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

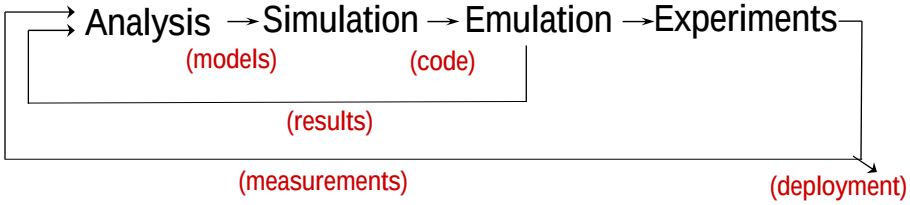
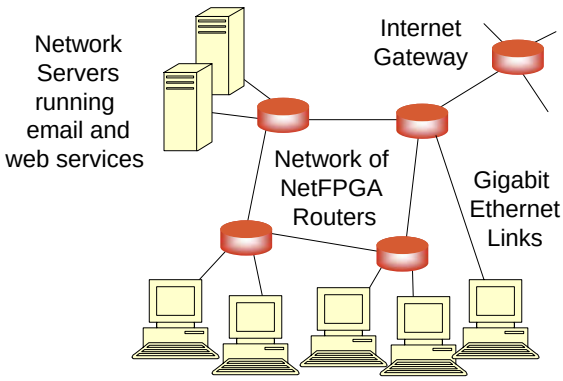


Diagram by: Larry Peterson (Princeton University)

Motivation to Teach Network Hardware

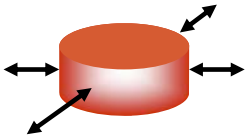
- **Research and Education**
  - Students Today
    - Build network systems mostly with software
  - Students Tomorrow
    - Can quickly learn to also build system components in hardware
- **Interesting Topics for Networking Hardware**
  - Switching and Routing
    - Gigabit-rate networking
  - Network Security
    - Intrusion Detection and Prevention Systems (IDS, IPS)
  - New Protocols
    - Wire-speed Content Routing and Clean-slate designs


Intrenet Routing & Switching



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

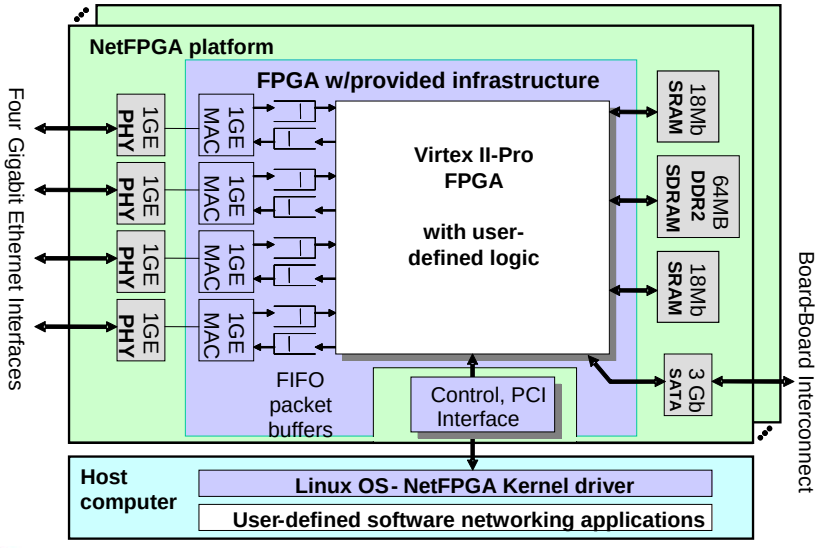

NetFPGA Platform



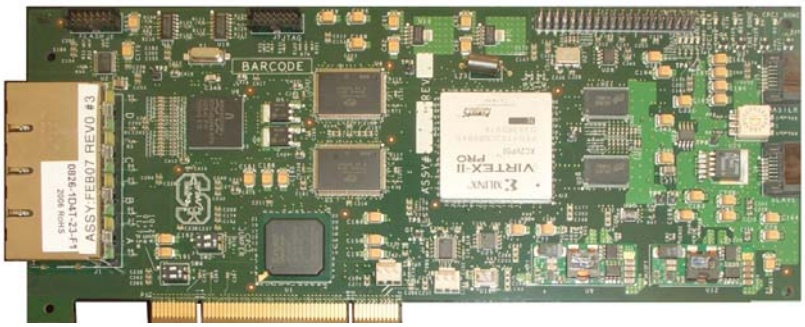
- **Function :**
  - 4 Gigabit Ethernet ports
- **Fully programmable**
  - FPGA hardware
- **Low cost**
  - Widely deployable platform

- **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 Fedore Core, RedHat ..)

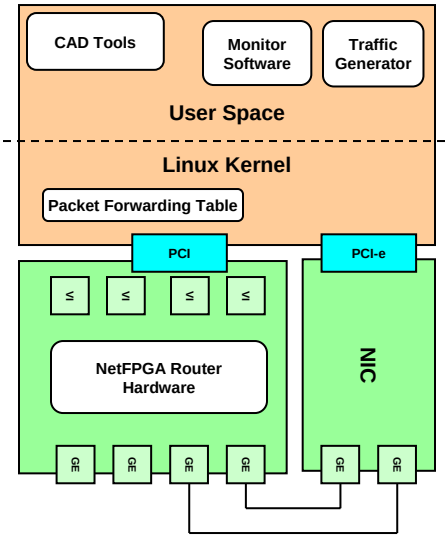
Internet2 Machines - Tested fine with the NetFPGA

NetFPGA properly
recognized in PCI-X slot

Dell 2950
with PCI-X and PCI-Express Slots

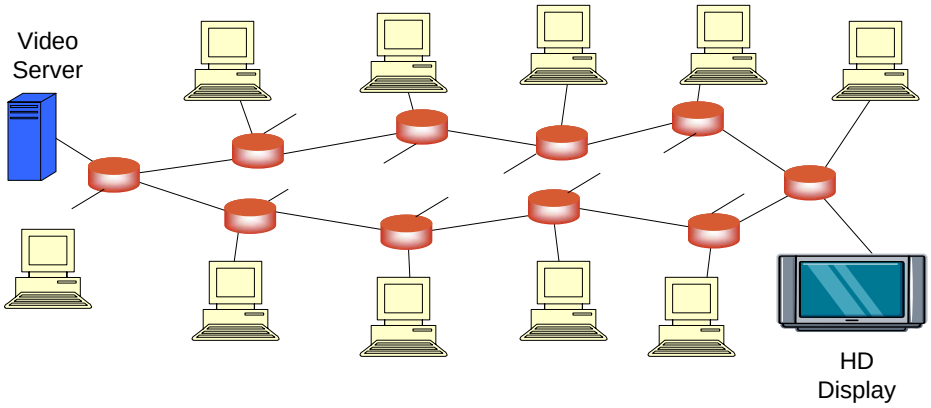
Thanks: Brian Cashman for providing machine

Hardware and Software View



Demo

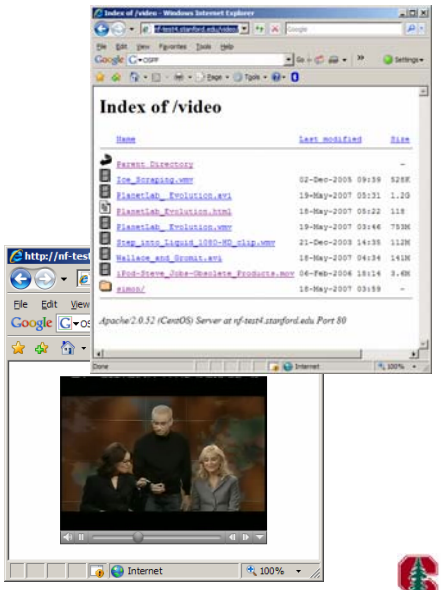
Topology of NetFPGA Routers



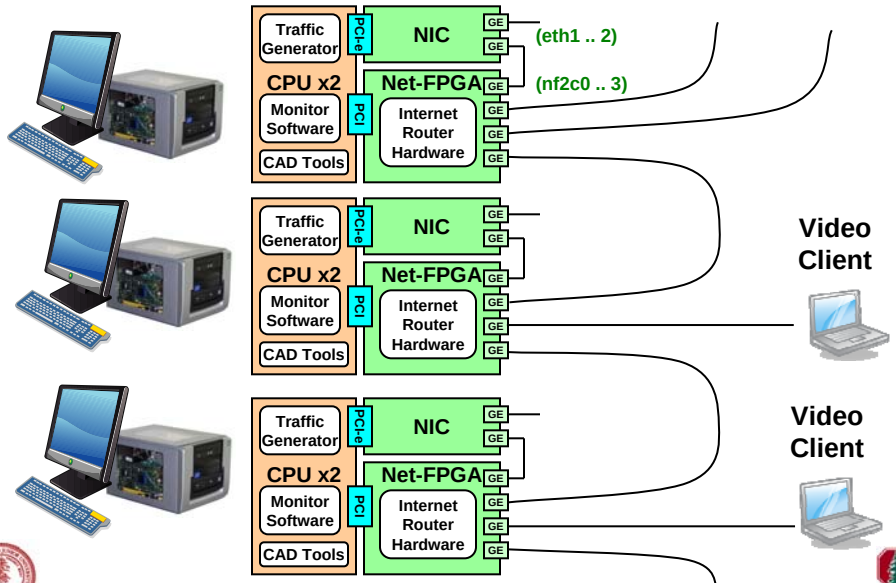
Demo

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)



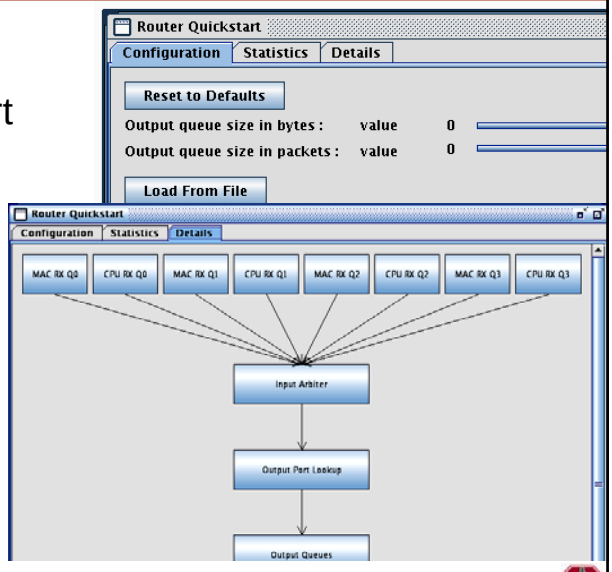
NetFPGA Lab Setup



Explore Router Architecture with GUI

GUI Configuration
- Router Quickstart configuration

Reference details
- simple
- modular
- pipeline



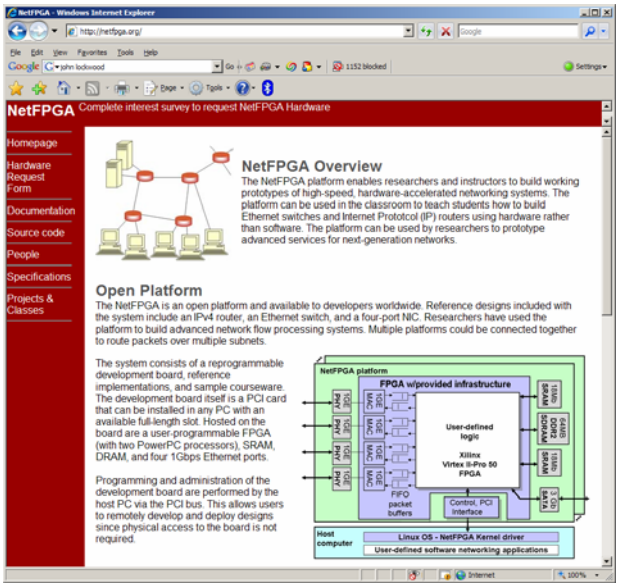
Networking Hardware Education

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

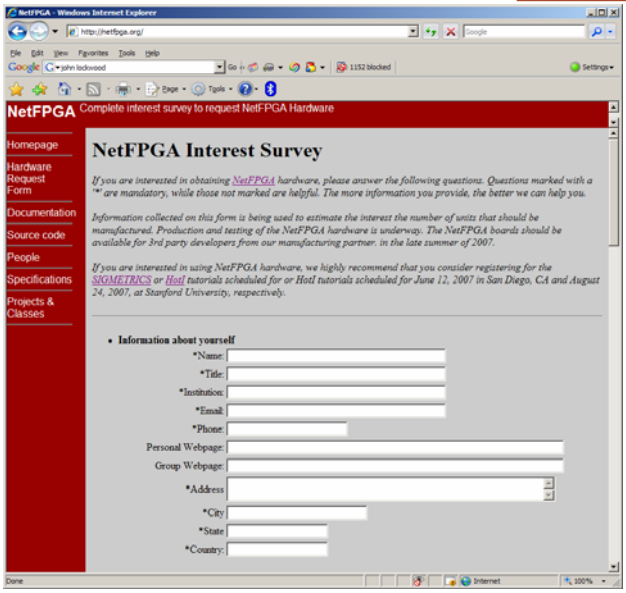
cs344: Build an Internet Router in 8 weeks

- **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



Request Hardware: http://NetFPGA.org



Upcoming NetFPGA Tutorials

- **SIGMetrics :**
  - Half-day Tutorial
  - June 12, 2007
  - San Diego, California

  http://www.cs.cmu.edu/~sigm07/workshops.html#TUTORIAL_2

- **Hot Interconnects :**
  - Full-day Tutorial
  - August 24, 2007
  - Stanford, California

  http://www.hoti.org

- **NetFPGA Homepage**

  http://NetFPGA.org