

## 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

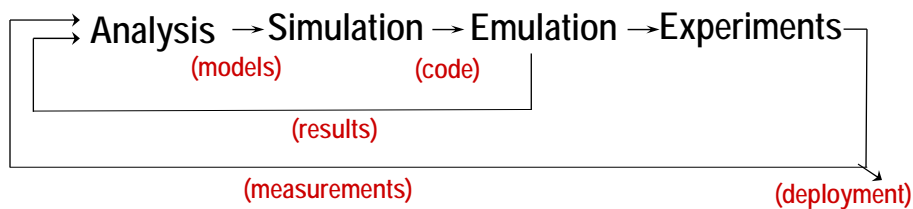


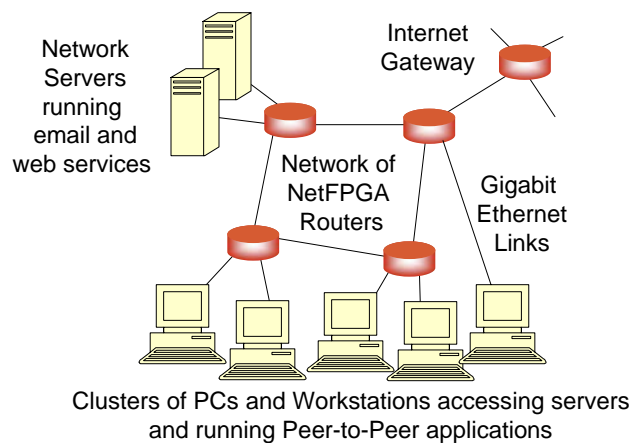
Diagram by: Larry Peterson (Princeton University)

## Motivation to Teach Network Hardware

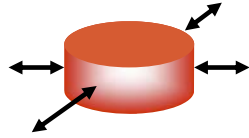
- **Research and Education**
  - Students Today
    - Build network systems mostly with software
  - Students Tomorrow
    - Can quickly learn to also build system components in hardware
- **Interesting Topics for Networking Hardware**
  - Switching and Routing
    - Gigabit-rate networking
  - Network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



## Intrenet Routing & Switching



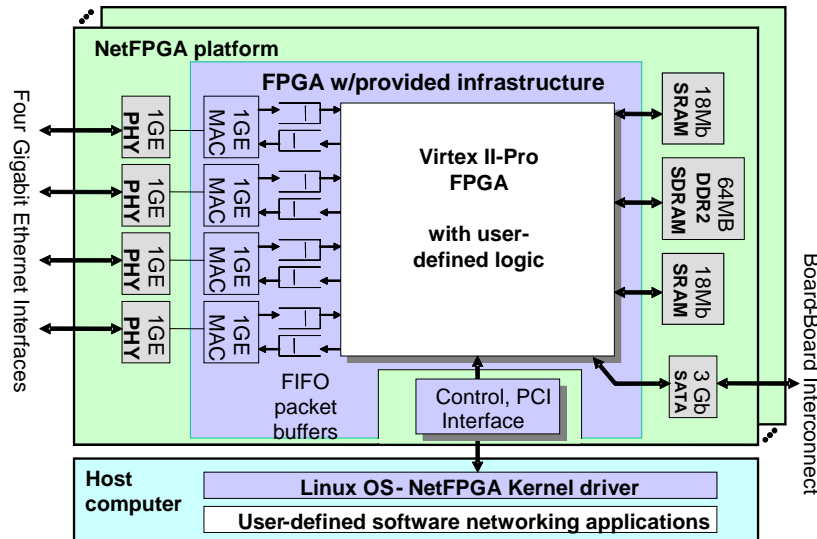
# NetFPGA Platform



- **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 software 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

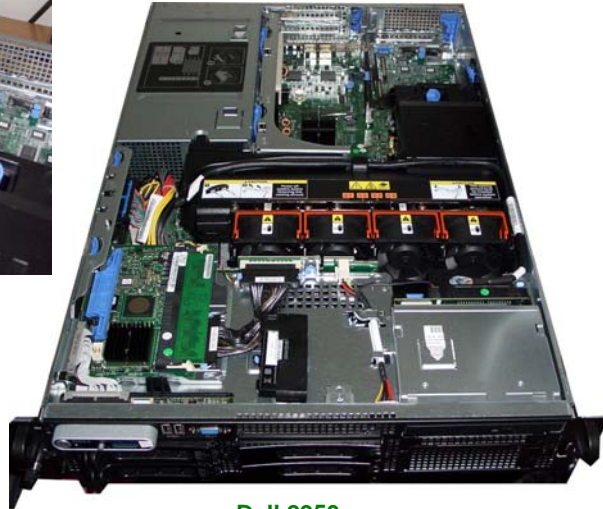
- **NetFPGA**
  - Quad Gigabit Ethernet Ports
- **Gigabit Host Ports**
  - Dual Gigabit Ethernets
- **Processor**
  - Dual-Core Athlon-64
- **Operating System**
  - Linux CentOS 4.4  
(or Fedore Core, RedHat ..)



## Internet2 Machines - Tested fine with the NetFPGA



NetFPGA properly recognized in PCI-X slot



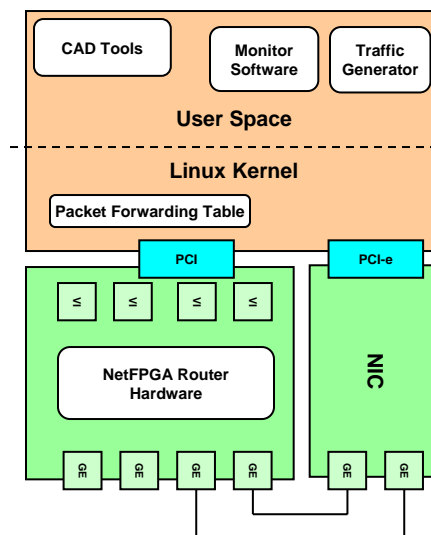
Dell 2950 with PCI-X and PCI-Express Slots

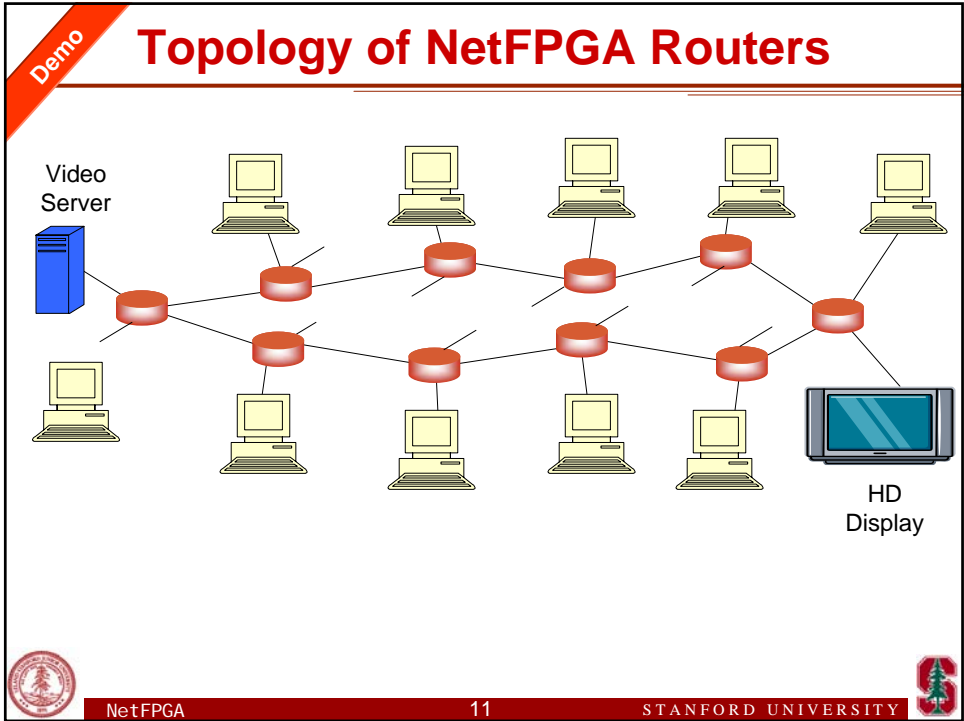


Thanks: Brian Cashman for providing machine



## Hardware and Software View





**Demo** **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)

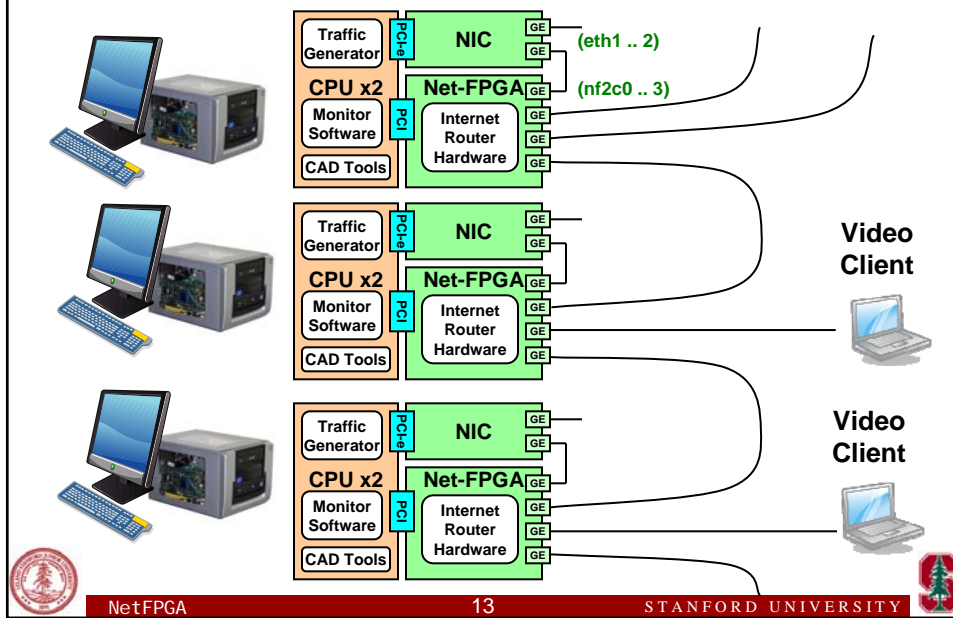
Index of /video

File	Last modified	Size
<a href="#">index.html</a>		
<a href="#">index.mpeg</a>	02-Sep-2006 09:59	528K
<a href="#">index.wmv</a>	19-May-2007 05:31	1.2G
<a href="#">index.html</a>	19-May-2007 05:22	118
<a href="#">index.wmv</a>	19-May-2007 03:46	793K
<a href="#">index.html</a>	21-Dec-2003 14:38	112K
<a href="#">index.wmv</a>	18-May-2007 04:34	141K
<a href="#">index.html</a>	04-Feb-2004 18:14	3.6K
<a href="#">index.wmv</a>	18-May-2007 03:59	-

Apache/2.0.32 (CentOS) Server at sf-netfpga.stanford.edu Port 80

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# NetFPGA Lab Setup



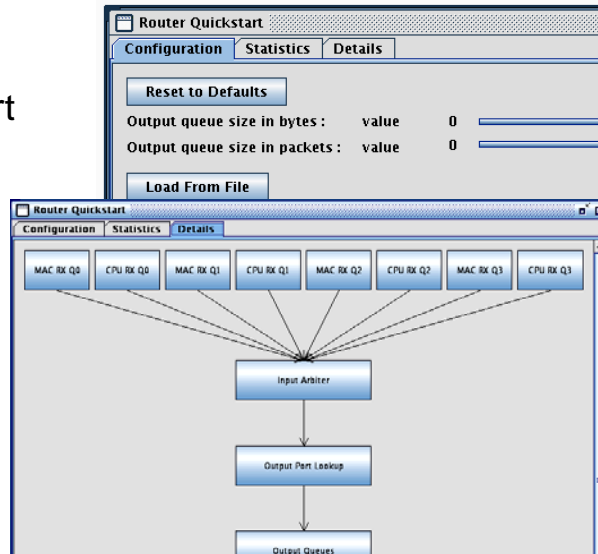
# Explore Router Architecture with GUI

## 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 Prevention 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>

The screenshot shows the NetFPGA project homepage in a Windows Internet Explorer browser. The page features a navigation menu on the left with links for Homepage, Hardware Request Form, Documentation, Source code, People, Specifications, and Projects & Classes. The main content area is titled "NetFPGA Complete interest survey to request NetFPGA Hardware" and includes a "NetFPGA Overview" section with a diagram of a network topology. Below this is an "Open Platform" section with a detailed diagram of the NetFPGA hardware architecture, showing the FPGA w/provided infrastructure, user-defined logic, and the host computer interface.



# Request Hardware: <http://NetFPGA.org>

The screenshot shows the NetFPGA Interest Survey form in a browser window. The form is titled "NetFPGA Interest Survey" and includes a "Hardware Request Form" link in the navigation menu. The survey text asks for information to estimate the number of units to be manufactured and provides details about the availability of hardware and tutorials. The form fields are organized into sections: "Information about yourself" (Name, Title, Institution, Email, Phone), "Personal Webpage", "Group Webpage", and "Address" (Address, City, State, Country).



## 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>
- **NetFPGA Homepage**

<http://NetFPGA.org>

