

Building New Networks

Diversified Networking and the Open Network Lab

Patrick Crowley

pcrowley@wustl.edu

<http://www.arl.wustl.edu/~pcrowley>



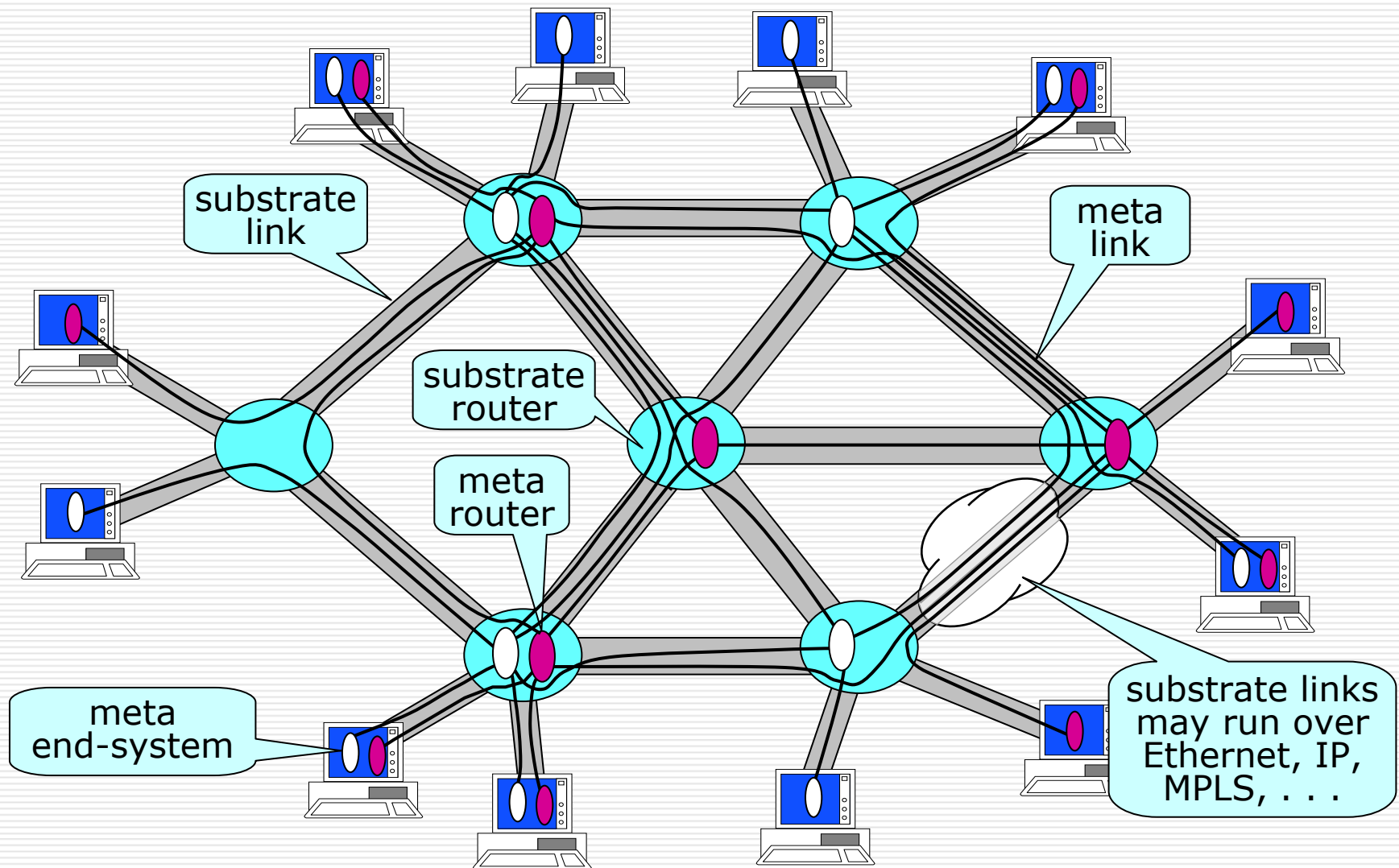
Summary

- Diversified Networking: Enabling Net Innovation
- Open Network Lab
- Note
 - » Joint work with Jon Turner and others at WU

Diversifying the Net

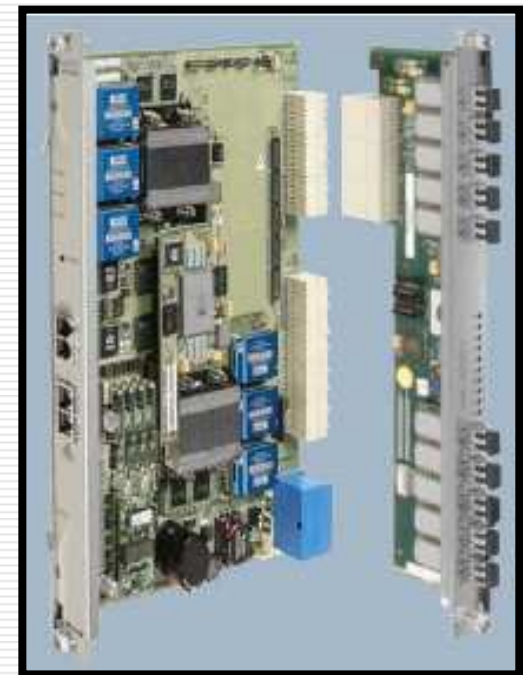
- Diversification allows many *diverse meta-networks* to co-exist within shared *substrate*.
 - » different meta-nets may differ radically
 - » no requirement that they use the same protocols
 - » enables new network architectures and services to compete
- More than just shared links.
 - » technology now makes it feasible to virtualize routers
 - » network processors and FPGAs deliver flexible packet processing
 - » virtualized switch fabrics can permit sharing with traffic isolation
- Diversification shifts the “waist of the hourglass”.
 - » new diversification layer lies just below the traditional IP layer
 - » operates over multiple layer 1 and 2 network technologies
 - » allows multiple end-to-end packet delivery systems
 - » focus of diversification layer is providing resources used by meta-networks

Diversified Networking Concepts



ATCA & NP-based Routers

- Development of ATCA enables use of commercial router components
- Radisys ATCA-7010
 - » 10 1 Gbps links
 - » 2 Intel IXP 2850 NPs
 - 17 programmable processor cores each
 - » 3 high-speed RDRAMs, 3 QDR SRAMs, 1 shared 18 Mb TCAM
- Other cards
 - » Multi-core compute blades
 - » Platform FPGAs
 - » DSPs



Radisys ATCA-7010

Node Architecture

■ ATCA Chassis

- » 14 slot chassis is typical
 - Two slots for switch fabrics
 - 12 slots for processing blades

■ General purpose blades.

- » shared blades run Plab OS
 - no change to current apps
- » also support dedicated blades
- » use separate blade server to preserve ATCA slots for NPs

■ NP blades.

- » support dedicated PEs
 - control from Vserver on PE/GP
- » shared PE options
 - shared NP for fast path

■ Line Cards:

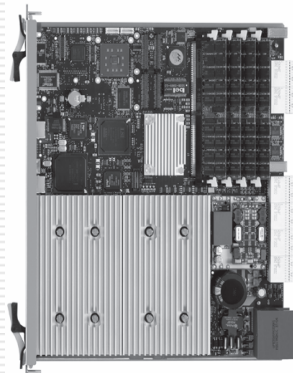
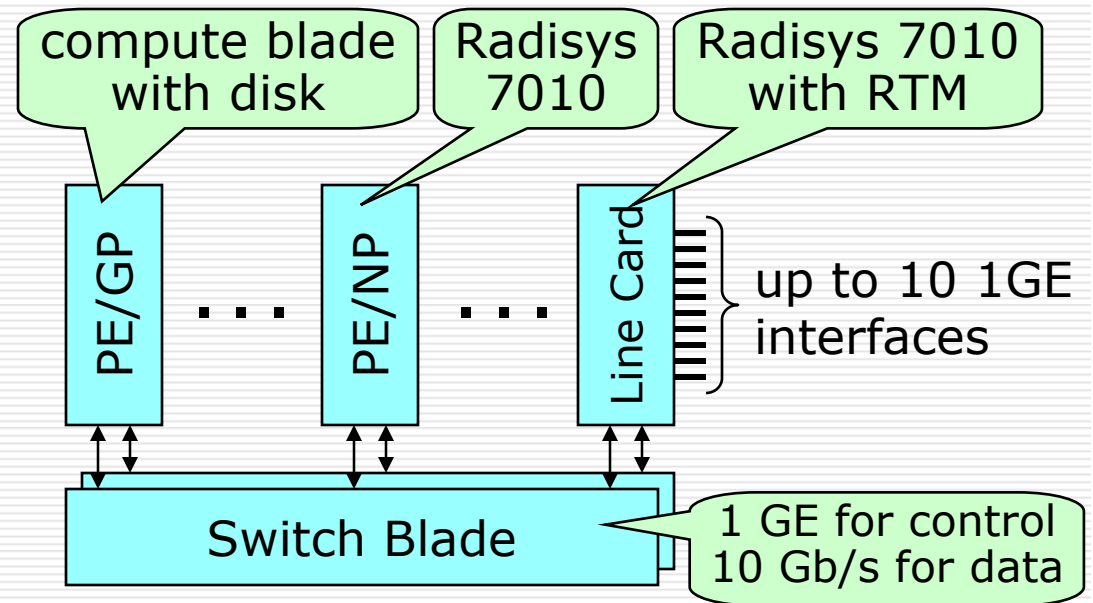
- » 10 1 GE Physical Interfaces

■ 10 GE fabric switch

- » VLANs used to isolate metarouters
- » uplinks for connecting to multiple chassis

■ Good ratio of PEs to LC: 3:1

- » 9 NP Blades, 3 LC Blades



Introduction to ONL

- What is ONL?
 - » remotely accessible networking lab
 - » gigabit routers with configurable hardware packet forwarding and embedded processors at each port
 - » routers can be remotely configured through intuitive GUI
 - » extensive support for traffic monitoring/visualization
 - » resource for network research community

- Why did we build ONL?
 - » difficult to experiment with high performance routers
 - commercial routers are not open
 - open PC routers have limited performance & experiments using them may have limited relevance to high performance routers
 - » net research community needs better experimental resources

- What can you do with ONL?
 - » evaluate new and existing protocols & apps in realistic testbed
 - » add new features to routers (embedded processors, hw mods)
 - » mount compelling demonstrations using real-time visualization

Sample ONL Session

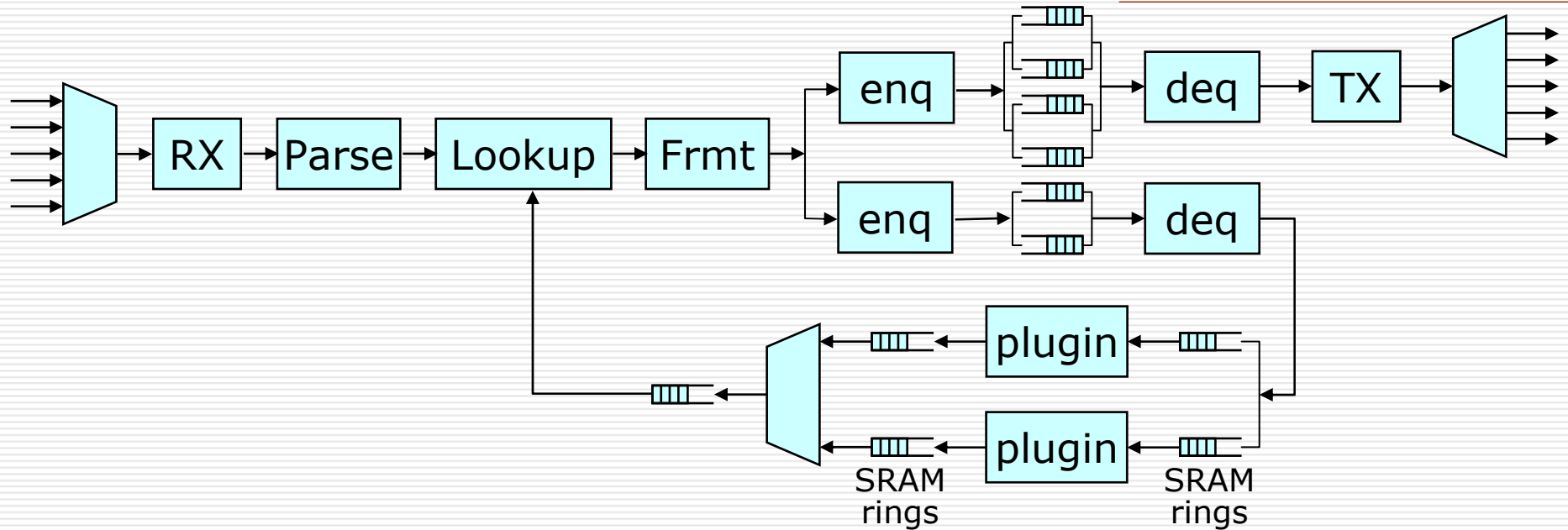
The screenshot displays the Remote Laboratory Interface (RLI) with several key components:

- Network Configuration:** A central diagram showing three NSP routers (NSP1, NSP2, NSP3) connected to various hosts (n1p1-n1p6, n2p1-n2p6, n3p1-n3p6) and GigE switches.
- Bandwidth Usage:** A graph showing bandwidth usage over time (secs) with a callout bubble labeled "Bandwidth Usage".
- Queues:** A graph showing queue lengths over time (secs) with a callout bubble labeled "Queue Length".
- Routing Tables:** A window titled "NSP1:port3 Route Table (60)" showing a list of routes with columns for prefix/mask, next hop, and stats. A callout bubble labeled "Routing Tables" points to this window.
- Queue Parameters:** A window titled "Port 6 Queues" showing parameters for VOQs and Egress Queues. A callout bubble labeled "Queue Parameters" points to this window.
- Terminal:** A terminal window showing a ping command and its output, along with a callout bubble labeled "Network Configuration".

Terminal Output:

```
[jst@onl02 ~]$ jobs
[2] + Suspended          ping n3p2
[3]   Running            iperf -c n2p2 -u -b 100m -t 300
[jst@onl02 ~]$ fg
ping n3p2
64 bytes from n3p2 (192.168.3.48): icmp_seq=172 ttl=62 time=0.267 ms
64 bytes from n3p2 (192.168.3.48): icmp_seq=173 ttl=62 time=0.254 ms
64 bytes from n3p2 (192.168.3.48): icmp_seq=174 ttl=62 time=0.242 ms
64 bytes from n3p2 (192.168.3.48): icmp_seq=175 ttl=62 time=0.240 ms
64 bytes from n3p2 (192.168.3.48): icmp_seq=176 ttl=62 time=0.241 ms
64 bytes from n3p2 (192.168.3.48): icmp_seq=177 ttl=62 time=0.236 ms
```


NP-Based Router Design



- Dual 5 port router configuration
 - » each NPU handles 5 GE ports
 - » allocate in pairs to maintain isolation between experiments
 - » “excess” micro-engines available for plugins
- Users extend via plugins, or modifying design

Getting Started w/ ONL

Open Network Laboratory (ONL) - Mozilla Firefox

File Edit View Go Bookmarks Tools Help del.icio.us

http://www.onl.arl.wustl.edu/

Open Net Lab

Information:

- [ONL VIDEO](#)
- [Announcements](#)
- [ONL in Courses](#)
- [Tutorial](#)
- [System Documents](#)
- [Presentations](#)
- [Contacts](#)
- [Get an account](#)

ONL Users:

Username:

Password:

Supported by the National Science Foundation (CNS 0230826)

53368 Hits (3/17/2005)

Done

Open Network Laboratory

A Resource for Networking Research

Take a look at this [ONL video](#) - *Real-Time Displays, Router Plugins and Much Much More !* (Your browser must have a media player plugin. The file is 40MB.)

We are now accepting new users.

... in the sidebar and follow the instructions.

The Open Network Laboratory is a resource for the networking research and educational communities, designed to enable experimental evaluation of advanced networking concepts in a realistic working environment. It is supported by a grant from the *National Science Foundation* (CNS 0230826). The laboratory is built around a set of open-source, extensible, high performance routers that have been developed at Washington University, and which can be accessed by remote users through a Remote Laboratory Interface (RLI). The RLI allows users to configure the testbed network, run applications and monitor those running applications using the built-in data gathering mechanisms that the routers provide. The RLI also allows users to extend, modify or replace the software running in the routers' embedded processors so that it can be dynamically reconfigured to support new capabilities. In the future, the RLI will also allow users to similarly extend, modify or replace the routers' hardware, which is implemented largely using Field Programmable Gate Arrays. The RLI provides support for data visualization and real-time remote displays, allowing users to develop the insights needed to understand the behavior of new capabilities within a complex operating environment. The testbed routers are built around a scalable switch fabric and are architecturally similar to high performance commercial routers. This enables researchers