



XinuPi: Porting a Lightweight Educational Operating System to the Raspberry Pi



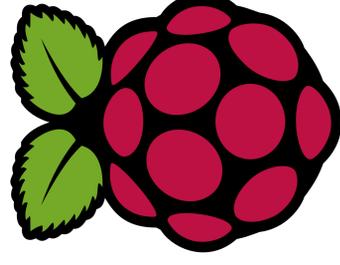
Eric Biggers and Dr. Dennis Brylow (mentor)

Motivation

Operating systems education suffers from a lack of easily accessible platforms and the high complexity of modern operating systems such as Linux. As a result, courses often use textbooks or simulations rather than real operating systems and hardware; this is not as helpful to students.

Raspberry Pi

The Raspberry Pi is a tiny, \$35 computer designed for educational use. The latest version has 512MB of RAM, an ARM CPU, a GPU, HDMI output, 2 USB ports, an Ethernet port, and SD card interface. It normally runs GNU/Linux. To use, users must insert an SD card, apply power, and connect other devices such as a keyboard and monitor.



Future and Other Work

Farzeen and Tyler's posters describe other aspects of the XinuPi port. We also had to implement low-level functionality such as interrupt handling, context switching, and a UART driver.

We plan to fully document XinuPi on the Embedded Xinu wiki (<http://xinu.ms.cs.mu.edu>), including previously undocumented hardware, our code, and instructions for a lab setup.

(Embedded Xinu) (arm-rpi) #9 (ebiggers@argo.lis.ms.cs.mu.edu) Tue Jul 23 11:04:38 CDT 2013

13421728 bytes physical memory.
32768 bytes reserved system area.
3776384 bytes Xinu code.
65536 bytes stack space.
130343040 bytes heap space.



v3.14

Welcome to the wonderful world of Xinu!
xshs

USB Support

Like many modern PCs, the Raspberry Pi relies heavily on USB in order to attach devices such as keyboards and mice. In addition, the Ethernet adapter on the Model B is internally attached to the USB. Although USB is very complicated, we have implemented a relatively simple USB subsystem for Embedded Xinu.

USB Host Controller

The primary challenge of supporting USB on the Raspberry Pi is driving the nonstandard, undocumented Synopsys USB Controller. However, we have implemented a working driver for this hardware that is ~20 times shorter than the corresponding Linux driver. The code is still over 1500 lines, but only 3 functions are exported to the USB core:

- hcd_start()
- hcd_submit_xfer_request()
- hcd_stop()

Embedded Xinu

Embedded Xinu is a re-implementation of the classic "Xinu" design for modern RISC architectures. It is a *simple* UNIX-like operating system designed for educational use. Embedded Xinu contains several orders of magnitude fewer lines of code than Linux-based software stacks, which have millions of lines of code.

Ethernet support

The Raspberry Pi model B has an integrated USB Ethernet Adapter (SMSC LAN9512), which, although not documented, we wrote a driver for. As a result, networking is now supported on XinuPi and it can be used for networking courses. Alternatively, XinuPi can be set up as a back-end network bootloader that loads experimental student kernels in the same way as in the current Embedded Xinu lab (which uses Linksys wireless routers).

USB Ethernet Adapters

USB Ethernet adapters like the SMSC LAN9512 work by sending and receiving packets over the USB bus via USB bulk transfers.

