# Yocto Project and OpenEmbedded training

## 3-day session

<table>
<thead>
<tr>
<th>Title</th>
<th>Yocto Project and OpenEmbedded development training</th>
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</thead>
</table>
| **Overview** | Understanding the Yocto Project  
Using it to build a root filesystem and run it on your target  
Writing and extending recipes  
Creating layers  
Integrating your board in a BSP  
Creating custom images  
Application development with the Yocto Project SDK |
| **Duration** | Three days - 24 hours (8 hours per day).  
40% of lectures, 60% of practical labs. |
| **Trainer** | One of the engineers listed on  
https://bootlin.com/training/trainers/ |
| **Language** | Oral lectures: English, French.  
Materials: English. |
| **Audience** | Companies and engineers interested in using the Yocto Project to build their embedded Linux system. |
| **Prerequisites** | Knowledge of embedded Linux as covered in our embedded Linux training  
(https://bootlin.com/training/embedded-linux/)  

**Knowledge and practice of Unix or GNU/Linux commands**  
People lacking experience on this topic should get trained by themselves, for example with our freely available on-line slides:  
https://bootlin.com/blog/command-line/ |
### Required equipment

For on-site sessions only.
Everything is supplied by Bootlin in public sessions.

- Video projector
- PC computers with at least 8 GB of RAM, a CPU at least equivalent to an Intel Core i5 and Ubuntu Linux installed in a **free partition of at least 40 GB**. **Using Linux in a virtual machine is not supported**, because of issues connecting to real hardware.
- We need Ubuntu Desktop 16.04 (Xubuntu and other variants are fine). We don’t support other distributions, because we can’t test all possible package versions.
- **High Speed Connection to the Internet** (direct or through the company proxy).
- **PC computers with valuable data must be backed up** before being used in our sessions. Some people have already made mistakes during our sessions and damaged work data.

### Materials

Print and electronic copies of presentations and labs.
Electronic copy of lab files.

<table>
<thead>
<tr>
<th>Hardware, first option</th>
<th>Hardware, second option</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BeagleBone Black board</strong></td>
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<tr>
<td>- An ARM AM335x processor from Texas Instruments (Cortex-A8 based), 3D acceleration, etc.</td>
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<tr>
<td>- 512 MB of RAM</td>
<td></td>
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<tr>
<td>- 2 GB of on-board eMMC storage (4 GB in Rev C)</td>
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<tr>
<td>- USB host and device</td>
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<tr>
<td>- HDMI output</td>
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<tr>
<td>- 2 x 46 pins headers, to access UARTs, SPI buses, I2C buses and more.</td>
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</table>

| **STMicroelectronics STM32MP157A-DK1 Discovery board** |
| - STM32MP157A (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 |
### Day 1 - Morning

<table>
<thead>
<tr>
<th>Lecture - Introduction to embedded Linux build systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Overview of an embedded Linux system architecture</td>
</tr>
<tr>
<td>- Methods to build a root filesystem image</td>
</tr>
<tr>
<td>- Usefulness of build systems</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Lecture - Overview of the Yocto Project and the Poky reference system</th>
<th>Lab - First Yocto Project build</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Organization of the project source tree</td>
<td></td>
</tr>
<tr>
<td>- Building a root filesystem image using the Yocto Project</td>
<td></td>
</tr>
<tr>
<td>- Downloading the Poky reference build system</td>
<td></td>
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<tr>
<td>- Building a system image</td>
<td></td>
</tr>
</tbody>
</table>

### Day 1 - Afternoon

<table>
<thead>
<tr>
<th>Lecture - Using Yocto Project - basics</th>
<th>Lab - Flashing and booting</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Organization of the build output</td>
<td></td>
</tr>
<tr>
<td>- Flashing and installing the system image</td>
<td></td>
</tr>
<tr>
<td>- Flashing and booting the image on the board</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Lecture - Using Yocto Project - advanced usage</th>
<th>Lab - Using NFS and configuring the build</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Configuring the build system</td>
<td></td>
</tr>
<tr>
<td>- Customizing the package selection</td>
<td></td>
</tr>
<tr>
<td>- Configuring the board to boot over NFS</td>
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</tr>
<tr>
<td>- Learn how to use the PREFERRED_PROVIDER mechanism</td>
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</tbody>
</table>
**Day 2 - Morning**

<table>
<thead>
<tr>
<th>Lecture - Writing recipes - basics</th>
<th>Lab - Adding an application to the build</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Writing a minimal recipe</td>
<td>• Writing a recipe for <em>n</em>Invaders</td>
</tr>
<tr>
<td>• Adding dependencies</td>
<td>• Adding <em>n</em>Invaders to the final image</td>
</tr>
<tr>
<td>• Development workflow with <em>bitbake</em></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Lecture - Writing recipes - advanced features</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Extending and overriding recipes</td>
</tr>
<tr>
<td>• Adding steps to the build process</td>
</tr>
<tr>
<td>• Learn about classes</td>
</tr>
<tr>
<td>• Analysis of examples</td>
</tr>
<tr>
<td>• Logging</td>
</tr>
<tr>
<td>• Debugging dependencies</td>
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**Day 2 - Afternoon**

<table>
<thead>
<tr>
<th>Lab - Learning how to configure packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Extending a recipe to add configuration files</td>
</tr>
<tr>
<td>• Using <em>ROOTFS_POSTPROCESS_COMMAND</em> to modify the final rootfs</td>
</tr>
<tr>
<td>• Studying package dependencies</td>
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<table>
<thead>
<tr>
<th>Lecture - Layers</th>
<th>Lab - Writing a layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What layers are</td>
<td></td>
</tr>
<tr>
<td>• Where to find layers</td>
<td></td>
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<tr>
<td>• Creating a layer</td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>• Learn how to write a layer</td>
<td></td>
</tr>
<tr>
<td>• Add the layer to the build</td>
<td></td>
</tr>
<tr>
<td>• Move <em>n</em>Invaders to the new layer</td>
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</table>
## Day 3 - Morning

<table>
<thead>
<tr>
<th>Lecture - Writing a BSP</th>
<th>Lab - Implementing the kernel changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Extending an existing BSP</td>
<td>• Extend the kernel recipe to add the nunchuk driver</td>
</tr>
<tr>
<td>• Adding a new machine</td>
<td>• Configure the kernel to compile the nunchuk driver</td>
</tr>
<tr>
<td>• Bootloaders</td>
<td>• Play \textit{nInvaders}</td>
</tr>
<tr>
<td>• Linux and the linux-yocto recipe</td>
<td></td>
</tr>
<tr>
<td>• Adding a custom image type</td>
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</table>

**Extend the kernel recipe to add the nunchuk driver**

**Configure the kernel to compile the nunchuk driver**

**Play \textit{nInvaders}**

## Day 3 - Afternoon

<table>
<thead>
<tr>
<th>Lecture - Creating a custom image</th>
<th>Lab - Creating a custom image</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Writing an image recipe</td>
<td>• Writing a custom image recipe</td>
</tr>
<tr>
<td>• Adding users/groups</td>
<td>• Adding \textit{nInvaders} to the custom image</td>
</tr>
<tr>
<td>• Adding custom configuration</td>
<td></td>
</tr>
<tr>
<td>• Writing and using package groups recipes</td>
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</table>

**Writing a custom image recipe**

**Adding \textit{nInvaders} to the custom image**

<table>
<thead>
<tr>
<th>Lecture - Creating and using an SDK</th>
<th>Lab - Experimenting with the SDK</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Understanding the purpose of an SDK for the</td>
<td>• Building an SDK</td>
</tr>
<tr>
<td>application developer</td>
<td>• Using the Yocto Project SDK</td>
</tr>
<tr>
<td>• Building an SDK for the custom image</td>
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</tr>
</tbody>
</table>

**Building an SDK**

**Using the Yocto Project SDK**