

## MTS Real-Time Civil Hybrid Simulation

High-performance hybrid simulation capabilities for any civil engineering test lab

By simultaneously combining physical testing of substructures with computer models of the remainder of the structure, hybrid simulation technology provides a complete picture of how earthquake events can affect large structures such as buildings and bridges without having to physically test the entire structure. This enables civil engineers to accurately and efficiently capture the effects that a substructure has on the overall structure, while subjecting the substructure to the same forces and motions it would experience within a complete structure.

In collaboration with leading universities — including the University of Colorado Boulder, the University of California Berkeley, State University of New York Buffalo, and others — MTS has developed an array of affordable, high-performance hybrid simulation solutions.

Easy-to-deploy and flexible, these solutions enable virtually any civil engineering lab to incorporate world-class hybrid simulation into their seismic research activities.

The MTS real-time hybrid simulation solution is used to evaluate substructures or components that contribute damping or inertia effects to the complete structure. Elements of this solution include a powerful MTS digital controller, robust MTS physical test equipment and a high-speed interface into real-time computer simulation tools.

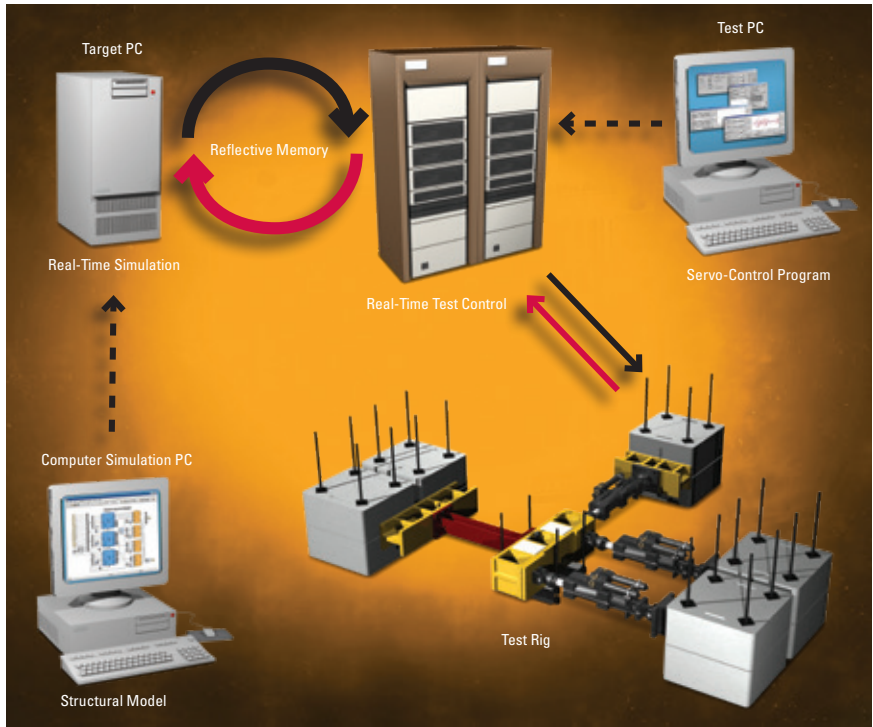
The system also features online access to an array of leading data management and sharing tools, enabling civil engineers to collaborate effectively with peer research organizations anywhere in the world.

**State-of-the-art Control & Integration**

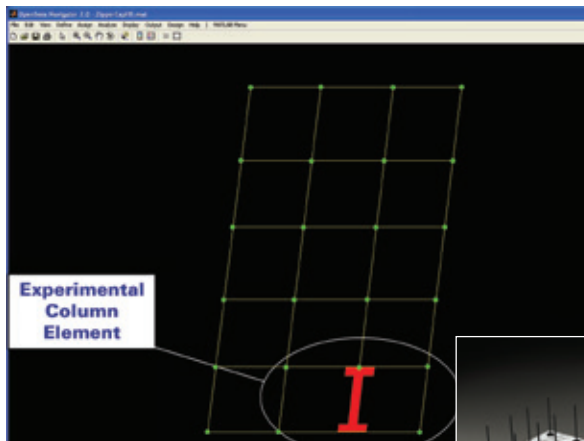
A powerful MTS Structural Test System (STS) Controller and software serves as the system's enabling hub. It is ideal for the simultaneous control and balance of multiple actuators during one, synchronized test.

STS software tools on the Test PC facilitate the setup of control parameters and mapping of actuators prior to simulation to ensure true real-time operation. The system downloads this information directly to the STS Controller's real-time processor where incoming command and outgoing feedback requests are acted upon instantaneously.

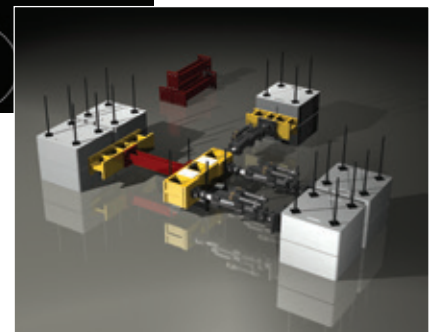
Reflective memory technology, such as SCRAMNet®, facilitates ultra-low latency data flow clocking and synchronization between the Real-Time Target PC and the MTS STS Controller. Reflective memory causes the distributed computer system to appear as one large, powerful "virtual" multi-processor to real time applications. With SCRAMNet, memory-writes to the replicated shared memory at one computer are instantly sent to all other replicated shared memories at 150 Mbits/sec via high-speed fiber optic cable.



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Representation of University of Colorado Boulder Hybrid Simulation Setup



### Robust Physical Testing

The system's physical test rig leverages robust MTS servohydraulic technology and decades of MTS civil structural testing expertise to deliver precise control of seismic forces and motions. Its components include fatigue-rated MTS structural actuators, high-quality TestLine components, and a reliable MTS hydraulic power solution.

Actuation is achieved with heavy-duty Series 244 hydraulic actuators. These linear, fatigue-rated force generators are designed for highly dynamic fatigue testing of substructures or components. They are made with proprietary materials that minimize friction while maximizing reliability and wear resistance.

The rig also integrates a wide array of high-quality MTS TestLine™ components, including adjustable reaction brackets, swivels, hydraulic service manifolds and distribution components, portal frames, modular beams and reaction stands.

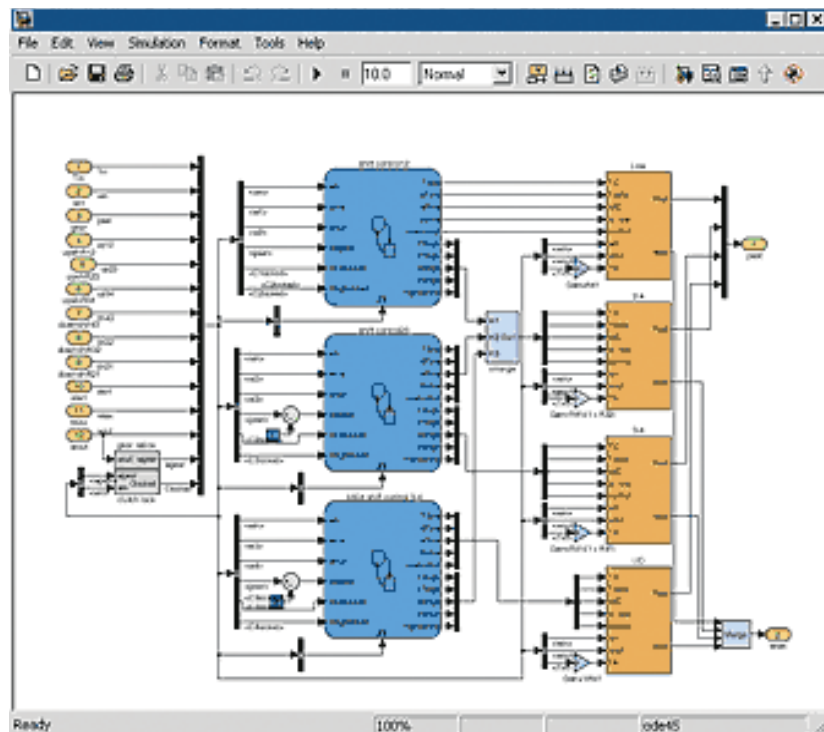
To meet the demanding requirements of real-time hybrid simulation, MTS offers a variety of high-capacity hydraulic power solutions. These include powerful hydraulic pumps and large accumulator systems, high-pressure blow-down accumulator systems, and diesel pumps when electric power is too expensive or unreliable.

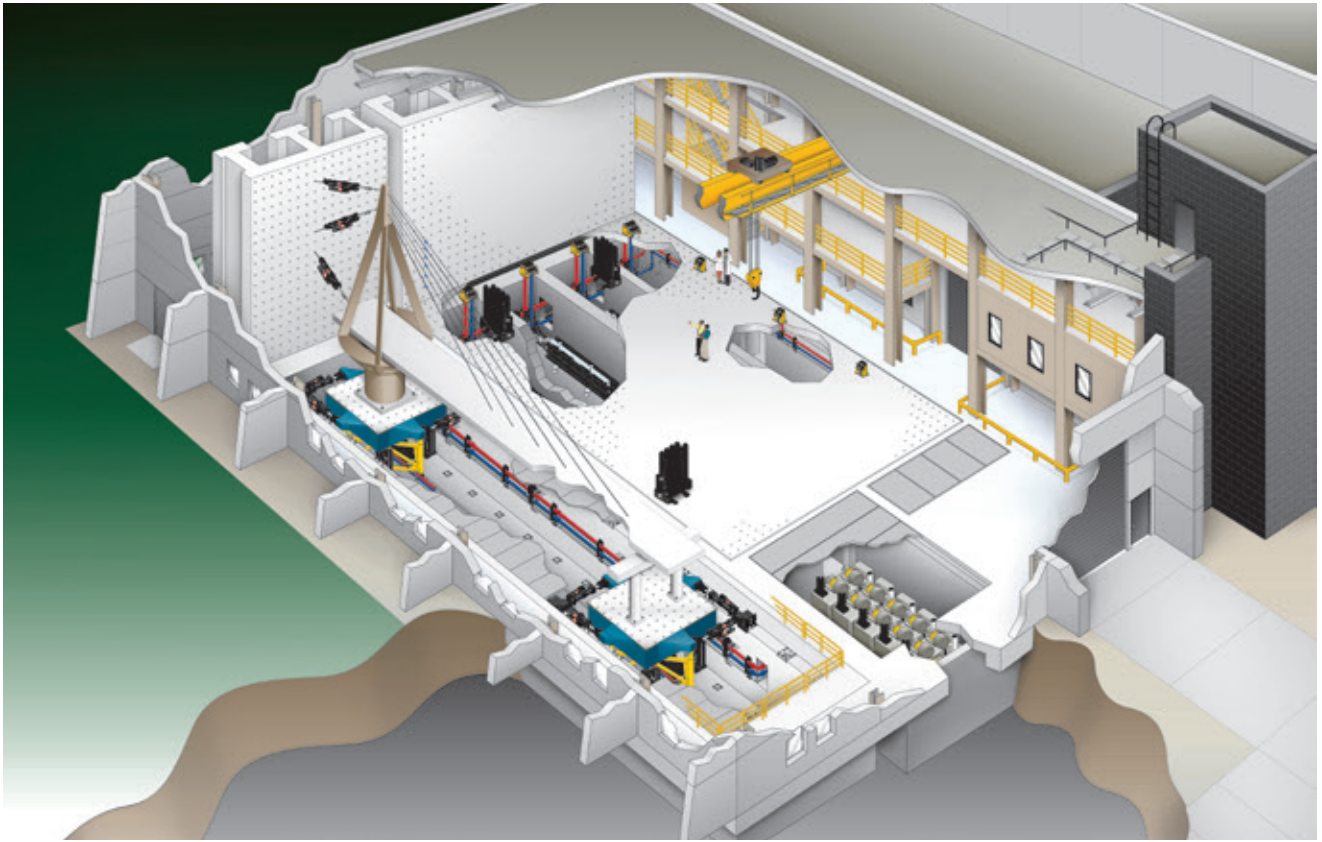


### Versatile Computer Simulation

The system's Computer Simulation PC features real-time dynamic modeling software, such as The Mathworks' Simulink®, which can run in real-time when downloaded to the system's xPC Target® PC. Simulink is a general purpose dataflow programming environment, widely used in universities and industry worldwide. After developing a Simulink model on the Computer Simulation PC, Real-Time Workshop® can be used to download it to the xPC Target PC where a connection is established to the MTS controller software via reflective memory.

The xPC Target PC runs a kernel that provides deterministic performance on PC hardware for running real-time models. High performance is achieved by booting the kernel rather than DOS or Windows. The xPC Target kernel is tuned for minimal overhead and maximum performance with published sample rates approaching 100 kHz.





### Unmatched Simulation & Facilities Consulting

MTS fields the largest, most experienced worldwide service, support and consulting staff of any testing solution provider. MTS consultants provide expert presales support to help you design the most capable and cost-effective lab possible, and responsive post-sales support to help you realize the most out of your MTS hybrid simulation investment.



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