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Technology for better life

Isar

Build Debian-Based Products with BitBake

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Contents

- Motivation
- Introduction to Isar
- Under the hood
- What's new
- Summary

Motivation

Need a product integration system

- Produce complete, ready-to-use firmware images
- Use pre-built binary packages for efficiency
- Add own packages built from source
- One-command, on-demand image creation
- Low effort: Avoid touching every upstream package
- Reproducible builds

Further Requirements

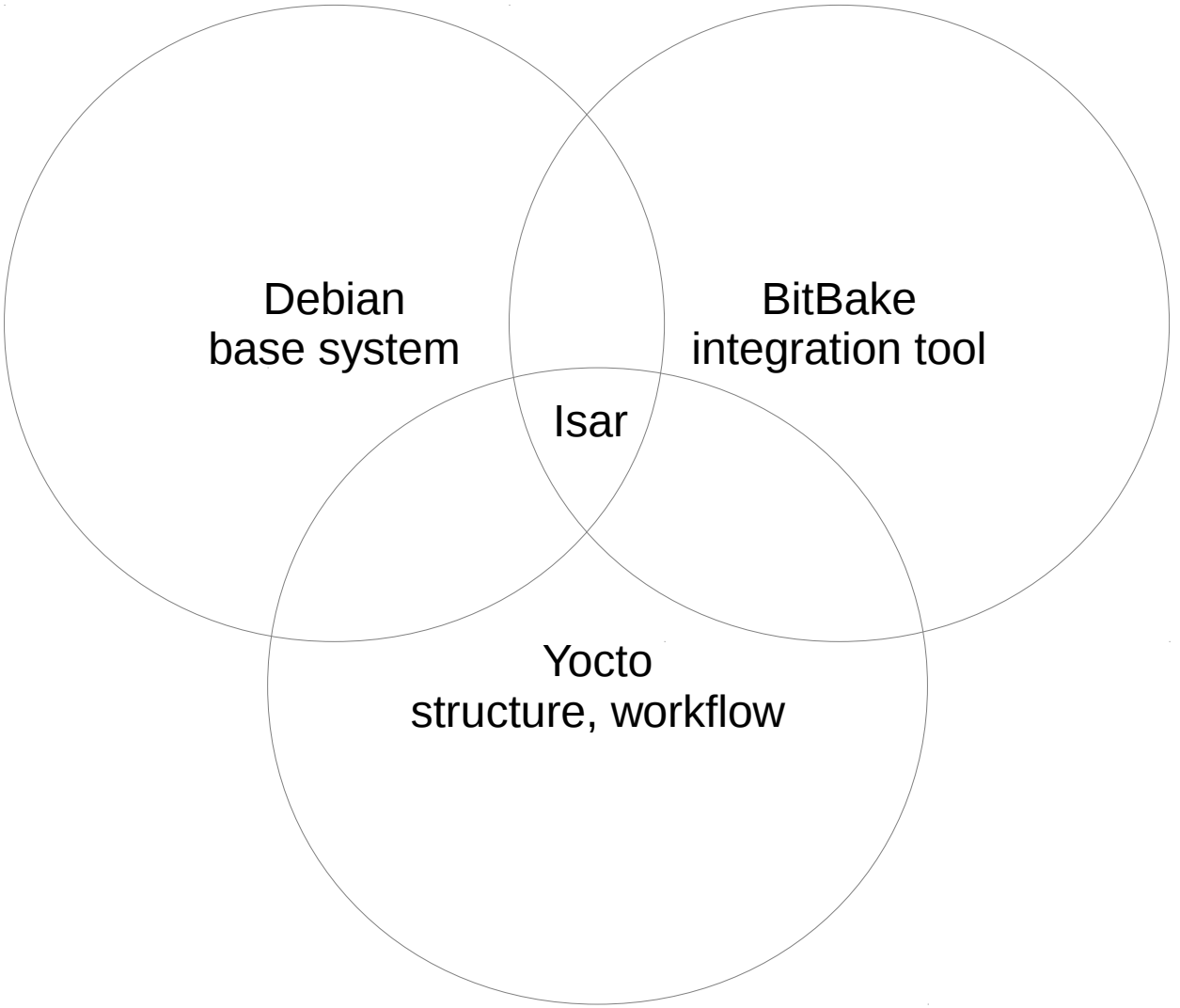
- Customization of upstream packages
- Build several products from one repo
- Share components between products
- Workflow for maintaining code from several vendors
- Maintenance for 10+ years

Prior Art

Debian	Yocto
Pre-built binary packages	Built from source
Many standard tools	Custom recipes
Tested as a whole	Continuous development
Clear licensing	Clear licensing
Long-term maintenance	Continuous development
Security updates	Security process underway
Fits big & small products	Issues with bigger products
No single-command integration OOTB	Single-command integration
N/A	Modular, flexible integration tool
Collaboration process for distributed repos	Collaboration policy for centralized repos
Builds available for chosen arches	Build optimized for a given CPU

Isar: Finding the Right Mix

Integration System for Automated Root filesystem generation



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The Isar Mix

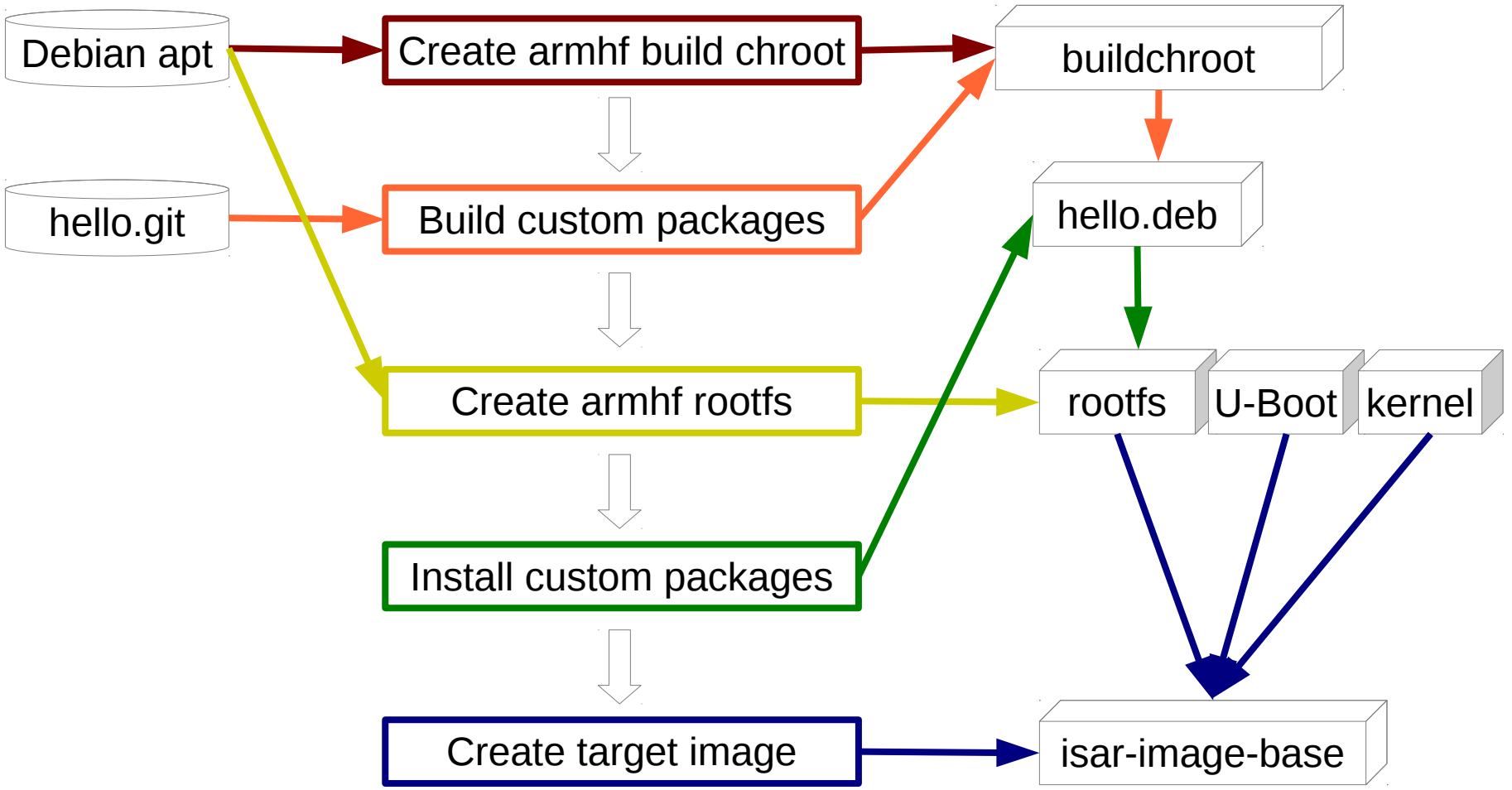
- Debian: Stable, tested distro
- Security updates
- Distributed source repos
- Pre-built binary packages
-
-
- Reuse standard tools

- BitBake: Flexible and efficient
-
- Centralized metadata repos
- Ready-to-use product setup
- Change as little as possible
- Build as little as possible
- Reuse tools, structure, workflows

Isar: Reuse vs. Rebuild

- Debian packages: Use pre-built ones
- Modified Debian packages: Build once, then use pre-built ones
- Product-specific packages:
  - U-Boot: Build once, then use pre-built one
  - Rebuild every time:
    - U-Boot
    - Kernel
    - Drivers
    - Libs
    - Apps

How Isar Works



- Native compilation with `dpkg-buildpackage` under QEMU armhf
- `buildchroot` dir: "SDK" and "devshell"

Using Isar: Build Default Images

```
$ git clone https://github.com/ilbers/isar
$ cd isar
$ . isar-init-build-env build
$ bitbake isar-image-base
```

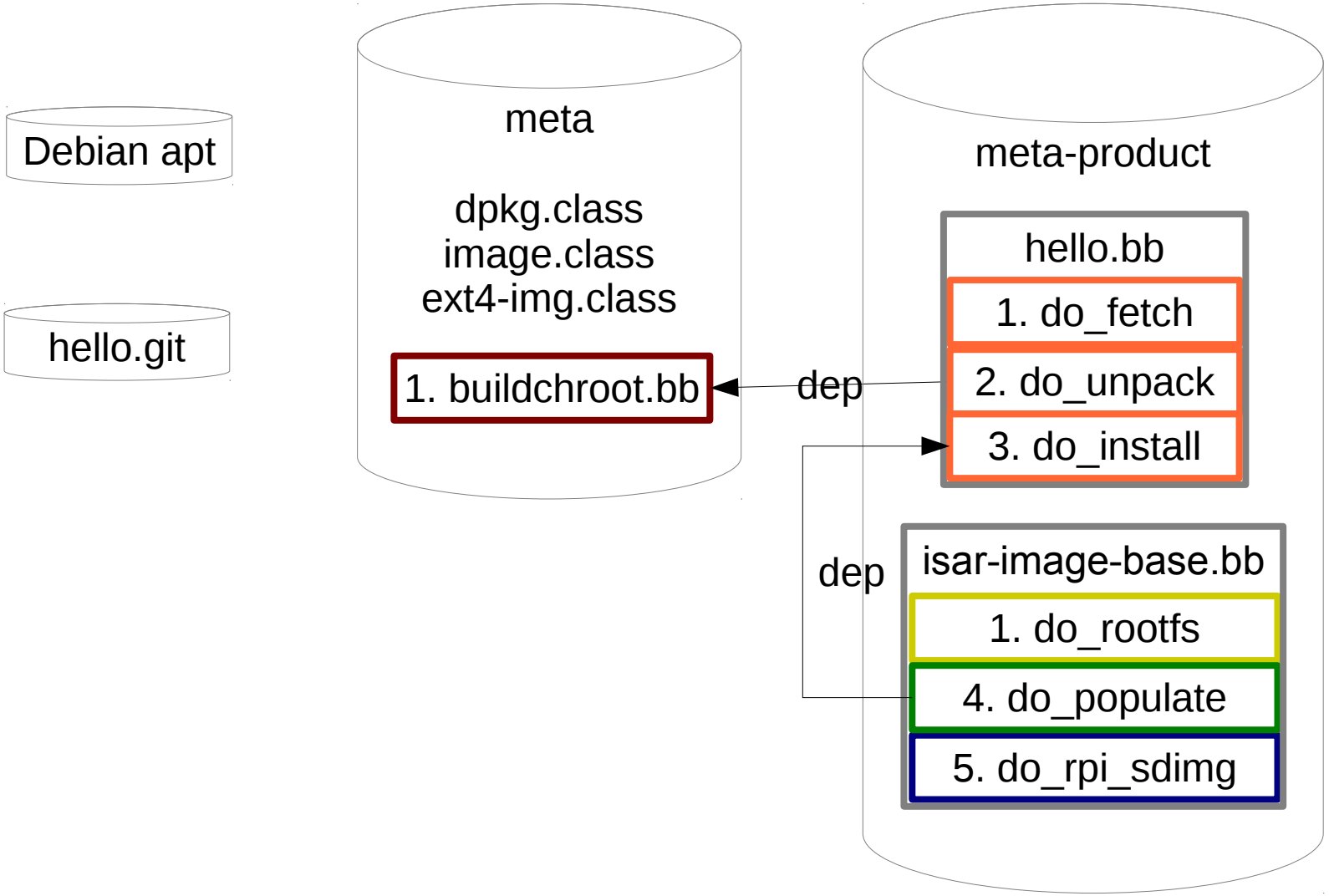
Build dir

BitBake *target(s)*
Image name(s), e.g.:
isar-image-debug
multiconfig:rpi:isar-image-base

Isar: Default Product

- Recipes: Files containing tasks executed in a defined order
  `meta/recipes-devtools/buildchroot/buildchroot.bb`
  `meta-isar/recipes-app/hello/hello.bb`
  `meta-isar/recipes-core/images/isar-image-base.bb`
  `meta-isar/recipes-core/images/isar-image-debug.bb`
- Tasks: Functions implemented in shell or Python
  - Ordering through tasks dependencies
  - Performance through parallel execution of independent tasks
- Layers: Organize code according to upstreams
  `meta`: Isar core layer *metadata* (build scripts as opposed to source)
  `meta-isar`: Product template layer metadata

Tasks and Layers



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Starting Your Own Project

- Clone `isar` and push as your own repo
- Define your product images
- Add your packages
- Add your boards

Adding Images

- To add an image, copy `isar-image-base.bb` as `meta-`*`PRODUCT`*`/recipes-core/images/`*`PRODUCT`*`-image-base.bb` and modify to taste. E.g., to install more packages in the target rootfs:

  ```
  IMAGE_PREINSTALL += "apt dbus openssh-server"
  ```

- To provide an image with more functionality (e.g., developer tools), create `meta-`*`PRODUCT`*`/recipes-core/images/`*`PRODUCT`*`-image-base.bb`:

  ```
  include recipes-core/images/PRODUCT-image-base.bb
  IMAGE_PREINSTALL += "gdb lsof strace"
  ```

- All vars from `.bb` and `.conf` files are added to a single global namespace
- Why not use a single config file? Not possible to reflect complexity without repeating yourself

Adding Packages

- Create the package repo `app1.git`
  - Commit unpacked sources
  - Create `debian/*` if necessary (e.g., with `dh_make`)
- Create recipe `meta-`*`PRODUCT`*`/recipes-app/app1/app1.bb`:

```
SRC_URI = "git://server/app1.git;protocol=http"
SRCREV="1234567890123456789012345678901234567890"
inherit dpkg
```

- Edit `meta-`*`PRODUCT`*`/recipes-core/images/`*`PRODUCT`*`-image-base.bb` and list the recipe name (without .bb) in:

```
IMAGE_INSTALL += "app1"
```

- Available tasks: `do_fetch`, `do_build`

Adding Boards

- Board (*machine*) definitions are files with Debian settings for the board
- `meta-isar/conf/multiconfig/qemuarm.conf`:

```
MACHINE = "qemuarm"
DISTRO = "debian-jessie"
DISTRO_ARCH = "armhf"
```

- `meta-isar/conf/machine/qemuarm.conf`:

```
IMAGE_PREINSTALL = "linux-image-3.16.0-4-armmp"
KERNEL_IMAGE = "vmlinuz-3.16.0-4-armmp"
INITRD_IMAGE = "initrd.img-3.16.0-4-armmp"
MACHINE_SERIAL = "ttyAMA0"
ROOTFS_DEV = "mmcblk0"
BAUDRATE_TTY = "9600"
IMAGE_TYPE = "ext4-img"
```

Distro Definition

- meta-isar/conf/distro/debian-jessie.conf:

```
DISTRO_SUITE = "jessie"
DISTRO_COMPONENTS = "main contrib non-free"
DISTRO_APT_SOURCE = "http://httpredir.d.o/debian"
DISTRO_CONFIG_SCRIPT = "debian-configscript.sh"
```

Organize Code in Layers

- Your layers might look like:
  - `meta`: Isar core
  - `meta-`*`VENDOR1-bsp`* (U-Boot, kernel, ...)
  - `meta-`*`VENDOR2-libs`* (codecs, ...)
  - `meta-`*`COMPANY`*: Company-wide common stuff
  - `meta-`*`DIV`*: Division-wide common stuff
  - `meta-`*`PRODUCT1`* (app1, ...)
  - `meta-`*`PRODUCT2`* (app2, ...)
- You may use `meta-isar` as a template for `meta-`*`PRODUCT`*.
- Layers may be in one or in different repos.
- Tools like `repo` can be used to clone all repos.

Include Layers in Build

- Layer clone dir must be listed in *build*/conf/bblayers.conf:

```
BBLAYERS ?= " \
  /home/user/PRODUCT/meta \
  /home/user/PRODUCT/meta-PRODUCT \
  "
```

- isar-init-build-env creates the *build* dir and generates *build*/conf/bblayers.conf (existing files are not overwritten).
- Edit meta/conf/bblayer.conf.sample so that your desired bblayers.conf is generated:

```
BBLAYERS ?= " \
  ##ISARROOT##/meta \
  ##ISARROOT##/meta-PRODUCT \
 "
```

Override an Upstream Package

- Quick and dirty: Image recipe (`inittab`, `fstab`, user creation, ...)
- Current way: Fork the respective package
- Vision: `sysvinit.bb`:

```
PV = "2.88dsf-59+myprj2"
SRC_URI = "http://server/sysvinit.dsc \
           file://99-inittab.patch"
SRC_URI[md5sum]="8f3ac1a308b594734ad3f47c809655f8"
inherit dpkg
```

Add to `IMAGE_INSTALL`.

Under the Hood

- `isar/`: Repo root
  - `bitbake/`: Recipe interpreter (copy, pulled from time to time)
  - `meta/`: Core layer
  - `meta-isar/`: Product template layer
  - `isar-init-build-env`: Build environment initialization script. Must be sourced in the current shell (`. isar-init-build-env` or `source isar-init-build-env`), not executed in a sub-shell (`./isar-init-build-env`).

Isar Core Recipes

- `meta/`: Core layer
  - `recipes-devtools/`: Development tool group (arbitrary)
    - `buildchroot/`: A recipe directory
      - `buildchroot.bb`: Recipe for creating an armhf build chroot on the host. Doesn't produce a binary package for the target.

```
BUILDCHROOT_PREINSTALL ?= "gcc make dpkg apt"
do_build() {
    sudo multistrap -a "${DISTRO_ARCH}" \
        -d "${BUILDCHROOT_DIR}" \
        -f "${WORKDIR}/multistrap.conf"
}
```

      - `files/`: Files belonging to the recipe

Isar Core Layer

- `meta/`: Core layer
  - `classes/`: Generic rules inherited by recipes to accomplish repeating tasks. Implemented in BitBake language.
    - `dpkg.bbclass`: Build binary `.deb` from `pkg.git`
    - `ext4-img.bbclass`: Create an ext4 image
    - `image.bbclass`: Create a filesystem image (uses pluggable `*-img.bbclass`)
  - `conf/`: Global configuration
    - `bitbake.conf.sample`: Global BitBake config (paths, etc.). Copied to the build directory by `isar-init-build-env`. `Include`s local configs to form a single global environment.
    - `layer.conf`: Layer config. Mandatory for every layer. Among other things, specifies where to look for recipes (`recipes-*/*/*.bb`).

Product Layer

- `meta-isar/`: Product template layer
  - `classes/`: Product-specific classes
    - `rpi-sdimg.bbclass`: Packs U-Boot, kernel, rootfs in an SD card image. Uses `ext4-img.bbclass`.
  - `conf/`: Layer configuration
    - `bblayers.conf.sample`: Global layer config. Copied to the build directory. Defines e.g. layers to use.

      ```
      BBLAYERS ?= "meta meta-isar"
      ```

    - `local.conf.sample`: Local build config. Copied to the build directory. Defines e.g. the default machine and number of tasks to start in parallel.

      ```
      MACHINE ??= "qemuarm"
      DISTRO ??= "debian-wheezy"
      IMAGE_INSTALL = "hello"
      BB_NUMBER_THREADS = "4"
      ```

Product Variants

- `meta-isar/`: Product template layer
  - `conf/`: Layer configuration
    - `distro/`: Distro configs (suite, arch, apt source, etc.)
      - `debian-wheezy.conf`
      - `raspbian-stable.conf`
    - `machine/`: Board configs (U-Boot, kernel, etc.)
      - `qemuarm.conf`
      - `rpi.conf`
    - `multiconfig`: Enables BitBake to create images for several different boards (*machines*) in one call
- Product variability through multiple images and `MACHINE` / `DISTRO` / `DEPENDS`
- Component sharing through `DEPENDS`, common packages, `MACHINE`, `DISTRO`

Product Recipes

- `meta-isar/`: Product template layer
  - `recipes-app/hello/hello.bb`: Recipe building a target application binary Debian package

    ```
    SRC_URI = "git://github.com/ilbers/hello.git"
    SRVREV = "ad7065e"
    inherit dpkg
    ```
  - `recipes-core/images/`: Recipes producing target images on the host
    - `isar-image-base.bb`

      ```
      IMAGE_PREINSTALL += "apt dbus"
      do_rootfs () { ... }
      ```
    - `isar-image-debug.bb`

      ```
      IMAGE_PREINSTALL += "gdb strace"
      include isar-image-base.bb
      ```

In Development

- i386 support
- Jessie fixes
- Image creation with `wic`
- Documentation improvements

Isar: Combining the Best

- **Quality**: Debian is a stable, tested distro with security updates
- **Quick start**: Product template, familiar tools
- **Customization**: BitBake is a flexible, efficient integration tool
- **Performance**: Pre-built packages, parallel task execution

References

- Code: https://github.com/ilbers/isar/
- User manual: https://github.com/ilbers/isar/wiki/User-Manual
- Mailing list: https://lists.debian.org/debian-embedded/

Questions?