NASM="" \
               "

EXTRA_OECONF += "${@bb.utils.contains("TUNE_FEATURES", "altivec", " --enable-altivec", \
                  " --disable-altivec", d)}"
EXTRA_OECONF += "${@bb.utils.contains("TUNE_FEATURES", "core2", " --enable-sse", "", d)}"
EXTRA_OECONF += "${@bb.utils.contains("TUNE_FEATURES", "corei7", " --enable-sse", "", d)}"

PACKAGES += "libflac libflac++ liboggflac liboggflac++"
FILES_${PN} = "${bindir}/*"
FILES_libflac = "${libdir}/libFLAC.so.*"
FILES_libflac++ = "${libdir}/libFLAC++.so.*"
FILES_liboggflac = "${libdir}/libOggFLAC.so.*"
FILES_liboggflac++ = "${libdir}/libOggFLAC++.so.*"
```

Grouping Local Metadata

- **Sometimes sharing metadata between recipes is easier via an *include file***

```
include file.inc
```

  - Will include `.inc` file if found via BBPATH
  - Can also specify an absolute path
  - If not found, will continue without an error

```
require file.inc
```

  - Same as an include
  - Fails with an error if not found

Examining Recipes: ofono

- **Look at 'ofono' recipe(s):**
- **Found in**

  `poky/meta/recipes-connectivity/ofono/ofono_1.16.bb`

  - Splits recipe into common `.inc` file to share common metadata between multiple recipes
  - Sets a conditional build configuration options through the `PACKAGECONFIG` var based on a `DISTRO_FEATURE` (in the `.inc` file)
  - Sets up an init service via do_install_append()
  - Has a `_git` version of the recipe (not shown)

Examining Recipes: ofono.bb

```
require ofono.inc

SRC_URI  = "\
      ${KERNELORG_MIRROR}/linux/network/${BPN}/${BP}.tar.xz \
      file://ofono \
      file://Revert-test-Convert-to-Python-3.patch \
      file://0001-backtrace-Disable-for-non-glibc-C-libraries.patch \
"
SRC_URI[md5sum] = "c31b5b55a1d68354bff771d3edf02829"
SRC_URI[sha256sum] = \
   "403b98dadece8bc804c0bd16b96d3db5a3bb0f84af64b3d67924da2d1a754b07"

CFLAGS_append_libc-uclibc = " -D_GNU_SOURCE"
```

Examining Recipes: ofono.inc

```
HOMEPAGE = "http://www.ofono.org"
SUMMARY  = "open source telephony"
DESCRIPTION = "oFono is a stack for mobile telephony devices on Linux. oFono supports speaking to
telephony devices through specific drivers, or with generic AT commands."
LICENSE  = "GPLv2"
LIC_FILES_CHKSUM = "file://COPYING;md5=eb723b61539feef013de476e68b5c50a \
  file://src/ofono.h;beginline=1;endline=20;md5=3ce17d5978ef3445def265b98899c2ee"

inherit autotools pkgconfig update-rc.d systemd bluetooth

DEPENDS  = "dbus glib-2.0 udev mobile-broadband-provider-info"

INITSCRIPT_NAME = "ofono"
INITSCRIPT_PARAMS = "defaults 22"

PACKAGECONFIG ??= "\
   ${@bb.utils.contains('DISTRO_FEATURES', 'systemd', 'systemd', '', d)} \
   ${@bb.utils.contains('DISTRO_FEATURES', 'bluetooth', 'bluez', '', d)} \
   "
PACKAGECONFIG[systemd] = "--with-systemdunitdir=${systemd_unitdir}/system/, \
   --with-systemdunitdir="
PACKAGECONFIG[bluez] = "--enable-bluetooth, --disable-bluetooth, ${BLUEZ}"
```

(con't next page)

Examining Recipes: ofono.inc

(con't from previous page)

```
EXTRA_OECONF += "--enable-test"

SYSTEMD_SERVICE_${PN} = "ofono.service"

do_install_append() {
  install -d ${D}${sysconfdir}/init.d/
  install -m 0755 ${WORKDIR}/ofono ${D}${sysconfdir}/init.d/ofono
}

PACKAGES =+ "${PN}-tests"

RDEPENDS_${PN} += "dbus"

FILES_${PN} += "${base_libdir}/udev ${systemd_unitdir}"
FILES_${PN}-tests = "${libdir}/${BPN}/test"
RDEPENDS_${PN}-tests = "python python-pygobject python-dbus"
```

WHEN THINGS GO WRONG

Some useful tools to help guide you when something goes wrong

Bitbake Environment

- **Each recipe has its own environment which contains all the variables and methods required to build that recipe**
- **You've seen some of the variables already**
  - DESCRIPTION, SRC_URI, LICENSE, S, LIC_FILES_CHKSUM, do_compile(), do_install()
- **Example**
  - S = "${WORKDIR}"
  - What does this mean?

Examine a Recipe's Environment

- **To view a recipe's envrionment**

  $ bitbake -e myrecipe

- **Where is the source code for this recipe"**

  $ bitbake -e virtual/kernel | grep “^S=”

  S="${HOME}/yocto/build/tmp/work-shared/qemuarm/kernel-source"

- **What file was used in building this recipe?**

  $ bitbake -e netbase | grep “^FILE=”

  FILE="${HOME}/yocto/poky/meta/recipes-core/netbase/netbase_5.3.bb"

Examine a Recipe's Environment (cont'd)

- **What is this recipe's full version string?**

  $ bitbake -e netbase | grep “^PF=”

  PF="netbase-1_5.3-r0"

- **Where is this recipe's BUILD directory?**

  $ bitbake -e virtual/kernel | grep “^B=”

  B="${HOME}/yocto/build/tmp/work/qemuarm-poky-linux-\
  gnueabi/linux-yocto/3.19.2+gitAUTOINC+9e70b482d3\
  _473e2f3788-r0/linux-qemuarm-standard-build"

- **What packages were produced by this recipe?**

  $ bitbake -e virtual/kernel | grep “^PACKAGES=”

  PACKAGES="kernel kernel-base kernel-vmlinux kernel-image \ kernel-dev kernel-modules kernel-devicetree"

BitBake Log Files

- **Every build produces lots of log output for diagnostics and error chasing**
  - Verbose log of bitbake console output:
    - Look in …/tmp/log/cooker/<machine>

```
$ cat tmp/log/cooker/qemuarm/20160119073325.log  | grep 'NOTE:.*task.*Started'
NOTE: recipe hello-1.0.0-r0: task do_fetch: Started
NOTE: recipe hello-1.0.0-r0: task do_unpack: Started
NOTE: recipe hello-1.0.0-r0: task do_patch: Started
NOTE: recipe hello-1.0.0-r0: task do_configure: Started
NOTE: recipe hello-1.0.0-r0: task do_populate_lic: Started
NOTE: recipe hello-1.0.0-r0: task do_compile: Started
NOTE: recipe hello-1.0.0-r0: task do_install: Started
NOTE: recipe hello-1.0.0-r0: task do_populate_sysroot: Started
NOTE: recipe hello-1.0.0-r0: task do_package: Started
NOTE: recipe hello-1.0.0-r0: task do_packagedata: Started
NOTE: recipe hello-1.0.0-r0: task do_package_write_rpm: Started
NOTE: recipe hello-1.0.0-r0: task do_package_qa: Started
NOTE: recipe ypdd-image-1.0-r0: task do_rootfs: Started
```

BitBake Per-Recipe Log Files

- **Every recipe produces lots of log output for diagnostics and debugging**
- **Use the Environment to find the log files for a given recipe:**

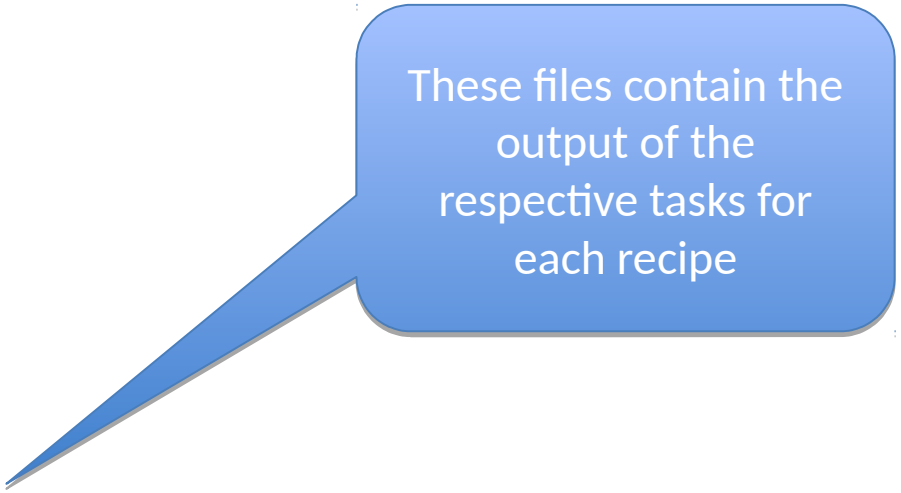
```
$ bitbake -e hello | grep “^T=”
T="${HOME}yocto/build/tmp/work/armv5e-poky-linux-gnueabi/hello/1.0.0-r0/temp"
```

- **Each task that runs for a recipe produces "log" and "run" files in**

  ${WORKDIR}/temp

BitBake Per-Recipe Log Files

```
$ cd ${T} (See definition of T in previous slide)
$ find . -type l -name 'log.*'
./log.do_package_qa
./log.do_package_write_rpm
./log.do_package
./log.do_fetch
./log.do_populate_lic
./log.do_install
./log.do_configure
./log.do_unpack
./log.do_populate_sysroot
./log.do_compile
./log.do_packagedata
./log.do_patch
```



BitBake Per-Recipe Log Files

```
$ cd ${T} (See definition of T in previous slide)
$ find . -type l -name 'run.*'
./run.do_fetch
./run.do_patch
./run.do_configure
./run.do_populate_sysroot
./run.do_package_qa
./run.do_unpack
./run.do_compile
./run.do_install
./run.do_packagedata
./run.do_populate_lic
./run.do_package
./run.do_package_write_rpm
```

BUILDING A FULL EMBEDDED IMAGE WITH YOCTO

This section will introduce the concept of building an initial system image

Quick Start Guide in one Slide

1. **Download Yocto Project sources:**
   - $ mkdir -p yocto ; cd yocto
   - $ wget http://downloads.yoctoproject.org/releases/yocto/yocto-2.0/poky-jethro-14.0.0.tar.bz2
   - $ tar xf poky-jethro-14.0.0.tar.bz2
   - $ cd poky-jethro-14.0.0
   - Can also use git and checkout a known branch e.g. Jethro
     - $ git clone -b jethro git://git.yoctoproject.org/poky.git
     - $ cd poky
2. **Build one of the reference Linux distributions:**
   - poky$ source oe-init-build-env
   - Check/Edit local.conf for sanity
     - e.g. Modify MACHINE=qemuarm
   - poky/build$ bitbake -k core-image-{minimal|base|sato}
3. **Run the image under emulation:**
   - $ runqemu qemuarm
4. **Profit!!! (well... actually there is more work to do...)**

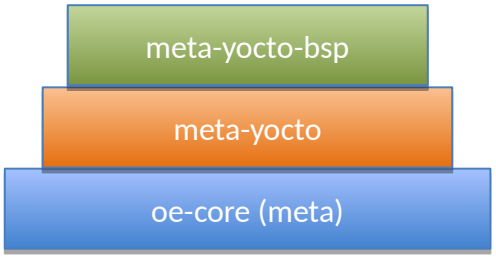
Host System Layout

```
$HOME/yocto/
  |---poky   (Do Not Modify anything in here* )
      Poky, bitbake, scripts, oe-core, metadata
  |---build  (or whatever name you choose)
      Project build directory
  |---downloads  (DL_DIR)
      Downloaded source cache
  |---sstate-cache   (SSTATE_DIR)
      Binary build cache
```

* We will cover how to use layers to make changes later

Poky Layout

```
$HOME/yocto/poky/
 |---LICENSE
 |---README
 |---README.hardware
 |---bitbake/                (The build tool)
 |---documentation/
 |---meta/                   (oe-core)
 |---meta-yocto/             (Yocto distro metadata)
 |---meta-yocto-bsp/         (Yocto Reference BSPs)
 |---oe-init-build-env       (Project setup script)
 |---scripts/                (Scripts and utilities)
```



Note: A few files have been items omitted to facility the presentation on this slide

Setting up a Build Directory

- **Start by setting up a build directory**
  - Local configuration
  - Temporary build artifacts

```
$ cd $HOME/yocto/
$ source ./poky/oe-init-build-env build
```

- **Replace *build* with whatever build directory name you want to use**
- **You need to re-run this script in any new terminal you start**

Build directory Layout

```
$HOME/yocto/build/
 |---bitbake.lock
 |---cache/          (bitbake cache files)
 |---conf/
 |    |--bblayers.conf   (bitbake layers)
 |    |--local.conf   (local configuration)
 |    `--site.conf     (optional site conf)
 `---tmp/                (Build artifacts)
```

Note: A few files have been items omitted to facility the presentation on this slide

Building a Linux Image

- **General Procedure:**
  - Create a project directory using

    oe-init-build-env
  - Configure build by editing local.conf

    `$HOME/yocto/build/conf/local.conf`
    - Select appropriate `MACHINE` type
    - Set shared downloads directory (`DL_DIR`)
    - Set shared state directory (`SSTATE_DIR`)
  - Build your selected Image

    $ bitbake -k core-image-minimal
  - (Detailed steps follow…)

Update Build Configuration

- Configure build by editing local.conf

  `$HOME/yocto/build/conf/local.conf`

  - Set appropriate `MACHINE`, `DL_DIR` and `SSTATE_DIR`
  - Add the following to the bottom of local.conf

```
MACHINE = "qemuarm"
DL_DIR = "${TOPDIR}/../downloads"
SSTATE_DIR = "${TOPDIR}/../sstate-cache/${MACHINE}"
```

- Notice how you can use variables in setting these values

Building an Embedded Image

- This builds an entire embedded Linux distribution
- Choose from one of the available Images
- The following builds a minimal embedded target

```
$ bitbake -k core-image-minimal
```

- On a fast computer the first build may take the better part of an hour
- The next time you build it (with no changes) it may take as little as 5 mins (due to the shared state cache)

Booting Your Image with QEMU

- **The runqemu script is used to boot the image with QEMU**
- **It auto-detects settings as much as possible, enabling the following command to boot our reference images:**

$ runqemu qemuarm [nographic]

  - Use nographic if using a non-graphical session (ssh), do not type the square brackets

- **Replace *qemuarm* with your value of `MACHINE`**
- **Your QEMU instance should boot**
- **Kill it using another terminal:**

```
$ killall qemu-system-arm
```

- End of Yocto Project part
- A full training class is available on training.linuxfoundation.org

- Next: AGL Specifics, then hands-on.

AGLs specifics and use of the Yocto Project

Agenda

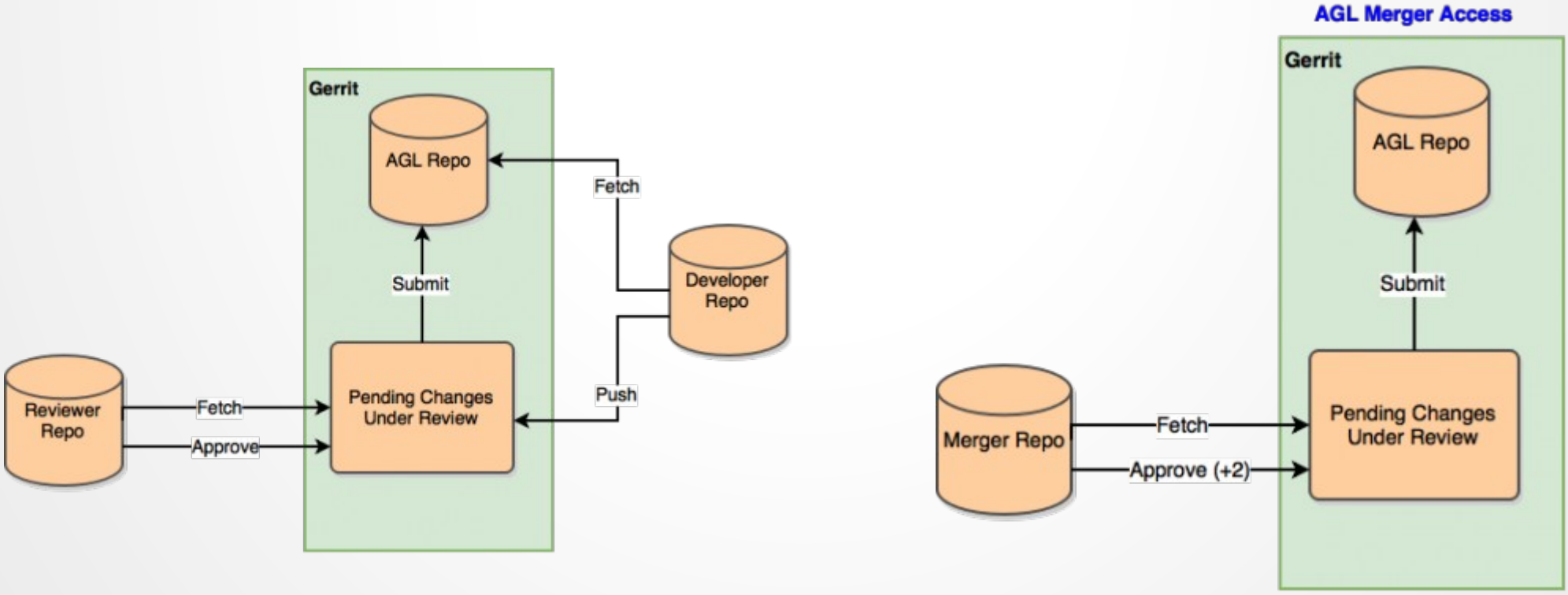
- Building AGL (User perspective)
  - Structure, downloading the sources, building
- (Platform-) Developer Environment setup
  - Account, gerrit, cloning, git review,
  - CI builds
  - Snapshot builds
  - Testing

•Building AGL (User perspective)

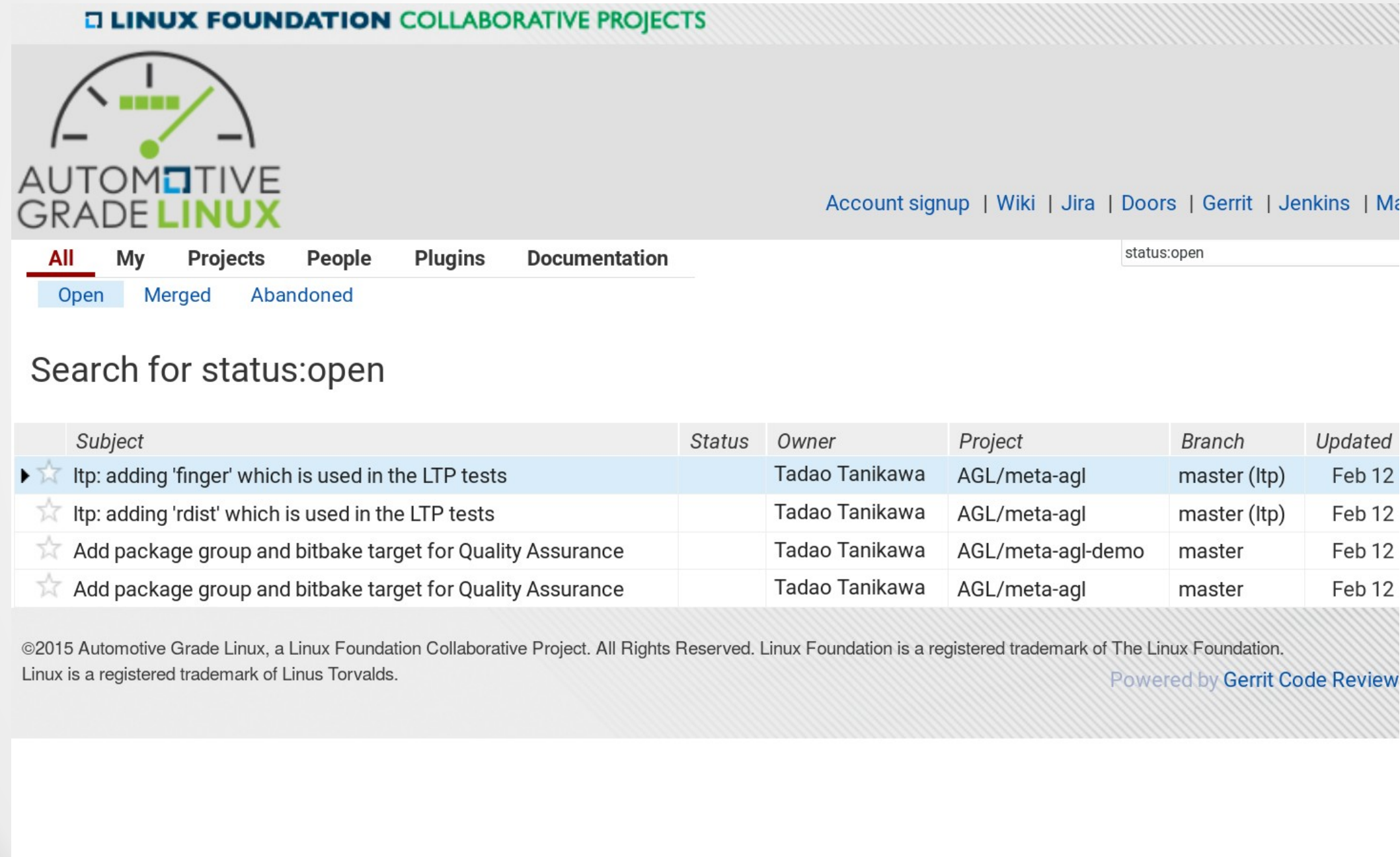
- Structure
- downloading the sources
- building

AGL source code

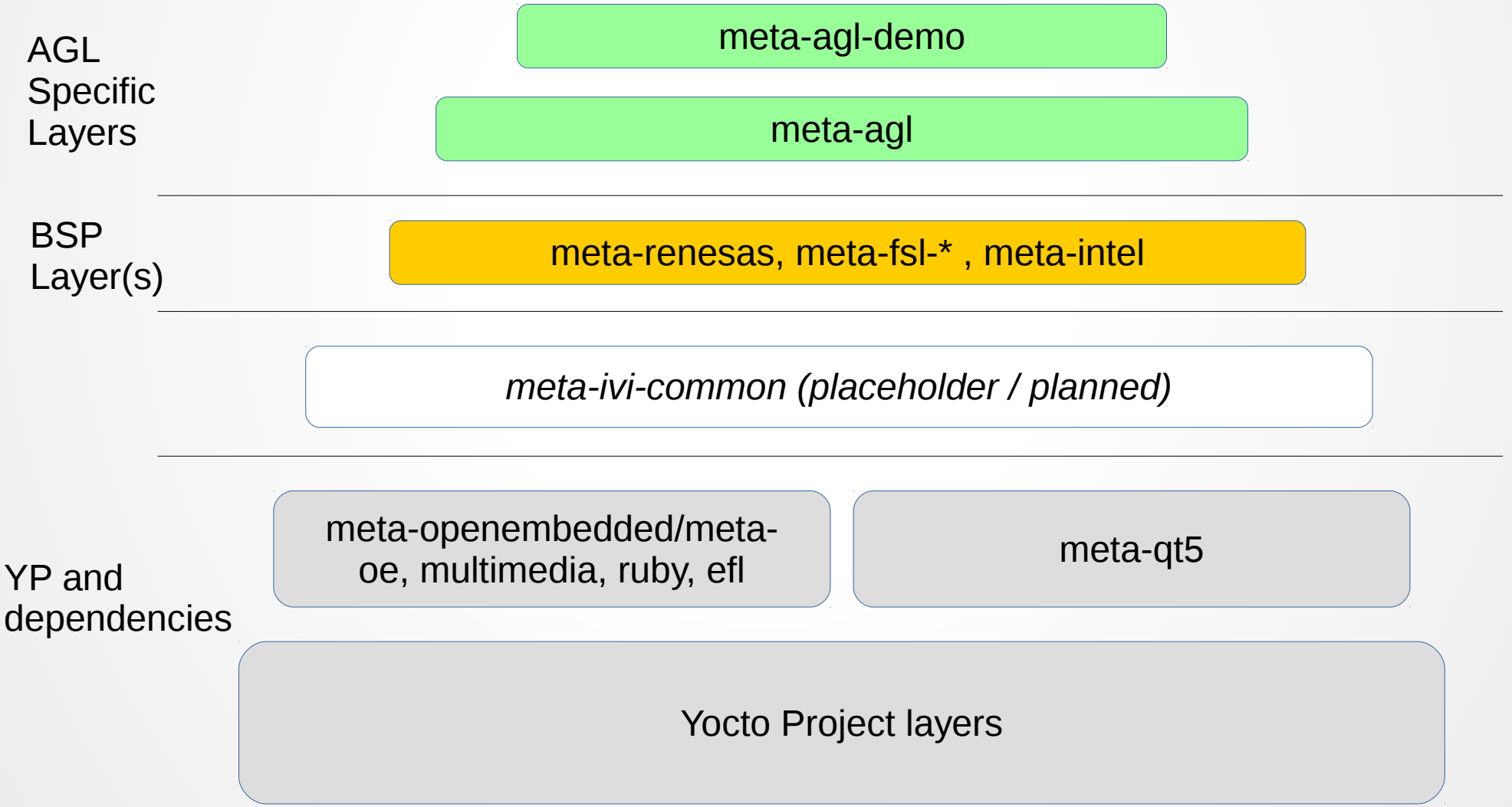
- AGL uses Gerrit to handle the review process and host the sources
- The url is: https://gerrit.automotivelinux.org/gerrit/



AGL Gerrit / Code Review



AGL Layers (per bblayers.conf)



Repo

- AGL uses the „repo“ tool to manage the multiple git repositories.
- „repo“ is basically a wrapper for git clone

```
$ mkdir ~/bin
$ export PATH=~/bin:$PATH

$ curl https://storage.googleapis.com/git-repo-downloads/repo \
      > ~/bin/repo
$ chmod a+x ~/bin/repo
```

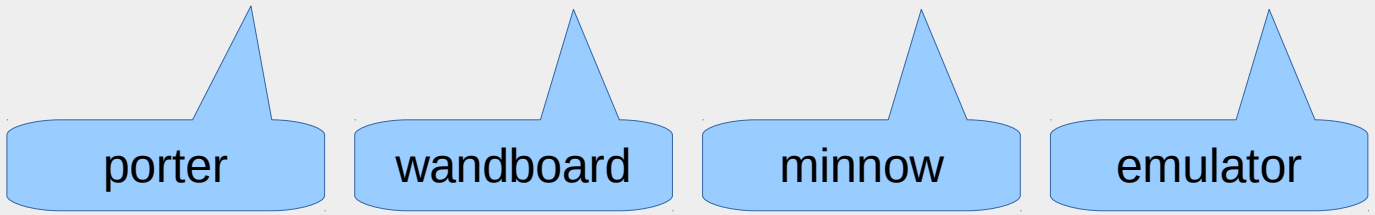
Repo cont.

```
$ repo init -u \
     https://gerrit.automotivelinux.org/gerrit/AGL/AGL-repo

$ repo sync

$ ls
meta-agl
meta-agl-demo
meta-fsl-arm
meta-fsl-arm-extra
meta-intel
meta-openembedded
meta-qt5
meta-renesas
poky
```

Setup of the project/environment

- AGL uses a wrapper around the Yocto Project oe-init-build-env.
- This is needed to pull-in the right BSP layers for each board (and take care of external resources)

```
$ source meta-agl/scripts/envsetup.sh \
     <porter|wandboard|intel-corei7-64|qemux86-64|...> [build-dir]
```



Setup of the project/environment

```
Example:

$ source meta-agl/scripts/envsetup.sh porter build-porter

envsetup: Set 'porter as MACHINE.
envsetup: Using templates for local.conf & bblayers.conf from :
          'meta-renesas/meta-rcar-gen2/conf'
envsetup: Setup build environment for poky/oe.

[...]

### Shell environment set up for builds. ###

You can now run 'bitbake <target>'

Common target are:
    agl-demo-platform

$
```

Building the AGL Demo Platform

```
$ bitbake <recipename>

    E.g.:
    $ bitbake virtual/kernel


$ bitbake <imagename>

    E.g.:
    $ bitbake core-image-minimal    # (defined in OE-core)
    $ bitbake agl-demo-platform     # (defined in meta-agl-demo)


 ( more in hands-on later )
```

•(Platform-)Developer Environment

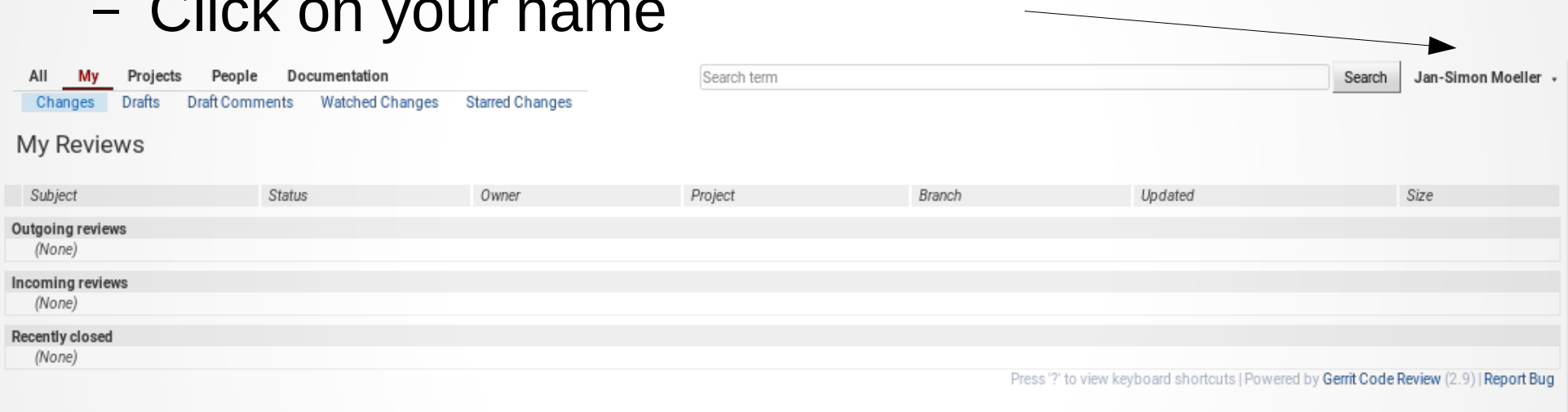
- Account
- gerrit
- cloning
- git review
  - CI builds
- Snapshot builds

AGL account

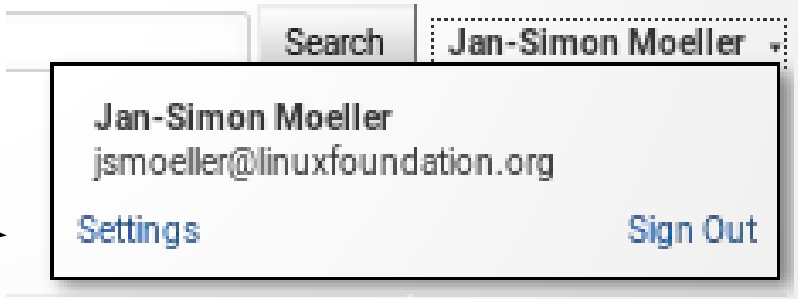
- All Automotive Grade Linux sites use a single sign-on. Start by creating an account here: **https://dev.automotivelinux.org**
- Next, you need to upload your **ssh public key** to gerrit.

Upload ssh key

- Browse to git.automotivelinux.org
  - Click on your name

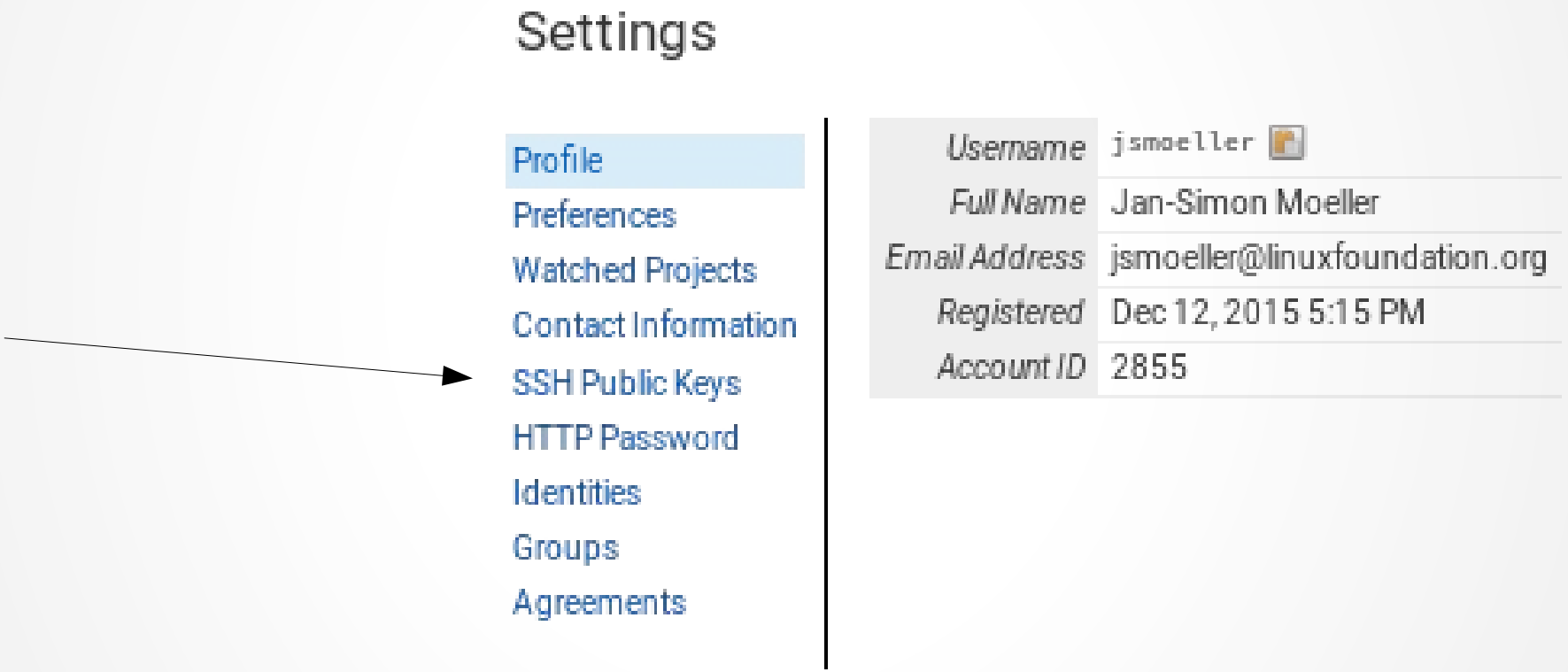


  - Click on 'Settings'



Upload ssh key

- Select 'SSH Public Keys'



- Use the 'Add Key...' button and paste your key

With the key uploaded, you can submit changesets for review

- Workflow:
  - git clone ssh://jsmoeller@gerrit.automotivelinux.org:29418/AGL/meta-agl-demo
  - cd meta-agl-demo
  - git review -s # initialize git review (once after cloning)
  - echo 'IMAGE_INSTALL_APPEND = " tar bzip2" >> \
    recipes-platform/images/agl-demo-platform.bb
  - git add recipes-platform/images/agl-demo-platform.bb
  - git commit -s # with good commit message
  - git review
- This will submit a changeset against master.

Best practices for commit messages

Brief description

Title: 50 chars max

```
Add new base for common puppet modules

Intent of this commit is to be a common place where we
can contain a common set of  modules that installers
should leverage when installing/configuring a target
system.

v3: fixed typos
v2: added 80 col linebreaks

(url, ml-post, change-id)

Signed-off-by: Jan-Simon Möller <dl9pf@gmx.de>
```

Blank line

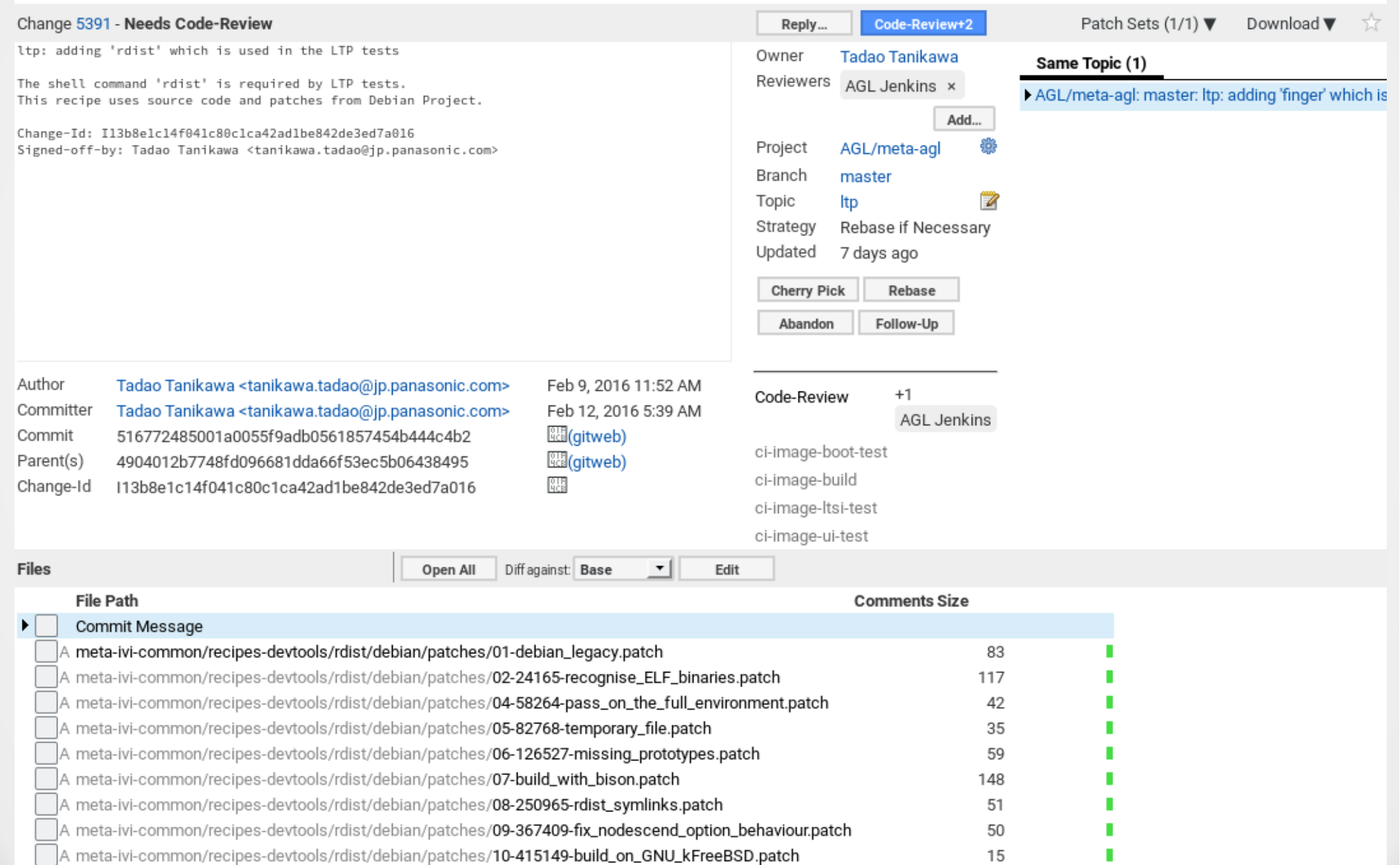
Detailed description

Optional: Track modifications (e.g. on ML)

Optional: References

Sign-off with name and email

A submitted changeset in Gerrit



Change 5391 - **Needs Code-Review**

Reply... Code-Review+2 Patch Sets (1/1) ▼ Download ▼

```
ltp: adding 'rdist' which is used in the LTP tests

The shell command 'rdist' is required by LTP tests.
This recipe uses source code and patches from Debian Project.

Change-Id: I13b8e1c14f041c80c1ca42ad1be842de3ed7a016
Signed-off-by: Tadao Tanikawa <tanikawa.tadao@jp.panasonic.com>
```

Owner Tadao Tanikawa
Reviewers AGL Jenkins ×
Add...
Project AGL/meta-agl
Branch master
Topic ltp
Strategy Rebase if Necessary
Updated 7 days ago

Cherry Pick Rebase
Abandon Follow-Up

Same Topic (1)

AGL/meta-agl: master: ltp: adding 'finger' which is

Author	Tadao Tanikawa <tanikawa.tadao@jp.panasonic.com>	Feb 9, 2016 11:52 AM
Committer	Tadao Tanikawa <tanikawa.tadao@jp.panasonic.com>	Feb 12, 2016 5:39 AM
Commit	516772485001a0055f9adb0561857454b444c4b2	(gitweb)
Parent(s)	4904012b7748fd096681dda66f53ec5b06438495	(gitweb)
Change-Id	I13b8e1c14f041c80c1ca42ad1be842de3ed7a016	

Code-Review +1
AGL Jenkins

ci-image-boot-test
ci-image-build
ci-image-ltsi-test
ci-image-ui-test

Files Open All Diff against: Base Edit

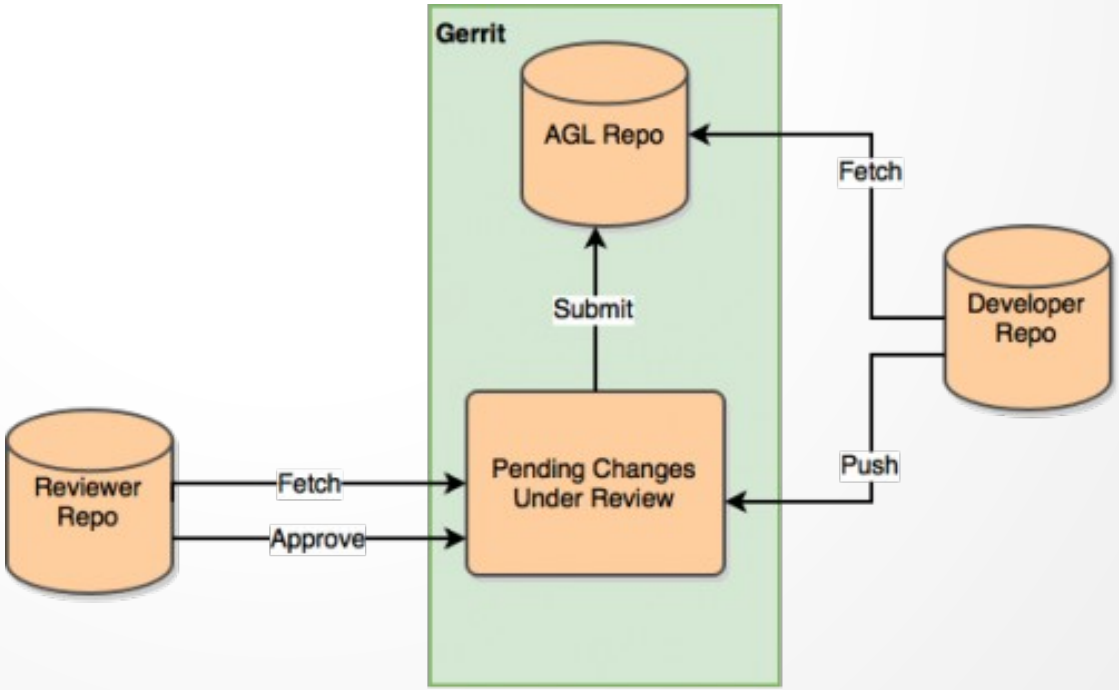
File Path	Comments	Size
Commit Message		
A meta-ivi-common/recipes-devtools/rdist/debian/patches/01-debian_legacy.patch	83	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/02-24165-recognise_ELF_binaries.patch	117	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/04-58264-pass_on_the_full_environment.patch	42	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/05-82768-temporary_file.patch	35	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/06-126527-missing_prototypes.patch	59	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/07-build_with_bison.patch	148	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/08-250965-rdist_symlinks.patch	51	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/09-367409-fix_nodescend_option_behaviour.patch	50	
A meta-ivi-common/recipes-devtools/rdist/debian/patches/10-415149-build_on_GNU_kFreeBSD.patch	15	

Code review / voting / merge

- Check

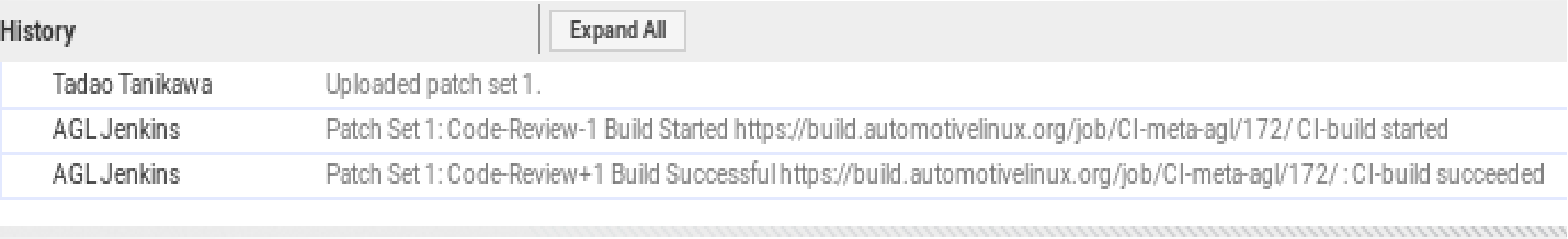
  https://wiki.automotivelinux.org/agl-distro/contributing

- Basically your fellow developers review and vote with +1/-1 on your change. The maintainer then merges it.



CI builds assist you for the review

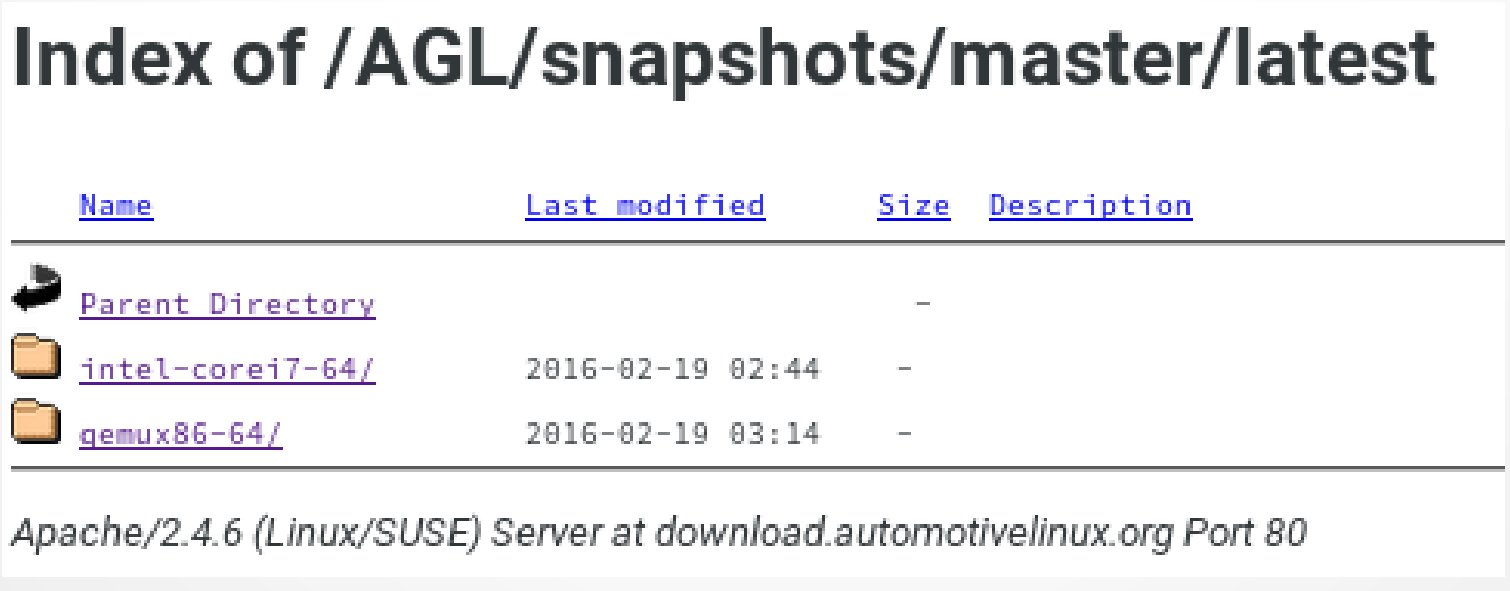
- You can see it in gerrit at the bottom



- It is done by a jenkins instance running at http://build.automotivelinux.org

Daily snapshot builds

- Are available here:
  - https://download.automotivelinux.org/AGL/snapshots/master
- Currently for
  - qemu/virtualbox (qemux86-64)
  - minnowboard (intel-corei7-64)



Index of /AGL/snapshots/master/latest

Name	Last modified	Size	Description
Parent Directory		-	
intel-corei7-64/	2016-02-19 02:44	-	
qemux86-64/	2016-02-19 03:14	-	

Apache/2.4.6 (Linux/SUSE) Server at download.automotivelinux.org Port 80

Testing

- JTA (Jenkins Test Automation) has been tailored for the Renesas boards (porter)
- LAVA from Linaro is an alternative
- openQA would be an option for bootup/UI testing (long-term)
- We had plenty of task during AMM
- No central instance(s), yet

Demo / Hands-on

The prepared VM

- User: training Password: training
- Data from tarballs extracted in
  - $HOME/yocto
- We will work inside of the folder yocto

If you have Ubuntu 15.10 installed

- Use the tarball and extract it in your $HOME
  - a folder yocto will be created.
  - same as on the previous slide

Task 1

- Create a project environment and set it up to build for the MACHINE type qemux86.

```
                        # Open a Terminal
                  $~/> cd yocto
            $~/yocto/> source poky/oe-init-build-env myqemux86
                       [... lots of output ...]
                       # we add a few preferences in this demo
$~/yocto/myqemux86/> ln -sf ../../site.demo conf/site.conf

$~/yocto/myqemux86/> tree
.
`-- conf
    |-- bblayers.conf
    |-- local.conf
    |-- site.conf -> ../../site.demo
    `-- templateconf.cfg
1 directory, 4 files
```

Task 2

- Execute the build for: core-image-minimal

```
                        # for qemux86 no edits in conf/local.conf
                        # thus we can start the build process

$~/yocto/myqemux86/> bitbake core-image-minimal
                        [... some output ...]
                        # check for "setscene"
                        [... done ...]

$~/yocto/myqemux86/> tree -L 1
```

Task 3

- Run the image in the emulator

```
                        # you need to be inside of your project
                        # environment!

            $~/yocto/> source poky/oe-init-build-env myqemux86

$~/yocto/myqemux86/> runqemu qemux86

                        [maybe you have to enter a password
                         should be 'training']

$~/yocto/myqemux86/>
```

Task 4

- Resetup and build **AGL** for minnowboard
  - use intel-corei7-64 as this is the MACHINE for minnow
  - Open a new terminal
  - we cloned the AGL repos for you with repo in
    - yocto/AGL/
  - Reference: yocto/AGL/meta-agl-demo/README.md
  - Steps:
    - source meta-agl/scripts/envsetup.sh intel-corei7-64
    - ln -sf ../../../site.demo conf/site.conf
    - bitbake agl-demo-platform