



## oY12 - Comprehensive Yocto Project Usage

### Objectives

- Using and customizing Yocto
- Creating Yocto-based Embedded Linux platforms
- Using Yocto to develop components
- Customizing the BSP
- Building out of tree modules
- Setup Source cache

Labs are conducted QEMU ARM-based board

We use a recent version of Yocto

### Prerequisite

- Good C programming skills (see our [oL2 - C Language for Embedded MCUs](#) course)
- Knowledge of Linux Embedded systems (see our [oD1 - Embedded Linux](#) course)
- Preferably knowledge of Linux user programming (see our [oD0 - Linux User Mode Programming](#) course)

### Course environment

- Theoretical course
  - PDF course material (in English)
  - Course dispensed using the Teams video-conferencing system
  - The trainer to answer trainees' questions during the training and provide technical and pedagogical assistance through the Teams video-conferencing system
- Practical activities
  - Practical activities represent from 40% to 50% of course duration
  - One Online Linux PC per trainee for the practical activities
  - The trainer has access to trainees' Online PCs for technical and pedagogical assistance
- Downloadable preconfigured virtual machine for post-course practical activities

### Duration

- Total: 30 hours
- 5 sessions, 6 hours +/-30 min each (excluding break time)
- From 40% to 50% of training time is devoted to practical activities
- Some Labs may be completed between sessions and are checked by the trainer on the next session

### Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

# Course Outline

## Session 1

### Introduction to Yocto

- Overview of Yocto
  - History
  - Yocto, Open Embedded and Poky
  - Purpose of the Yocto project
  - The main projects
- Yocto architecture
  - Overview
  - Recipes and classes
  - Tasks

### The Yocto build system

- Build system objectives
  - Building deployable images
  - Layers and layer priorities
  - Directory layout
  - Configuration files (local, machine and distribution)
  - The bitbake tool
- Using Yocto
  - Building a package
  - Building an image (root file system + u-boot + kernel)
- Miscellaneous tools around Yocto
  - Yocto SDK
  - Extensible SDK

**Exercise:** Building a root file system using Yocto

**Exercise:** Use bitbake commands to build package & images

**Exercise:** Building a root file system using Yocto

**Exercise:** Build an extensible SDK for the generated image

**Exercise:** Deploy the generated image

### Yocto package recipes structure

- Recipe architecture
  - Tasks
  - Task dependencies
  - Recipe dependencies
- The bitbake language
  - Standard variables and functions
  - Classes and recipes
  - The base Yocto classes
  - Main bitbake commands
- Adding a new layer
  - Layer structure
  - Various kinds of layers

**Exercise:** Adding a new layer

## Session 2

### Writing package recipes for Yocto

- Various kind of recipes and classes
  - Bare program
  - Makefile-based package
  - autotools-based package
  - u-boot
  - kernel
  - Out-of-tree module
- Recipe creation strategies
  - From scratch
  - Using devtool
  - Using recipetool
  - From an existing, similar, recipe
- Debugging recipes
  - Debugging recipe selection
  - Debugging dependencies
  - Debugging tasks
- Defining packaging
  - Package splitting
- Automatically starting a program

**Exercise:** Writing a recipe for a local user-maintained package

**Exercise:** Writing and debugging a package recipe for an autotools-based package

**Exercise:** Starting a program at boot (systemd)

### Modifying recipes

- Customizing an existing package recipe (.bbappend)
- Recipe dependencies
- Creating and adding patches
  - Creating a patch for a community-provided component
  - Creating a patch for an user-maintained component
- Defining new tasks
  - Task declaration
  - Coding tasks

**Exercise:** Adding patches and dependencies to a community package

**Exercise:** Adding a rootfsinstall task to directly copy the output of a user package in the rootfs image

## Session 3

### Creating new kinds of recipes

- Creating classes
  - Creating new independent classes
  - Inheriting from an existing class

**Exercise:** Create a class to generalize the “rootfsinstall” task

### Creating a root file system

- Building a root file system with Yocto
  - Creating a custom root file system
- Writing an image recipe
  - Selecting the packages to build
  - Selecting the file system types

- The various kinds of images
- Inheriting and customizing images
  - Customizing system configuration files (network, mount points, ...)
- Users and groups management
- Package management
  - rpm
  - opkg

**Exercise:** Writing and building an image recipe

**Exercise:** Add new users to the image

**Exercise:** Create an image with package support for OTA deployment

**Exercise:** Test OTA update on the generated image

## Session 4

### Development process using the extensible SDK and devtool

- Using devtool to create a package and its recipe
- Using devtool to modify an existing package and recipe
- Using devtool to update a recipe to build a new version of a package

**Exercise:** Create, test and modify a recipe for an existing package using devtool

### Develop and debug applications using SDK and eclipse

- Adding eclipse remote debug packages
- Configuring eclipse

**Exercise:** Create remote debugging session using eclipse

### Writing tasks in python

- Introduction to python
- Using python in Yocto
  - The main bitbake classes
  - Defining variable values in Python
  - Writing tasks in Python

**Exercise:** Writing a task and customizing a recipe in Python

### Porting Yocto

- Porting Yocto to a new board
- BSP architecture
  - Selecting and configuring u-boot recipe
  - Selecting and configuring kernel recipe
- Adding a new BSP layer (yocto-bsp create)

**Exercise:** Creating a new BSP layer

## Session 5

### BSP Development

- Adding a custom u-boot to Yocto
- Customizing the Yocto kernel recipe
  - Setting the default configuration
  - Adding patches
  - Specifying the kernel sources
- Configuring Linux Kernel
  - Using menuconfig
  - Using patches

- Creating Configuration Fragments
- Validating Configuration
- Kernel device tree

**Exercise:** Create u-boot and kernel recipes to use custom versions, test the result

**Exercise:** Patch kernel and activate new options using a fragment

**Exercise:** Create and use a new device tree

## Out-of-Tree Modules

- Adding modules to image
- Creating an out-of-tree module
- Kernel modules with eSDK

**Exercise:** Build and test modules

## Tailoring the build system

- Setting up a Yocto source cache
  - Local, per system, cache setup
  - Setting up a global, network wide, cache
- Customizing the build system
  - Using a prebuilt toolchain
  - Using a pre-compiled kernel
- Optimizing Yocto build times
  - Using prebuilt, binary, packages
  - Using shared compilation caches

**Exercise:** Setting up a global source cache

**Exercise:** Setting up an optimized build environment and rebuilding an image