NHERI Lehigh Experimental Capabilities and Protocols

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IT Systems Administrator

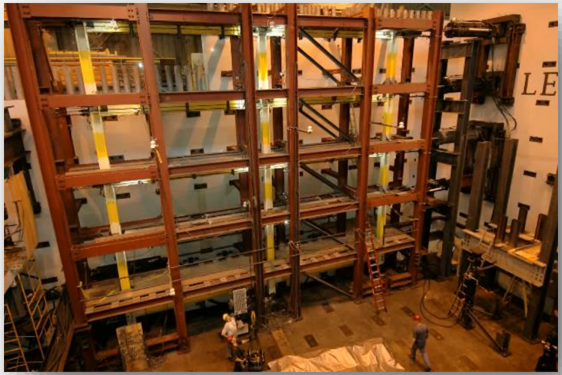
NHERI Lehigh EF

Outline

- Experimental Capabilities
- Test Beds
- Equipment
- Experimental Protocols
- IT Operations
- Cyber Infrastructure

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

- Large-Scale Hybrid Simulation



HS EQ Simulation of Buildings with SC-MRF

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation

RTHS EQ Simulation of Buildings with Dampers

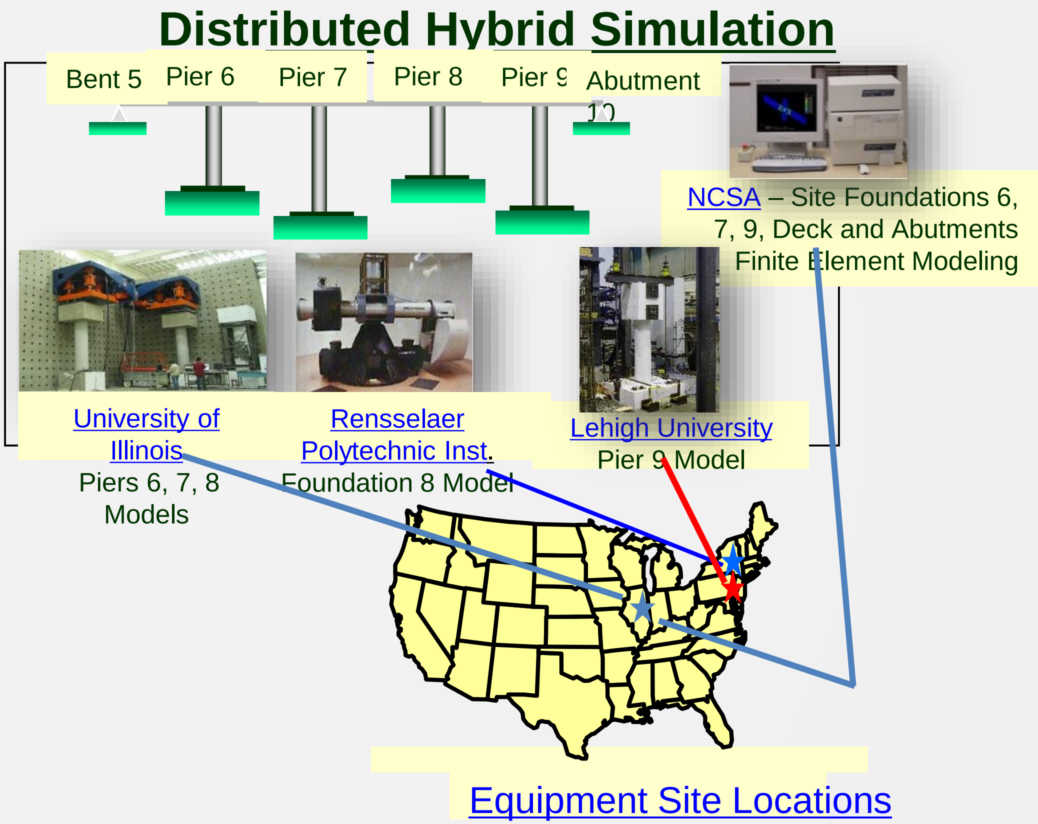
NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures

RTHS EQ Simulation of Building with Multiple Dampers

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

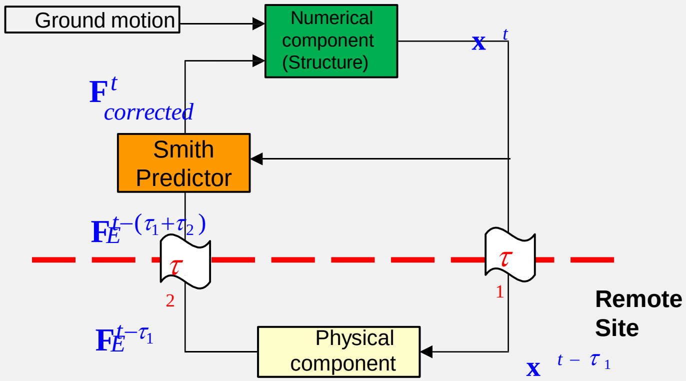
- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures
- Geographically Distributed Hybrid Simulation



Distributed RTHS EQ Simulation of I-10 Collector Bridge

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures
- Geographically Distributed Hybrid Simulation
- Geographically Distributed Real-time Hybrid Simulation



Lehigh

UIUC

RTHS EQ Simulation of Building with MR Dampers (Kim, Christenson)

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures
- Geographically Distributed Hybrid Simulation
- Geographically Distributed Real-time Hybrid Simulation
- Predefined load or displacements (Quasi-static testing or characterization testing)

Temperature Control Chamber

Characterization of Full-scale Semi-active and Passive Dampers

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

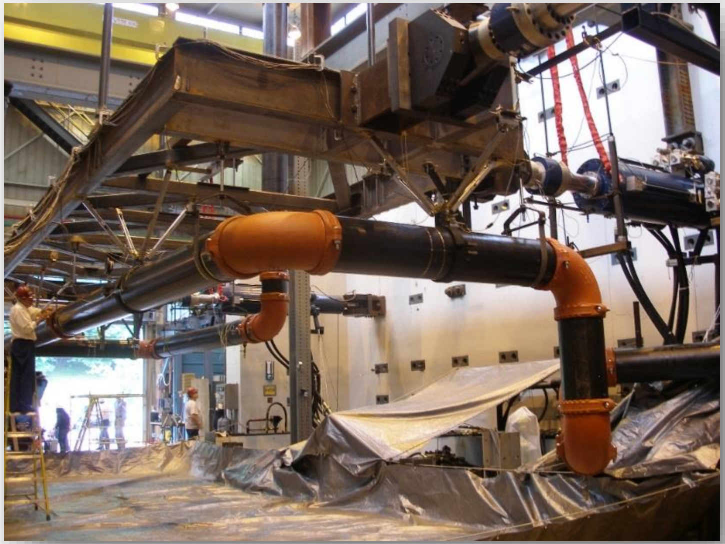
- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures
- Geographically Distributed Hybrid Simulation
- Geographically Distributed Real-time Hybrid Simulation
- Predefined load or displacements (Quasi-static testing or characterization testing)

Characterization of Large-scale RC Coupled Shear Wall System

LEHIGH UNIVERSITY ATLSS RTMD REAL-TIME MULTI-DIRECTIONAL SIMULATION NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE NSF DESIGNSAFE-CI A NATURAL HAZARDS ENGINEERING COMMUNITY

NHERI Lehigh EF Testing Capabilities for Natural Hazards Engineering Research

- Large-Scale Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation
- Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures
- Geographically Distributed Hybrid Simulation
- Geographically Distributed Real-time Hybrid Simulation
- Predefined load or displacements (Quasi-static testing or characterization testing)
- Dynamic testing



Multi-directional Dynamic Testing of Pipe Couplers

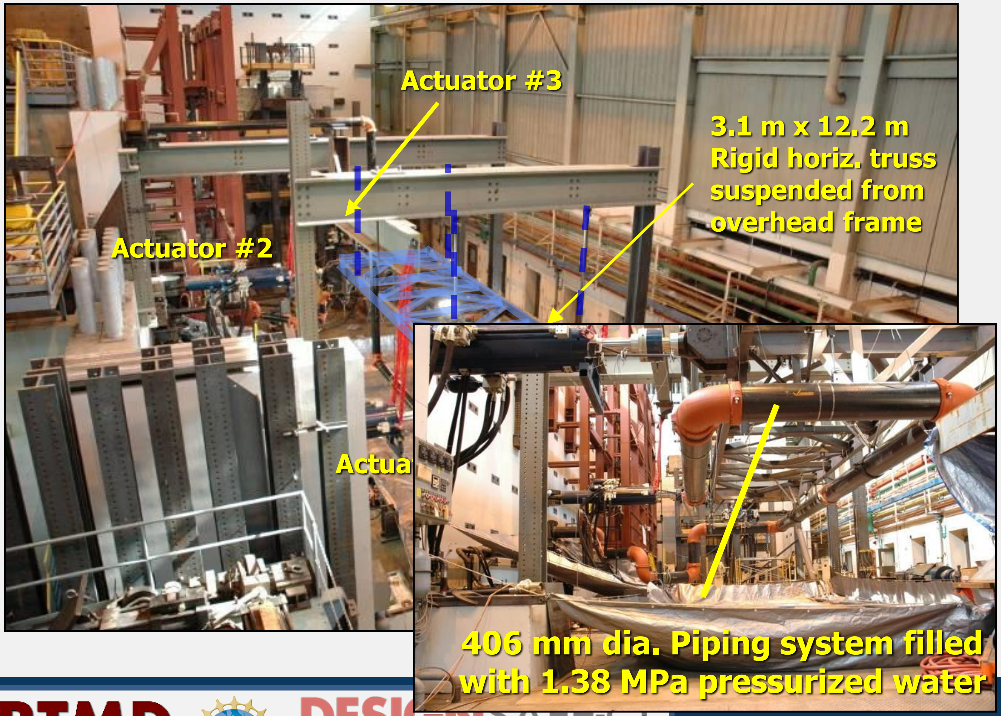
NHERI Lehigh EF/ATLSS Testbeds

- **Bracing Frame**
  - Perform experiments (e.g., characterization tests, real-time hybrid simulations) on test frame specimens of:
    - Up to 13.7 m (45 ft) in height
    - Up to 11 m (36 ft) in width

NHERI Lehigh EF/ATLSS Testbeds

- **Non-Structural Component Seismic Simulator**
  - Enables multi-directional real-time hybrid simulation of non-structural components and systems:
    - ➢ Up to 12.2 m (40 ft) in length
    - ➢ Up to 3.1 m (10 ft) in width

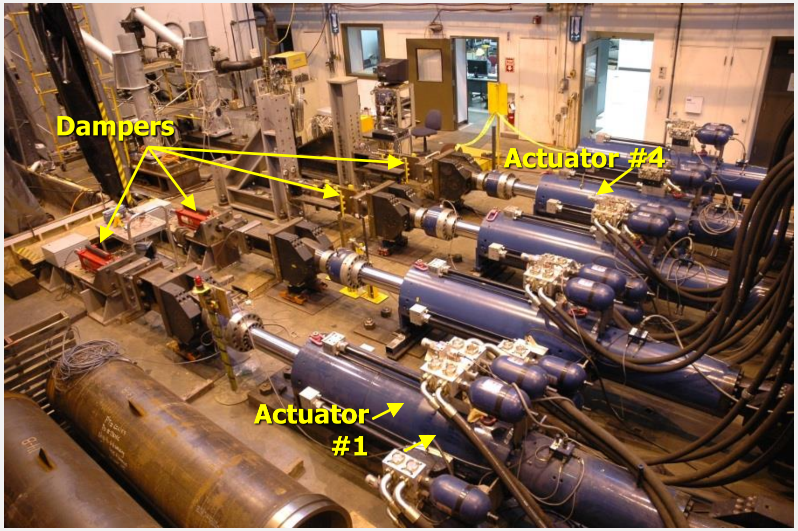
Multi-directional Real-time hybrid simulation of building piping system



NHERI Lehigh EF/ATLSS Testbeds

- **Full-scale Damper Testbeds**
  - Enables full-scale damper tests:
    - ➢ Damper characterization tests
    - ➢ Real-time hybrid simulations
  - Stoke, velocity, and force capacity:
    - ➢ +/- 500 mm (20 in.) stroke
    - ➢ 1140 mm/s (45 in/s) for 1700 kN actuators
    - ➢ 840 mm/s (33 in/s) for 2300 kN actuators

Real-time hybrid simulation of building with four passive dampers



NHERI Lehigh EF/ATLSS Testbeds

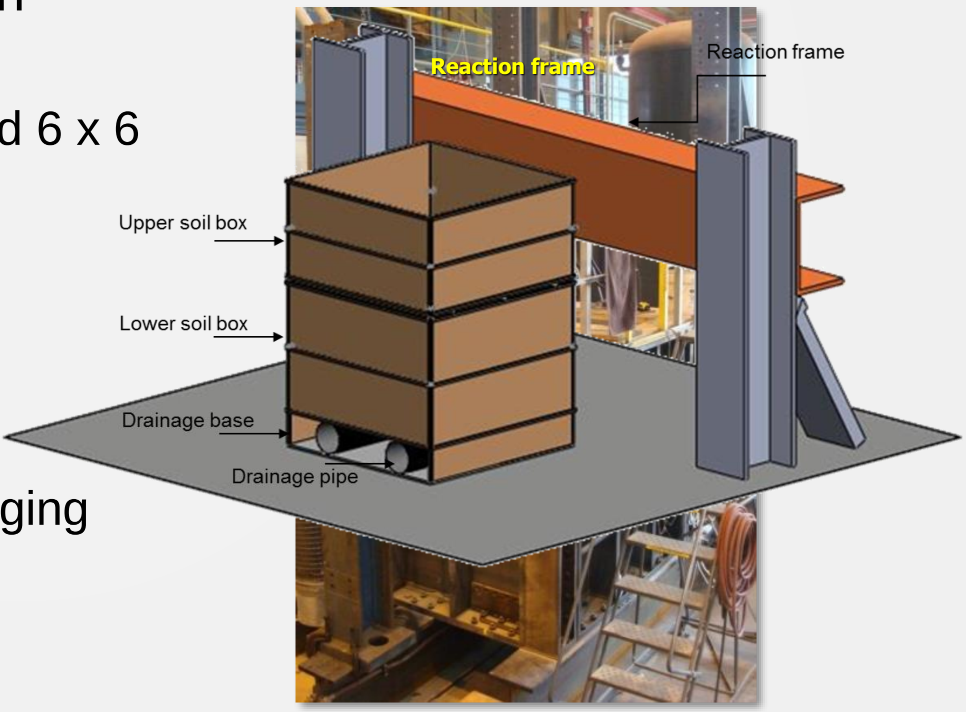
- **Tsunami Debris Impact Force Testbed**
  - Enables full-scale debris impact tests:
    - High speed DAQ; high speed 5000 fps cameras
    - High bandwidth, resolution load cells
    - Accelerometers, laser-displacement transducers

Real-time simulation of impact forces from tsunami shipping container debris

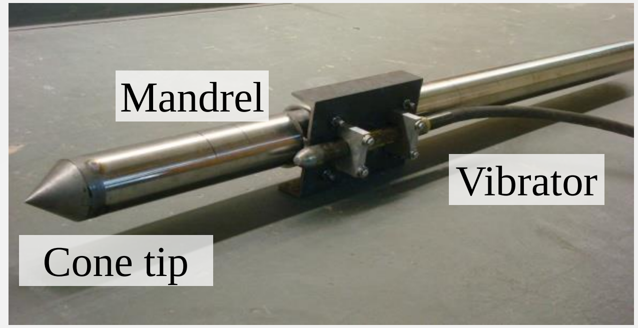
NHERI Lehigh EF/ATLSS Testbeds

- **Reduced-scale Soil Box**
  - Enables soil-structure interaction research
    - ➢ Flexible designs (6 x 6 x 6 ft and 6 x 6 x 3 ft in size)
    - ➢ Actuators with load cells; data acquisition system
    - ➢ Sensors for soil and foundation response measurements
    - ➢ Advanced sensors - Digital Imaging Correlation

Soil-foundation structure interaction testbed

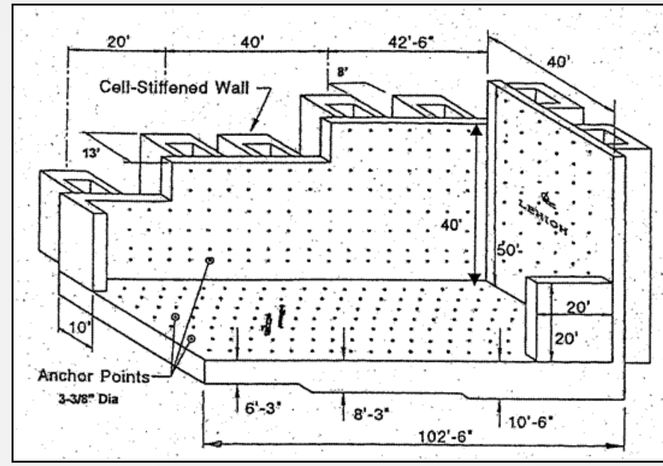


Soil-Structure Interaction Testbed



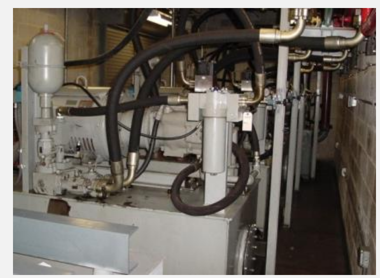
Existing ATLSS Infrastructure

- **3-D Multi-directional reaction wall facility**
  - 3-dimensional
  - Up to 15.2 m (50 ft) height
  - 1.5 m (5 ft) anchor point grid
- **Strong floor**
  - 12.2 m by 30.5 m (40 ft by 100 ft)
  - Anchor assembly capacity
    - 2,224 kN (500 kips) shear
    - 1,334 kN (300 kips) tension
- **Hydraulic Supply System**
- **Over 30 Hydraulic Actuators**
- **Large array of Conventional Sensors**
- **Crane**
- **Skilled staff**



NHERI Lehigh EF Hydraulic Equipment and Power

- **Enables real-time EQ large scale demand to be imposed for up to 30 seconds**
- **Hydraulic supply system (ATLSS)**
  - 5-120 gal/min variable axial piston pumps
- **Accumulator System (NHERI)**
  - 16 piston accumulators
    - 50.2 gal each
- **5 dynamic hydraulic actuators (NHERI)**
  - Maximum load capacity
    - 2 actuators: 517 kips at 3000 psi
    - 3 actuators: 382 kips at 3000 psi
  - Stroke
    - +/- 19.7 in
  - Maximum velocity
    - 45 in/s for 382 kip actuators
    - 33 in/s for 517 kip actuators
- **10 3-stage 550 gal/min Servovalves and HSMs (NHERI)**



Other NHERI Lehigh EF Equipment

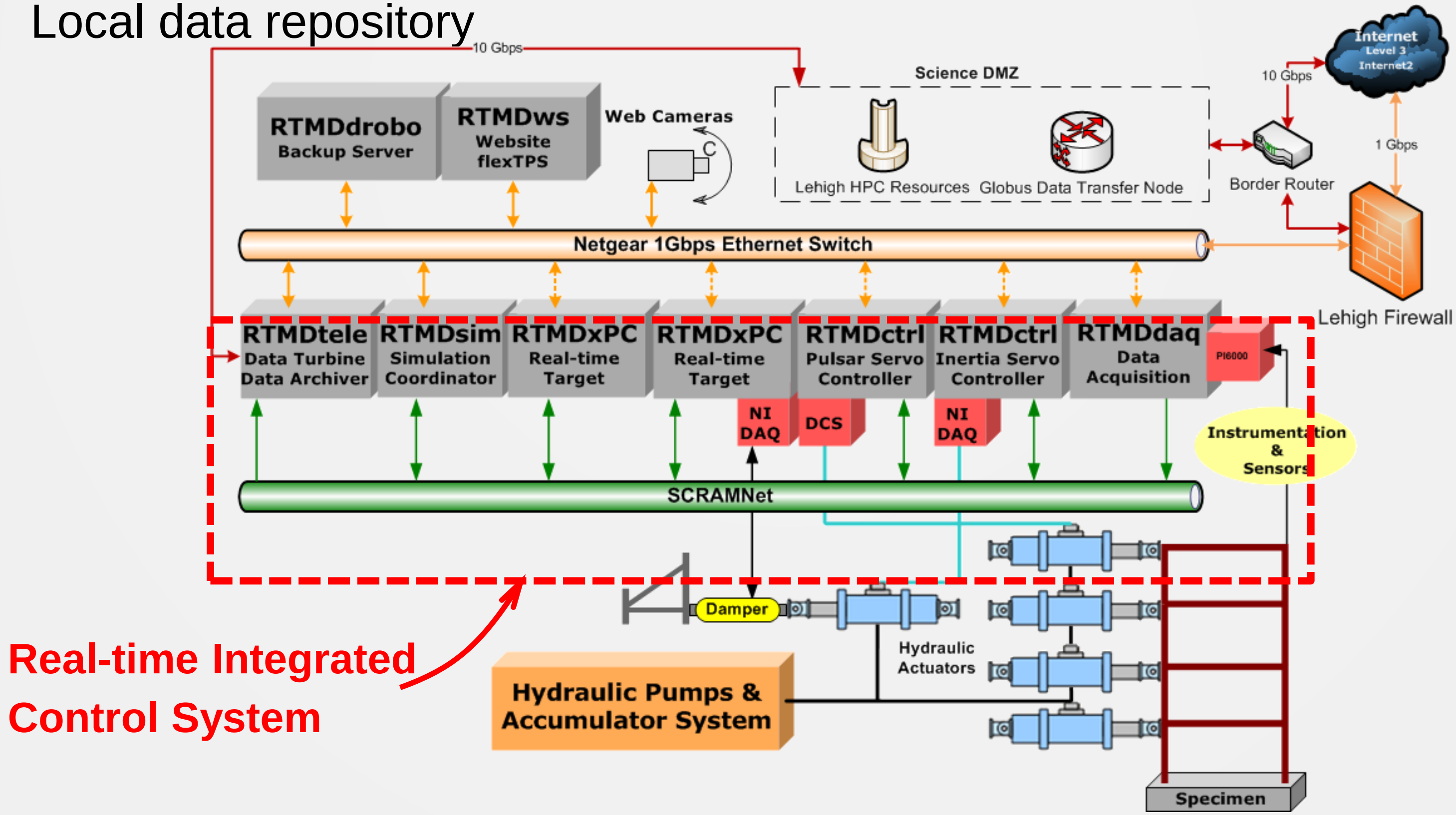
- High Speed 304 Channel Data Acquisition System
- 2 xPCs for simulation coordination, including additional NI DAQ
- Two real-time servo-hydraulic controllers
- Sensors (displacement, accelerometers, inclinometers)
- Telepresence webcams
- Specs for all equipment found in Users Guide

Instrumentation

- Displacement transducers
  - Strokes ranging from ±6.4mm (LVDTs) to 1524mm (linear potentiometers).
  - Temposonic position sensors with a ±760 mm stroke, to a ±1100 mm stroke.
  - All transducers are calibrated to within ±1% accuracy, with the LVDTs calibrated to within ±0.1%.
- Inclinometers ranging up to ±20 degrees with 1% accuracy.
- Each hydraulic actuator is equipped with a load cell.
  - All load cells are calibrated to within ±0.1% accuracy.

Other Major NHERI Lehigh EF Equipment

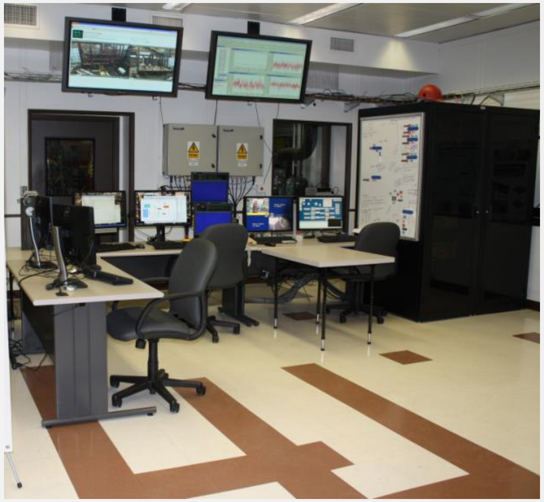
- Real-time Integrated Control System
  - Real-time simulation coordinator
  - Multiple xPCs for simulation coordination with additional DAQ
  - Two real-time servo-hydraulic controllers
  - High Speed 304 Channel Data Acquisition System
  - Real-time telepresence system
  - Local data repository

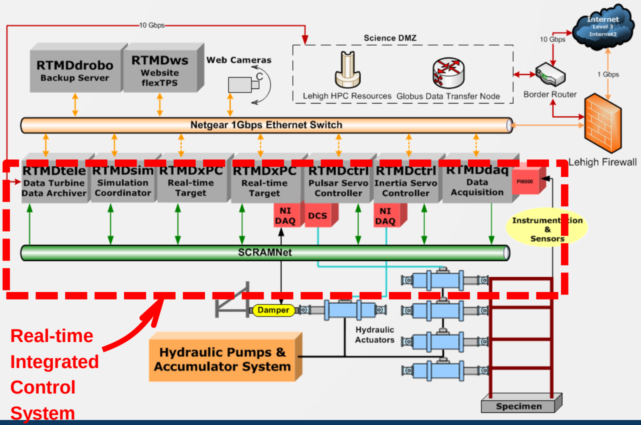


NHERI Lehigh EF Control Room

Control Center

- Houses Real-time Integrated Control System
- Camera Control
- Data Acquisition System and Server
- Data Streaming System
  - Video
  - Sensors
- Video Displays
- Local Repository





NHERI Lehigh EF non-NHERI Equipment

- Site leverages Non-NHERI equipment to provide capability, improve capacity and maintain throughput.
  - 30 Actuators
  - ATLSS Wineman Controller
  - 2 MTS 458 Controllers
  - MTS FlexTest 100 Controller
  - DAQ systems
  - Trilion System for Digital Image Correlation - full field displacement and strain
  - Transducers - over 96 LVDTs, 62 load cells, Temposonics (12 ATLSS)
  - SSI instrumentation

NHERI Lehigh EF non-NHERI Equipment

Equipment	Year Acquired
Multi-Directional Reaction Wall System	
15.2m to 6.1m tall L-shaped reaction wall	1989
30.5m x 12.2m strong test floor	1989
Hydraulic Equipment	
20.7 MPa (3000psi) Hydraulic power system with 2270 liters/min	1988,1992**
Central hydraulic distribution system	1988,1992**
6-Vickers Service hydraulic manifolds (1500 liters/min)	n/a
Hydraulic Loading Equipment	
Sactec 2670 kN universal test machine	1992
MTS 245 kN fatigue test machine	1992
Hydraulic Actuators	
3-2680kN Hanna, +-750 mm stroke, 20mm/sec max. velocity*	1997
2-2050kN Hanna, +-480 mm stroke, 25mm/sec max. velocity*	1988
4-1500kN Hanna, +-480 mm stroke, 35mm/sec max. velocity*	1988
2-150kN Hanna, +-125 mm stroke, 35mm/sec max. velocity*	1988
2-1050kN Hanna +-125 mm stroke, 50mm/sec max. velocity*	1988
2-607kN Hanna, +-300 mm stroke, 80mm/sec max. velocity*	1988
8-580kN Hanna, +-125 mm stroke, 60mm/sec max. velocity*	1992
2-1000kN Hanna, +-125 mm stroke, 35mm/sec max. velocity*	1992

Users Guide Available ATLSS Actuators

https://lehigh.designsafe-ci.org/resources

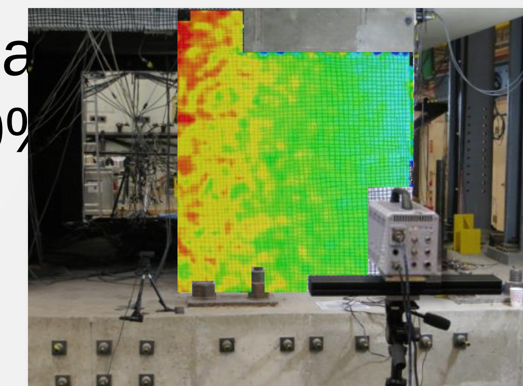
ATLSS Actuators

Instrumentation

- Digital imaging correlation (DIC) systems.
  - Utilize the 3D ... ethod.
  - Works on bot ... r pattern, thus simplifying sa
  - The same se ... to measure small and large obj ... m) a the range of (... 100%

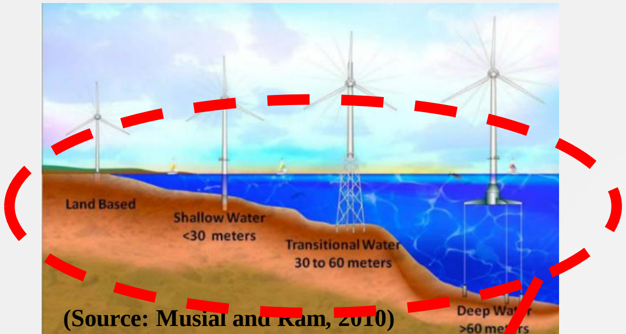
Figure F.4 DIC System

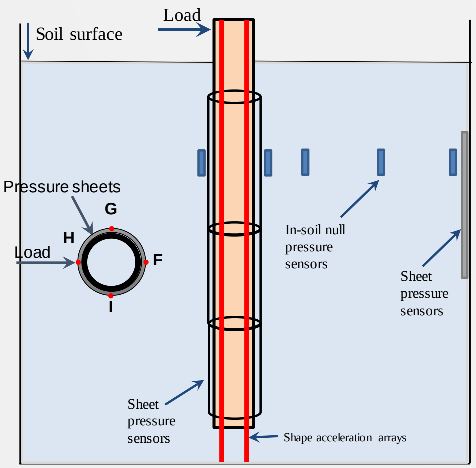
NEES@Lehigh Coupled Shear Wall Test Specimen with Multi-Directional Loading



Digital Imaging Correlation System: reinforced concrete coupled-shear wall test specimen measured pier vertical displacements (courtesy M. McGinnis)

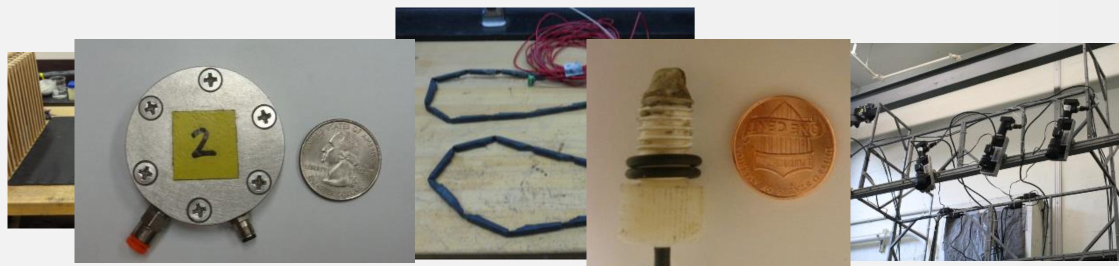
Soil-Structure Interaction Instrumentation

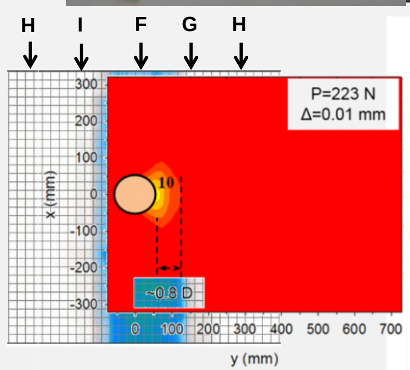


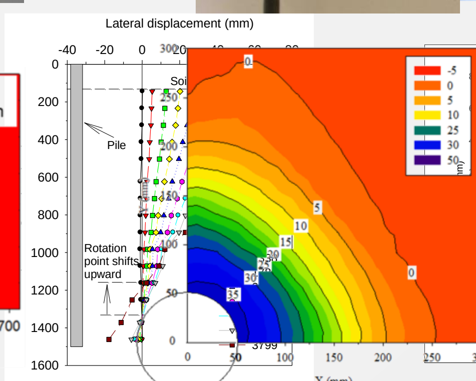


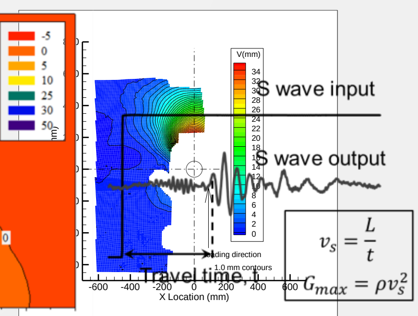
Test Setup and instrumentation

- Advanced instrumentation to understand SSI of foundation systems under different loading conditions
- Combine with hybrid simulation to improve analytical substructure models, or
- Hybrid simulation with soil included in experimental substructure









Soil-pile interaction pressure sensors

Pressure sensors

Shape acceleration arrays

Shear wave sensors

Digital image correlation

NHERI Lehigh EF - ATLSS Space and Resources

- **Specimen Prep**
  - Staging Areas
  - Machine Shop
- **Laboratories**
  - Intelligent Structures
  - Mechanical Testing
  - Welding and Joining
  - Materials
  - Microscopy
- **Offices**: Faculty; Staff; Visiting Researchers
- **Meeting Rooms**: Auditorium; Conference Room
- **Storage Areas**
- **Secure Facility**

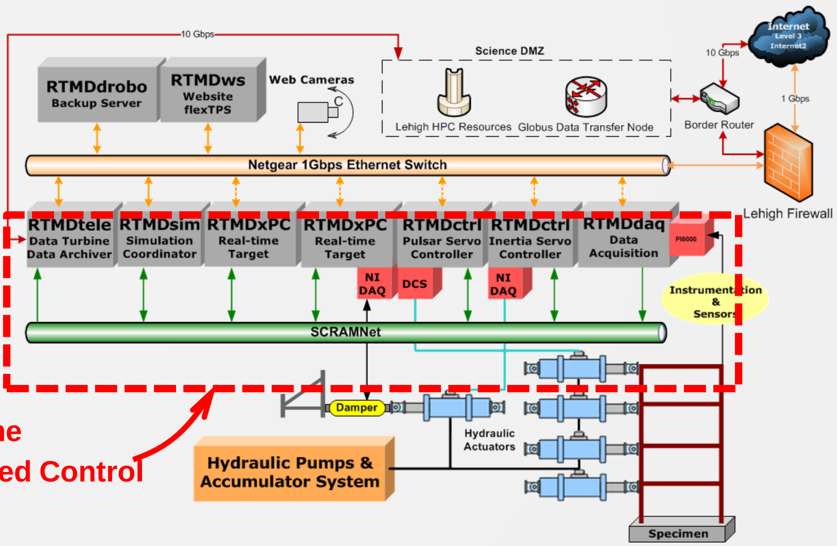
Specimen preparation staging area

Mechanical testing

Auditorium – ECO Activities

NHERI Lehigh EF Experimental Protocols

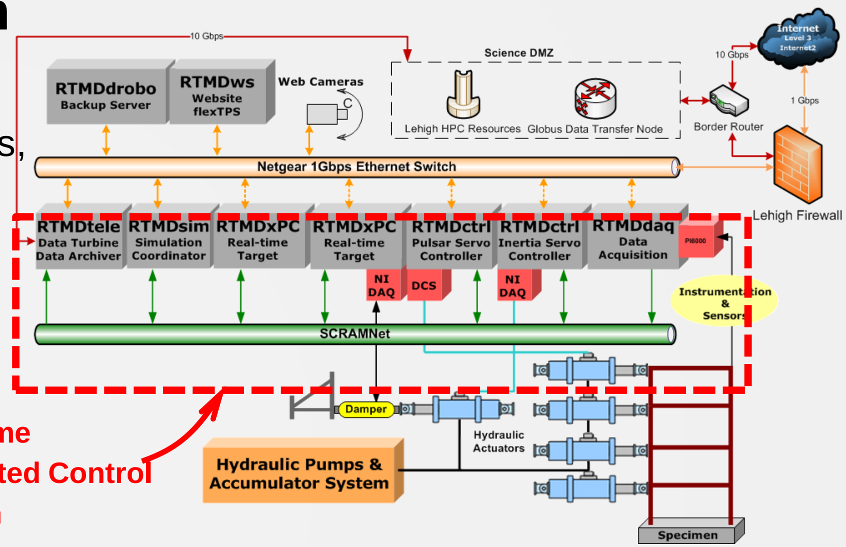
- **Real-time Integrated Control System**
  - Configured with experimental protocol required by user to perform test
    - Large-Scale Hybrid Simulation
    - Large-Scale Real-time Hybrid Simulation
    - Large-Scale Real-time Hybrid Simulation with Multiple Experimental Substructures
    - Geographically Distributed Hybrid Simulation
    - Geographically Distributed Real-time Hybrid Simulation
    - Predefined load or displacements (Quasi-static testing or characterization testing)
    - Dynamic testing
  - Testing algorithms reside on an RTMDxPC and run in real time
    - <u>Experiments can be run in true real-time</u> (real-time hybrid simulation, real-time distributed hybrid simulation, dynamic testing, characterization testing).
    - <u>Experiments can be run at an expanded time scale</u> (hybrid simulation, distributed hybrid simulation, quasi-static testing).
  - Distributed hybrid simulation via:
    - OpenFresco
    - Simcor
    - Custom software
  - Flexible-designed system
    - Software and middleware packages developed by users or NHERI CI can be plugged in and utilized for testing



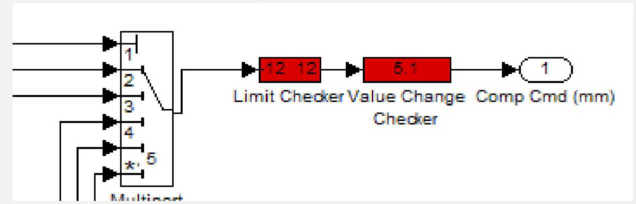
Real-time Integrated Control System

NHERI Lehigh EF Experimental Protocols

- **Real-time Integrated Control System**
  - Hydraulics-off mode
    - Used for validation of testing methods/algorithms, training, education
    - Both servo-hydraulic system, test structure and any analytical substructure modeled analytically
  - Safety
    - Software limits are enabled on the System.
    - Hardware actuator positon stroke and test specimen displacement limit switches placed.
    - Emergency stop system activated throughout laboratory



Real-time
Integrated Control
System



NHERI Lehigh EF Experimental Protocols

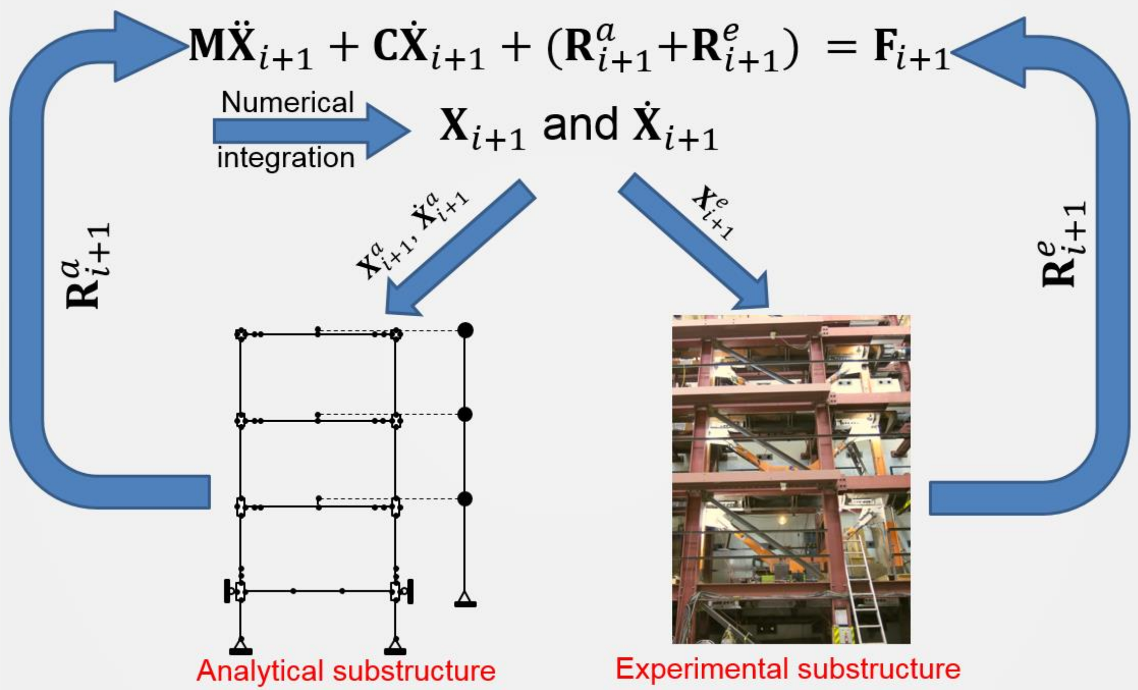
- **Real-time Integrated Control System**
  - Hybrid simulation:
    - Robust integration algorithms: Explicit Modified KR-α (MKR-α) Integration Algorithm - Explicit unconditionally stable integration algorithm with controlled numerical energy dissipation (*Kolay and Ricles, 2014*).
    - Adaptive actuator control: Adaptive Time Series (ATS) Compensator *(Chae et al. 2013)* –
      - Negates both variable time delay and variable amplitude error response, using measured test structure state feedback to achieve accurate specimen displacements
      - No user-defined adaptive gains ➔ applicable for large-scale structures susceptible to damage (i.e., concrete structures)
      - Time delay and amplitude response factor can be easily estimated from the identified values of the coefficients

Kolay, C., & Ricles, J. (2014). “Development of a family of unconditionally stable explicit direct integration algorithms with controllable numerical energy dissipation.” *Earthquake Engineering & Structural Dynamics*, *43*(9), 1361–1380. DOI:10.1002/eqe.2401

Chae, Y., Kazemibidokhti, K., and Ricles, J.M. (2013). “Adaptive time series compensator for delay compensation of servo-hydraulic actuator systems for real-time hybrid simulation.” *Earthquake Engineering and Structural Dynamics,* 42(11), 1697–1715, DOI: 10.1002/ eqe.2294.

NHERI Lehigh EF Experimental Protocols

- **Real-time Integrated Control System**
  - Hybrid simulation analytical substructure created by either
    - HybridFEM
    - OpenSees with OpenFresco interface



Schematic of hybrid simulation

HybridFEM

- MATLAB and SIMULINK based computational modeling and simulation coordinator software for dynamic time history analysis of inelastic-framed structures and performing real-time hybrid simulation
- xPC architecture facilitates real-time testing through multi-rate processing
- Run Modes
  - MATLAB script for numerical simulation
  - SIMULINK modeling for Real-Time Hybrid simulation with experimental elements via xPCs, and hydraulics-off for training and validation of user algorithms.
- User's Manual for training

HybridFEM

Configuration Options:

- Coordinate system of nodes
- Boundary, constraint and restraint conditions
- Elements
  - Elastic beam-column
  - Elastic spring
  - Inelastic beam-column stress resultant element
  - Non-linear spring
  - Displacement-based NL beam-column fiber element
  - Force-based beam NL column fiber element
  - Zero-length
  - 2D NL planar panel zone
  - Elastic beam-column element with geometric stiffness
- Geometric nonlinearities
- Steel wide flange sections (link to AISC shapes Database)
- Reinforced concrete sections
- Structural mass & inherent damping properties
- Adaptable integration methods

- Materials
  - Elastic
  - Bilinear elasto-plastic
  - Hysteretic
  - Bouc-Wen
  - Trilinear
  - Stiffness degrading
  - Concrete
  - Steel

Users Guide

- Details of the Equipment Specifications, Experimental Protocols, and Equipment Inventory are given in the User's Guide

https://lehigh.designsafe-ci.org/resources/

IT Operations and Cyber Infrastructure

Thomas Marullo

IT Systems Administrator

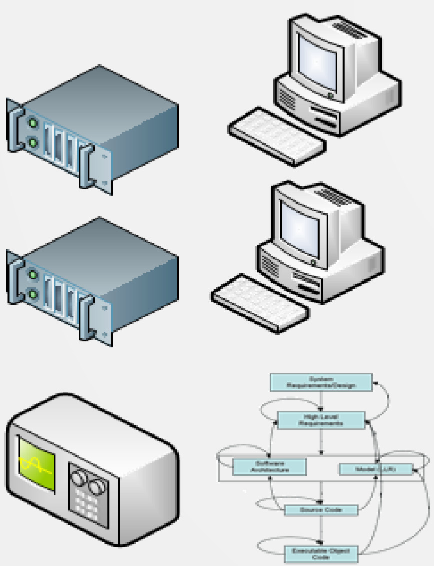
Overview

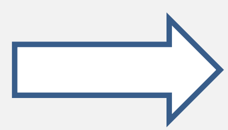
- IT Infrastructure and Equipment
- Cybersecurity and Risk Mitigation
- Software Capabilities
- User Training and Testing

IT Mission

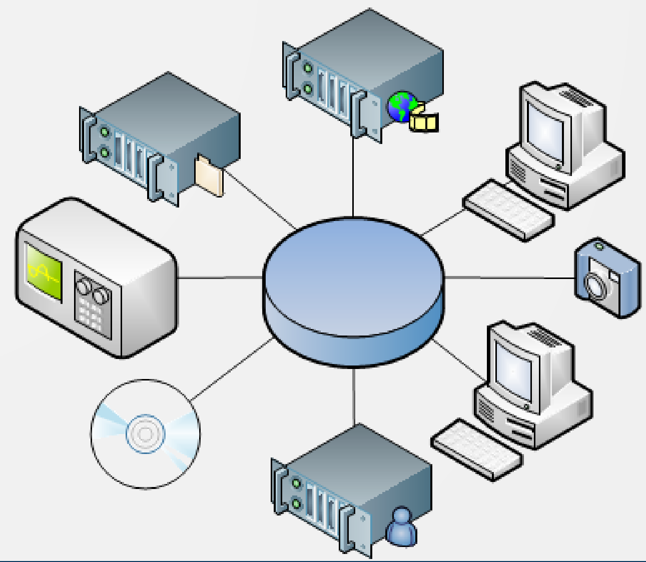
- Design IT Architecture from the ground up
- Complete control of all IT aspects to facilitate all types of required simulation techniques

2004

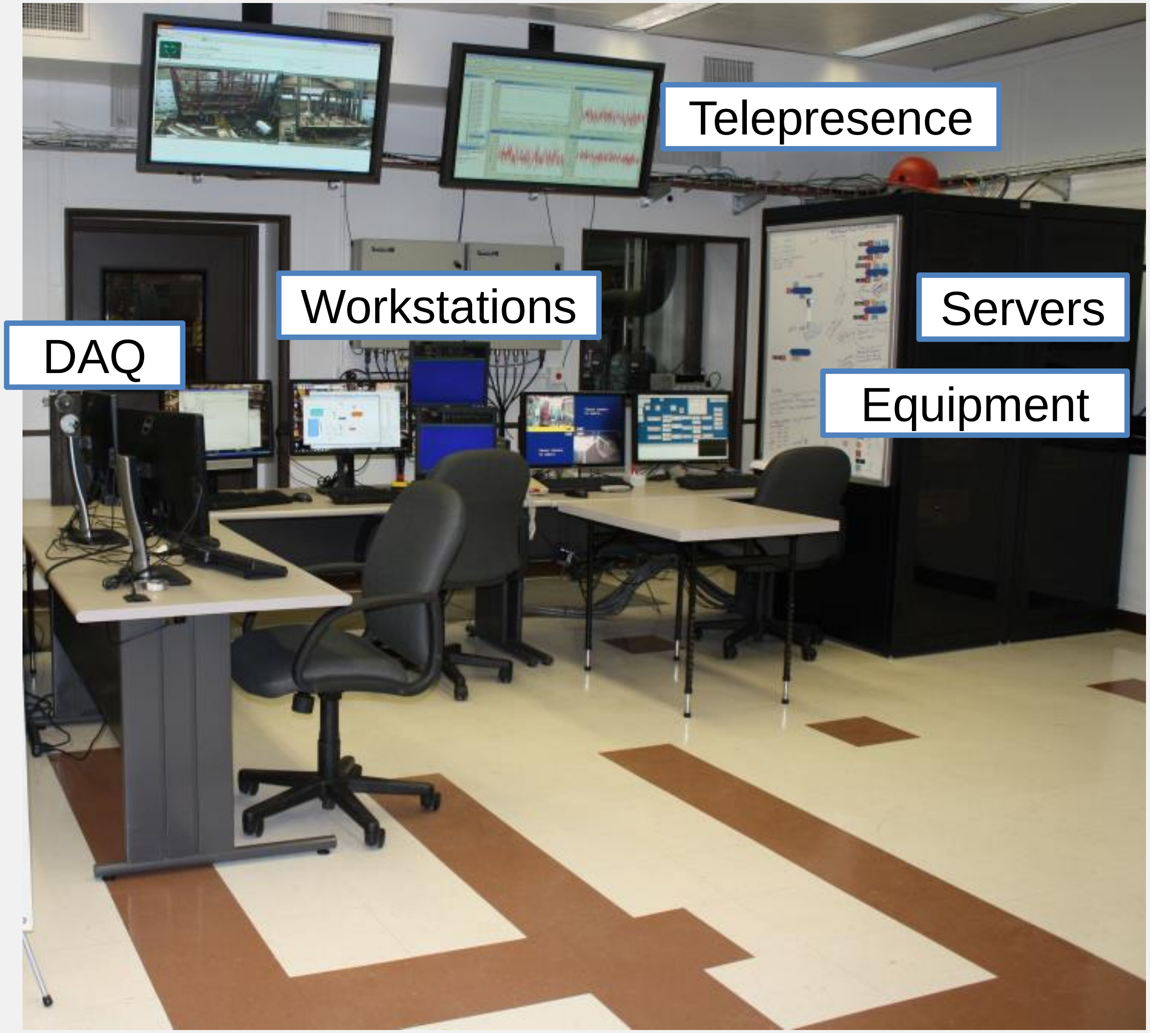




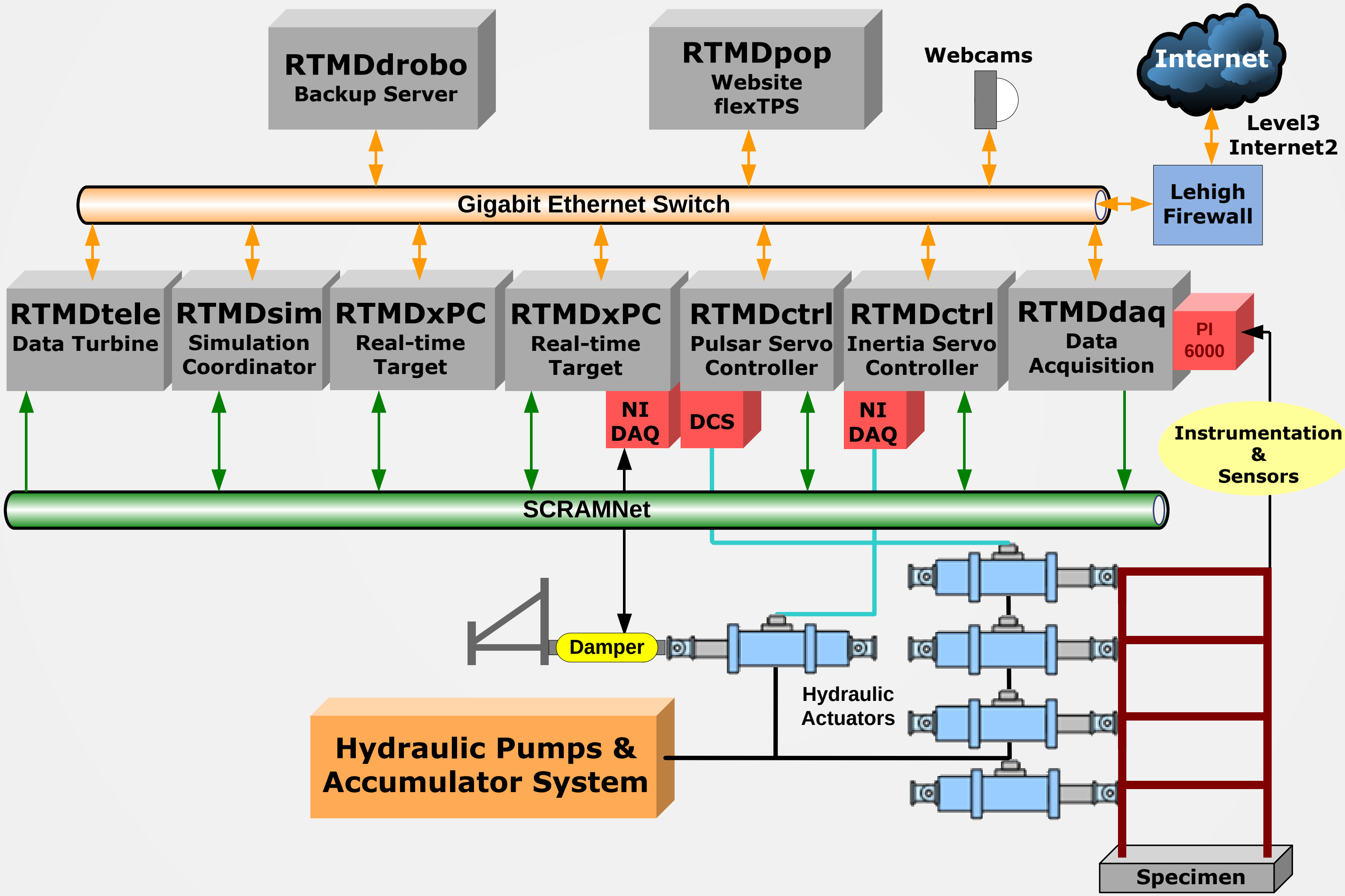
Present



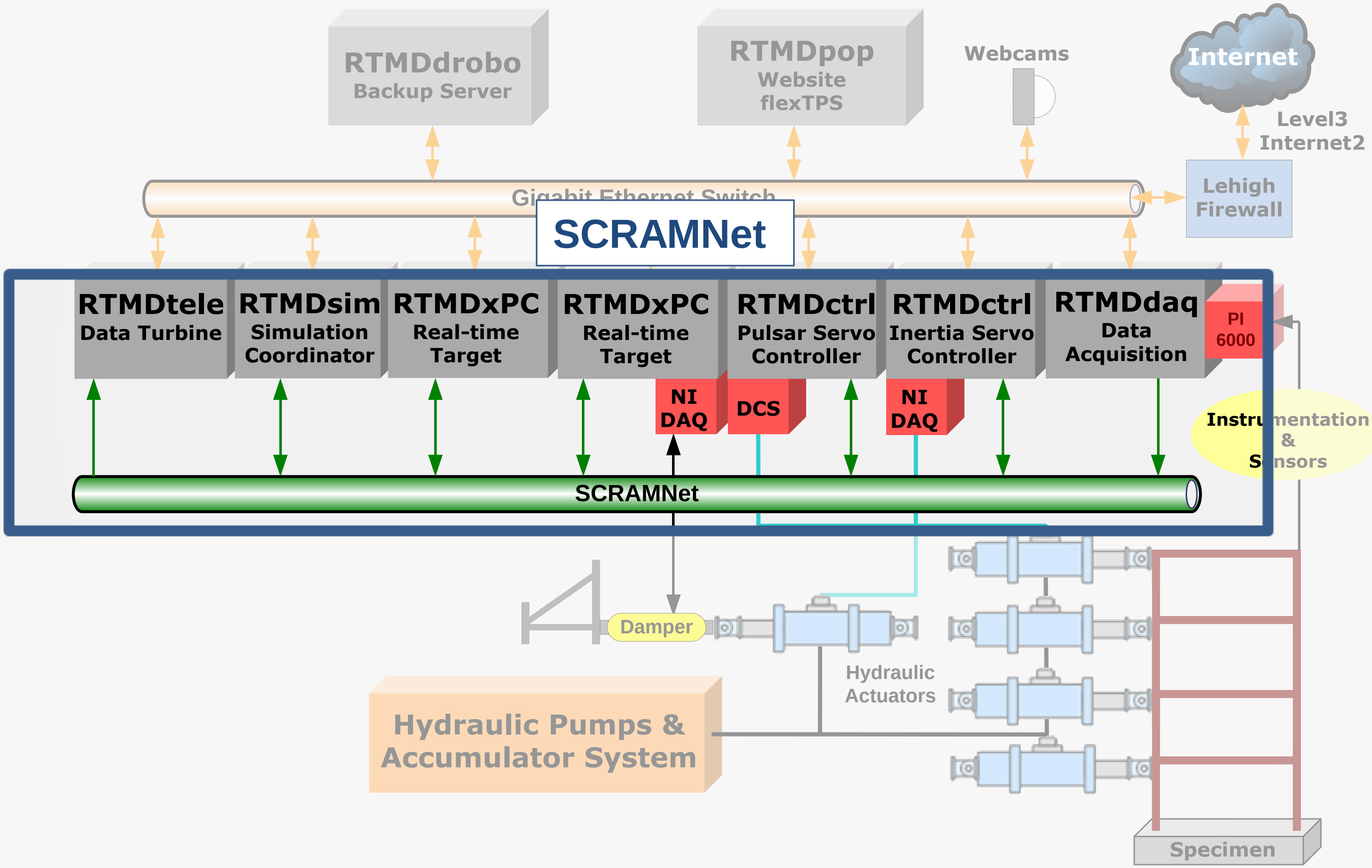
RTMD Control Room



IT Infrastructure



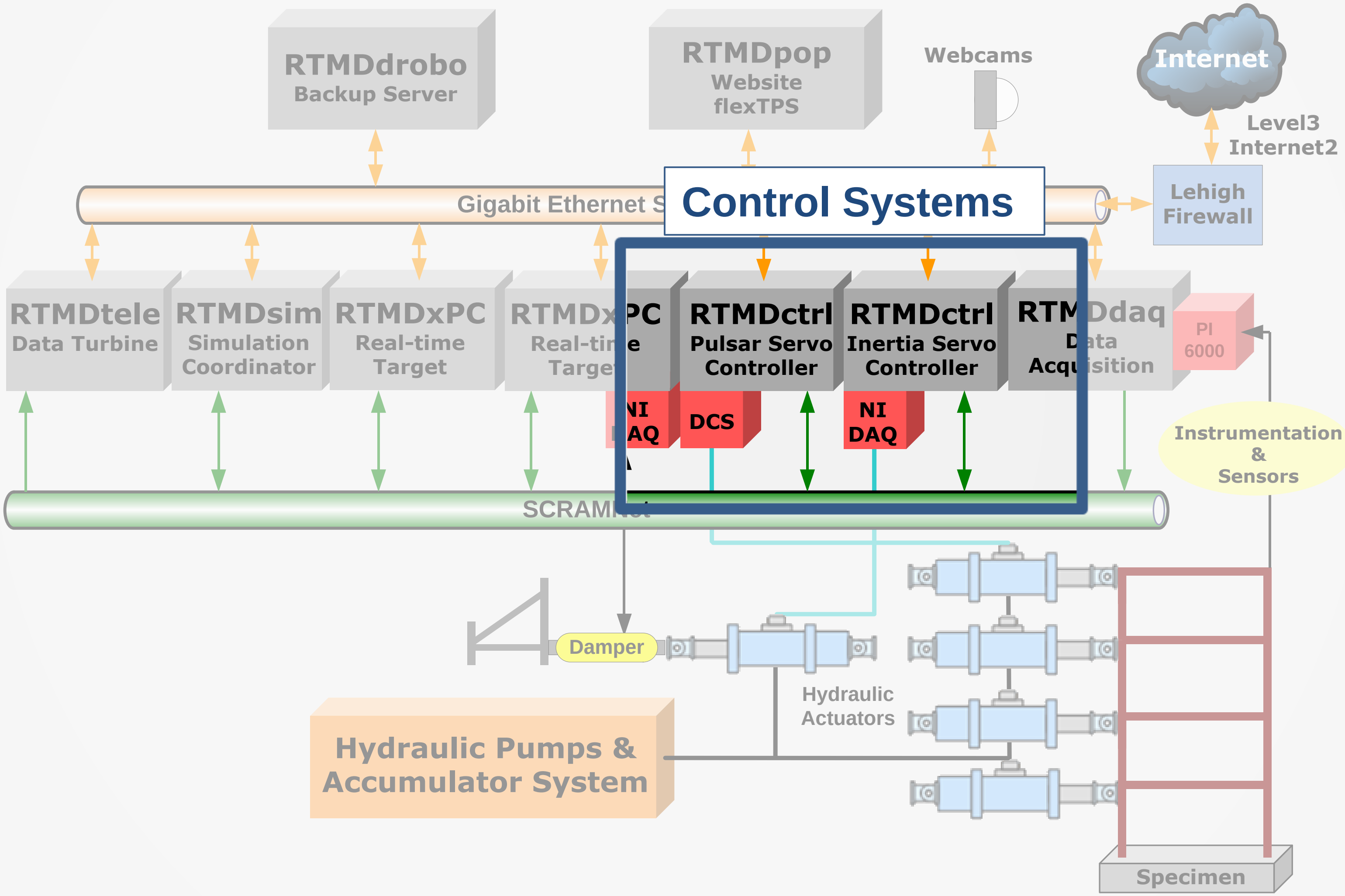
IT Infrastructure



SCRAMNet

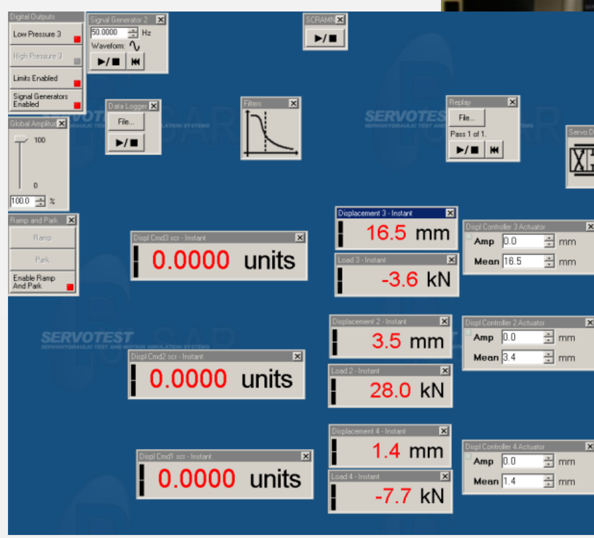
- Shared memory space for multiple systems
- High speed communication over fiber optics
- Mathworks/Java/C++ Support
- Flexible memory structure for defining multiple control and DAQ systems

IT Infrastructure



RTMDctrl

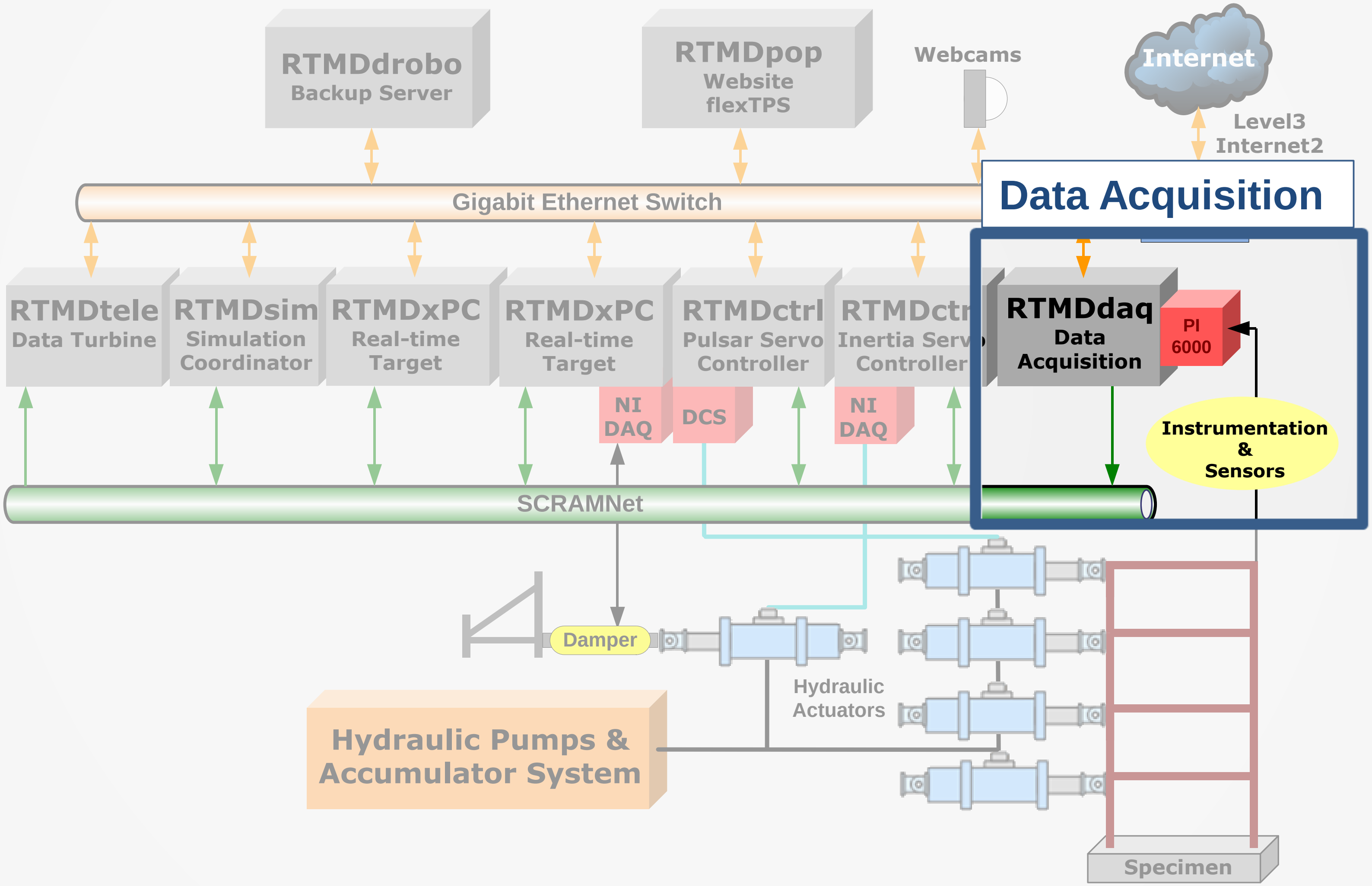
- Servotest Pulsar Control System
  - Configurable servo-control system for hydraulics actuator control
  - 1024Hz control rate
  - Fine tuning of PID loops
  - Customizable interface



RTMDctrl

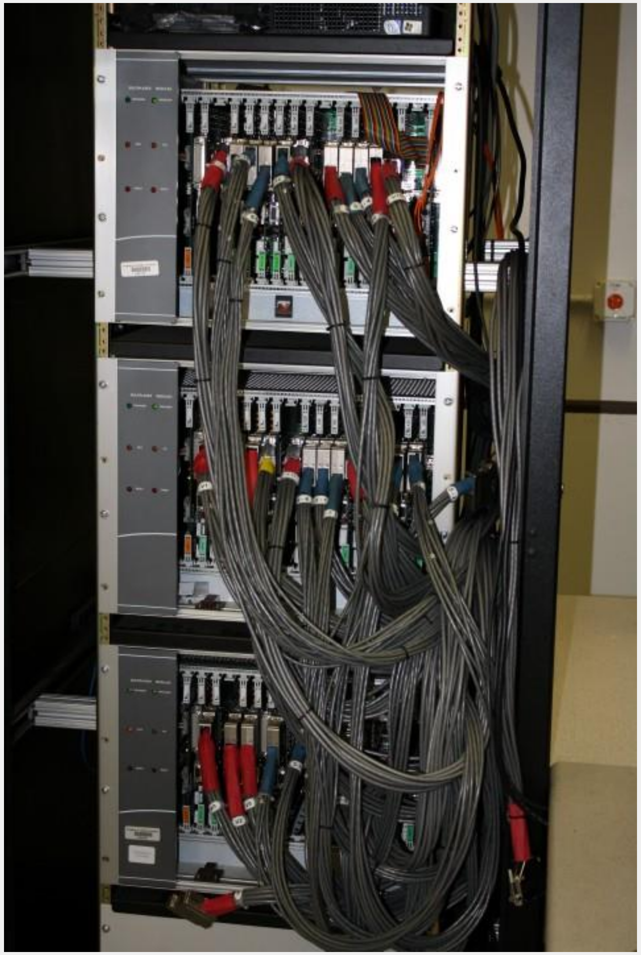
- Wineman INERTIA Control System
  - Unlimited multi-mode closed-loop control
  - Integrated test editor
  - Integrated with various NI modules
  - Integrated PID control loop tuning
  - Complete access to tuning system variables
  - Programmable control and DAQ rates

IT Infrastructure

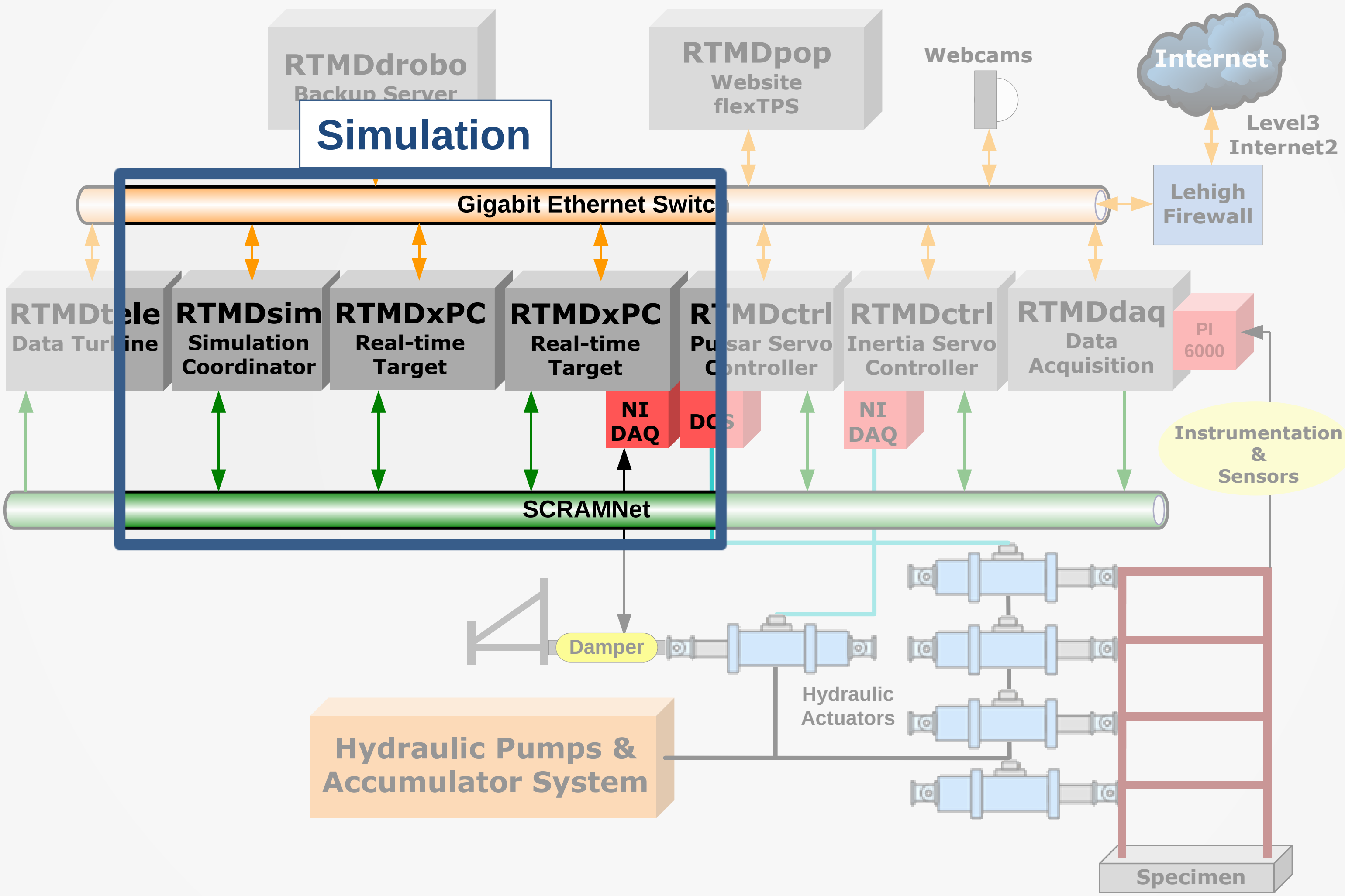


RTMDdaq

- Pacific Instruments 6000 Data Acquisition System
  - 304 channels, 384 expandable
    - Voltage, Strain, Thermocouple
  - Variable sampling rates
    - 4 kHz for Real-time Testing
  - Sensor list exporting for archival



IT Infrastructure



Simulation – RTMDsim/RTMDxPC

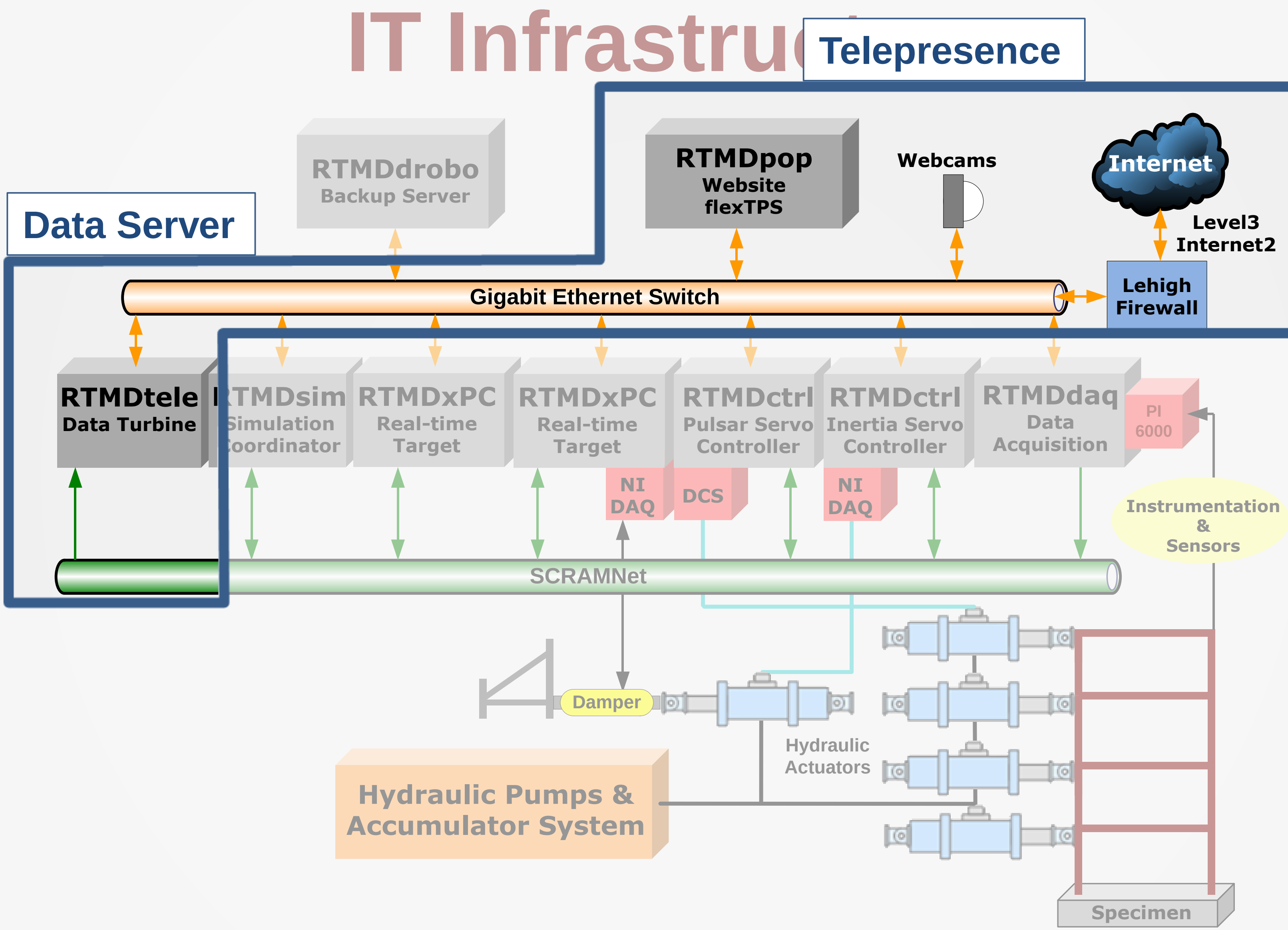
- Host-Target configuration
  - Real-time and custom applications
- Dell i7 Precision Workstation
  - High power workstation for execution and processing
- Speedgoat xPC Targets (Simulink Real-time)
  - Dedicated Intel i7 4Ghz real-time systems
- Multiple Targets
  - Defined roles
  - Grid processing for larger and more complex models

RTMDsim

- Workstation/Host
  - Mathworks suite
  - Coordinator of synchronized control and data acquisition
  - Hydraulics on/off testing – numerical simulation for safety, validation & training
  - Process and analyze data

RTMDxPC

- CPU performance up to 4 GHz
- Industrial quality design for robustness
- Multi-core support for parallel processing
- Daisy chaining
- Available modules for DAQ and control
- Simple interface with SIMULINK and custom code
- Plug and Play software Architecture

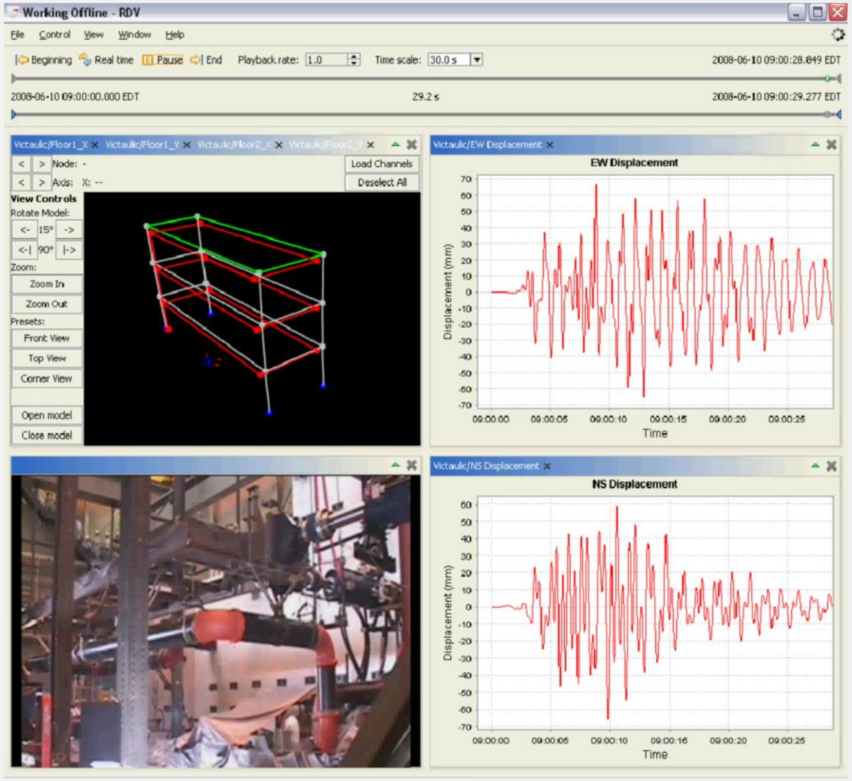

IT Infrastru
Telepresence
Data Server
RTMDdrobo
Backup Server
RTMDpop
Website
flexTPS
Webcams
Internet
Level3
Internet2
Lehigh
Firewall
Gigabit Ethernet Switch
RTMDtele
Data Turbine
RTMDsim
Simulation
Coordinator
RTMDxPC
Real-time
Target
RTMDxPC
Real-time
Target
RTMDctrl
Pulsar Servo
Controller
RTMDctrl
Inertia Servo
Controller
RTMDdaq
Data
Acquisition
PI
6000
NI
DAQ
DCS
NI
DAQ
Instrumentation
&
Sensors
SCRAMNet
Damper
Hydraulic
Actuators
Hydraulic Pumps &
Accumulator System
Specimen

Telepresence

- Data Turbine (RBNB) (dataturbine.org)
  - Aggregates data from SCRAMNet using RTMD tools to define channel list, sample rate and duration
  - Streaming of data and images locally and remotely
  - Additional storage archive of test data

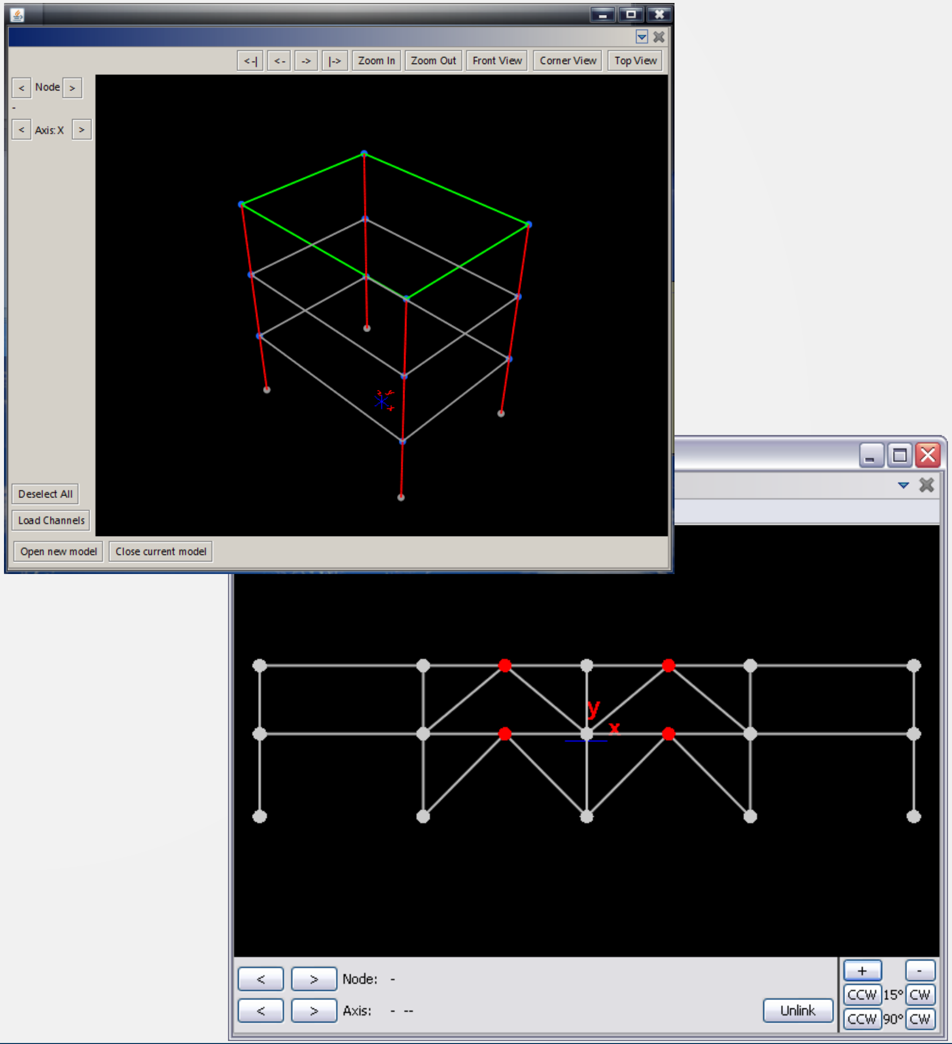
RDV

- Real-Time Data Viewer
  - Connect from anywhere on any system
  - Invaluable tool for visualizing Real-Time Hybrid Simulations



3D Model Panel for RDV

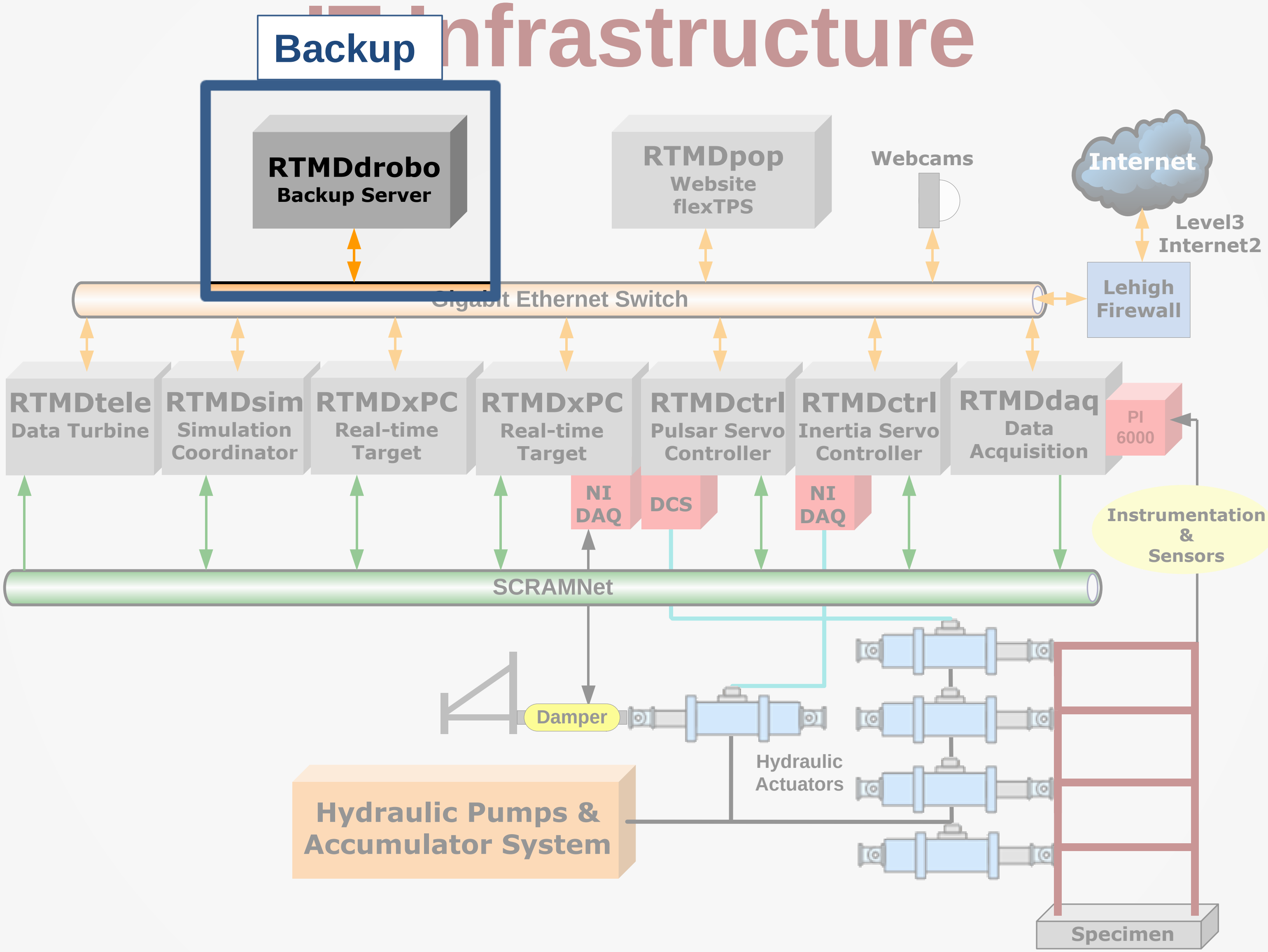
- 3D Modeling for RDV
- Real-time visualization complete structural system in hybrid simulation
- REU development



Telepresence

- Video/Imaging systems
  - (4) Sony SNC-EP550 HD portable network cameras
  - (9) GoPro Hero 3 Black camcorders
  - (2) Axis 2401 fixed network web cameras
  - (2) Axis 205 fixed network web cameras
  - (2) Sony SNC-RZ30N portable network cameras
  - Nikon D70 D-SLR camera
  - HD camcorders available upon request through Lehigh
- Blue Iris Software
  - Portal for all users to access and control web cameras
  - Archived video available for previous experiments

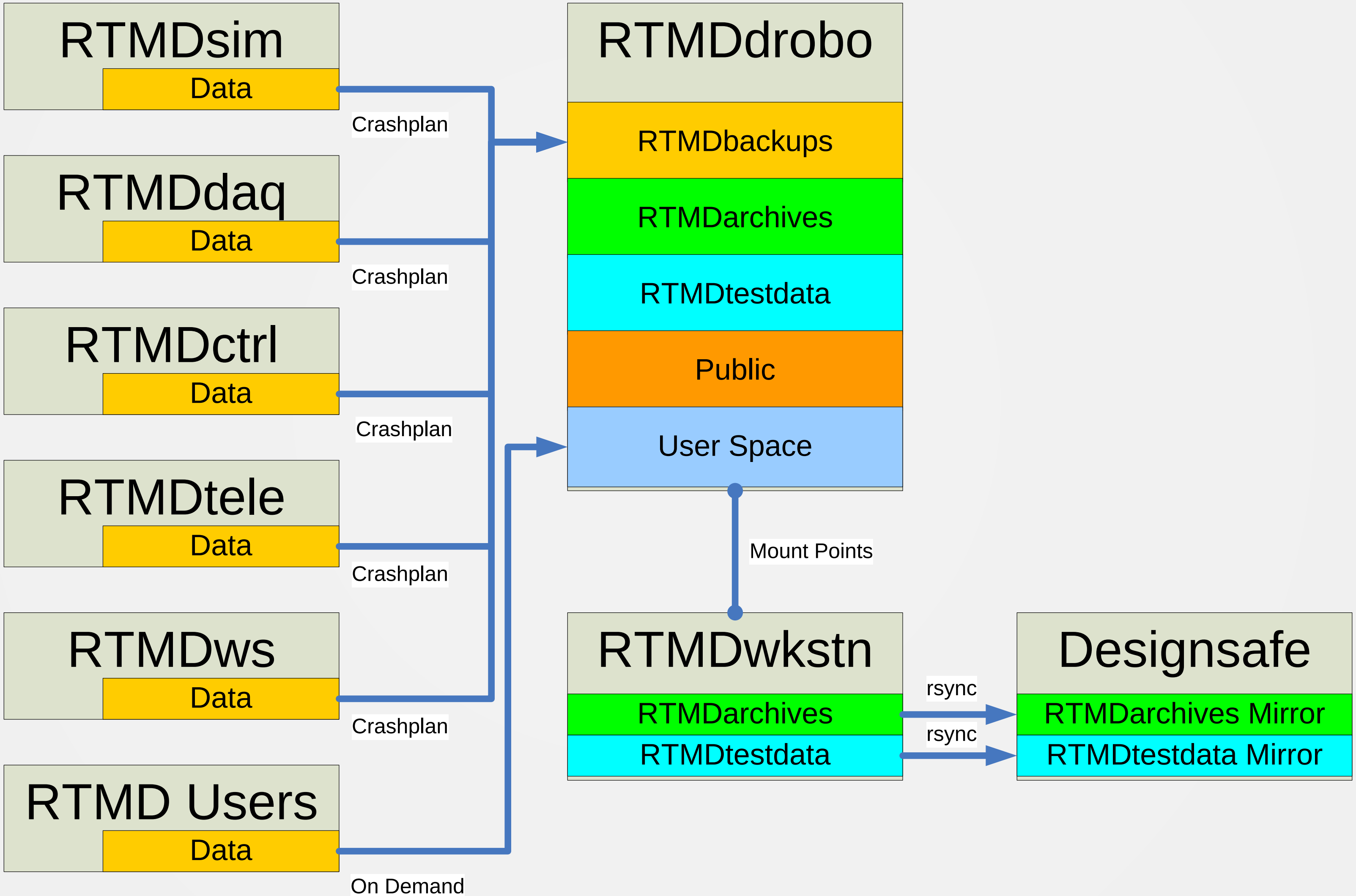
IT Infrastructure



RTMDdrobo

- Data Robotics DroboPro FS
  - 8 hard drive slots, 32 TB capacity
- Dual-disk Redundancy
- Network Attached Storage
- Public and Private storage

Backup Procedure



Cyber Security

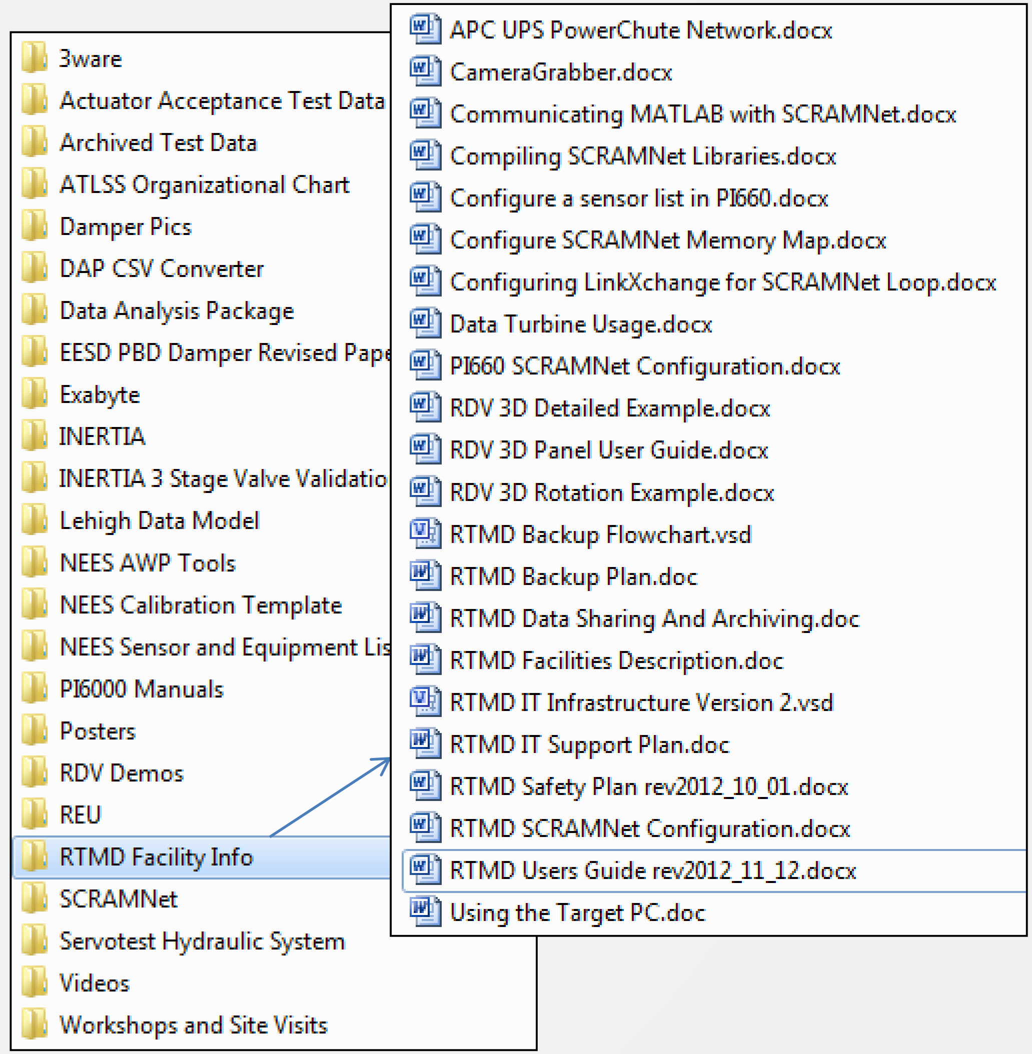
- Weekly updates of all workstations and servers
- Password protected systems
- Local firewalls and virus protection
- Lehigh University firewall
- LTS intrusion detection
- Yearly audit through Designsafe-ci.org
- Secured system racks
- Secured building and offices

Software Capabilities

- Components for simulation coordination
  - MATLAB, SIMULINK (RT)
  - Lehigh HybridFEM through SIMULINK
  - Java and C++
  - OpenSEES via OpenFresco
  - SIMCOR (UIUC)
  - ANSYS
  - LabVIEW

Training: Documentation

- User’s Guide
- Repository of technical documents, demos and video tutorials
- Available to all users

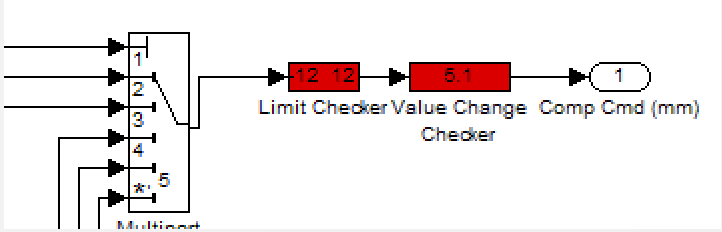


Training: Hands on

- Familiarize users with Lab & IT equipment
- Describe all safety requirements
- Introduce users to software and user tools
- Perform validation studies on physical test bed
- Demonstrate various simulation techniques

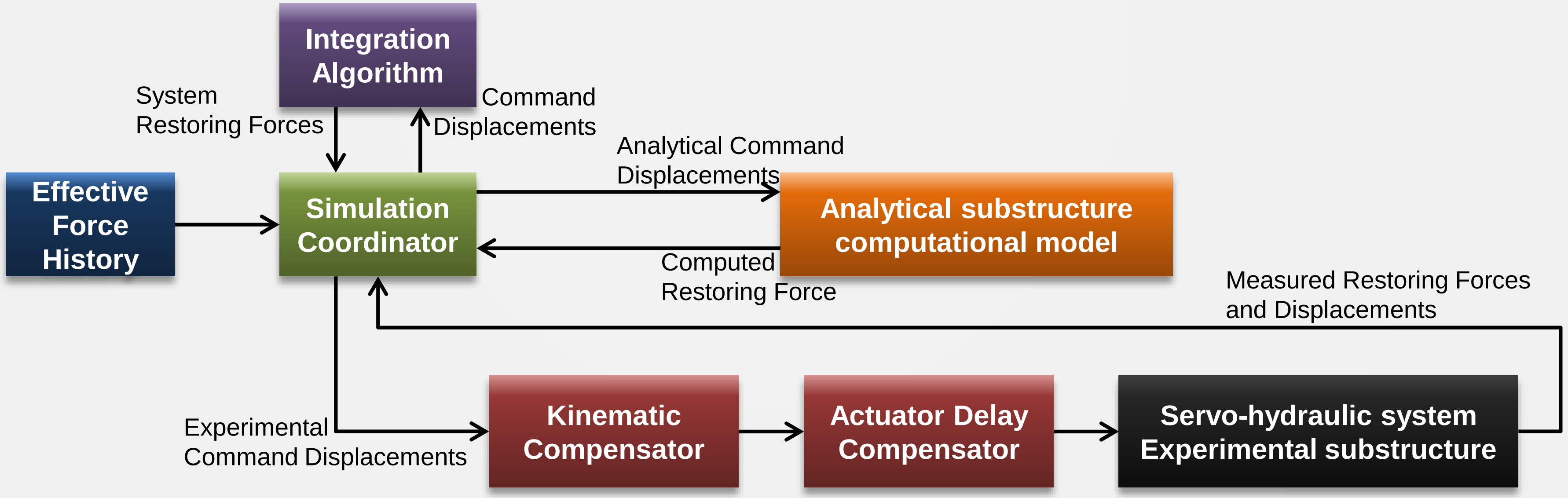
Simulation Safety

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



Hybrid Simulation Components

- Simulation coordinator
- Integration algorithm
- Computational model of analytical substructure
- Kinematic error compensator
- Actuator delay compensator
- Experimental substructure

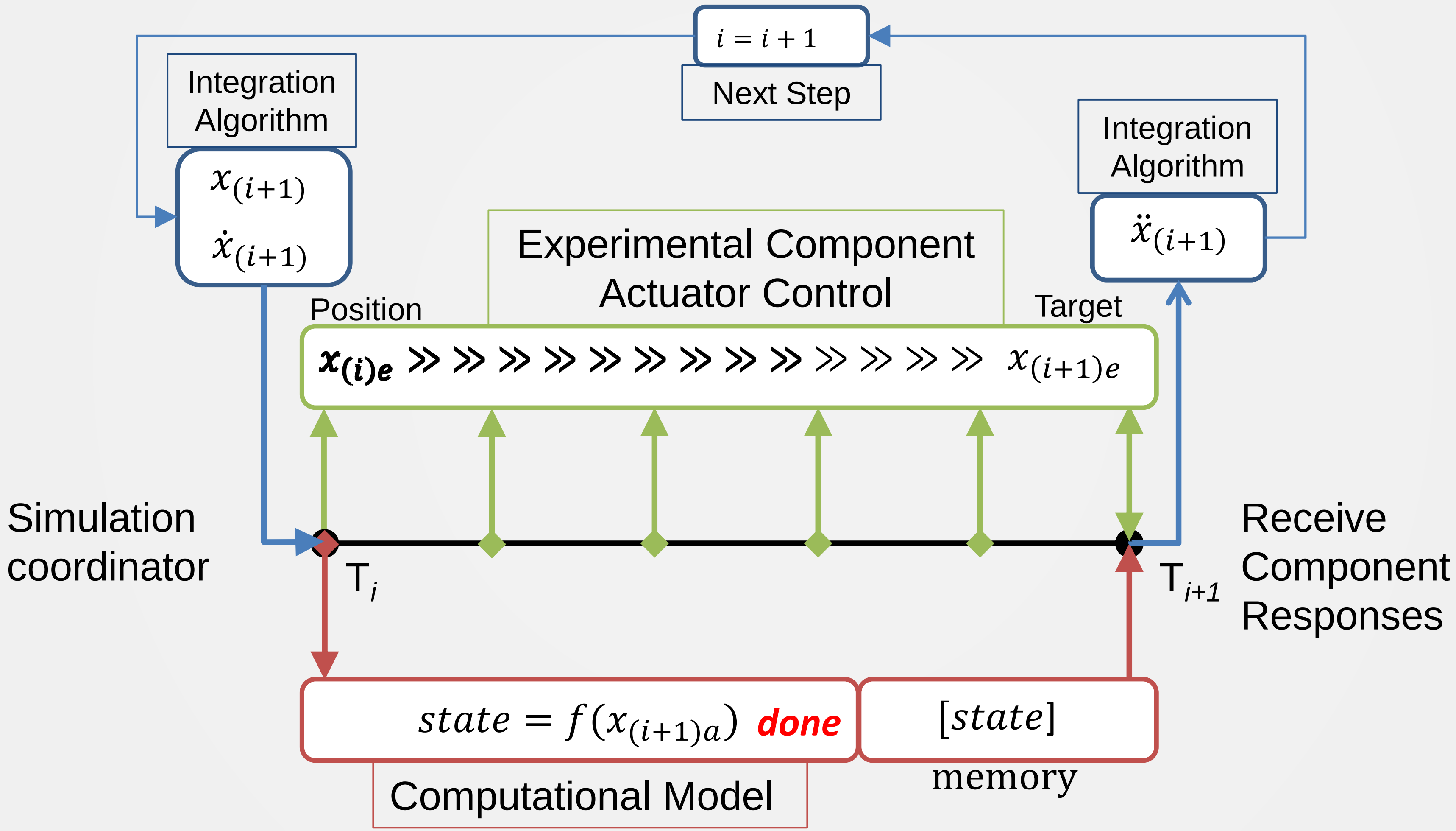


Hybrid Simulation Modules

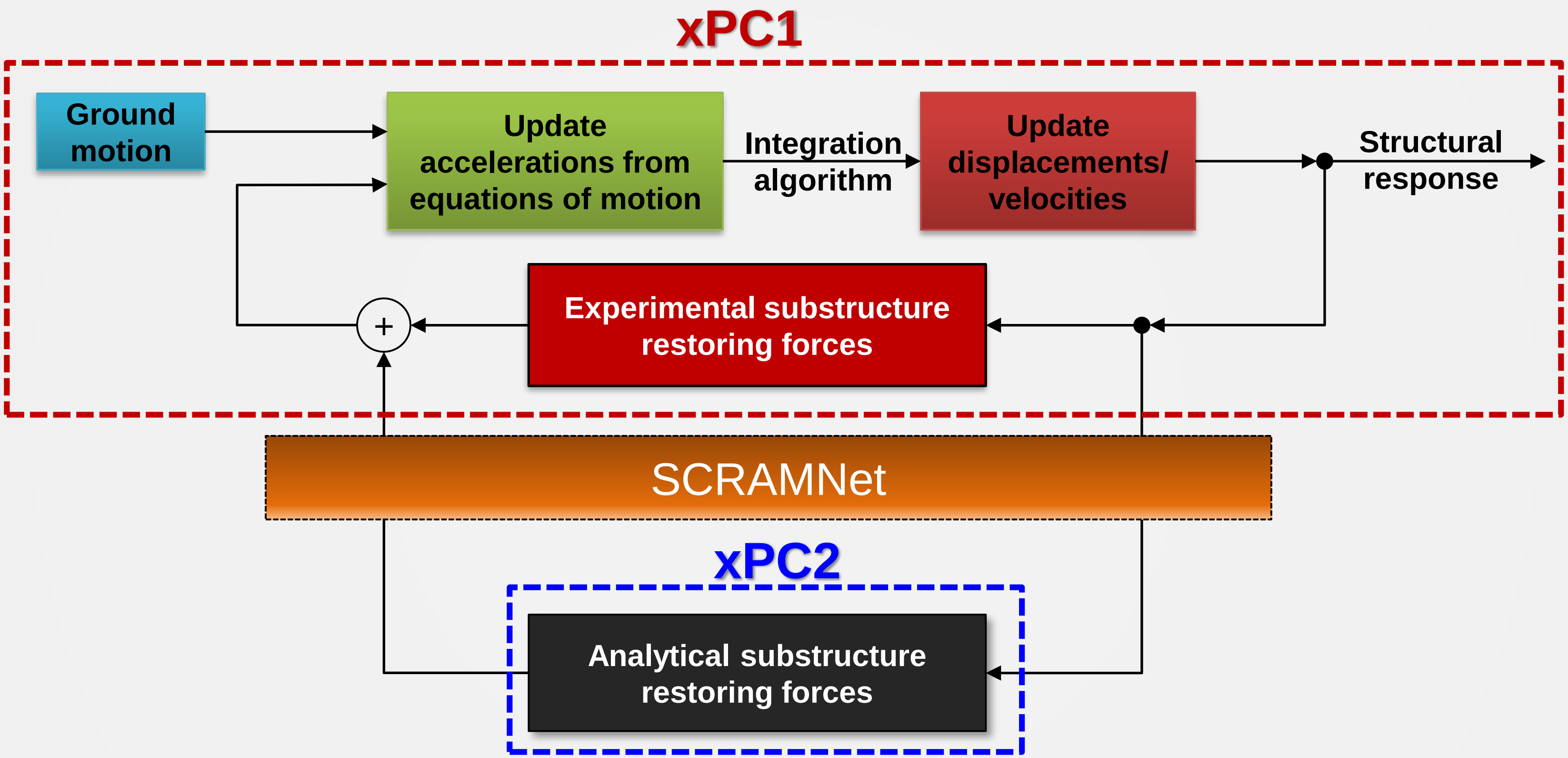
Module	Developer	Status
Simulation Coordinator	Marullo and Chen(1)	Open Source
CR Integration Algorithm	Chen and Ricles(2)	Open Source
Actuator Control: Inverse Compensation	Chen and Ricles(2)	Open Source
Actuator Control: Adaptive Inverse Compensation	Chen and Ricles(1)	Open Source
Actuator Control: Adaptive Time Series Compensation	Chae, Ricles, and Kazemibidokhti(1)	Open Source
Actuator Control: Kinematic Error Compensation	Mercan and Ricles(1)	Open Source
Computational Modeling/Sim Coordinator: HybridFEM	Karavasilis, Seo, Kolay, Marullo, and Ricles(2)	Available on xPC for all users. Open Source Summer 2013

(1) developed by NEES@Lehigh
(2) developed by users

RTHS: Model Flow

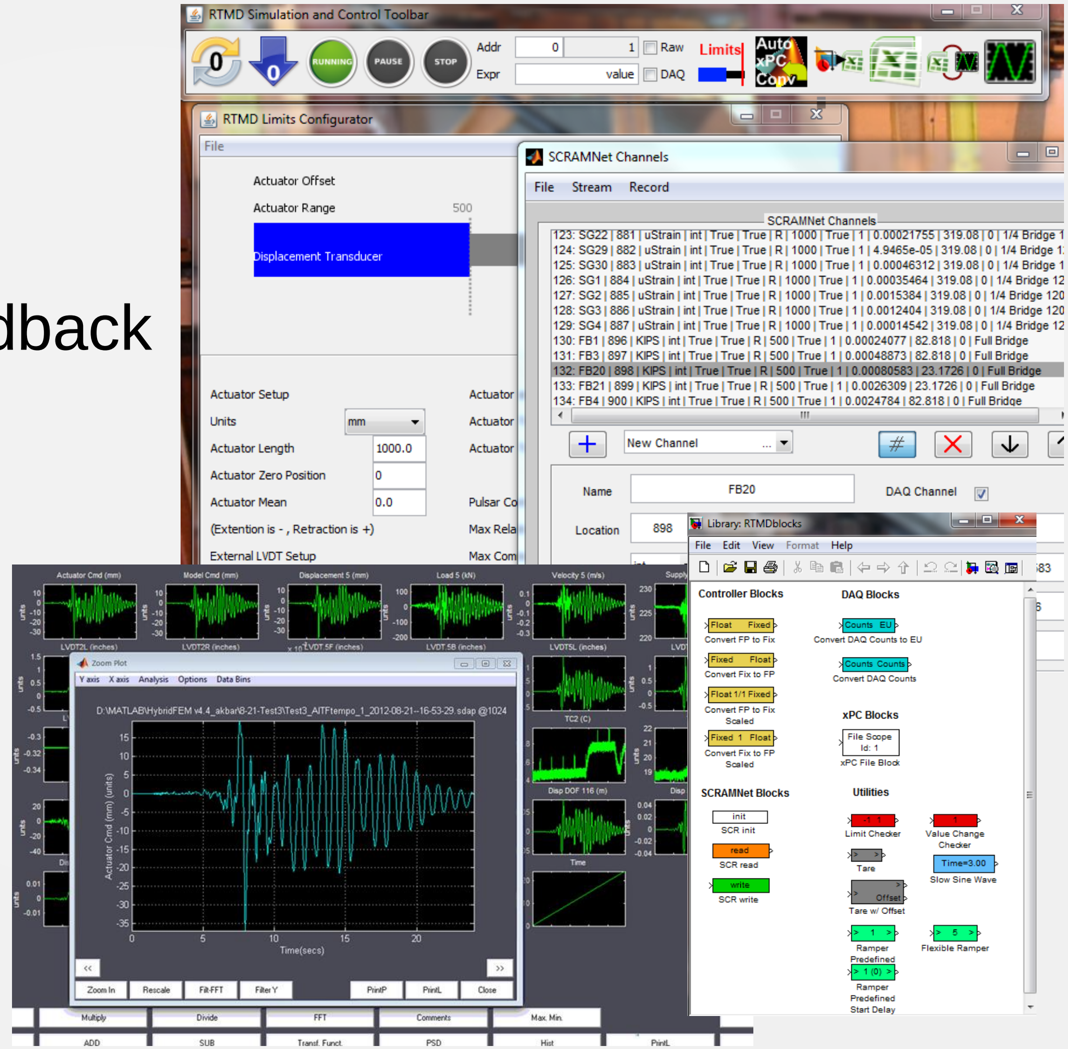


RTHS: xPC Grid



Site Developed Tools

- User Tools
  - XML configurations
    - Control and Feedback
    - Data Conversion
    - Telepresence
  - Safety Limits
  - Simulink Libraries
  - Data Analysis

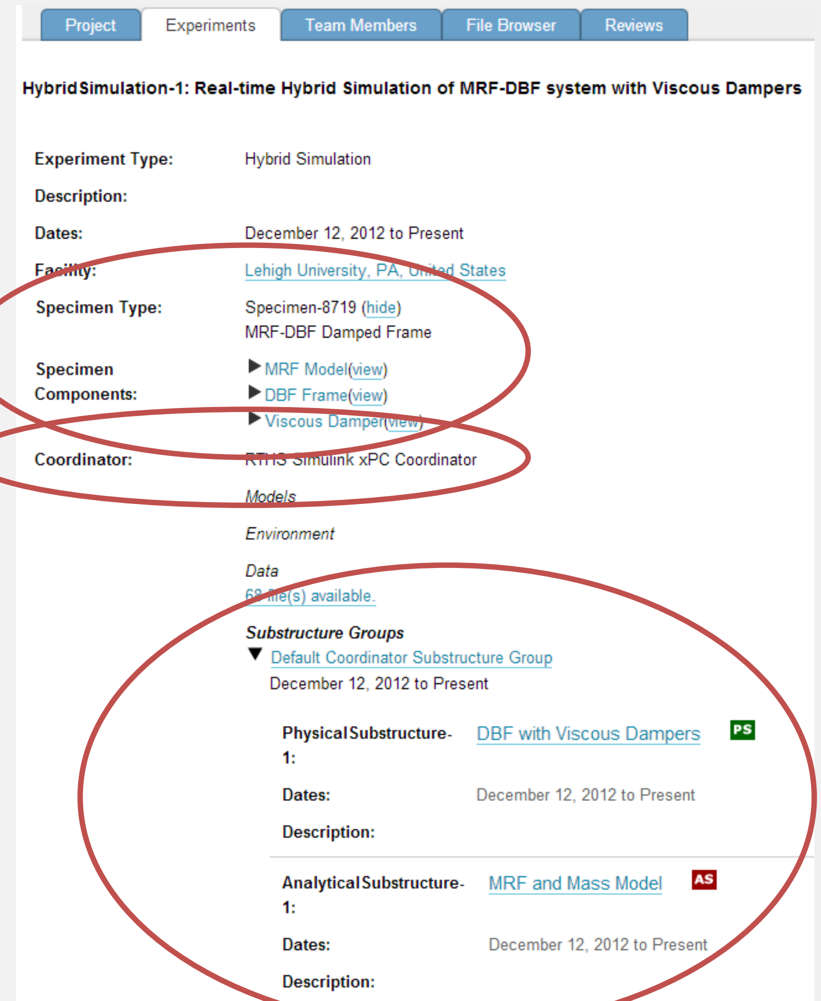


Simulation: Start to Finish

1. Research team meeting to define testing protocols, safety measures and train users
2. Create project storage and collaboration space
3. Design control configuration through numerical and hydraulics off simulations for validation
4. Configure data acquisition system for sensors
5. Define camera points for video telepresence
6. Generate data turbine sources for data telepresence
7. Initiate safety protocols for humans and equipment
8. Run Experiment!
9. Researcher analyzes and processes data
10. Collect data into local data repository
11. Archive and curate data

Lehigh Data Model

- Improve existing schemas
- Focuses on large-scale structural experiments
- Detailed specimen and component model
- Hybrid simulation metadata
- Currently integrating into NHERI Project Workspace



Thank you!