IT Operations and Cyber Infrastructure

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NHERI Lehigh EF







Overview

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





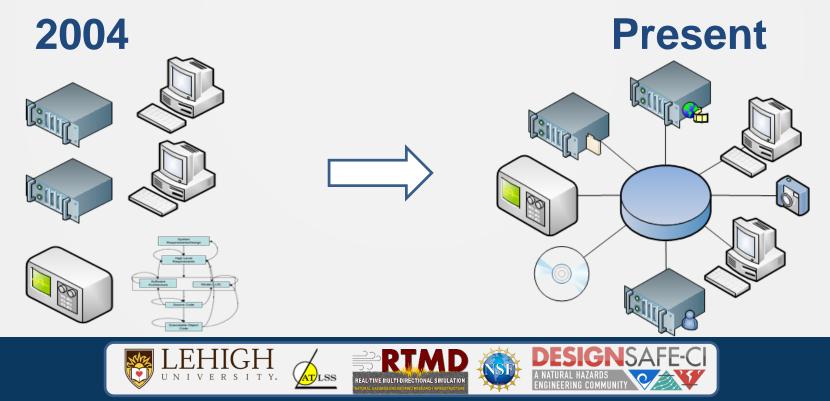
IT Experiment Support Start to Finish

- 1. Researchers and NHERI Lehigh team work together on training, development of experimental protocols, instrumentation, control and safety plans
- Create project storage and collaboration space on DesignSafe-CI Data Depot
- 3. Design control configuration through numerical and hydraulics off simulations for validation
- 4. Configure data acquisition system for sensors
- 5. Configure video acquisition system for cameras
- 6. Configure data stream for local and remote data viewing
- 7. Initiate safety protocols and run experiment
- 8. Data is locally archived and synced with Project Warehouse
- 9. Research team processes data locally and stored in Data Depot at DesignSafe-CI into data model. Tools available to process data available locally and on DesignSafe-CI



IT Mission

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



IT Infrastructure 10 Gbps Level 3 Internet2 Science DMZ 10 Gbps **RTMDws** Web Cameras **RTMD**data Website 1 Gbps **Backup Server** flexTPS Border Router Lehigh HPC Resources Globus Data Transfer Node **Cisco 1/10 Gbps Ethernet Switch** Lehigh Firewall **RTMDdag** RTMDtele RTMDsim RTMDxPC **RTMDxPC RTMDctrl RTMDctrl** Data Data Turbine Simulation Real-time **Real-time** Pulsar Servo Inertia Servo PI6000 Acquisition Data Archiver Coordinator Target Target Controller Controller NI NI DCS DAQ Instrumentation DAQ & Sensors **SCRAMNet** 0 Damper 10 0) 0 (0 Hydraulic Actuators to 6 **Hydraulic Pumps & Accumulator System** 0 (0 Specimen



IT Infrastructure 10 Gbps Level 3 Interne Science DMZ 10 Gbps **RTMDws** Web Cameras **RTMDdata** Website 1 Gbps **Backup Server** flexTPS Border Router Lehigh HPC Resources Globus Data Transfer Node **Cisco 1/10 Gbps Ethernet Switch SCRAMNet** Lehigh Firewall **RTMDdaq** RTMDsim RTMDxPC **RTMDxPC RTMDctrl RTMDctrl** RTMDtele Data **Data Turbine** Simulation **Real-time Real-time** Pulsar Servo Inertia Servo PI6000 Acquisition Data Archiver Coordinator Target Target Controller Controller NI NI DCS DAQ **Instrum**entation DAQ Sen ors **SCRAMNet** Damper Hydraulic







ENGINEERING COMMUNITY

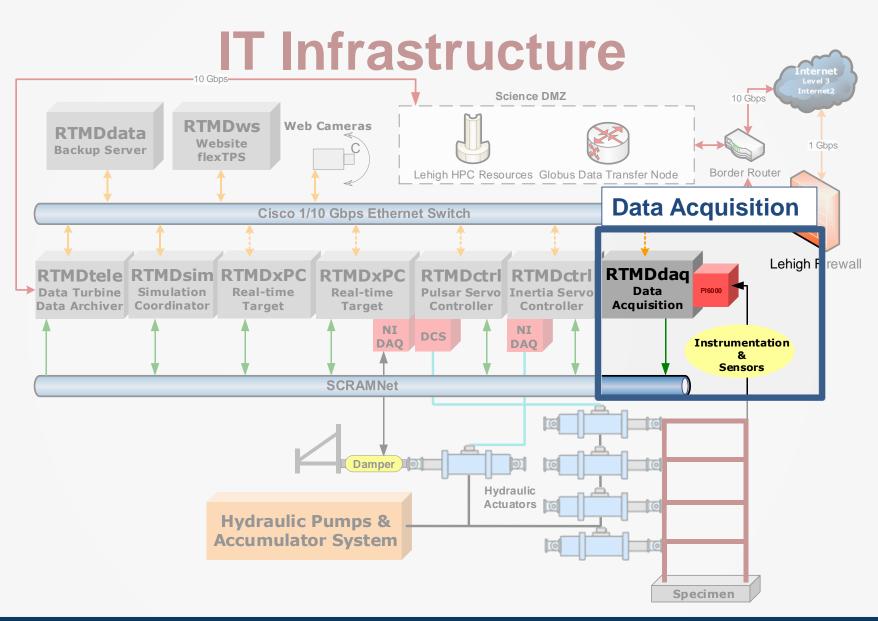
SCRAMNet GT

- Replaced EOL SCRAMNet+ equipment
- Increased throughput and reliability
- Expanded vendor compatibility
- Maintenance contract













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RTMDdaq

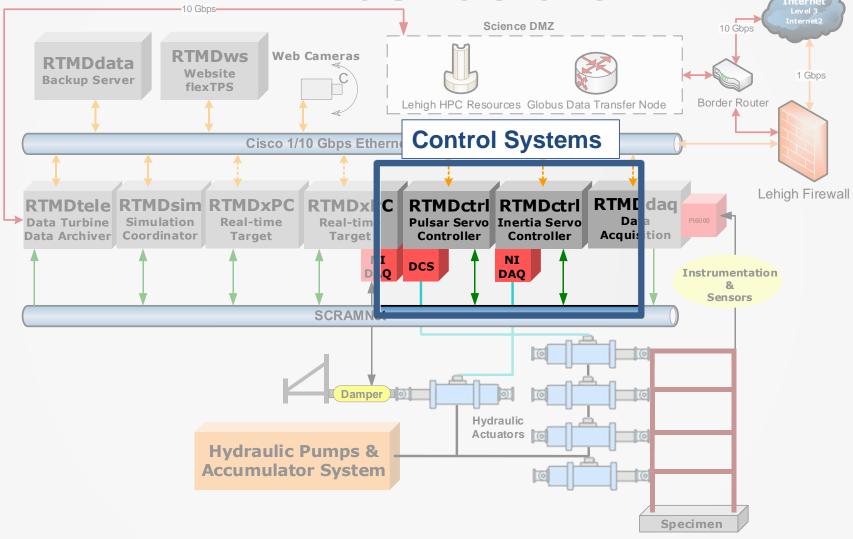
- Pacific Instruments 6000
 Data Acquisition System
 - 304 channels, 384 expandable
 - Voltage, Strain, Thermocouple
 - Variable sampling rates
 - 4 kHz for Real-time Testing







IT Infrastructure





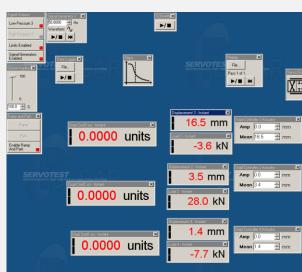


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RTMDctrl

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











RTMDctrl

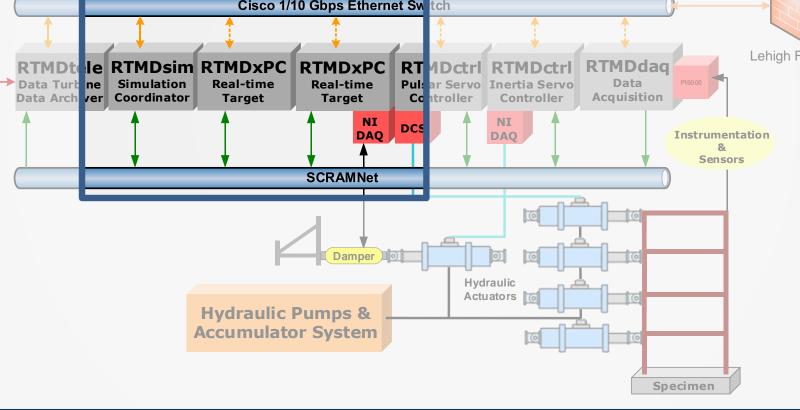
- Wineman INERTIA Control System
 - Unlimited multi-mode closed-loop control
 - Integrated test editor
 - Integrated with various NI modules
 - Integrated PID control loop tuning
 - Complete access to tuning system variables
 - Programmable control and DAQ rates







IT Infrastructure 10 Gbps Level 3 Interne Science DMZ 10 Gbps **RTMDws** Web Cameras **RTMDdata** Website 1 Gbps **Backup Server Simulation** Border Router Lehigh HPC Resources Globus Data Transfer Node Cisco 1/10 Gbps Ethernet Sw tch Lehigh Firewall **RTMDdaq RTMDxPC RT** 1Dctrl RTMDctrl





Simulation – RTMDsim/RTMDxPC

- Host-Target configuration
 - Real-time and custom applications
- Dell i7 Precision Workstation



- High power workstation for execution and processing
- Speedgoat Targets (Simulink Real-time)
 - Dedicated Intel i7 4Ghz real-time systems
- Multiple Targets
 - Defined roles
 - Parallel processing for larger, 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

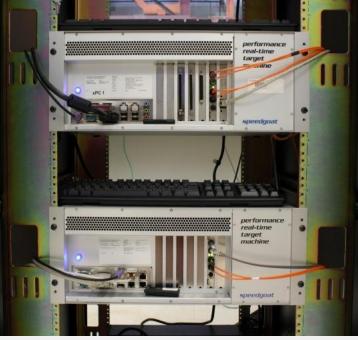






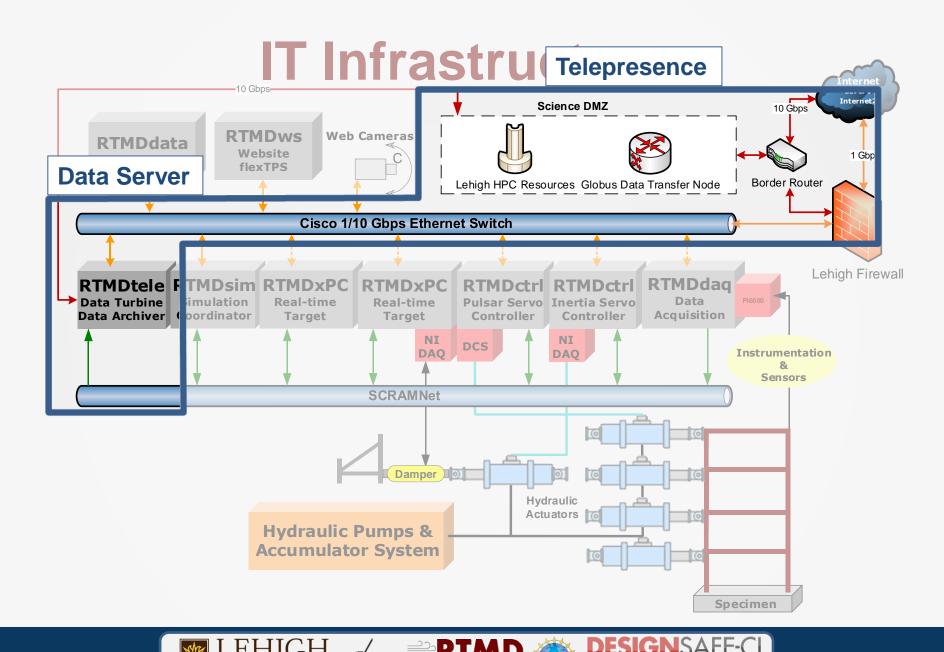
RTMDxPC

- Speedgoat systems, 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 S-Functions
- Quick prototype turnaround









REAL-TIME MULTI-DIRECTIONAL SIMULATION

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AT/LSS

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



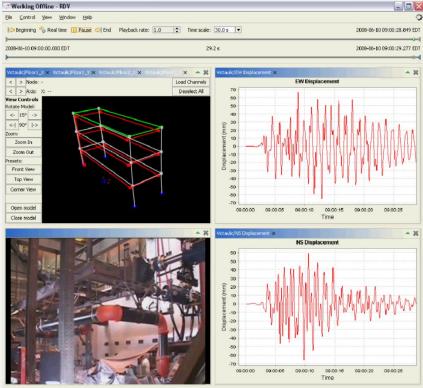




RDV

• Real-Time Data Viewer (RDV)

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









Video

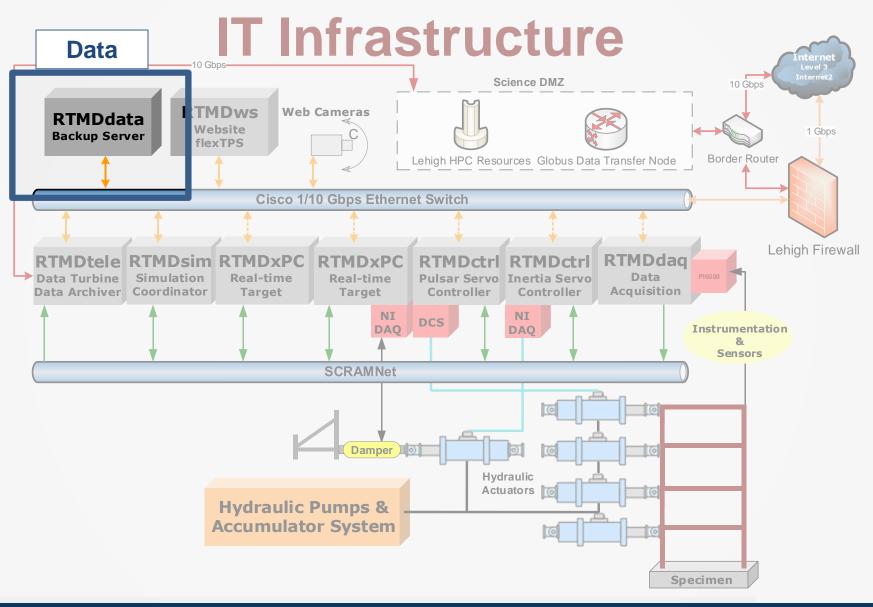
Video/Imaging systems

- (24) Amcrest Bullet/PTZ IP Cameras (up to 8k)
- (4) Sony SNC-EP550 HD (720p HD)
- (9) GoPro Hero 3 Black camcorders (1080p60 HD)
- (2) Sony SNC-RZ30N network cameras (SD Security)
- Nikon D70 D-SLR camera
- HD camcorders available upon request through Lehigh

Blue Iris Servers

- Portal for all users to access and control web cameras
- Archived video available for previous experiments







RTMDdata

- Synology DS 1817
 - 8 hard drive slots, 96 TB capacity up to 216 TB
 - 10Gb Connection
- Dual-disk Redundancy
- Network Attached Storage
- Public and Private storage







Data Management Plan

- Local repository for data storage managed by NHERI Lehigh with offsite backup risk mitigation through DesignSafe-CI
- Unlimited Google Drive space through Lehigh University
- Locally stored data adheres to the Lehigh University records retention policy or extended by the ATLSS Center IT management
- Included under NHERI Lehigh data management umbrella:
 - Unprocessed and RAW data from experiments
 - Converted and derived data sets using computational software
 - Experimental photos and videos
 - Computational models and analytical data sets
 - Scripts and software developed for project tasks
- Local curation utilizing folder/file structure
 - Project/Date/Task Description/Data Set; format "testname_date"
- Automated Globus Project data upload
- DesignSafe-CI curation through Data Depot and Data Model

Software Capabilities

- Components for simulation coordination
 - MATLAB, Simulink (RT)
 - Lehigh HybridFEM through Matlab, Simulink
 - LabVIEW RT/VeriStand (Wineman Inertia)
 - OpenSEES via OpenFresco







Training: Documentation

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

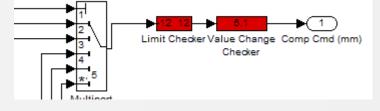
1			APC UPS PowerChute Network.docx
		3ware	CameraGrabber.docx
		Actuator Acceptance Test Data	Communicating MATLAB with SCRAMNet.docx
		Archived Test Data	Compiling SCRAMNet Libraries.docx
		ATLSS Organizational Chart	Configure a sensor list in PI660.docx
		Damper Pics	Configure SCRAMNet Memory Map.docx
		DAP CSV Converter	Configuring LinkXchange for SCRAMNet Loop.docx
		Data Analysis Package	Data Turbine Usage.docx
		EESD PBD Damper Revised Pape	PI660 SCRAMNet Configuration.docx
,		Exabyte	RDV 3D Detailed Example.docx
	n.	INERTIA	
	n	INERTIA 3 Stage Valve Validatio	RDV 3D Panel User Guide.docx
	ň	Lehigh Data Model	RDV 3D Rotation Example.docx
	n	NEES AWP Tools	RTMD Backup Flowchart.vsd
		NEES Calibration Template	TMD Backup Plan.doc
			RTMD Data Sharing And Archiving.doc
		NEES Sensor and Equipment Lis	RTMD Facilities Description.doc
		PI6000 Manuals	RTMD IT Infrastructure Version 2.vsd
		Posters	🖷 RTMD IT Support Plan.doc
		RDV Demos	RTMD Safety Plan rev2012_10_01.docx
		REU	RTMD SCRAMNet Configuration.docx
		RTMD Facility Info	RTMD Users Guide rev2012_11_12.docx
		SCRAMNet	Using the Target PC.doc
		Servotest Hydraulic System	
		Videos	

Workshops and Site Visits



Simulation Safety

- Command software limits
 - Bound and rate limits
- Controller software limits
 - System trip and shutdown



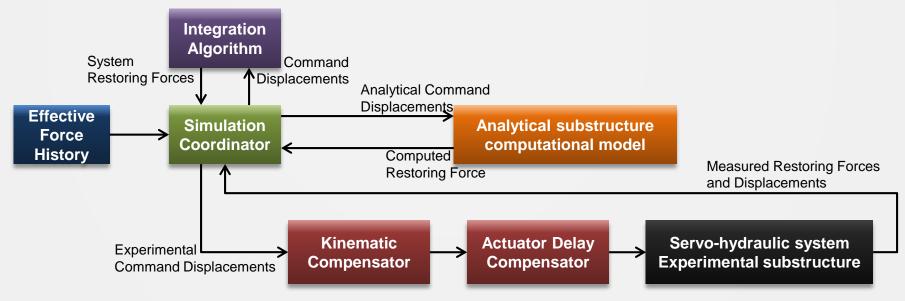
- Hardware displacement limit switches
- E-Stop buttons





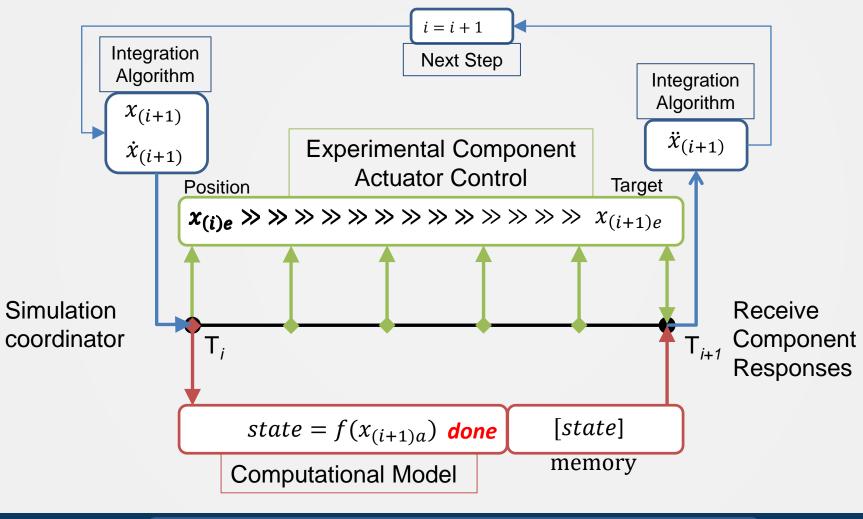
Hybrid Simulation Components

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





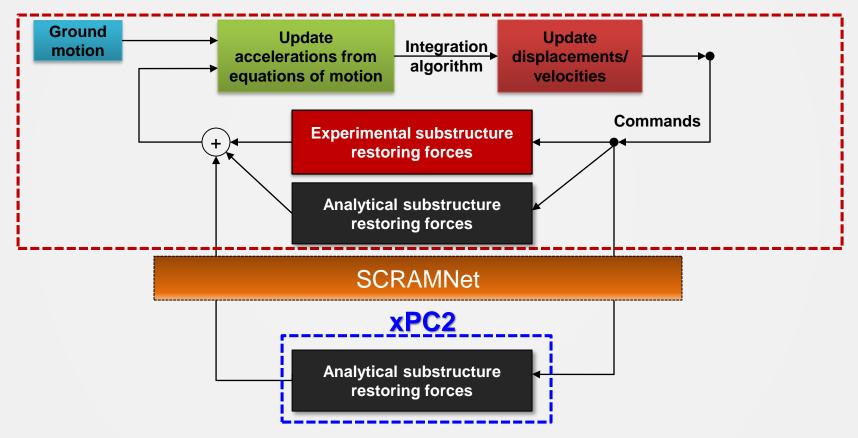
RTHS: Model Flow





RTHS: Multiple Targets

xPC1





Example Projects and Demos Thank you!





