



University of Oxford



# UK-Network for Earthquake Engineering Simulation (NEES)

Connecting Local Services to Wider Research Community

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# Outline

- What is Earthquake Engineering?
- Why do Earthquake Engineers need e-Science?
- NEES
- UK-NEES
- Proposed Web Portal for NEES
- Extending UK-NEES to wider Research Community
- Conclusion



# What is Earthquake Engineering

- Major seismic events are truly tragedies affecting the community for years after an event, with significant human and economic losses hampering the physical and social infrastructure.
- Disasters are a global problem with the Sumatra Earthquake and Tsunami of 2004.
- Damages totalling \$20bn and with over 200,000 deaths a recent warning of the devastating potential of earthquakes.
- Earthquake engineers study the effects of ground motion through seismic loading on structures by running computer simulations or by performing physical experiments in an effort to
  - **increase survivability.**
  - **Ensure immediate occupancy post event.**



# Continued-What is Earthquake Engineering

- UC San Diego – large outdoor shaking table. 400 ton capacity, 1.8 m/s peak velocity
- SUNY Buffalo – twin shaking tables and reaction wall



Pictured: Wind turbine test set-up on the UCSD-NEES Outdoor Shake Table at UCSD's Jacobs School of Engineering. The UCSD-NEES Outdoor Shake Table at UCSD's Jacobs School of Engineering is the world's first outdoor shake table and is capable of creating realistic simulations of the most devastating earthquakes ever recorded. The facility is part of the National Science Foundation's George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES).

Photography by Alan Decker. Courtesy of Jacobs School of Engineering.  
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Shaking tables

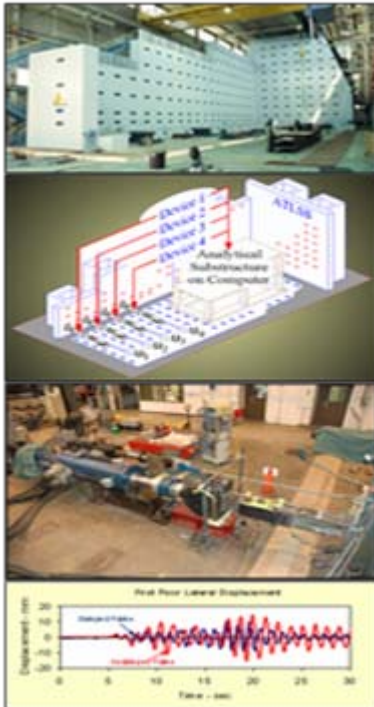


# Continued-What is Earthquake Engineering

Lehigh University

Large L-shaped reaction wall (31 x 15 x 15 m)

Actuators up to 200 tons



University of Minnesota

The MAST system specializes in three-dimensional, quasi-static, cyclic testing of large-scale structural test specimens

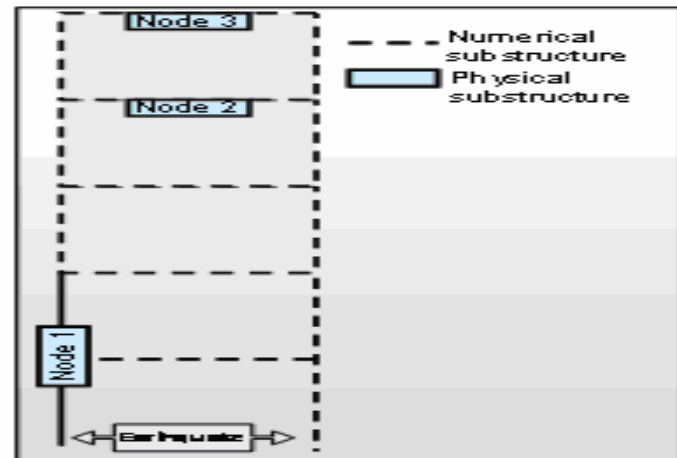


Hybrid Test Facilities



# Why do Earthquake Engineers need Grid

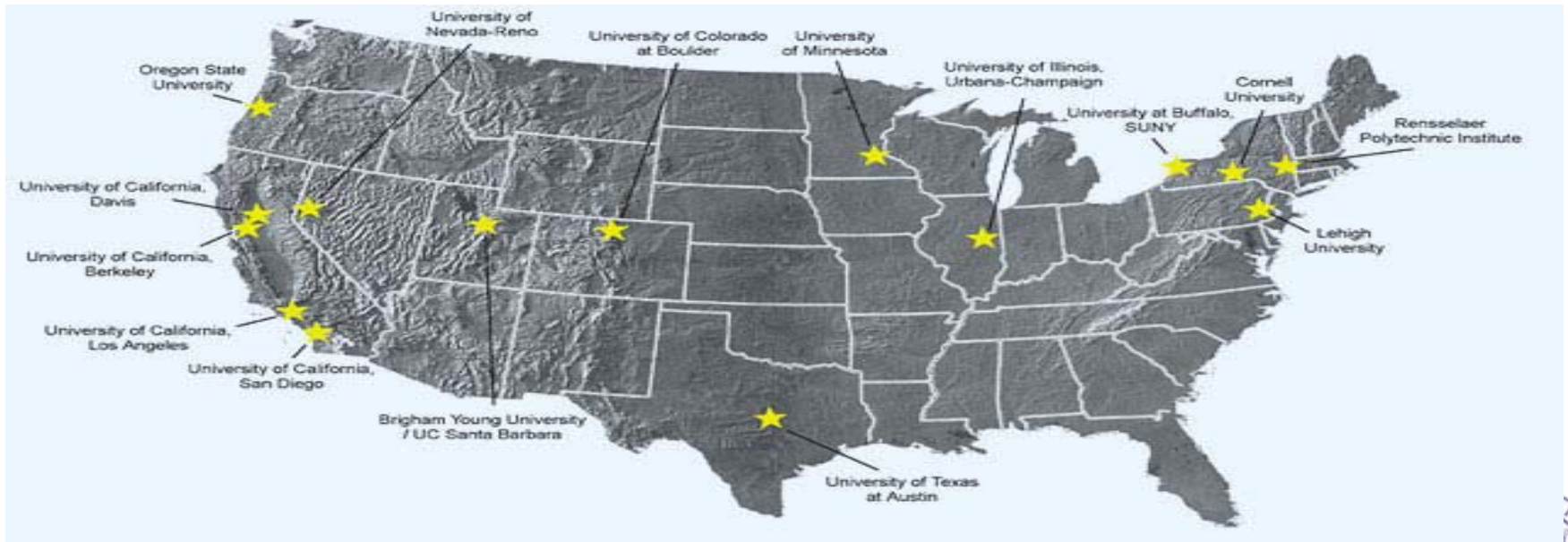
- Need to evaluate new seismic-resistant design concepts
- Important to test designs at full or large scale
- Expense of seismic test facilities
- Potential for “sub-structuring” experiments using hybrid test techniques
- Hybrid physical/numerical test
- Multi-site tests





# Network for Earthquake Engineering Simulation (NEES)

- National Science Foundation created the George E. Brown, Jr. national Network for Earthquake Engineering Simulation (US-NEES) connecting 15 experimental facilities.
- Sharing collaborative tools, centralized data repository, and earthquake simulation software, all linked by the ultra-high-speed Internet2 connections

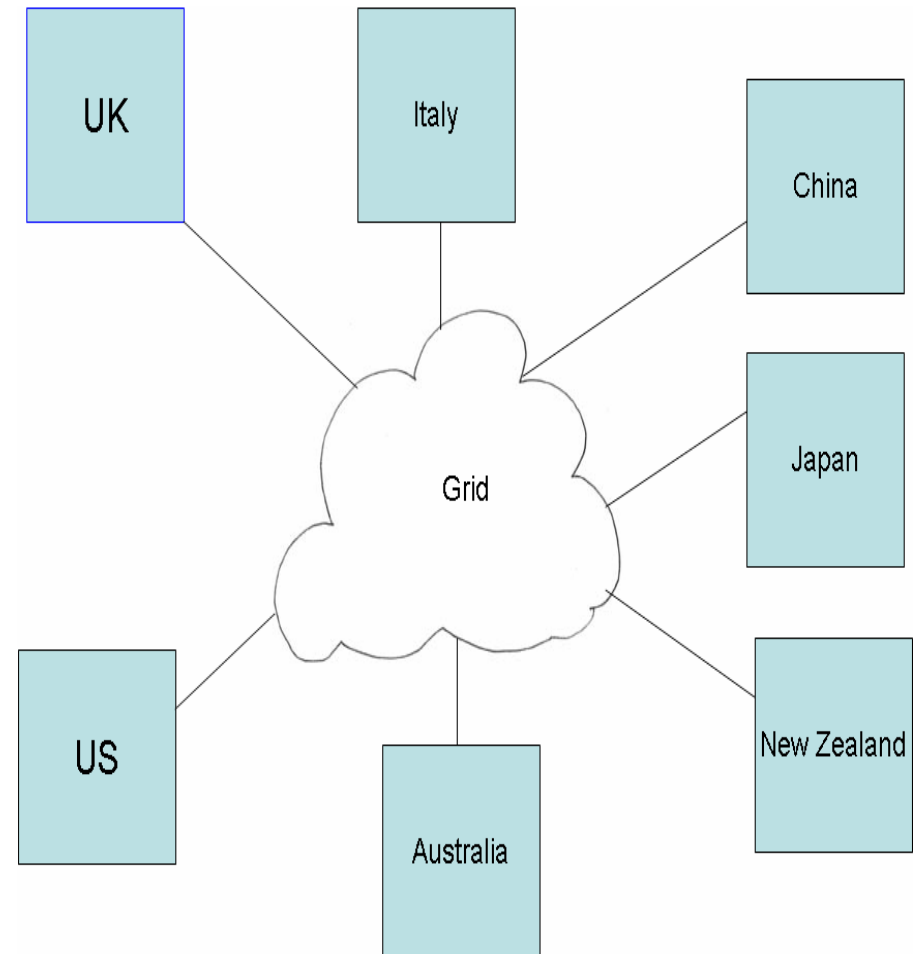


**NEES Research Facilities**



# World Wide NEES Network

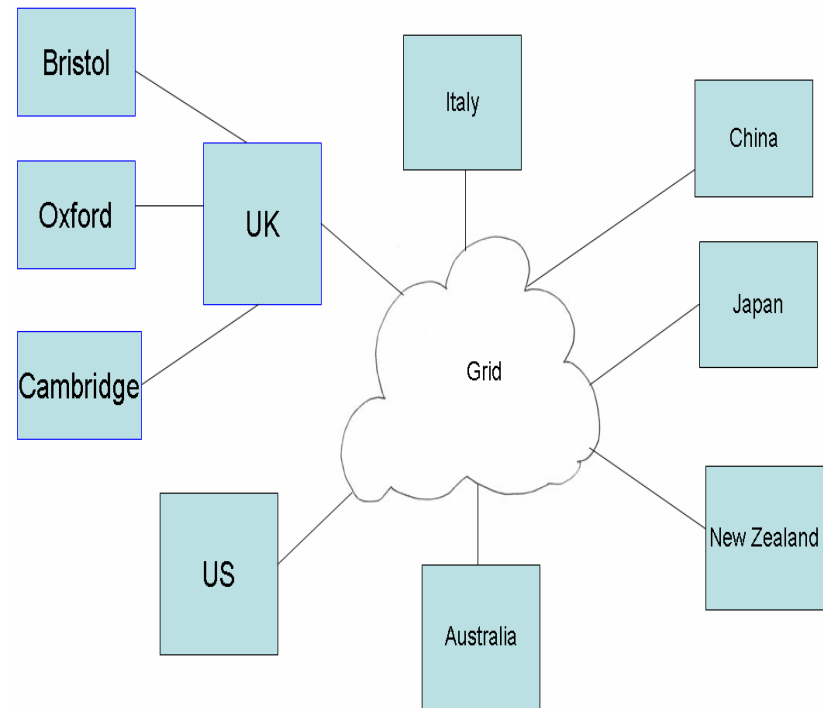
- The New Zealand Network for Earthquake Engineering Simulation (NZ-NEES).
- Japanese Science and Technology (*JST*): Carrying out distributed tests.
- International Solid Earthquake Research Virtual Observatory (*ISERVO*): Interconnecting earthquake research groups in Australia, China, Japan, and the US.





# UK-Network for Earthquake Engineering Simulation (UK-NEES)

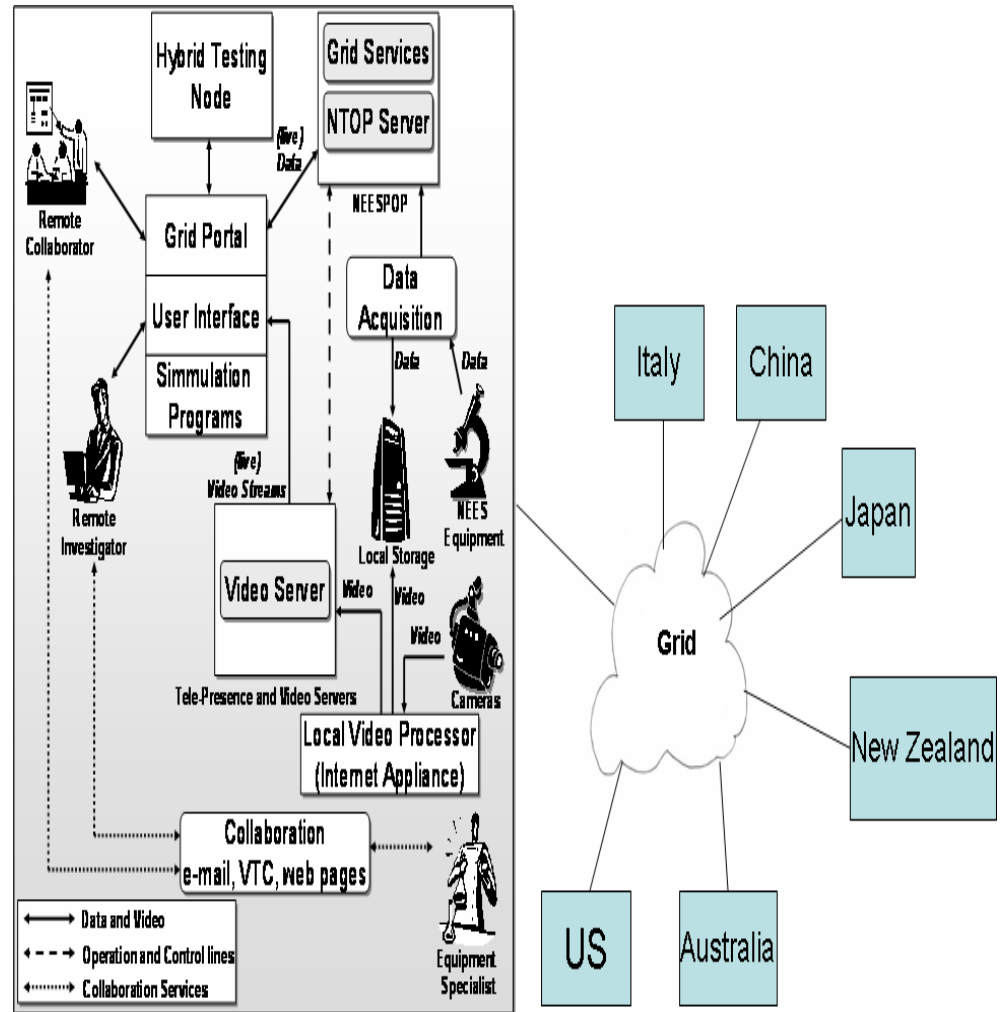
- UK Network for Earthquake Engineering Simulation (UK-NEES) comprised of research laboratories at Bristol, Oxford and Cambridge universities.
- Oxford: Building structures
- Bristol: Bridge Foundation Structures
- Cambridge: Centrifuge, soil structure interactions
- Interconnected through collaborative experimentation, computation, databases and model-based simulation.



# Continued- UK-Network for Earthquake Engineering Simulation (UK-NEES)

Key components of the system are:

- NEES Equipment: Test Specimen, Actuators, Sensors, Hydraulic System (DAQ): acquires data from research Equipment.
- NEES “Point of Presence” (NEES POP): provides a home for NEES Grid Services at the equipment site.
- Hybrid Testing Node: synchronizes and runs the geographically distributed hybrid tests.



# Proposed UK-NEES Web Portal

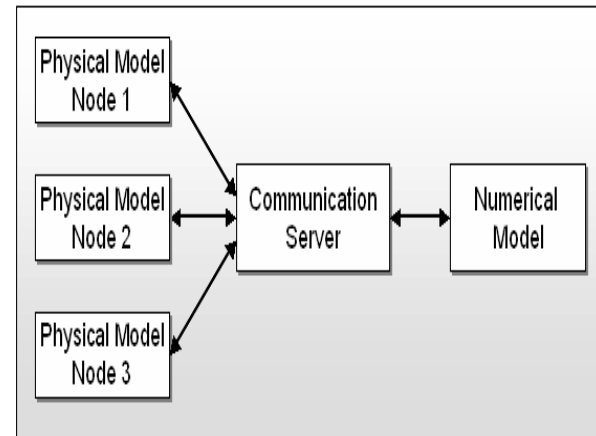
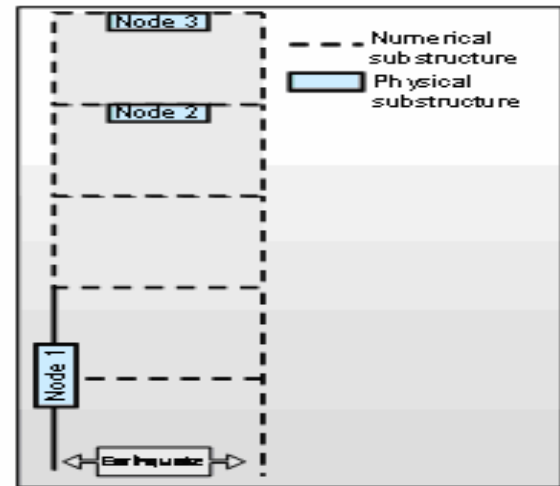
- Viewing of live camera streams.
- Real time data viewer.
- Level of Operations:
  - Tele-observation
  - Tele-participation
  - Tele-operation
  - On-line data access
  - Distributed hybrid testing
- Running and managing experiments on the portal.



Source : <http://www.nznees.auckland.ac.nz/>

# Extending UK-NEES to wider research community

- Hybrid dynamic model of a five storey five degree of freedom steel framed building structure split into numerical and physical parts.
- Communication Server manages the communication between the physical model nodes and the numerical model.



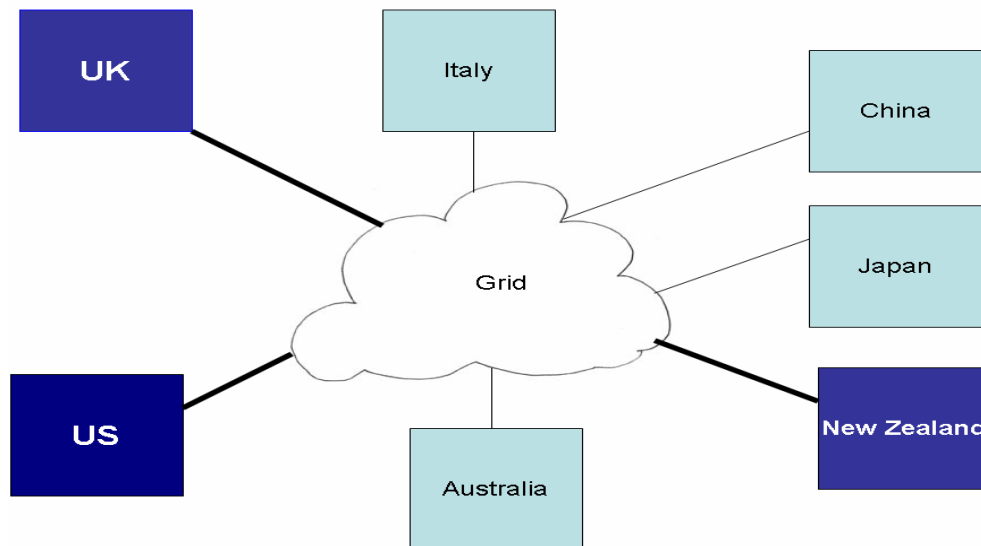
# Continued-Extending UK-NEES to wider research community

- Using open source tools and software developed by other US-Partners.
- Standardized way of connected to the UK-NEES Network using OpenFresco due to heterogeneity in the hardware and the security policies etc
- Minimize the bottlenecks using UK-Light : Network connections to peer facilities within UK, in US (StarLight) and the Netherlands (NetherLight) to enable international collaboration.



# UK-NEES International Collaboration

- NZ-NEES @ Auckland:
  - Seismic response of bridge foundation structures.
  - Benchmarking of distributed hybrid testing.
- US-NEES @ UC-Berkeley:
  - Benchmarking of distributed hybrid testing.





# Conclusion

- Utilizing global research resources such as expertise, lab facilities etc through collaborative tools.
- Interoperable: Standardization of the earthquake engineering research.
- Distributive Hybrid Testing to use the resources of the other sites to meet the demands of the bigger tests.
- Grid Enabling provides new paradigms of problem solving that would provide solutions faster, better and amenable .



*Questions?*

