

# NHERI Lehigh IT Overview

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**LEHIGH**  
UNIVERSITY



NSF NHERI  
CYBER-PHYSICAL SIMULATION

# Overview and Synergy

## RTMD Lab



## CPSSL Lab



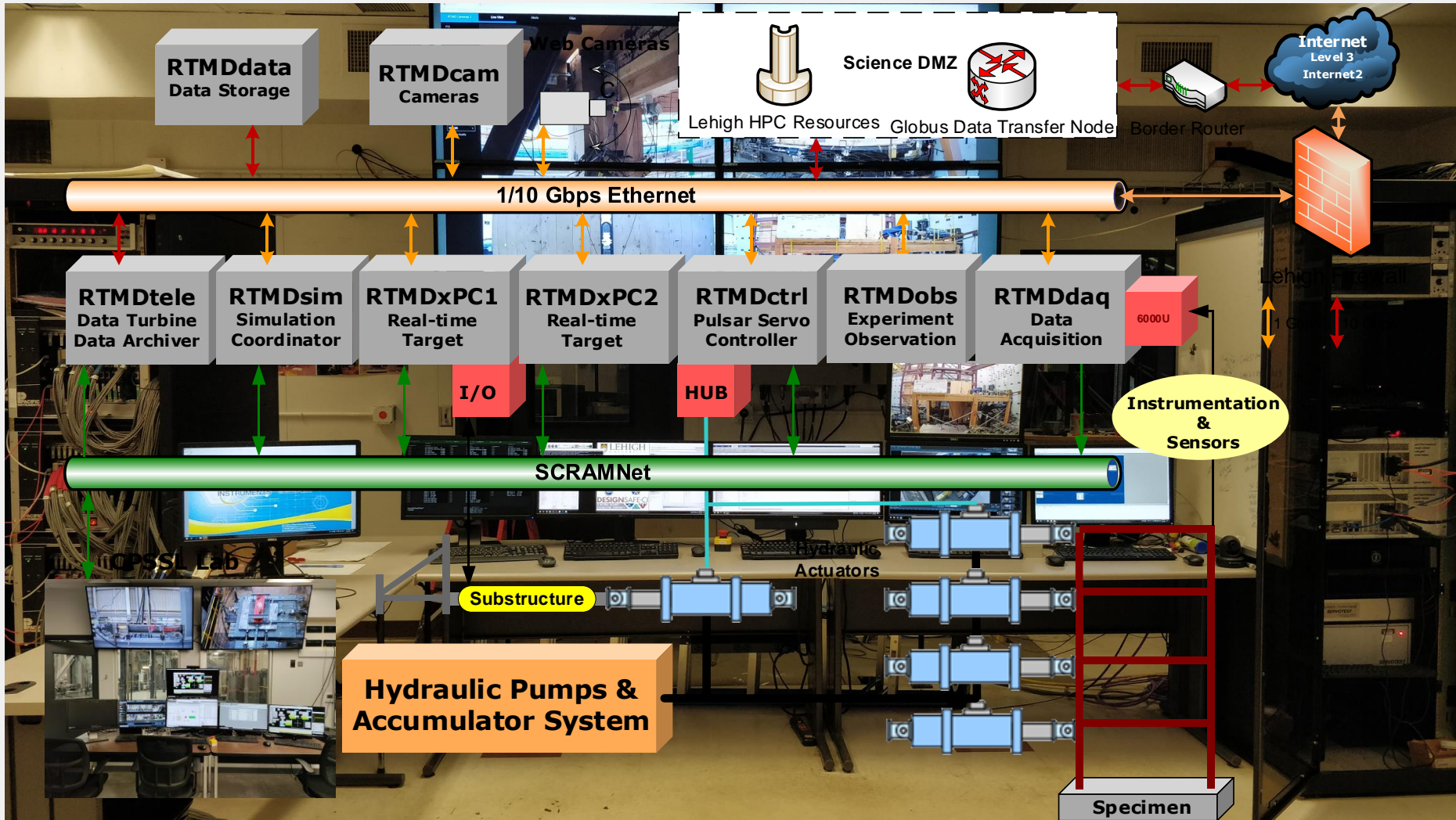
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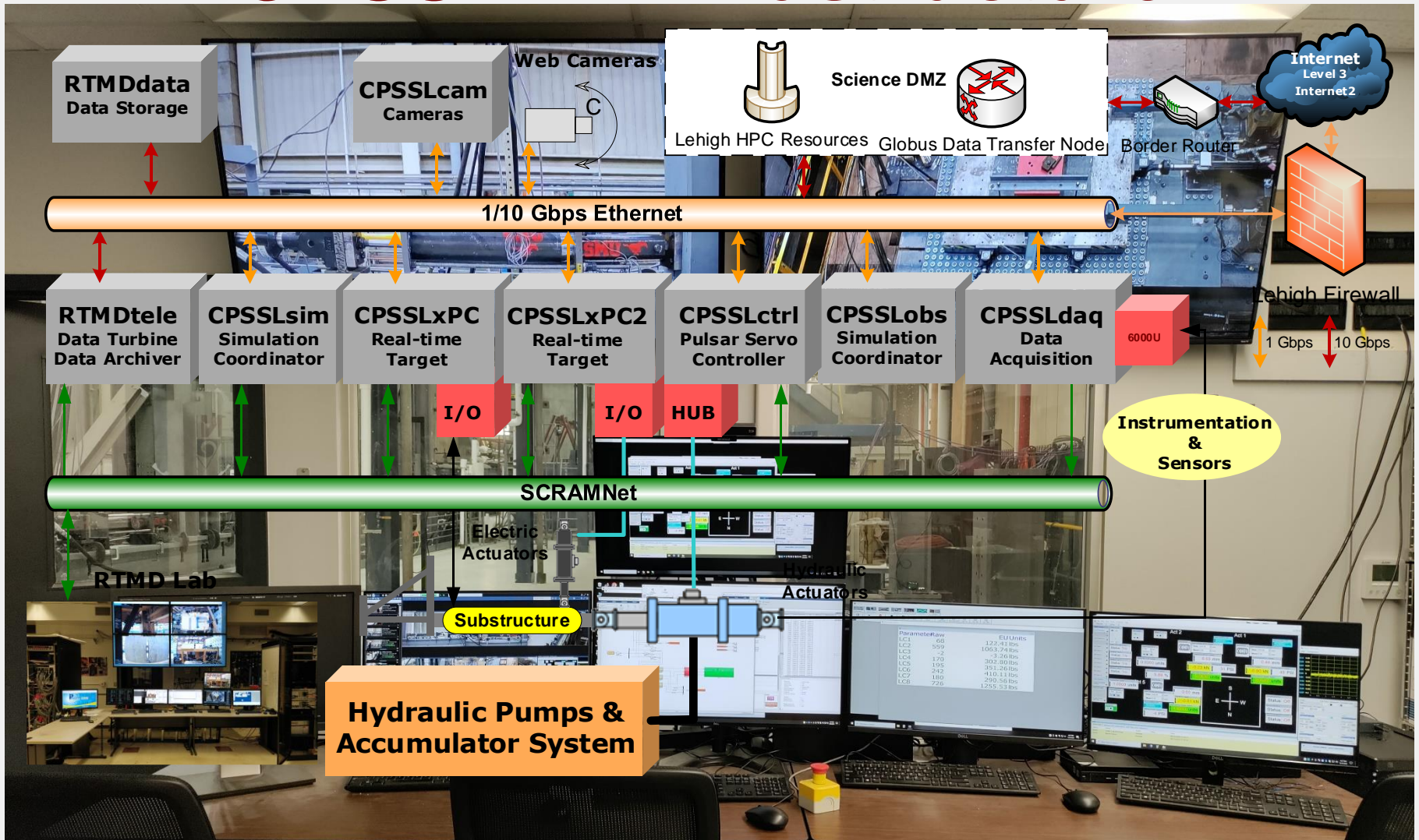
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# RTMD IT Infrastructure



# CPSSL IT Infrastructure

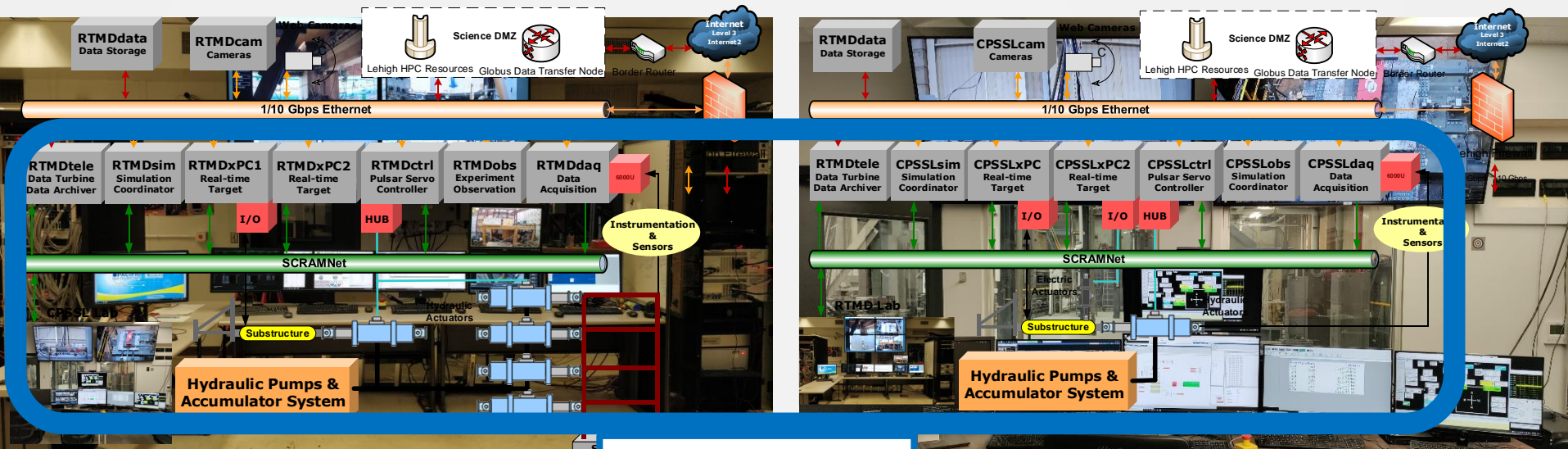




# System Synchronization

## RTMD Lab

## CPSSL Lab



### SCRAMNet GT

SCRAMNet GT Node Map

A121 RTMD Lab



M201 CPSSL Lab



PHYSICAL SIMULATION

# SCRAMNet GT

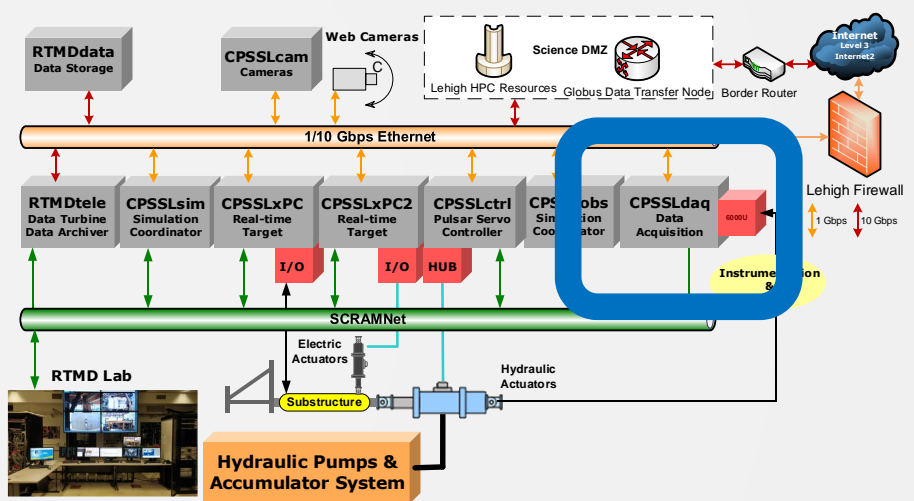
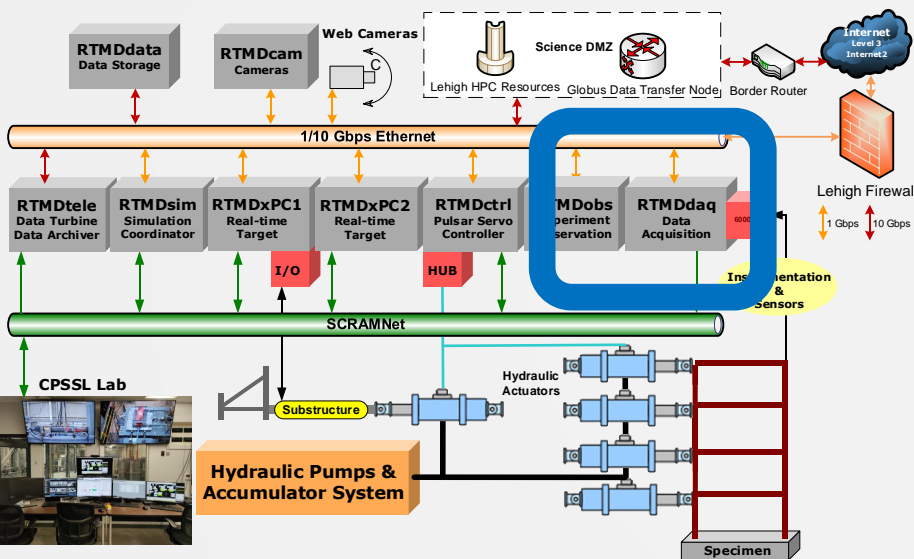
- Fiber-optic based High-Speed, Low-Latency Industrial Protocol for Real-time data control



# IT Infrastructure

## RTMD Lab

## CPSSL Lab

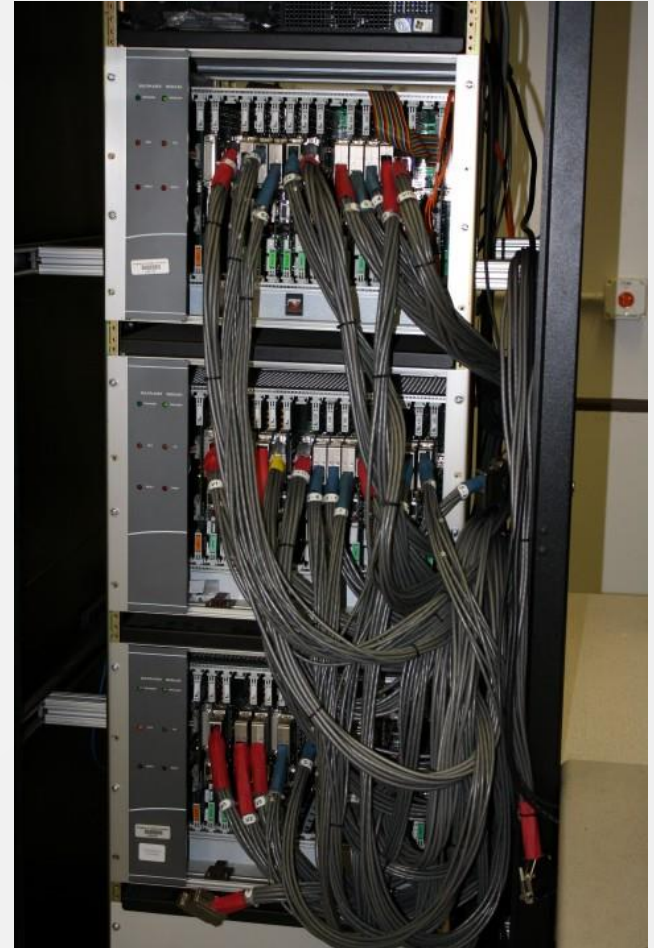


Data Acquisition



# Data Acquisition

- Pacific Instruments 6000 Data Acquisition Systems
- RTMD Lab
  - 304 channels, 384 expandable
    - Voltage, Strain, Thermocouple
- CPSSL PI 6000
  - 32 channel
    - 16 bridge/voltage
    - 16 voltage/thermocouple
- Variable sampling rates
  - 4 kHz for Real-time Testing

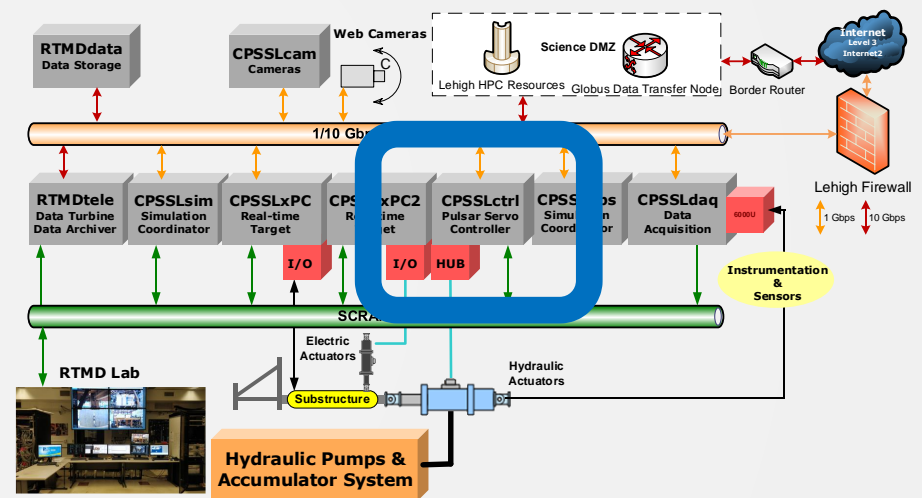
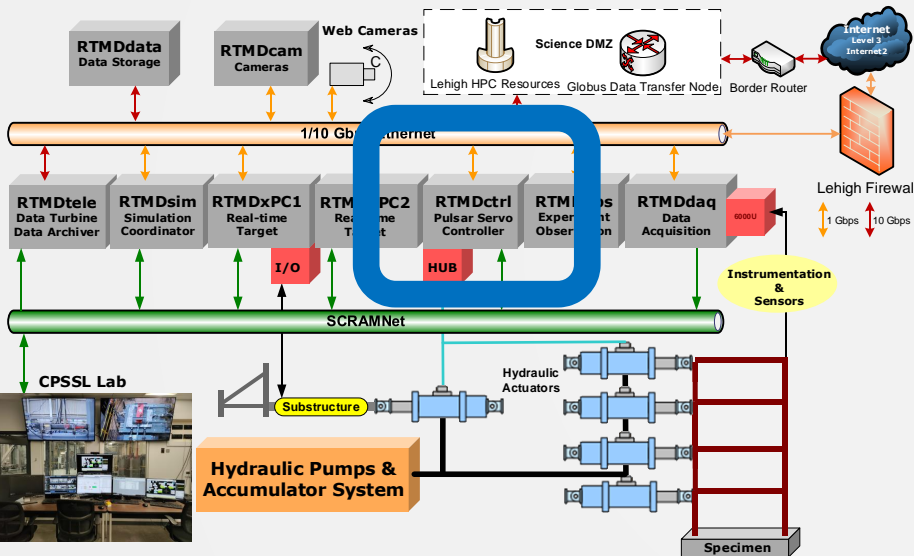




# IT Infrastructure

## RTMD Lab

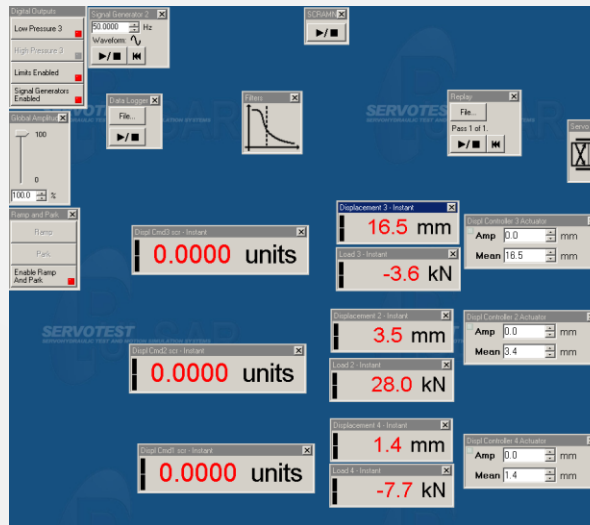
## CPSSL Lab



**Control Systems**

# Control Systems

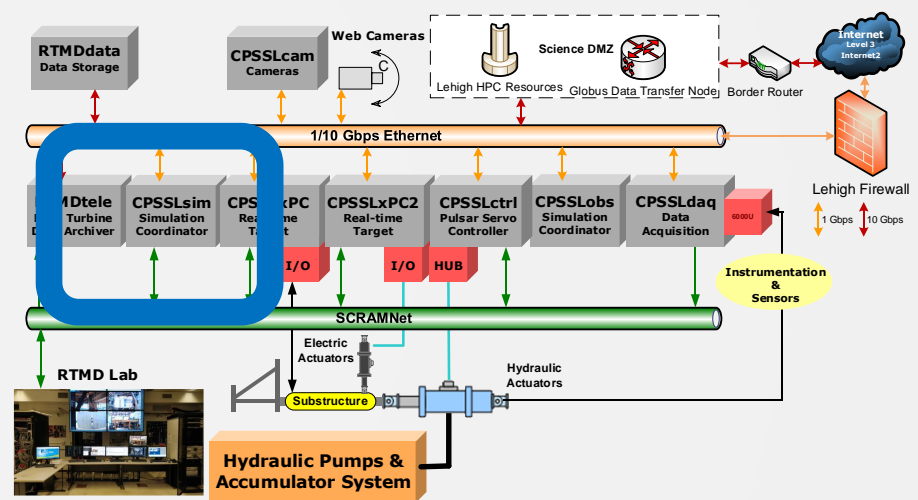
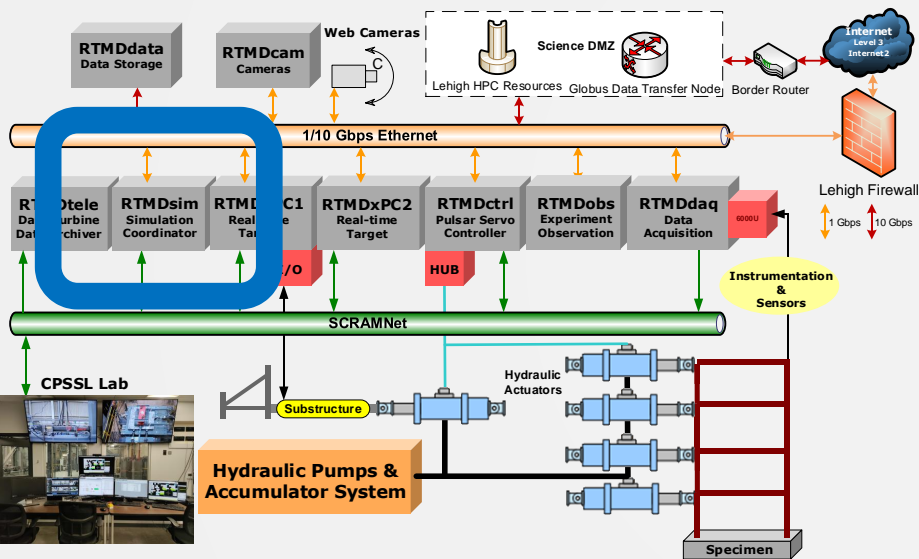
- Servotest Pulsar Hub Control System
  - Configurable servo-control system for hydraulics actuator PID control
  - 2048Hz or higher control rate
  - 20 years of support
  - Customizable interface



# IT Infrastructure

## RTMD Lab

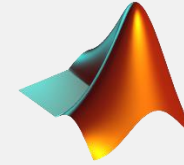
## CPSSL Lab



Development  
and  
Simulation  
Coordination



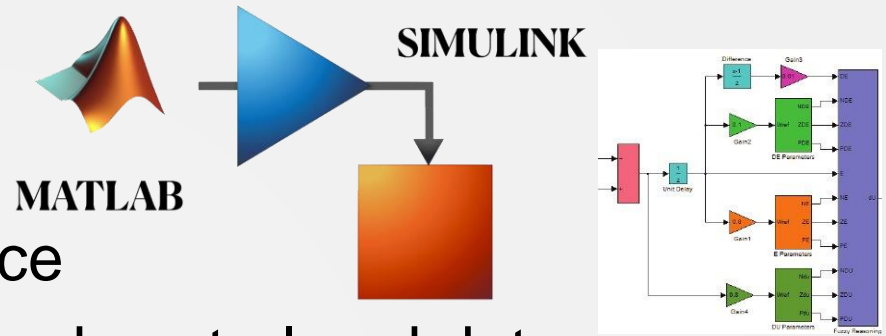
# Model Development and Simulation Coordination



- Dell Precision Workstations
  - High power workstation for compilation and processing
  - GPU and SCRAMNet GT200 Nodes
- Speedgoat Performance Targets
  - Dedicated Intel i7 4Ghz 4-Core real-time systems
  - Various I/O modules
  - Real-time and custom applications
- Multiple Targets
  - Defined roles in experiments
  - Parallel processing for larger, more complex models



# Simulation Coordinator



- Host Workstations
  - MATLAB/Simulink Interface
  - Coordinator of synchronized control and data acquisition
  - Hydraulics on/off testing – numerical simulation for safety, validation & training
  - Process and analyze data
  - GPU Node for analysis and machine learning



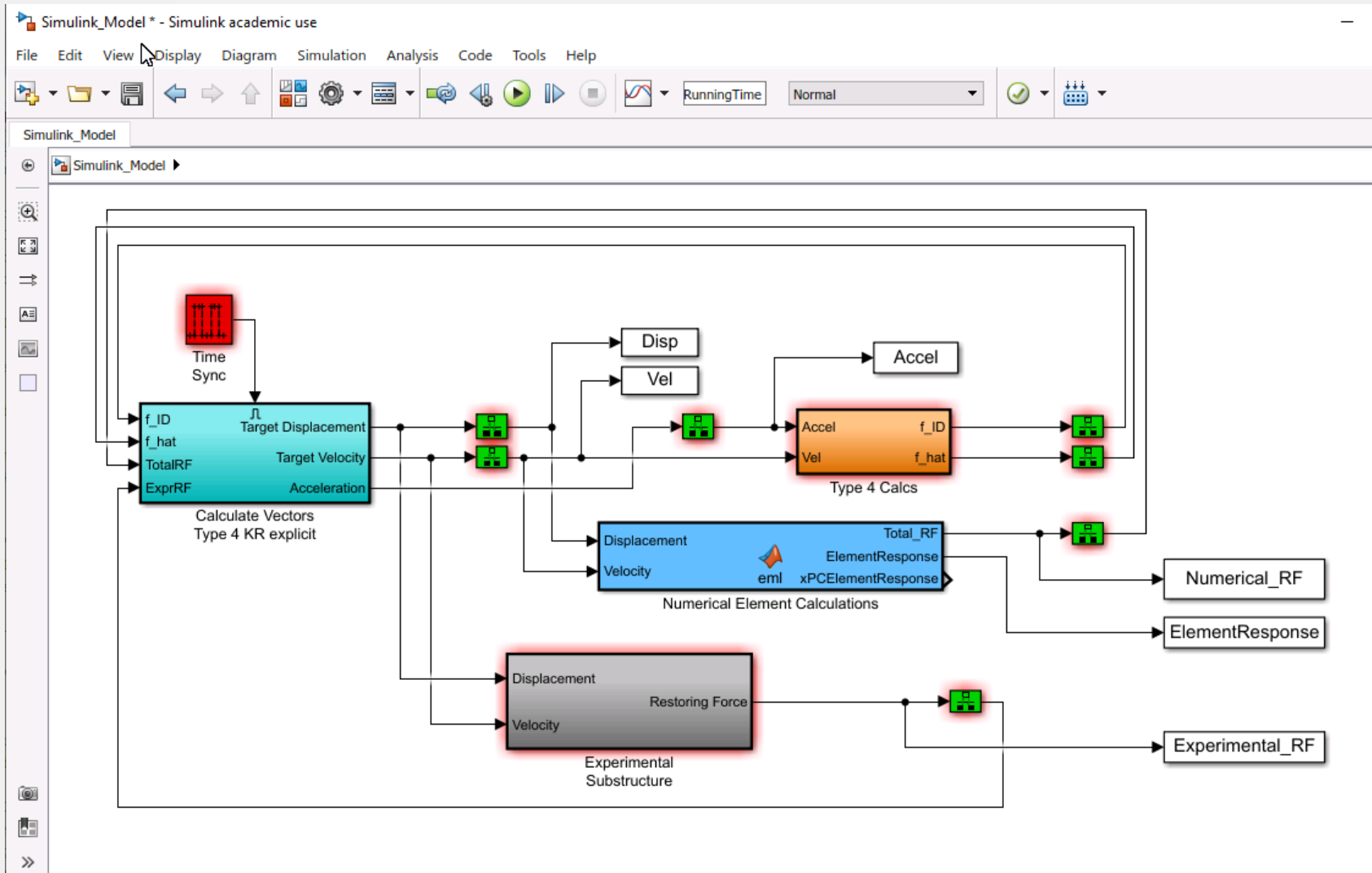
# Real-Time Targets

- Speedgoat systems, CPU performance up to 4 GHz
- Industrial quality design for robustness
- Multi-core support for parallel processing
- >>> **Facilitates RTHS**<<<
- SCRAMNet GT
- Synchronized Multi-system execution
- Built-in modules for data acquisition and control
- RT Neural Networks
- “Bring your own model” infrastructure for researchers

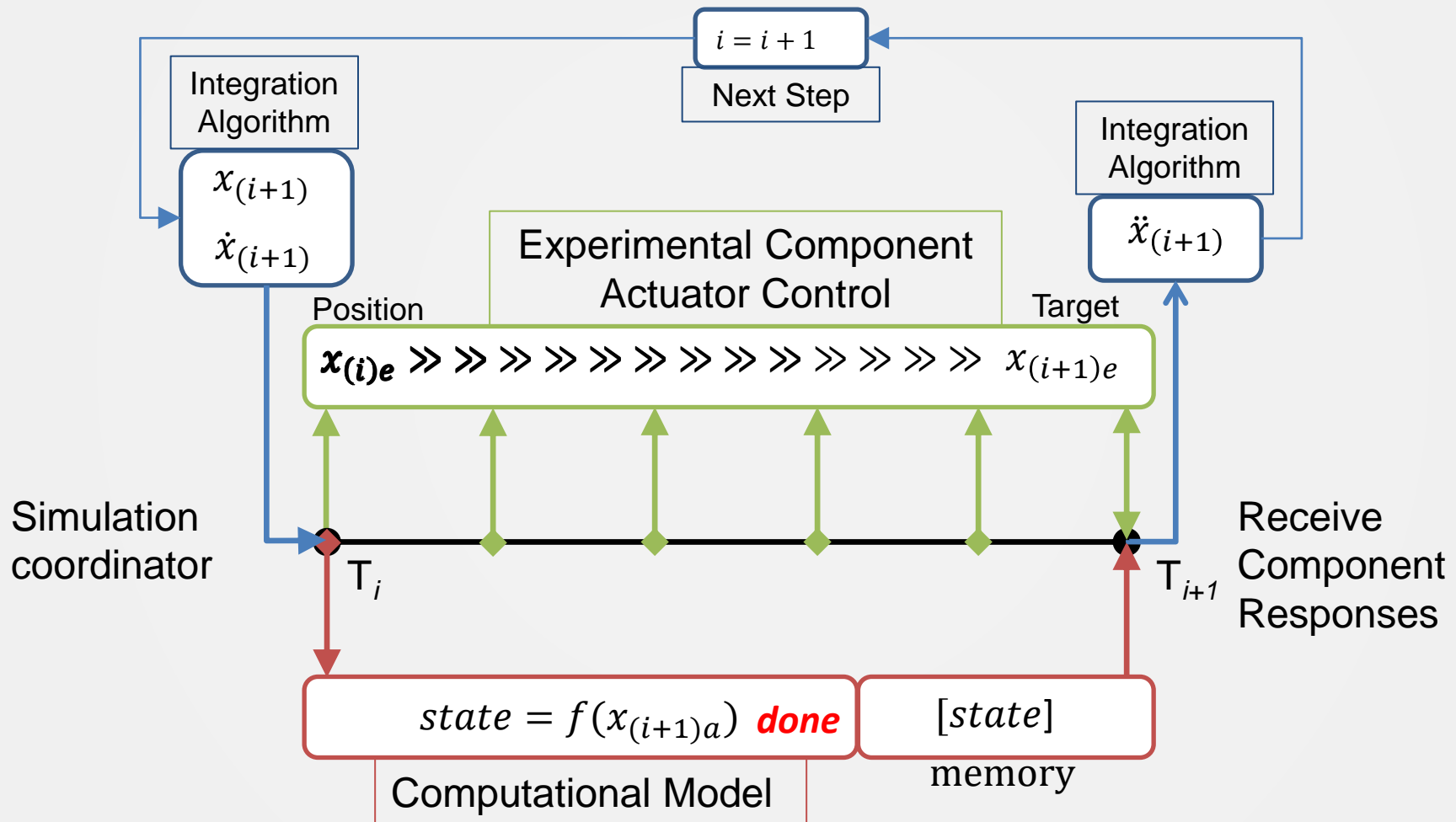




# RTHS: Simulink

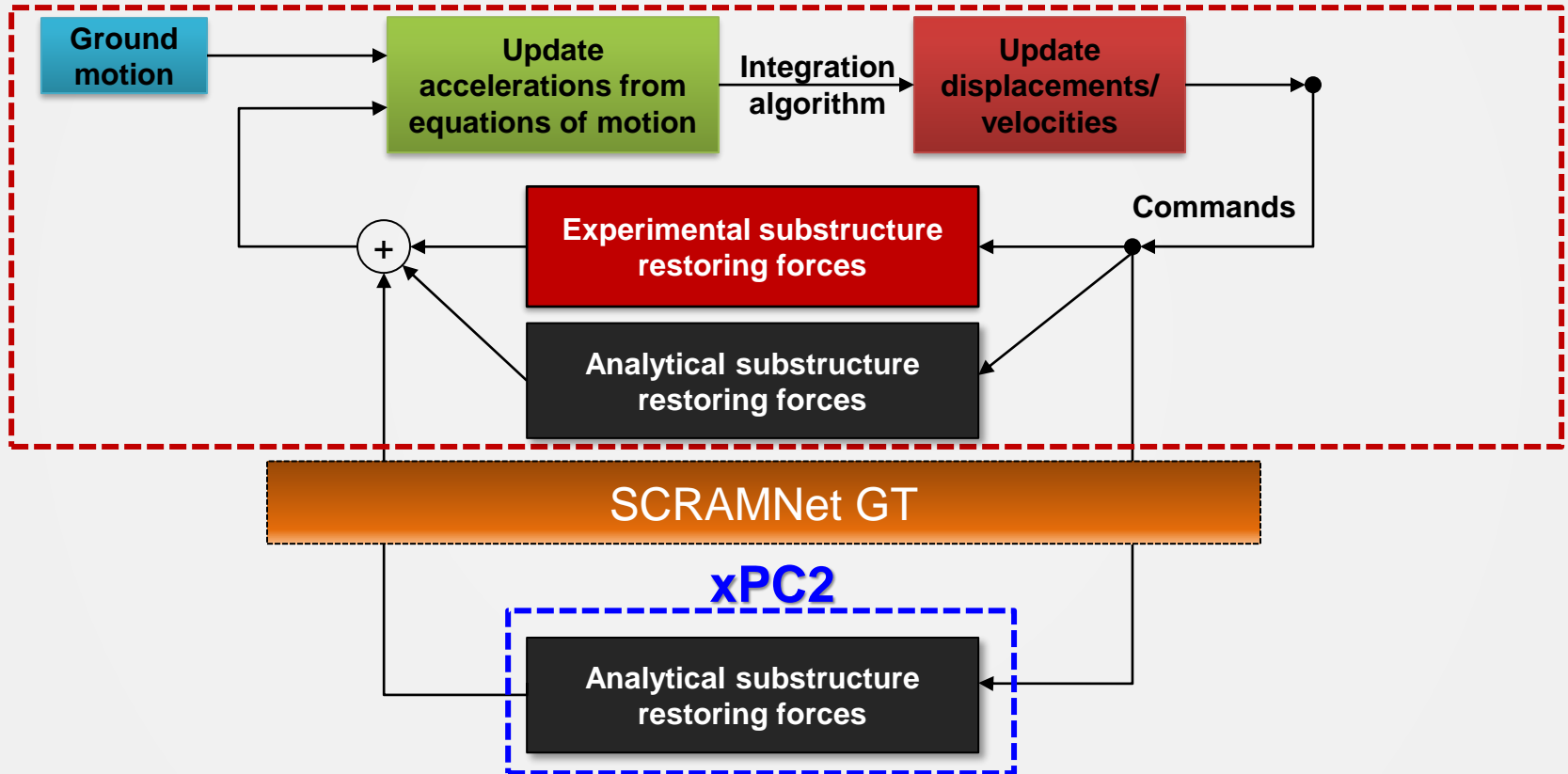


# RTHS: Model Flow through Simulink Simulation



# RTHS: Multiple Targets

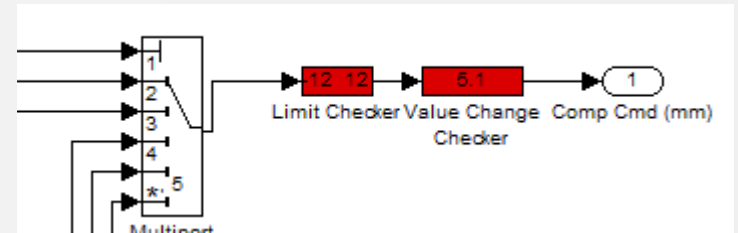
## xPC1





# Simulation Safety

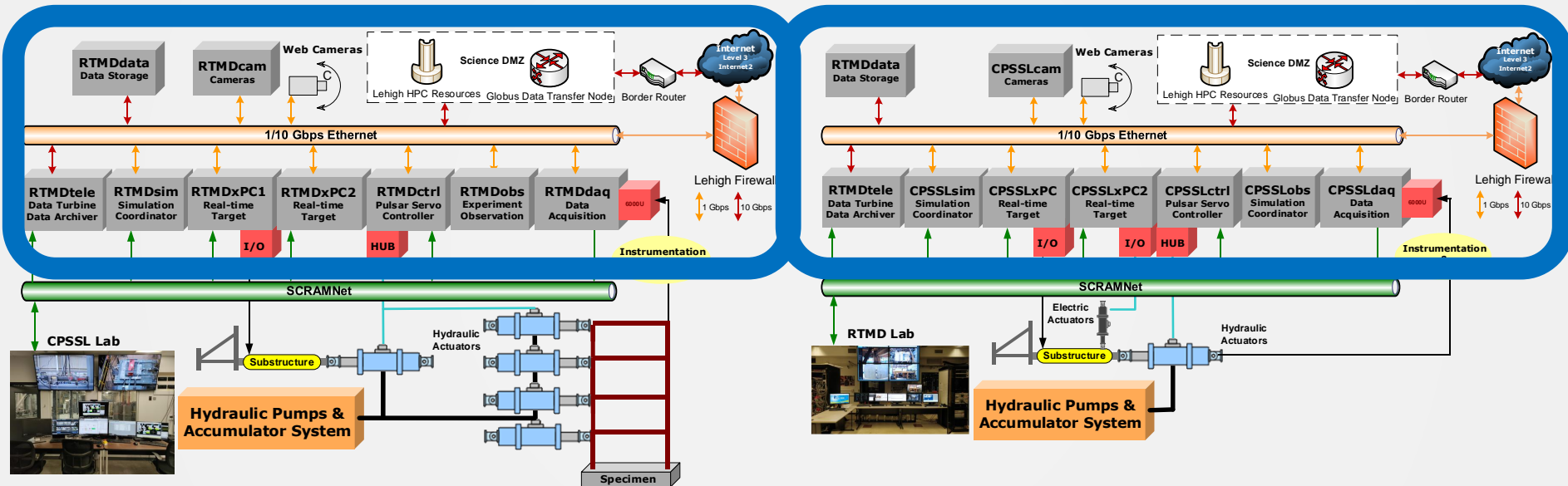
- Command software limits
  - Bound and rate limits
- Controller software limits
  - System trip and shutdown
- Hardware displacement limit switches
- E-Stop buttons



# IT Infrastructure

## RTMD Lab

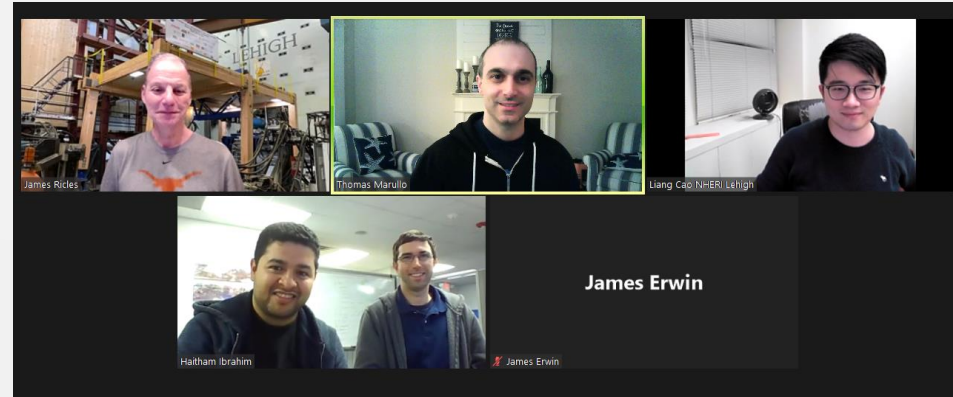
## CPSSL Lab



Telepresence  
and  
Observation

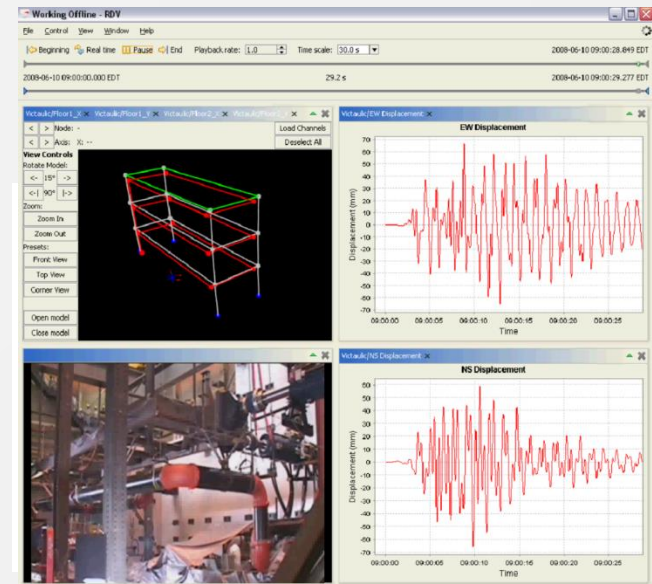
# Collaboration

- Zoom
- Shared Desktop
- Remote Desktop
- Data Streaming
- Cameras
- Cloud Storage



# Data Streaming

- Data Turbine (RBNB) ([dataturbine.org](http://dataturbine.org))
  - Aggregates data from systems integrated on SCRAMNet GT ring
  - Storage archive of test data based on timestamps
- Real-Time Data Viewer (RDV)
  - Plot-based and numerical observation of data locally and remotely
  - Time-controlled playback





# Photo and Video Capabilities

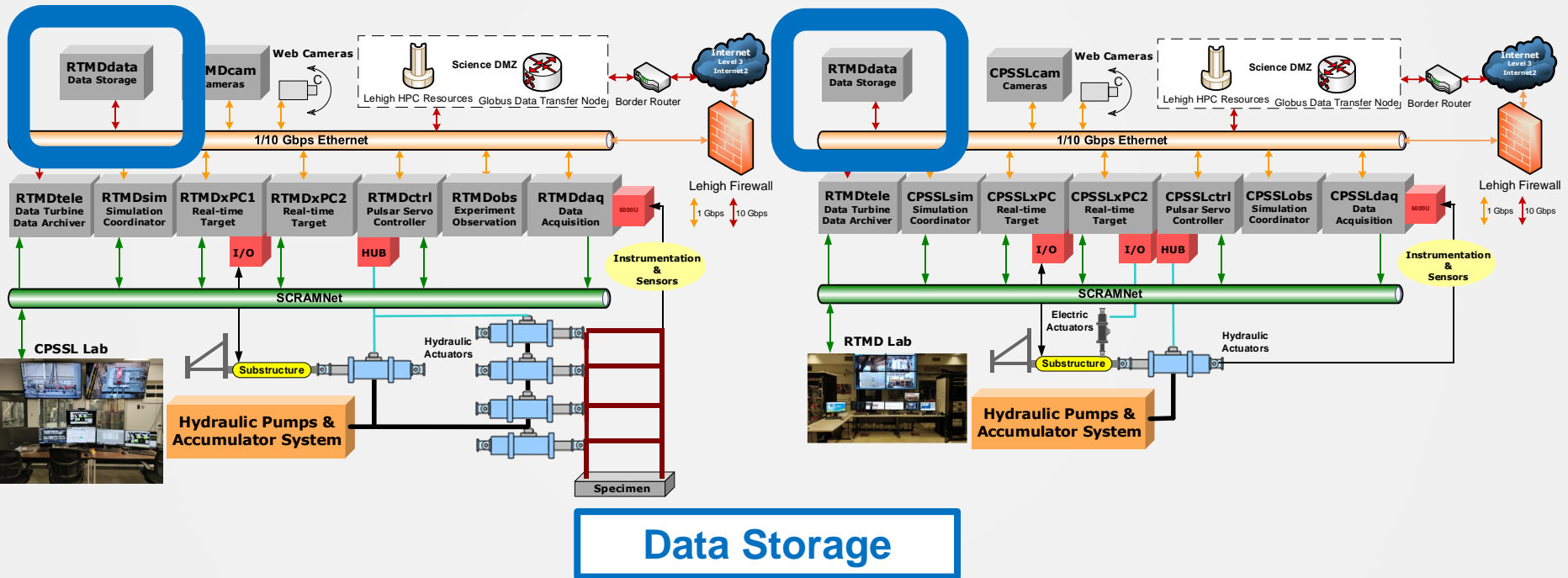
- Video/Imaging systems
  - (30) Amcrest Bullet/PTZ IP Cameras (up to 8k)
  - (4) Sony SNC-EP550 HD (720p HD)
  - (4) GoPro Hero 10 camcorders (4k 60Hz)
  - (9) GoPro Hero 3 Black camcorders (1080p60 HD)
  - Lab Security Cameras
  - Additional camera equipment upon request through LU Media
- Blue Iris Servers
  - Portal for all users to access and control web cameras
  - Archived video available for previous experiments



# IT Infrastructure

## RTMD Lab

## CPSSL Lab



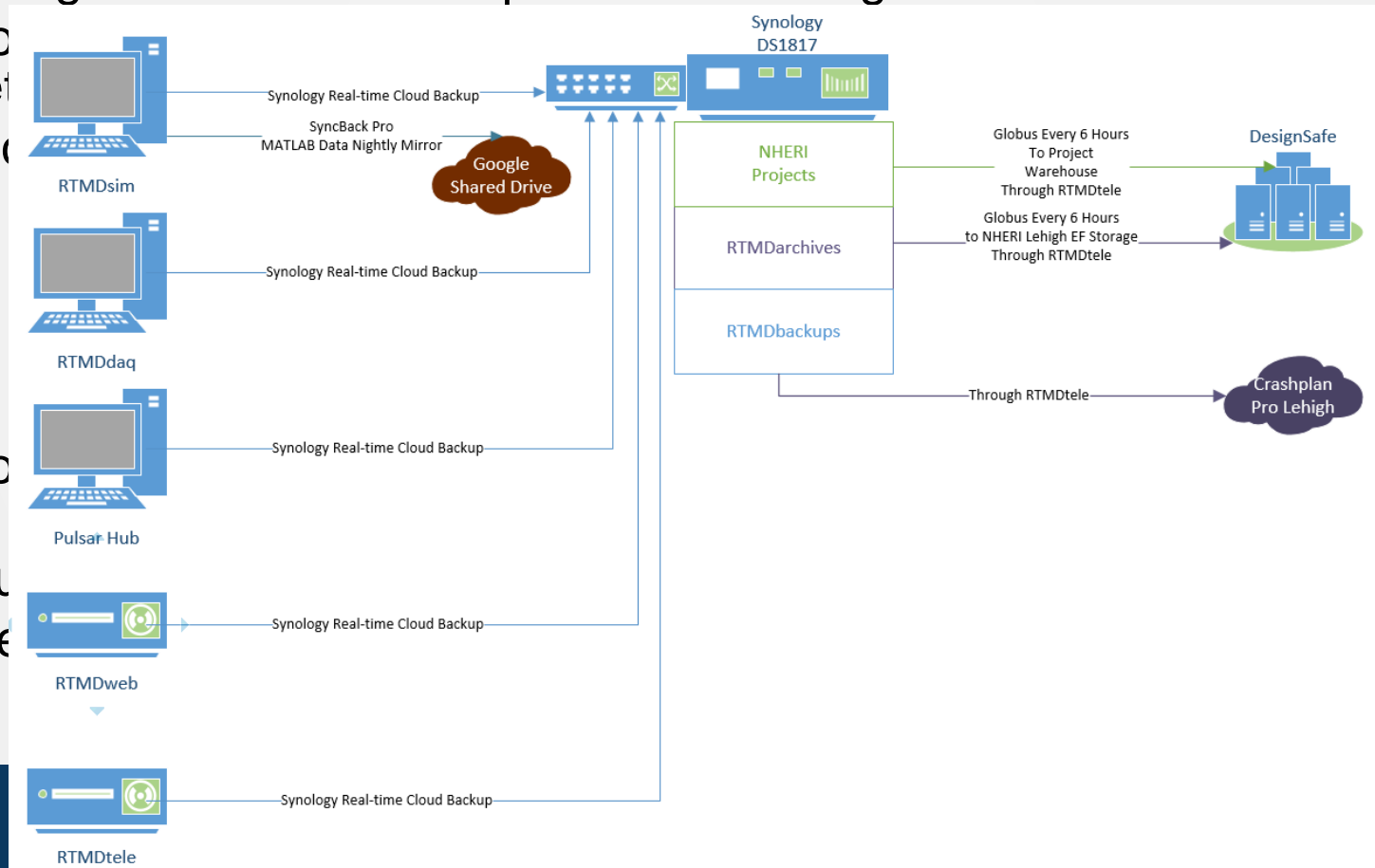
# RTMDdata

- Synology DiskStation
  - 50TB Expandable
  - 10Gb Connection
- Dual-disk Redundancy
- Network Attached Storage
- Mirrored to DesignSafe through Globus



# Data Management Plan

- Local repository for data storage managed by NHERI Lehigh with offsite backup risk mitigation through DesignSafe-CI
- Google Drive and Crashplan cloud storage



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# Thank you



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