

# The Application of Embedded System based on ColdFire in BEPC-II

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## Abstract

The embedded system based on Coldfire and uClinux/uCOS-II will be used in more and more control system. This article introduce the architecture of this embedded system and its application in BEPC-II.

**Keywords:** BEPC-II, Embedded System, ColdFire, TCPIP, uCOS-II, uClinux

Due to the demand of higher and higher performance of the control module, more and more embedded systems have been used in the control systems. The system module we designed using uClinux/uCOS-II (software) and ColdFire 32-bit CPU (hardware) has superior performance, and can be used in the newest control systems as the central modules.

## Background

Motorola's M68K series micro-controllers have good fame in the area of industrial controlling. ColdFire series micro-controllers are the natural continuity of M68K series. They are also RISC (Reduced Instruction Set Computer) micro-controllers and have similar structures and instruction systems with traditional M68K series. What makes ColdFire different are the more advanced manufacturing techniques and more modules suit for application in industrial controlling. Using ColdFire series micro-controller as the central processor is really a good choice for high-performance control systems.

Embedded system software normally runs on an embedded microprocessor like ColdFire,

For the hardware composition of the data acquisition module based on ColdFire micro-controller, please refer to Fig 1. The system includes:

- ❖❖ Motorola ColdFire 5307 32-bit micro-controller, with 45MHz exterior Bus frequency and 90MHz interior Bus frequency; can reach 75MIPS.
- ❖❖ 16Mbytes 32-bit SDRAM, composed of two 8Mbytes 16-bit SDRAM, running on the 45MHz exterior frequency of ColdFire 5307.
- ❖❖ 2Mbytes 16-bit Flash ROM, can be inline updated.
- ❖❖ 10Mbps Ethernet Interface, using RTL8019AS of the RealTek as the network interface chip. Connect to the Ethernet with 10Mbps (10BaseT).
- ❖❖ VME Bus Interface. Using

PowerPC or ARM. The embedded system (including software and hardware) have relatively complete network communication protocol stack (e.g. TCP/IP), complete file system and complete drivers lib like large operating systems (e.g. RedHat Linux, Free BSD, etc.). At the same time it do not need large memory systems and low cost. It also has higher reliability. Due to these advantages, there have been a trend that embedded systems replacing traditional controlling.

BEPC- II system put forwarded higher demand in the data acquisition module. The system need a control module with 10Mbps or 100Mbps Ethernet communication interface to control the front-end detector, and get data of the front-end detector (standard VME plug-in) through the front-end VME Bus, then upload the data to the data storage and processing module. Using commercial real time operating systems (such as VxWorks, etc.) costs much, and it is also complete in supports and usages. In the data acquisition module of BEPC-II, we plan to use uClinux + ColdFire. UClinux is a mature operation system, and is the first choice for 68K/ColdFire series micro-controllers. It has complete and reliable TCP/IP protocol stack and file system, well suited for embedded systems based on ColdFire series micro-controllers without MMU.

## Hardware description

The functional diagram of the data acquisition module based on ColdFire micro-controller is shown in Fig 2:

- ❖❖ Virtex-E100 of Xilinx to achieve part of the VME Bus Interface function. Can be used to get data from other devices connected to the VME Bus.
- ❖❖ UART Interface. The terminal interface to display debugging information.
- ❖❖ Debug Interface. Used to debugging ColdFire. Standard 26 pin BDM interface.

## Software description

On this hardware platform runs the uClinux. The core edition is 2.0.1. The software mainly deals with the data read from the VME Bus, and then upload the data into the network storage devices via Ethernet interface. The data is then ready to be analyzed by other tools. The software also checks and calibrates the front-end detectors when the system power-on.

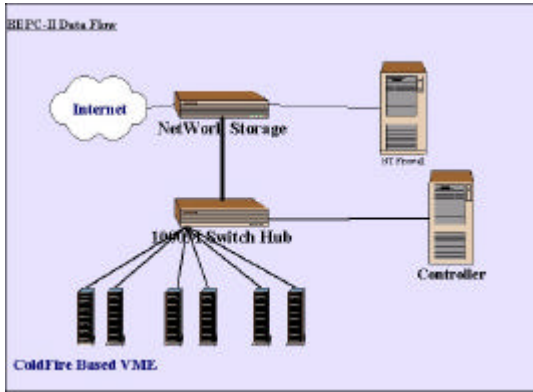


Figure 1

**Subnet controller module**

The subnet controller module, which makes a node on the network, has been developed in our lab. The module has another name of lean

containers and an image system.

- ✍ In BEPC-II, the module would be useful in some sub system control systems such as power supply, vacuum system or beam monitor systems.
- ✍ For Beijing Electron Spectrum, the modules could hopefully to replace some parts of the VME based DAQ systems, at least it would be useful in slow control.
- ✍ The module will be used in the alpha and beta ray detector for the environment monitor.

**Future Improvement**

Further improvement will be the upgrade of the Ethernet interface from 10Mbps to 100Mbps, and the usage of higher-speed ColdFire5407 (pin compatible with ColdFire5307) to replace ColdFire5307. The higher operating speed and the better performance are expected.

And a PCMCIA based wireless LAN

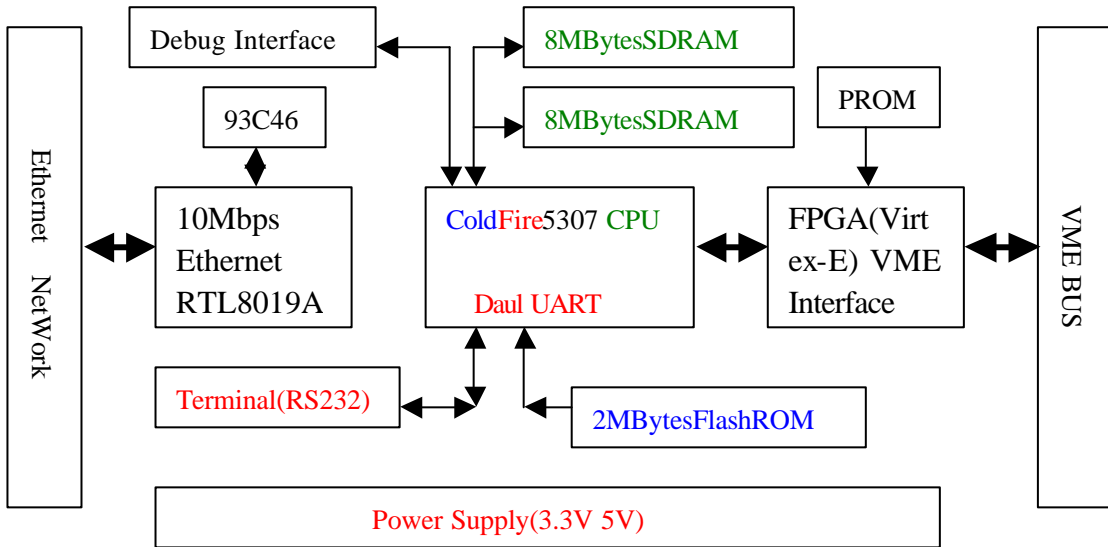


Figure 2: System Hardware Architecture

server. The hardware cost of the lean server is less than 10 dollars. The 8 bits MCU 68HC908GP32 has 32K Flash and 512 bytes RAM.

The 13 pins within the total of 31 I/O pins are used to interface the Ethernet controller RTL8019. The left 18 I/O pins has a RS-232 port and some A/D channels, which are good enough to control a little device such as a pump, a vacuum valve and so on. The TC/PIP stack has been developed, which has the code size around 7K bytes. (Fig. 4 shows the module and its size is as small as half floppy.)

**Application**

- ✍ The module has been already used in the DAQ system for the saner of large

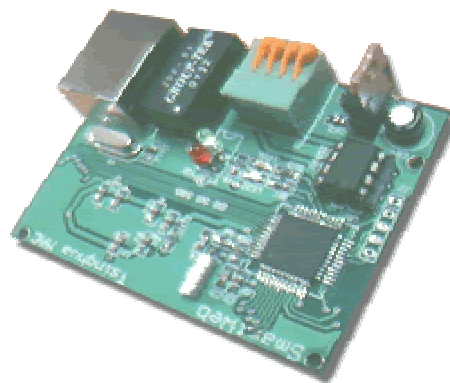


Figure 3: Subnet controller module

card(802.11b based) will added for wireless control.

## Acknowledgement

We would like to thank Dr. M. Clauson in DESY. In 1998, he gave us an Euro-card ColdFire 5206 module, which was designed in DESY and manufactured in Russian. Although we can't use the module, because we do not have the Vxwork,. For using of the Vxwork, in the module, DASY has paid already the 15DM of the royalty. It was that module brought us the interest to the ColdFire.

Thanks also to Mr. Wang yunfei, who helped us to setup the cross gcc in Linux. With the nice freeware, we do not need to pay royalty. We'd



Figure 4: ColdFire Module

like to thank Mr. J.J. Labrosse. His Real Time kernel  $\mu\text{C}/\text{OS}$  and  $\mu\text{C}/\text{OS-II}$  is nice a teaching material not only for us but also for our University students.

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