



NHERI Lehigh IT Overview

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NHERI Lehigh EF IT Systems Manager



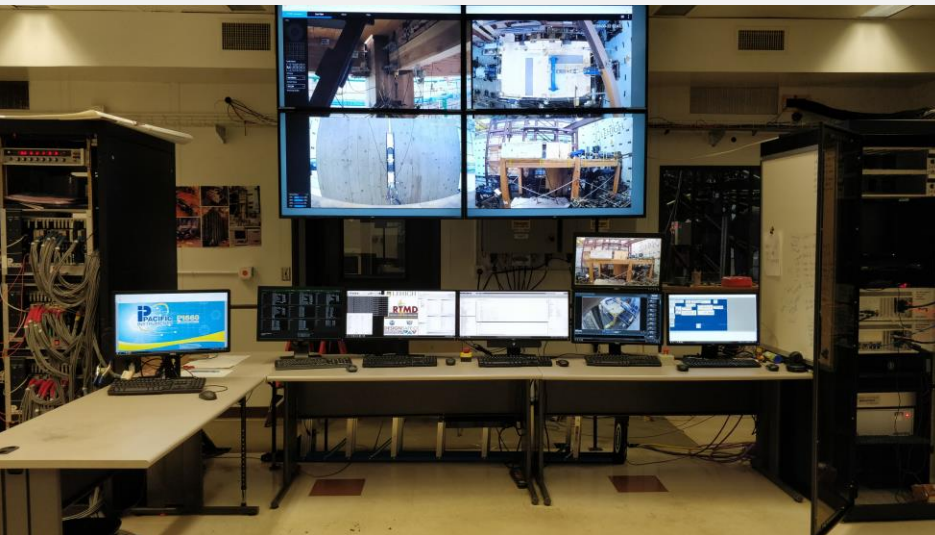
LEHIGH
UNIVERSITY



NSF NHERI 
CYBER-PHYSICAL SIMULATION

Overview and Synergy

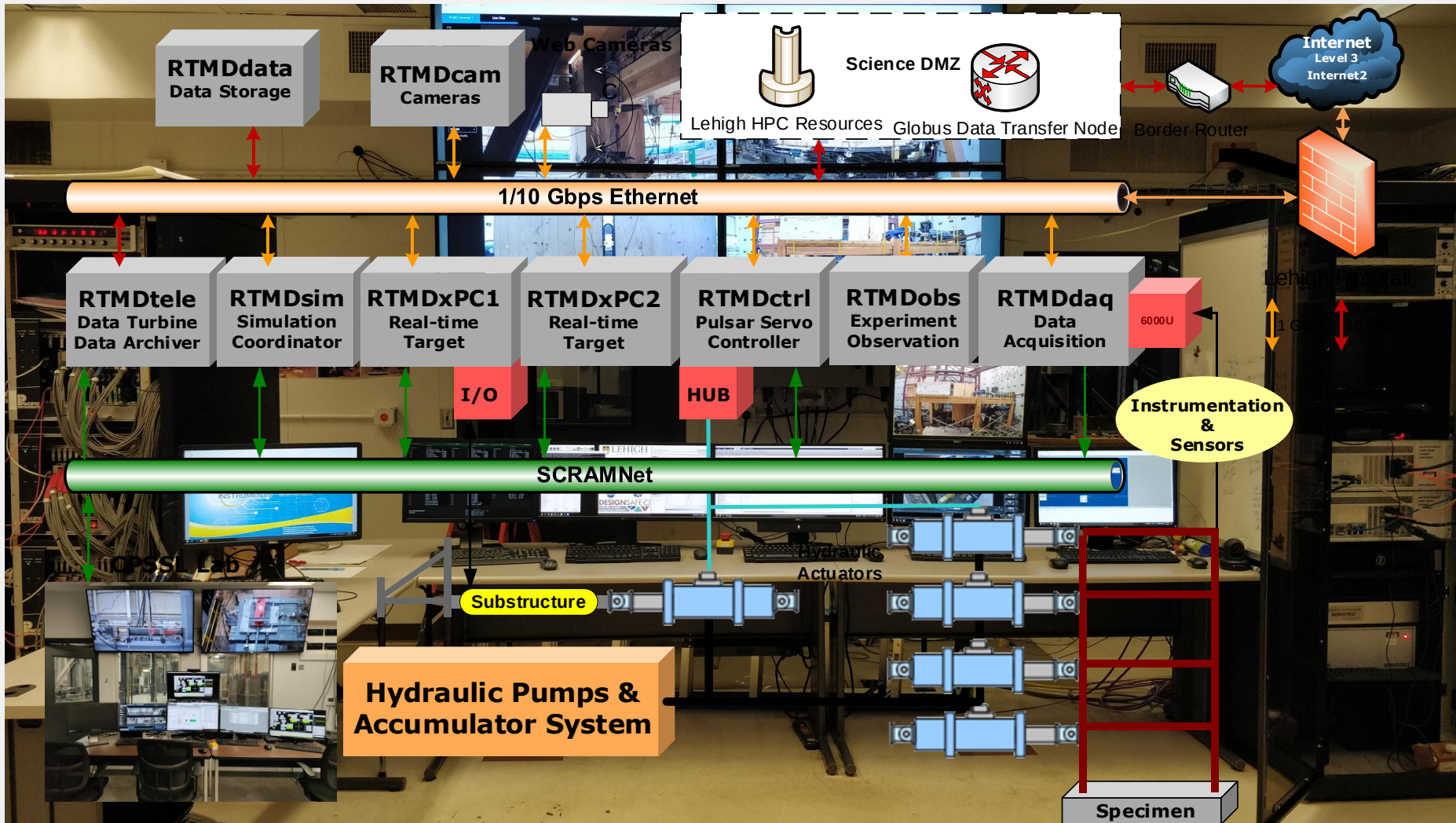
RTMD Lab



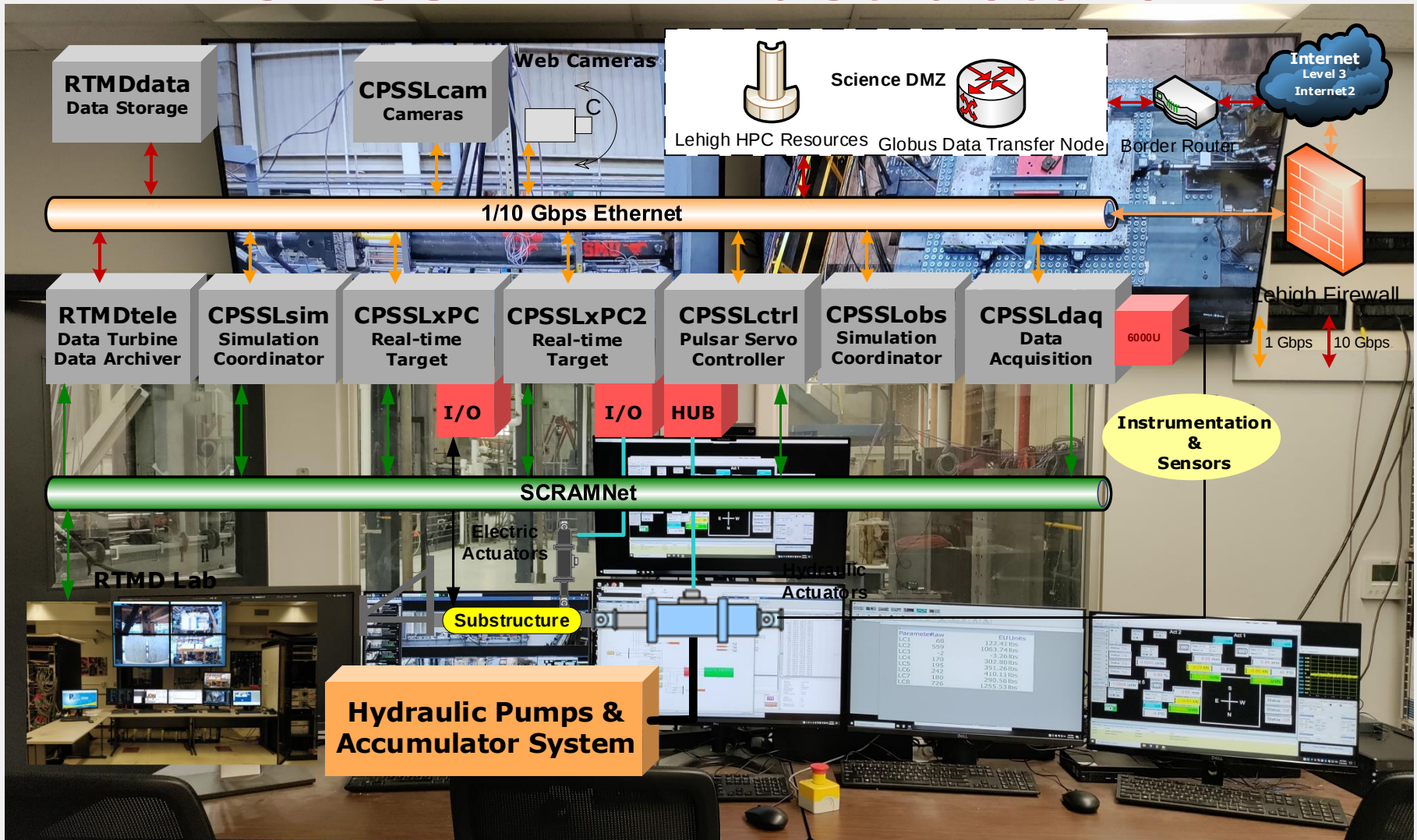
CPSSL Lab



RTMD IT Infrastructure



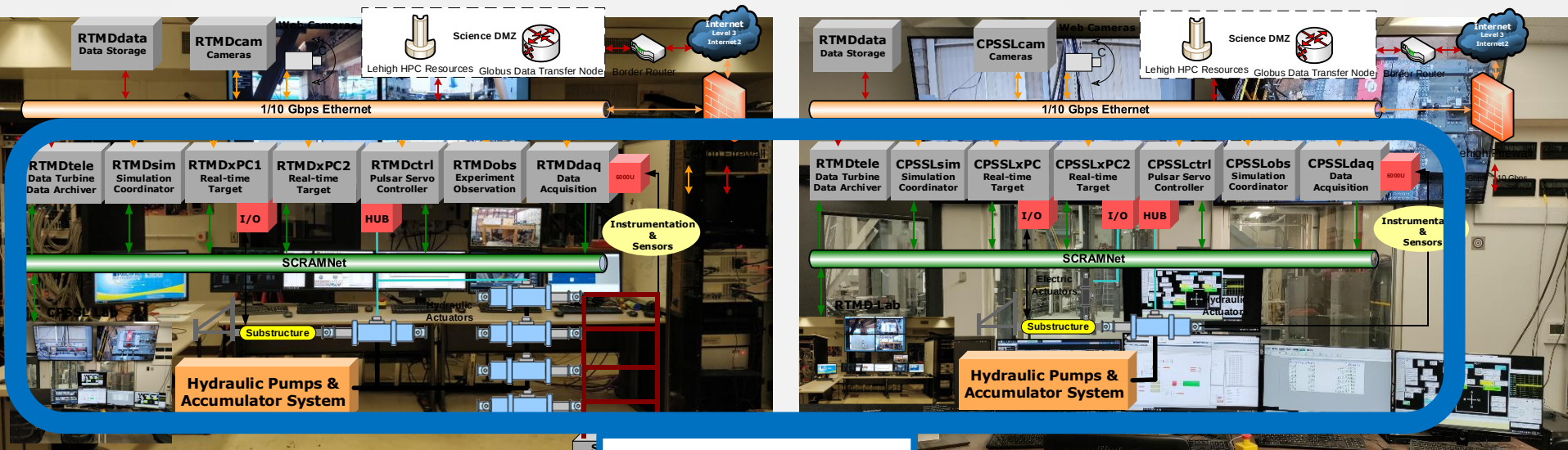
CPSSL IT Infrastructure



System Synchronization

RTMD Lab

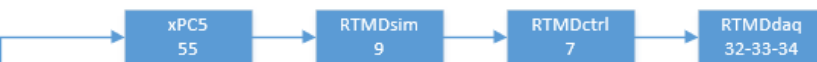
CPSSL Lab



SCRAMNet GT

SCRAMNet GT Node Map

A121 RTMD Lab



M201 CPSSL Lab



SCRAMNet GT

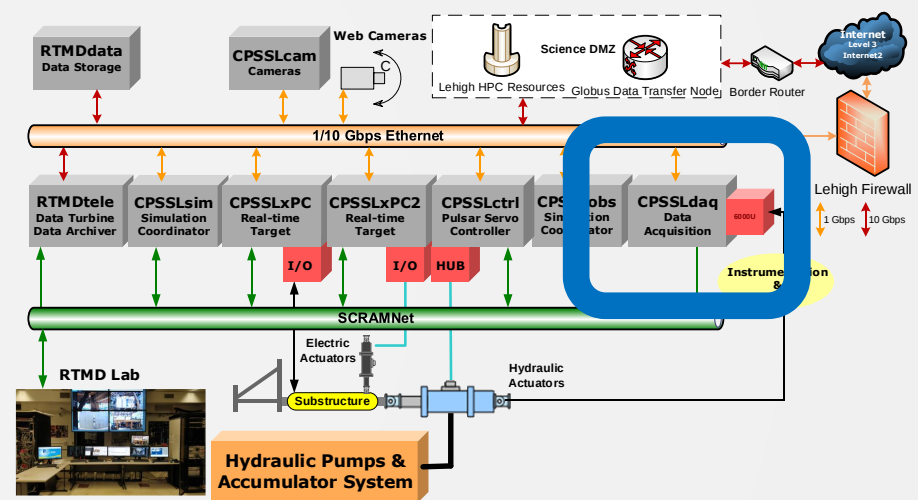
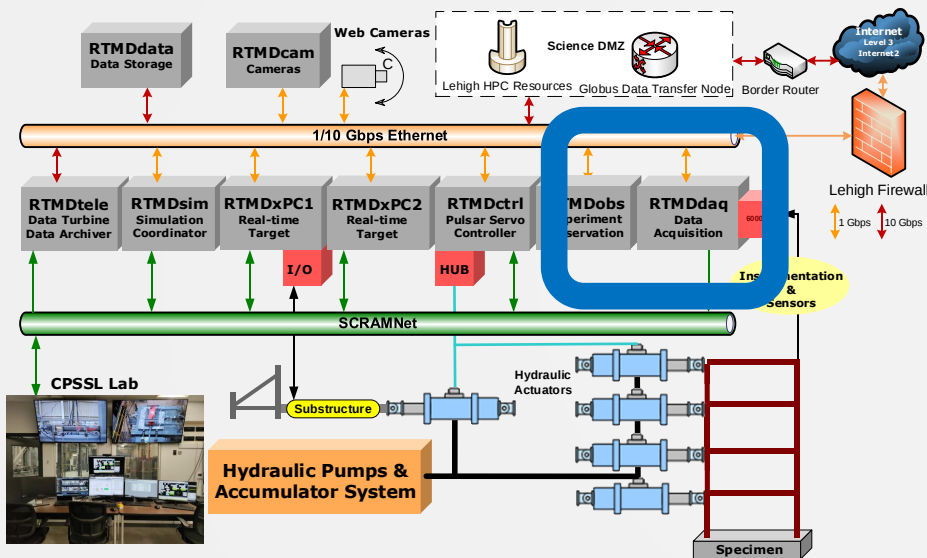
- Fiber-optic based High-Speed, Low-Latency Industrial Protocol for Real-time data control



IT Infrastructure

RTMD Lab

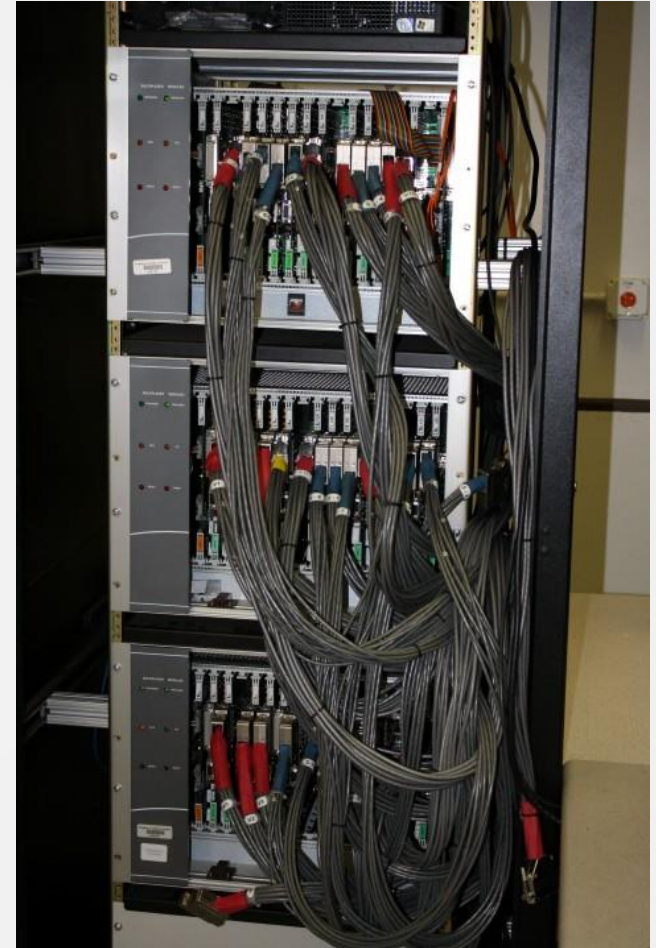
CPSSL Lab



Data Acquisition

Data Acquisition

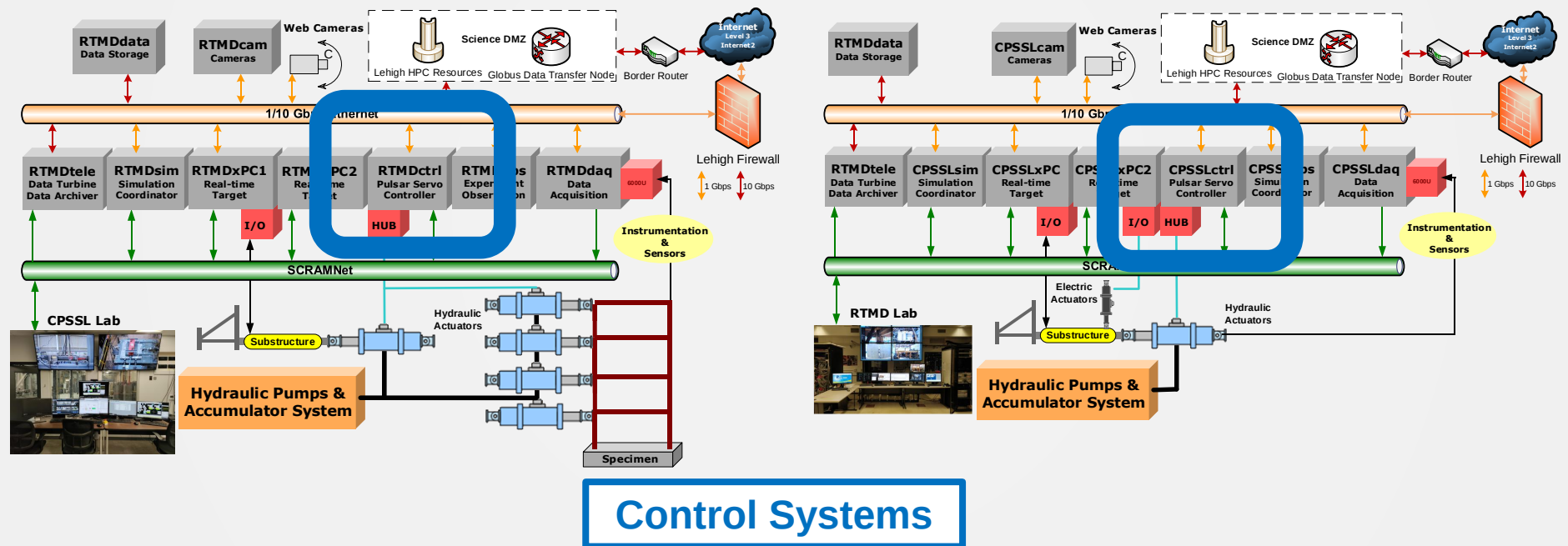
- Pacific Instruments 6000 Data Acquisition Systems
- RTMD Lab
 - 304 channels, 384 expandable
 - Voltage, Strain, Thermocouple
- CPSSL PI 6000
 - 32 channel
 - 16 bridge/voltage
 - 16 voltage/thermocouple
- Variable sampling rates
 - 4 kHz for Real-time Testing



IT Infrastructure

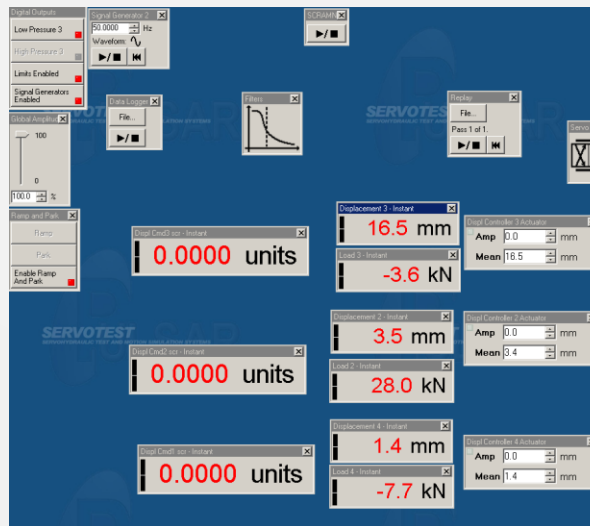
RTMD Lab

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Control Systems

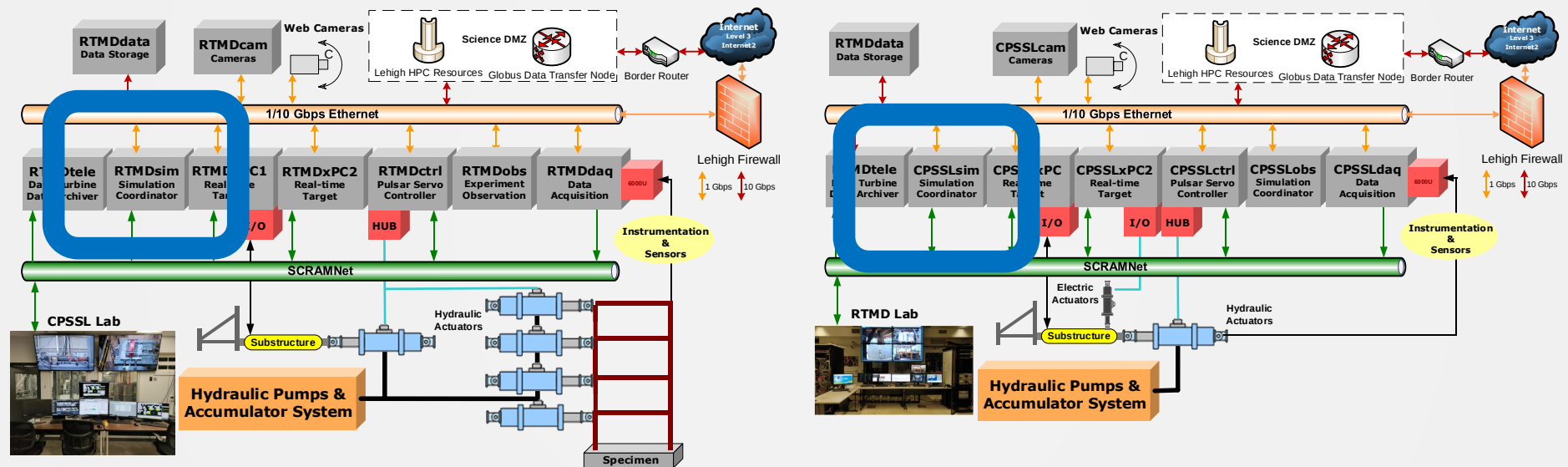
- Servotest Pulsar Hub Control System
 - Configurable servo-control system for hydraulics actuator PID control
 - 2048Hz or higher control rate
 - 20 years of support
 - Customizable interface



IT Infrastructure

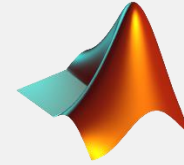
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Development
and
Simulation
Coordination

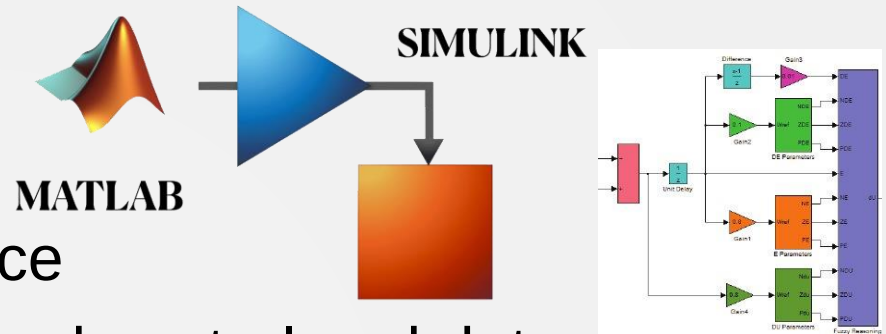
Model Development and Simulation Coordination



- 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

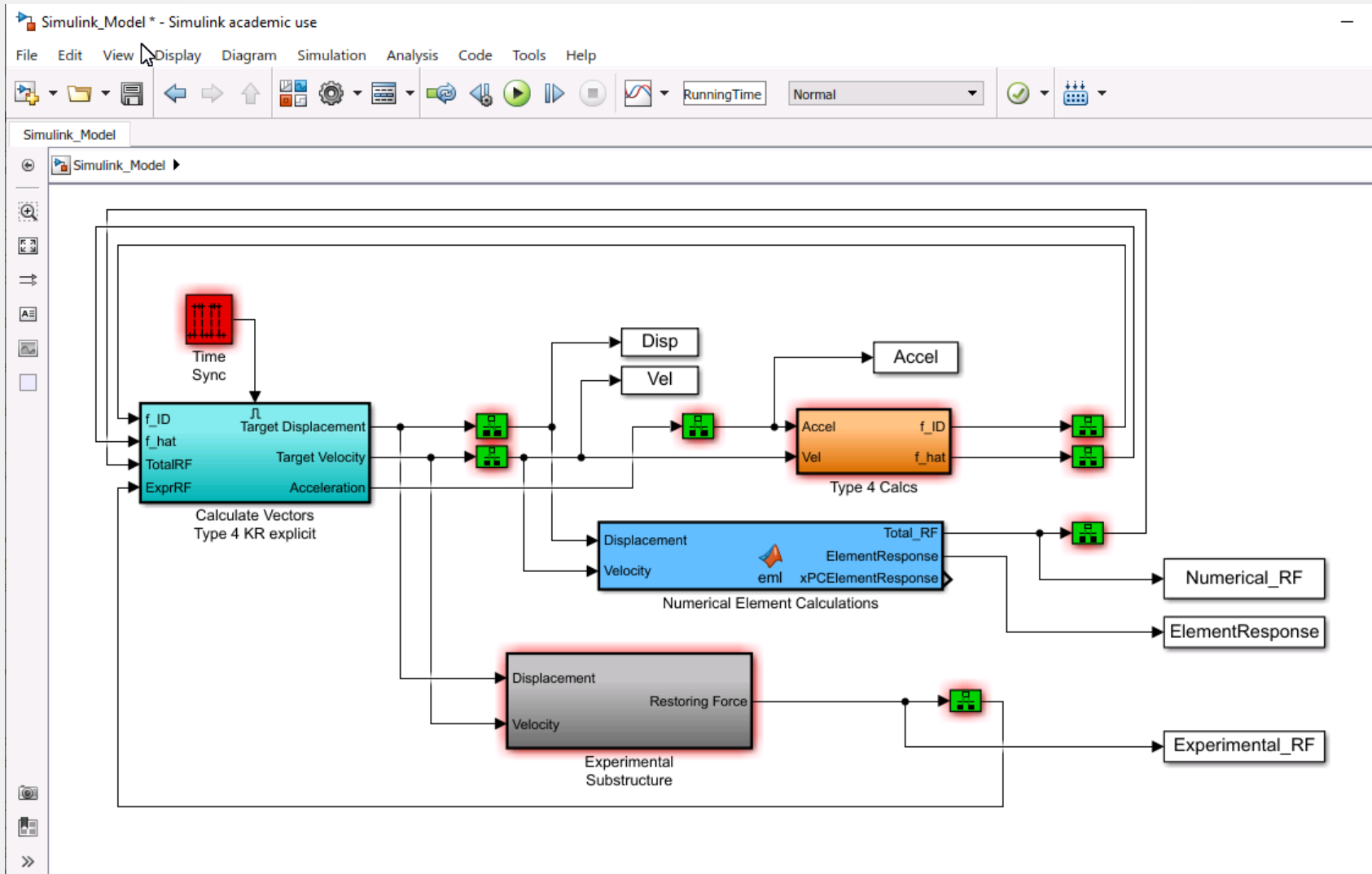


Real-Time Targets

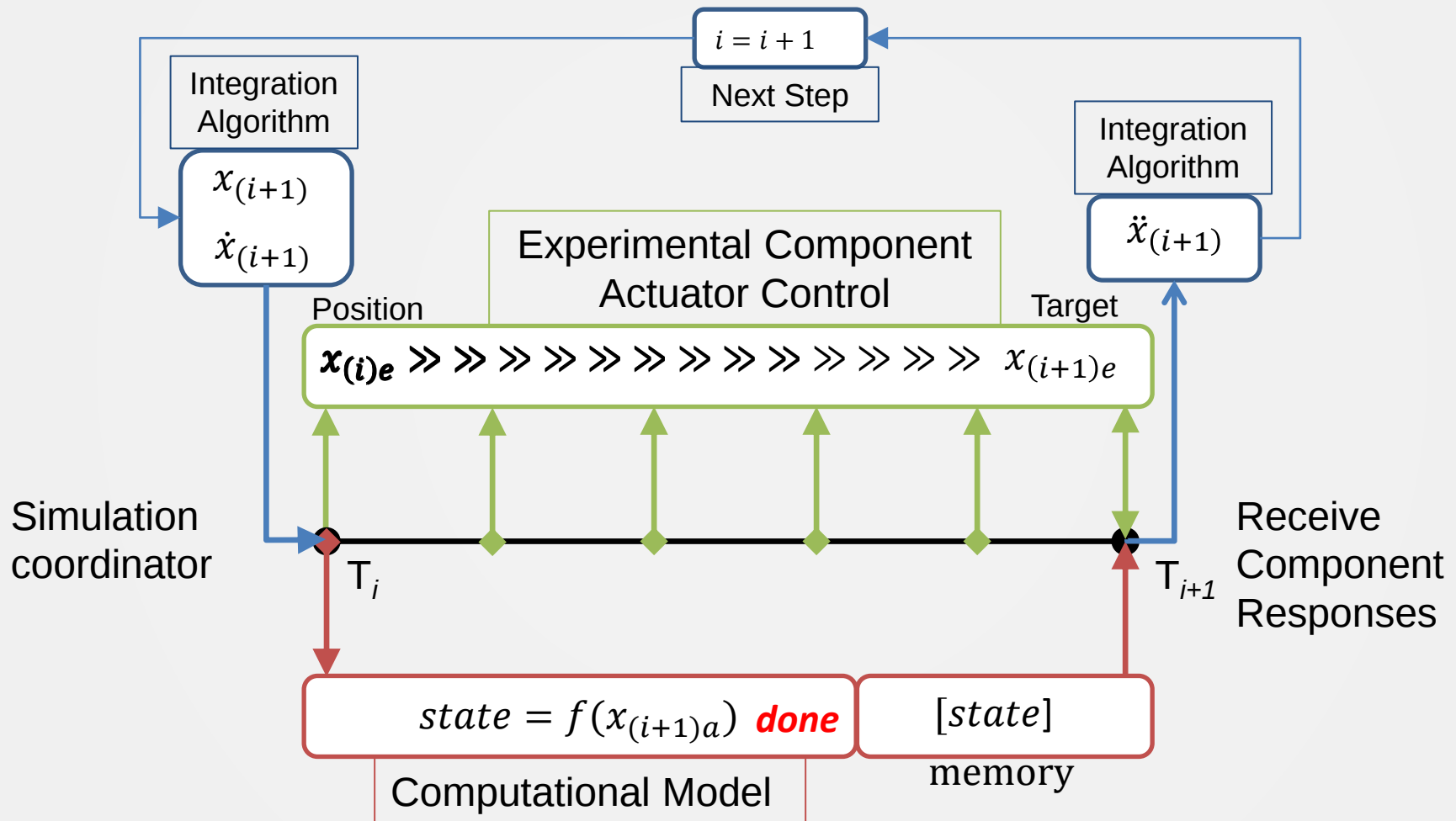
- Speedgoat systems, CPU performance up to 4 GHz
- Industrial quality design for robustness
- Multi-core support for parallel processing
- >>> **Facilitates RTHS**<<<
- SCRAMNet GT
- Synchronized Multi-system execution
- Built-in modules for data acquisition and control
- RT Neural Networks
- “Bring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



RTHS: Simulink

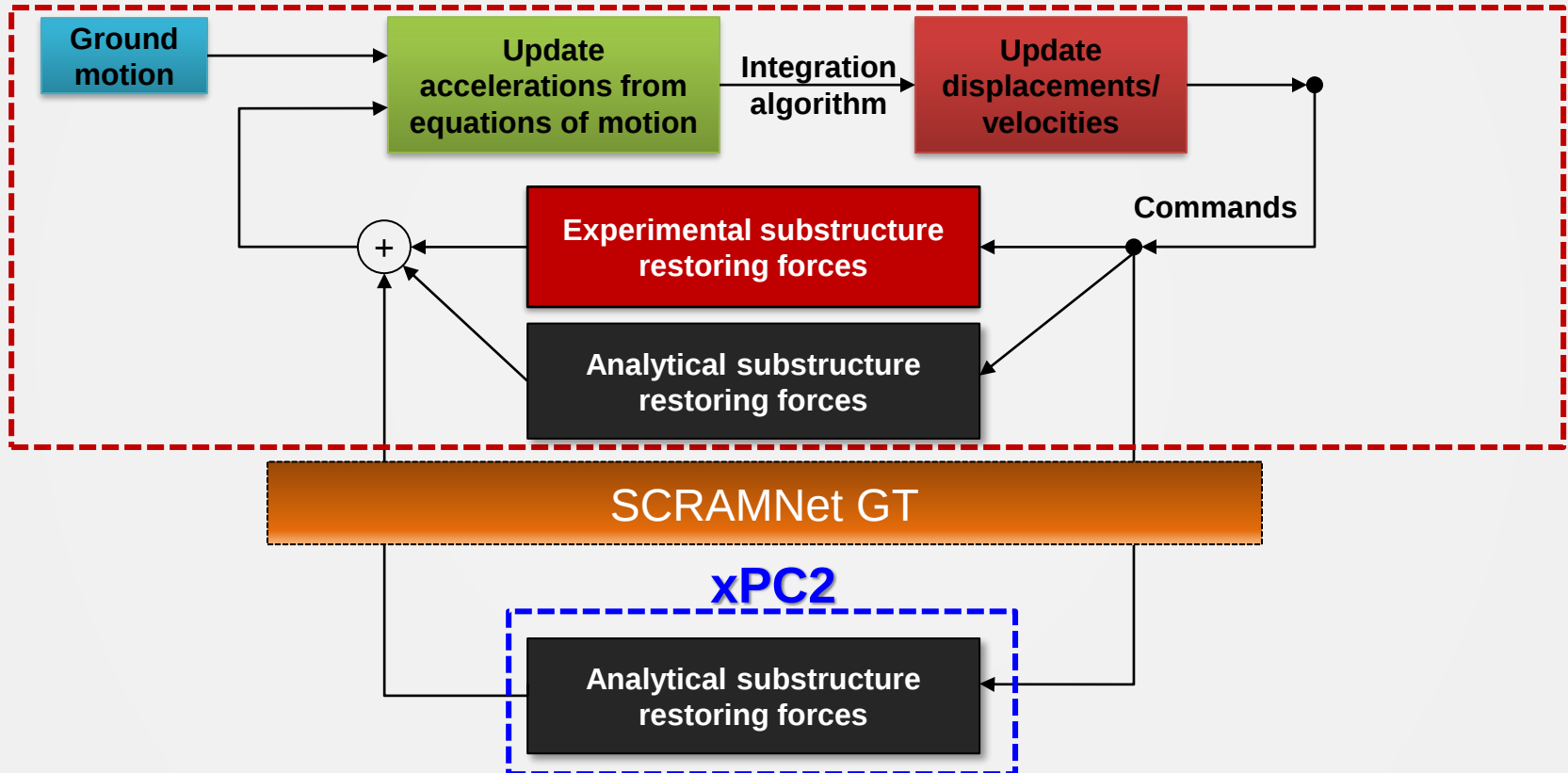


RTHS: Model Flow through Simulink Simulation



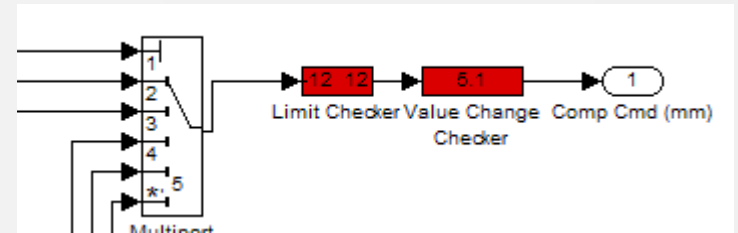
RTHS: Multiple Targets

xPC1



Simulation Safety

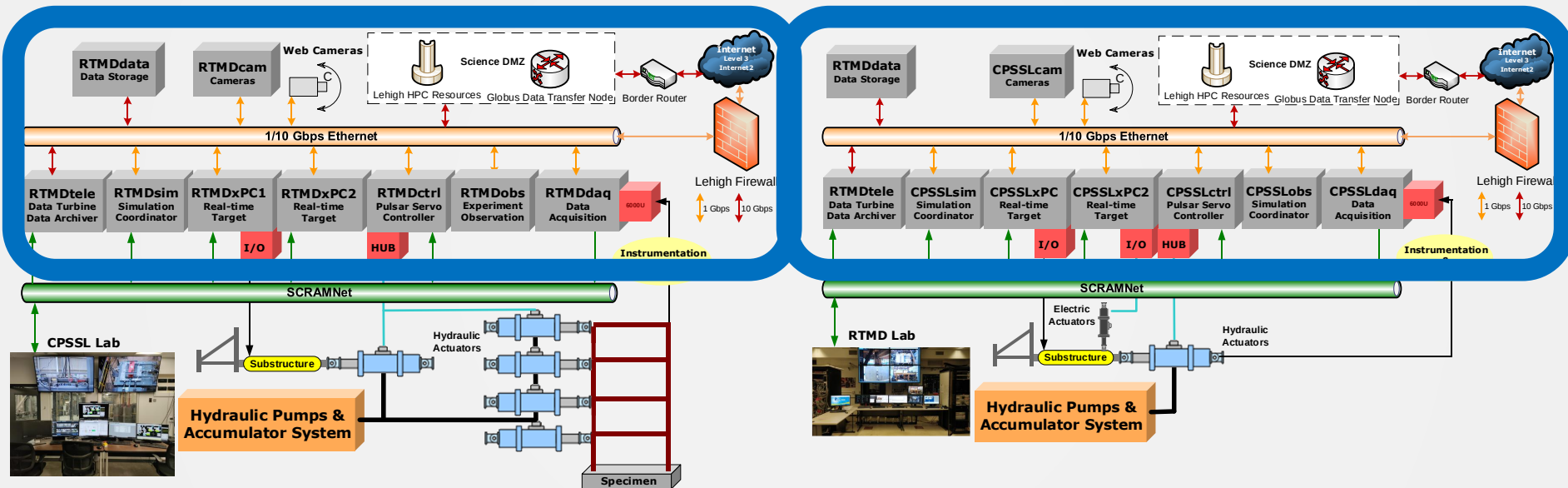
- Command software limits
 - Bound and rate limits
- Controller software limits
 - System trip and shutdown
- Hardware displacement limit switches
- E-Stop buttons



IT Infrastructure

RTMD Lab

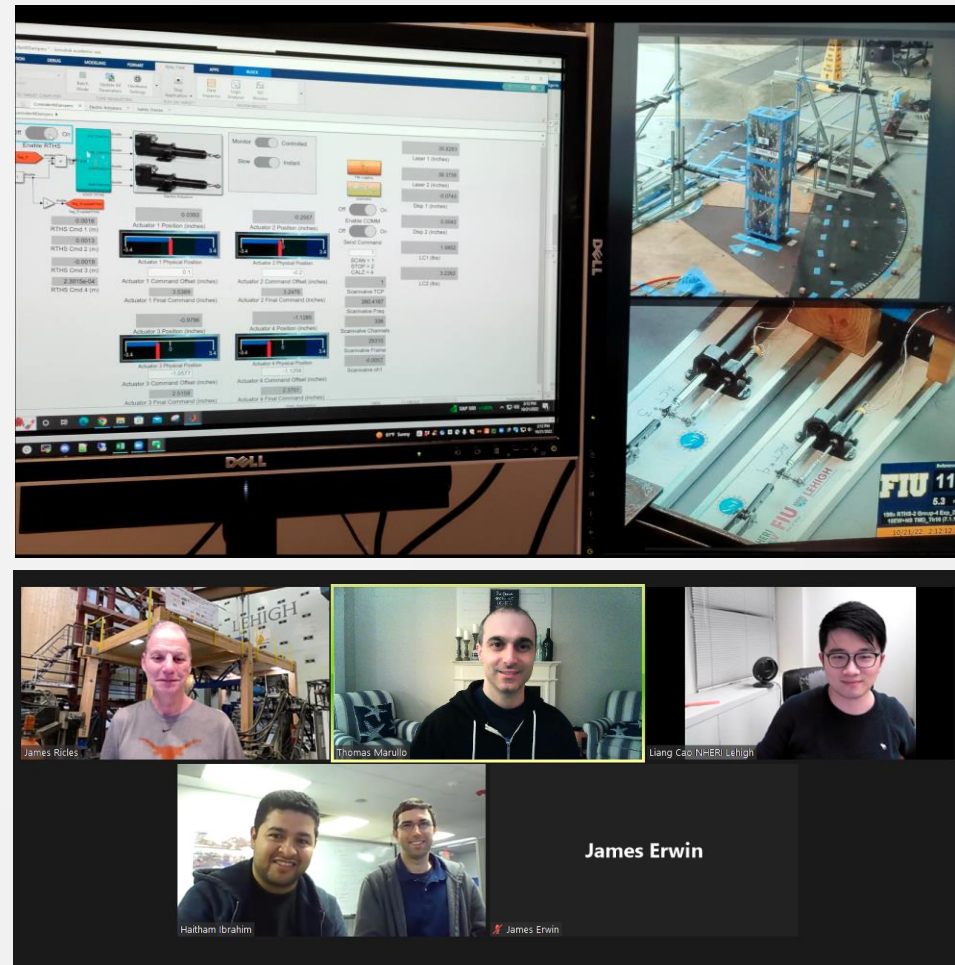
CPSSL Lab



Telepresence
and
Observation

Collaboration

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



Data Streaming

- Data Turbine (RBNB) (dataturbine.org)
 - 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

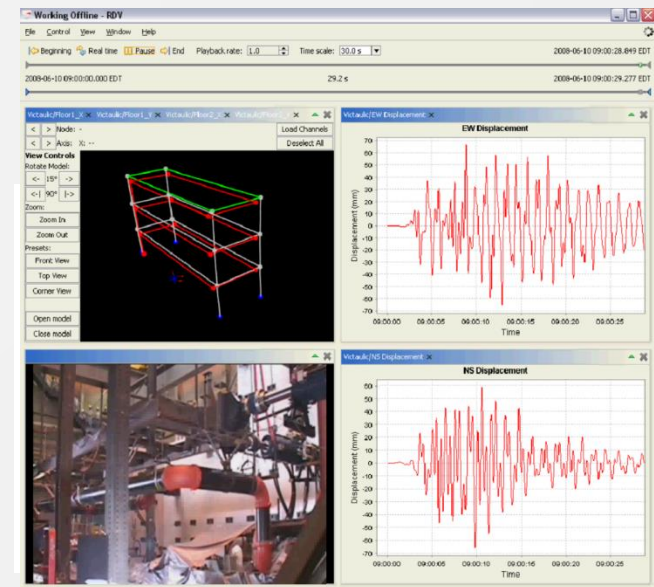


Photo and Video Capabilities

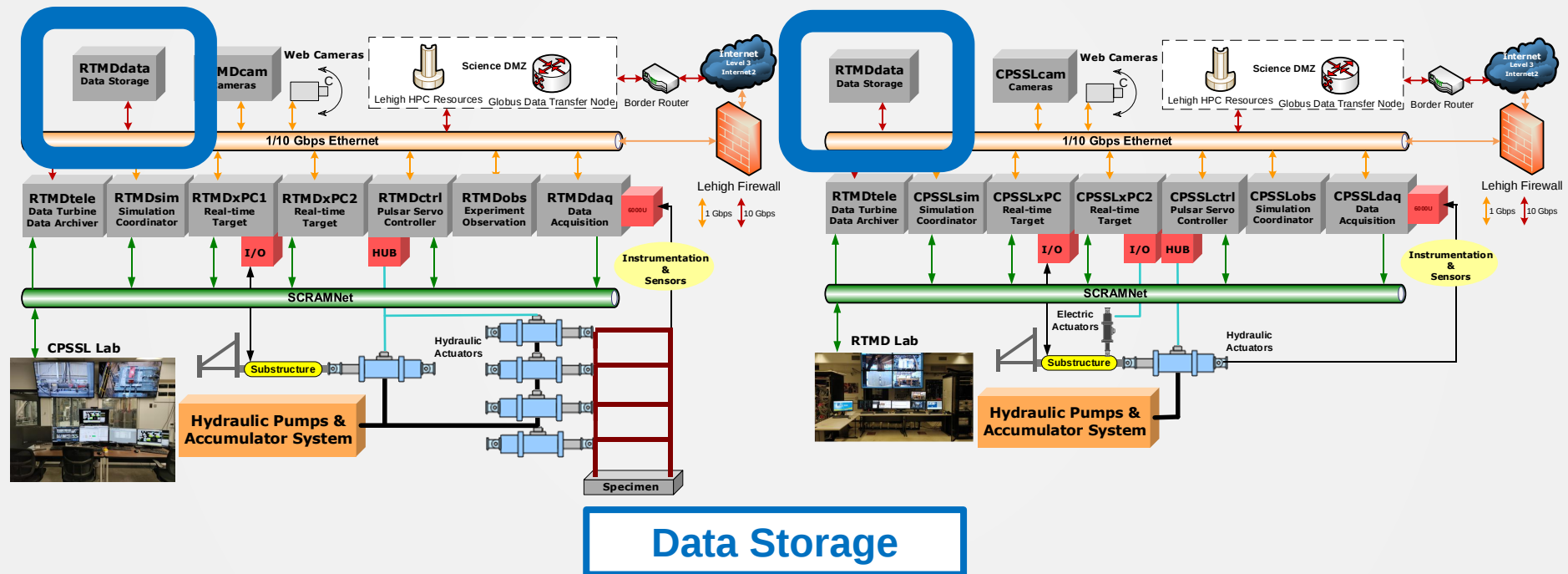
- Video/Imaging systems
 - (30) Amcrest Bullet/PTZ IP Cameras (up to 8k)
 - (4) Sony SNC-EP550 HD (720p HD)
 - (4) GoPro Hero 10 camcorders (4k 60Hz)
 - (9) GoPro Hero 3 Black camcorders (1080p60 HD)
 - Lab Security Cameras
 - Additional camera equipment upon request through LU Media
- Blue Iris Servers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



IT Infrastructure

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CPSSL Lab



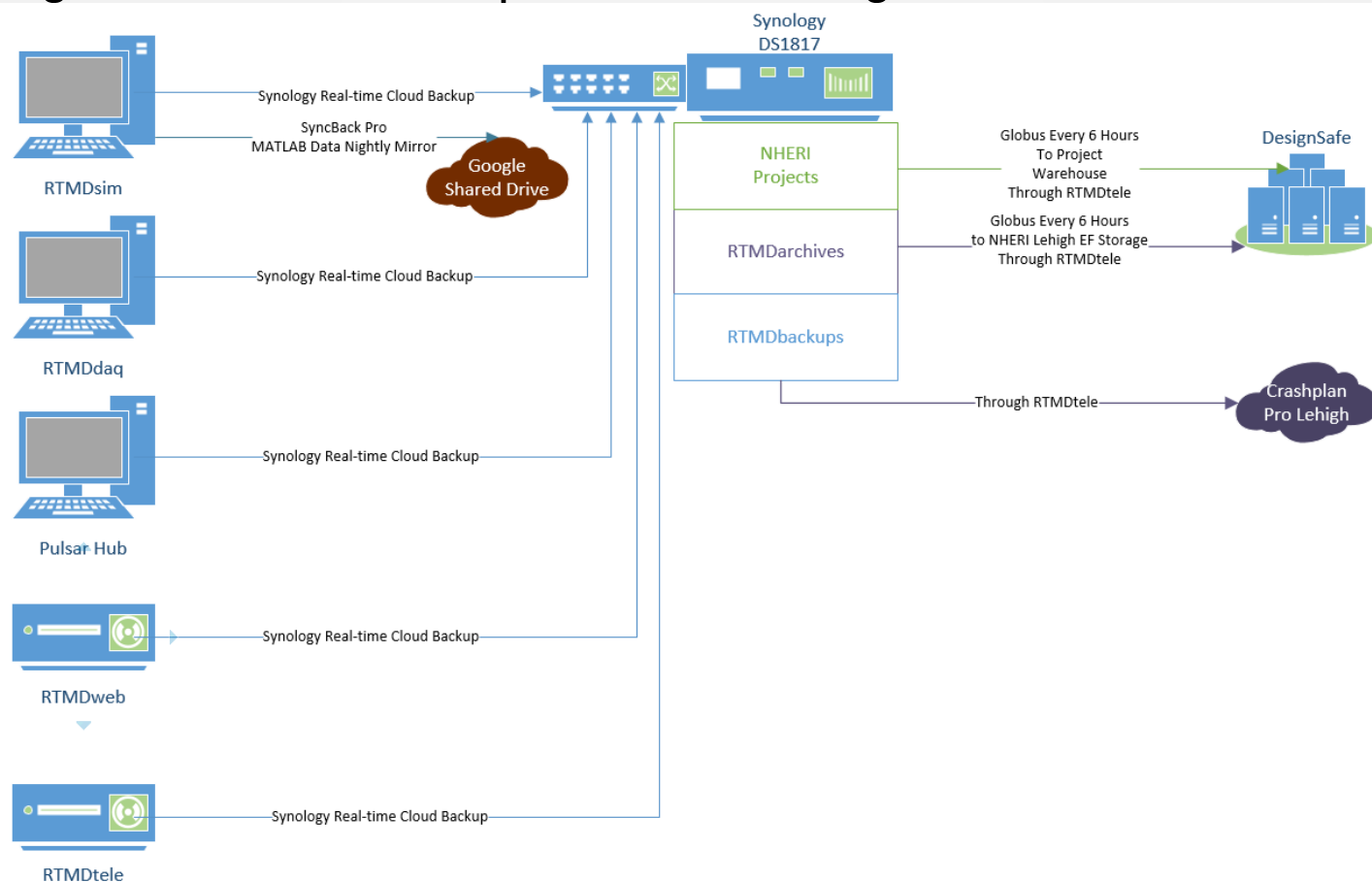
RTMDdata

- 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



Thank you

