



# Yocto Project and OpenEmbedded development training

On-site training, 3 days

Latest update: May 08, 2024

<b>Title</b>	<b>Yocto Project and OpenEmbedded development training</b>
<b>Training objectives</b>	<ul style="list-style-type: none"><li>• Be able to understand the role and principle of an embedded Linux build system, and compare Yocto Project/OpenEmbedded to other tools offering similar functionality.</li><li>• Be able to configure and build basic embedded Linux system with Yocto, and install the result on an embedded platform.</li><li>• Be able to write and extend recipes, for your own packages or customizations.</li><li>• Be able to use existing layers of recipes, and create your own new layers.</li><li>• Be able to integrate support for your own embedded board into a BSP layer.</li><li>• Be able to create custom images.</li><li>• Be able to use the Yocto Project SDK to develop applications.</li><li>• Be able to use devtool to generate and modify recipes.</li></ul>
<b>Duration</b>	<b>Three</b> days - 24 hours (8 hours per day)
<b>Pedagogics</b>	<ul style="list-style-type: none"><li>• Lectures delivered by the trainer: 40% of the duration</li><li>• Practical labs done by participants: 60% of the duration</li><li>• Electronic copies of presentations, lab instructions and data files. They are freely available at <a href="https://bootlin.com/doc/training/yocto">https://bootlin.com/doc/training/yocto</a>.</li></ul>
<b>Trainer</b>	One of the engineers listed on: <a href="https://bootlin.com/training/trainers/">https://bootlin.com/training/trainers/</a>
<b>Language</b>	Oral lectures: English, French, Italian. Materials: English.
<b>Audience</b>	Companies and engineers interested in using the Yocto Project to build their embedded Linux system.



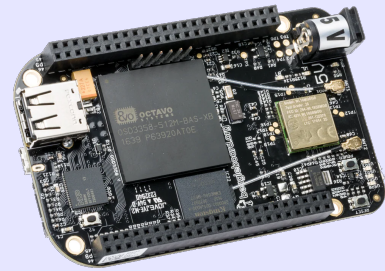
<b>Prerequisites</b>	<ul style="list-style-type: none"><li>• <b>Knowledge and practice of UNIX or GNU/Linux commands:</b> participants must be familiar with the Linux command line. Participants lacking experience on this topic should get trained by themselves, for example with our freely available on-line slides at <a href="http://bootlin.com/blog/command-line/">bootlin.com/blog/command-line/</a>.</li><li>• <b>Minimal experience in embedded Linux development:</b> participants should have a minimal understanding of the architecture of embedded Linux systems: role of the Linux kernel vs. user-space, development of Linux user-space applications in C. Following Bootlin's <i>Embedded Linux</i> course at <a href="http://bootlin.com/training/embedded-linux/">bootlin.com/training/embedded-linux/</a> allows to fulfill this pre-requisite.</li><li>• <b>Minimal English language level: B1</b>, according to the <i>Common European Framework of References for Languages</i>, for our sessions in English. See <a href="http://bootlin.com/pub/training/cefr-grid.pdf">bootlin.com/pub/training/cefr-grid.pdf</a> for self-evaluation.</li></ul>
<b>Required equipment</b>	<ul style="list-style-type: none"><li>• Video projector</li><li>• One PC computer on each desk (for one or two persons) with at least an Intel Core i5 processor, 8 GB of RAM, and Ubuntu Linux 22.04 installed in a <b>free partition of at least 100 GB</b></li><li>• Distributions other than Ubuntu Linux 22.04 are not supported, and using Linux in a virtual machine is not supported.</li><li>• <b>Unfiltered and fast connection to Internet:</b> at least 50 Mbit/s of download bandwidth, and no filtering of web sites or protocols.</li><li>• <b>PC computers with valuable data must be backed up</b> before being used in our sessions.</li></ul>
<b>Certificate</b>	Only the participants who have attended all training sessions, and who have scored over 50% of correct answers at the final evaluation will receive a training certificate from Bootlin.
<b>Disabilities</b>	Participants with disabilities who have special needs are invited to contact us at <a href="mailto:training@bootlin.com">training@bootlin.com</a> to discuss adaptations to the training course.



## Hardware, first option

### BeagleBone Black board

- An ARM AM335x processor from Texas Instruments (Cortex-A8 based), 3D acceleration, etc.
- 512 MB of RAM
- 2 GB of on-board eMMC storage (4 GB in Rev C)
- USB host and device
- HDMI output
- 2 x 46 pins headers, to access UARTs, SPI buses, I2C buses and more.



## Hardware, second option

One of these Discovery Kits from STMicroelectronics: **STM32MP157A-DK1**, **STM32MP157D-DK1**, **STM32MP157C-DK2** or **STM32MP157F-DK2**

- STM32MP157 (dual Cortex-A7) CPU from STMicroelectronics
- USB powered
- 512 MB DDR3L RAM
- Gigabit Ethernet port
- 4 USB 2.0 host ports
- 1 USB-C OTG port
- 1 Micro SD slot
- On-board ST-LINK/V2-1 debugger
- Arduino Uno v3-compatible headers
- Audio codec
- Misc: buttons, LEDs
- LCD touchscreen (DK2 kits only)





## Day 1 - Morning

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### Lecture - Introduction to embedded Linux build systems

- Overview of an embedded Linux system architecture
- Methods to build a root filesystem image
- Usefulness of build systems

### Lecture - Yocto Project and Poky reference system overview

- Introduction to the Yocto / OpenEmbedded build system and its lexicon
- Overview of the Poky reference system

### Lecture - Using Yocto Project - basics

- Setting up the build directory and environment
- Configuring the build system
- Building a root filesystem image

### Lab 1 - First Yocto Project build

- Downloading the Poky reference build system
- Configuring the build system
- Building a system image

## Day 1 - Afternoon

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### Lecture - Using Yocto Project - basics

- Organization of the build output

### Lab 1 - Flashing and booting

- Flashing and booting the image on the board



### Lecture - Using Yocto Project - advanced usage

- Variable assignment, operators and overrides
- Package variants and package selection
- bitbake command line options

### Lab 2 - Using NFS and configuring the build

- Configuring the board to boot over NFS
- Add a package to the root filesystem
- Learn how to use the PREFERRED\_PROVIDER mechanism
- Get familiar with the bitbake command line options

## Day 2 - Morning

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### Lecture - Writing recipes - basics

- Recipes: overview
- Recipe file organization
- Applying patches
- Recipe examples

### Lab 3 - Adding an application to the build

- Writing a recipe for *nInvaders*
- Troubleshooting the recipe
- Troubleshooting cross-compilation issues
- Adding *ninvaders* to the final image

### Lecture - Writing recipes - advanced features

- Extending and overriding recipes
- Virtual packages
- Learn about classes
- BitBake file inclusions
- Debugging recipes
- Configuring BitBake network usage



## Day 2 - Afternoon

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### Lecture - Layers

- What layers are
- Where to find layers
- Creating a layer

### Lab 4 - Writing a layer

- Learn how to write a layer
- Add the layer to the build
- Move *ninvaders* to the new layer

## Day 3 - Morning

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### Lab 5 - Extend a recipe

- Extend the kernel recipe to add patches
- Configure the kernel to compile the nunchuk driver
- Edit the ninvaders recipe to add patches
- Play *nInvaders*

### Lecture - Writing a BSP

- Introduction to BSP layers
- Adding a new machine
- Bootloader configuration
- Linux: the kernel bbclass and the linux-yocto recipe

### Lab 6 - Create a custom machine configuration

- Create a new machine configuration
- Build an image for the new machine

### Lecture - Distro layers

- Distro configuration
- Distro layers



### Lecture - Images

- Writing an image recipe
- Image types
- Writing and using package groups recipes

### Lab 7 - Create a custom image

- Add a basic image recipe
- Select the image capabilities and packages
- Add a custom package group
- Add an image variant for debugging

## Day 3 - Afternoon

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### Lecture - Writing recipes - going further

- The per-recipe sysroot
- Using Python code in metadata
- Variable flags
- Packages features and PACKAGECONFIG
- Conditional features
- Package splitting
- Dependencies in detail

### Lecture - Licensing

- Managing open source licenses

### Lecture - The Yocto Project SDK

- Goals of the SDK
- Building and customizing an SDK
- Using the Yocto Project SDK

### Lab 8 - Develop your application in the Poky SDK

- Building an SDK
- Using the Yocto Project SDK

### Lecture - Devtool

- About devtool
- Devtool use cases

### Lab 9 - Using devtool

- Generate a new recipe
- Modify a recipe to add a new patch
- Upgrade a recipe to a newer version



## Lecture - Automating layer management

- Automating layer management

## Lecture - Runtime Package Management

- Introduction to runtime package management
- Build configuration
- Package server configuration
- Target configuration