NetFPGA Update at GEC4

http://NetFPGA.org/

NSF GENI Engineering Conference 4 (GEC4)
March 31, 2009

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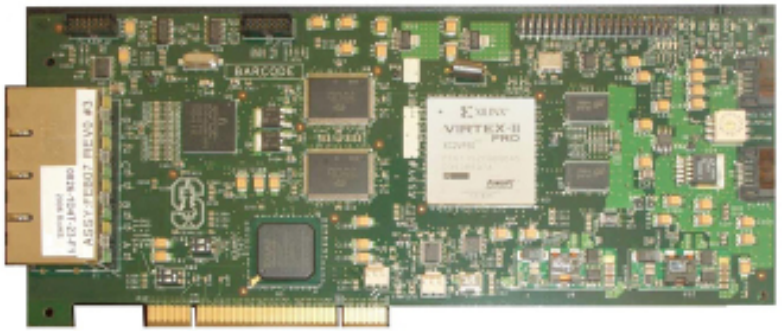
Hardware and tools available for university programs thanks to grants, donations, and/or partnerships from:

What is the NetFPGA?

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



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- Network Interface Card
- Hardware Accelerated Linux Router
- IPv4 Reference Router
- Traffic Generator
- Openflow Switch
- List of All Projects
- Add Your Project

Outline

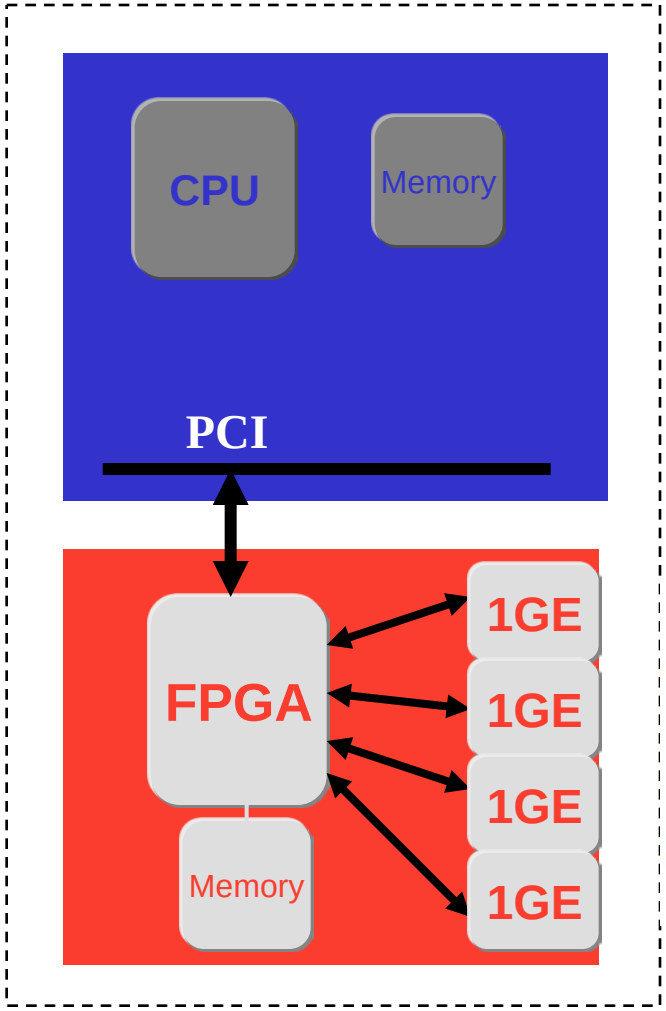
- **What is a NetFPGA system**
  - Open hardware and software
- **Why do we use reconfigurable hardware**
  - Strengths and weaknesses
- **Who uses the NetFPGA**
  - Update on worldwide deployments
- **What's new**
  - Upcoming 2.0 Release
- **Where is the NetFPGA**
  - Source code and documentation
- **How are projects contributed**
  - Regression tests
- **When is the 2009 Developers workshop**

What is a NetFPGA System

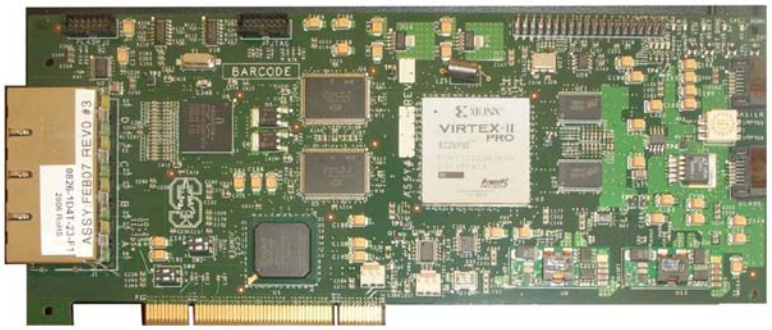
Software running on a standard PC

+

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



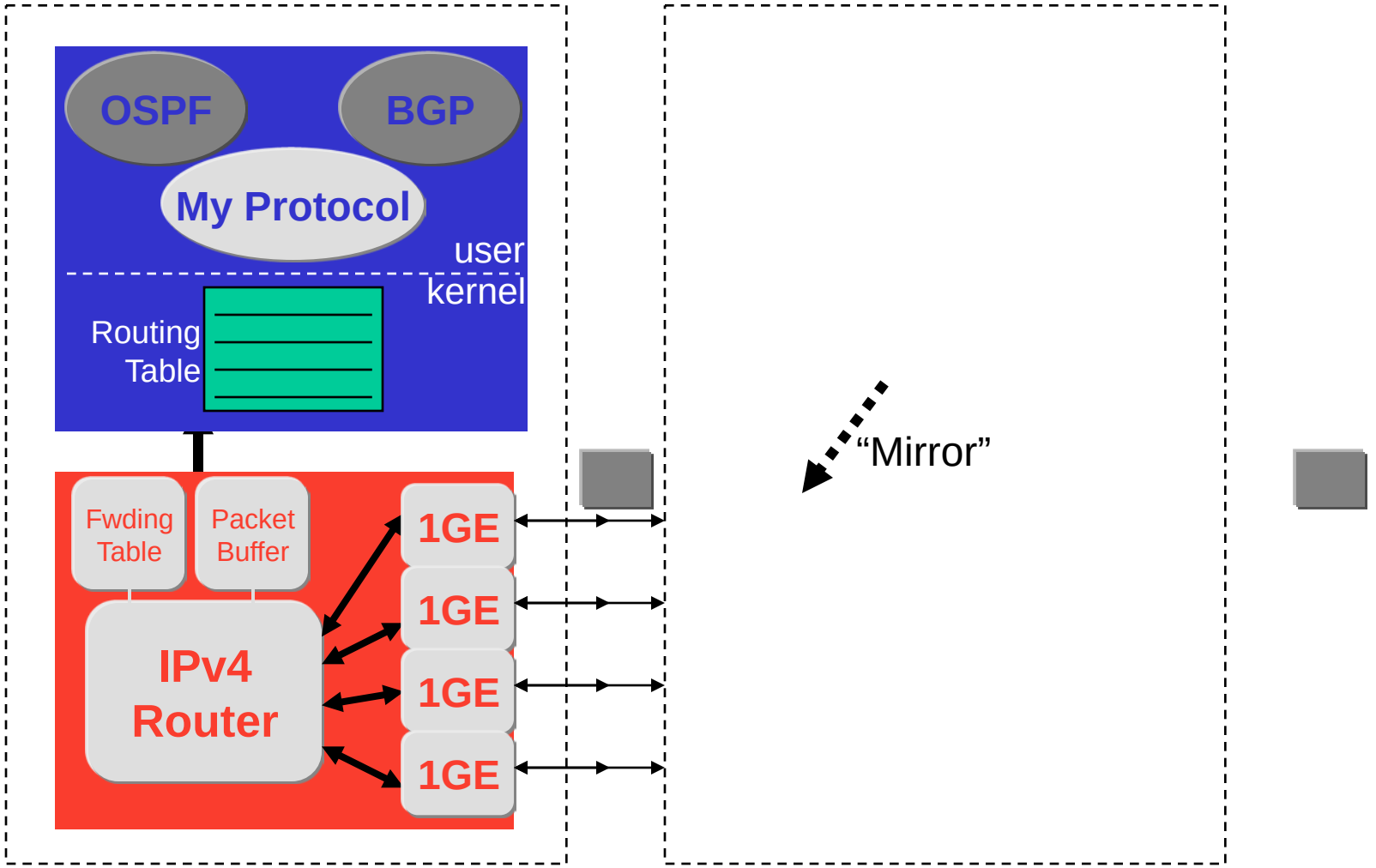
PC with NetFPGA



NetFPGA Board

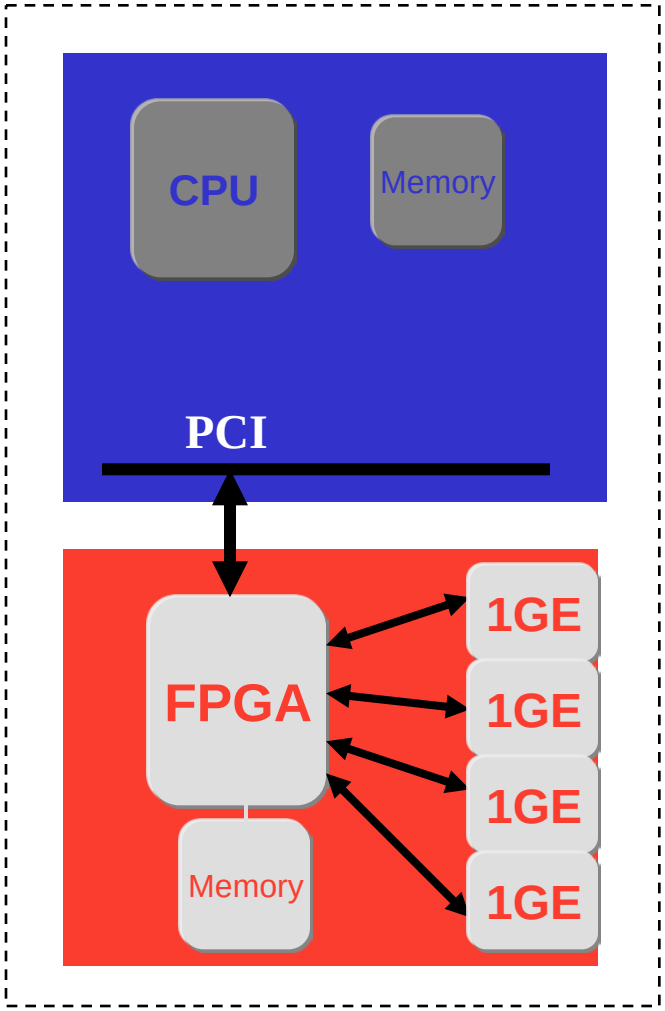
How do I Run the Router Kit

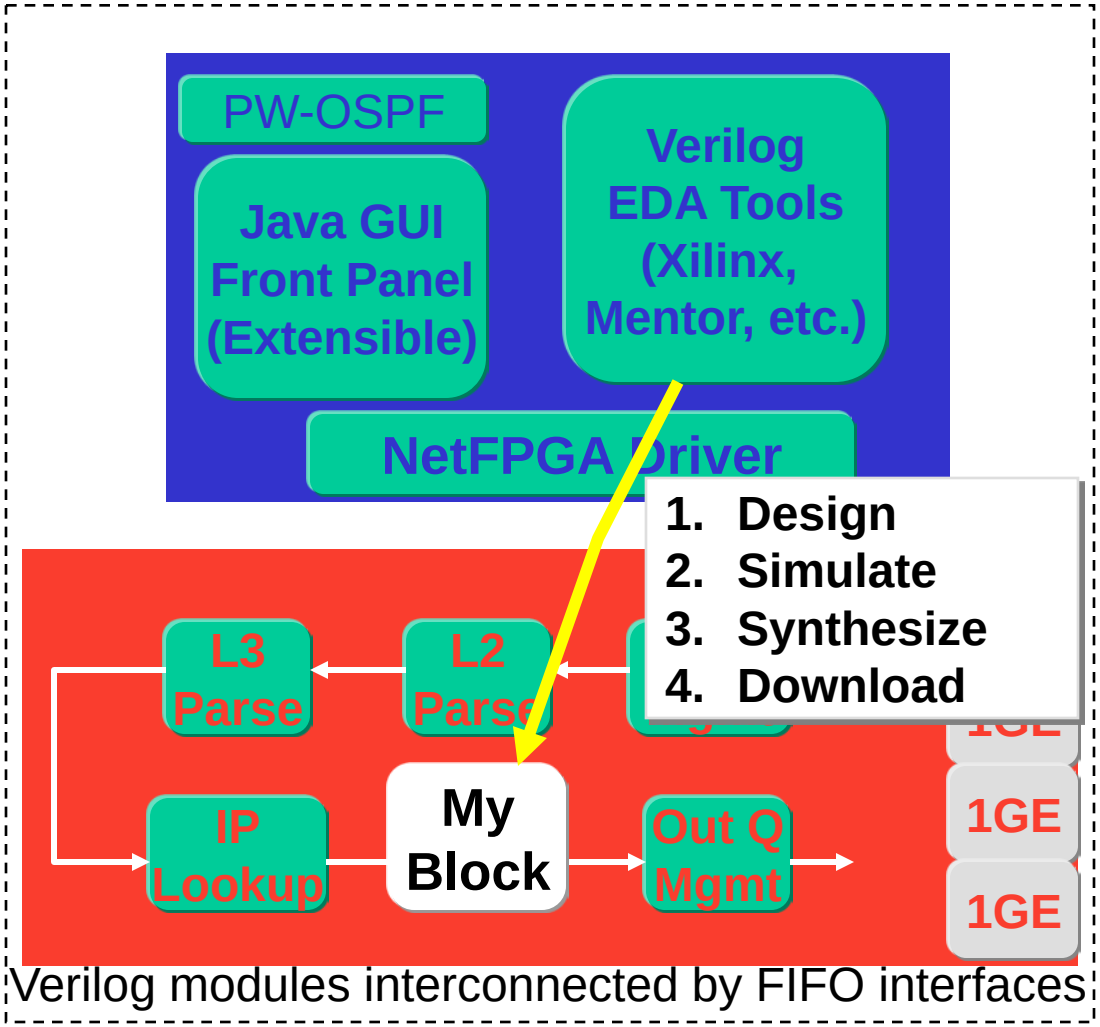
User-space development, 4x1GE line-rate forwarding



Usage #2

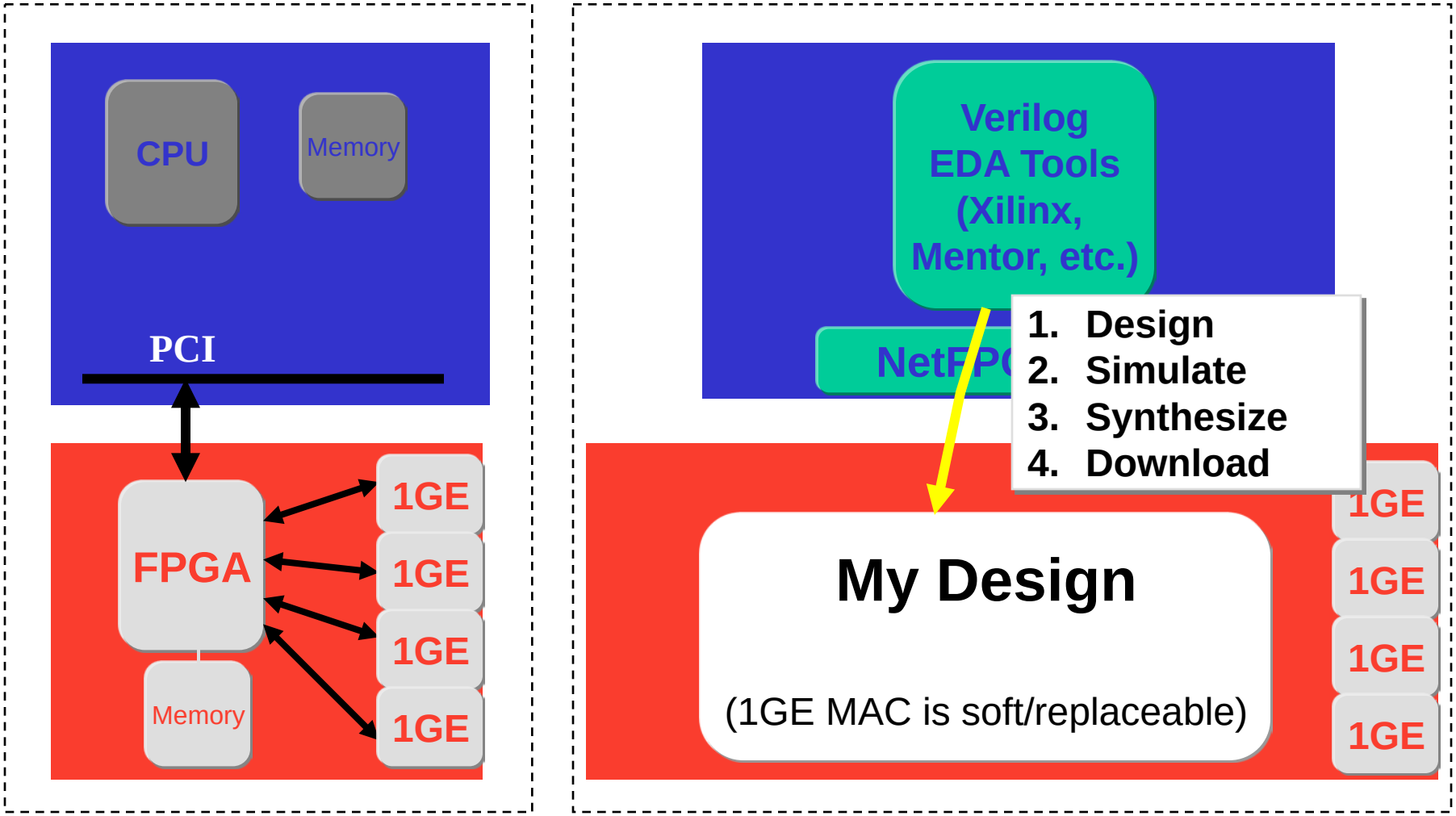
Building Modular Router Modules





Verilog modules interconnected by FIFO interfaces

How do I create new systems



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 ..

Weaknesses of Reconfiguration Nets

- **Device configuration must be secure**
  - Hackers will try to reconfigure devices
  - Competitors will try to reverse engineer applications
- **Network systems are complex**
  - Cisco routers contains 18M+ lines of code
  - Modular components needed for large systems
- **Must be power efficient**
  - FPGAs use 5-50x more power than ASIC, however
  - FPGAs use 5-50x less power than software

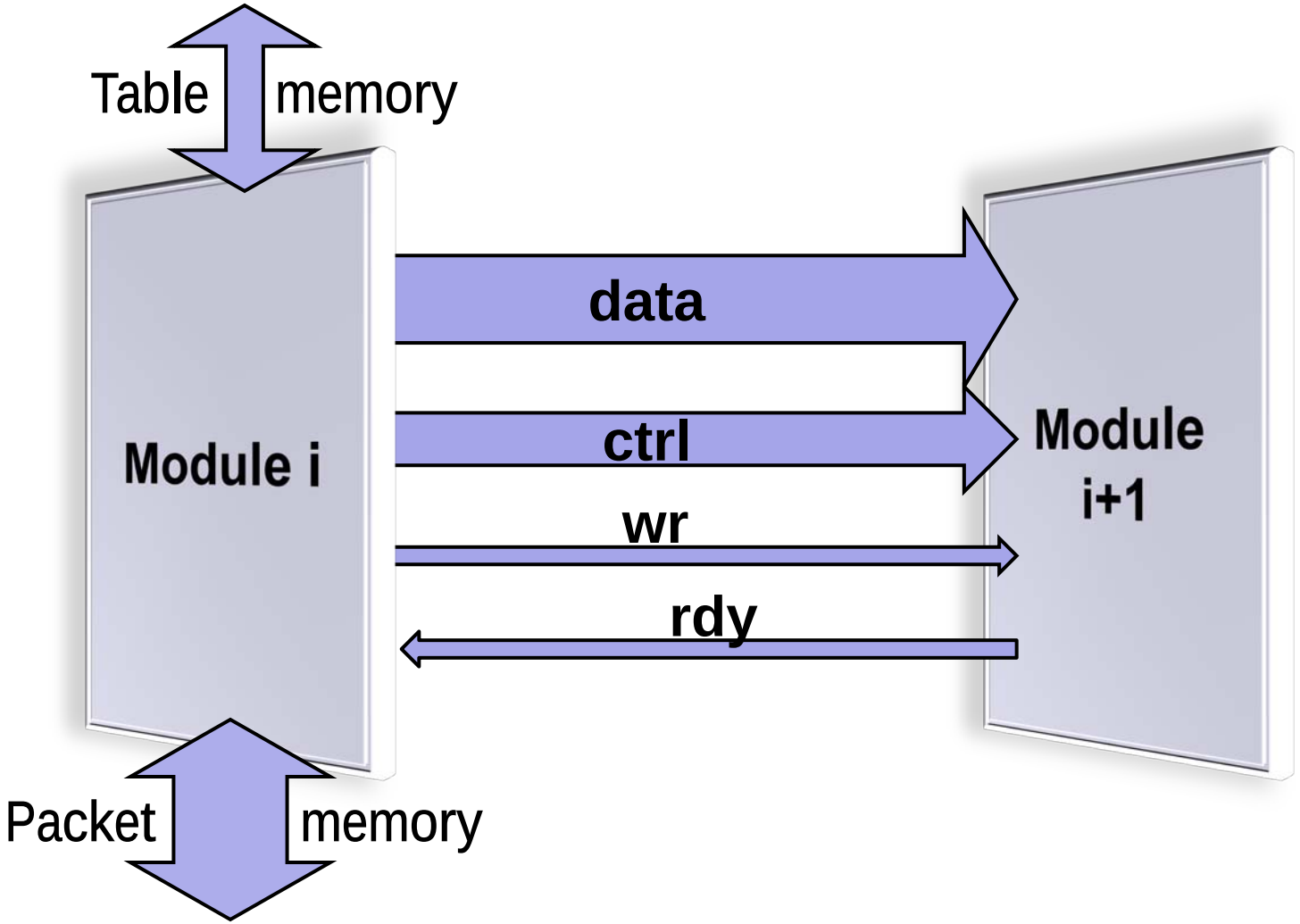
Time to Prototype New systems

- **Network systems use Multiple Languages**
  - VHDL, Verilog (Synthesizable Hardware)
  - Bluespec, Handel-C, SystemC (High-Level)
  - C, C++, Perl, PHP, Java (SW, Verification, GUIs)
- **Networks are implemented in**
  - Software:
    - Compile in seconds to minutes
  - FPGAs:
    - Synthesize in minutes to hours
  - ASICs:
    - Fabricate in months to years

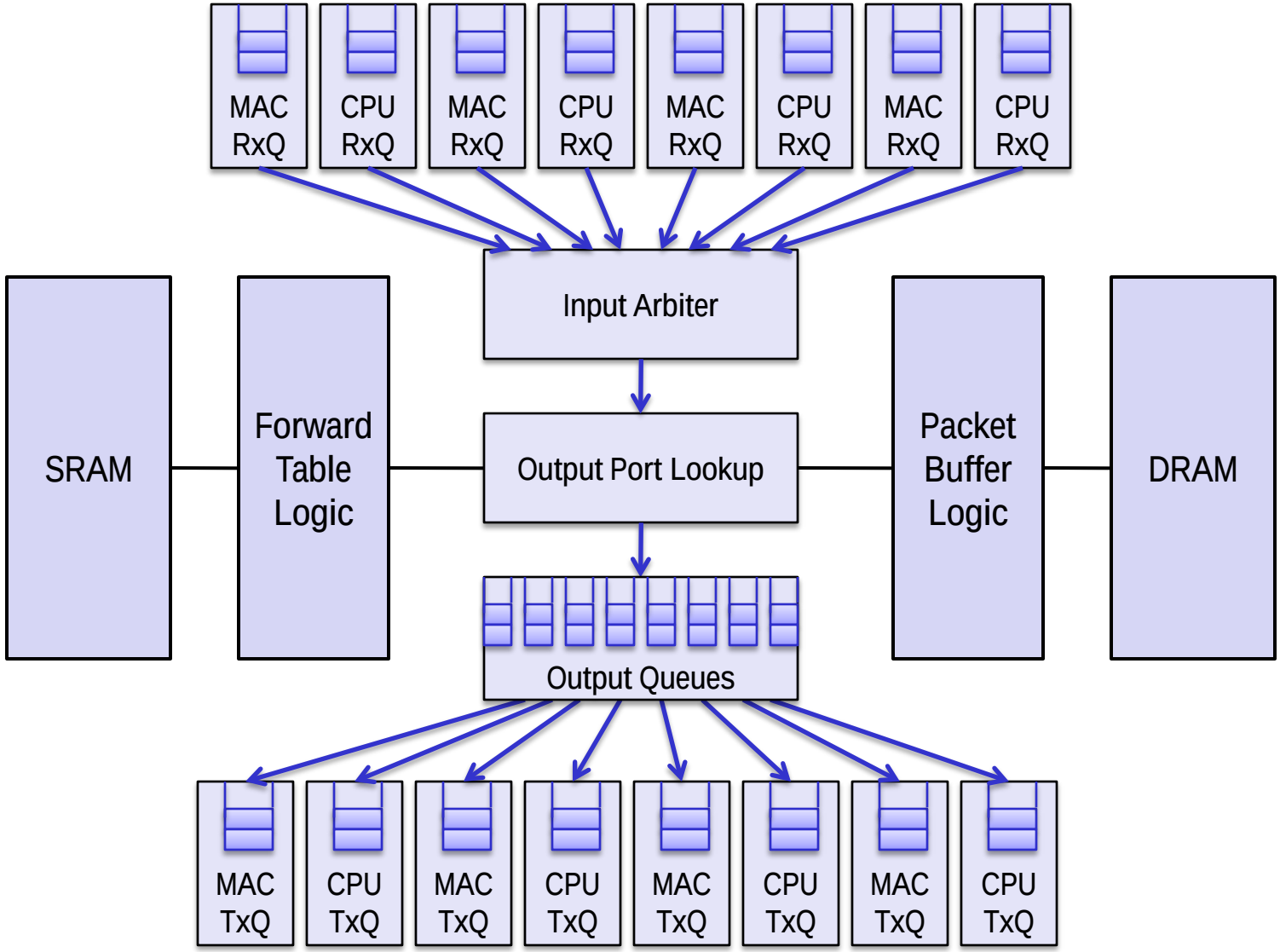
Goals for an Ideal Network Platform

- **Provide a large library of elements**
  - With modular interfaces
- **Enable systems to easily compose**
  - By combining multiple, standard elements
- **Clearly define the functionality**
  - By verification to a set of regression tests
- **Widely disseminate projects**
  - Make download as easy as using iTunes
- **Build a community of developers**
  - Organize projects
  - Document contributions
  - Respond to feedback from users
  - Encourage the community to contribute

Inter-module Communication



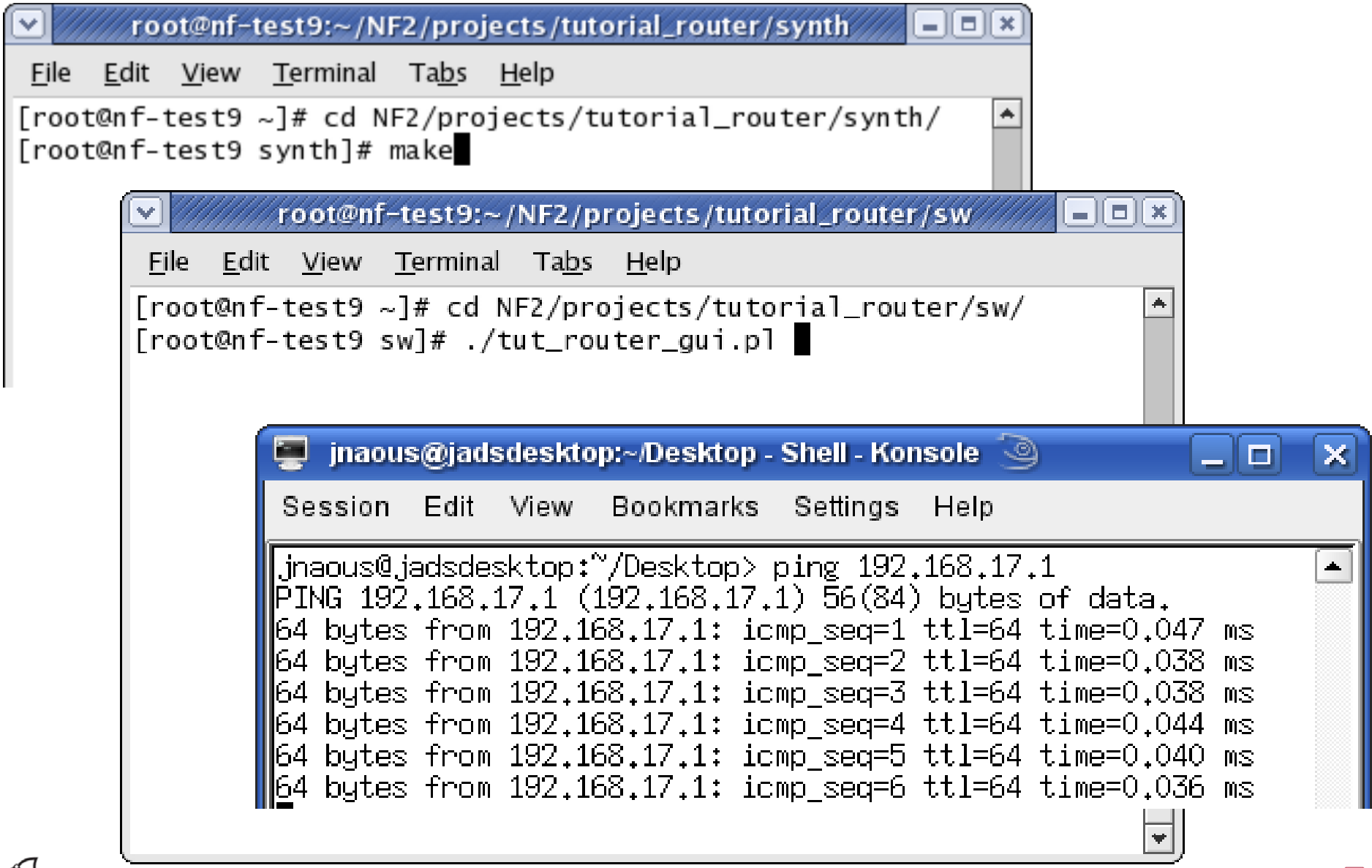
NetFPGA 1G Pipeline Stages



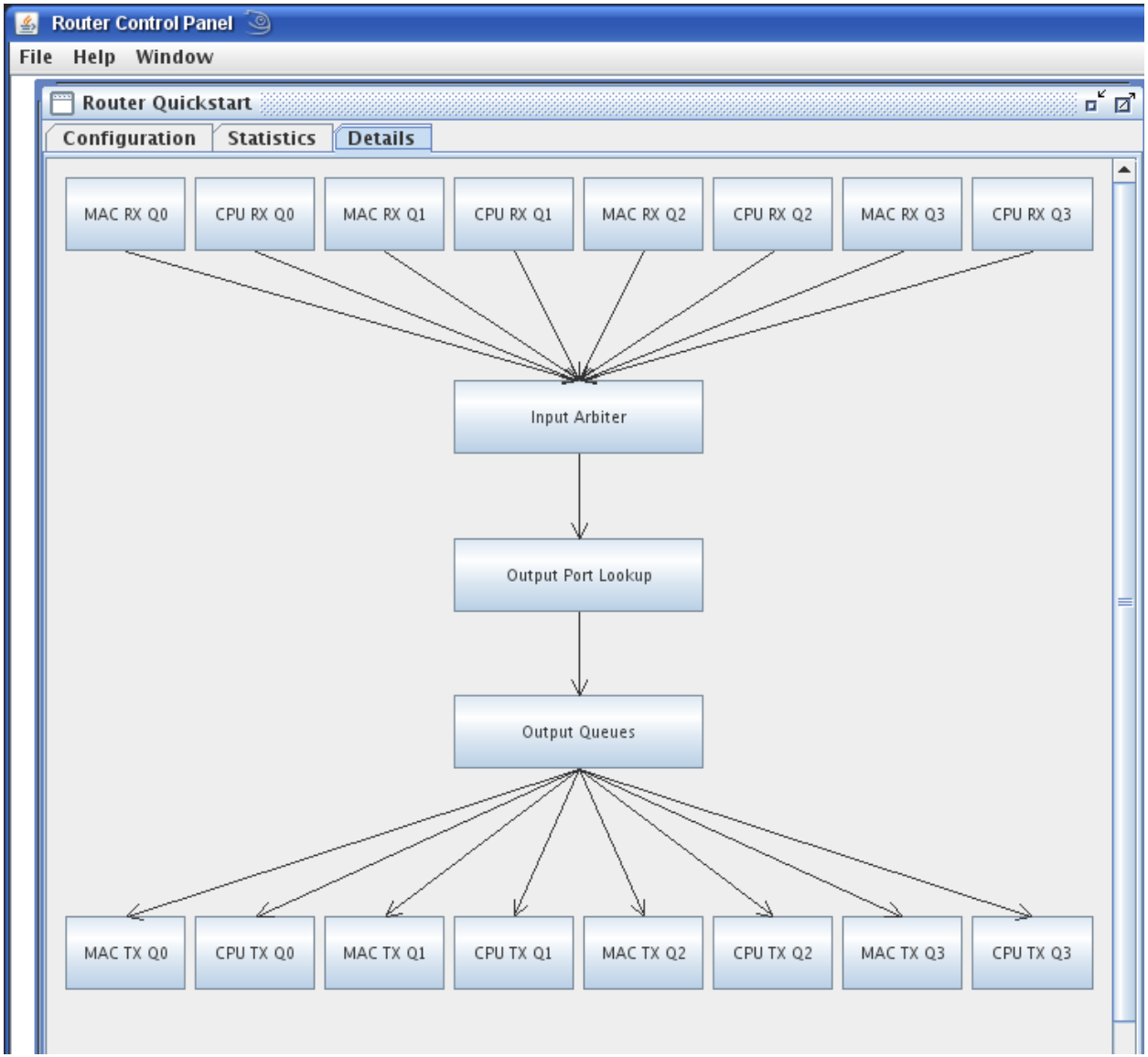
Building the NetFPGA route from the Verilog Source Code

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

Building the NetFPGA Router

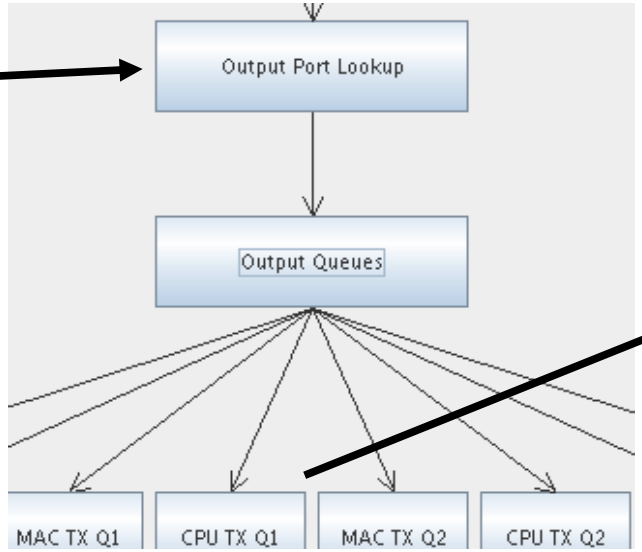


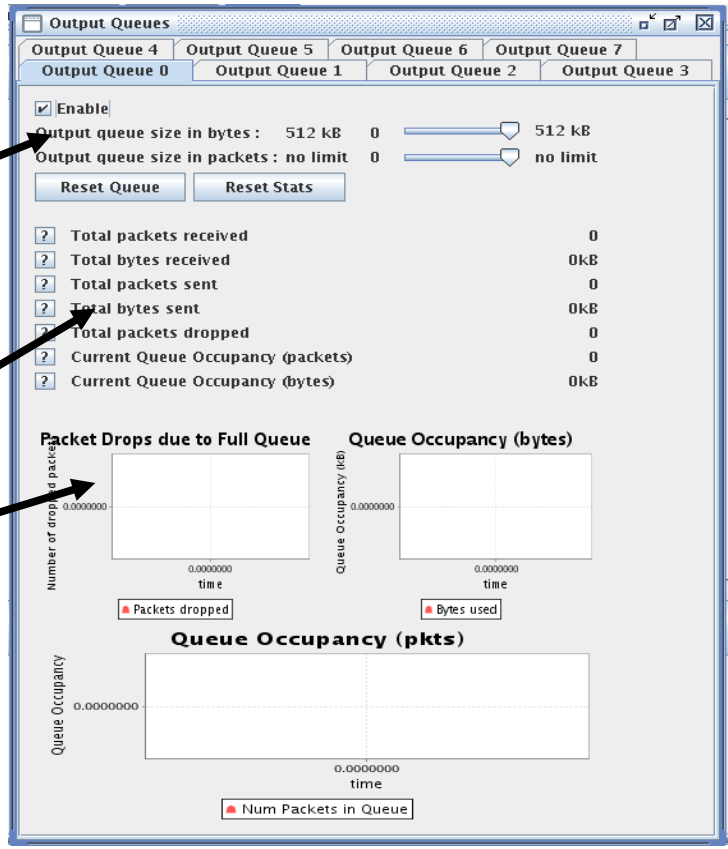
Explore the Router



Look inside the Router

Click





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, ..)

Where are NetFPGAs?

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

NetFPGA

Photos from NetFPGA Tutorials

SIGCOMM - Seattle, Washington, USA

Beijing, China

SIGMETRICS - San Diego, California, USA

EuroSys - Glasgow, Scotland, U.K.

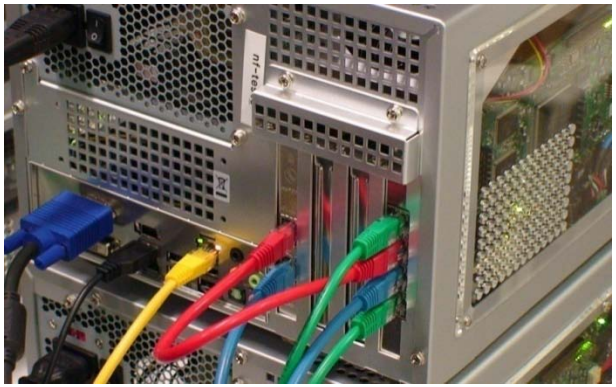
Bangalore, India

http://netfpga.org/pastevents.php and http://netfpga.org/upcomingevents.php

NetFPGA

NetFPGA Systems

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



Rackmount NetFPGA Servers

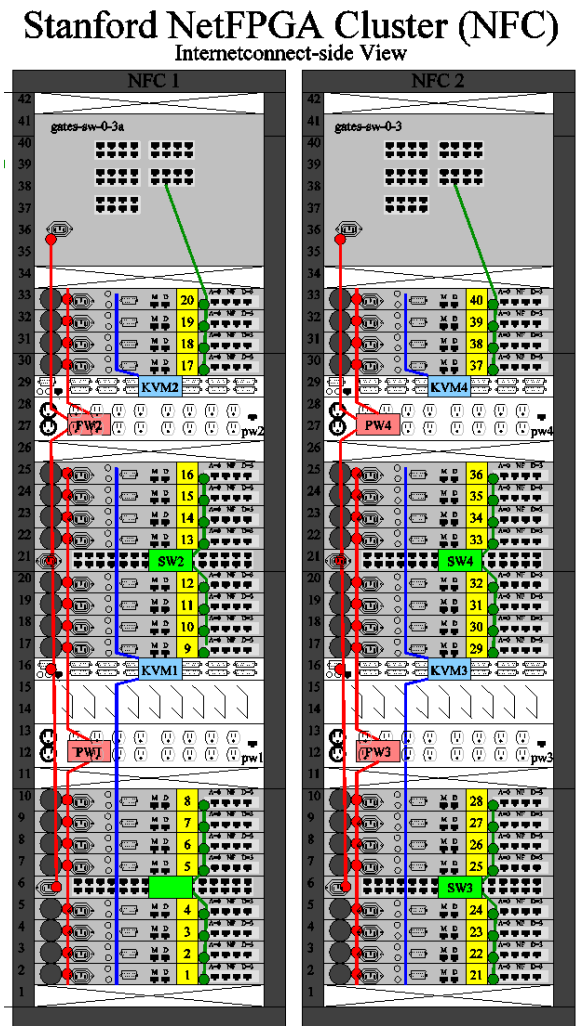
2U Server
(Dell 2950)

NetFPGA inserts in
PCI or PCI-X slot

1U Server
(Accent Technology, Inc)

Thanks: Brian Cashman for providing machine

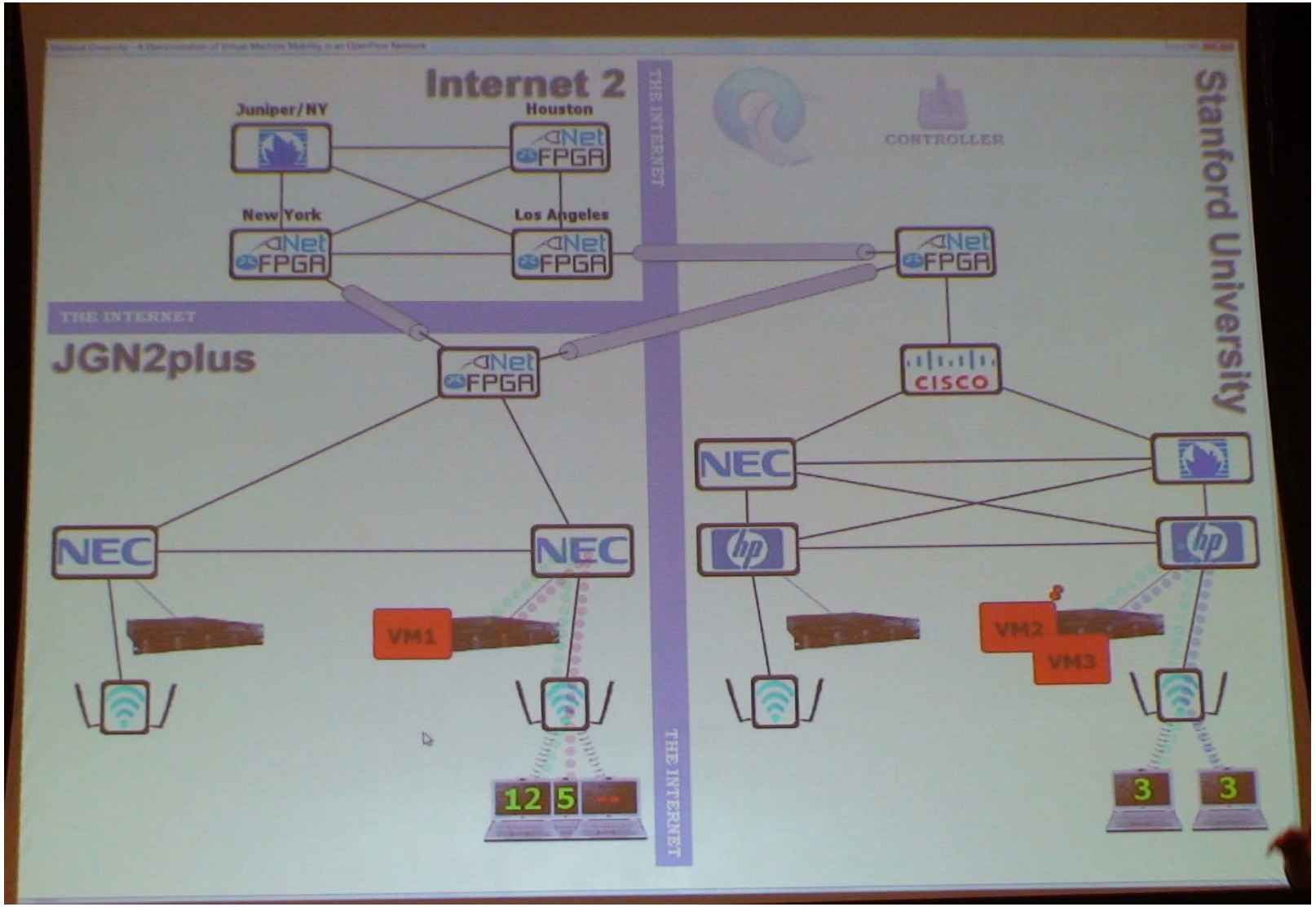
Stanford NetFPGA Cluster



Statistics

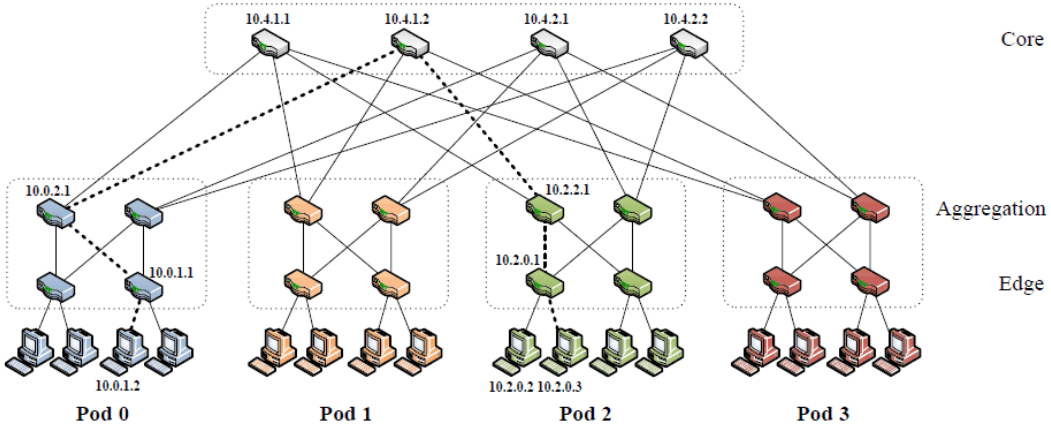
- Rack of 40
  - 1U PCs
  - NetFPGAs
- Manged
  - Power,
  - Console
  - VLANs
- Provides 160 Gbps of full line-rate processing bandwidth

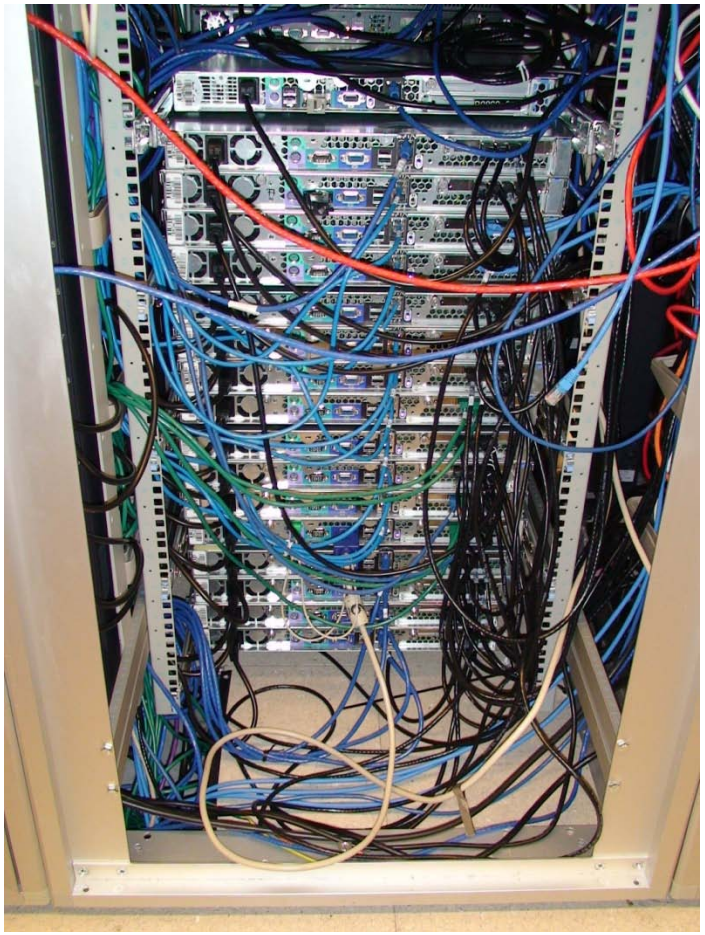
NetFPGAs in the Internet 2 & Japan



From GENI Engineering Conference – Oct 2008

UCSD-NetFPGA Cluster





Preview of Upcoming 2.0 Release

- **Modular Registers**
  - Shares
  - Project registers specified by XML list
  - Joined together at build time

- **Packet buffering in DRAM**
  - Deep buffer
  -

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

NetFPGA 2008 Summer Camp

- **Participants**
  - Professors
  - Graduate Students
  - Engineers from Industry

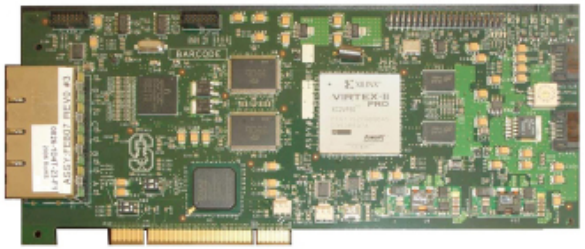
- **Format : One week event at Stanford**
  - 2.5 Days of Training on the reference router
  - 2 Days to work on projects
  - Final Projects presented on Friday Afternoon

NetFPGA Developers Workshop

August 13-14, 2009 at Stanford University

- **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!**

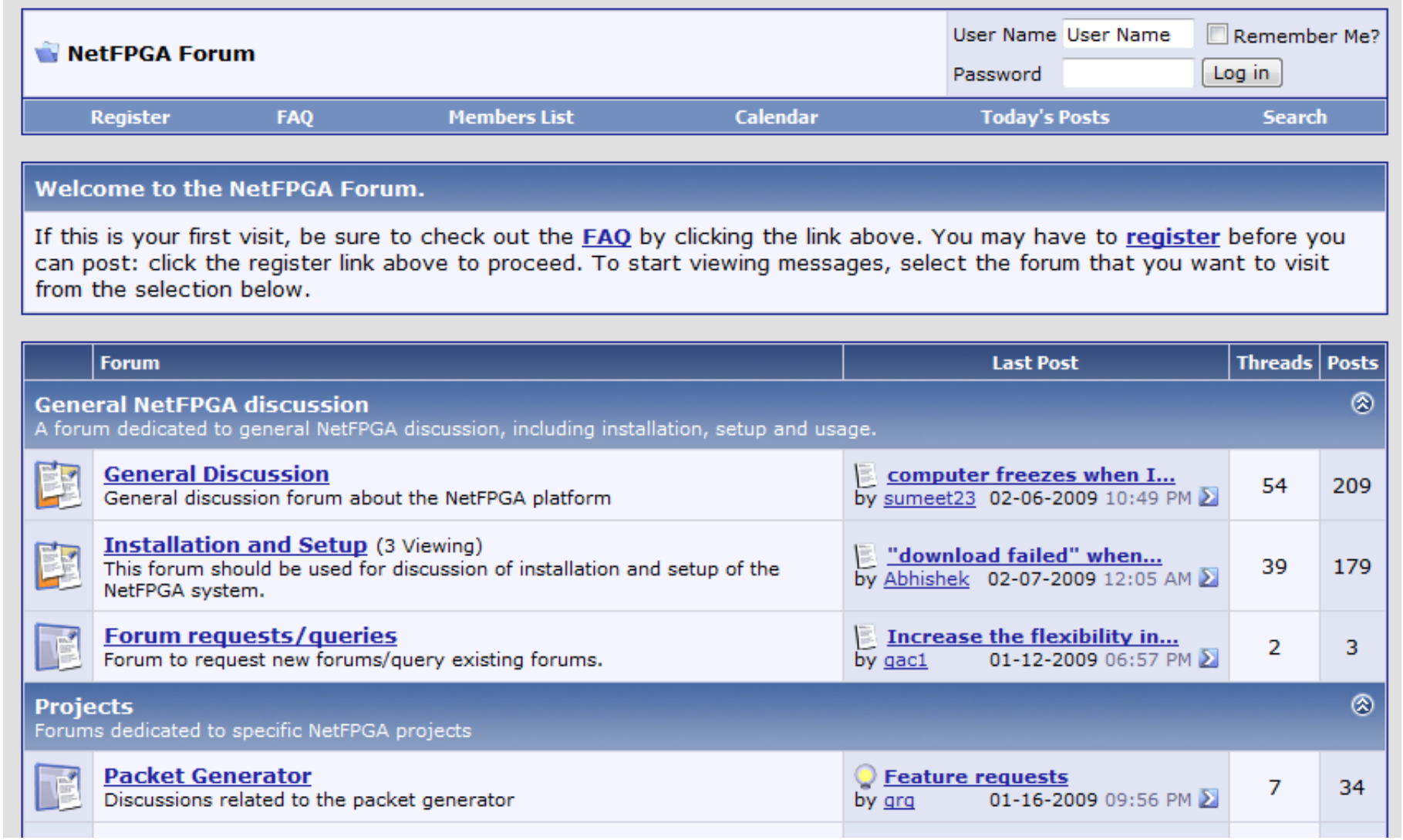
- **Papers Due:**
  - April 20, 2009
- **Workshop Date:**
  - Aug. 13-14, 2009
- **Paper Format:**
  - 4-8 page, ACM-style
- **Demonstrations:**
  - Run on NetFPGA(s)
- **Program Chairs:**
  - John W. Lockwood (Stanford University)
  - Andrew W. Moore (Cambridge University)
- **Full Details**
  - http://NetFPGA.org/DevWorkshop



"What have you built with your NetFPGA?"

Additional Slides

Need Help? – See Discussion Forums



NetFPGA Forum

User Name User Name Remember Me?
Password Log in

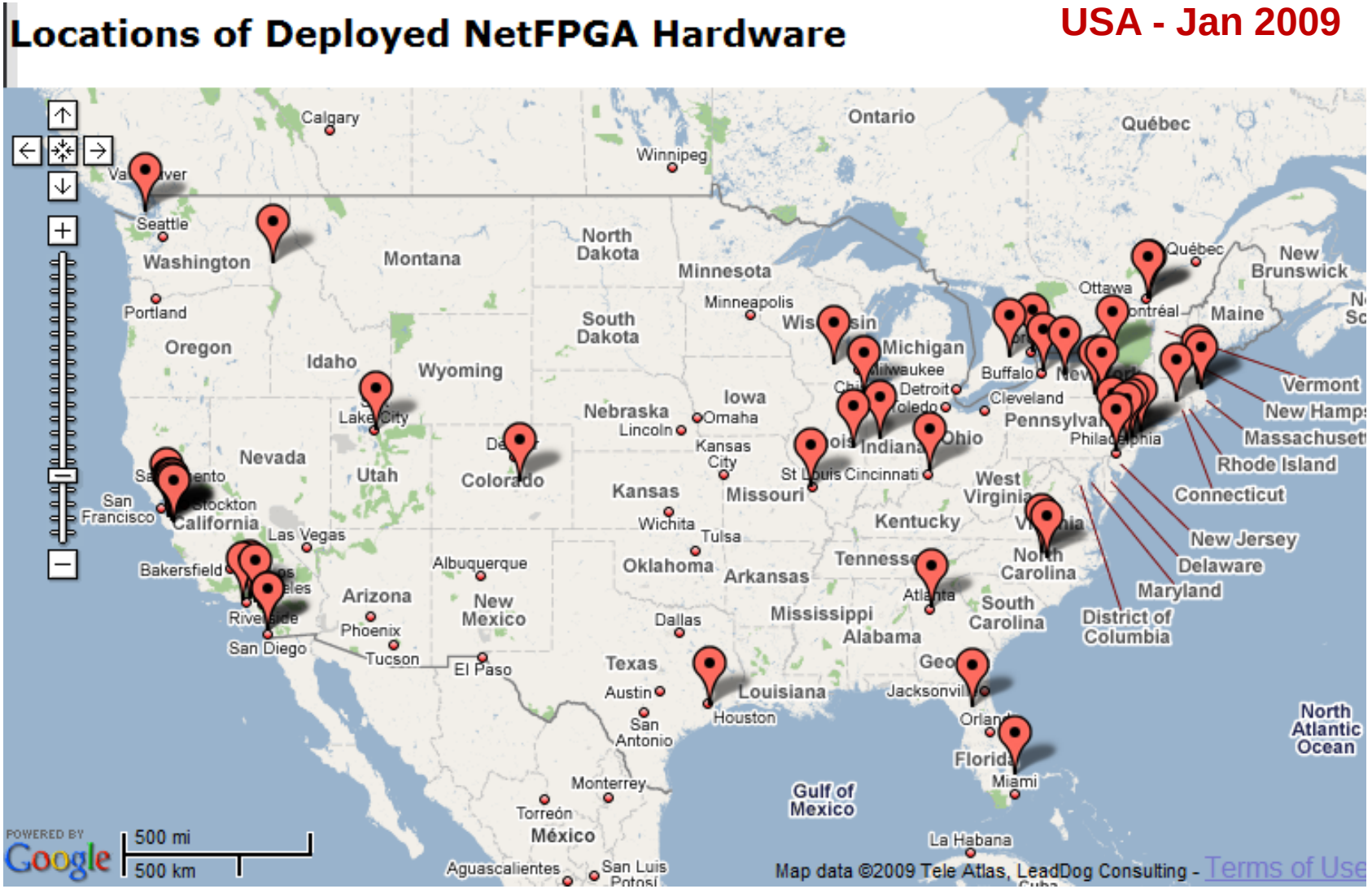
Register | FAQ | Members List | Calendar | Today's Posts | Search

Welcome to the NetFPGA Forum.

If this is your first visit, be sure to check out the FAQ by clicking the link above. You may have to register before you can post: click the register link above to proceed. To start viewing messages, select the forum that you want to visit from the selection below.

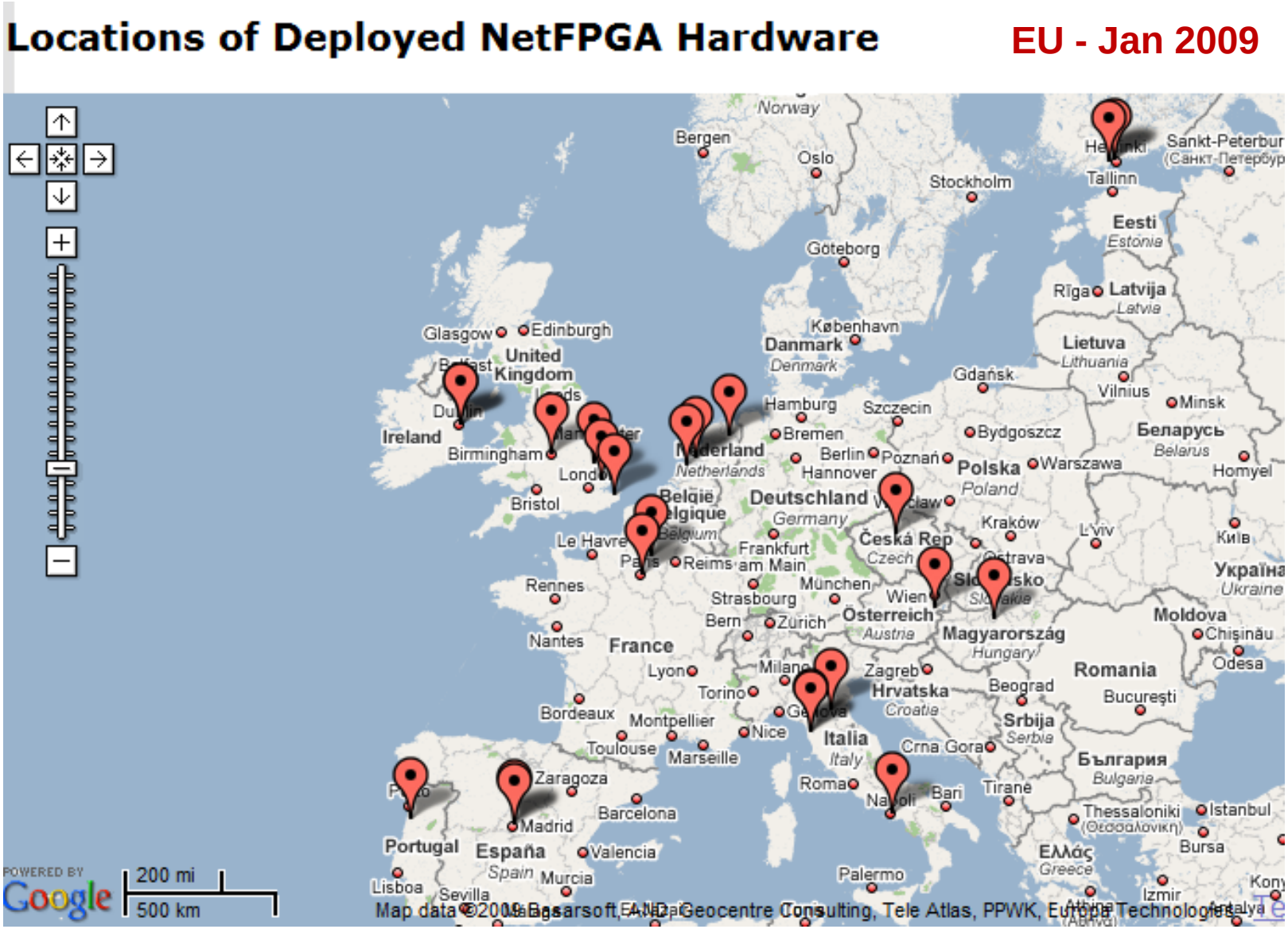
Forum	Last Post	Threads	Posts
General NetFPGA discussion A forum dedicated to general NetFPGA discussion, including installation, setup and usage.			
General Discussion General discussion forum about the NetFPGA platform	computer freezes when I... by sumeet23 02-06-2009 10:49 PM	54	209
Installation and Setup (3 Viewing) This forum should be used for discussion of installation and setup of the NetFPGA system.	"download failed" when... by Abhishek 02-07-2009 12:05 AM	39	179
Forum requests/queries Forum to request new forums/query existing forums.	Increase the flexibility in... by gac1 01-12-2009 06:57 PM	2	3
Projects Forums dedicated to specific NetFPGA projects			
Packet Generator Discussions related to the packet generator	Feature requests by grg 01-16-2009 09:56 PM	7	34

NetFPGA Hardware in North America



NetFPGA

NetFPGA Hardware in Europe



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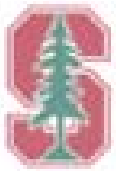
NetFPGA Hardware in Asia

Locations of Deployed NetFPGA Hardware

NetFPGA

Acknowledgements

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



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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