NetFPGA: An Open Platform for Building Extensible Networks with Reconfigurable Hardware

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http://NetFPGA.org

NetFPGA Enables

• **Emulation** of Networking systems
  – Results obtained at Gigabit Speeds

• **Experiments** with multiple systems
  – Measurements performed with live traffic

Diagram by: Larry Peterson (Princeton University)
Motivation to Teach Network Hardware

- Research and Education
  - Students Today
    - Build network systems mostly with software
  - Students Tomorrow
    - Can quickly learn to also build system components in hardware

- Interesting Topics for Networking Hardware
  - Switching and Routing
    - Gigabit-rate networking
  - Network Security
    - Intrusion Detection and Prevention Systems (IDS, IPS)
  - New Protocols
    - Wire-speed Content Routing and Clean-slate designs

Internet Routing & Switching

Clusters of PCs and Workstations accessing servers and running Peer-to-Peer applications
NetFPGA Platform

- **Function:**
  - 4 Gigabit Ethernet ports

- **Fully programmable**
  - FPGA hardware

- **Low cost**
  - Widely deployable platform

- **Open-source FPGA hardware**
  - Routing hardware base in Verilog

- **Embedded Software**
  - Host PC, Embedded PowerPC, and/or softcore LEON or Microblaze
  - Drivers in C and C++

NetFPGA Block Diagram
Details of the NetFPGA (ver 2.1)

- Fits into Standard PCI Host Interface
- Provides 4 Gigabit Ethernet Interfaces
- Enables hardware-accelerated processing of content using Field Programmable Gate Array (FPGA) logic & attached memory
  - Virtex-2 Pro FPGA
  - 4MB ZBT SRAM
  - 64MB DDR2 DRAM

NetFPGA Reference Routing System

- **NetFPGA**
  - Quad Gigabit Ethernet Ports

- **Gigabit Host Ports**
  - Dual Gigabit Ethernets

- **Processor**
  - Dual-Core Athlon-64

- **Operating System**
  - Linux CentOS 4.4
    (or Fedora Core, RedHat ..)
Internet2 Machines - Tested fine with the NetFPGA

Dell 2950
with PCI-X and PCI-Express Slots

NetFPGA properly recognized in PCI-X slot

Hardware and Software View
### Topology of NetFPGA Routers

- **Video Server**
- **HD Display**

### Streaming Video through the NetFPGA

**Video server**
- NetFPGA Router
- Apache Web server

**Video client**
- Windows Media Player
- Linux `mplayer`

**Video traffic**
- MPEG2 HDTV (35 Mbps)
- MPEG2 TV (9 Mbps)
- DVI (3 Mbps)
- WMF (1.7 Mbps)
NetFPGA Lab Setup

![Diagram showing NetFPGA Lab Setup](image)

Explore Router Architecture with GUI

**GUI Configuration**
- Router Quickstart configuration

**Reference details**
- simple
- modular
- pipeline
Networking Hardware Education

• **CS344 Course @ Stanford**
  – Build an Internet router in 8 weeks
  – Hardware forwards packets
  – Software implements pw-OSPF

• **CSE565, CSE566 Courses @ WU**
  – Accelerate Networking algorithms in hardware
    • TCP/IP Flow processing
  – Build a Reconfigurable Networking System-on-Chip
    • Intrusion Detection and Prevention Systems

• **Tutorials and Workshops**
  – SIGMETRICS : June 12, 2007 in San Diego, CA
  – Hot Interconnects : August 24, 2007 at Stanford, CA

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**cs344: Build an Internet Router in 8 weeks**

• **Stanford class offered Spring ‘03, ‘05, ‘07**
  – Laboratory utilizes NetFPGA hardware

• **Organized as student teams working on projects**
  – One hardware developer + one-two software developers

• **Results**
  – Students start with baseline
    • Two port learning Ethernet switch
    • pw-OSPF software
  – Students build
    • Four-port Gigabit-speed Internet Router
    • Hardware performs MAC address learning & IP forwarding
    • Software performs OSPF distributed routing
Project Homepage: http://NetFPGA.org

NetFPGA Overview

Open Platform

The NetFPGA platform enables researchers and instructors to build working prototypes of high-level software routers and networking systems. The platform provides a low-cost means to test and validate networking software in a realistic environment. The platform is based on an Altera Stratix EP1S200 device, which is built into a low-cost host with an Ethernet interface. The platform includes the essential IP and Ethernet (IEEE 802.3) subnetwork hardware, as well as the software required to connect a Linux computer to the network.

NetFPGA Interest Survey

There are numerous benefits of using NetFPGA hardware. These benefits include the following:

- You can experiment with different networking protocols and protocols on your own computer.
- You can test your own networking code in a real-world environment.
- You can learn about networking hardware and software.
- You can share your results with others.

If you are interested in NetFPGA hardware, please complete the interest survey below. The survey will help us determine the number of boards that should be available for your lab.

Informations collected from this form will be used to determine the number of boards that should be available for your lab. The survey is voluntary and the information provided will be kept confidential. Please complete the survey below.

- Name:
- Email:
- Organization:
- Address:
- City:
- State:
- Zip Code:
- Phone:
- Additional comments:

NetFPGA Interest Survey Form

NetFPGA is a project at Stanford University.
Upcoming NetFPGA Tutorials

• **SIGMetrics**:
  – Half-day Tutorial
  – June 12, 2007
  – San Diego, California
  [http://www.cs.cmu.edu/~sigm07/workshops.html#TUTORIAL_2](http://www.cs.cmu.edu/~sigm07/workshops.html#TUTORIAL_2)

• **Hot Interconnects**:
  – Full-day Tutorial
  – August 24, 2007
  – Stanford, California
  [http://www.hoti.org](http://www.hoti.org)

• **NetFPGA Homepage**
  [http://NetFPGA.org](http://NetFPGA.org)