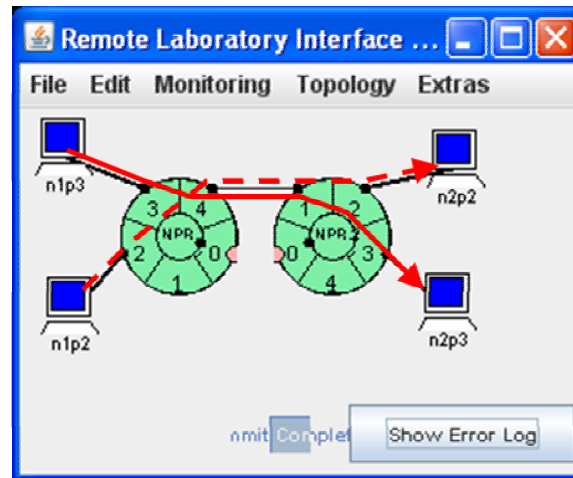


Open Network Laboratory



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TA: CSE 473S (Fall 2010)

Introduction to Computer Networks

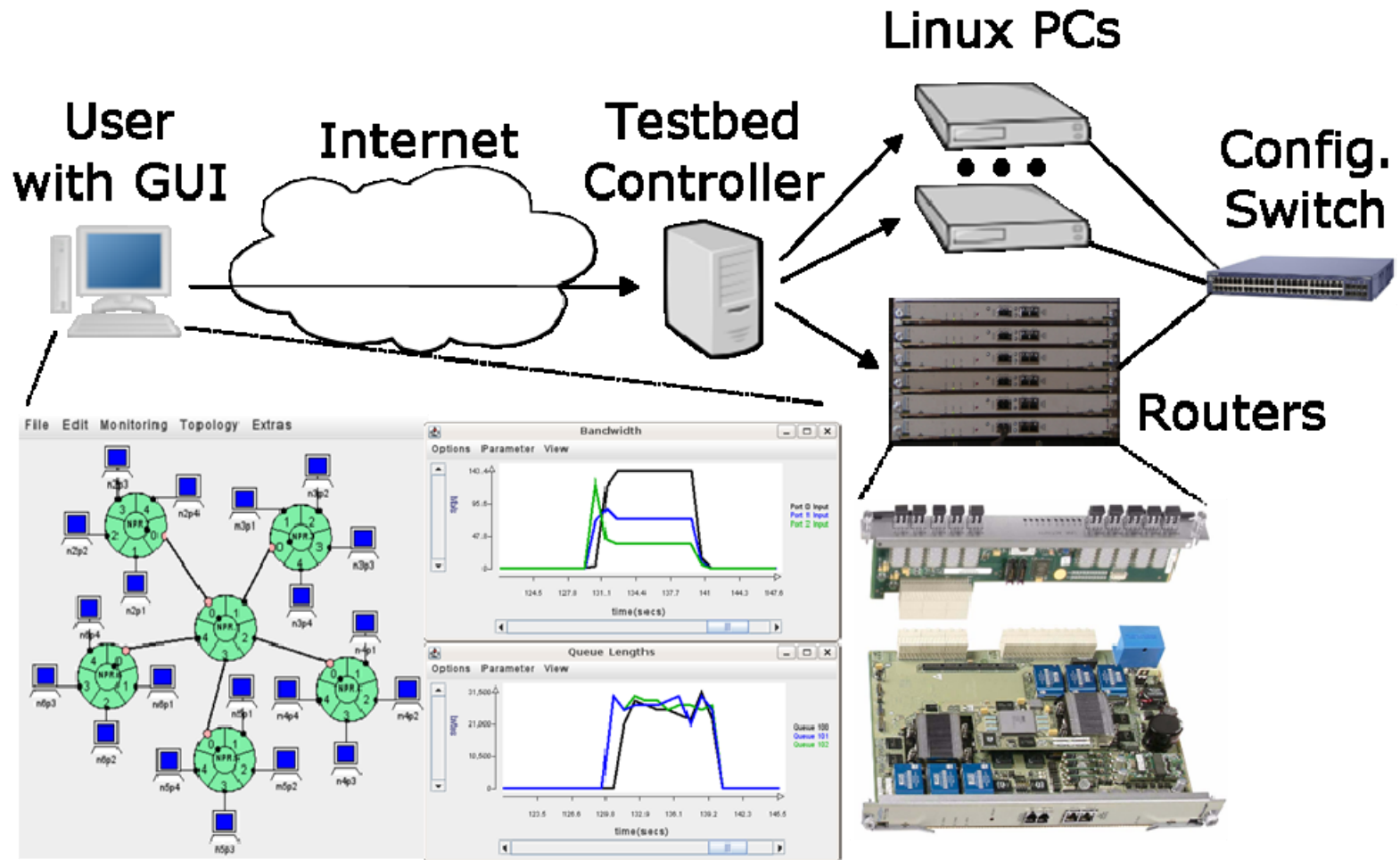
These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse473-10/>

Outline

1. Open Network Laboratory (ONL)
2. Remote Laboratory Interface (RLI)
3. ONL accounts
4. SSH tunneling
5. Network interfaces
6. Routing and forwarding
7. Running ONL experiment
8. Lab assignments
9. Summary

Overview of ONL



Open Network Laboratory (ONL)

ONL - Remotely accessible gigabit network testbed

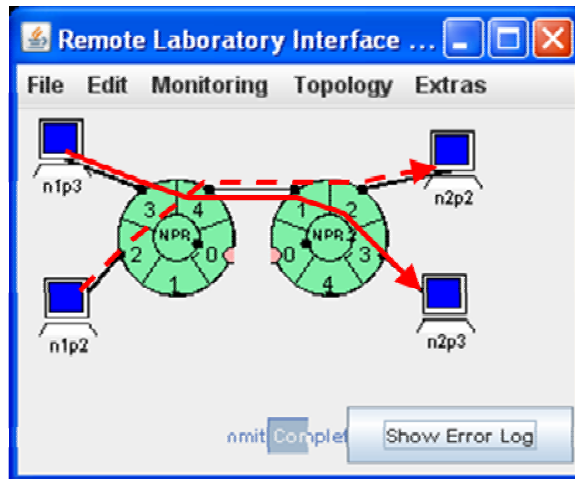
Infrastructure

- ❑ Routers (NSP, NPR)
- ❑ 1-core and 8-core hosts
- ❑ Gigabit Ethernet switches
- ❑ NetFPGAs
- ❑ Gbps links
- ❑ Filters, Plugins, Packet scheduling
- ❑ Remote laboratory interface (RLI)

What can you do with ONL

- ❑ Configure experiments
- ❑ Real-time data visualization
- ❑ Evaluate protocols & applications
- ❑ Hands-on experience with real hardware

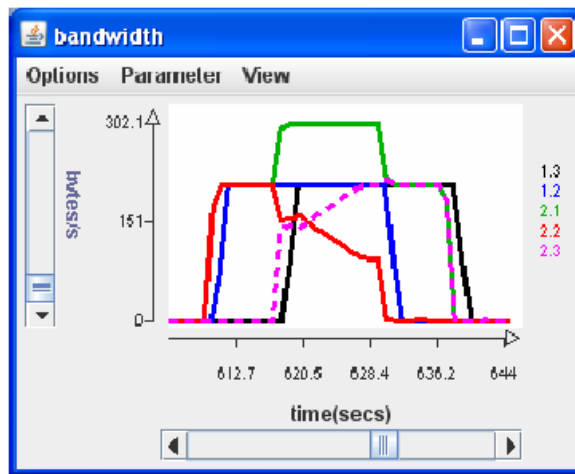
Remote Laboratory Interface (RLI)



Configure network topology

prefix/mask	next hop	stats
192.168.1.16/28	0	44
192.168.1.32/28	1	45
192.168.1.48/28	2	46
192.168.1.64/28	3	47
192.168.1.80/28	4	48
192.168.2.0/24	4	49

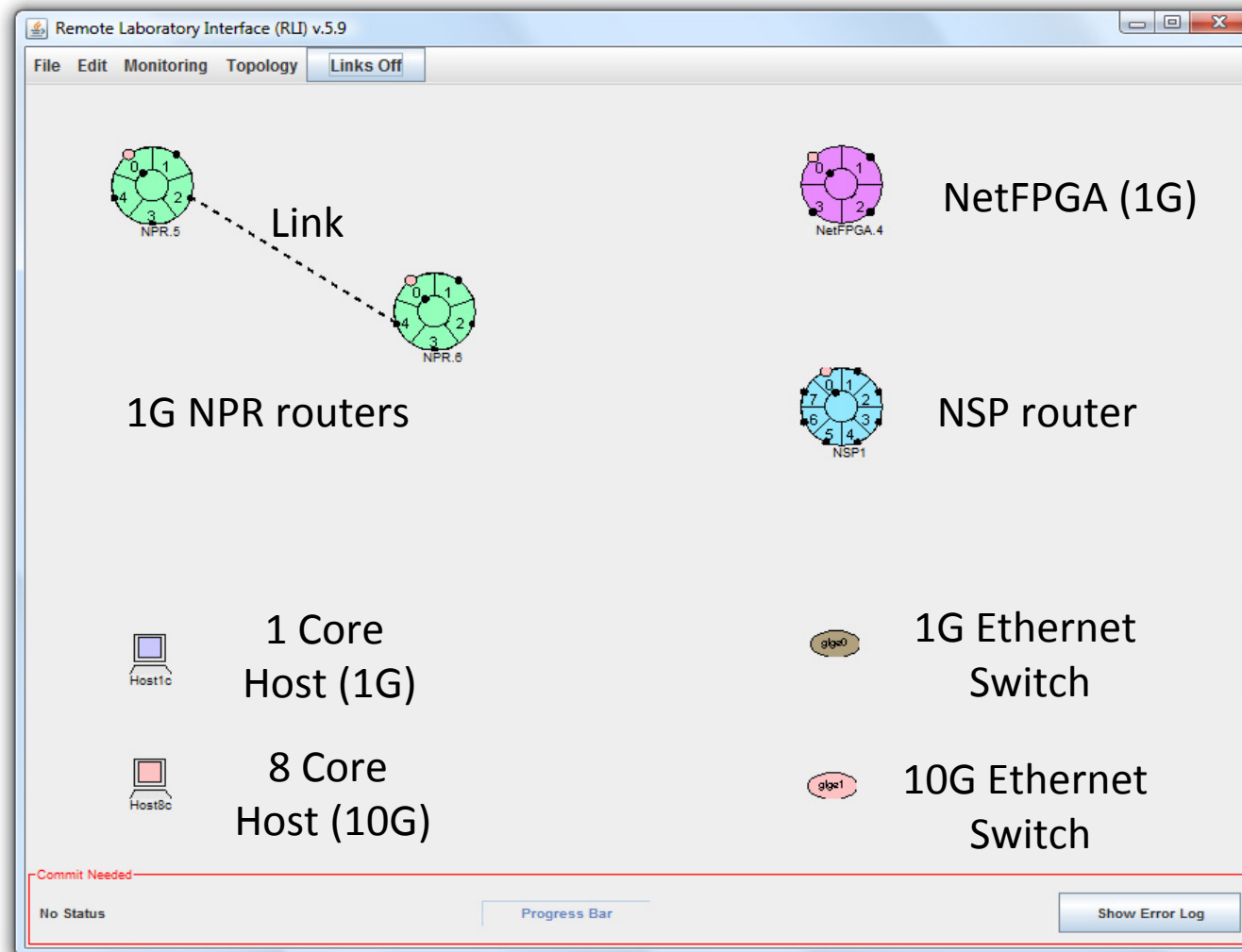
Routing and forwarding



Real-time charts

Adding filters

Hardware as It Appears on RLI



ONL Accounts

- ❑ Username and password will be provided
- ❑ Same password for web login and host login
- ❑ Host account restrictions
 - ❑ Firewall blocks all connections from within ONL
 - ❑ SSH to onl.arl.wustl.edu from remote host
 - ❑ Only access hosts assigned to your experiment
- ❑ Password-free SSH between ONL hosts

SSH Tunnel Configuration

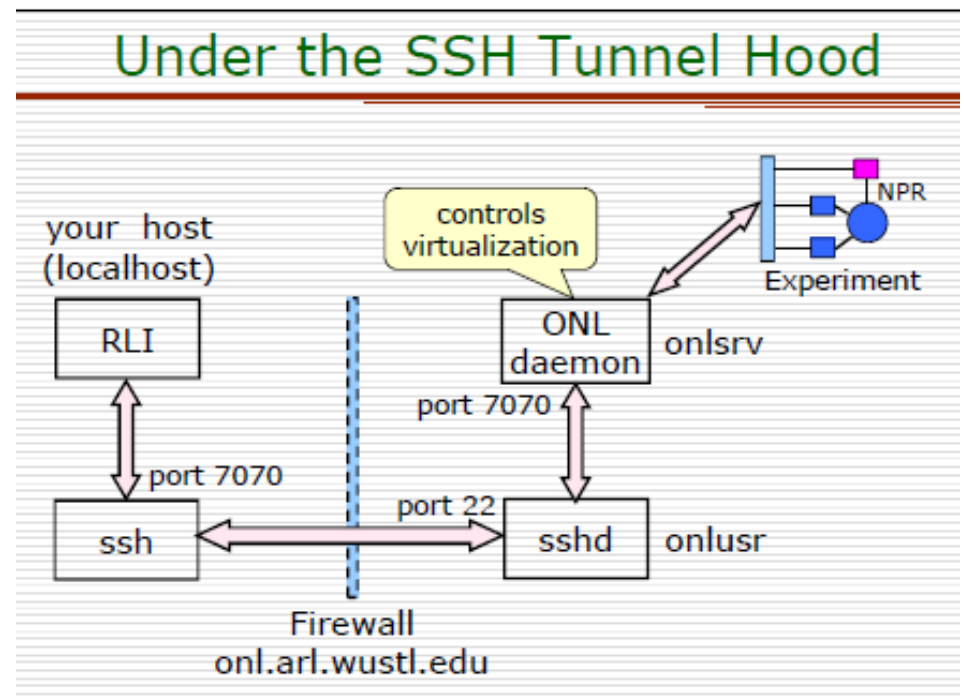
- Build before each experimental session
- Allows your RLI to communicate with ONL daemon
- Needed to make reservation and commit experiment
- SSH tunneling

- Unix or Unix-like command line

- `ssh -L 7070:onlsrv:7070 username@onl.arl.wustl.edu`

- Windows PuTTY
- Windows SSH client

- *Getting Started, RLI SSH Tunneling*



Running an Experiment

1. Create local directory *.onldir* on your machine
2. Download latest *RLI.jar* file and put in *.onldir*
3. Launch RLI (double click or run *java -jar RLI.jar*)
4. Open or create network topology
5. Build SSH tunnel to *onl.arl.wustl.edu*
6. Make reservation for resources
7. Commit network topology
8. Monitor your experiment
9. Commit after any topology modification
10. Completed experiment
Save & close topology, exit RLI

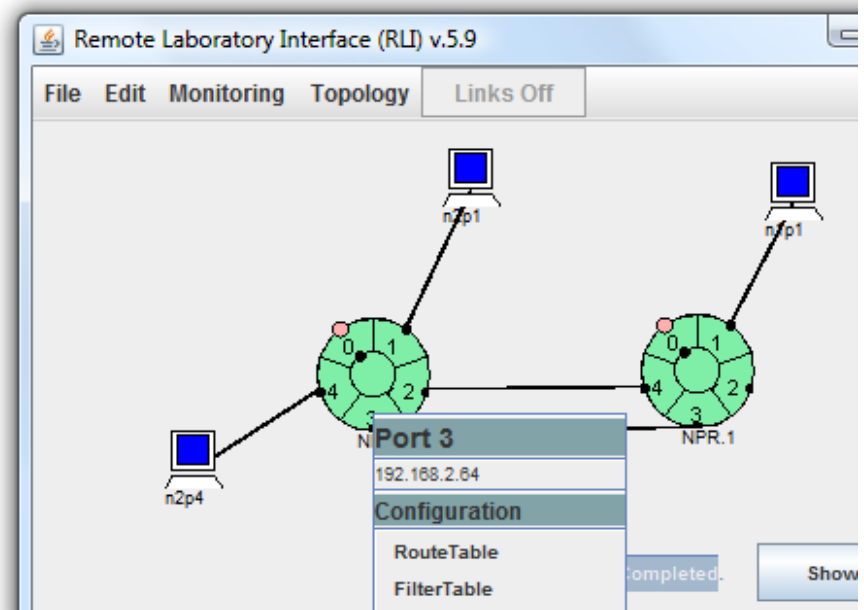
Network Interfaces

After commit, ONL hosts have two network interfaces:

- ❑ Control network interface name (e.g. pc1core49)
- ❑ Internal data network interface IP address (e.g. 192.168.1.65)

Port Y of NPR X gets an IP address of the form 192.168.X.Z

- ❑ nXpY is interface name of host attached to port Y of NPR X
- ❑ Y is the port number
- ❑ X is the logical NPR number
- ❑ $Z=16*(Y+1)$



Routing and Forwarding

The screenshot displays the Remote Laboratory Interface (RLI) v5.9. The main window shows a network topology with two nodes, NPR.1 and NPR.2, connected to each other and to three external hosts (n2p1, n2p4, n2p1). Below the topology, a 'Commit Completed.' message and a 'Show Error Log' button are visible.

Three route tables are shown in the bottom row:

- NPR.2:port1 RouteTable:**

prefix/mask	nexthop	stats
192.168.2.16/28	0	6
192.168.2.32/28	1	7
192.168.2.48/28	2	8
192.168.2.64/28	3	9
192.168.2.80/28	4	10
192.168.1.0/24	2	27
- NPR.2:port2 RouteTable:**

prefix/mask	nexthop	stats
192.168.2.16/28	0	11
192.168.2.32/28	1	12
192.168.2.48/28	2	13
192.168.2.64/28	3	14
192.168.2.80/28	4	15
192.168.1.0/24	2	28
- NPR.1:port4 RouteTable:**

prefix/mask	nexthop	stats
192.168.1.16/28	0	21
192.168.1.32/28	1	22
192.168.1.48/28	2	23
192.168.1.64/28	3	24
192.168.1.80/28	4	25
192.168.2.0/24	4	30
- NPR.1:port1 RouteTable:**

prefix/mask	nexthop	stats
192.168.1.16/28	0	6
192.168.1.32/28	1	7
192.168.1.48/28	2	8
192.168.1.64/28	3	9
192.168.1.80/28	4	10
192.168.2.0/24	4	27

Lab Assignments

Objective: Hands-on experience & apply concepts

Lab assignment 1:

- ❑ Familiarize with ONL through ONL tutorial
- ❑ Network topology, packet path (forwarding), link capacity

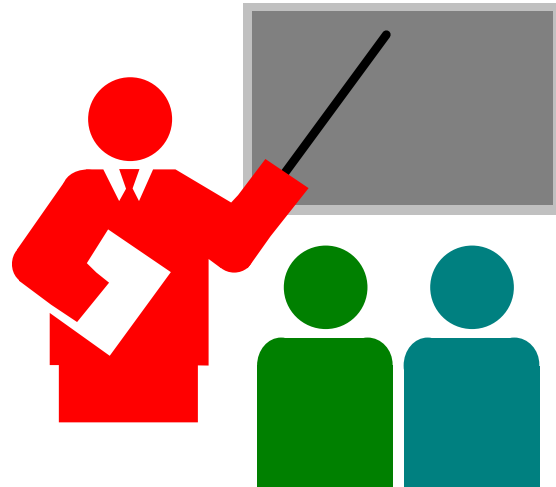
Lab assignment 2:

- ❑ Transmit and monitor packet traffic
- ❑ Routing (edit routing table)
- ❑ Analyze behavior of a queue

Lab assignment 3:

- ❑ XSTCP protocol

Summary



- ❑ ONL - Remotely accessible gigabit network testbed
- ❑ RLI – Remote laboratory interface for ONL
- ❑ Labs - Hands-on experience & apply concepts
- ❑ Work on your labs as soon as possible, do not wait until the last minute