



2023 Internet2 Technology Exchange Science DMZs and Networking for All

End-to-end monitoring with
perfSONAR, NETLAB platform

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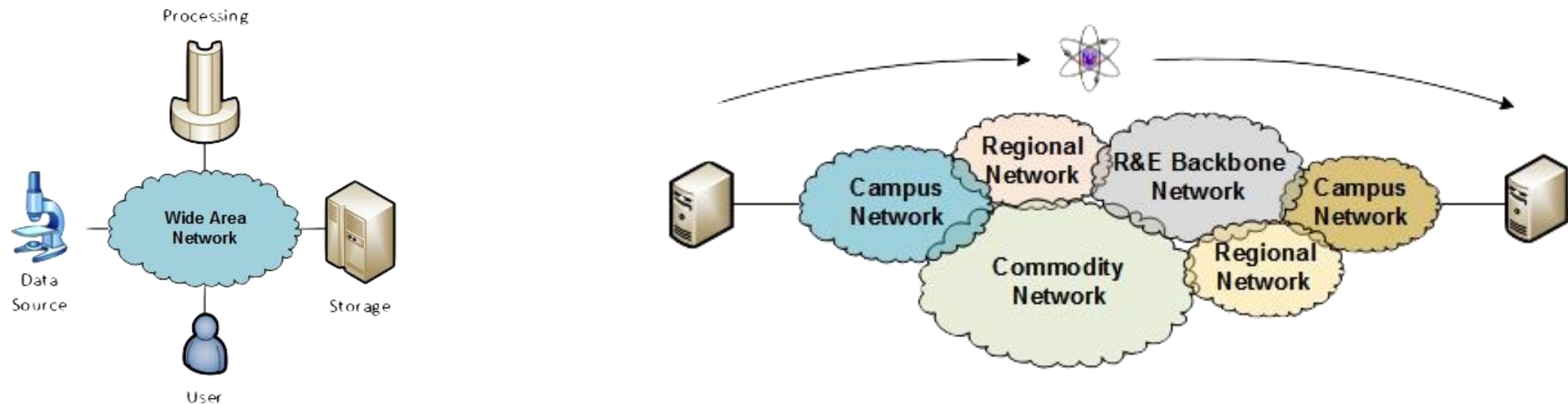


Agenda

- Motivation
- Soft Network Failures
- Hard Network Failures
- Network Monitoring
- End-to-end Monitoring with perfSONAR
- perfSONAR 5 Lab Library
- Organization of the Labs
- Netlab Platform
- Accessing the Platform

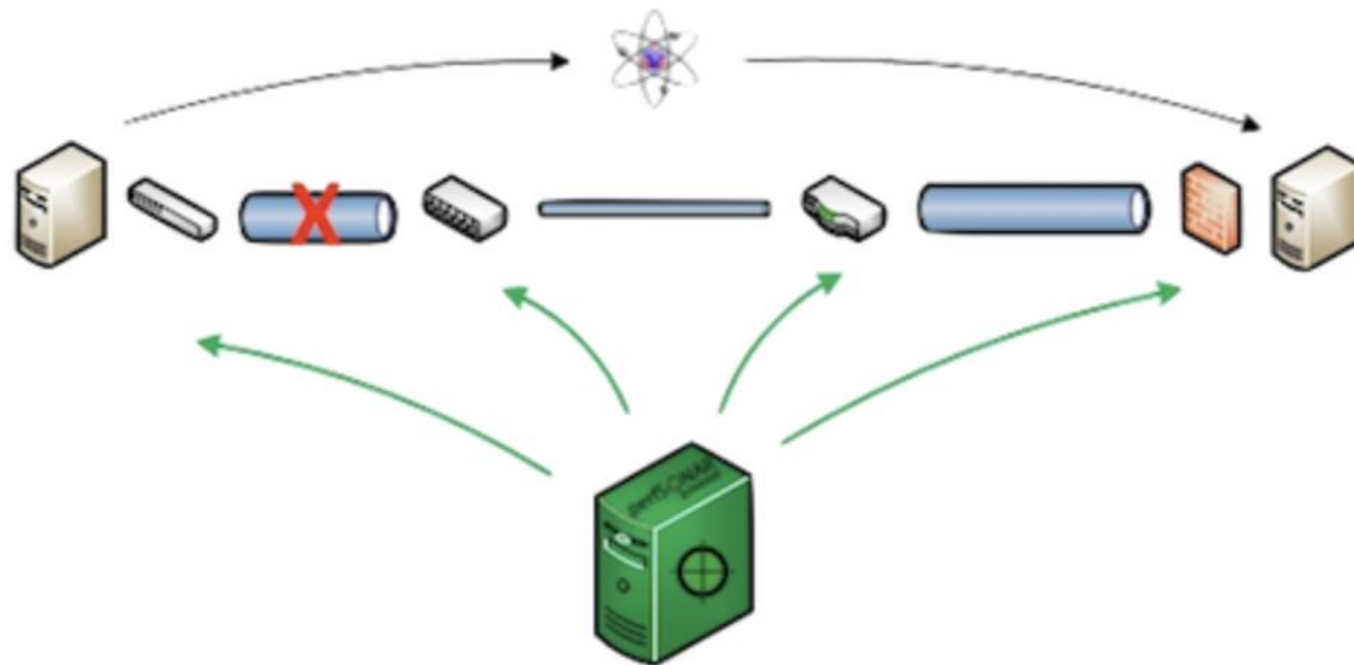
Motivation

- The global Research & Education network ecosystem is comprised of hundreds of international, national, regional, and local-scale resources
- Each of them is owned and operated independently
- This complex, heterogeneous set of networks must operate seamlessly from “end to end” to support science and research collaborations
- Typically, this type of collaboration is distributed globally



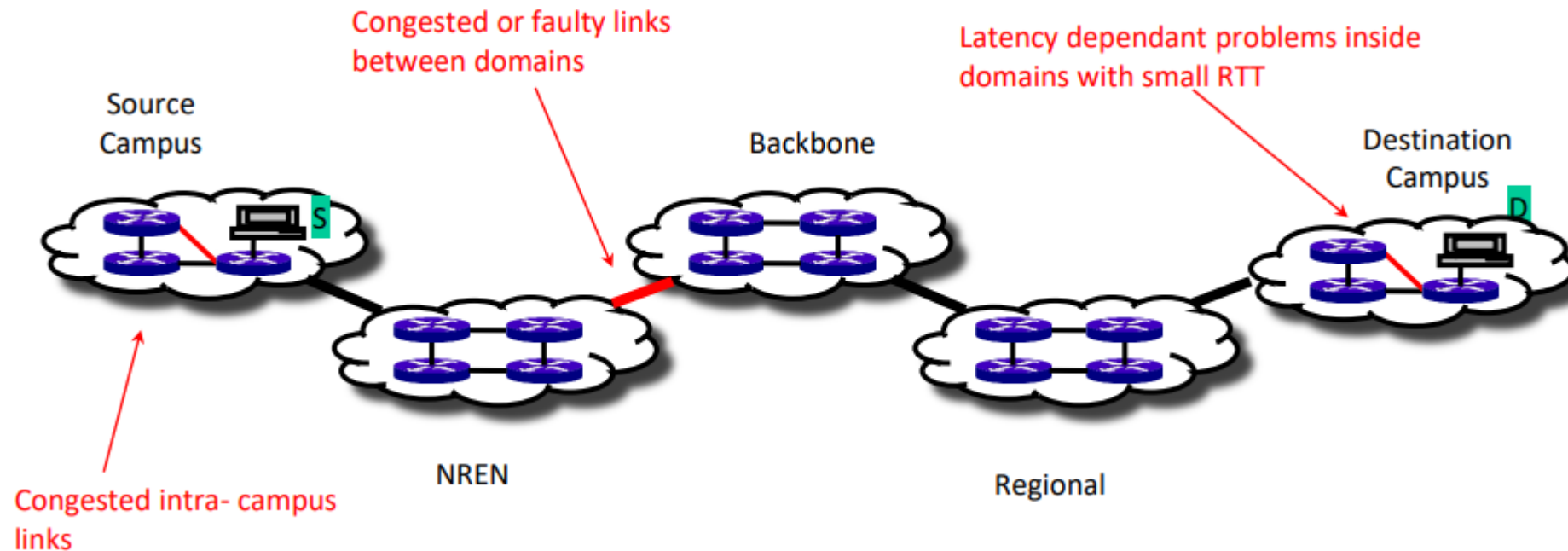
Motivation

- Organizations must understand the behavior of their network by monitoring the performance metrics to ensure that the underlying system is functional
- In large systems, there will be something that will cause performance issues
- We need tools to identify these problems



Motivation

- Network issues can have different sources and locations
- Performing local testing might not find the cause of these problems



Hard Network Failures

- On the other hand, hard failures are easy to detect & fix
- These types of failures are easy to understand
 - Fiber cut
 - Power failure takes down routers
 - Hardware malfunction
- Classic monitoring systems are good at alerting hard failures
- For example, the network operator visualizes an alert in the system's dashboard

Soft Network Failures

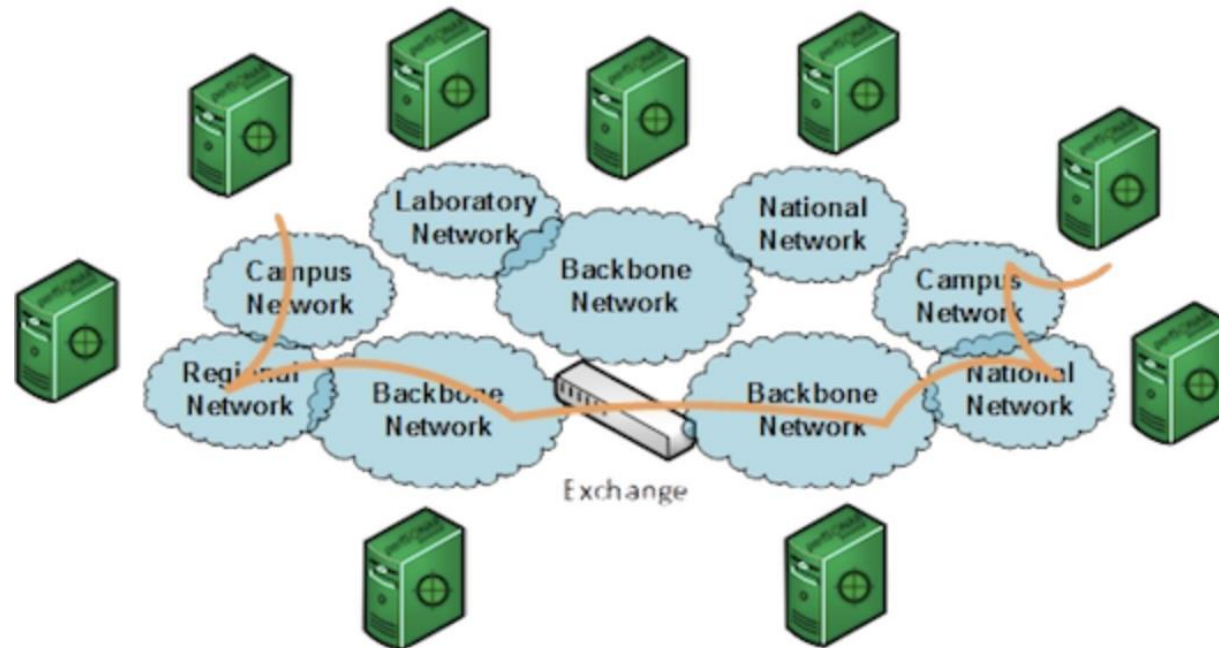
- Soft failures affect basic connectivity functions (e.g., long delays, packet losses)
- High performance is not possible
- For example, TCP was intentionally designed to hide all transmission errors from the user
- Some soft failures only affect high bandwidth long RTT flows
- Soft failures are difficult to detect and fix
- They can be hidden for years and cause resource underutilization

Network Monitoring

- All network operators perform monitoring tasks in their organizations
- These monitoring tasks results in getting insights into the network behavior
- perfSONAR orchestrates and automates regular network measurements

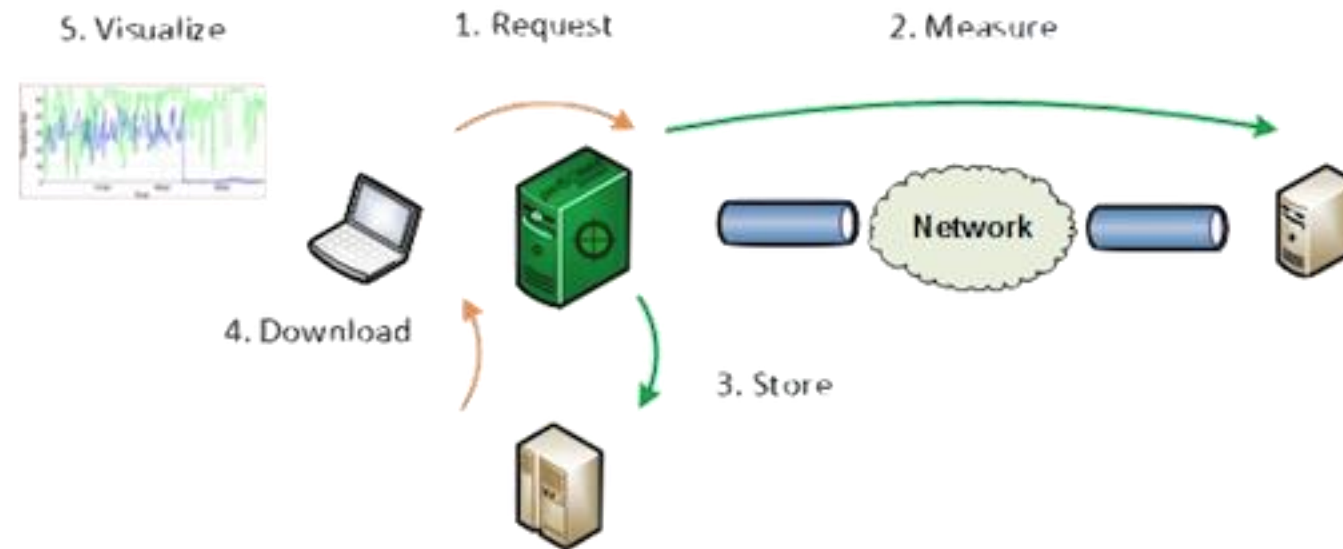
End-to-end Monitoring with perfSONAR

- perfSONAR is a network measurement tool designed to provide federated coverage of paths and help to achieve end-to-end usage expectations
- The tool facilitates diagnosing, visualizing, and troubleshooting network performance issues



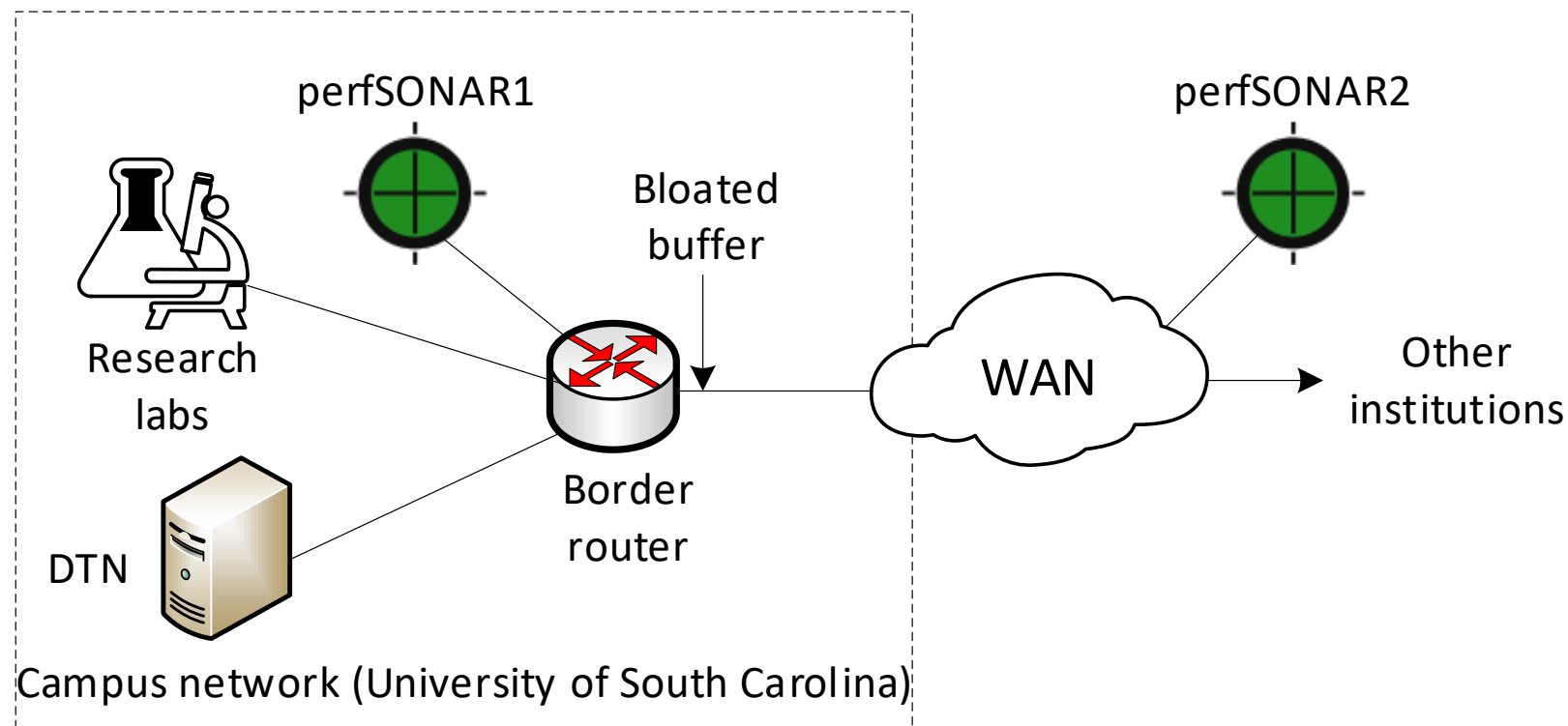
End-to-end Monitoring with perfSONAR

- perfSONAR aims at providing a snapshot of the network performance to allow researchers to perform large data transfers and enhance collaboration
- Key metrics such as throughput, latency, and packet losses are collected by perfSONAR nodes and displayed in a dashboard

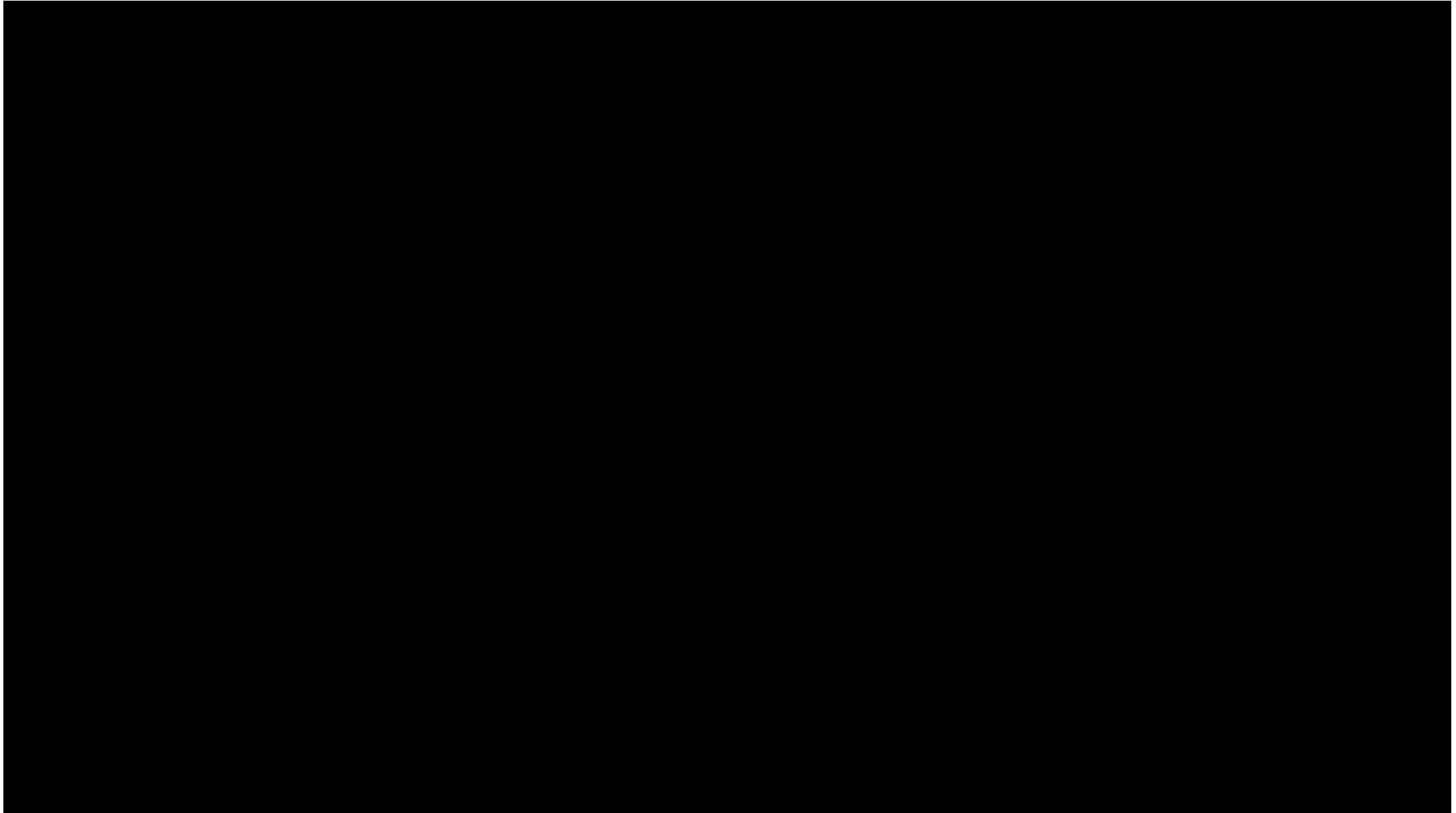


Use case: RTT Unfairness

- Data transfers from the University of South Carolina experienced high delay
- perfSONAR was used to identify that the cause of this issue was bufferbloat

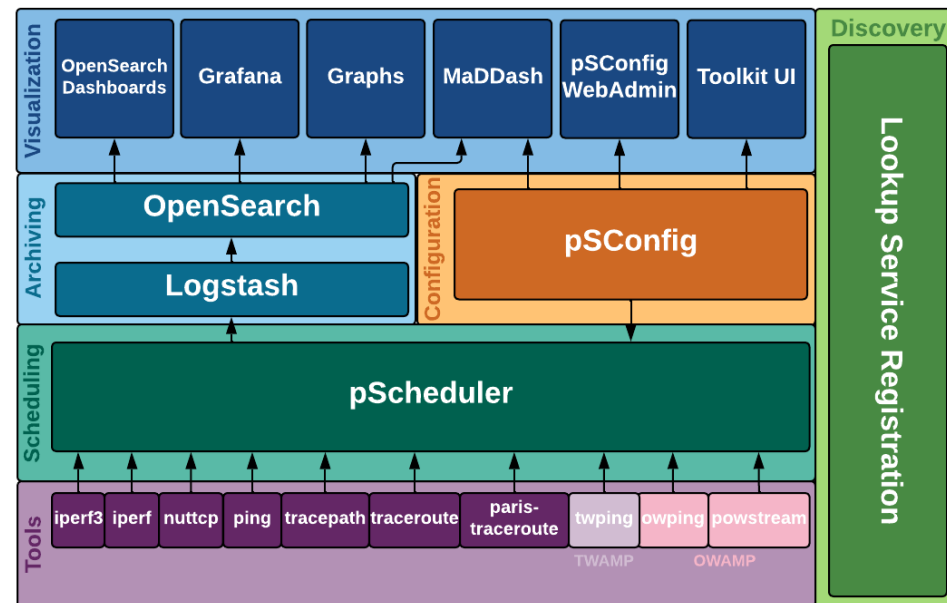


Use case: RTT Unfairness



perfSONAR 5 Lab Library

- The perfSONAR lab library aims to guide users through hands-on lab activities covering different components of the perfSONAR tools
- The library is divided into two parts:
 - Part 1 demonstrates the usage of basic perfSONAR components, including pScheduler, pSConfig, the web interface, and the Grafana dashboard
 - Part 2 focuses on using perfSONAR as a debugging tool for diagnosing network issues



perfSONAR layers

perfSONAR 5 Lab Library

- The labs are based on perfSONAR version 5, running within a Docker container for easy setup and management.
- Network topologies for the labs are implemented using Mininet, allowing users to emulate various network configurations.
- Virtual pods are available through the Netlab platform.

perfSONAR 5 Lab Library

- Part 1: Understanding perfSONAR's components
 - Lab 1: Introduction to Mininet
 - Lab 2: Setting Administrative Information via perfSONAR Toolkit GUI
 - Lab 3: Scheduling Regular Tests Using perfSONAR GUI
 - Lab 4: Configuring Regular Tests Using pScheduler CLI Part I (throughput, latency, and traceroute)
 - Lab 5: Configuring Regular Tests Using pScheduler CLI Part II (repeat, store, monitor, and cancel)
 - Lab 6: Defining Regular Tests with a pSConfig Template
 - Lab 7: Configuring pScheduler Limits
 - Lab 8: Visualizing pScheduler Measurements using Grafana
- Part 2: Using perfSONAR as a debugging tool
 - Lab 9: Observing the Impact of TCP Window Scaling and Small TCP Buffer Sizes
 - Lab 10: Investigating the Effects of MTU Mismatch

Organization of the labs

Each lab starts with a section *Overview*

- Objectives
- Lab topology
- Lab settings: passwords, device names
- Roadmap: organization of the lab

Section 1

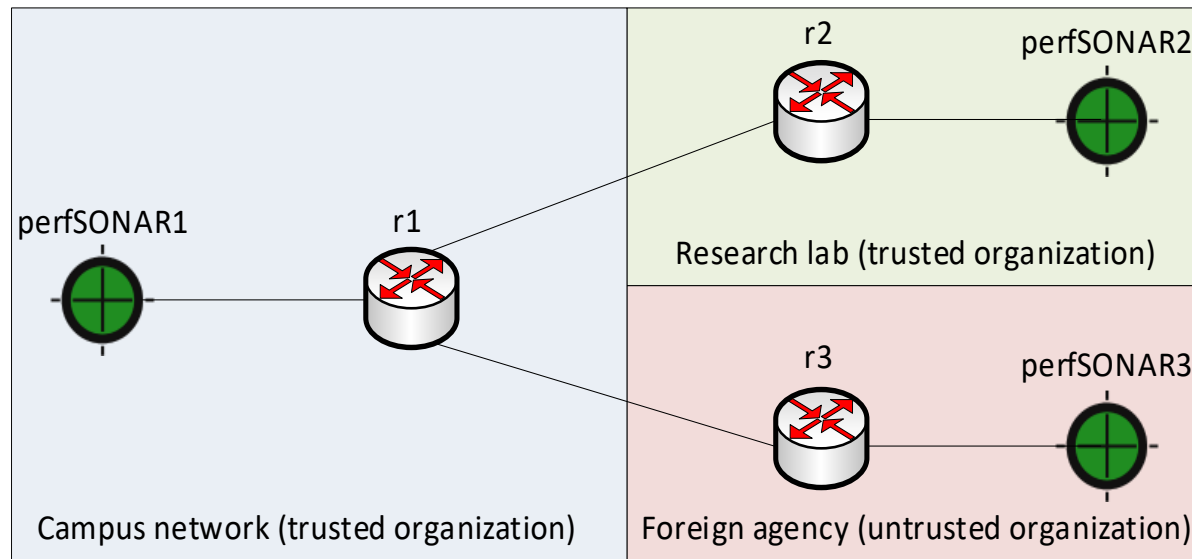
- Background information of the topic being covered (e.g., fundamentals of perfSONAR)
- Section 1 is optional (i.e., the reader can skip this section and move to lab directions)

Section 2... n

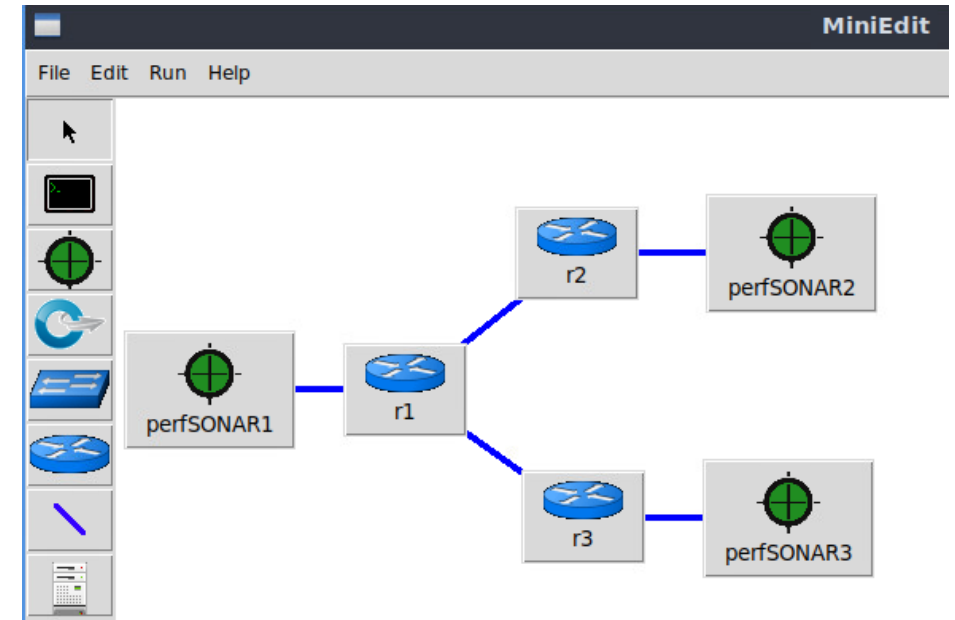
- Step-by-step directions

Netlab Platform

- The perfSONAR labs are implemented using Mininet, a network emulator capable of reproducing realistic network scenarios
- MiniEdit, a user-friendly GUI network editor for Mininet, enables the creation of custom topologies tailored to specific lab requirements
- These labs are designed to run efficiently on a single virtual machine (VM), making them easily shareable among users



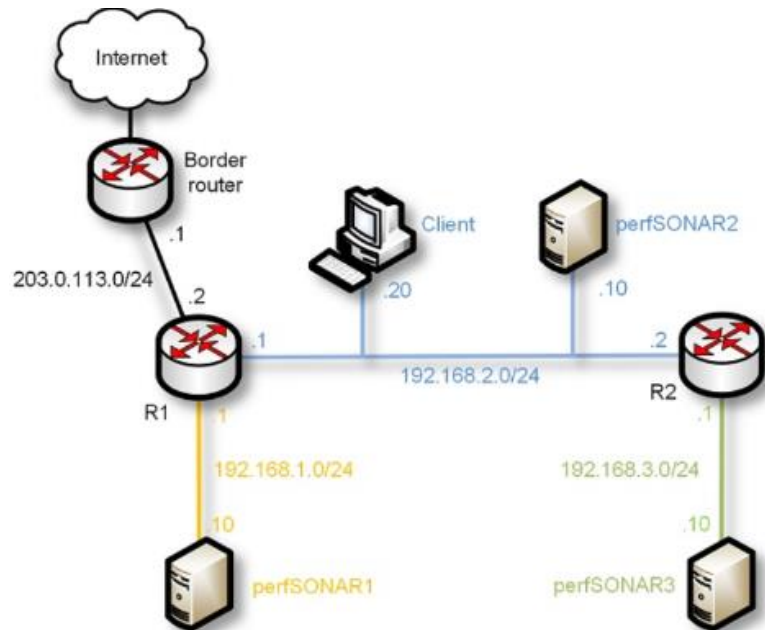
Lab scenario



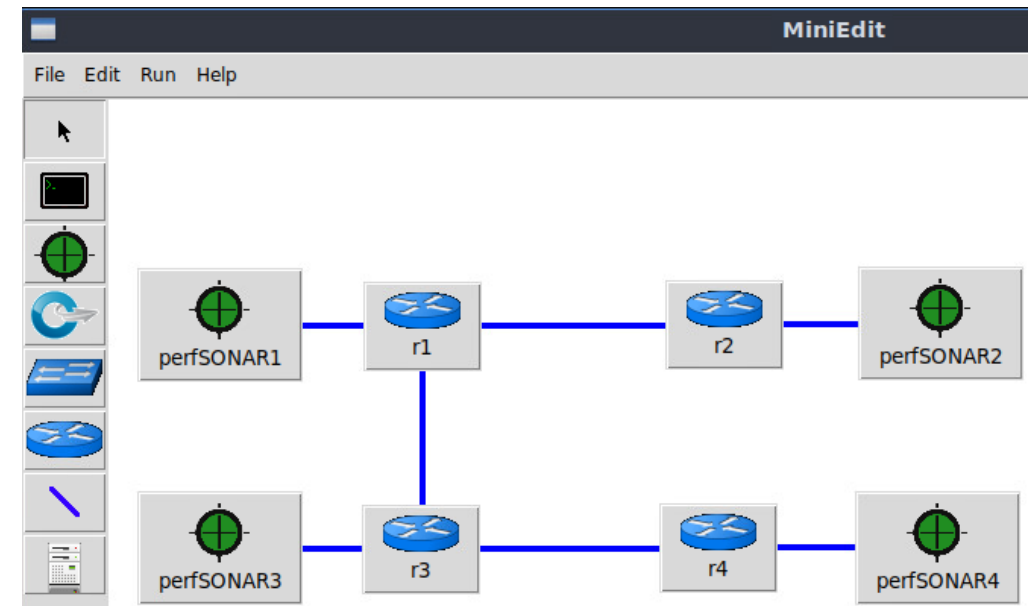
Mininet topology

Improvements

- The current perfSONAR lab library is based on perfSONAR5
- The labs run efficiently on a single VM
- This advancement facilitates seamless sharing of the lab environment with experimenters and reduces resource requirements
- This version can seamlessly integrate with container technologies, enabling the use of P4 switches, firewalls, and other containerized elements in the network environment



Pod used for the previous perfSONAR version

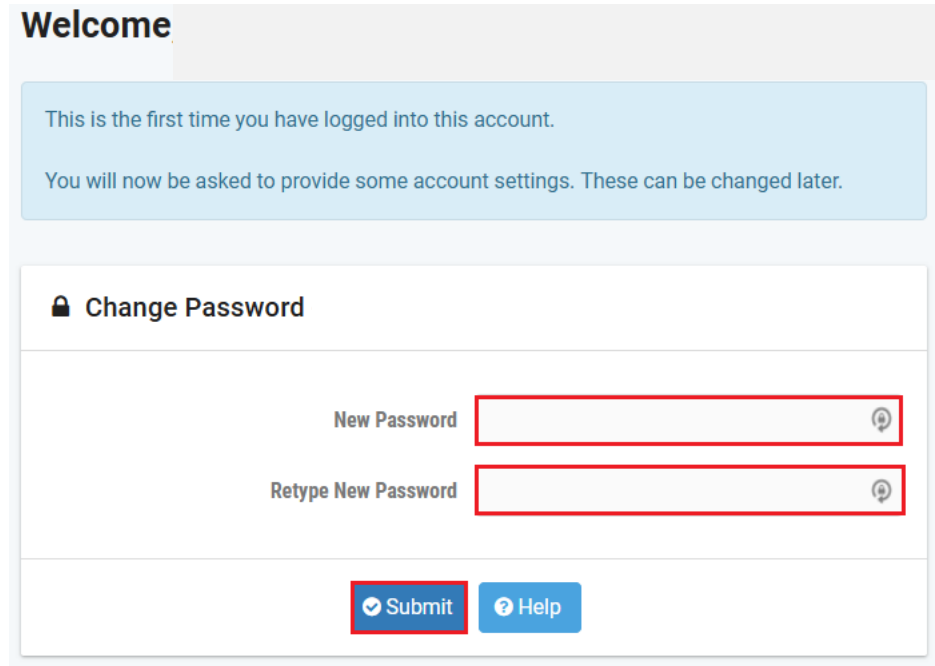


Topology used for a lab in the current version

Additional Slides

Accessing the Platform

- Please use the following link to access the platform:
 - <https://netlab.cec.sc.edu/>
- Login using your credentials
- **Username:** user1, user2,, userN
- **Temporary Password:** nsf2023



Cyberinfrastructure
Lab @ UofSC

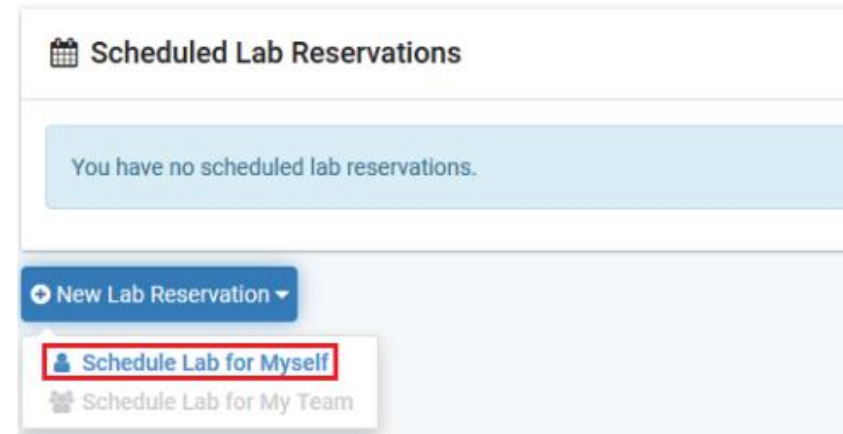
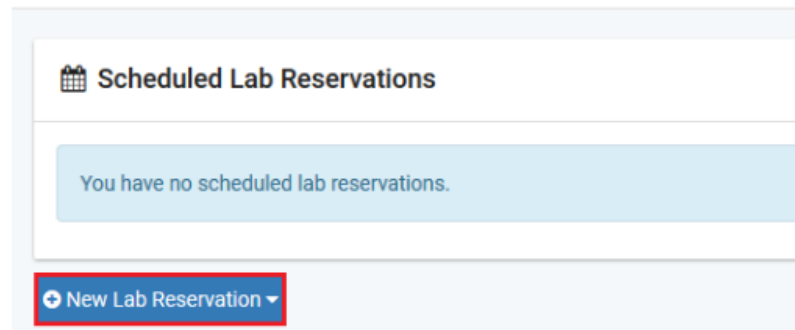
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The image shows two screenshots of a web application interface, connected by a large orange arrow pointing from left to right. The left screenshot is titled 'Change E-mail Address' and features a light blue header with the text 'Please enter a valid e-mail address.' and 'You can leave this blank if you do not want to receive e-mail from the system.' Below this is a form with a label 'E-mail Address' and a text input field containing 'testuser@example.edu'. At the bottom of the form are two buttons: 'Submit' (highlighted with a red box) and 'Help'. The right screenshot is titled 'Date and Time Settings' and contains four dropdown menus: 'Time Zone' set to '(GMT-05:00) Eastern Time (US & Canada)', 'Date Display Format' set to 'YYYY-MM-DD (2016-09-15)', 'Time Display Format' set to '24 Hour (15:37)', and 'First Day of Week' set to 'Sunday'. At the bottom of this form are also two buttons: 'Submit' (highlighted with a red box) and 'Help'.

Accessing the Platform

- Click on New Lab Reservation
- Click on Schedule Lab for Myself



Accessing the Platform

- Select the course
- For this session, we will use “Introduction to perfSONAR with Mininet”

Multiple course topics are available in this class. Please select one.

Intoduction to perfSONAR with Mininet

This lab series focuses on perfSONAR using Mininet

Network Tools and Protocols

Network Tools and Protocols

Accessing the Platform

- Select the Lab
- For this session, we will run:
 - Lab 3: Configuring Regular Tests Using pScheduler CLI Part I (throughput, latency, and traceroute)

🚩 This lab series focuses on perfSONAR using Mininet

Lab Name	Action
Lab 1: Setting up Administrative Information via perfSONAR Toolkit GUI	▼
Lab 2: Scheduling Regular Tests Using perfSONAR GUI	▼
Lab 3: Configuring Regular Tests Using pScheduler CLI Part I (throughput, latency, and traceroute)	▼
Lab 4: Configuring Regular Tests Using pScheduler CLI Part II (repeat, store, monitor, and cancel)	▼
Lab 5: Defining Regular Tests with a pSConfig Template	▼
Lab 6: Configuring pScheduler Limits	▼
Lab 7: Visualizing pScheduler Measurements using Grafana	▼
Lab 8: Observing the Impact of TCP Window Scaling and Small TCP Buffer Sizes	▼
Lab 9: Investigating the Effects of MTU Mismatch	▼
Lab 10: Observing the Effects of Packet Reordering	▼

Show entries Showing 1 to 10 of 10 items

< 1 >

Accessing the Platform


- Select the next available POD and allocate time

Pod Scheduler

September 2023

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Selected Day
September
5
2023

Current Time

18:37
Eastern Time (US & Canada)

	perfSONAR_H3_Master perfSONAR	perfSONARv3_H3_17001 perfSONAR	perfSONARv3_H2_17002 perfSONAR	perfSONAR_H3_17003 perfSONAR
18:00				
19:00				
20:00				
21:00				
22:00				



Add Reservation

Pod perfSONARv3_H2_17002


Reservation Type Instructor Private Reservation

Reserve For Jose Gomez

Lab Exercise Lab 3: Configuring Regular Tests Using pScheduler CLI Part I

Time Zone Eastern Time (US & Canada)

Start Time 2023-09-05 18:38

End Time 2023-09-05 19:30 

Length of Reservation 41 mins.

Accessing the Platform

We will use the NETLAB virtual platform:

- **URL:** <https://netlab.cec.sc.edu/>
- **Username:** user1, user2,, userN
- **Temporary Password:** nsf2023