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openembedded

Embedded Linux system development

5-day session

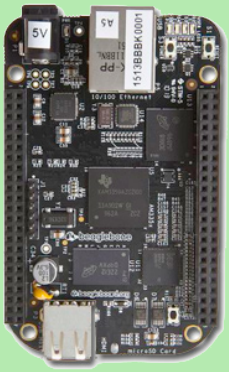
Title	Embedded Linux system development
Overview	Introduction to Embedded Linux Cross-Compiling Toolchains Bootloaders Linux Kernel Introduction Linux Root Filesystems Embedded Linux System Development Embedded Linux Application Development Real Time in Embedded Linux Systems Practical labs with the ARM-based Beagle Bone Black.
Duration	**Five** days - 40 hours (8 hours per day). 50% of lectures, 50% of practical labs.
Trainer	Ulf Samuelsson http://www.emagii.com/
Language	Oral lectures: English, Swedish. Materials: English.
Audience	People developing devices using Linux People supporting embedded Linux system developers.
Prerequisites	**Solid experience in C programming** In particular, participants must be familiar with creating and dealing with complex data types and structures, with pointers to such symbols, as well as with function pointers. **Knowledge and practice of UNIX or GNU/Linux commands** People lacking experience on this topic should get trained by themselves with our freely available on-line slides (http://free-electrons.com/docs/command-line/).

Required equipment	**For on-site sessions only** Everything is supplied by eMagii in public sessions. • Video projector • PC computers with at least 4 GB of RAM, and **Ubuntu Linux 12.04 (x64)** installed in a **free partition of at least 60 GB**. We don't support other distributions, because we can't test all possible package versions. **Using Linux in a virtual machine is not supported**, because of issues connecting to real hardware. • Labs should be run on Intel Core i5 or better. • **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. • It is a good idea to do a fresh install on a new disk which subsuquently can be used as an external USB disk.
Materials	Print and electronic copies of presentations and labs. Electronic copy of lab files.
Credits	This material is developed by Free-Electrons and eMagii.

Hardware

The hardware platform used for the practical labs of this training session is the **BeagleBone Black**, which features:

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



Labs

The practical labs of this training session use the following hardware peripherals to illustrate the development of Linux device drivers:

- A high-speed micro-SD card (minimum 4 GB)
- A SD-Card Reader
- USB - Ethernet adapter. The Ethernet will be reconfigured, and if you do not want to change your normal setup, an USB - Ethernet adapter is OK.
- USB - Serial Adapter
- Two free USB ports for USB, or an external powered USB hub.

Day 1 - Morning

Lecture - Introduction to Embedded Linux	Lab - Training Setup
• Advantages of Linux and open source for embedded systems • A few examples of embedded systems running linux • Embedded Hardware for Linux systems • Embedded Linux system architecture	• Install the Lab archives

Day 1 - Afternoon

Lecture - Cross Compiling Toolchains	Lab - Cross Compiling a toolchain
• Definitions and Components • C Libraries • Toolchain Options • Obtaining a Toolchain	• Building a Yocto SDK • Configuring Crosstool-NG • Build a toolchain • Getting a free commercially supported toolchain (Sourcery)

Day 2 - Morning

Lecture - Bootloaders	Lab - U-Boot
• Boot Sequence • The U-Boot Bootloader	*Using the BeagleBoneBlack* • Communication with the board using a serial console • Configure, Build and Install U-Boot • Learn U-Boot commands • Setup TFTP communications

Day 2 - Afternoon

Lecture - Linux kernel Introduction	Lab - Kernel cross-compiling
• Linux Features • Linux Versioning Schemes • Linux Kernel Sources • Kernel Configuration • Compiling and Installing the Kernel for the host • Cross-Compilining the kernel • Using kernel modules	*Using the BeagleBoneBlack* • Set up the cross compiling environment • Configure the kernel using Kconfig • Cross-compile for an ARM platform • Boot the kernel

Day 3 - Morning

Lecture - Linux Root Filesystem	Lab - A tiny embedded systems
• Principle and solutions • Contents • Device Files • Virtual File Systems • Minimal File Systems • Busybox	• Make linux boot using NFS • Configure and Create a minuimalistic Linux embedded system • Install and use Busybox • System startup with /sbin/init • Setup a simple web interface • Use shared libraries

Day 3 - Afternoon

Lecture - Block Filesystems	Lab - Block Filesystems
• Difference vs Flash file systems • Devices • Traditional file systems (ext2,vfat) • Journalled file systems (ext3,ext4) • Filesystem recovery • Mounting filesystems • Squashfs • Tmpfs	*Using the BeagleBoneBlack* • Creating partitions • Booting with a mix of filesystems

Lecture - Flash Filesystems	Lab - Block Filesystems
• The MTD subsystem • MTD partitions • JFFS2 • Yaffs • UBI	*Using the BeagleBoneBlack* • Note: this lab needs revising, Beagle-bone does not have NAND Flash • Note: Needs to show UBI • Creating partitions on flash storage • Read-Only JFFS2 • Read-Write JFFS2

Day 4 - Morning

Lecture - Embedded Linux system development	Lab - Manual cross-compiling
• Open Source components and licensing • Networking • System Utilities • Language Interpreters • Audio, Video and Multimedia • Graphical Toolkits • Databases • Web Browsers • Examples	*Using the BeagleBoneBlack* • Manual cross-compiling applications and libraries • Common techniques and issues

Day 4 - Afternoon

Lecture - Build Systems	Lab - Buildroot
• System Building • Commercial Linux solutions	*Using the BeagleBoneBlack* • Rebuilding using Buildroot • Adding your own DirectFB based application

Day 5 - Morning

Lecture - Embedded Linux application development	Lab - Application Development and debugging
• Developing applications on embedded linux • Integrated development environment • Version Control Systems • Debuggers • Remote debugging • Memory checkers • System analysis • (Not) Developing on Windows	*Using the BeagleBoneBlack* • Compile your own application • Set up remote debugging • Debug a simple application

Day 5 - Afternoon

Lecture - Real-time in embedded linux systems	Lab - Real-time
• PREEMPT_RT • Real time extensions • Xenomai	*Using the BeagleBoneBlack* • Check Clock accuracy • Build a POSIX real-time application • Build a Xenomai real-time application • Compare the two solutions