Linux/M32R - An M32R GNU/Linux Software Platform

Hirokazu Takata
Renesas Technology Corp., System Core Technology Div.
takata.hirokazu@renesas.com
Renesas = Hitachi + Mitsubishi

- **Renesas** Technology Corporation
  - Renaissance Semiconductor
    - for Advanced Solutions
  - New joint company established by *Hitachi* and *Mitsubishi* (April 2003)
  - World’s Largest Microcontroller Company
    - 32-bit RISC Microcomputer
      - SuperH Family … for processor application
      - M32R Family … for controller application

http://www.renesas.com/
Introduction

- Progress of system LSI technology ⇒ **System-on-a-Chip (SoC)**
- Embedded systems will be connected each other.
- It is required to develop software efficiently on a **de facto** standard environment (Linux etc.).

**Objects**
- Establish **GNU/Linux** environment for the M32R

Ubiquitous Network

- Sensor system
- Terminal system
- Control system
- Server system
M32R Linux Platform

• **M32R microprocessor**
  - 32-bit RISC microprocessor for embedded systems (Renesas original architecture)

• **Linux/M32R Project (2000〜)**
  - GNU/Linux Environment for M32R
  - Development of **Linux/M32R** (A new architecture port to the M32R)
    - Development of target hardware environment:
      - New M32R cores (with MMU) and evaluation boards
    - Porting Linux kernel
    - Development of GNU toolchains (GCC, Binutils)
    - Porting GNU C libraries
    - Preparation of self tools and root filesystem
Development of Linux/M32R

- Port the Linux kernel
- Enhance GNU tools (GCC, Binutils)
  - m32r-linux toolchain
  - Dynamic linking support for shared libraries
- Port GNU libraries (glibc, etc.)
- Build software packages
- Prepare debug environment
M32R Softmacro Core

- Softmacro Core
  (Full Synthesizable Core)
  - Not dependent on process technologies
  - Can be mapped to an FPGA
    → Easy revise and update

- M32R-II Core
  - Upward-compatible ISA
  - 5-stage pipeline, dual-issue
  - out-of-order completion
  - MMU support
  - Compact size
Porting of the Linux Kernel

• Architecture dependent portions
  – include/asm-m32r/, arch/m32r/

• M32R specific implementations
  – Asm function routines
  – System call interface
  – Memory management routines
    • Based on the M32R’s MMU/Cache specification
    • Split MMU exception handlers to lighten the TLB miss operation.
Development of GNU Toolchain

• Enhancement of GNU tools (GCC, Binutils)
  – **GCC** (gcc-2.95 $\rightarrow$ gcc-3.2.3), **Binutils** (v2.13)
  – Support ELF’s dynamic linking function
    • PIC generation, shared library support
    • Enhancement of BFD library
  – Not change the M32R’s ABI of C-language
    ※ ABI (Application Binary Interface)

• Cross tools
  – **m32r-linux** toolchain

• Development of self tools
  – gcc, binutils, bash, sed, awk, perl, tcl
Building Software Packages

- Employ the **Debian GNU/Linux** as a base distribution
  - Sophisticated Package Management (efficient for developing)
  - With cross development support
    - dpkg-cross
    - dpkg-buildpackage –a m32r –t m32r-linux

- Building Software Packages
  - .deb packages for M32R: bash, libc6, perl, etc. … more than 300 packages
  - Utilize both self and cross development environment
    - Header/library path is different from native environment.
    - Cannot configure/make correctly
      (Perl, X server/clients, etc.)
# Linux/M32R Current Status

<table>
<thead>
<tr>
<th>Platform</th>
<th>Mappi</th>
<th>Mappi-II (M3A-ZA36)</th>
<th>μ T-Engine (M3T-M32700UT)</th>
<th>Mitsubishi μ Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Drivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial IO</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Network (Ethernet)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td>(10BASE-T)</td>
<td>(100BASE-TX)</td>
<td>(100BASE-TX)</td>
<td>(Wireless LAN, Wired LAN)</td>
</tr>
<tr>
<td>CF</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Display</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>–</td>
</tr>
<tr>
<td>Frame Buffer</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>(CRT/LCD)</td>
<td>(CRT)</td>
<td>(LCD)</td>
<td></td>
</tr>
<tr>
<td>X server</td>
<td>○</td>
<td>△</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>USB</td>
<td>–</td>
<td>○</td>
<td>○</td>
<td>–</td>
</tr>
<tr>
<td>AR</td>
<td>△</td>
<td>–</td>
<td>○</td>
<td>–</td>
</tr>
<tr>
<td>MTD</td>
<td>△</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>


Linux/M32R Current Status

• GUI Environment
  – Window Systems
    • X
    • Qt-Embedded
    • MicroWindows

Snapshot of the X desktop image
Summary

• Linux/M32R
  – The GNU/Linux environment for the M32R architecture
  – Linux system (UP / MP version) operates on both the M32R softmacro cores mapped on FPGAs, and an M32R single-chip multiprocessor evaluation chip.
    • Hardware/software co-design approach is employed

• Linux for embedded systems
  – The Open Source will provide a large impact on developing and designing of embedded systems.
  – Linux will play a great role in the field of embedded systems.
M32R Evaluation Chip

• M32R On-Chip Multiprocessor  (Ref.: Proc. of ISSCC 2003, 14.5)
Evaluation Board “Mappi-II”

- FPGA: XCV2000E (2M system gates)
- Serial: × 1
- LAN: × 1 (100BaseTx)
- USB: × 2
- PC104 Bus
- Compact Flash: × 1
- JTAG Emulator

On Board Memory
- SDRAM: 64MB
- Flash ROM: 4MB

Board Details:
- M3A-ZA36
- SD Card: 64MB
- Flash ROM: 4MB

Renesas
Everywhere you imagine.
Extension Boards for “Mappi-II”

Main Board

M3A-ZA36
XCV2000E
(2M system gates)

Extension FPGA Board

M3A-ZA36G01
XC2V4000
(4M system gates)

M3A-ZA36G02
XC2V1000
(1M system gates)
Micro Server Module

"CF Card Size" CPU Module

- Features
  - CPU: M32R (Dual CPU)
  - OS: Linux
  - MW: WebServer (Boa)
  - SDRAM: 32MB
  - Flash: 8MB
  - I/F Con.: System, Debug, Power Supply

- System Components
  - I/O: Compact Flash Card (*)
  - System Board, Power Supply

(*) LAN, PHS, MicroDrive, etc.
Lightweight wireless network

M32R (Evaluation Chip)