

Poky meets Debian: Understanding How to Make an Embedded Linux by Using an Existing Distribution's Source Code

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Information

- **All source code are available at the following URL:**
 - <https://github.com/ystk>
 - Poky-debian
 - <https://github.com/ystk/poky-debian>
 - Branch: master
 - Meta-debian
 - <https://github.com/ystk/meta-debian>
 - Branch: daisy

Can we create a “Standard Embedded Linux Distribution”?

Embedded Linux Conference Europe 2014

It is really difficult!

How to choose a suitable distribution for you?

- **There are a lot of Linux distributions**
- **Need to be considered the following**
 - **Usecases**
 - Supported CPU architectures
 - X86, ARM, PowerPC, etc.
 - Number of packages
 - How many packages are enough?
 - Security fix support period for some distributions
 - Centos 10 years
 - OpenSUSE 3 years
 - Debian 3 years+2years(LTS)
 - Ubuntu 5 years
 - Gentoo Incremental update (rolling release)

Why Debian?

- **Would like to use Desktop and Embedded with a same source code base**
- **Would like to build embedded Linux environment for the following CPUs**
 - X86(32bit and 64bit)
 - ARM
 - PowerPC
 - might be others
- **Would like to use same package version in one major release**

Why not Emdebian?

- **<http://www.emdebian.org/>**

- As of July 2014, updates to the Emdebian distributions ceased. There will be no further updates and no further stable releases.

- **Would like to customize more than Emdebian's way**

Why Poky?

- **Poky is one of the most popular reference distribution for embedded Linux**
- **Would like to share the knowledge**
 - Bitbake
 - Recipes
 - Tools

What we want?

- **Use Debian's source code**
- **Make custom embedded Linux environments**
- **Would like to change it to open**
- **Share knowledge with Yocto Project**

Scope of this presentation

- **Introducing of the following two implementation**
 - Poky-debian (BAD manners)
 - Meta-debian (GOOD manners)

- **Out of scope**
 - What is the Yocto Project

Compareing Poky-debian and Meta-debian

	Poky-debian	Meta-debian
Poky version	Edison	Daisy
Debian version	6 (Squeeze)	8 (Jessie)
Kernel	LTSI + RT patch	LTSI + RT patch
Distribution Support	Debian 6	Debian 8

poky-debian

Introduction of Poky-debian

- **Replacing meta layer to adapt Debian source**
- **Source code**
 - <https://github.com/ystk/poky-debian.git>

What is "poky-debian" ?

■ Based on

- Poky (Edison)
- Debian 6 (squeeze-lts)

■ Generate Linux environment for embedded systems (x86, ARM, PowerPC, etc.)

- Based on "poky" developed by Yocto Project
- Kernel, rootfs and toolchain only from Debian source codes
- Common sources + board-specific customization

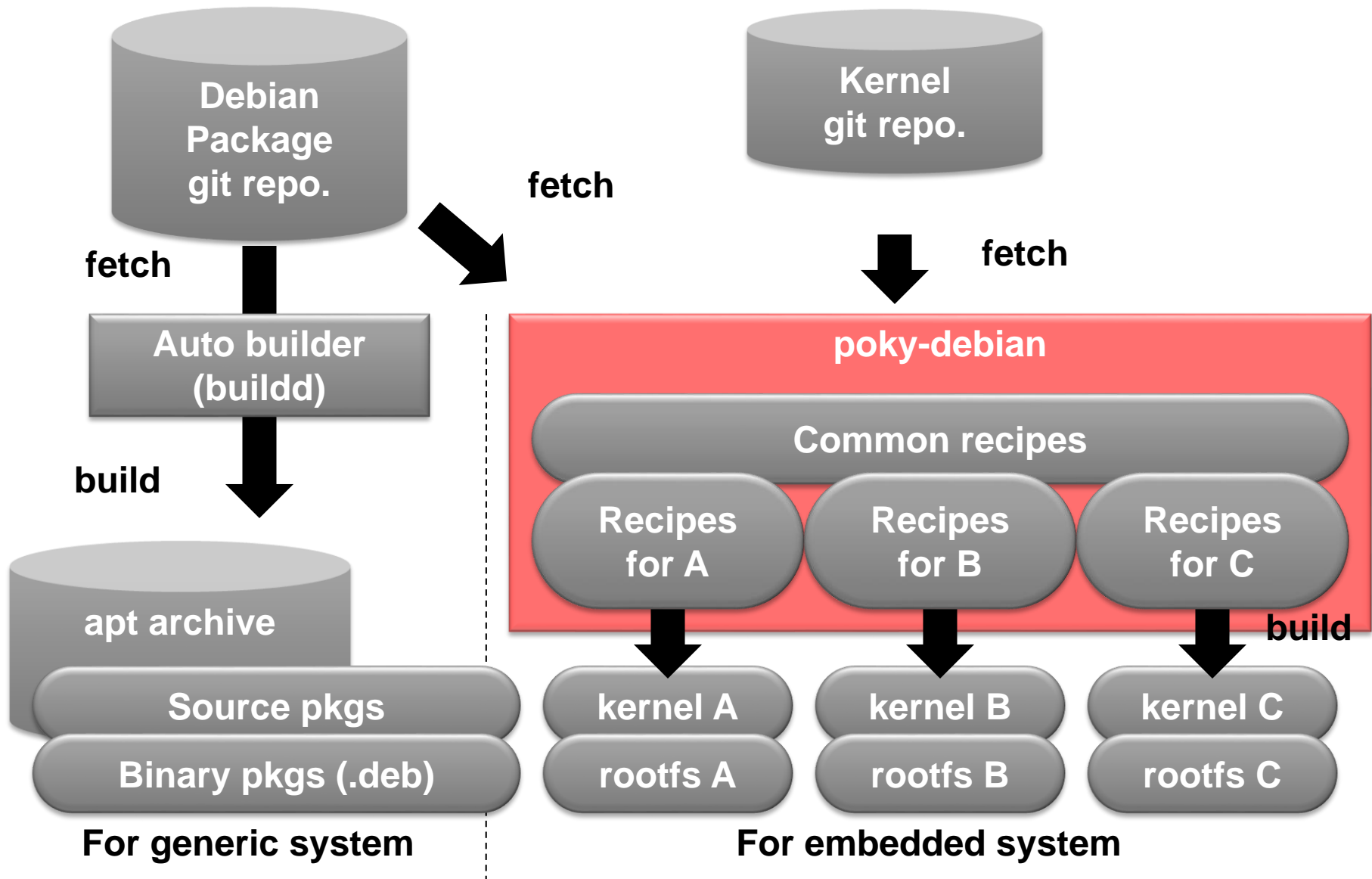
■ Support distro

- Debian 6 LTS (squeeze-lts) only
- All build test has been done on x86-32bit environment

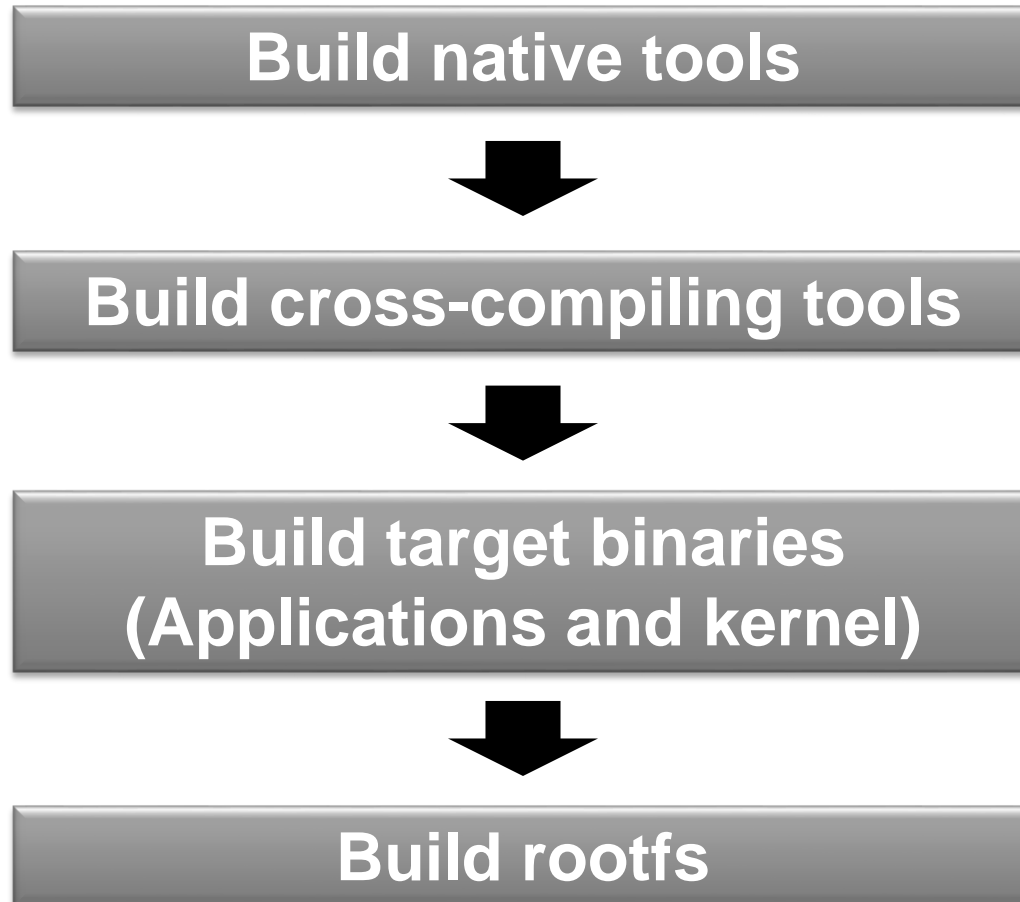
Goal of poky-debian

- **Build Debian based Linux environment for many embedded systems as quickly as possible**
- **Generate "minimal" environment for each requirement**
 - Ex: Consists only busybox and libc
- **Share problems between all systems generated by it**
- **Share know-how for embedded Linux system implementation**
- **Improve traceability of all sources & customization**

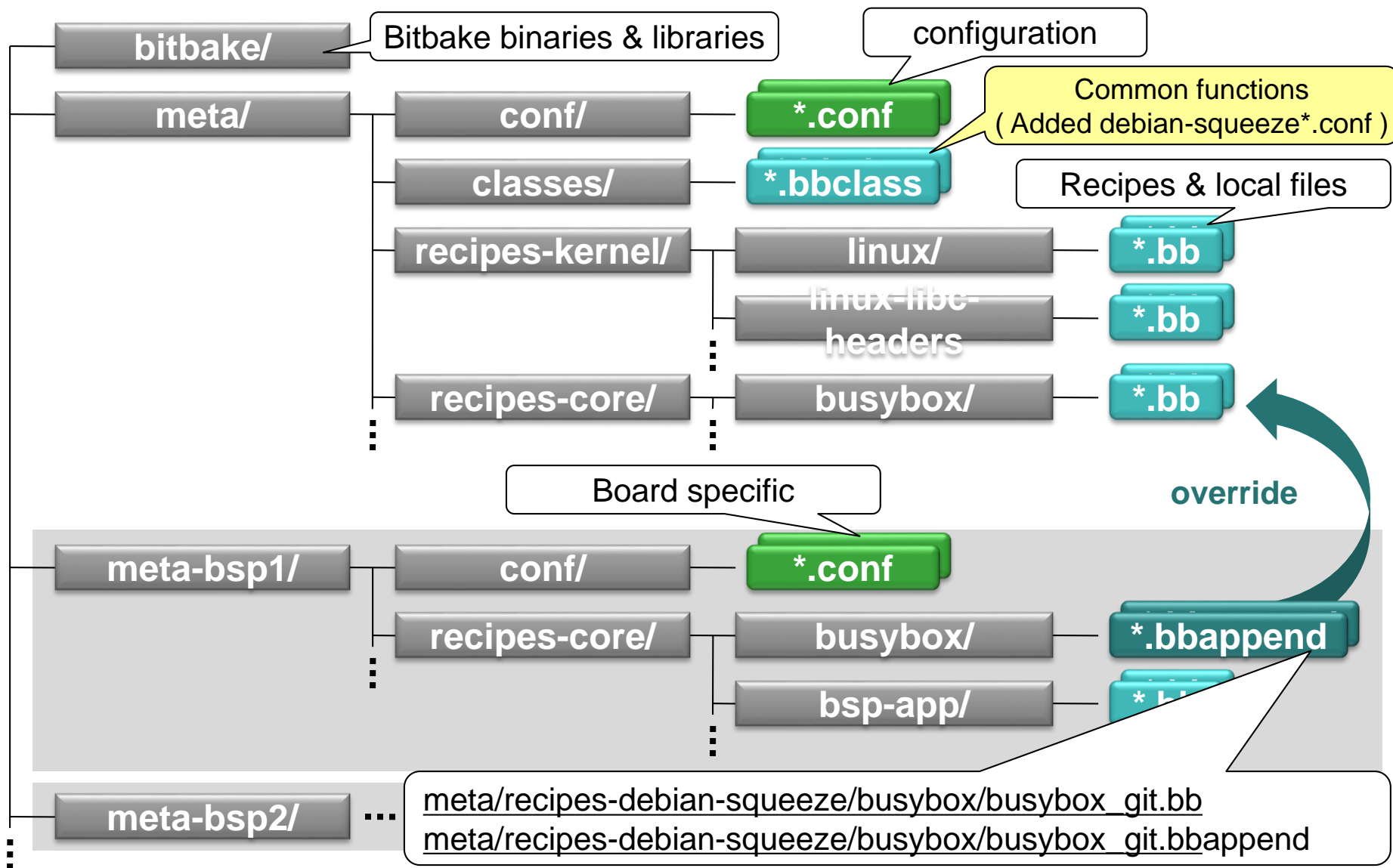
Packaging system structure



Build flow



Directory structure of poky-debian



Core components

■ **bitbake**

- Core build tool of poky
- Parse all recipes and run all build actions
- Ex: To build busybox, run `$ bitbake busybox`

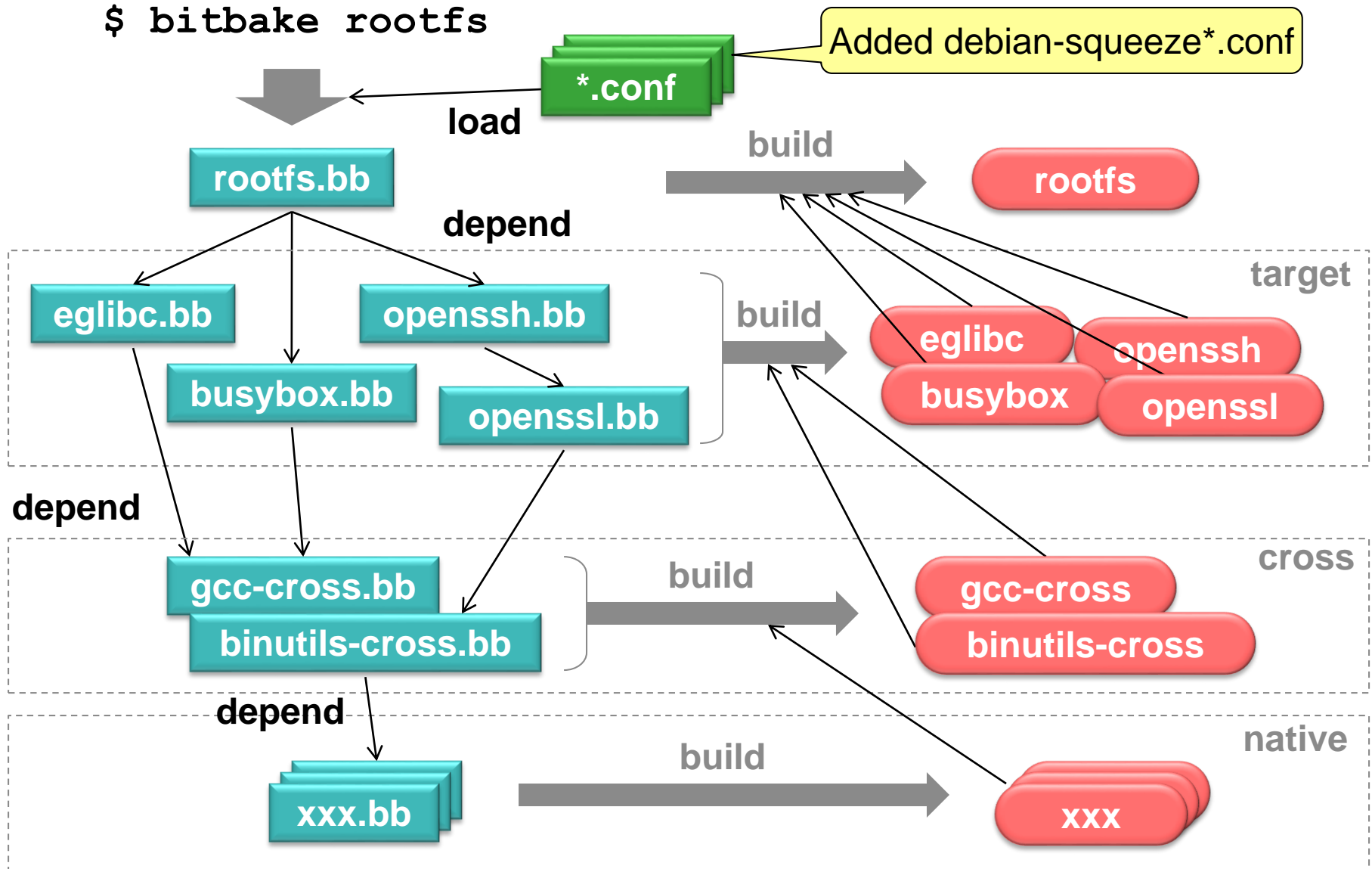
■ **Recipes (*.bb)**

- Defines how to build each package, kernel, rootfs, toolchain, etc.
- Written in shell & python based script
- Actions in some recipes depend on other recipes

■ **Configuration (.conf)**

- Defines machine or build environment-specific values

The relation of core components



Build tasks

■ Each recipe has the following "task":

1. do_fetch*: Fetch source to the download directory
2. do_unpack*: Checkout git, unpack archives, etc.
3. do_patch*: Apply local patches
4. do_configure: Do `$./configure`
5. do_compile: Do `$ make`
6. do_install: Do `$ make install`
-

■ Each task is defined as a function in a recipe

```
do_unpack() {
    tar xzf ...
}

do_compile() {
    export ARG1=...
    export ARG2=...
    make
}

do_install() {
    install -d ...
    install -m 0755 ...
}

.....
```

Developing recipes for poky-debian

Issues

- **At least 200-300 packages are required to apply poky-debian to embedded systems**

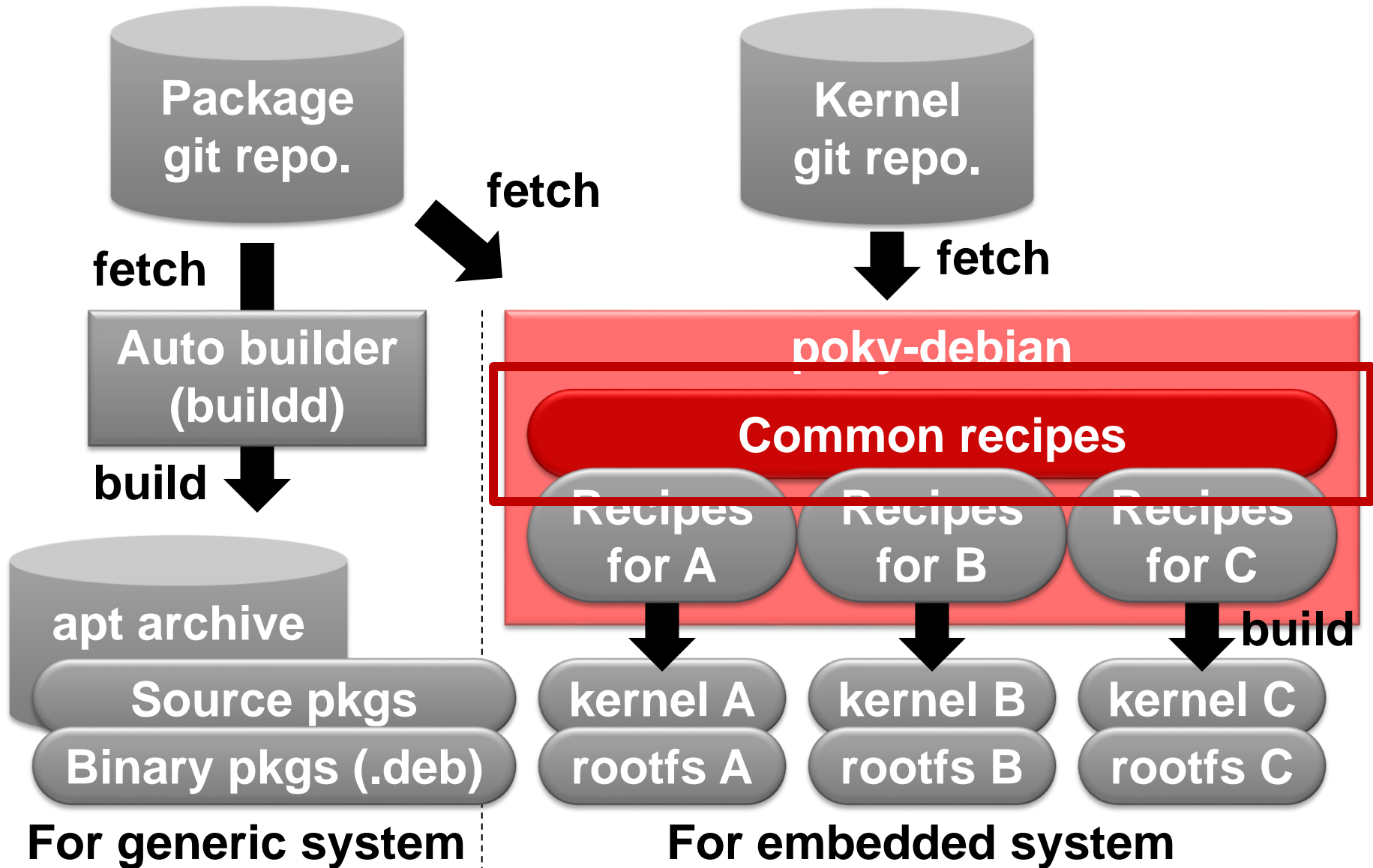
- Social Infrastructure, power system, train/highway, medical, ...



- **Need to implement & update many "common" recipes for Poky-debian**

- "common" means "not depend on target system"
- All recipes for board X are created based on "common" recipes

Packaging system structure (target)

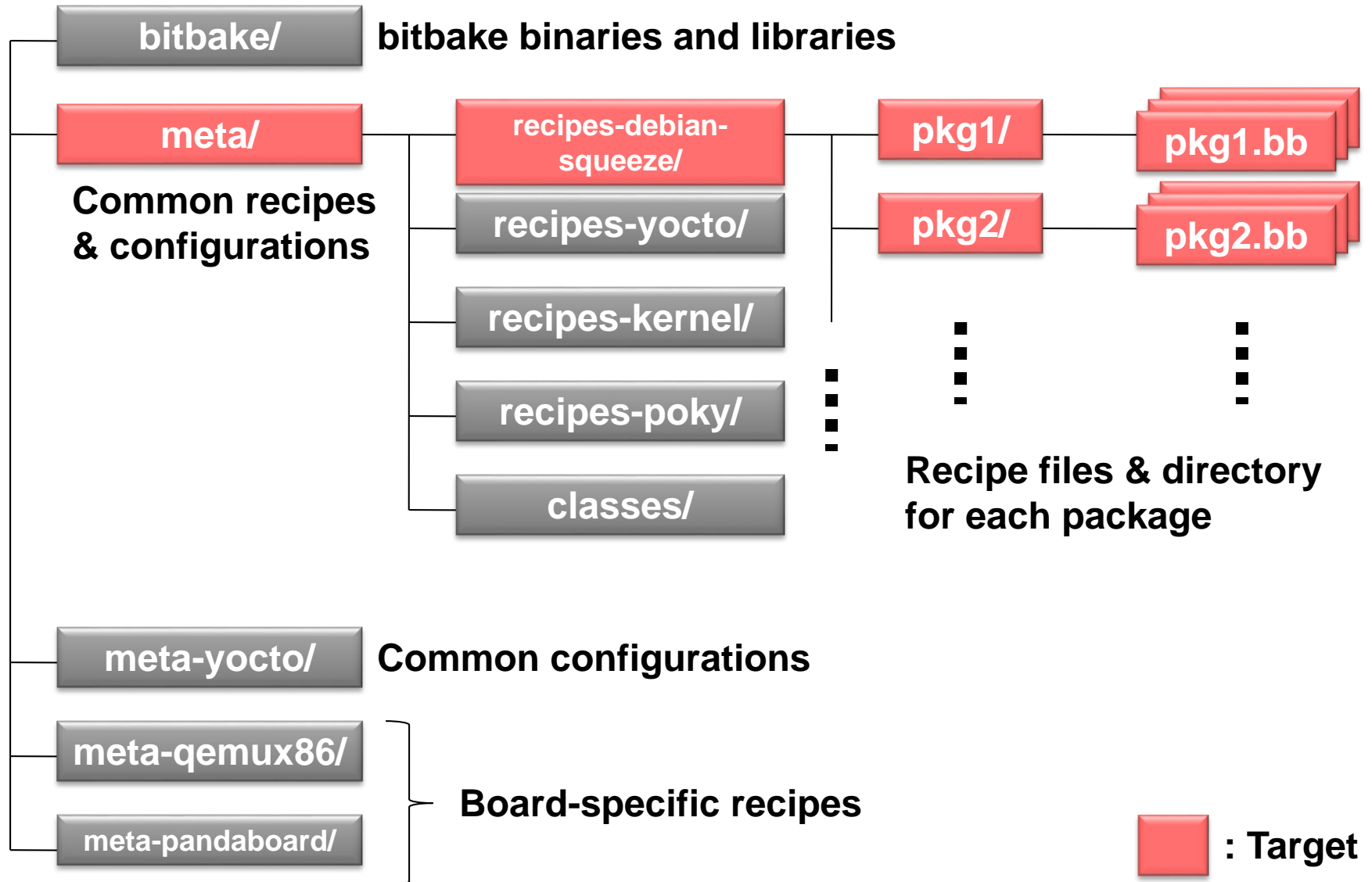


Why BAD manners?

- **First step**

- Move all original recipes to somewhere... ☹

Directory structure



How to implement a recipe for "xyz" (modify)

1. Copy recipes from original poky directory

- `$ cp -r meta/ORIGINAL/recipes-*/xyz meta/recipes-debian-squeeze`

2. Modify recipe files

- Change to fetch all sources from git repository
(Original recipes fetch sources from upstream site or Yocto Project source repository)

3. Build test => Usually error occurs :(

- Because of lack of source repositories, patch rejects, missing source files, build-dependency, include / link problems, ……

4. Re-modify recipe files to fix errors

Example: Recipe for "sed"

```
#
# sed_4.2.1.bb
#

DESCRIPTION = "sed is a Stream Editor."
HOMEPAGE = "http://www.gnu.org/software/sed/"
...

#SRC_URI = "${GNU_MIRROR}/sed/sed-${PV}.tar.gz"

#SRC_URI[md5sum] = "f0fd4d7da574d4707e442285fd2d3b86"
#SRC_URI[sha256sum] =
"8773541ce097fdc4c5b9e7da12a82dffbb30cd91f7bc169f52f05f93b7fc3060"

inherit autotools update-alternatives gettext

...

BBCLASSEXTEND = "native"

#
# debian
#

inherit debian-squeeze
```

How to implement a recipe for "xyz" (create)

- **Implement a recipe for "xyz" from scratch if there is no original poky recipe**

- **Need to check the following:**
 - Proper configure & make options
 - Build dependency
 - Run-time dependency
 - How to split output binaries to packages (.debs)
 - And more...

Poky-debian Quick Start

Setup poky-debian source tree

■ Disable dash on Debian

```
$ sudo dpkg-reconfigure dash
```

- Select "no" in menu

■ Download poky-debian

```
$ mkdir $WORKDIR; cd $WORKDIR  
$ git clone git://github.com/ystk/poky-debian.git  
$ cd poky-debian
```

■ Install dependent packages

```
$ ./scripts/install-deps.sh
```

Setup poky-debian (Need to do every time)

■ Setup build environment for target board

```
$ . ./poky-debian/setup.sh qemux86
```

- This command means that we use "qemu for x86" as the target board

■ Build

```
$ bitbake core-image-base
```

- Output directory: build-qemux86/tmp/deploy/

Meta-debian

Lessons learned from Poky-debian development

- **Poky-debian has a lot of local rules**
- **As the result**
 - poky-debian cannot follow the Poky's development tree
 - Difficult to make it open

- **Next time, we would like to create more friendly one with Poky**

Meta-debian

What is meta-debian?

- **Extending poky recipes to use Debian sources**
- **Based on newer Poky provided by Yocto Project**
- **Provide "meta-debian" only**
 - All recipes and configuration are included in it
 - Completely separated from OE-core (meta) and other layers
- **Source code**
 - <https://github.com/ystk/meta-debian.git>

Purpose

- **Make everyone to be able to use Debian source through Poky**
- **Would like to contribute something to Debian long term support and use the source code with Poky**
- **Keep reproducibility of each build**
- **Output more detail information about package and license**

meta-debian : Basic information

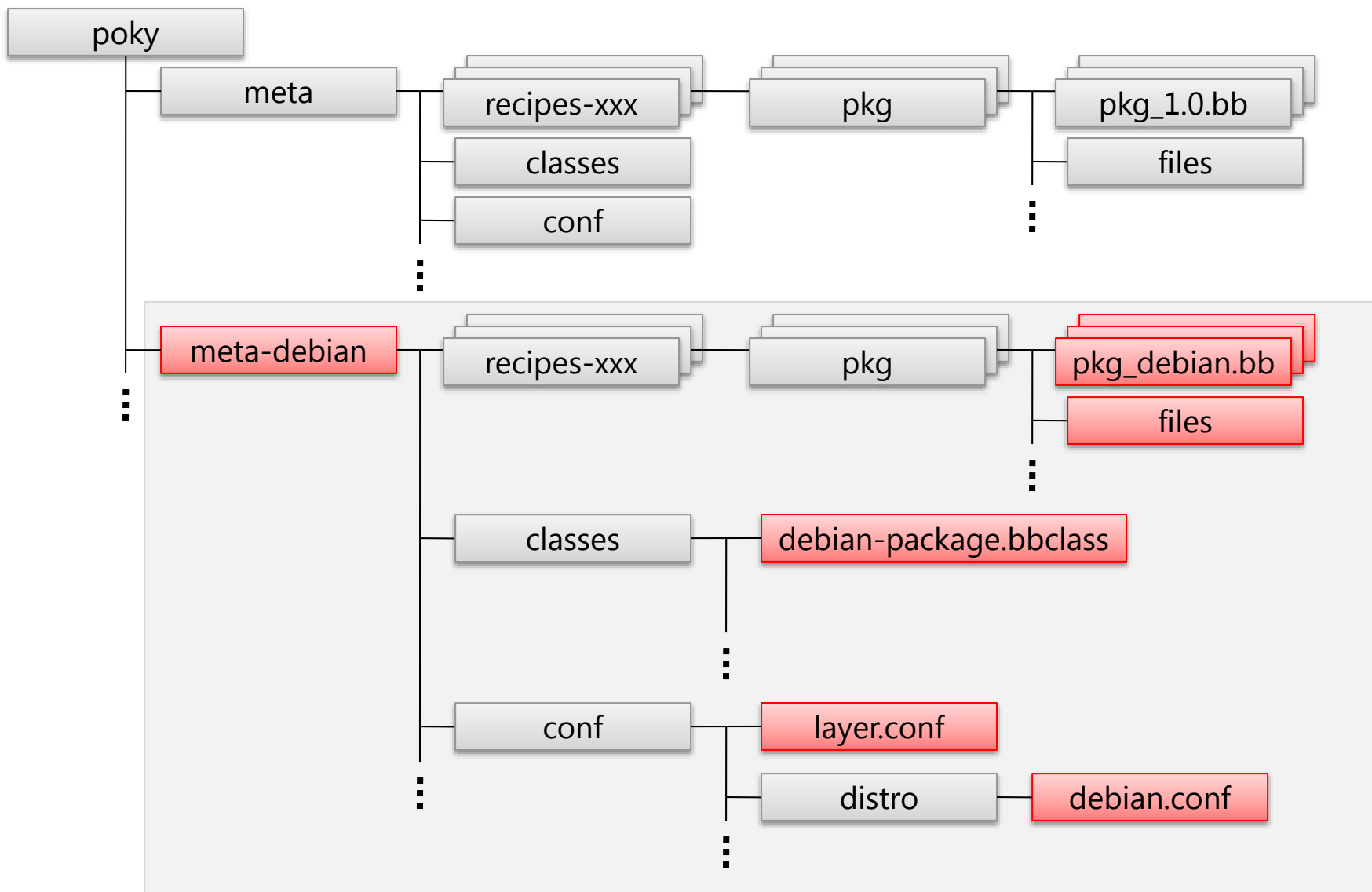
- **Debian version**

- Debian GNU/Linux 8 (jessie)

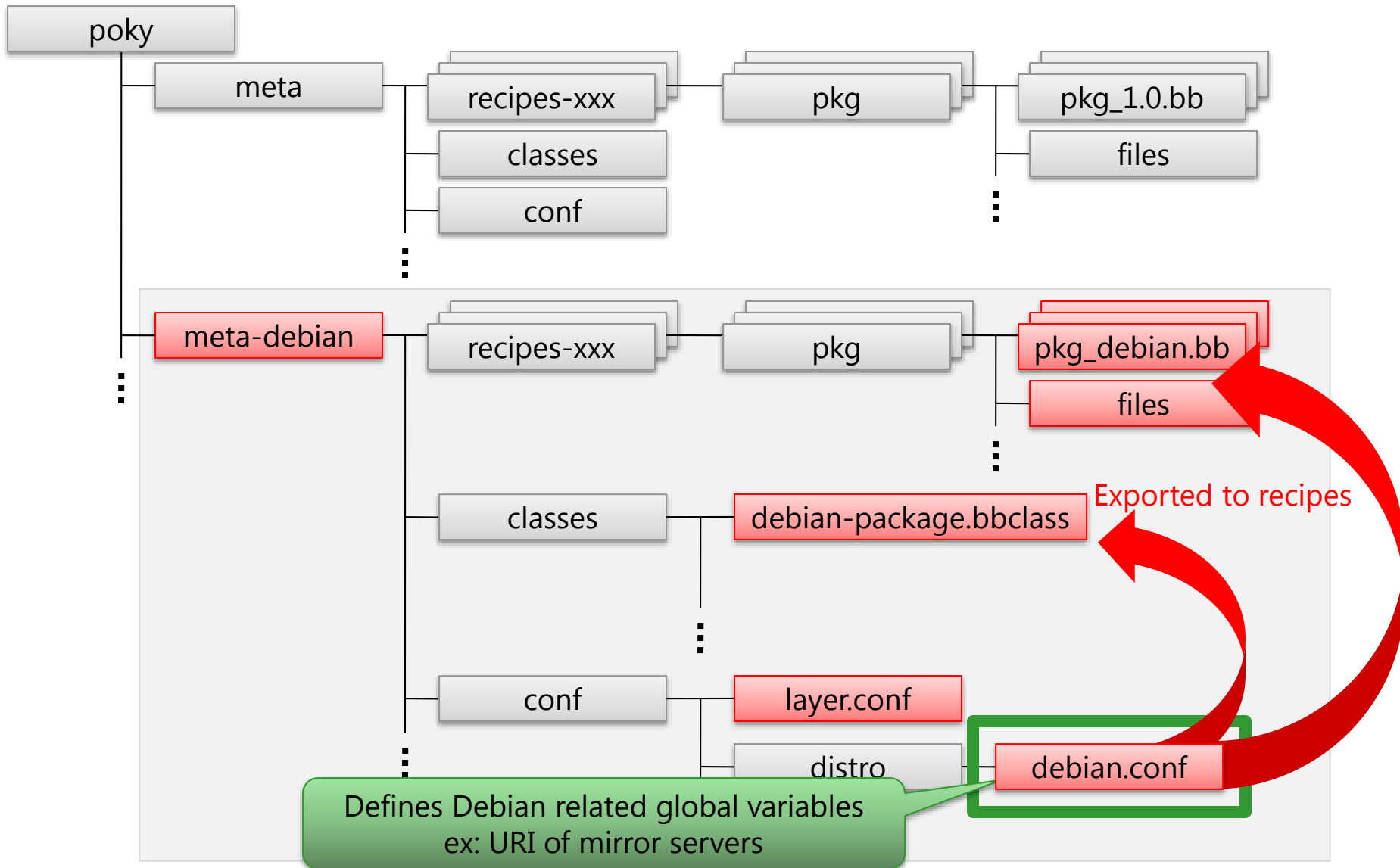
- **Poky version**

- Yocto Project 1.6 Daisy

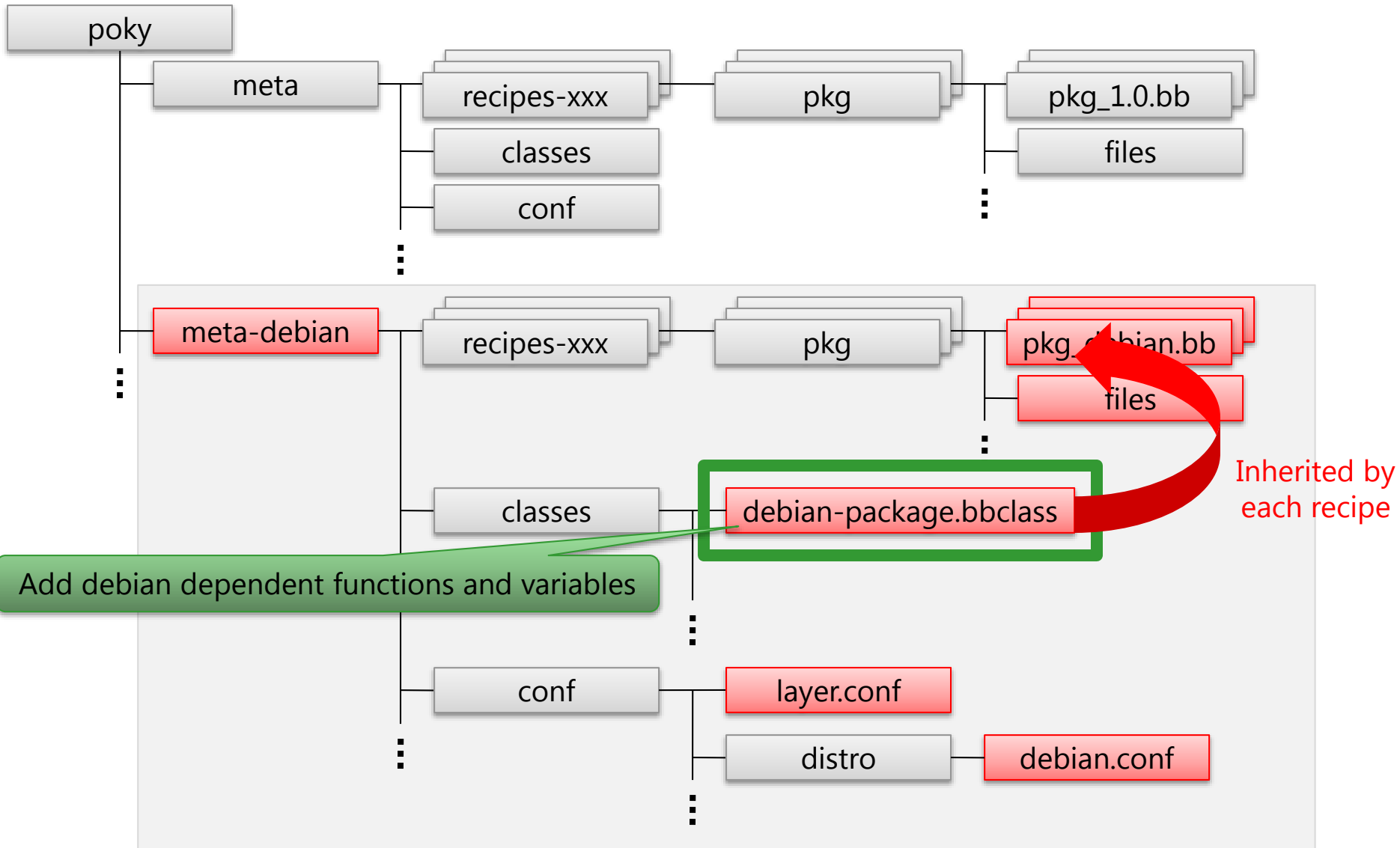
Directory structure of poky and meta-debian



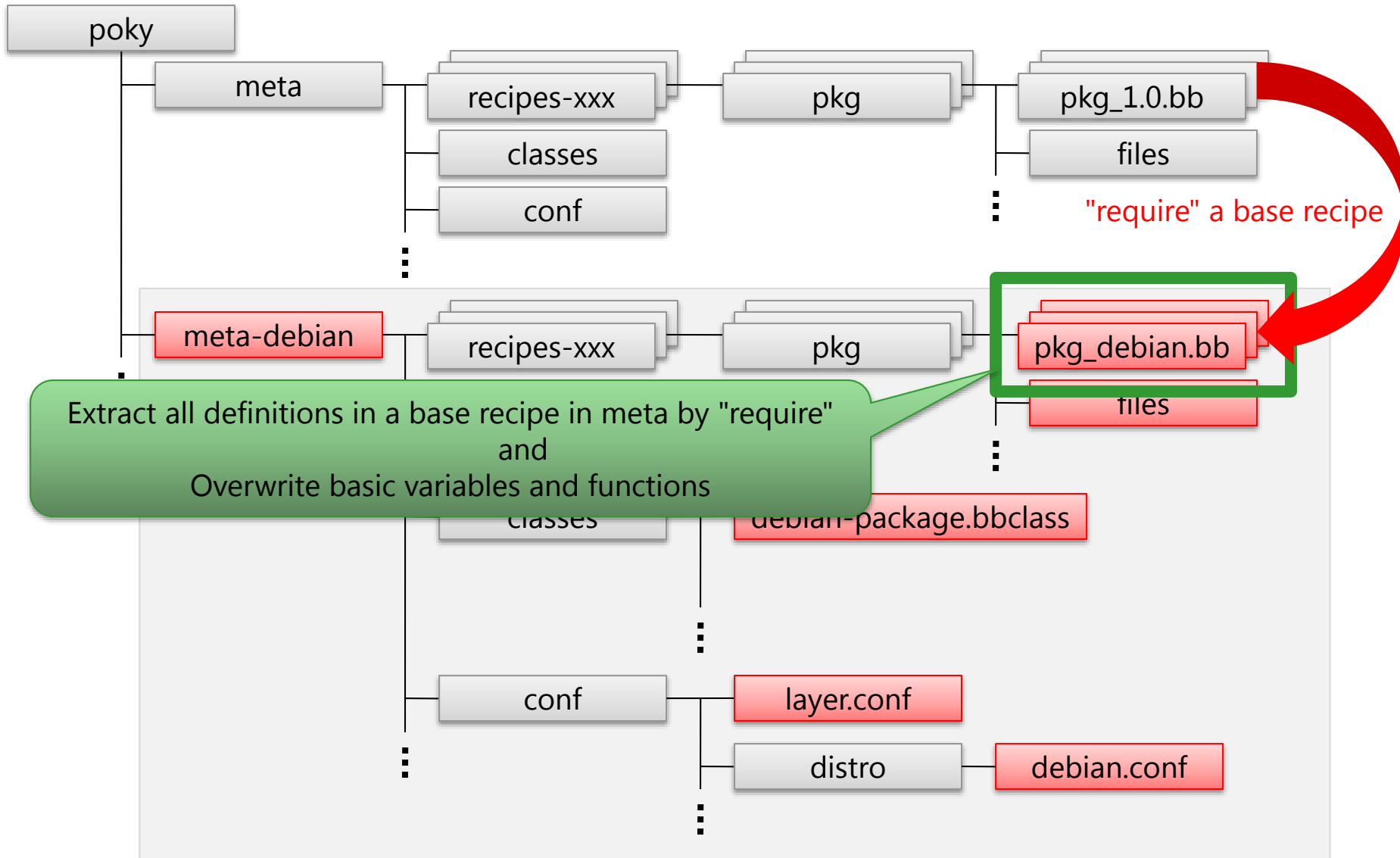
Directory structure of meta-debian



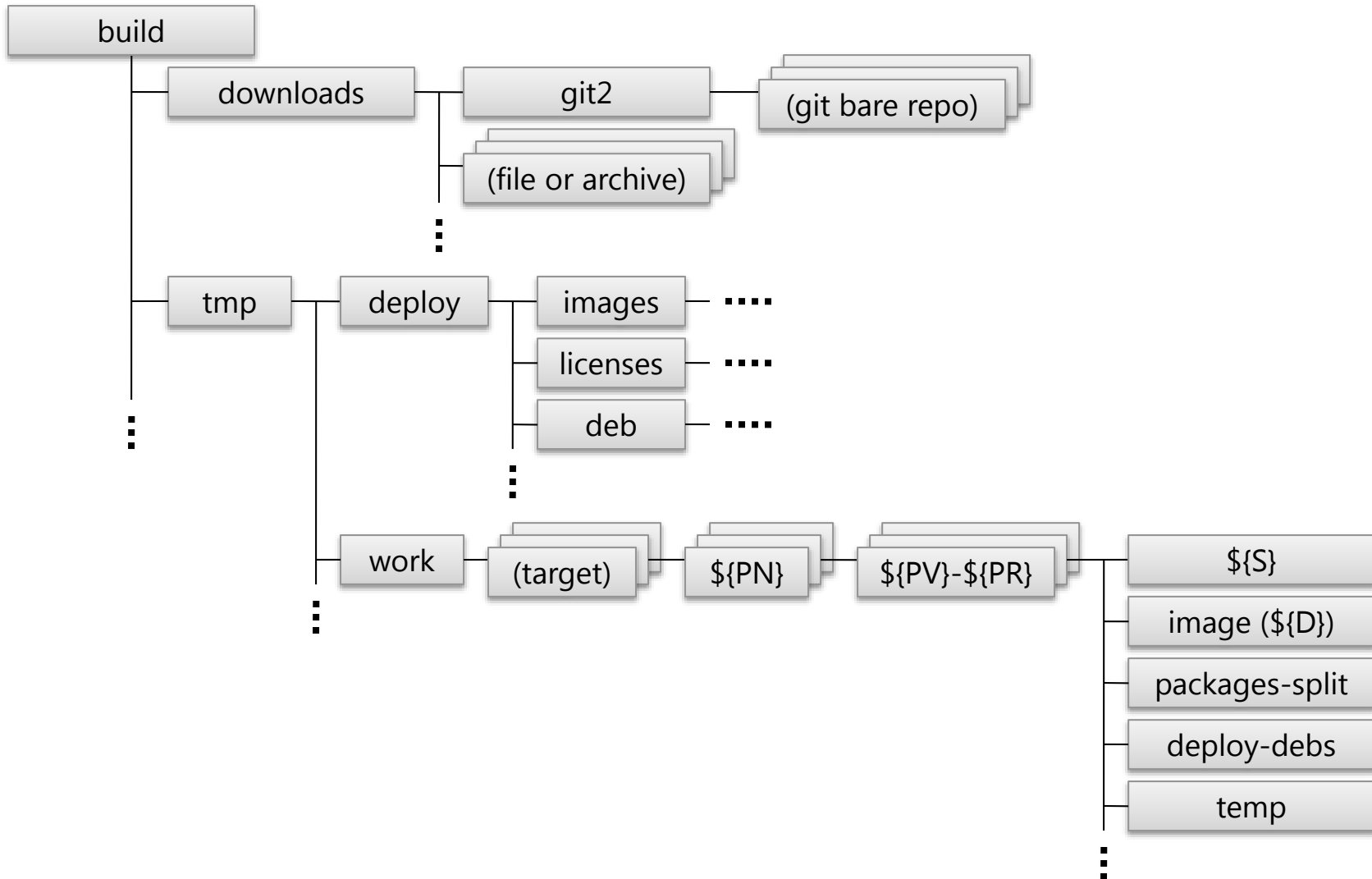
Directory structure of meta-debian



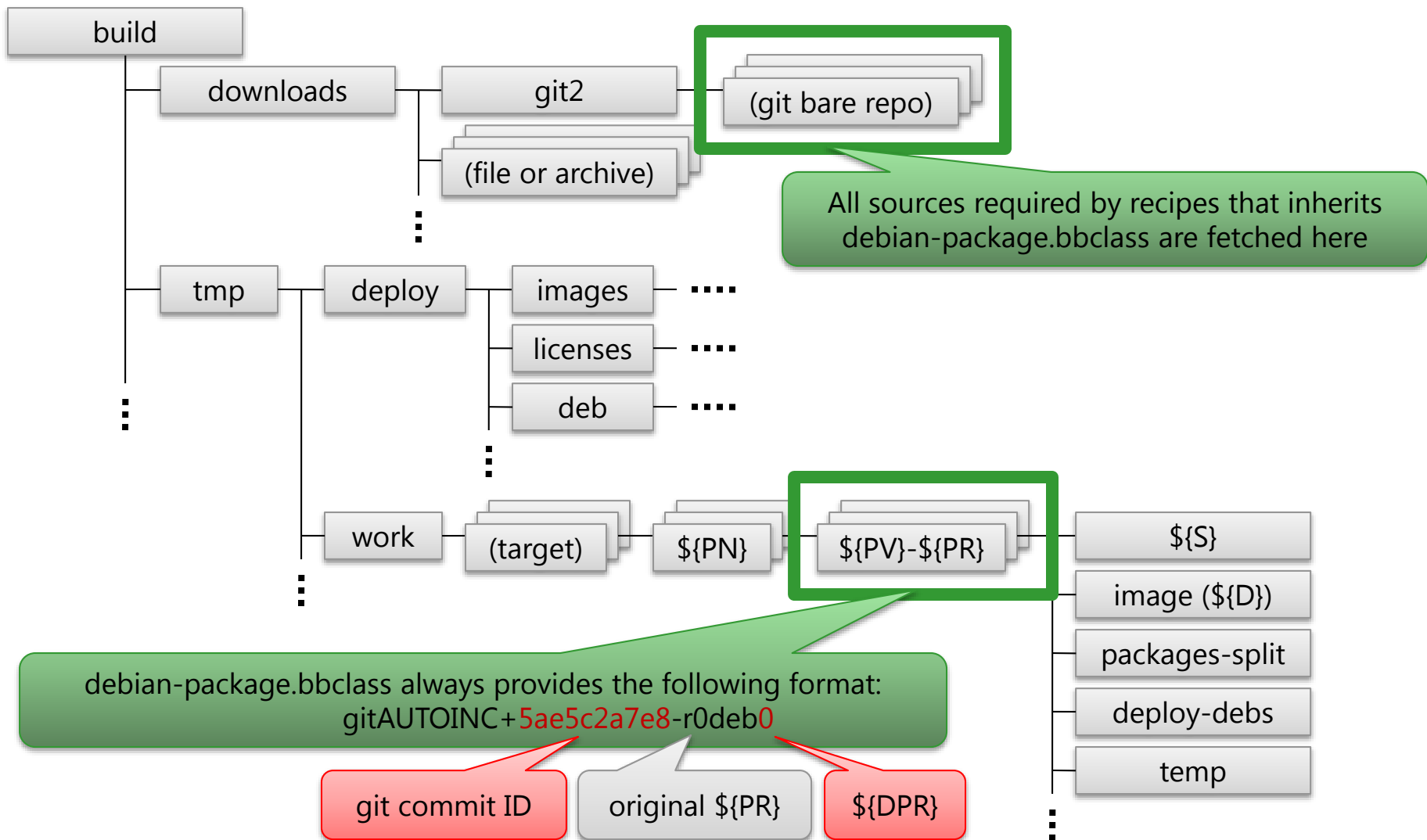
Directory structure of meta-debian



Build directory structure



Build directory structure



Build flow

bitbake tasks

(initialize)
do_fetch()
do_unpack()
do_debian_patch()
do_patch()
... (same as original)
...

bitbake variables

PN = quilt-native
PV = debian
PR = r0
DPN = N/A
DPR = N/A



\${DL_DIR}

\${WORKDIR}

Build flow

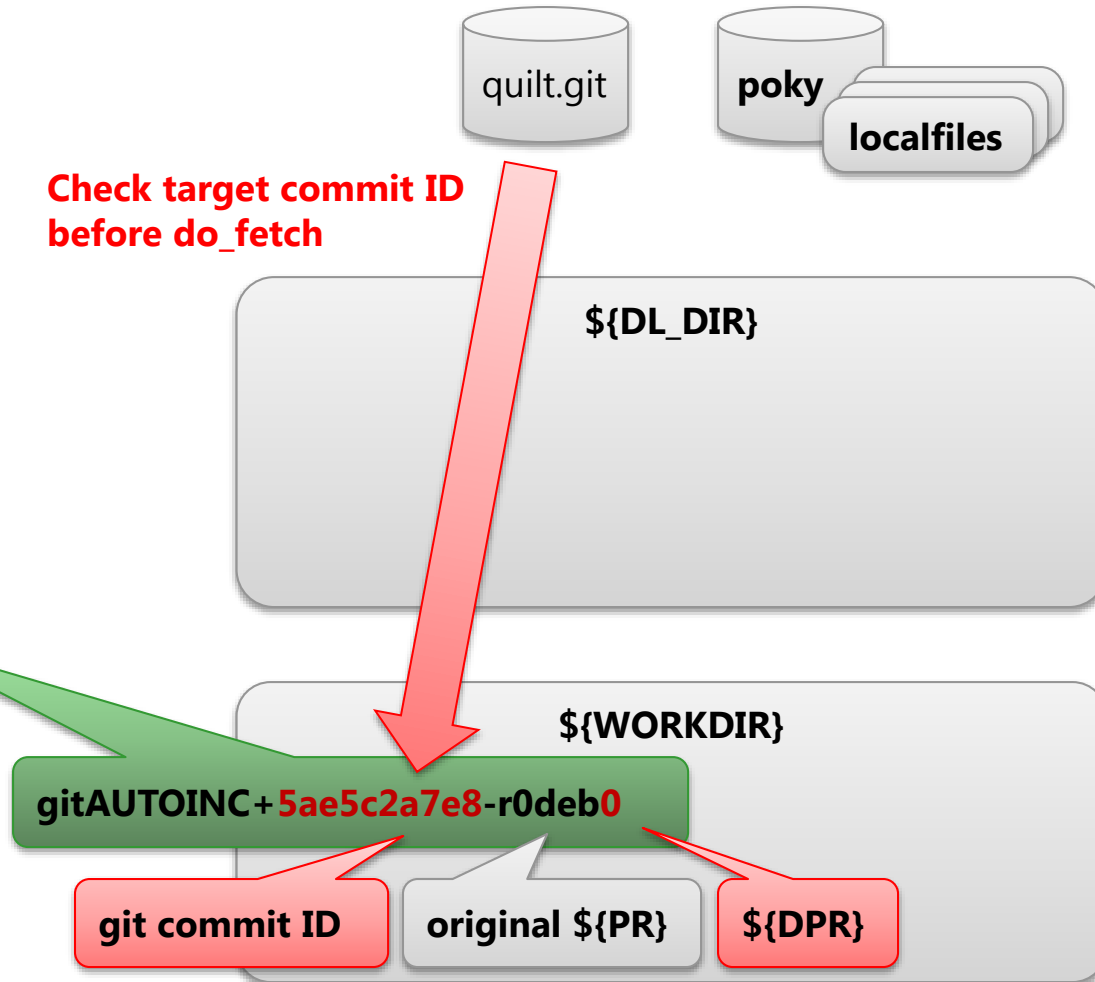
bitbake tasks

(initialize)
do_fetch()
do_unpack()
do_debian_patch()
do_patch()
... (same as original)
...

bitbake variables

PN = quilt-native
PV = git{SRCPV}
PR = r0
DPN = quilt ({BPN})
DPR = 0

Check target commit ID
before do_fetch



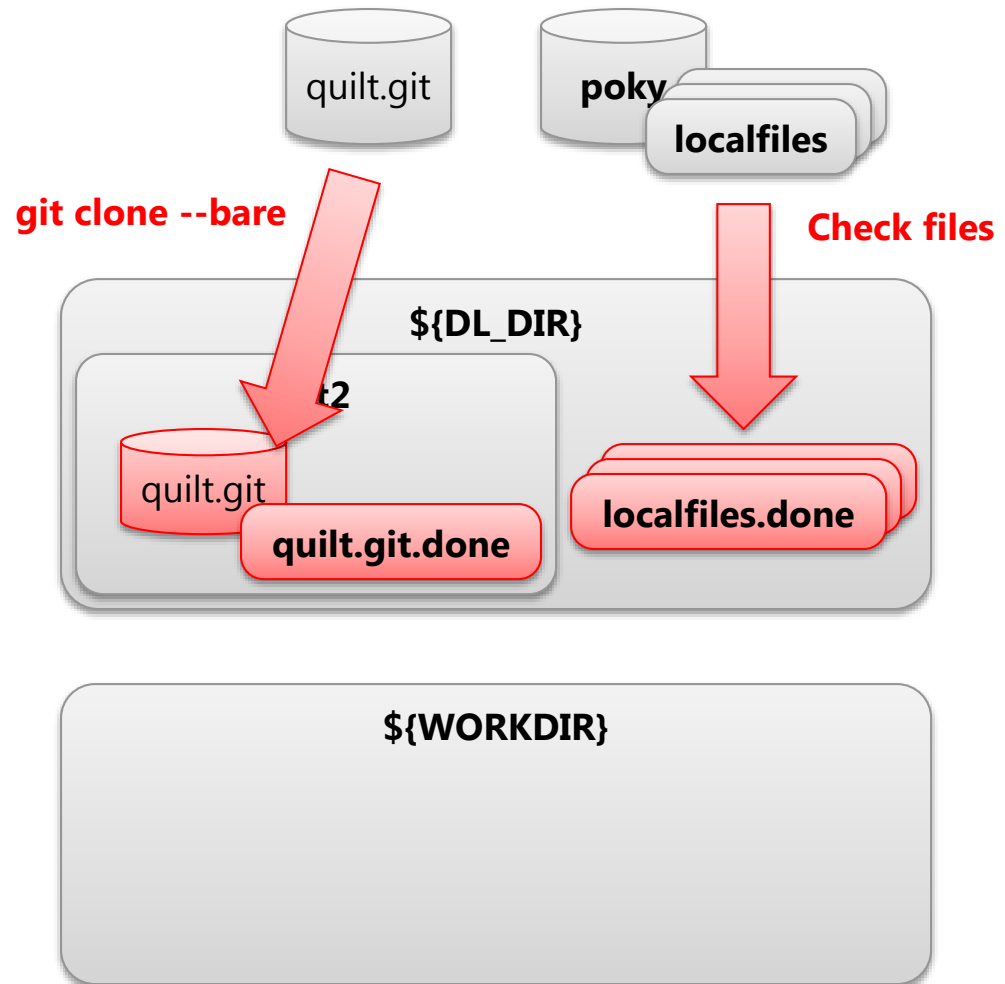
Build flow

bitbake tasks

(initialize)
do_fetch()
do_unpack()
do_debian_patch()
do_patch()
... (same as original)
...

bitbake variables

PN = quilt-native
PV = git\${SRCPV}
PR = r0
DPN = quilt (\${BPN})
DPR = 0



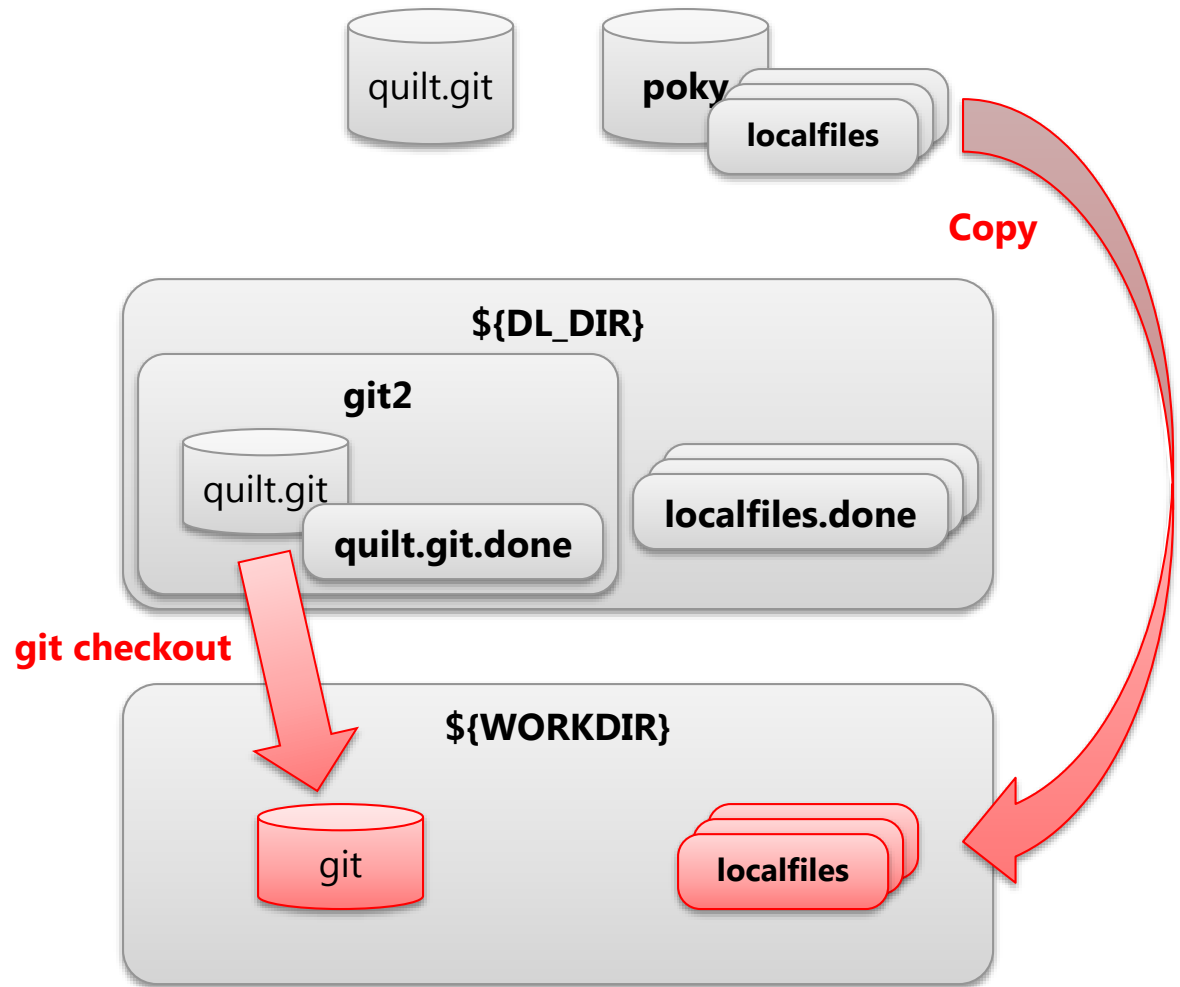
Build flow

bitbake tasks

(initialize)
do_fetch()
do_unpack()
do_debian_patch()
do_patch()
... (same as original)
...

bitbake variables

PN = quilt-native
PV = git\${SRCPV}
PR = r0
DPN = quilt (\${BPN})
DPR = 0



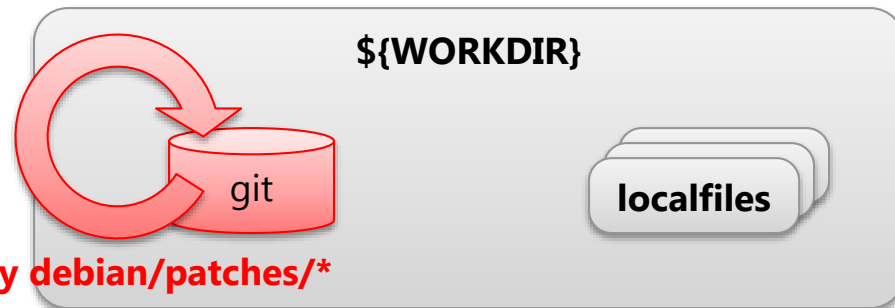
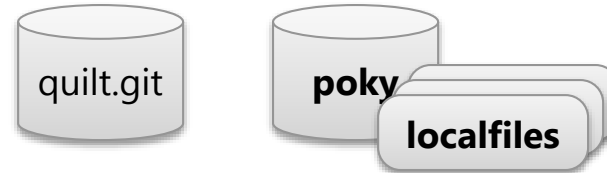
Build flow

bitbake tasks

(initialize)
do_fetch()
do_unpack()
do_debian_patch()
do_patch()
... (same as original)
...

bitbake variables

PN = quilt-native
PV = git\${SRCPV}
PR = r0
DPN = quilt (\${BPN})
DPR = 0



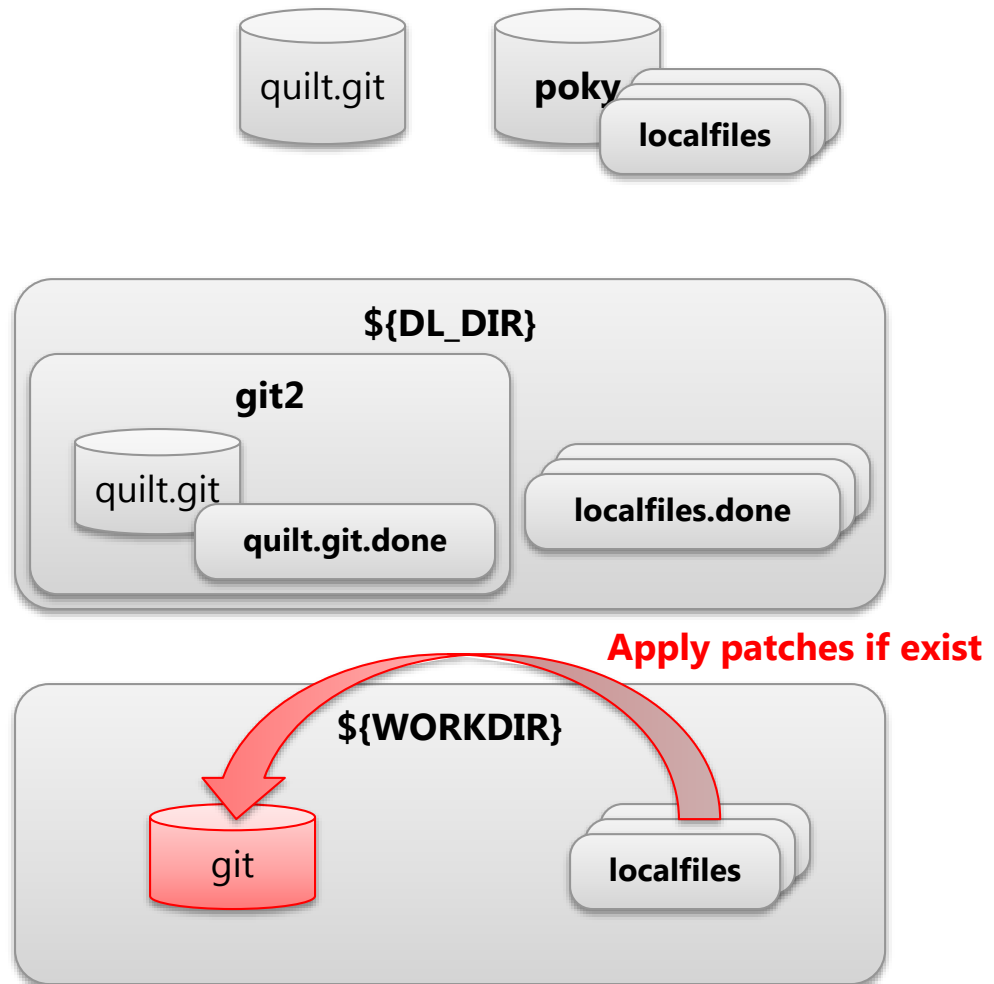
Build flow

bitbake tasks

(initialize)
do_fetch()
do_unpack()
do_debian_patch()
do_patch()
... (same as original)
...

bitbake variables

PN = quilt-native
PV = git\${SRCPV}
PR = r0
DPN = quilt (\${BPN})
DPR = 0



Creating a recipe

Sample recipe: quilt-native

■ meta-debian/recipe-debian/quilt/quilt-native_debian.bb

```
require recipes-devtools/quilt/${PN}_0.61.bb
FILESEXTRAPATHS_prepend = "${COREBASE}/meta/recipes-devtools/quilt/quilt:"

inherit debian-package

DPR = "0"

LICENSE = "GPLv2"
LIC_FILES_CHKSUM = "file://COPYING;md5=94d55d512a9ba36caa9b7df079bae19f"

SRC_URI = " ¥
file://install.patch ¥
file://run-ptest ¥
file://Makefile ¥
"

debian_patch_quilt() {
    ...
}
```

Step 1: Create files and directories

- **Create directory meta-debian/recipe-debian/quilt**
 - Same path as the base recipe in poky/meta
- **Touch `${PN}_debian.bb`**
 - PN = quilt-native
 - PV = debian
- **Create sub directories including local files if needed**
 - Ex: files, `${PN}`, `${BPN}`, etc.

Step 2: Define a base recipe

```
require recipes-devtools/quilt/${PN}_0.61.bb  
FILESEXTRAPATHS_prepend = "${COREBASE}/meta/recipes-devtools/quilt/quilt:"
```

■ Require a base recipe included in meta

- Find a base recipe from poky's tree
- Sometimes `${PN}` is not the same name as Debian source package
 - Ex: libusb
 - `PN = "libusb1"`
 - Debian source package name: "libusb-1.0"

■ Add directories to **FILESEXTRAPATHS** if needed

- By default, bitbake doesn't search files from the directory that includes the base recipe which requires

Step 3: Inherit debian-package

```
require recipes-devtools/quilt/${PN}_0.61.bb
FILESEXTRAPATHS_prepend = "${COREBASE}/meta/recipes-devtools/quilt/quilt:"

inherit debian-package
```

■ Added/overwritten variables

- PN = quilt-native
- PV = git\${SRCPV}
- PR = r0 (Same as PR in the base recipe)
- DPN ?= quilt (\${BPN})
- DEBIAN_UNPACK_DIR ?= "\${WORKDIR}/git"
- S = "\${DEBIAN_UNPACK_DIR}"
- etc.

■ Exported functions

- do_debian_patch

Step 4: Add PR

```
require recipes-devtools/quilt/${PN}_0.61.bb
FILESEXTRAPATHS_prepend = "${COREBASE}/meta/recipes-devtools/quilt/quilt:"

inherit debian-package

DPR = "0"
```

- "0": Initial version
- Don't forget to add 1 to this value when you modified
 - 0 -> 1 -> 2 ...

Step 5: Add license information

```
require recipes-devtools/quilt/${PN}_0.61.bb
FILESEXTRAPATHS_prepend = "${COREBASE}/meta/recipes-devtools/quilt/quilt:"

inherit debian-package

DPR = "0"

LICENSE = "GPLv2"
LIC_FILES_CHKSUM = "file://COPYING;md5=94d55d512a9ba36caa9b7df079bae19f"
```

- **Always investigate source tree and set correct values**
 - Don't copy them from the base recipe
 - Usually license information can be found in COPYING*, LICENSE*
- **Choose a license name from meta/files/common-licenses if exists**

Step 6: Overwrite SRC_URI

```
require recipes-devtools/quilt/${PN}_0.61.bb
FILESEXTRAPATHS_prepend = "${COREBASE}/meta/recipes-devtools/quilt/quilt:"

inherit debian-package

DPR = "0"

LICENSE = "GPLv2"
LIC_FILES_CHKSUM = "file://COPYING;md5=94d55d512a9ba36caa9b7df079bae19f"

SRC_URI = " ¥
file://install.patch ¥
file://run-ptest ¥
file://Makefile ¥
"
```

- **Exclude the upstream source code**
 - Ex: [http://download.savannah.gnu.org/releases/quilt/quilt-\\${PV}.tar.gz](http://download.savannah.gnu.org/releases/quilt/quilt-${PV}.tar.gz)
- **Add all local files (scripts, patches, etc.) to SRC_URI**
 - Need to solve problems if these files conflict with Debian source

Other rules about modifying recipes

- **Don't modify all files except meta-debian**
- **Don't include specific hardware, company or project related name and functions into meta-debian**
- **Add only really essential DEPENDS and RDEPENDS**
- **Always leave comments**
 - **Why** did you modify so? Nobody knows, you will forget it ☹
- **(... And more, I'll add them in future ... : TBD)**

Build

Preparation

■ Setup Poky and Meta-debian sources

```
$ cd $WORKDIR
(checkout poky)
$ git clone git://git.yoctoproject.org/poky.git
$ cd poky
$ git checkout daisy

(checkout meta-debian)
$ git clone git://github.com/ystk/meta-debian.git
$ cd meta-debian
$ git checkout daisy
```

How to build recipes

■ Run startup script

```
$ cd $WORKDIR
$ source /path/to/poky/oe-init-build-env
```

■ Add "meta-debian" layer to conf/bblayers.conf

```
BBLAYERS ?= " ¥
/path/to/poky/meta ¥
/path/to/poky/meta-debian ¥
"
```

■ Run bitbake

```
$ bitbake <build_target>
```

Comparing Poky-debian and Meta-debian

	Poky-debian	Meta-debian
Poky version	Edison	Daisy
Debian version	6 (Squeeze)	8 (Jessie)
Kernel	LTSI + RT patch	LTSI + RT patch
Distribution Support	Debian 6	Debian 8
Status	Stable	Under development
Number of packages	440	70
Number of BSPs	10	1
Debian binary compatibility	NO	NO
Yocto project compatible	Absolutely not	-

- **Please send your feedback**

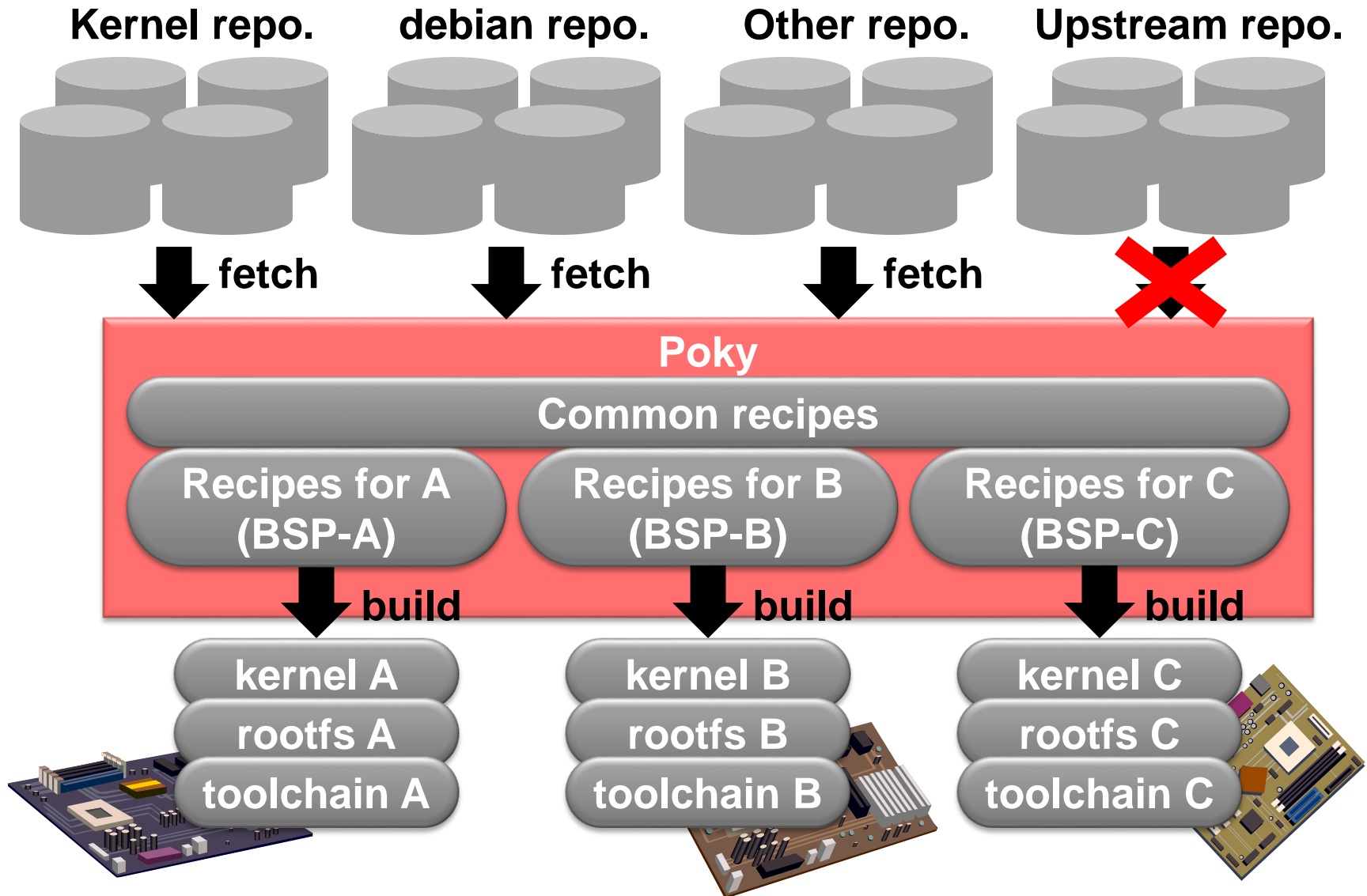
- E-mail: yoshitake.kobayashi@toshiba.co.jp

Thank you

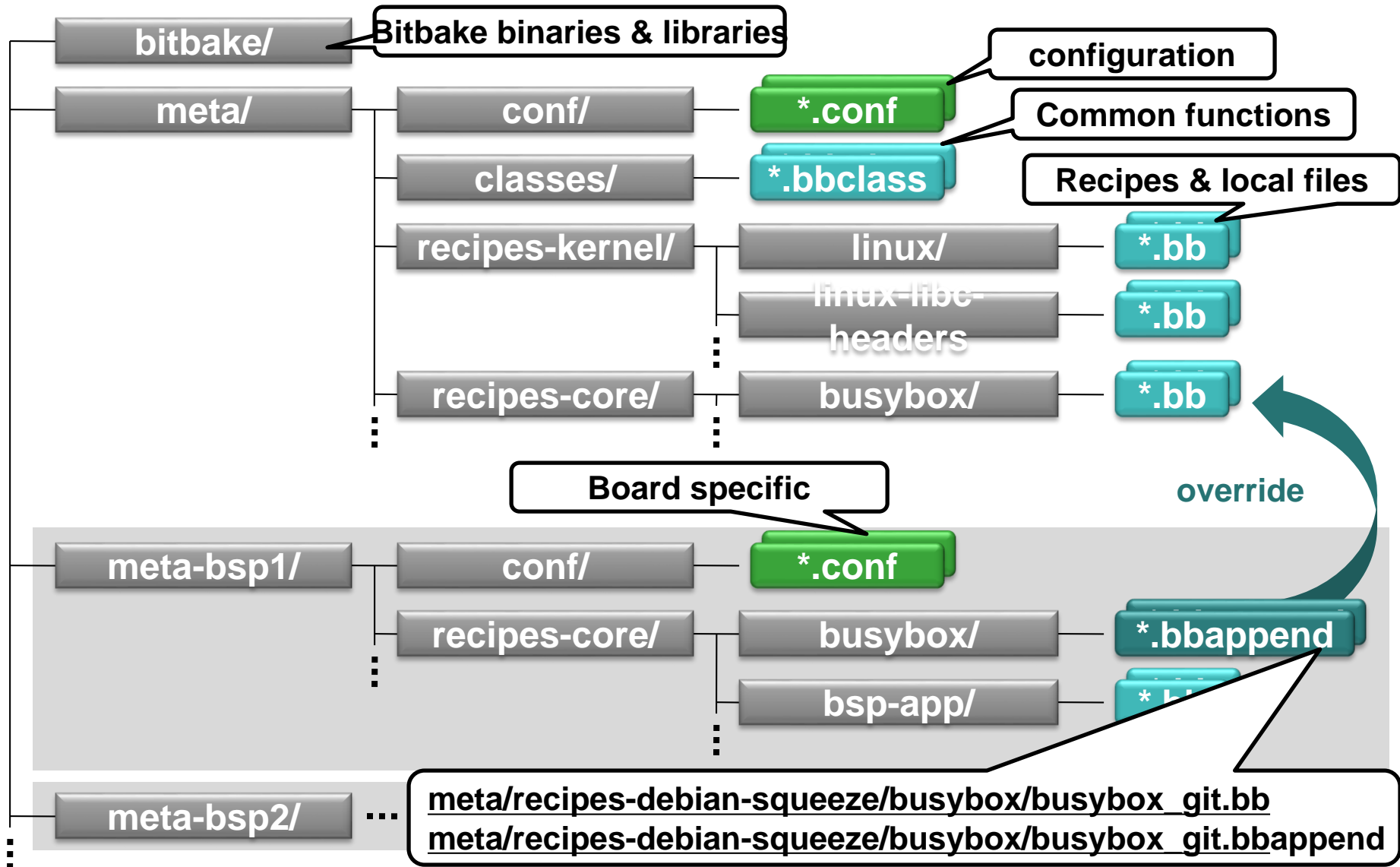
Appendix

More details for poky-debian

Poky-debian Overview

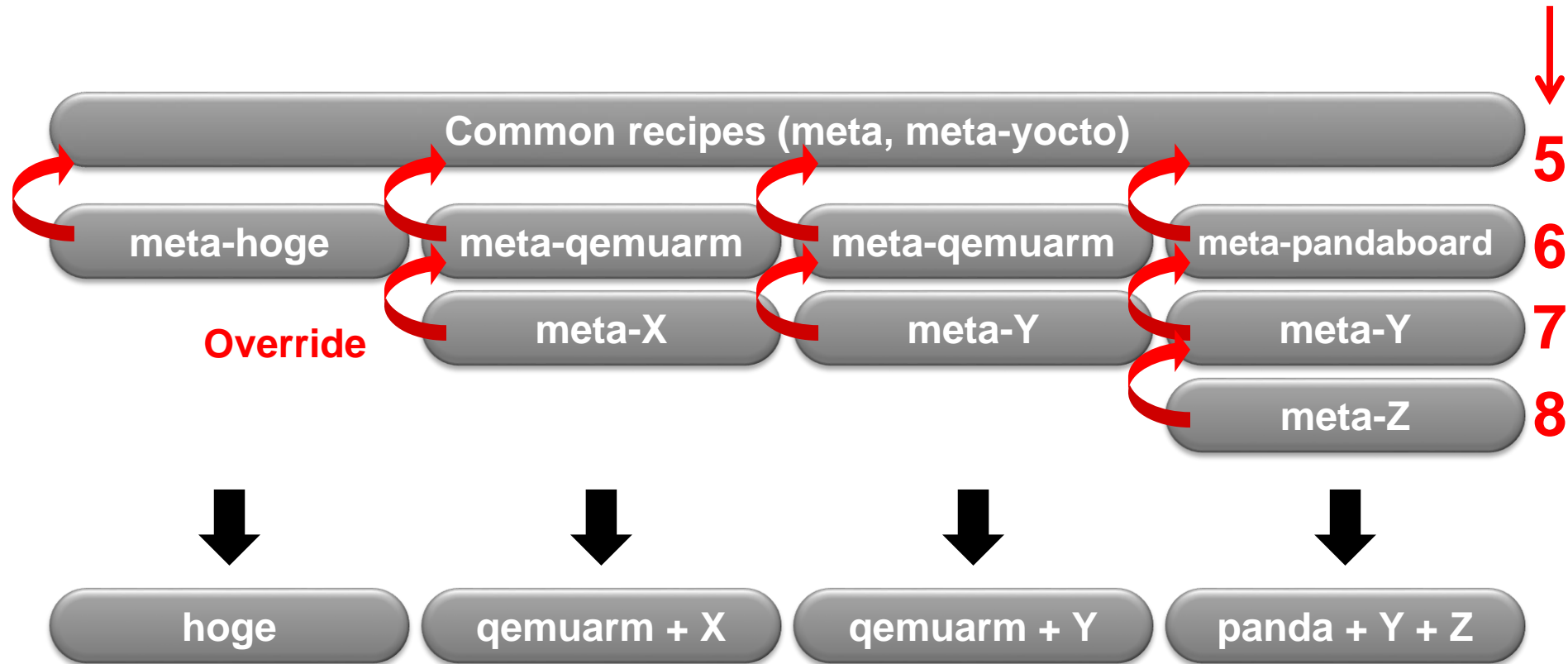


Directory structure



Layeis (meta-*)

BBFILE_PRIORITY_XXX



Directory rules

■ **recipes-debian-squeeze**

- All recipes in this directory fetch all sources from “Git server”
 - `DEBIAN_SQUEEZE_GIT_APP` ?= `git://github.com/ystk/debian-`
- All recipes need to “inherit debian-squeeze”

■ **recipes-kernel**

- All recipes in this directory fetch all sources from “Git server”
 - `DEBIAN_SQUEEZE_GIT_KERNEL` ?= `"git://github.com/ystk/linux-poky-debian.git"`

■ **recipes-yocto**

- All recipes in this directory fetch all sources from “Git server”
 - `DEBIAN_SQUEEZE_GIT_YOCTO` ?= `git://github.com/ystk/tools-yocto1-`
 - These repositories are imported from non-Debian upstream used by original Poky without modification
- All recipes need to “inherit debian-squeeze-yocto”
- No need to be modified in BSP layers

■ **recipes-poky**

- All recipes in this directory never fetch source from remote servers (use only local file)

■ **conf**

- Layer specific configuration, machine configuration, etc.
- All configuration files define variables applied ONLY to the layer

■ **classes**

- This directory includes only common “class files” inherited by recipes in recipes-*
- No need to be modified in BSP layers

Contents

■ **conf/layer.conf**

- Layer specific configuration (See later for more details)

■ **conf/bblayers.conf**

- Define which layers are enabled

```
LCONF_VERSION = "4"
BBFILES ?= ""
BBLAYERS = " ¥
##COREBASE##/meta ¥
##COREBASE##/meta-yocto ¥
##COREBASE##/meta-beagleboard ¥
##COREBASE##/meta-target1/meta-sub1 ¥
##COREBASE##/meta-target1/meta-sub2 ¥
"
```

Don't modify

Don't modify (Always required)

Write additional layers

- Automatically copied to the build directory by setup.sh
 - `./poky-debian/setup.sh foo/bar`
`meta-foo/meta-bar/conf/bblayers.conf` →
`BUILD/conf/bblayers.conf`

Contents

■ `conf/machine/*.conf`

- Target board specific settings
- Typical settings are ...

```
require conf/machine/include/tune-cortexa8.inc
```

CPU dependent settings
Use template .inc files under meta/
Ex: tune-armv7ahf.inc, tune-ppc750.inc

```
IMAGE_FSTYPES += "tar.bz2 jffs2"
```

Type of rootfs
Ex: tar.gz, tar.bz2, ext2, ext3, jffs2

```
SERIAL_CONSOLE = "115200 ttYO2"
```

Serial console name and baudrate
Used in some core files like /etc/inittab

```
KERNEL_IMAGETYPE = "uImage"
```

Kernel image type
Ex: vmlinux, vmlinuz, zImage, uImage

```
EXTRA_IMAGEDEPENDS += "u-boot x-load"
```

Additional recipes you want to build with rootfs
(Usually bootloaders are set)

Contents

■ files/device-table/*.txt

- Device files which are installed statically
- Add it to IMAGE_DEVICE_TABLES in core-image-*.bb
 - IMAGE_DEVICE_TABLES += "files/device-table/hoge.txt"
- Typical lists are already defined in meta/files/device-table
 - Please define additional device files required only on target board

#	path	type	mode	uid	gid	major	minor	start	inc	count
	/dev	d	755	0	0	-	-	-	-	-
	/dev/console	c	662	0	0	5	1	-	-	-
	/dev/kmem	c	640	0	15	1	2	-	-	-
	/dev/mem	c	640	0	15	1	1	-	-	-
	/dev/null	c	666	0	0	1	3	-	-	-
	/dev/tty	c	600	0	5	4	0	0	1	7
	...									
	/dev/ttyO2	c	640	0	5	253	2	-	-	-

Board dependent device file

Contents

- **recipes-debian-squeeze/xxx/xxx.bb**
- **recipes-poky/xxx/xxx.bb**
- **recipes-kernel/xxx/xxx.bb**
 - Recipes which are required only in this layer
 - Please add a recipe under meta(common) if it's able to be shared with multiple layers
- **recipes-debian-squeeze/xxx/xxx.bbappend**
- **recipes-poky/xxx/xxx.bbappend**
- **recipes-kernel/xxx/xxx.bbappend**
 - All settings in xxx.bbappend are appended to xxx.bb
 - Ex: Override functions, add new functions, use another local file, etc.

layer.conf

■ Essential definitions

```
BBPATH := "${BBPATH}:${LAYERDIR}"
BBFILES := " ${BBFILES} ¥
${LAYERDIR}/recipes-*/*/*.bb ¥
${LAYERDIR}/recipes-*/*/*.bbappend ¥
"
BBFILE_COLLECTIONS += "xxx"
BBFILE_PATTERN_xxx := "^${LAYERDIR}/"
BBFILE_PRIORITY_xxx = "8"
```

File paths

Layer name and priority

■ MACHINE

- Name of target machine
 - Ex: beagleboard, pandaboard, cubox
- Machine independent layers should not define this value

layer.conf

■ Kernel information

- LINUX_REPO: Repository name (linux-poky-debian.git)
- LINUX_SRCREV:
Branch name (the latest commit is used) or Tag name or Commit ID
- LINUX_CONF: Path to config (arch/arm/configs/hoge_defconfig)
- See meta/classes/debian-squeeze-linux-checkout.bbclass for more details

■ RELEASE_VERSION

- Release version for each target
 - Output to /etc/debian_version (See debian-squeeze-files.bb for more details)
- Format
 - `${debian_VERSION}-BOARDNAME-BOARDVERSION`
 - Ex: 1.0.1-myboard-2.0

layer.conf

- **PREFERRED_PROVIDER_xxx = "x1"**
 - Bitbake uses "x1" as a 'real' recipe of "xxx"
 - Ex
 - PREFERRED_PROVIDER_gcc = "gcc-default"
 - PREFERRED_PROVIDER_gcc = "gcc-linaro"
- **PREFERRED_VERSION_xxx = "1.0"**
 - Bitbake uses "1.0" as a version of recipe "xxx"
 - Default version: git (the latest commit is used)
 - For example
 - PREFERRED_VERSION_qt4-embedded = "4.8.2+dfsg-2debian1"

layer.conf

- **DISTRO_FEATURES**
- **DISTRO_FEATURES_append = "x11"**
 - <http://www.yoctoproject.org/docs/1.1/poky-ref-manual/poky-ref-manual.html#ref-features-distro>
 - Default value is defined in meta/conf/distro/include/default-distrovars.inc
 - It tells all recipes that specified "features" are enabled
 - Examples of features: ipv4, ipv6, x11, etc.
- **DEBIAN_SQUEEZE_FEATURES**
- **DEBIAN_SQUEEZE_FEATURES_append**
 - Debian own features
 - Default value is defined in meta/conf/distro/debian-squeeze.conf

Update BSP

■ Update kernel

- Modify the following variables if you update kernel
 - LINUX_SRCREV, LINUX_CONF

■ Update userland files

- Modify recipes in recipes-debian/*, recipes-poky/*

■ Update release version

- First of all, build & install & run on the target system and confirm that there is no problem
- Update RELEASE_VERSION and build image from nothing

Build images for release

- **Ex: Use meta-foo/meta-bar as target BSP**

- NOTE: Please build from nothing (clean build)
 - Because all caches and unneeded sources should not be included in snapshot information
- How to build

```
$ ls
poky-debian
$ . ./poky-debian/setup.sh foo/bar
$ bitbake core-image-base      ← for rootfs
$ bitbake meta-toolchain      ← for SDK
```

Recipe development for poky-debian

(Some slide has already obsoleted)

Recipe components

- **Each recipe consists of the following three file types:**
 - `xyz_VERSION.bb`
 - Core file. It includes or inherits other subfiles
 - `xyz*.inc`
 - Included by `.bb` or other `.inc` files
 - Usage of `xyz.inc`: `include xyz.inc`
 - Directories (`files/`, `xyz/`, `xyz-VERSION/`)
 - Includes local files (patches, configuration files, etc.)
- **Class recipes**
 - `meta/classes/*.bbclass` has basic common functions which shared by all recipes that inherits it **Take care to modify !**
 - Usage of `abc.bbclass`: `inherit abc`

Package's own variables

- **PN**
 - `_PackageName` (Ex: `eglibc`, `busybox`, etc.)
- **PV**
 - `_PackageVersion` (Ex: `2.11.2-10`, `1.17.1-8`)
- **PR**
 - `_PackageRevesion` (`r0`, `r1`, `r2`, ...)
- **WORKDIR**
 - Top of the build directory
 - `build-$TARGET/tmp/work/$ARCH/${PN}-${PV}-${PV}`
- **S**
 - `_Source code directory path used by do_unpack* and do_patch*`
- **B**
 - `_Build directory path used by do_configure and do_compile`
- **D**
 - `_Destination directory path used by do_install`
- **These values are automatically set by bitbake**

How to write a recipe for package "hoge"

- **A. From scratch with a non-debian source (rare case)**
 - Add license information
 - Add SRC_URI
 - Set some variables or functions if needed
- **B. From scratch with a debian source (rare case)**
 - Add license information
 - Inherit debian class
 - Inherit autotools class if needed
 - Add SRC_URI if needed
- **C. Use an existing recipe with a debian source**
 - Copy poky's original recipe
 - Modify version
 - Modify license information
 - Inherit debian class

A-1. Add license information

```
LICENSE = "GPLv2"  
LIC_FILES_CHKSUM = "file://COPYING;md5=1a2b3c..."
```

- **LICENSE: License name**
 - Usually written in `${S}/COPYING` or `${S}/LICENSE`
- **LIC_FILES_CHKSUM: License filename + its checksum**
 - Format: `file://FILENAME;md5=CHECKSUM`
 - Base path of `FILENAME` is `"${S}"`
 - You need to check the MD5 of `COPYING` by `md5sum`

A-2. Add "SRC_URI"

```
SRC_URI = " \
http://url.to.archive/foo.tar.gz \
file://default_config \
"
```

- **"SRC_URI" is a list of source codes, configurations, or other support files**
- **bitbake fetches, unpacks and patches all files listed in SRC_URI**
 - Archives (*.tar.gz, *.tar.bz2, etc.) are automatically unpacked
 - Patches (*.diff.gz, *.patch, etc.) are automatically patched

B-1. Add license information

```
LICENSE = "GPLv2"  
LIC_FILES_CHKSUM = "file://COPYING;md5=1a2b3c..."
```

- Same as "A-1"

B-2. Inherit debian class

```
inherit debian-squeeze
```

■ Debian-squeeze class adds:

- `do_fetch_srcpkg`, `do_unpack_srcpkg` and `do_patch_srcpkg`
- These functions fetch, unpack, patch essential sources automatically according to `${PN}` and `${PV}`
- No need to write debian source URI in each package

B-3. Inherit autotools class

```
inherit autotools
```

- **autotools class adds:**

- do_configure, do_make, do_install, etc. for autotools-based sources
- Default functions are already defined in "base.bbclass", but some functions (do_configure, do_install, etc.) are empty

- **Don't inherit autotools if the source code is not based on autotools**

- Please implement do_configure, do_compile, do_install, etc. from scratch

B-4. Add other required files to "SRC_URI"

```
SRC_URI = " \
file://COPYING \
file://default_config \
http://uri.to.sourcecode/poky-debian/rc-init.sh
"
```

- Usually, only "inherit debian-squeeze" (source of package) is required
- Need to add file URIs to "SRC_URI" if the package requires some support files
 - License file (COPYING)
 - Default configuration file for "menuconfig"
 - "rc" scripts to be installed to the target system
 - Ex: /etc/init.d/sshd

C-1. Copy poky's recipe from ORIGINAL

```
$ cp -r meta/ORIGINAL/recipes-??*/foo meta/recipes-bar
```

- Check whether "foo/hoge_1.2.3.bb" is included in meta/recipes-debian-squeeze/ or not before copying

C-2. Modify version

```
$ cd meta/recipes-bar/hoeg
$ mv hoge_1.2.3.bb hoge_1.2.1-4.bb
```

- **Replace Poky's version (1.2.3) by Debian's (1.2.1-4)**
- **The version of debian consists of two elements separated by "-"**
 - Format: UpstreamVersion-debianVersion
 - UpstreamVersion = 1.2.1
 - debianVersion = 4

C-3. Modify license information

```
LICENSE = "GPLv2"  
LIC_FILES_CHKSUM = "file://COPYING;md5=1a2b3c..."
```

- Same as "A-1"
- Need to modify license information if Debian's license differs from poky's

C-4. Inherit debian-squeeze class

```
inherit debian-squeeze
```

- Same as "B-2"

C-5. Modification rule example

- Modifying a recipe according to the following rules

```
#  
# ORIGINAL FILENAME  
#
```

Write the original filename not to forget it

```
...  
...  
#...  
...
```

Comment out only (Don't add / delete)

```
#  
# debian  
#
```

Write new definitions at the bottom

```
OUR DEFINITIONS
```

Example A: Recipe for "hello"

- Implement a recipe to build the following program

```
#include <stdio.h>

int main()
{
    printf("hello\n");
    return 0;
}
```

```
default: clean hello
hello: hello.o
clean:
    rm -f hello *.o
```

Example A: Setup files

- **Make a directory for hello**

```
$ mkdir meta/recipes-test/hello
```

- **Make a source code directory and copy hello.c, Makefile and COPYING**

```
$ cd meta/recipes-test/hello  
$ mkdir -p hello/src  
$ cd hello/src  
$ emacs hello.c  
$ emacs Makefile  
$ touch COPYING # dummy
```

- **Make a recipe file for hello**

```
$ emacs meta/recipes-test/hello/hello_1.0.bb
```


Example A: Write a recipe

- Add license information
- Add source files ("src") to "SRC_URI"
- Define "S" and "B" for hello
- Define do_install function to install binaries generated by our Makefile

- Run "bitbake hello"

Example A: Answer

```
LICENSE = "tmp"
LIC_FILES_CHKSUM = ¥
"file://COPYING;md5=d41d8cd98f00b204e9800998ecf8427e"

SRC_URI = "file://src"

S = ${WORKDIR}/src
B = ${S}

do_install() {
    install -d ${D}/${bindir}
    install -m 0755 ${B}/hello ${D}/${bindir}
}
```

Example C: Recipe for "sed"

- **Copy a recipe from ORIGINAL**

```
$ cp meta/ORIGINAL/recipes-extended/sed meta/recipes-test
```

- **Remove un-required files**

```
$ rm -f sed_4.1.2.bb sed-4.1.2/
```

- **Rename "4.2.1" to the debian version**

- Check the version of source archive for Debian

- **Inherit debian-squeeze class**

- **Comment out all "SRC_URI"-related lines**

Example C: Recipe for "sed"

```
#
# sed_4.2.1.bb
#

DESCRIPTION = "sed is a Stream Editor."
HOMEPAGE = "http://www.gnu.org/software/sed/"
...

#SRC_URI = "${GNU_MIRROR}/sed/sed-${PV}.tar.gz"

#SRC_URI[md5sum] = "f0fd4d7da574d4707e442285fd2d3b86"
#SRC_URI[sha256sum] =
"8773541ce097fdc4c5b9e7da12a82dffbb30cd91f7bc169f52f05f93b7fc3060"

inherit autotools update-alternatives gettext

...

BBCLASSEXTEND = "native"

#
# debian
#

inherit debian-squeeze
```

Kernel build

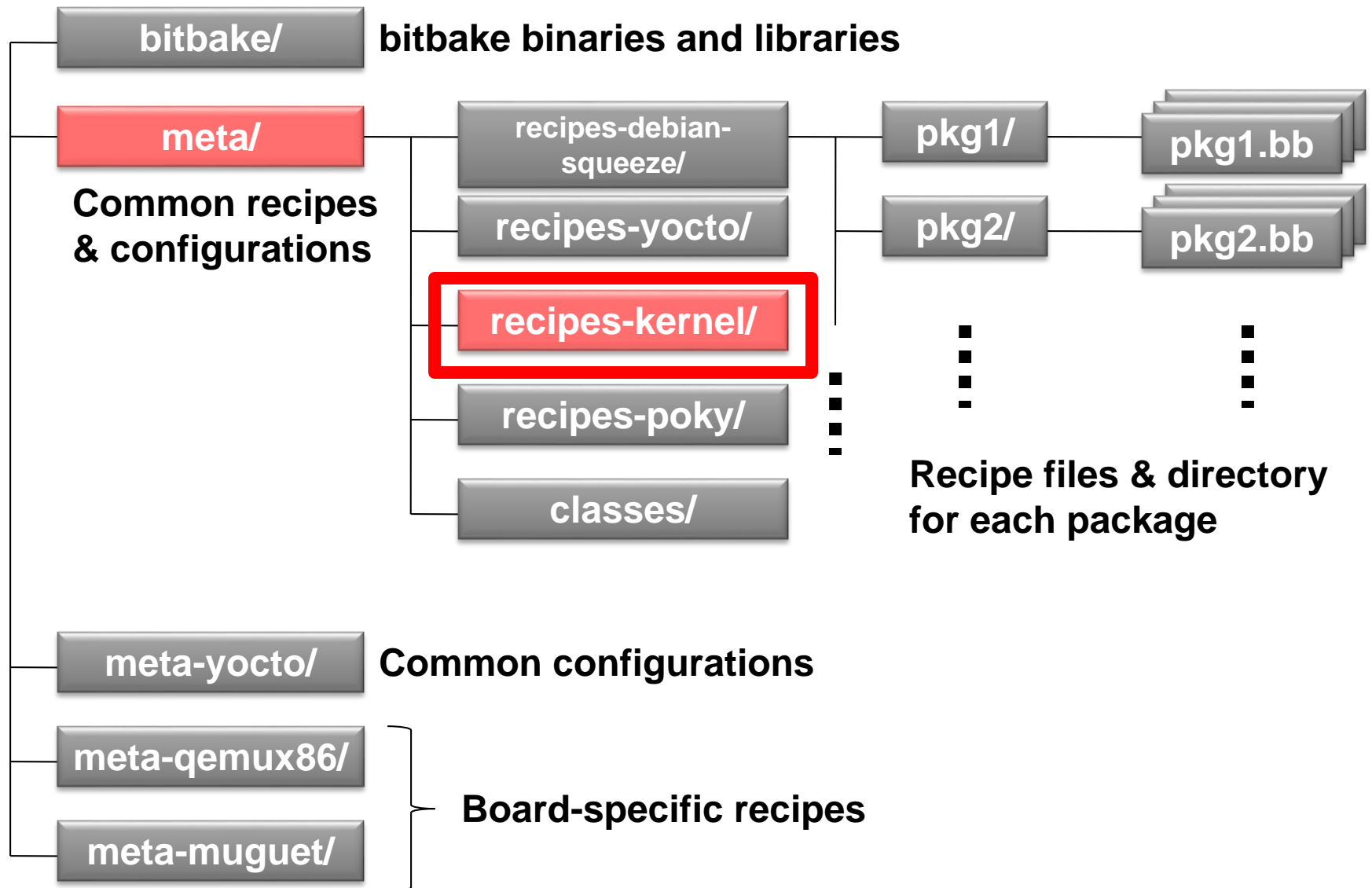
debian kernel repositories

- **Sample kernel sources are able to download by the following command**

```
git clone git://github.com/ystk/linux-poky-debian.git
```

- **The kernel repository consists:**
 - Source code branch
 - v3.0-rt, etc.
 - Modifications for the target board
- **Poky-debian estimate to fetch all kernel source from git repository via git protocol**
 - Need to prepare sources and configurations using SDK (toolchain) of poky-debian before build

Kernel recipes in poky-debian



Kernel recipes in poky-debian

■ **meta/recipes-kernel/linux/linux_git.bb**

- A sample recipe to build generic linux kernel
- Fetch linux kernel source from git server
- Inherit "debian-squeeze-linux.bbclass" instead of "debian-squeeze.bbclass"

■ **meta/recipes-kernel/linux/linux-libc-headers_git.bb**

- Include kernel headers (Ex: /usr/include/linux/*.h)
- Used to build other userland packages
- Fetch the same file as "linux_git.bb"
- Inherit "debian-squeeze-linux-libc-headers.bbclass" instead of "debian-squeeze.bbclass"

linux_git.bb

■ Variables

- LINUX_REPO
 - Name of kernel repository (Ex: linux-poky-debian.git)
 - Searched from `${DEBIAN_SQUEEZE_GIT}`
- LINUX_BRANCH_SRC
 - Name of source code branch
 - Default: "master"
- LINUX_BRANCH_CONF
 - Name of configuration branch
 - Default: "configs"
- LINUX_COMMIT_SRC / LINUX_COMMIT_CONF
 - Commit ID (hash value) of source code / configuration
- LINUX_CONF
 - Name of configuration file in "configs" directory

linux_git.bb

■ Example 1

```
LINUX_REPO = "linux-poky-debian.git"  
LINUX_BRANCH_SRC = "v3.0-rt"  
LINUX_BRANCH_CONF = "configs"  
LINUX_CONF = "configs/v3.0/arm/versatile_defconfig"
```

- Fetch github.com/ystk/linux-debian.git
- Use the newest commit of "v3.0-rt" branch as a source
- Use "versatile_defconfig" in configs branch as a configuration

■ Example 2

```
LINUX_REPO = "linux-debian.git"  
LINUX_COMMIT_SRC = "eb25ca22426dbaea10a4748c8741ccbc3aaa24c8"  
LINUX_COMMIT_CONF = "1ea6b8f48918282bdca0b32a34095504ee65bab5"  
LINUX_CONF = "configs/v3.0/arm/versatile_defconfig"
```

- Use two commits ("eb2..." and "1ea...") as a source & conf

How to build?

■ bitbake kernel

```
$ bitbake virtual/kernel
```

■ Build directory

- build- $\${MACHINE}$ /tmp/work/ $\${MACHINE}$ -poky-linux/linux-git-r0

■ Deployment

- build- $\${MACHINE}$ /tmp/deploy/images/zImage- $\${MACHINE}$.bin

How to customize the kernel? (menuconfig)

- Launch "screen"
- You can modify the configuration you choose

```
$ bitbake -c clean virtual/kernel  
$ rm -f sstate-cache/sstate-linux-*  
$ bitbake -c menuconfig virtual/kernel
```

- You will get the following message:

```
WARNING: Screen started. Please connect in another terminal with  
"screen -r devshell"
```

- Generate new screen and type:

```
$ screen -r devshell
```

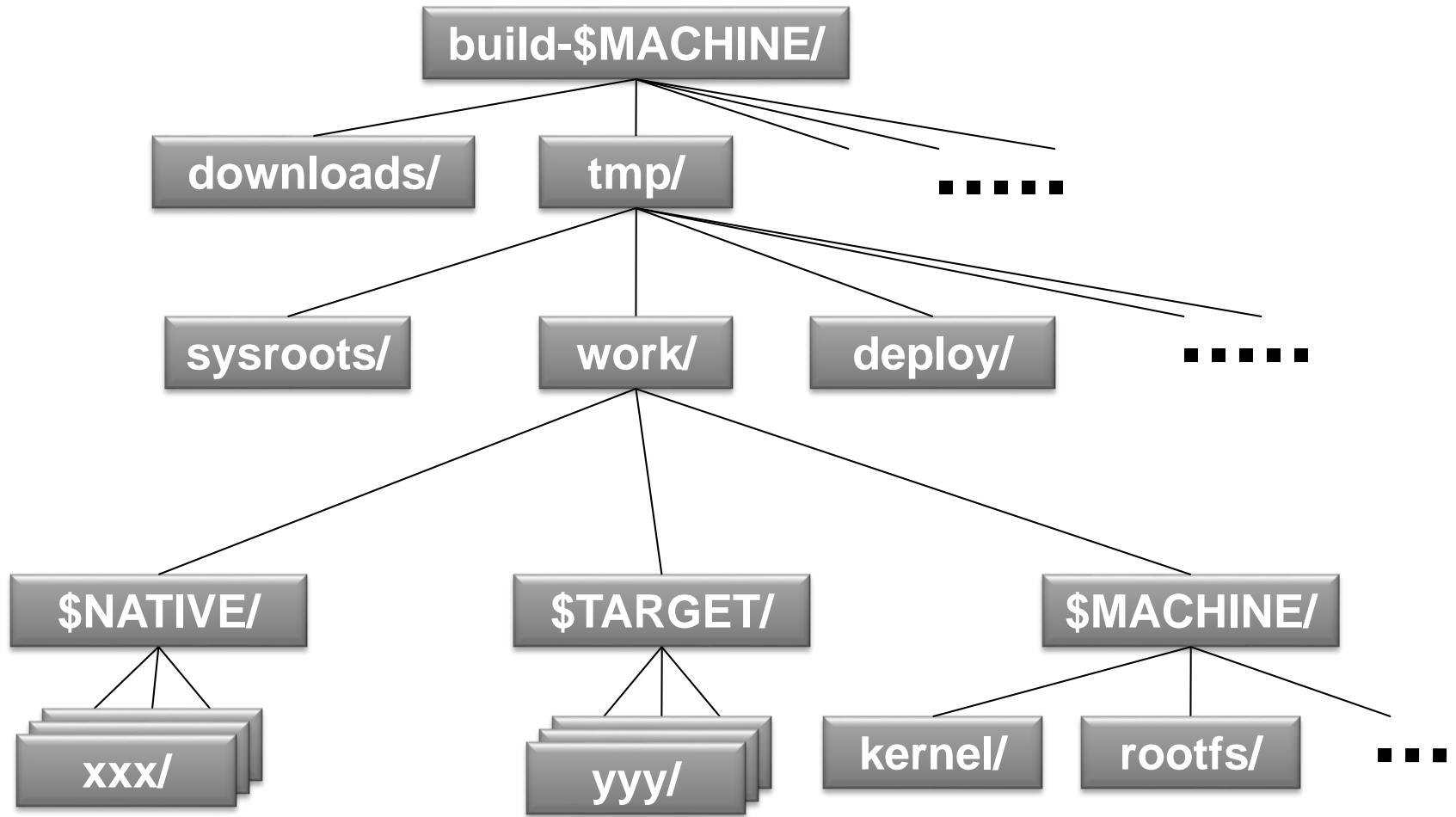
- Retry bitbake

Debug

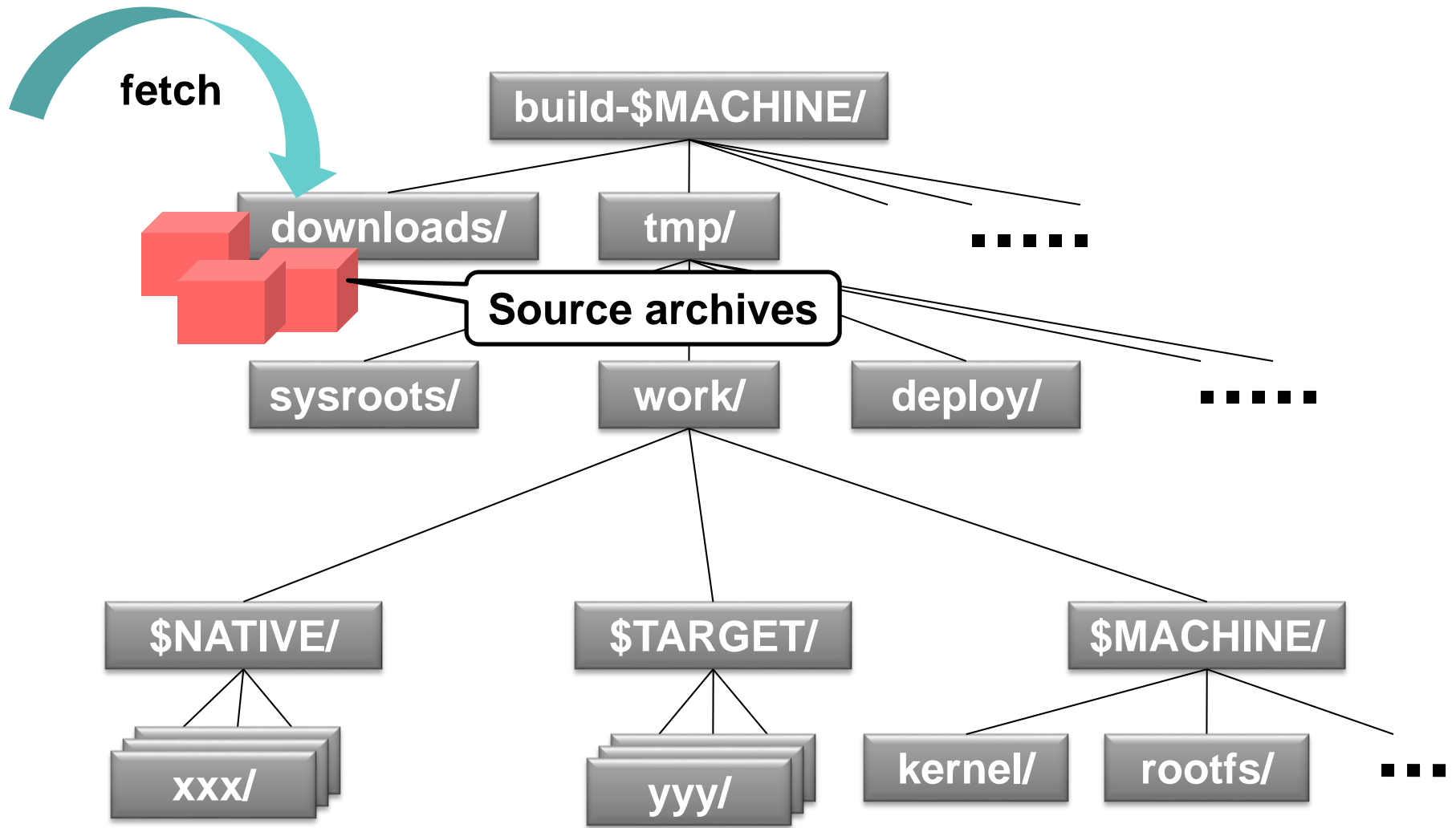
Build directory and deployment

- **setup.source** generates a build directory which named **"build- $\$$ MACHINE"**
 - bitbake outputs all files only to this directory
- **The build directory consists of...**
 - **conf**
 - Includes configuration files copied by setup.source
 - **downloads**
 - Includes all downloaded files fetched by do_fetch*
 - **tmp/work**
 - Work directories that bitbake uses to build each recipe
 - **tmp/sysroots**
 - Includes tools & libraries shared by all recipes
 - Ex: native tools, cross compiler, cross libraries, headers, etc.
 - **tmp/deploy**
 - Final outputs are put into this directory
 - kernel, rootfs, toolchain, etc.

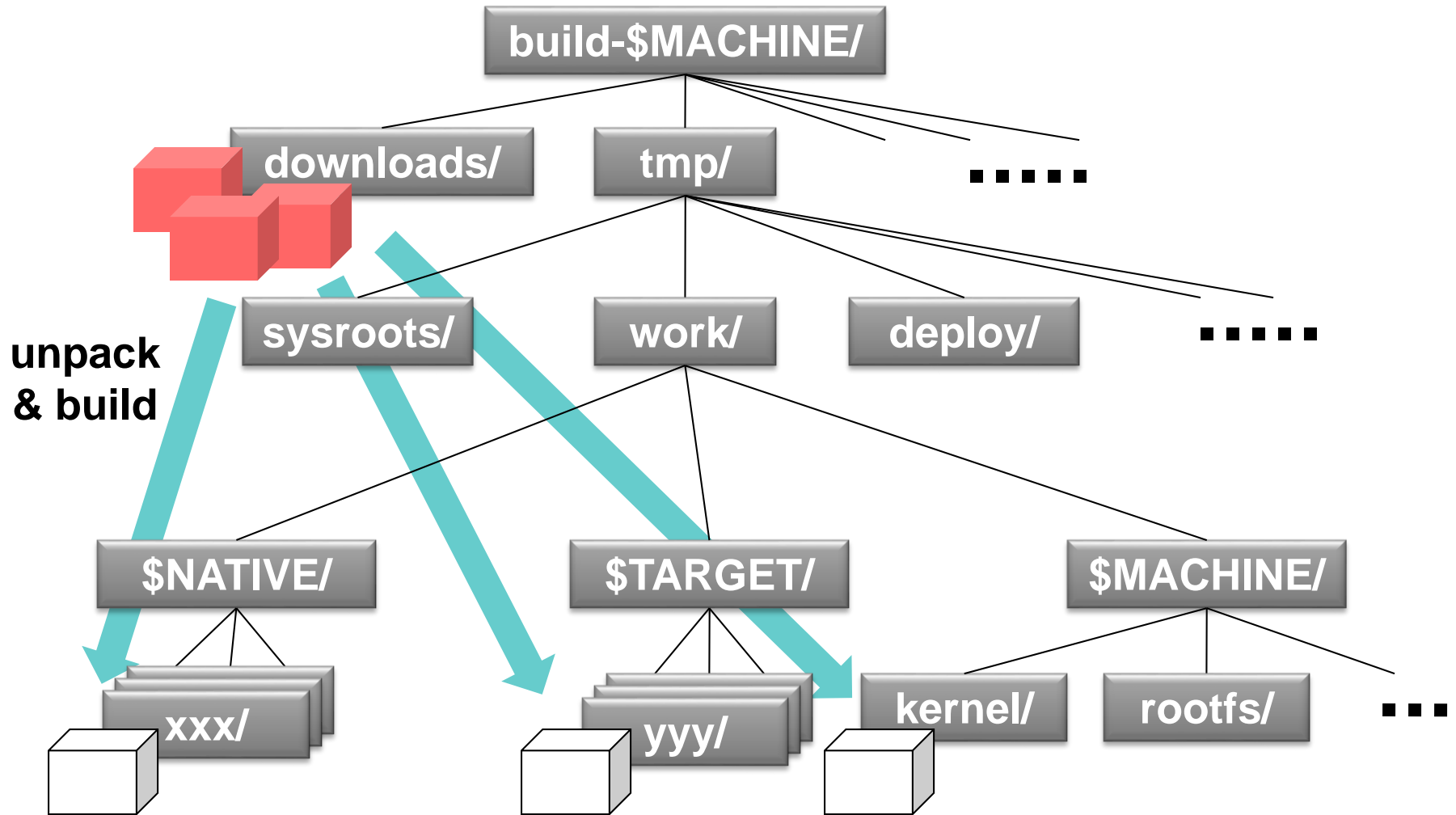
Build directory and deployment



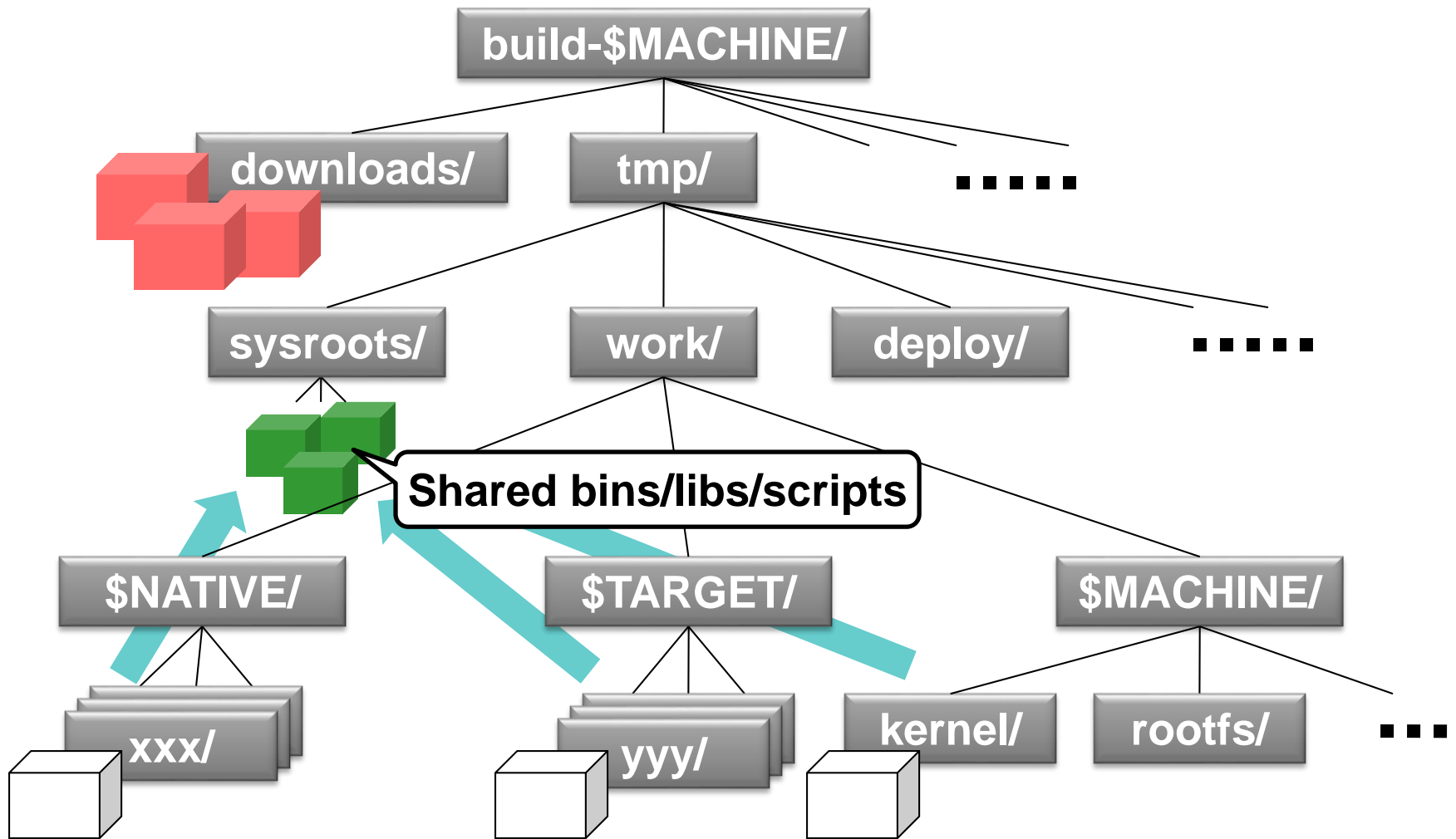
Build directory and deployment



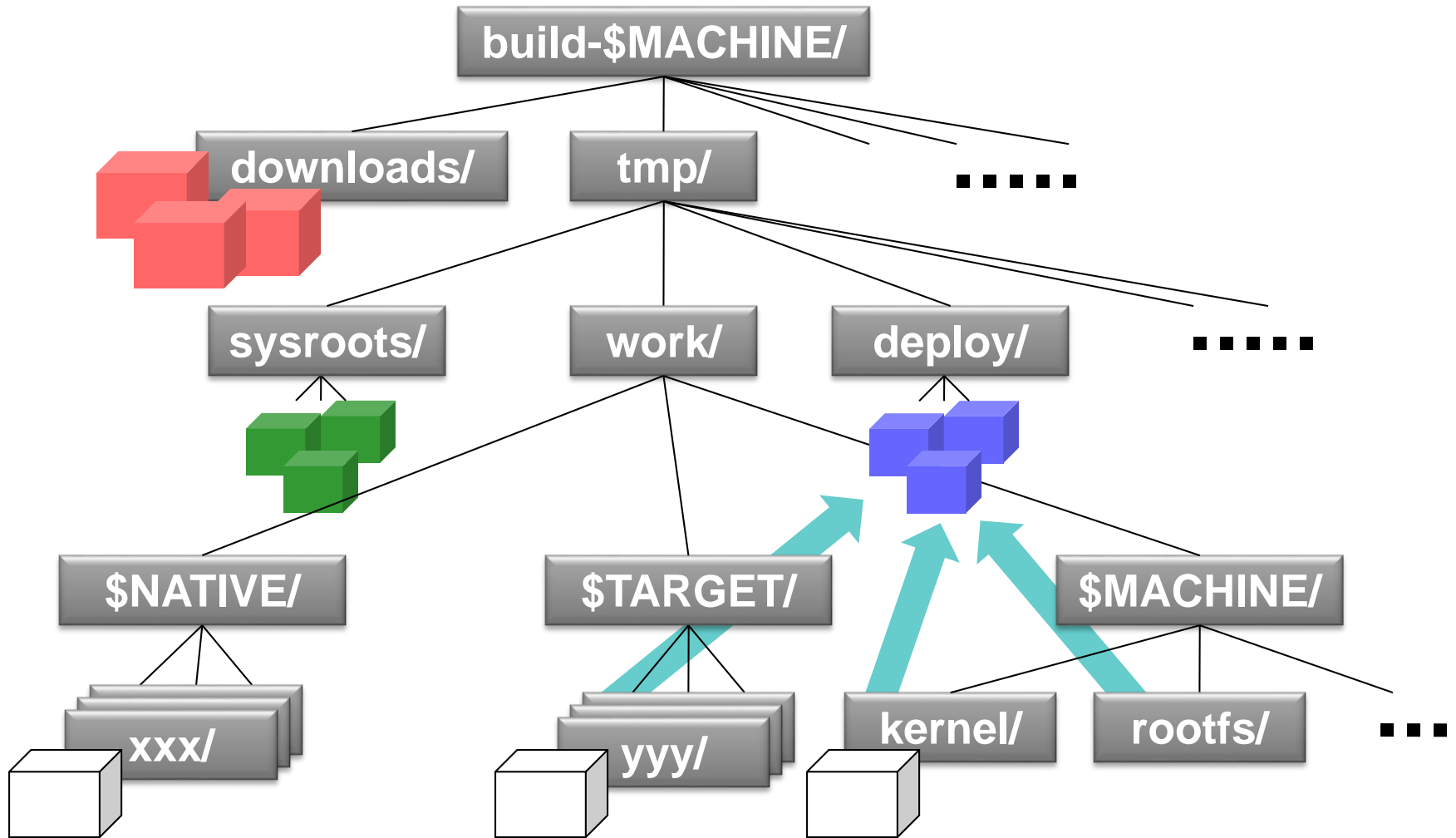
Build directory and deployment



Build directory and deployment



Build directory and deployment



Build directory and deployment

- **Each package build directory consists...**
 - temp
 - Includes all log files and 'real' build scripts generated by bitbake according to recipes
 - Please check logs under this directory when some errors occur
 - $\${S} = \${PN}-\${PV}/$
 - Source directory unpacked by do_unpack
 - $\${D}: image/$
 - All outputs are put into this directory (usually by "make install")
 - deploy-debs
 - All packaged files named "*.deb" are put into this directory

Errors

- **Fetch errors caused by repository servers**
- **Errors caused by source directory structure**
- **Path-related errors**
- **libtool-related errors**
- **Manual-related errors**
- **Patch failures when we apply some poky's patches**

Fetch errors caused by repository servers

■ Source archives not found

- Some packages don't exist on repository servers
- Please add the package to debian git repository yourself

■ debian package name is different from poky's

- Ex: debian="lm-sensors-3" poky="lm-sensors"
- Use "DEBIAN_SQUEEZE_SRCPKG_NAME"

```
inherit debian  
debian_SRCPKG_NAME = "lm-sensors-3"
```

```
lm-sensors_xxx.bb
```

Errors caused by source directory structure

- **Structure of some source directories are different from poky's source directories**
 - debian
 - pkgname-0.1-2/
 - Makefile, src.c, configure, ...
 - poky
 - pkgname-0.1/
 - srcdir, support-tools, ...
 - └─> Makefile, src.c, ...
- **Please fix "S" and related functions such as do_unpack**

Path-related errors

- **Sometimes, Makefile is hard-coded**
 - Ex: CC = gcc
 - Cannot use cross compiler in poky in this case

- **You may have some patches that resolve this problem**
 - Ex: fix-path-xxx.patch

- **You need to fix paths if there is no patches in poky**

libtool-related errors

- **Some packages fail with libtool-related errors**

- **libtool**
 - One of autotools
 - Compile, build, install libraries

- **poky-debian uses internal libtool to build each package**
 - Some packages need to be patched to use internal libtool
 - Please search "libtool-xxx.patch" and apply it when you get some libtool-related errors

Manual-related errors

- **Some packages fail with manual-related errors**
 - manpage, documents, etc.
 - Ex: help2man

- **Please fix Makefile**
 - Delete rules to build manual or documents in Makefile
 - No need to build manual or documents because we are generating root file systems not for generic PC but for embedded systems

Patch failures

- **Need to apply some patches included in poky-debian to build packages**
- **Usually, some patches reject ☹**
 - Because the patches assume that it is applied to poky's source
 - But we use debian's source now
- **Please fix patches by yourself..**

How to create a new patch?

- **First, backup (1) the original source files (such as Makefile)**
- **Second, do bitbake**
 - The error occurs
- **Third, (2) modify the source files and retry bitbake**

- **Create a patch from difference between (1) and (2) using "diff" command**

- **Add your patch to SRC_URI**

```
SRC_URI = "my-patch.patch"
```

Packaging

Build directory and deployment

■ Build directory of each package consist of...

- temp
 - Includes all log files and 'real' build scripts generated by bitbake according to recipes
 - Please check logs under this directory when some errors occur
- $\${S} = \${PN}-\${PV}/$
 - Source directory unpacked by do_unpack
- $\${D}: image/$
 - All outputs are put into this directory (usually by "make install")
- **deploy-debs**
 - All packaged files named "*.deb" are put into this directory

***.deb is a binary package format of Debian**

How *.deb packages are created?

- After `do_compile`, we have some outputs of the package under `${B}`

`build-${MACHINE}/.../${PN}-${PV}-${PR}/`

`${S}/`

`${B}/`

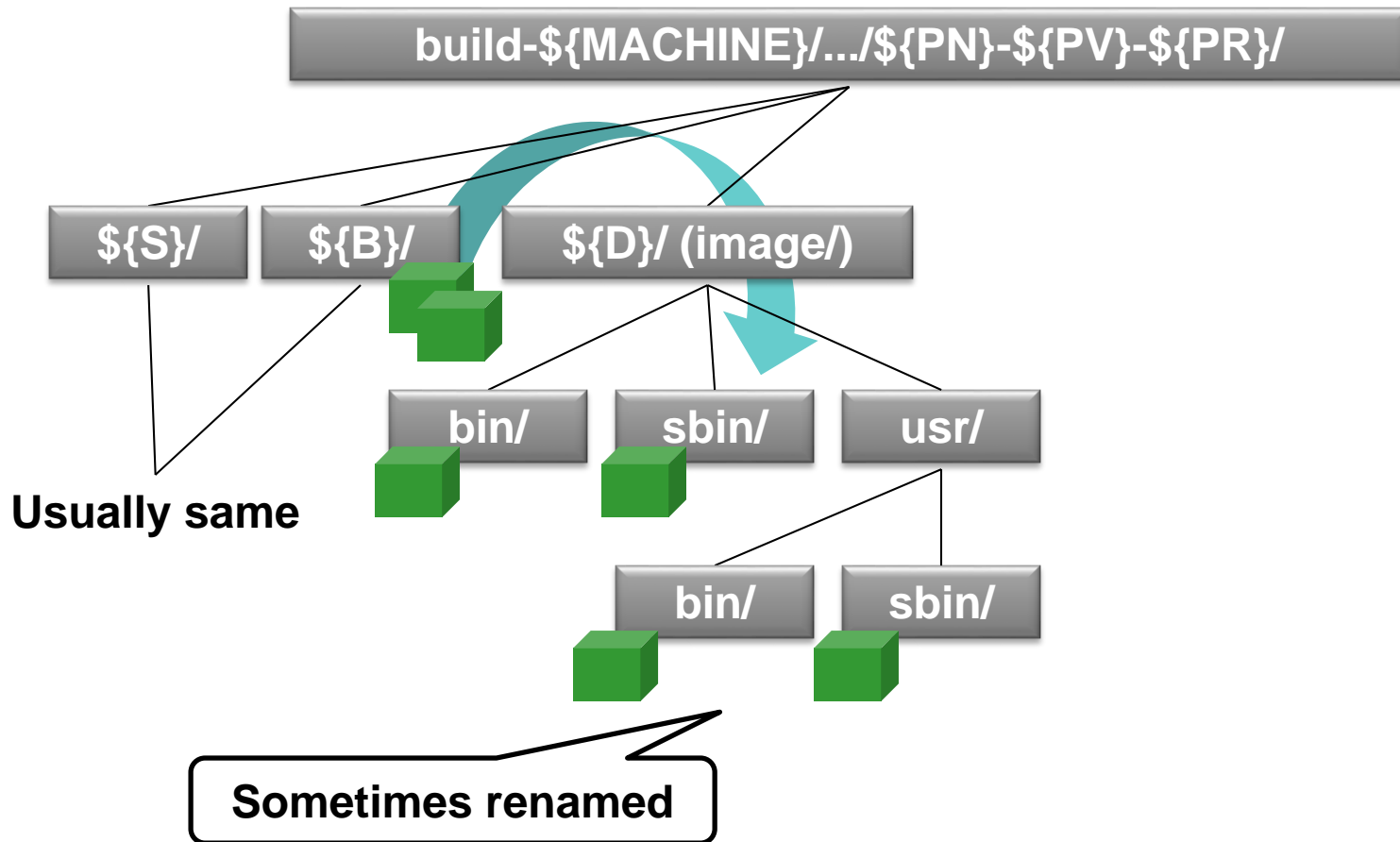


Ex: `ls`, `cat`, `su`, etc.

Usually same

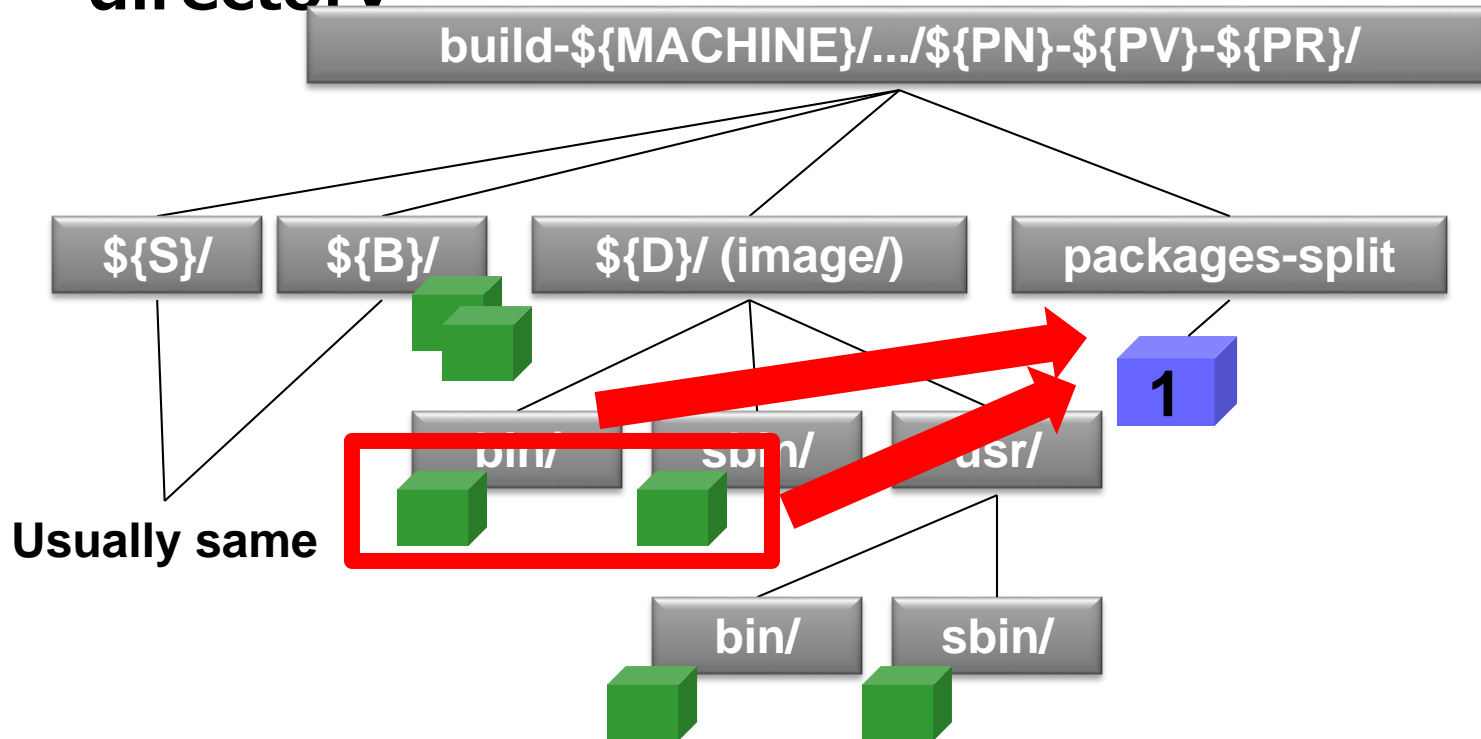
How *.deb packages are created?

- After `do_install`, outputs are put into `${D}` according to "make install"



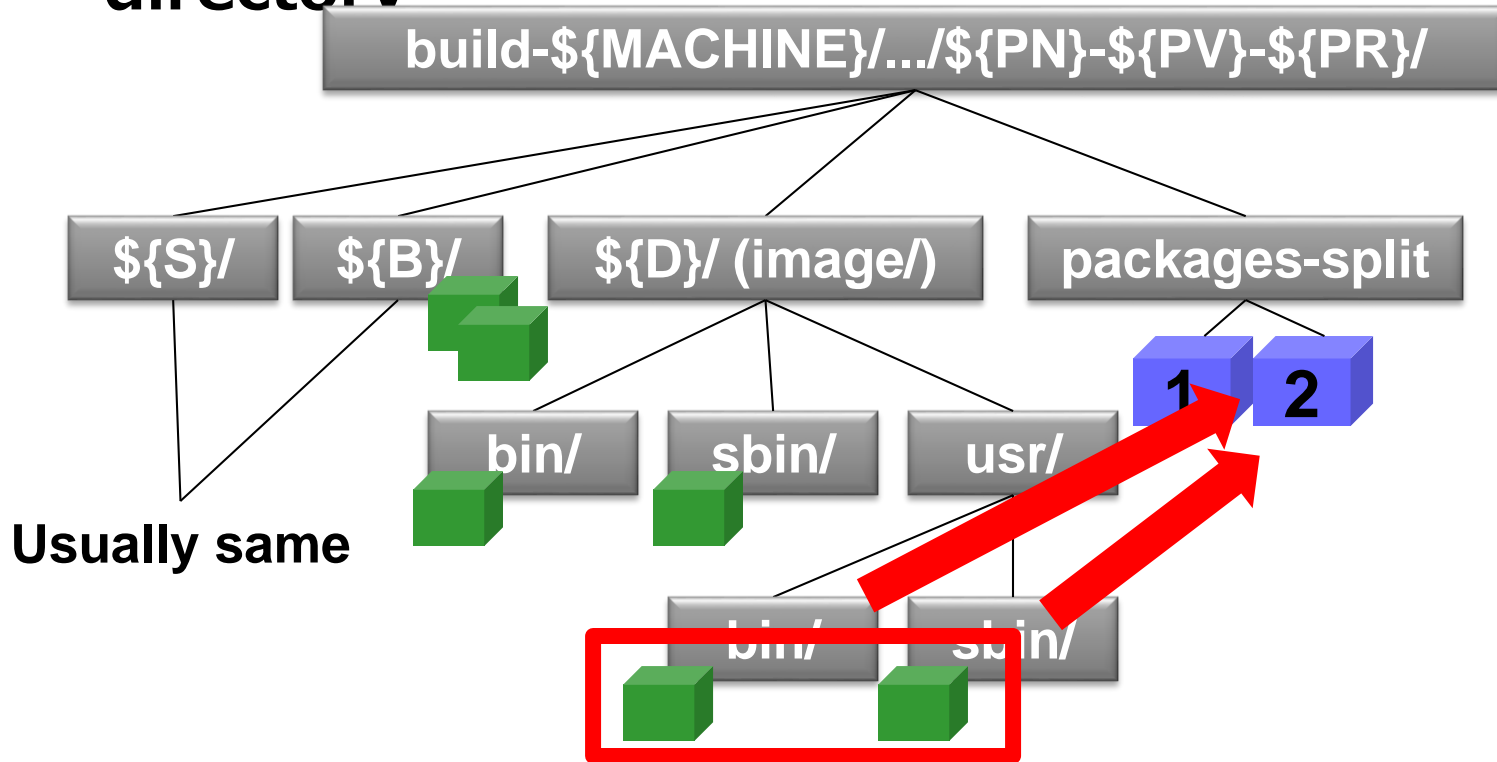
How *.deb packages are created?

- In `do_package*` functions, each output file are installed to "packages" and "packages-split" directory



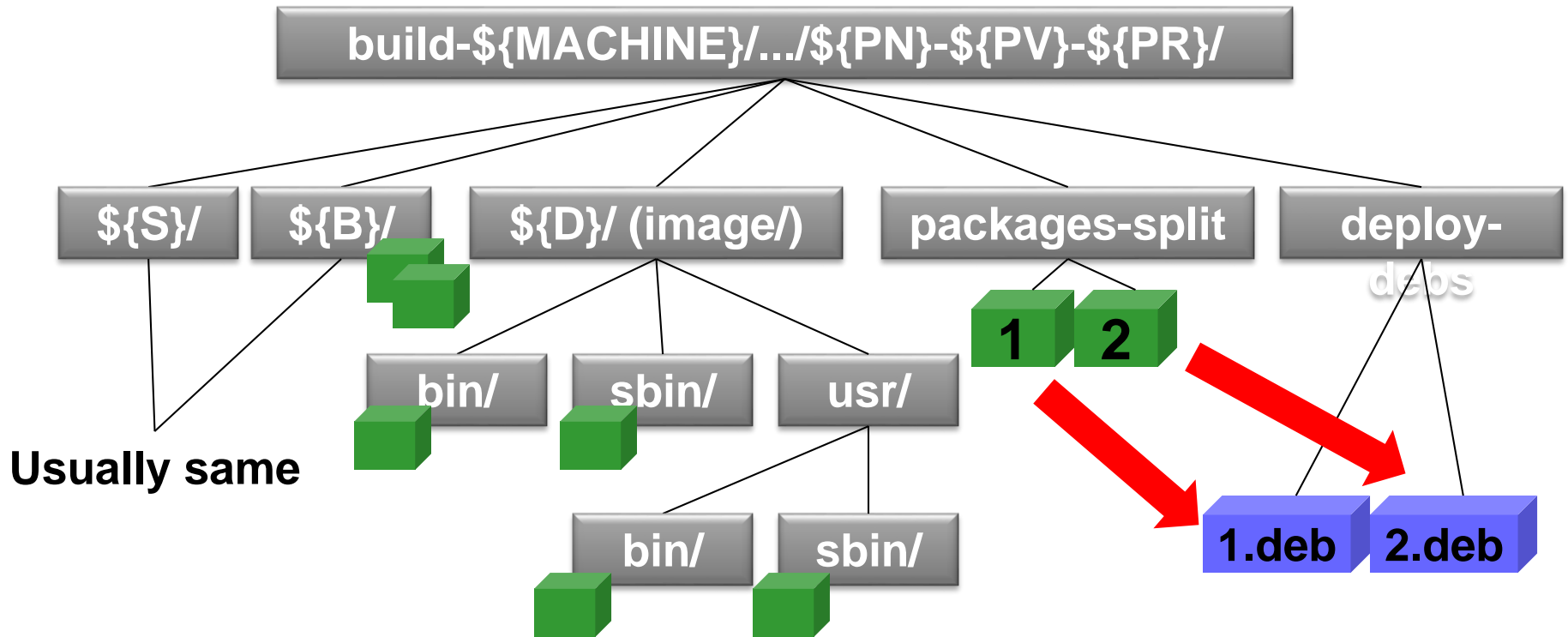
How *.deb packages are created?

- In do_package* functions, each output file are installed to "packages" and "packages-split" directory



How *.deb packages are created?

- Finally, split *.debs are generated in "deploy-debs"



How to control packaging?

- **We can use the following variables to control packaging**
 - PACKAGES
 - The list of package name
 - Ex: `PACKAGES = "busybox busybox-module1 busybox-module2"`
 - FILES_XXX
 - The list of files included in package "xxx"
 - Ex: `FILES_busybox-module1 = "${bindir}/bin1 ${sbindir}/bin2"`
 - RDEPENDS_XXX
 - The list of packages "xxx" depends on
 - Ex: `RDEPENDS_busybox-module1 = "busybox-module2 mylib"`
 - **NOTE: "DEPENDS" != "RDEPENDS"**
 - DEPENDS: "Build-time" dependency
 - RDEPENDS: "Runtime" dependency

Dependency

