HW/SW Codesign Project
Linux on the Xilinx Virtex2 Pro Board

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27 April 2007

Overview

The team researched and documented a process for building and using embedded Linux on the Xilinx XV2UP development boards. The team promised to deliver: Documentation of the best build process found, source code from the team's build environment, and a working build on a CF card. This report will explain the motivation for the project, the progress made, and finally our best build process and tutorial.

Project Motivation

There are many advantages to having Linux running on an embedded system. Linux provides a broad code base, important drivers, and access to a wide variety of useful utilities. By using the Xilinx Virtex-2 Pro FPGA it is also possible to create custom hardware implementations on the FPGA and then write drivers that allow Linux to use this hardware in programs that the user develops. This is an incredibly valuable tool for project prototyping, whether for a clinic project or other project development, perhaps such as the GPS system studied in E168b.

Build Process

The team has thoroughly verified the build process up to the compilation of a booting Linux kernel. We ran into many difficulties along the way, as each tutorial we followed had a some pieces that worked, but each with one or two things that introduced critical errors into our build process. We began working with the BYU tutorial and managed to build a kernel, but could not get it to boot. Next we used the instructions from the EMPART team, but during compilation we ran into driver errors. Finally, we found documentation of the process written by a student from RIT. This documentation is far more detailed than the others and it became clear that the issues we ran into on the other tutorials likely arose from mismatching drivers and IP cores. We're using MontaVista Linux because it contains a good deal of driver support for Xilinx boards, but these drivers are not complete; a few of them must be built from sources provided by Xilinx. We have both the IP core for the FPGA and the driver for that hardware for Linux for only a few configurations. However, through trial and error, we've managed to build one booting kernel with a working file system.

Tutorial and other Documentation

While working through existing documentation found online, the team has compiled a revised and detailed tutorial for a port of MontaVista Linux to the XUP V2P environment. This documentation is included in the total documentation package, under the title of "Best Known Build Process". This documentation includes guidance for compilation of the PowerPC cross compiler, the process of creating the necessary drivers and architecture files for a basic implementation of the kernel using the Xilinx EDK, a minimalist kernel build, and implementation of a booting system with a root file system on a 1 GB Compact Flash drive.

In addition to the best known build process, the team has also provided additional documentation outlining some problems encountered and their solutions, as well as contact information for the team members and references to our sources.

Sources and CF Disk Installation

To ensure that we had useful sources at the end of our project, we began by setting up a subversion repository to hold all the code that the team will be modifying along the way. The subversion repository has tagged versions of the code at various milestones as well as the work being done in the main trunk. Versioned sources include: the edk project folder, the kernel sources, the root file system and the various scripts and config files for the tools used. These sources have been provided so that any team wishing to quickly replicate our results can download them and, after installing the necessary build tools, compile a working kernel.

In addition to the build sources, the team has also created a working example Linux installation on a CF card. The flash card is partitioned into three parts: one partition holds the ACE file (which contains the kernel and FPGA configuration), the second is a swap partition and the third holds the root file system. The flash card currently contains a bootable system with a minimal file system.

Possible Future Improvements

Though the team was able to fulfill our primary project goals we were unable to make progress with the secondary goals the team outlined at the beginning of the project. Additionally, while working on the project the team found other interesting potential development areas. These areas could be further developed by a clinic team, future classes, or potentially as an independent study. Some of these potential improvements are:

- Further implementation of the Linux software, especially gcc, so that sources could be natively compiled.
- Additional progress with available drivers for the XUPV2P Development Board. The team only tested a few different drivers, such as those for GPIO, RS232, and external RAM. The development board contains many more modules, such as Ethernet, Audio processors and others.
- Development of a tutorial for custom driver implementation. One of the most powerful aspects of the FPGA with an embedded processor is the ability to instantiate custom hardware in the FPGA and access it from the PowerPC core. Thorough documentation on how to develop custom drivers to do such a thing would prove invaluable.
- Implementation of a general Linux kernel/upgrade to v2.6 of the Linux kernel. MontaVista has only the 2.4 version of their kernel freely available, and porting to the general Linux kernel would free us from dependency on the MontaVista distro, as well as potentially make many more drivers available for use.