Embedded Linux on PowerPC based embedded platforms

Patrick Pelgrims (ppe@denayer.wenk.be)
Björn Van de Vondel (bvd@denayer.wenk.be)
Gerrit Van de Velde (gvd@denayer.wenk.be)

Copyright (c) 2004 by Gerrit Van de Velde, Björn Van de Vondel, Patrick Pelgrims. This material may be distributed only subject to the terms and conditions set forth in the Open Publication License, v1.0 or later (the latest version is presently available at http://www.opencontent.org/openpub/).
Outline

• Embedded Linux
  – What is.. , Why .. & Examples of Linux in embedded systems
• Motorola MPC5200
  – Introduction
  – Installing Linux
• Elphel Network Camera Demo
• MPC5200 Demo
• Plans
What?

- “Normal” Linux
- Size matters
- Support for typical embedded features
- Real-Time extensions
What?

- Comparison workstation vs. Embedded
- Size: 500Mb-2Gb vs. 2-8Mb
- Bootup time: +30 seconds vs. 5-10 seconds
- Applications: A lot (too much?) vs. Selected set of applications
What?

• “Embedded Linux” refers to a distribution

• Kernel Space
  – Kernel (with patches for specific architecture)
  – Set of drivers

• User Space
  – Libraries
  – Utilities, commands
The boot process explained
Linuxdevices.com Poll

• Poll during 2004
• Targeted 600 embedded system developers
  – Linux dwarves other Oses!
  – Which Linux form?
  – Most popular CPU type?
Linuxdevices.com Poll

“Embedded Linux on PowerPC platforms”
Linuxdevices.com Poll

“Embedded Linux on PowerPC platforms”
Linuxdevices.com Poll

“Embedded Linux on PowerPC platforms”
Why? – Why Not?

+ Free & Open Source
+ Supplier independent
+ Varied HW architecture support
+ Very active developers community
+ Makes the application platform independent

- New hardware support
- Custom hardware / drivers
Examples

- Gateways, servers, wireless access points
- Audio/Video entertainment devices
- Mobile phones & IP phones
- PDA’s & Handhelds
- Robotics
Examples

Sharp Zaurus    Elphel Networked Camera
+ many other consumer electronic devices …
Linea LX PDA

• Motorola i.MX Dragonball running @ 200 Mhz
• 240x320 LCD (QVGA)
• 64Mb SDRAM
• 32Mb FLASH
Intermec CK1 – Industrial Terminal

- µClinux 2.4
- ARM 7 running @ 67 Mhz
- 1 Mb Nor Flash: Boot loader
- 8 Mb Nand Flash: OS + File System
- Linux footprint: 3.5Mb
- 16 Mb SDRAM
- 160x160 pixels LCD
Outline

• Embedded Linux
  – What is.., Why .. & Examples of Linux in embedded systems

• Motorola MPC5200
  – Introduction
  – Installing Linux

• Elphel Network Camera Demo

• MPC5200 Demo

• Plans
PowerPC Processors

• Why PPC?
  – Low power consumption
  – Low cost (MPC5200: $27)
  – Supported by the Linux kernel
  – IBM provides core
  – Motorola implements cores with additional peripherals & features
Motorola MPC5200

- PowerPC 603e
- Interfaces
- Memory controller
- DMA
- GPIO
- Timers, Interrupts
MPC5200 Lite “Icecube”
Features

• MPC5200
  – 760 MIPS performance
  – Ethernet, UART
  – USB
  – PCI
  – 64MB SDRAM
  – 16MB FLASH
  – I²C, SPI, CAN, etc.
Outline

• Embedded Linux
  – What is.., Why .. & Examples of Linux in embedded systems
• Motorola MPC5200
  – Introduction
  – Installing Linux
• Elphel Network Camera Demo
• MPC5200 Demo
• Plans
Das U-Boot

• Universal Boot Loader
• Open Source Firmware project
• Very active user group / mailinglist
• Has support for different CPU/HW types:
  – CPU: X86, PPC, ARM, MIPS, Xscale
  – Supports USB, LAN, UART, IDE, Flash chips
Denx ELDK

- Embedded Linux Development Kit
  - Kernel sources (PowerPC tree)
  - Set of user applications, libraries
  - Tested GNU Toolchain for each supported processor type
Implementation

• Replace original boot loader with U-Boot
  – Try U-Boot running from SDRAM
  – Program the loader in Flash
• Compile the Linux kernel
  – Load into memory (SDRAM) and test
  – Write to Flash
• Cross compile tools, libs and user apps
  – Test with NFS mounted partition
  – If all is ok, write a Flash partition
• Now the system is self-hosting…
Results

• Footprints
  – Linux Kernel: 0.6Mb
  – Root File System (CramFS): 3.9Mb
    • Including: webserver, sshd, busybox, tinylogin, …

• Bootup Time: ~ 5 seconds

• Demo after presentation
Outline

• Embedded Linux
  – What is.., Why .. & Examples of Linux in embedded systems
• Motorola MPC5200
  – Introduction
  – Installing Linux
• Elphel Network Camera Demo
• MPC5200 Demo
• Plans
Elphel Network Camera

- Xilinx FPGA
- Axis CPU
- 2x16Mb SDRAM
- 8 Mb FLASH
- 10/100 Ethernet
- UART
Outline

• Embedded Linux
  – What is.. , Why .. & Examples of Linux in embedded systems
• Motorola MPC5200
  – Introduction
  – Installing Linux
• Elphel Network Camera Demo
• MPC5200 Demo
• Plans

“Embedded Linux on PowerPC platforms”
Demo – Linux Installation

• Startup process explained
  – dBug Monitor
  – U-Boot
  – Linux

• Applications
  – Autofocus (over NFS)
Outline

• Embedded Linux
  – What is.., Why .. & Examples of Linux in embedded systems
• Motorola MPC5200
  – Introduction
  – Installing Linux
• Elphel Network Camera Demo
• Plans
Future Plans

• Interface a Camera via PCI on MPC5200
  – Spartan 2 w. 200k gates
  – P160 Connectors

• Develop our own intelligent camera
  – Processor board based on PowerPC or Xscale
  – Expansion boards w. interface to
    • Image sensor board for image capturing
    • FPGA board for image processing
    • DSP board for image processing
Block Diagram

~ vs Elphel Camera

- Processor
- Peripherals

Benefit: Embedded Linux on development platform.
Block Diagram

~ vs Elphel Camera

- Xilinx FPGA
- 16Mb SDRAM
- Link to sensor

Benefit: Flexible interfacing with different sensor chips.
Elphel camera does not allow extra image processing boards.

A dedicated processing board will boost performance & enable new application domains.

Benefit: Performant image processing. Implementations of complex algorithms possible.
The End

• Questions ?
• Suggestions ?
• Remarks ?

• Website: http://emsys.denayer.wenk.be
  – Gerrit Van de Velde: Gvd@denayer.wenk.be
  – Björn Van de Vondel: Bvd@denayer.wenk.be
  – Patrick Pelgrims: Ppe@denayer.wenk.be