What is the NetFPGA?

A line-rate, flexible, open networking platform for teaching and network research

- Network Interface Card
- Hardware Accelerated Linux Router
- IPv4 Reference Router
- Traffic Generator
- OpenFlow Switch
- List of All Projects
- Add Your Project
Goals for GENI Network Substrate

- **Easily compose Systems**
  - By combining multiple, standard elements
- **Clearly define the functionality**
  - Functionality defined through regression tests
- **Widely disseminate projects**
  - Open-source code downloads and installs with yum
  - Projects documented on Web, Wiki, Blog, & Facebook
- **Build a community of developers**
  - Organize projects
  - Document contributions
  - Respond to feedback from users
  - Encourage the community to contribute

Strengths of Reconfigurable Networks

- **Implement Wire-speed Processing**
  - Header Processing
    - Switching, routing, firewalls
  - Full Payload Processing
    - Content distribution and intrusion prevention
- **Enhance and create new datapath functions**
  - Monitor network flows
    - NetFlow probe
  - Control network flows
    - OpenFlow switch
  - Generate traffic
    - Traffic generator
  - Process new protocols
    - Reference Router
- **Power efficient**
  - Datapath optimized for switching
Why do we use the NetFPGA

• To run laboratory courses on network routing
  – Professors teach courses (CS344, Workshops, ..)

• To teach students how to build real Internet routers
  – Train students to build routers (Cisco, Juniper, Huawei, ..)

• To research how new features in the network
  – Build network services for data centers (Google, UCSD, ..)

• To prototype systems with live traffic
  – That Buffer measurement (while maintaining throughput, ..)

• To help hardware vendors understand device requirements
  – Use of hardware (Xilinx, Micron, Cypress, Broadcom, ..)

NetFPGA Summer Camp

• Participants
  – Professors
  – Graduate Students
  – Engineers from Industry

• Format : One week event
  – 2.5 Days of Training on the reference router
  – 2 Days to work on projects
  – Final Projects presented on Friday Afternoon
Photos from NetFPGA Tutorials

SIGCOMM - Seattle, Washington, USA

Beijing, China

SIGMETRICS - San Diego, California, USA

EuroSys - Glasgow, Scotland, U.K.

Bangalore, India


Where are NetFPGAs?

- Over 500 users with ~1,000 cards deployed
- Deployed in ~120 universities in 17 Countries
NetFPGA Hardware in Asia

Locations of Deployed NetFPGA Hardware

China, Korea, Japan, Taiwan - Jan 2009

• Pre-built systems available
  – From 3rd Party Vendor
• PCs assembled from parts
  – Integrates into standard PC
• Details are in the Guide
  – http://netfpga.org/static/guide.html
**Rackmount NetFPGA Servers**

- NetFPGA inserts in PCI or PCI-X slot
- 2U Server (Dell 2950)
- 1U Server (Accent Technology, Inc)

**Stanford NetFPGA Cluster**

- Stanford NetFPGA Cluster (NFC)
- **Statistics**
  - Rack of 40
    - 1U PCs
    - NetFPGAs
  - Managed
    - Power
    - Console
    - VLANs
  - Provides 160 Gbps of full line-rate processing bandwidth
NetFPGAs in the Internet 2 & Japan

From GENI Engineering Conference – Oct 2008

UCSD-NetFPGA Cluster
Building the NetFPGA route from the Verilog Source Code

Using the Xilinx ISE tools to synthesize the logic for the FPGA
Explore the Router

Click NetFPGA

Look inside the Router

Click
Preview of Upcoming 2.0 Release

• Modular Registers
  – Simplifies integration of multiple modules
    • Many users control NetFPGas from software
  – Register set joined together at build time
    • Project specifies registers in XML list

• Packet Buffering in DRAM
  – Supports Deep buffering
    • Single 64MByte queue in DDR2 memory

• Programmable Packet Encapsulation
  – Packet-in-packet encapsulation
    • Enables tunnels between OpenFlowSwitch nodes

Conclusions

• NetFPGA Provides
  – Open-source, hardware-accelerated Packet Processing
  – Modular interfaces arranged in reference pipeline
  – Extensible platform for packet processing

• NetFPGA Reference Code Provides
  – Large library of core packet processing functions
  – Scripts and GUIs for simulation and system operation
  – Set of Projects for download from repository

• The NetFPGA Community of Developers use
  – Well defined functionality defined by regression tests
  – Blogs that organize projects
  – Wiki pages that Document contributions
  – Forum for discussion of feedback from users
You already know that the NetFPGA implements a Gigabit NIC, a hardware-accelerated Internet router, a traffic generator, an OpenFlow switch, a NetFlow probe and more. What else can it do? We invite you, our worldwide NetFPGA Developers, to show off your project. Submit a paper to describe your project, prepare a demo, and come to Stanford in August to demonstrate your work!

- **Papers Due:**
  - April 20, 2009
- **Workshop Date:**
  - Aug. 13-14, 2009
- **Paper Format:**
  - 4-8 page, ACM-style
- **Demonstrations:**
  - Run on NetFPGA(s)
- **Program Chairs:**
  - John W. Lockwood (Stanford University)
  - Andrew W. Moore (Cambridge University)
- **Full Details**

“What have you built with your NetFPGA?”
What is a NetFPGA System

Software running on a standard PC

+ 

A hardware accelerator built with Field Programmable Gate Array driving Gigabit network links

How do I Run the Router Kit

User-space development, 4x1GE line-rate forwarding
Building Modular Router Modules

Verilog modules interconnected by FIFO interfaces

How do I create new systems

(1GE MAC is soft/replaceable)
**Inter-module Communication**

- Module $i$ to Module $i+1$
  - Data flow
  - Control flow
  - Timing flow

**NetFPGA 1G Pipeline Stages**

- SRAM
- Forward Table Logic
- Input Arbiter
- Output Port Lookup
- Packet Buffer Logic
- Output Queues
- MAC TxQ, CPU TxQ
- DRAM
Acknowledgements

Support for the NetFPGA project is provided by the following organizations, companies, and institutions
Learn more About the NetFPGA

http://NetFPGA.org/

-Or-

Google: “NetFPGA”

Learn More
- Project summary, videos, publications, tutorials

Get Started
- Obtain NetFPGA hardware, download gateware & software, review reference designs

Develop
- Create user account, contribute your code, document your project