SIEMENS

First Experiences with the Embedded Debian Build System Isar

Jan Kiszka | Embedded Linux Conference, February 21, 2017

Agenda

Why Yet Another Build System?

Isar Introduction

First Steps

Customizations

To-Dos & Outlook

Summary

Types of Embedded Linux Build Systems

“Roll your own” (OE, Yocto, buildroot, ...)

- Usually implies cross-build & toolchain bootstrap
- Highly customizable
- Production times explode with long package lists
- Non-zero dependencies on host for reliable reproducibility

Distribution-based (ELBE, OBS, Ubuntu Core...)

- Reuse standard desktop/server distribution
- Install pre-built binary packages
- Larger images & slower boots – unless extra customization is applied

Hybrid approach (meta-debian)

- Use distribution packages
- Rebuild from source under Yocto
- New package recipes required (replicates poky + OE)

Requirements on Embedded Linux Build Systems

General needs

- Generate ready-to-use device firmware image
- Ensure reproducible builds
- Support for integration of business logic as well as third-party components
- Enable product-line development: reusable components & configurations
- Easy for beginners, yet powerful for advanced

Our additional requirements

- Avoid building from source where possible
  - Integrate binary packages
  - Do not invalidate upstream QA
- Access to large package pool for increasingly complex systems
- Reuse well-established long-term maintenance
- Clean and well-documented package licenses

Choosing a Base Distribution

Why Debian?

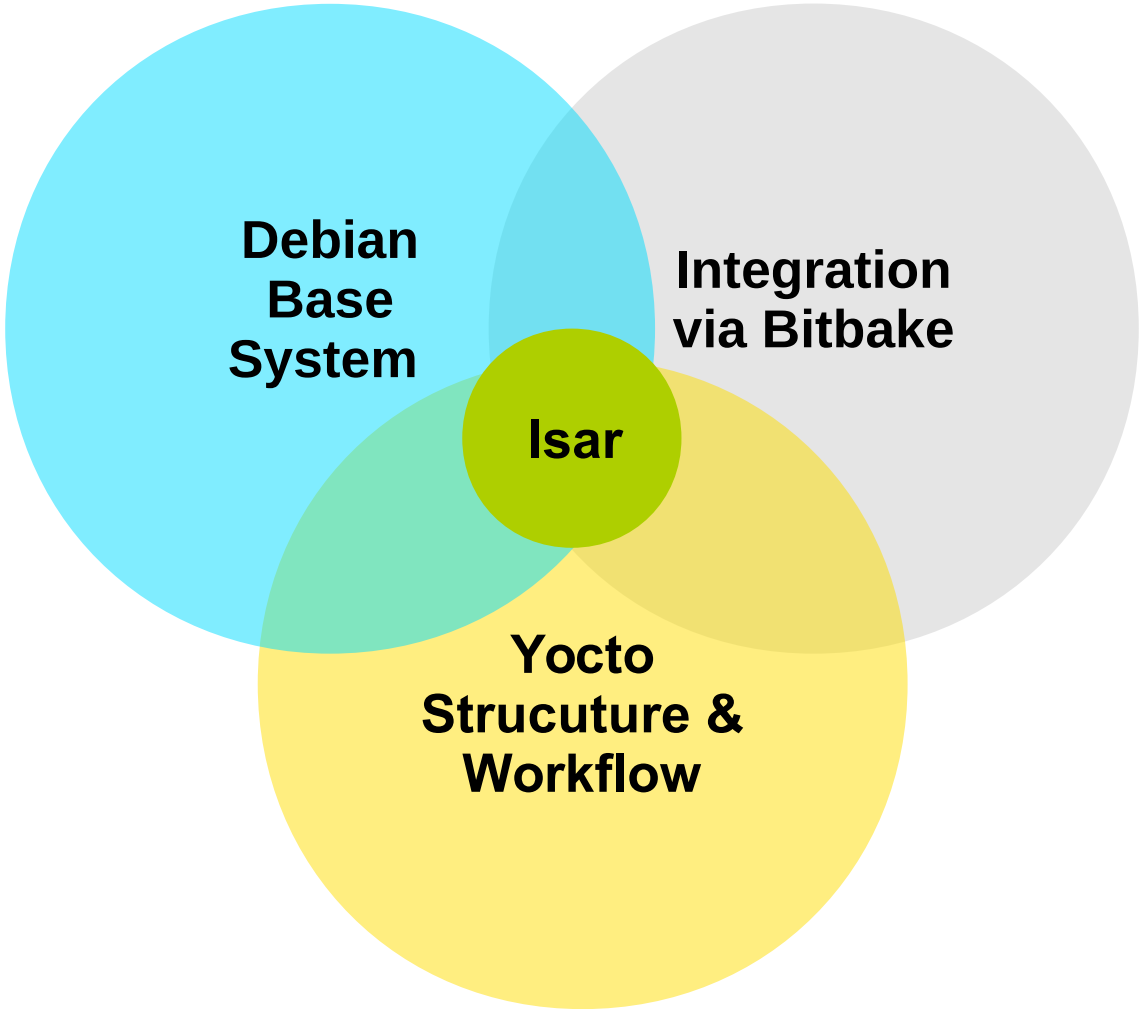
- Large community-driven ecosystem
- Popular in embedded (Raspbian, Armbian, …)
- Successfully used in several of our products
  - But no standardized image builder
- Long-term support
- Strict license checks
  - To ensure “free software only”
- Scales up and down

debian

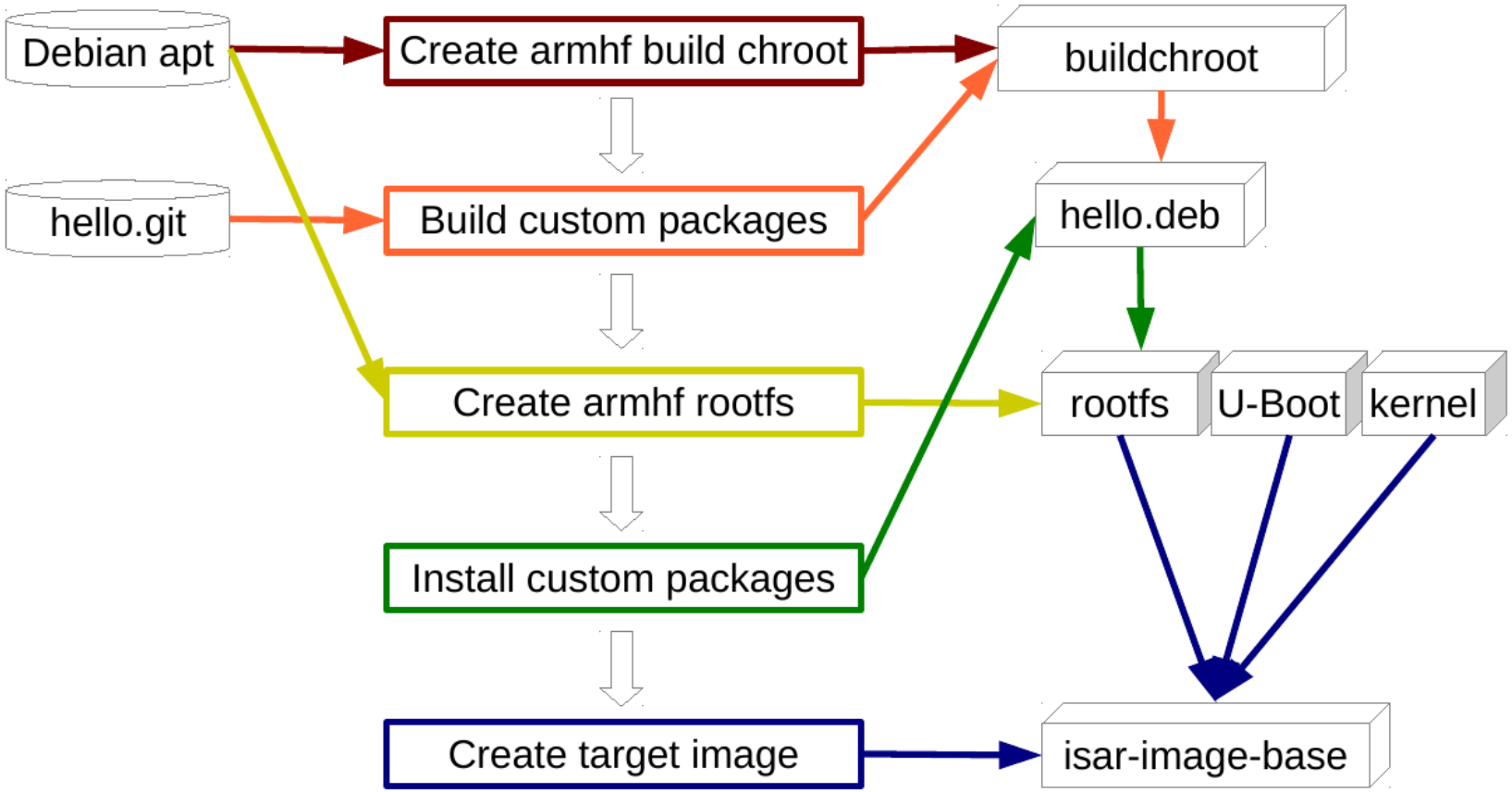
Isar – New Project, Long History

- 2004: SLIND (Siemens Linux Distribution, Debian-based, cross-building) + build.sh
- 2011: SLIND + bitbake, used in Siemens products
- 2015: Debian + bitbake
- 2016: Released as Isar open source project
  - Developed by ilbers GmbH
  - Sponsored by Siemens Corporate Technology
- Isar?
  - **I**ntegrated **S**ystem for **A**utomated **R**oot filesystem generation
  - River along traditional BBQ site in Munich

Combining the Best of 3 Worlds



How Isar Works (ARM Targets)



First Steps into the Isar

Testing in QEMU

- Requires Debian on the host or in a VM
- Clone https://github.com/ilbers/isar
- `. isar-init-build-env /path/build-dir`
- ```
  bitbake \
    multiconfig:qemuarm:isar-image-base
  ```
- `start_armhf_vm`

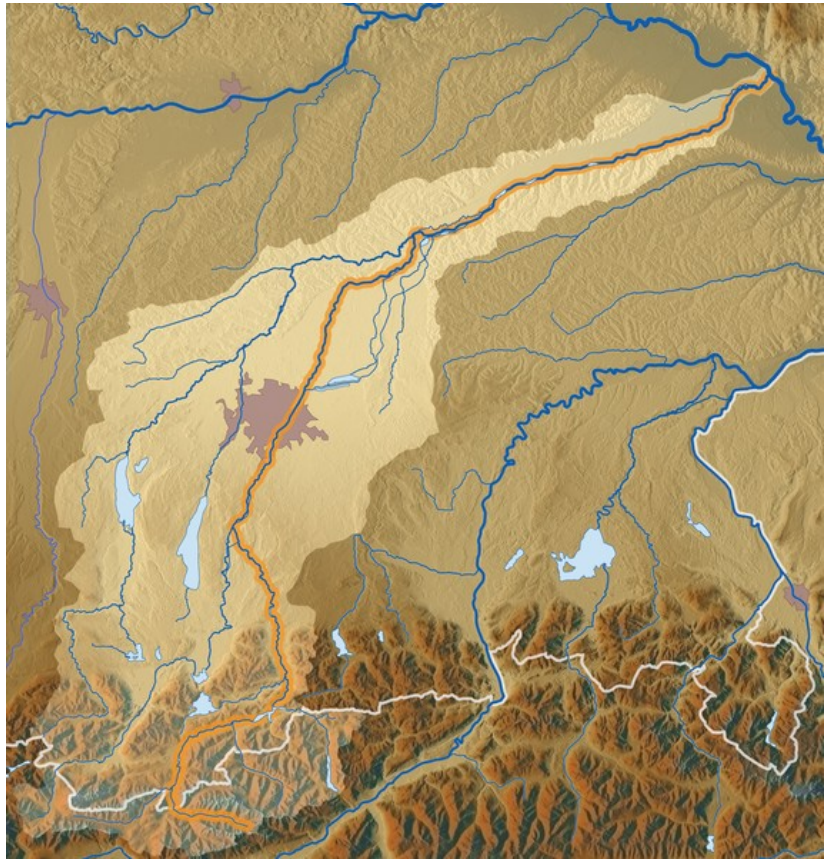
Testing on Raspberry Pi 1

- Uses Raspbian instead of Debian
- ```
  bitbake \
    multiconfig:rpi:isar-image-base
  ```
- ```
  cd tmp/deploy/images;
  dd if=isar-image-base.rpi-sdimg \
     of=/dev/mmcblk0 bs=4M
  ```
  ```

Structure of Isar

Top-level view

- **`bitbake`** – Recipe interpreter (copy, updated from time to time)
- **`meta`** – Core layer
- **`meta-isar`** – Template layer
- **`scripts`** – Helpers scripts
- **`isar-init-build-env`** – Build environment setup script (equivalent to **`oe-init-build-env`**)



Starting an Isar Project

Basic steps

- Clone Isar repository
- Derive from meta-isar as template
- Add your own
  - ...image
  - ...packages
  - ...board (machine)
- Or create separate repo with own layer, including Isar layer in configuration (bblayers.conf)
- Configuration management via repo etc.

Options when organizing in layers

- meta-VENDOR1-bsp (U-Boot, kernel, ...)
- meta-VENDOR2-libs (codecs, ...)
- meta-COMPANY: Company-wide common bits
- meta-PRODUCT1 (app1, …)
- meta-PRODUCT2 (app2, …)

Adding Your Own Image

Basic steps

- Setup
  - Derive from templates (see **`meta-isar/recipes-core/images`**)
  - Extend base image
- Typical tasks
  - Add Debian packages → IMAGE_PREINSTALL
  - Add self-built packages → IMAGE_INSTALL
  - Add files to rootfs → do_rootfs task
  - Modify rootfs → …**`/images/files/debian-configscript.sh`**

my-image.bb

```
require \
  recipes-core/images/isar-image-base.bb

IMAGE_PREINSTALL += "dropbear"

do_rootfs_append() {
  install -m 600 \
   ${THISDIR}/files/dropbear_ecdsahost_key\
   ${S}/etc/dropbear
}
```

Adding Your Own Application

Basic steps

- Two options
  - Build out of source via Isar
  - Install pre-built Debian package from own repo
- Source-based
  - Code repo must be Debianized (debian/ folder containing metadata files)
  - Build natively, using QEMU in cross setups
- Add package to IMAGE_INSTALL in local.conf or your own image recipe

Source-based example recipe

```
DESCRIPTION = "Sample application for ISAR"

LICENSE = "gpl-2.0"
LIC_FILES_CHKSUM = \
 "file://${LAYERDIR_isar}/licenses/CO[...]"

PV = "1.0"
SRC_URI = \
 "git://github.com/ilbers/hello.git"
SRCREV = "ad7065ecc484..."

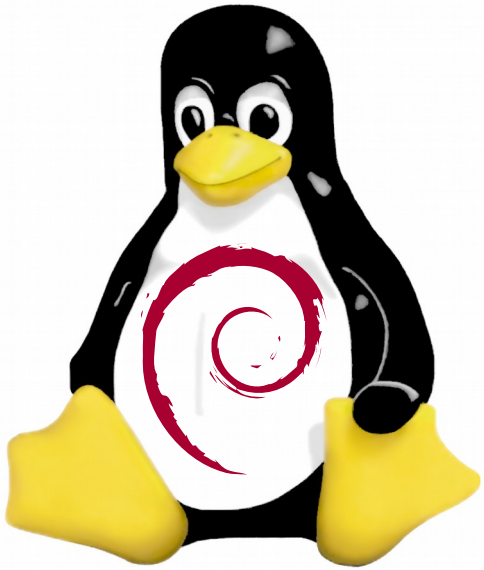
SRC_DIR = "git"

inherit dpkg
```

Using a Custom Kernel

Kernel or app – no major differences

- Debianize your kernel tree
- Let Isar build it
- See example in **`custom_kernel`** branch (needs fix-up for URI to work)
- Or build separately (e.g. **`make deb-pkg`**) and pull from local repo



Custom Kernel + Debianization

Carry metafiles in Isar

- Goal: Keep kernel tree unmodified (e.g. pull from external source repo)
- Copy metafiles and config from recipe into unpacked Linux tree
- Make pattern reusable via include

- Pattern may also be applied to self-built applications

+

Custom Kernel Recipe – Reusable Bits

Reusable files

```
meta/recipes-kernel/
└── linux
    ├── files
    │   └── debian
    │       ├── changelog
    │       ├── compat
    │       ├── control
    │       ├── control.in
    │       ├── README.debian
    │       └── rules
    └── linux.inc
```

linux.inc

```
DESCRIPTION = "Linux Kernel"
FILESPATH_prepend := "${THISDIR}/files:"
LICENSE = "gpl-2.0"
LIC_FILES_CHKSUM = "..."
SRC_URI += "file://debian/ \
            file://defconfig"
SRC_DIR = "git"
inherit dpkg

do_build_prepend() {
    cp ${BUILDROOT}/defconfig \
       ${BUILDROOT}/${SRC_DIR}/arch/arm/...
       ...configs/isar_defconfig
    cp -r ${BUILDROOT}/debian \
          ${BUILDROOT}/${SRC_DIR}
}
```

Custom Kernel Recipe – Specific Bits

Self-provided files

```
meta-mylayer/recipes-kernel/linux/
├── files
│   └── defconfig
└── linux_4.9.bb
```

linux_4.9.bb

```
require recipes-kernel/linux/linux.inc

SRC_URI += "git://git.kernel.org/[...]
  .../linux-stable.git;branch=linux-4.9.y"
SRCREV = "390caeedd4fd"
```

Adding Custom Bootloader

See custom_uboot branch

- Debianize u-boot
  → see `custom_uboot` branch in Isar repo
- Or apply kernel pattern presented before

How to make it bootable?

Image layout definition

- `# meta-isar/conf/machine/rpi.conf`

```
IMAGE_TYPE = "rpi-sdimg"
```

- `# meta-isar/classes/rpi-sdimg.bbclass`

```
inherit ext4-img
do_rpi_sdimg () {
    # shell commands
}
addtask rpi_sdimg before do_build \
    after do_ext4_image
```

- Logically the same what Yocto & Co. do
- Vision: use common tools and descriptions – wic?

Lessons Learned

The good

- Similarities to Yocto / OpenEmbedded helps writing recipes
  - Same language
  - Same structuring
- Recipes can become very simple
- Image generation out of packages is nicely fast
- Structure is simple, code complexity still low
  - About 350 LOC Python and shell code
  - OK, +Bitbake (46K Python code)

...and the not-yet-so-good

- Needs root-privileges for image generation
- Room for improvements for recipe development
  - Some recipe changes do not trigger rebuilds as expected
  - No clean-up tasks implemented yet
- QEMU-based build can be too slow for large packages (e.g. kernels)
  - Selective cross-building, at least during development
  - ARM-based build servers can help

What's next?

Isar changes in the queue

- Address findings reported earlier
- x86 support, adding reference board
- Jessie integration & fixes
- Image creation via `wic`
- Documentation improvements

One size fits all?

Out-of-Source Build Systems Remain Relevant

- SIMATIC IOT2000 (industrial IoT platform)
  - Erratum workaround for Intel Quark in toolchain
  - Many distro packages do not work
  - https://github.com/siemens/meta-iot2000 (Yocto-based BSP)
- Also: systems highly optimized
  - for size (package configurations)
  - for performance (compiler tunings, boot times)

Summary

- Isar: Promising framework for building embedded Debian images
- Some rough edges remaining, but none seem unfixable
- Code & recipe sharing is in the center
  - ...between Isar-based images
  - ...with related build system projects (Yocto, ELBE, meta-debian)
- Smooth path for switching between Yocto-based and Debian-based projects

Resources

- Code: https://github.com/ilbers/isar/
- User manual: https://github.com/ilbers/isar/wiki/User-Manual
- Mailing lists
  - Isar specifics: https://groups.google.com/d/forum/isar-users
  - Collaboration topics: https://lists.debian.org/debian-embedded/

SIEMENS

Thank you!

Jan Kiszka <jan.kiszka@siemens.com>