The Yocto Project
A bird's Eye View

Robert Berger

Reliable Embedded Systems e.U.

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Intro

Let me introduce myself

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Building world class world wide win/win cooperations by helping you to create better embedded software!

Consulting

- /> (private) ~~in-house training~~ includes ~~consulting time~~ while ~~on-site~~
- /> (private) online/remote training includes consulting time while training is in progress
- /> book additional (remote) Yocto Project/Embedded Linux consulting time
- /> ~~book additional on-site Yocto Project/Embedded Linux consulting time~~

Training

/> Embedded Linux - From Systems Architecture to Real-Time (5 days)

/> Refresher to Embedded Linux & Intro to the Yocto Project (5 days)

/> Embedded Linux Kernel Internals and Device Drivers (5 days)

/> The Yocto Project - A thorough Overview (4 days)

/> Introduction to Embedded Linux & Real-Time, bird's eye view of the Yocto Project (4 days)

/> Introduction to Embedded Linux in Theory and Practice - a Crash Course (3 days)

/> (Embedded) Linux debugging (3 days)

/> FreeRTOS in Theory and Practice (3 days)

We trained (excerpt)

On-site training (excerpt)

1 trainee from your company

- /> public online/remote
  - /» worldwide
- /> ~~public on-site~~
  - /» ~~Mainz~~
  - /» ~~Vienna~~
  - /» ~~Munich~~
  - /» ~~Zurich~~

2 and more trainees from your company in Europe

- /> ~~private~~
  - /» ~~at your site~~
- /> $\leq$ 2 see above
- /> $>$ 2 see below

3 and more trainees from your company

- /> private online/remote

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YP Intro

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What is Linux?

What is Linux?

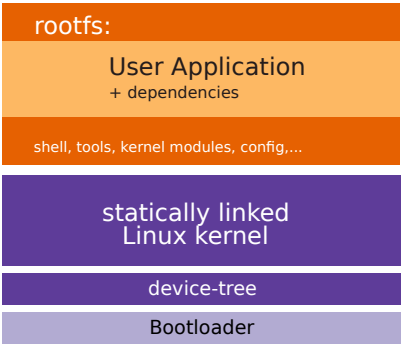

Figure: What is Linux?

- root file system
  - shell
  - application(s)/tools + dependencies
  - libraries
  - linux kernel modules
  - configuration,...
- (statically linked) kernel
- device-tree
- Bootloader

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What is a Linux distro?

What is a Linux distro?

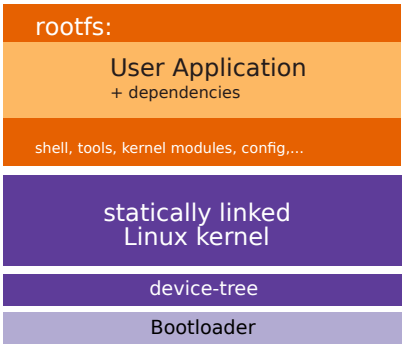

Figure: What is a Linux distro?

- build system combines those via SW packages
  - package manager(s)
  - build/run-time dependencies
  - configuration,...
- policies
  - big/tiny distro?
  - SELinux?
  - LTS (long term support)?
  - container support? which? how?,...
- ideally also
  - Open Source License Compliance
  - SW update facilities - atomic?
  - security updates - cve checks?
  - customize-able

What kind of Linux distros?

- Source distros
  - Build system builds packages from sources
  - Gentoo, Linux from Scratch, Android, Buildroot, OpenWrt, YP/OE,...
  - Recipes describe how to BitBake binary packages (cross compilation)
- Binary distros
  - User typically uses pre-built packages e.g. `.deb`, `.rpm`, `.ipk`,...
  - Debian, Raspian, Ubuntu, Red-Hat, Suse,...
  - YP/OE: sstate, package feeds,...
- Container based distros
  - micro-services (app + user space dependencies)
  - https://www.edgexfoundry.org/, https://foundries.io/,...
  - YP/OE:
    - poky: http://git.yoctoproject.org/cgit/cgit.cgi/poky/tree/meta/classes/image-container.bbclass,
    - meta-virtualization: http://git.yoctoproject.org/cgit/cgit.cgi/meta-virtualization/tree/classes/image-oci.bbclass,...

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What is the YP?

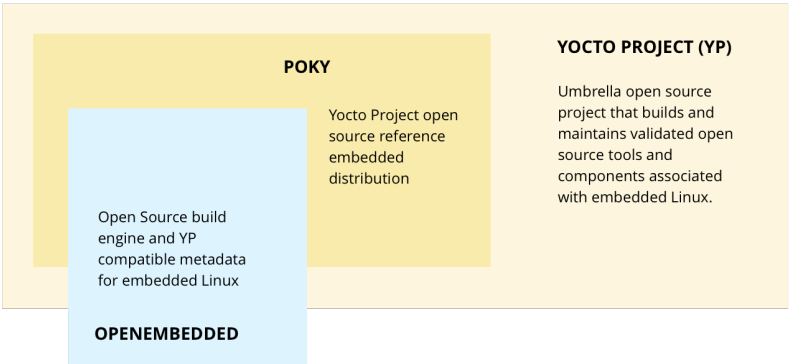
OE Architecture

What is the Yocto Project?

The Yocto Project is an open source collaboration project that provides templates, tools and methods to help you create custom Linux-based systems for embedded products regardless of the hardware architecture. It was founded in 2010 as a collaboration among many hardware manufacturers, open-source operating systems vendors, and electronics companies to bring some order to the chaos of embedded Linux development.[1]

[1] https://www.yoctoproject.org/about

What is the Yocto Project?



- /> the OpenEmbedded build system, co-maintained with the OE project
- /> a reference embedded distribution (called Poky)
- /> integrated tools - also automated building and testing, processes for board support and license compliance, component information for custom Linux-based embedded operating systems
- /> https://www.yoctoproject.org/software-overview/
- /> What is the Yocto Project? (MM)

What is the Yocto Project?

/> https://www.yoctoproject.org/ecosystem/participants

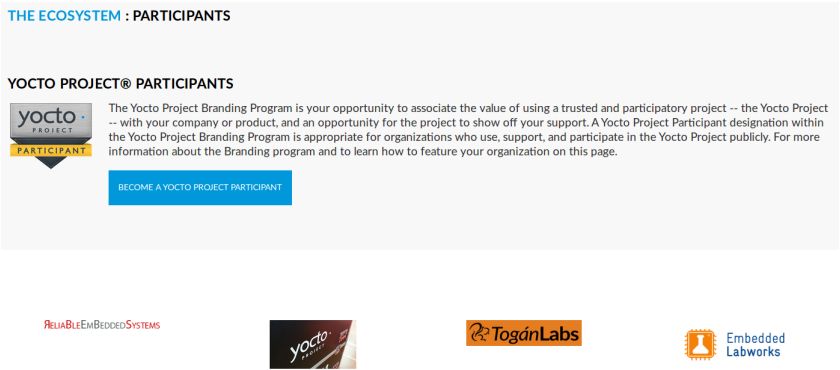


Figure: Yocto Project Participants

Features

- /> widely adopted across the industry
- /> architecture agnostic (ARM, MIPS, PPC, x86, RISC-V and others)
- /> transfer images and code easily between architectures and from free to commercially supported distros
- /> can be used in many different ways - flexibility
- /> ideal for constrained embedded and IoT devices - custom distro
- /> comprehensive toolchain capabilities via platform-specific tuning parameters
- /> (classic) SDK and extensible SDK
- /> mechanism over policy - you can define distro policies
- /> supports partial builds - sstate
- /> releases according to a strict schedule - 6 months
- /> rich ecosystem of individuals and organizations
- /> binary reproducibility - work in progress

Features

- /> CROPS (CROssPlatformS) - https://git.yoctoproject.org/cgit/cgit.cgi/crops/about/
- /> Toaster - https://www.yoctoproject.org/docs/latest/toaster-manual/toaster-manual.html
- /> Multi-Config - build system can automatically and efficiently build multiple specified architectures with one command
- /> Binary Builds - binary files can be included in the build without including the corresponding source code files
- /> License Manifest - keep track of all open source licenses used in the build and provide you with a manifest of those licenses and source references
- /> uses a layer model - see: The Yocto Project Layer Model

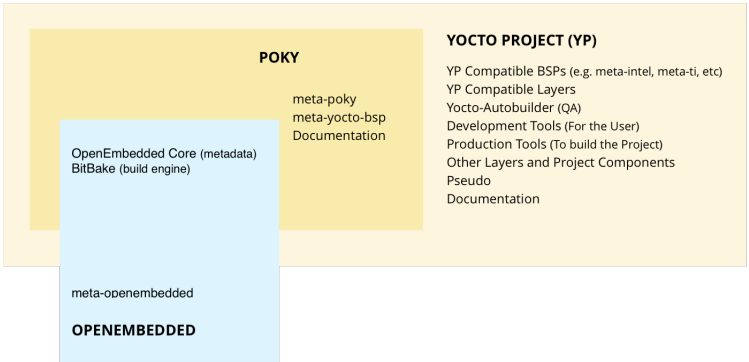
Terminology

- We BitBake images (MM) - see example images (MM)
  - e.g. bitbake core-image-minimal
- images (MM) install packages - see Working with Packages (MM)
- Recipes (BB) (.bb) describe where to fetch code from, how to build it, what should go into which package,...
  - an image recipe describes which packages should go into the specific image
- Recipes (BB) (.bb) reside in Layers (MM)
- Layers (BB) allow you to isolate different types of customizations from each other
  - layers: meta, meta-poky, meta-yocto-bsp,...

Challenges

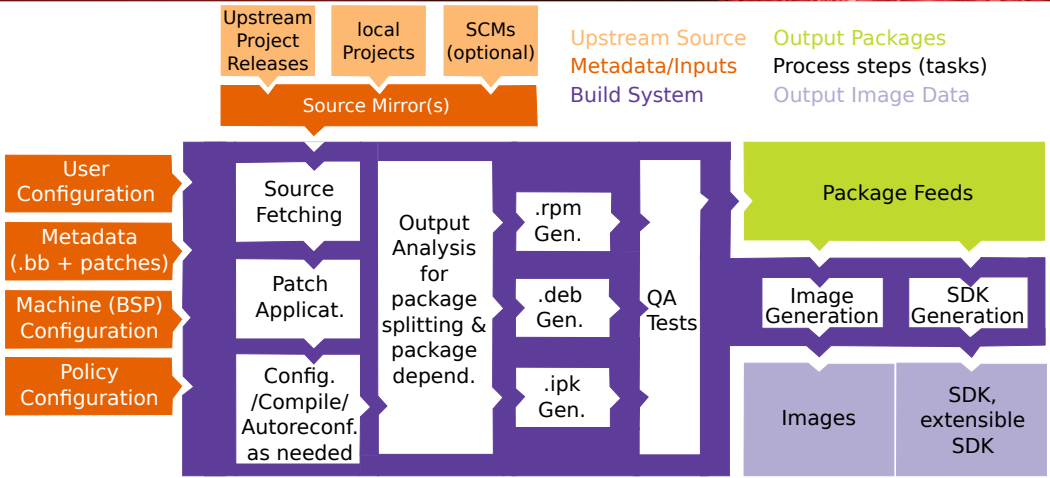
- /> steep learning curve
- /> understanding what changes you need to make for your design requires some research (Mega Manual, mailing lists, IRC,...)
- /> YP workflow could be confusing - see: The Yocto Project Development Environment
- /> working in a cross-build environment can feel unfamiliar
- /> initial build times can be significant - tune the build config to your machines (RAM, cores,...)

The YP - Overview



- /> BitBake, OE-core
- /> Poky
- /> different open source components and tools within the YP umbrella
- /> see: https://www.yoctoproject.org/software-overview/

OE Architecture Workflow



/> see also:

/» OpenEmbedded Build System Concepts (MM)

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Thank you

Thank you!

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