RENESAS
Everywhere you imagine.

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)

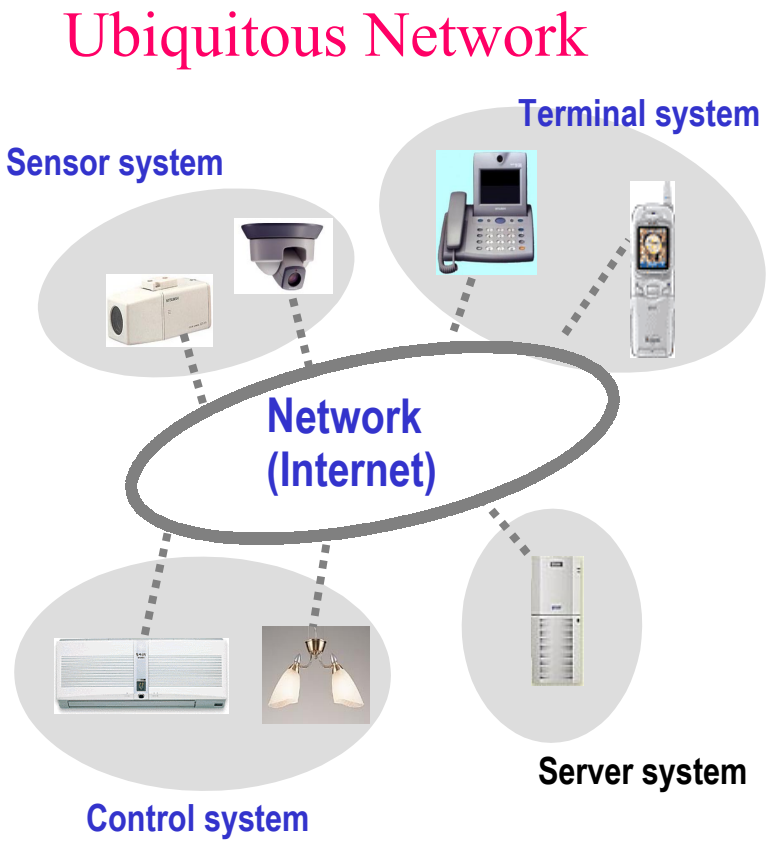
  – World's Largest Microcontroller Company

    - 32-bit RISC Microcomputer
      – SuperH Family … for processor application
      – M32R Family … for controller application

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



RENESAS
Everywhere you imagine.

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
      :

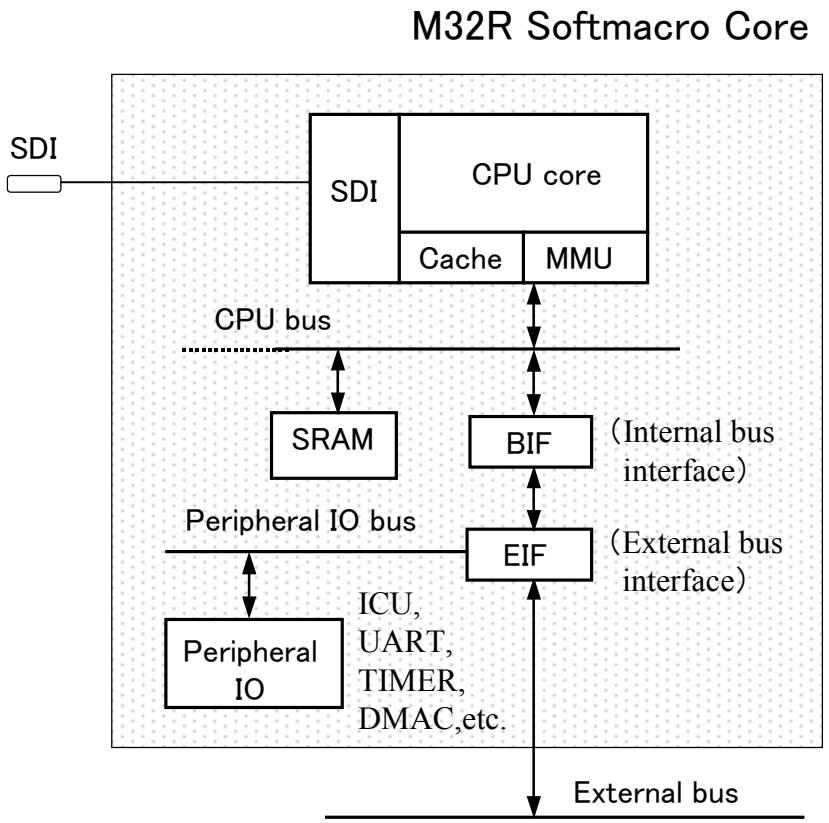
Development of Linux/M32R

- 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



RENESAS
Everywhere you imagine.

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

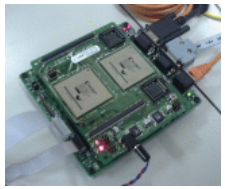
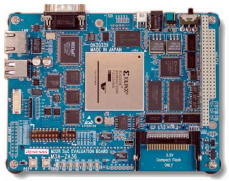
- Enhancement of GNU tools (GCC, Binutils)
  - **GCC** (gcc-2.95 → gcc-3.2.3), **Binutils** (v2.13)
  - Support ELF's dynamic linking function
    - PIC generation, shared library support
    - Enhancement of BFD library
  - Not change the M32R's ABI of C-language

    ※ 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

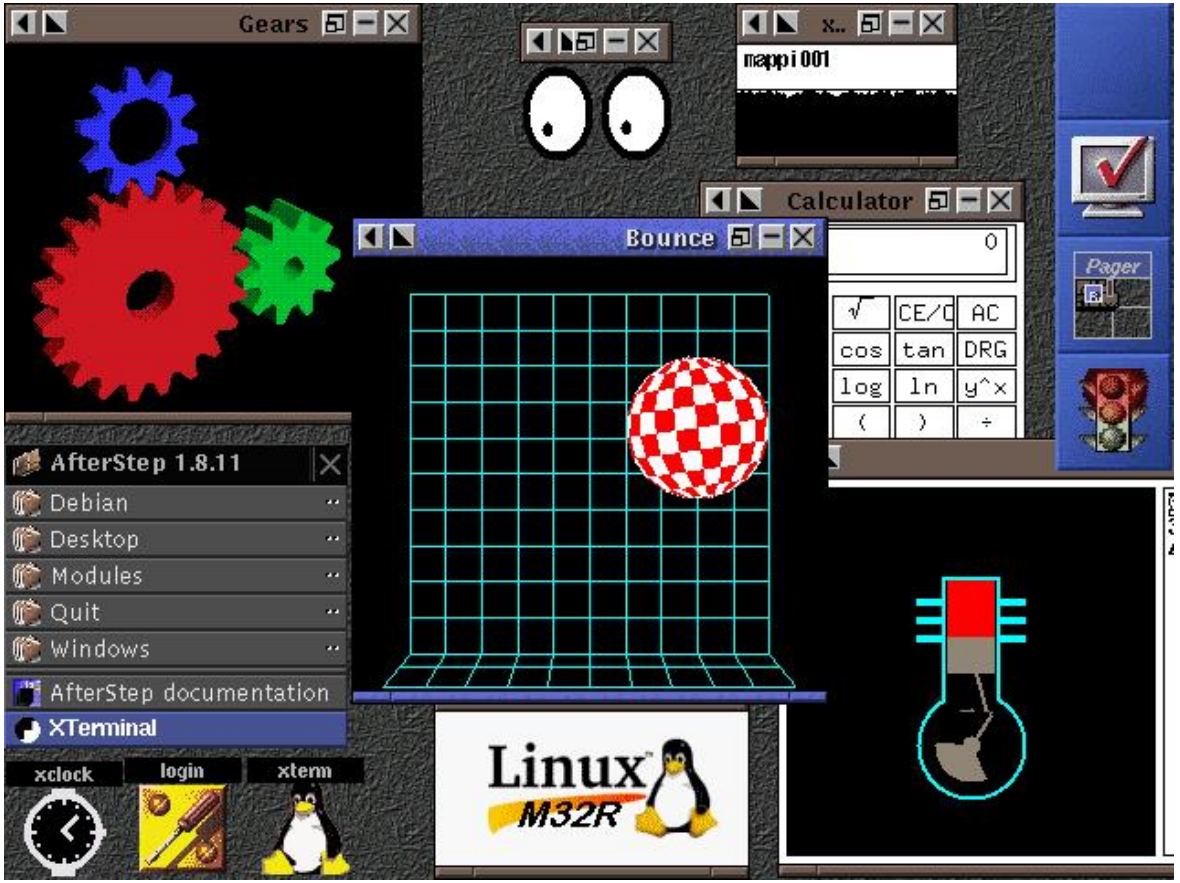
Platform / Device Drivers		Mappi	Mappi-II (M3A-ZA36)	μ T-Engine (M3T-M32700UT)	Mitsubishi μ Server
					
Serial IO		○	○	○	○
Network (Ethernet)		○ (10BASE-T)	○ (100BASE-TX)	○ (100BASE-TX)	○ (Wireless LAN, Wired LAN)
CF		○	○	○	
Display	Frame Buffer	○ (CRT/LCD)	○ (CRT)	○ (LCD)	–
	X server	○	△		–
USB		–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

μ T-Engine: http://www.renesas.com/jpn/products/mpumcu/tools/tengine/tem32r.html
μ Server: http://www.mitsubishielectric.co.jp/news-data/2003/pdf/1008.pdf

Linux/M32R Current Status

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

Snapshot of the X desktop image ⇒



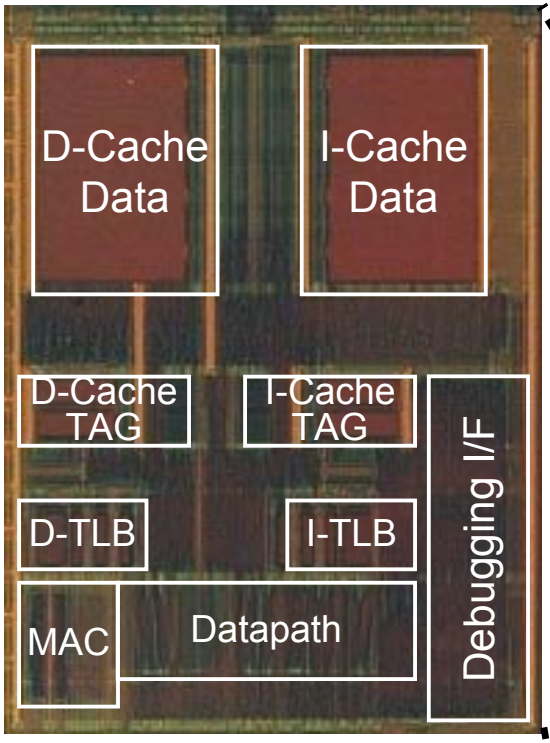
RENESAS
Everywhere you imagine.

Summary

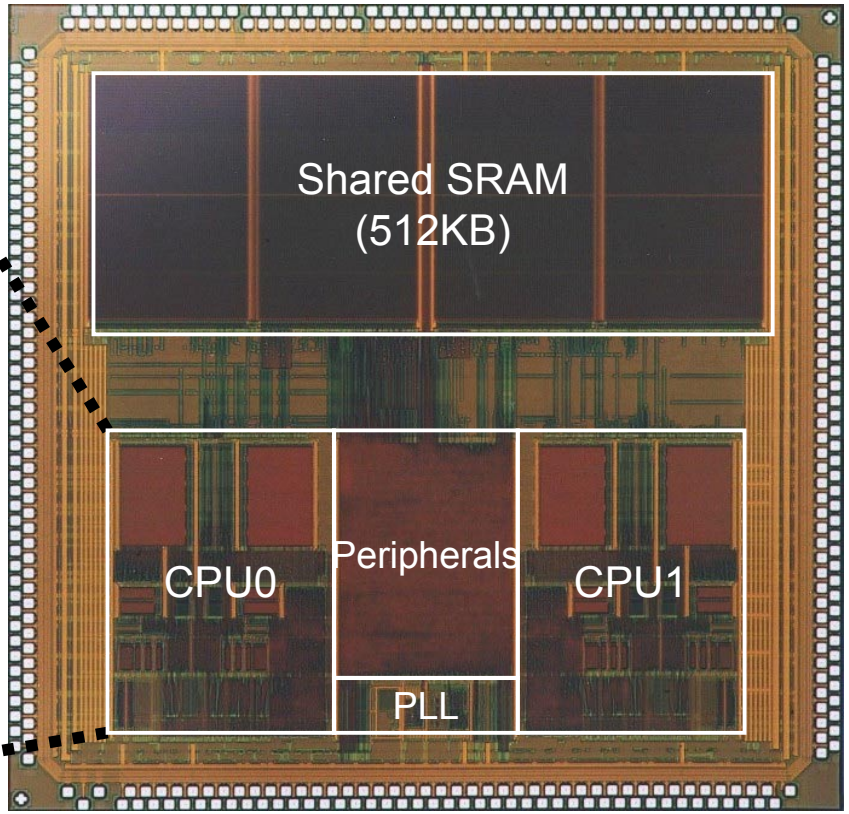
- Linux/M32R
  - The GNU/Linux environment for the M32R architecture
  - Linux system (UP / MP version) operates on both the **M32R softmacro** cores mapped on FPGAs, and an **M32R single-chip multiprocessor** evaluation chip.
    - Hardware/software co-design approach is employed
- Linux for embedded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



M32R CPU Core



Chip Photomicrograph

RENESAS
Everywhere you imagine.

Evaluation Board “Mappi-II”

FPGA
XCV2000E
(2M system gates)

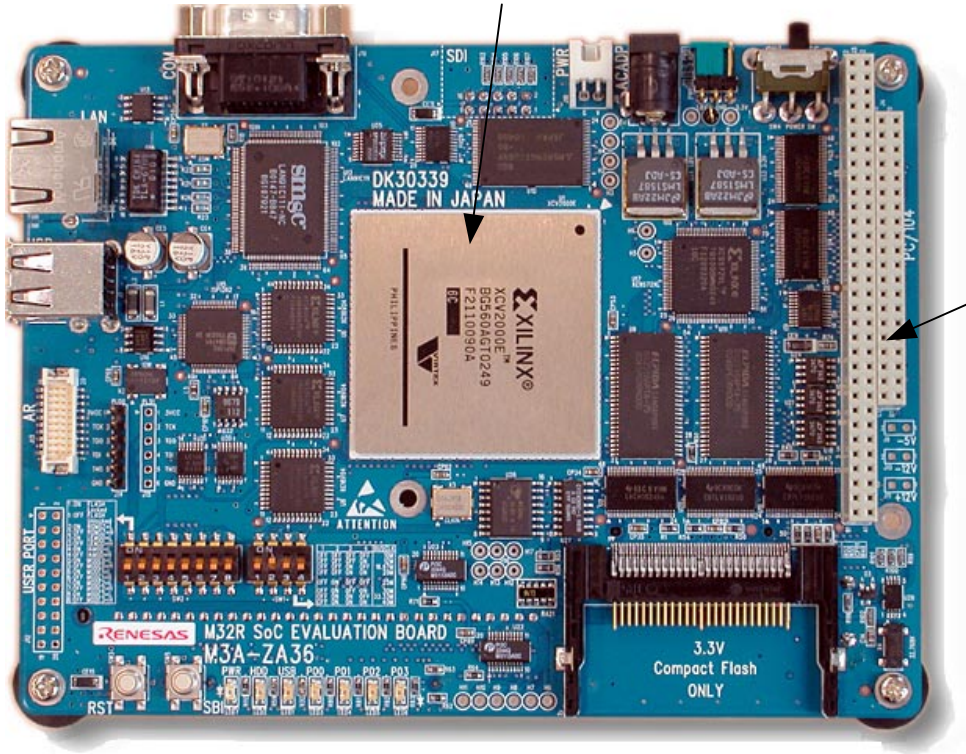
Serial × 1

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

LAN × 1
(100BaseTx)

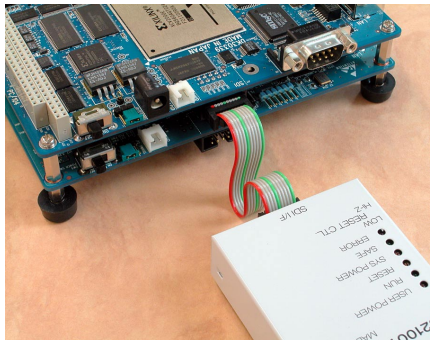
USB × 2

PC104 Bus



M3A-ZA36

Compact Flash
× 1



JTAG Emulator

RENESAS
Everywhere you imagine.

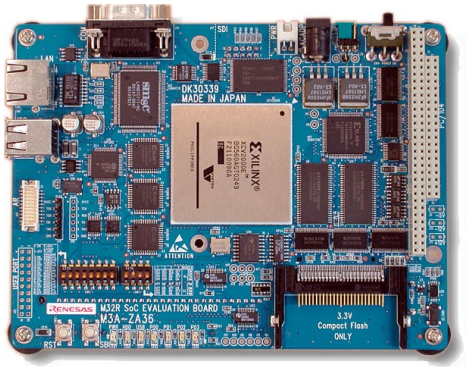
Extension Boards for “Mappi-II”

Main Board

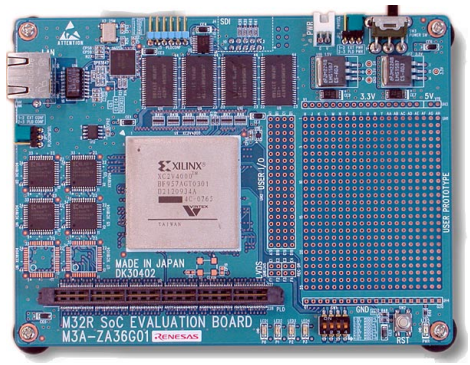
M3A-ZA36

XCV2000E

(2M system gates)



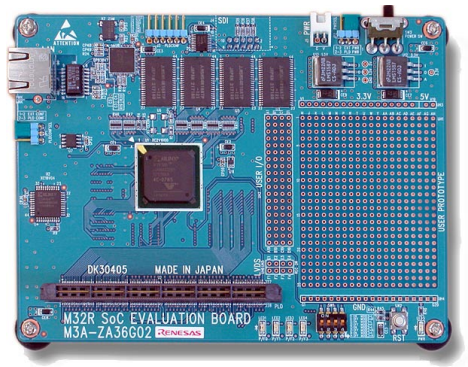
Extension FPGA Board



M3A-ZA36G01

XC2V4000

(4M system gates)



M3A-ZA36G02

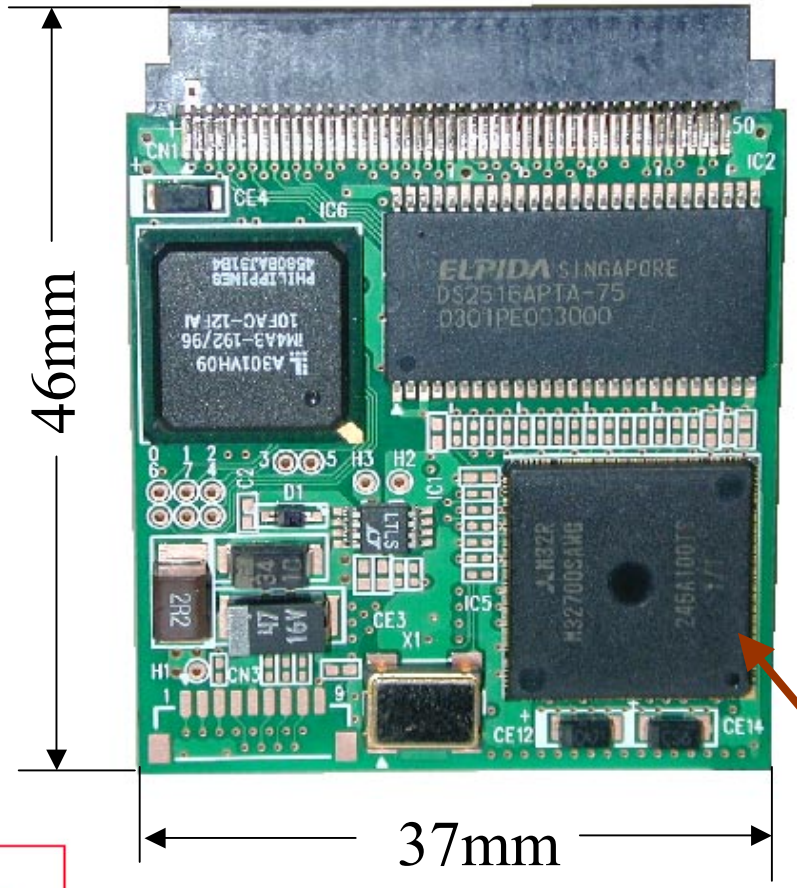
XC2V1000

(1M system gates)

RENESAS
Everywhere you imagine.

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)