NHERI Computational Modeling and Simulation Center

Lehigh EF
Researcher's Workshop
December 5-6, 2016

NSF NHERI

Berkeley
UNIVERSITY OF CALIFORNIA

NHERI SimCenter Vision

"Transforming the nation's ability to understand and mitigate adverse effects of natural hazards on the built environment through computational simulation"

Grounded in the present
Five year focus
Ten year vision

NHERI SimCenter

SimCenter Mission

Pivot to a comprehensive, open source, cloud-based, HPC framework or simulation "ecosystem" that:

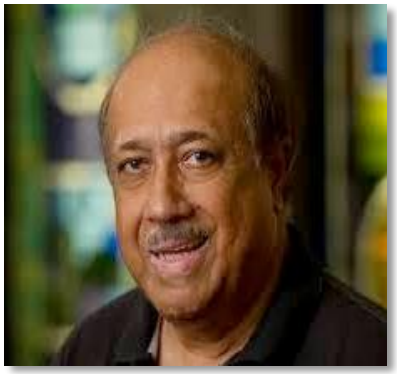
- ✓ is modern, extensible, scalable, secure and robust,
- ✓ harnesses machine learning, artificial intelligence, expert systems, self-assembling knowledge bases to help model, validate and build trust in numerical simulations,
- ✓ quantifies the sensitivity of performance to various uncertainties,
- ✓ is performance oriented and data-driven, and
- ✓ characterizes performance appropriately for different stakeholders.

SimCenter Broader Goals

- Treats all natural hazards equally.
- Considers models at all scales.
- Remembers cities are not just structures, includes infrastructure, lifeline networks and social services.
- Integrates seamlessly with other NHERI components to ensure a functional and cohesive national infrastructure.
- Supports decision-making at all levels.

Capable Leadership Team

Steve Mahin
UC Berkeley



Ahsan Kareem
Notre Dame

Laura Lowes
Washington

Greg Deierlein
Stanford

Sanjay Govindjee
UC Berkeley

Camille Crittenden
UC Berkeley

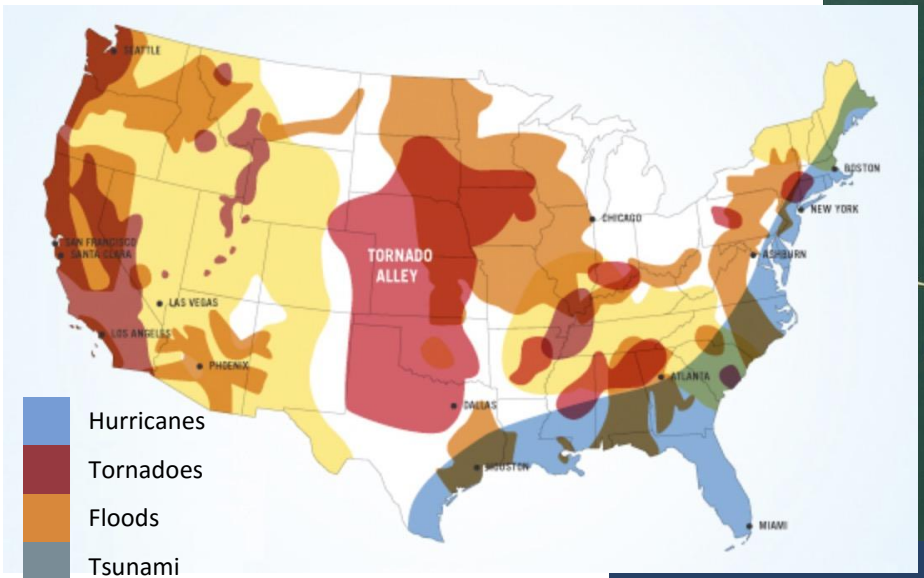
Frank McKenna
UC Berkeley

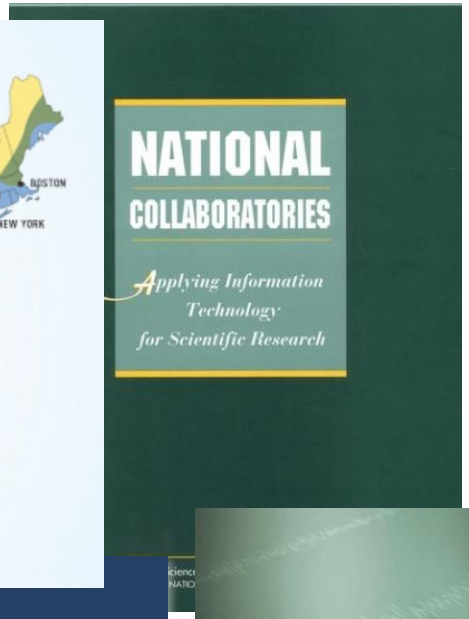
Matt Schoettler
UC Berkeley

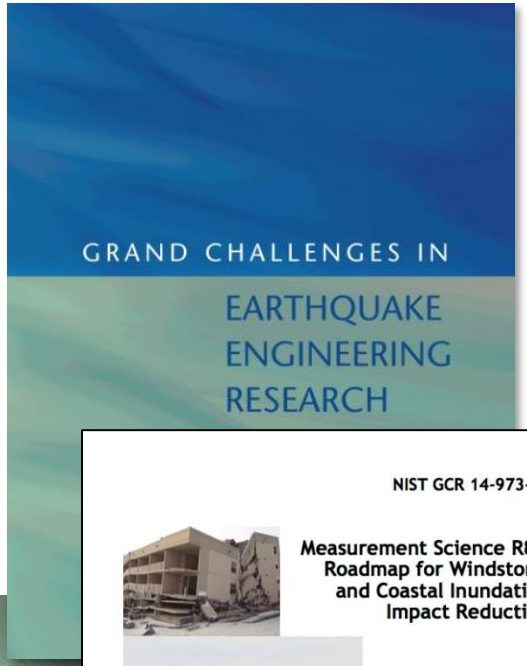
Plus nearly 25 experts in engineering, urban planning, social science and computer and information science

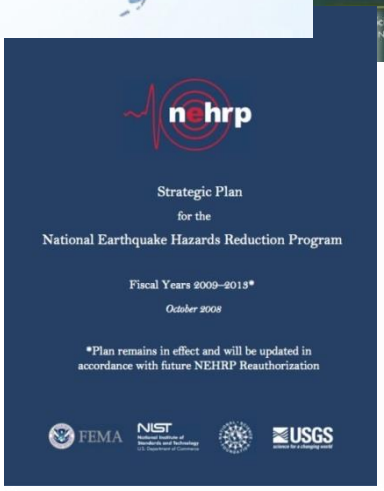
NSF NHERI SimCenter

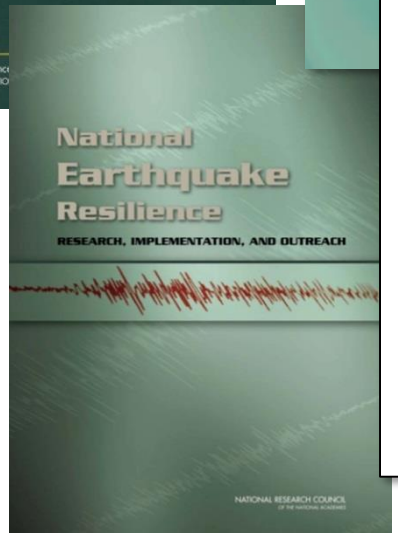
Tackling the "Grand" Challenges posed by a Nation at Risk from Natural Hazards

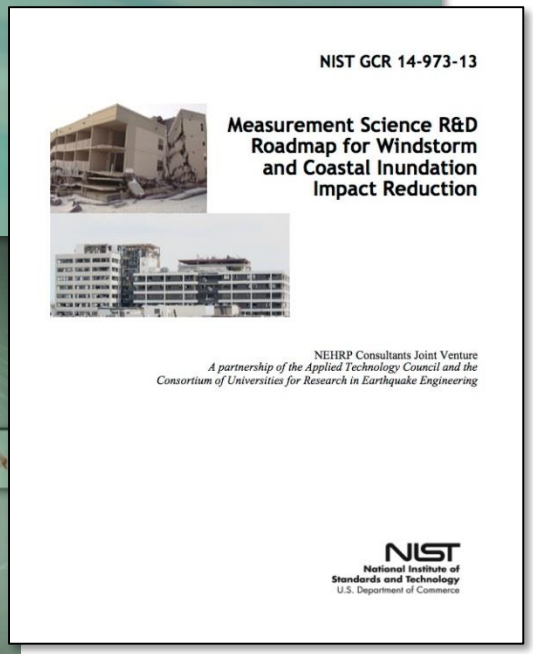








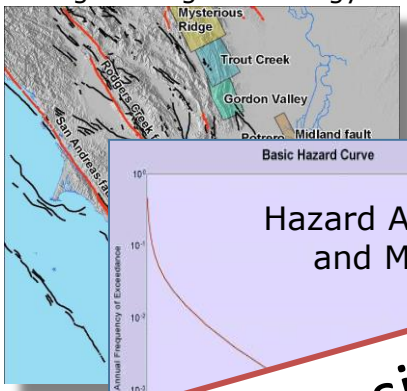




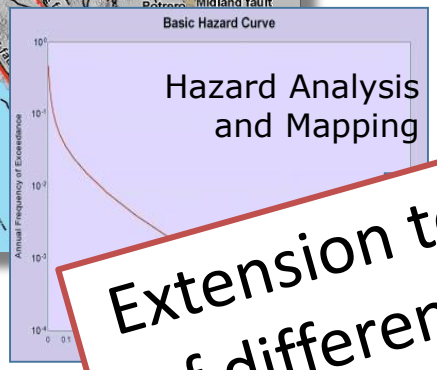
NSF NHERI SimCenter

Builds upon a solid performance-based, risk informed methodology

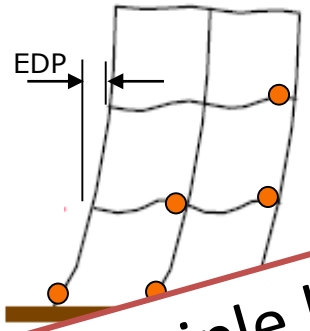
Engineering Seismology



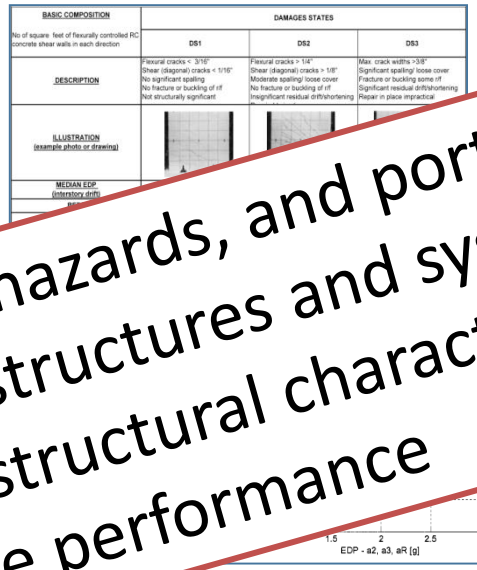
Hazard Analysis and Mapping



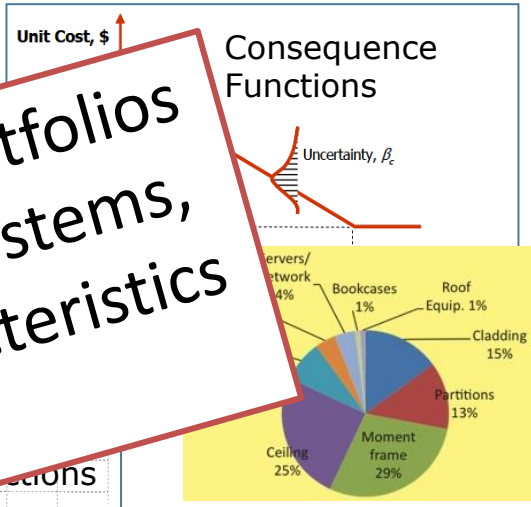
HPC simulation



Performance Databases

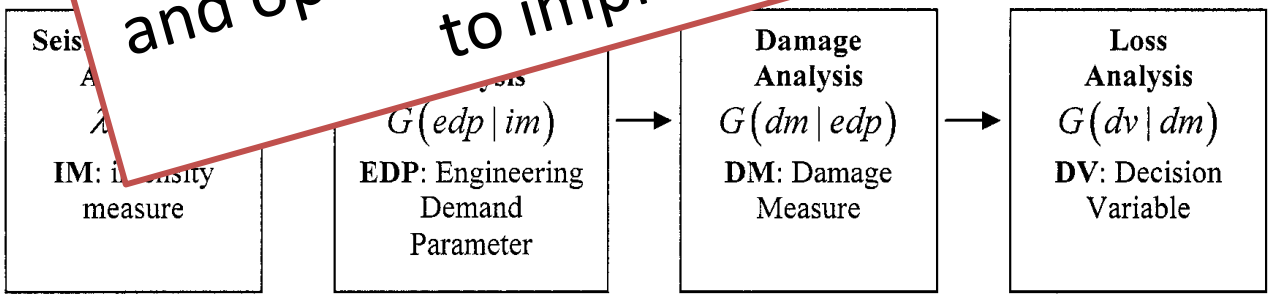


Consequence Functions



Loss Assessment

Extension to multiple hazards, and portfolios of different kinds of structures and systems, and optimization of structural characteristics to improve performance



$$\lambda(DV > dv) = \int_{im} \int_{dm} \int_{edp} G(dv \mid dm)\, dG(dm \mid edp)\, dG(edp \mid im) \left| d\lambda(im) \right|$$

Probabilistic Assessment of:

- ✓ Cost of repair and loss of function
- ✓ Downtime
- ✓ Casualties
- ✓ *Embodied energy*

Our plan:
Transitioning from PCs to the cloud

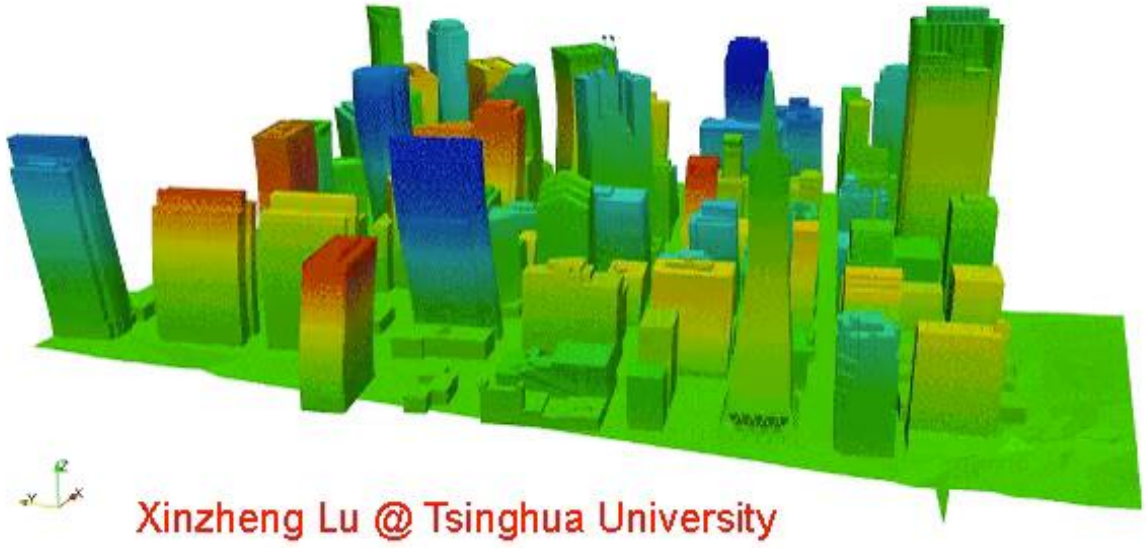
Current software is often good, but:

- Regular software updating needed
- Unable to scale to HPC,
- Difficult to interact with and move data from one app to another.

- Move to cloud-based HPC environment
- Provide integrated “plug and play” capability to link multiple software apps together into workflows

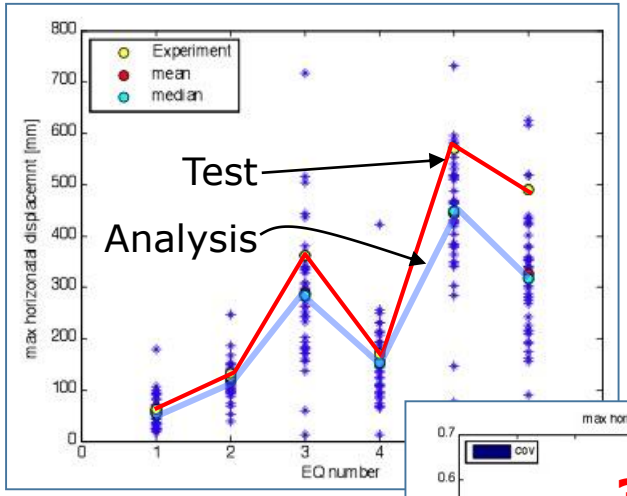
Application of Applications Framework

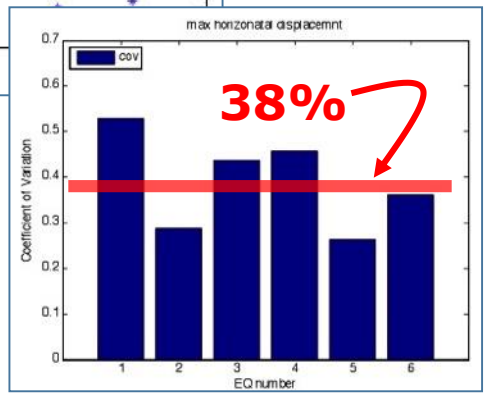
Application of Applications Framework



Trustworthy Simulations

Concrete Column Blind Prediction Contest 2010





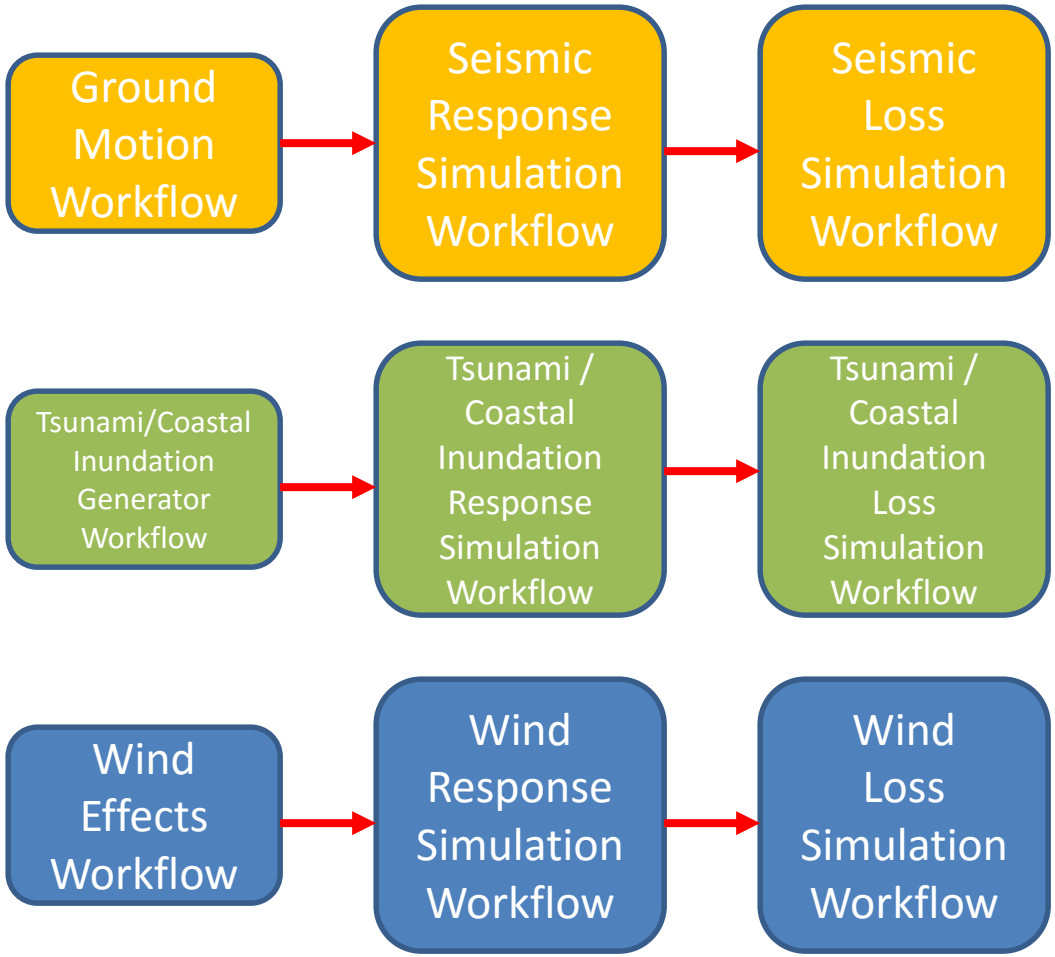
41 expert teams participated

PEER-NEES Blind Analysis Contest

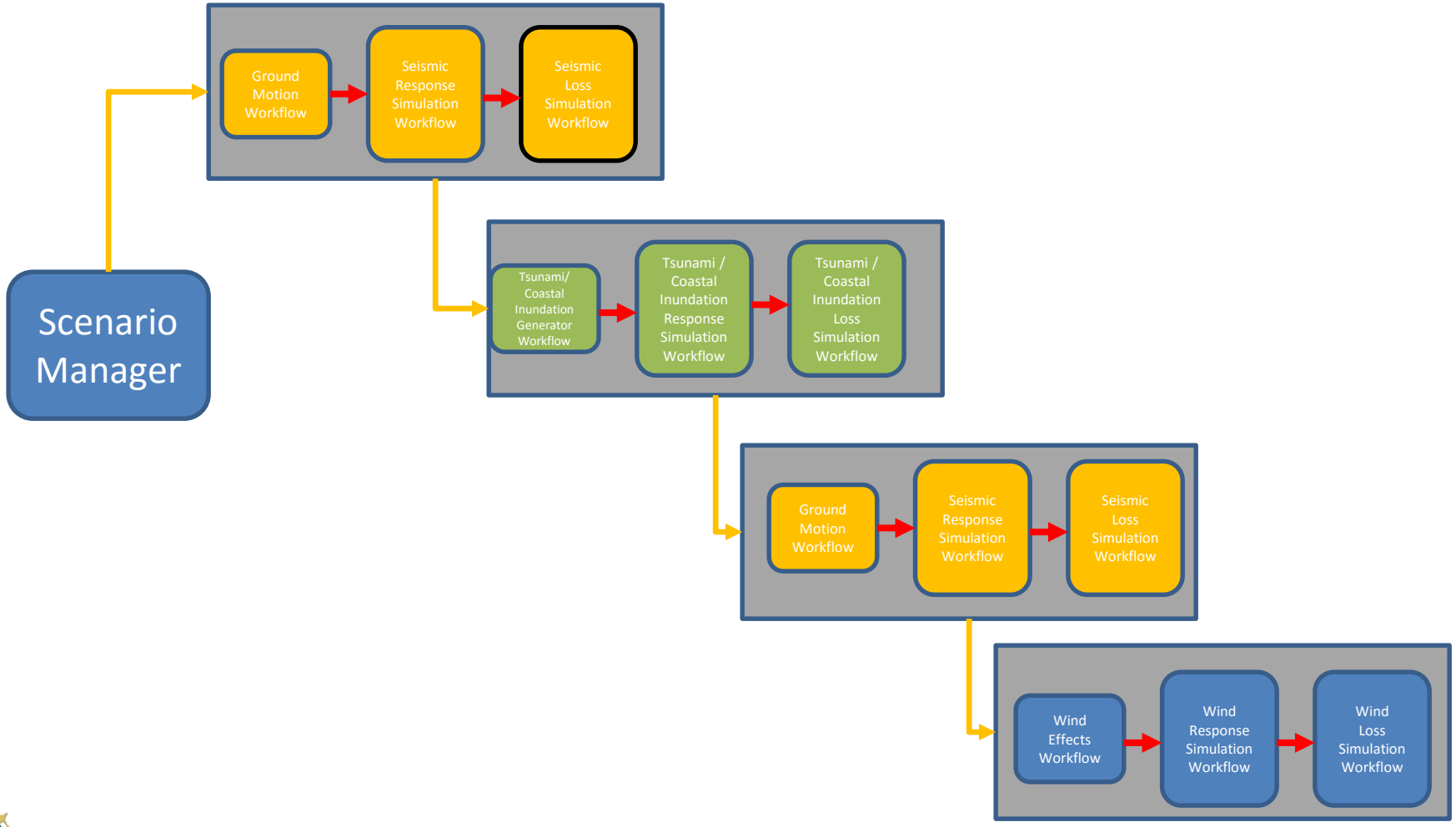
Full-scale 1D tests of circular column - Jose Restrepo, PI (PEER, Caltrans, UNR, FHWA, NEES@UCSD, NEEScomm & NSF)

NHERI SimCenter

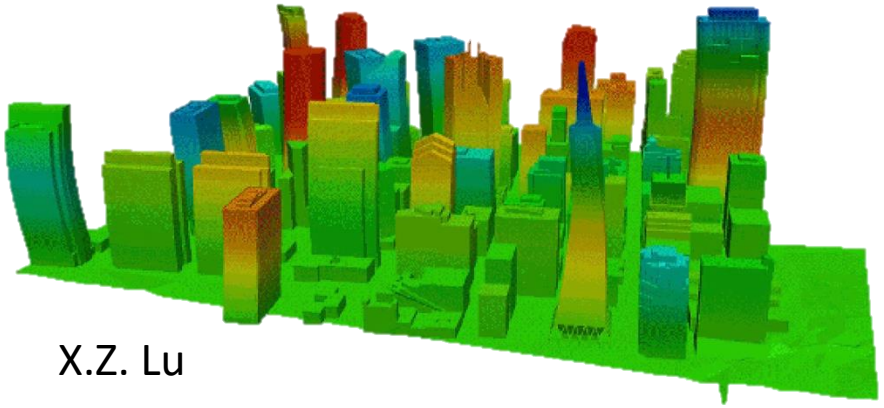
Enabling complex workflows



Enabling complex workflows

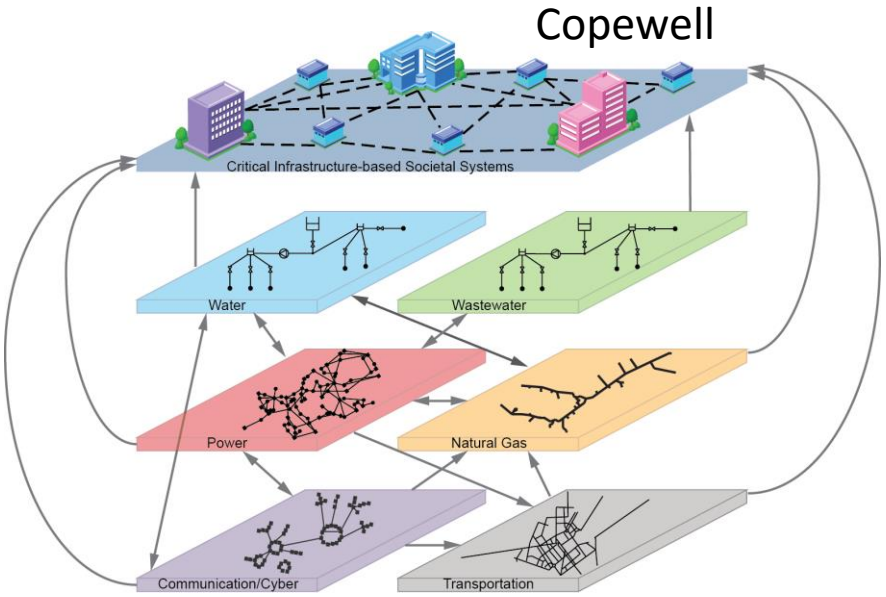


If you can do this for one facility



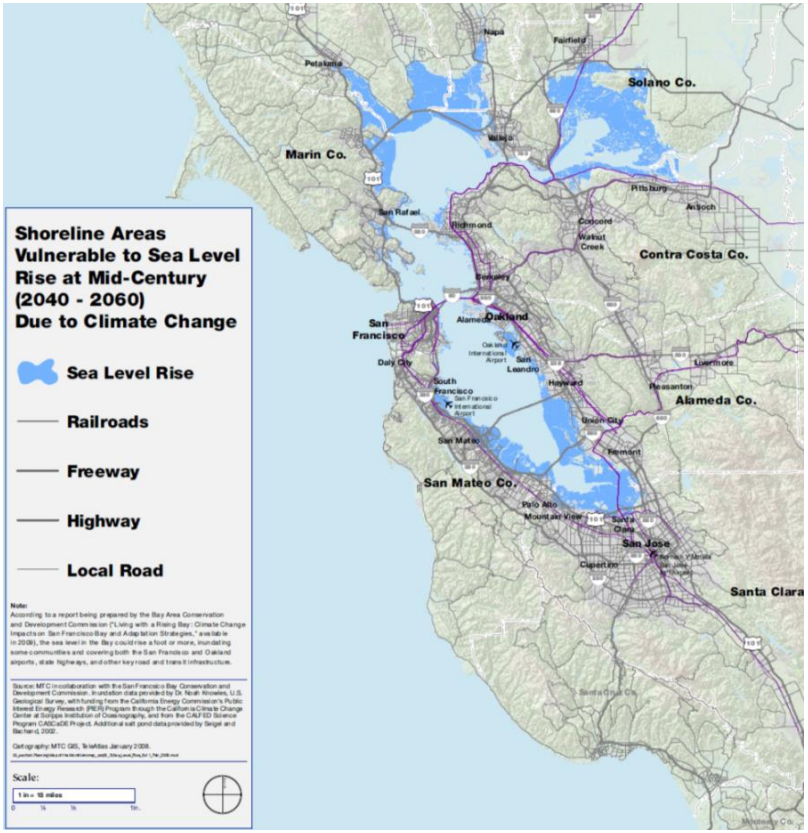
X.Z. Lu

Portfolio and community simulation models

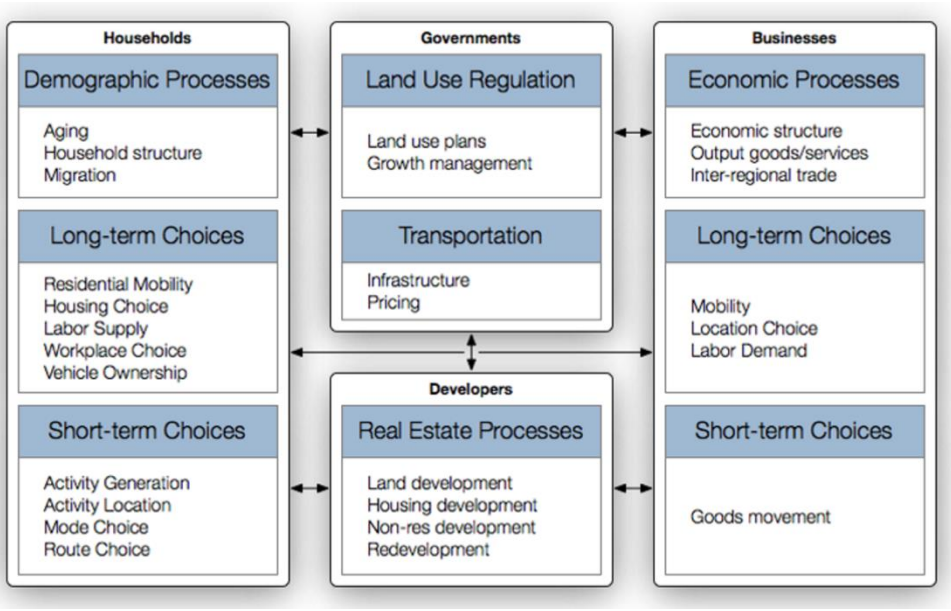


Lifeline, supply chain and service networks

Local and Regional Government Planning Development, Policies & Programs



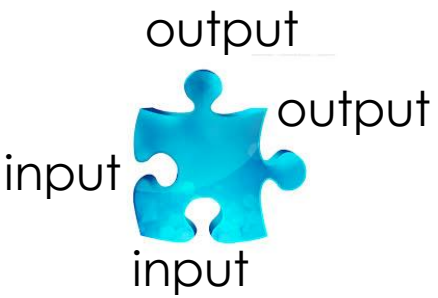
(Source: Bay Conservation and Development Commission, 2009)



Decision Support - UrbanSim

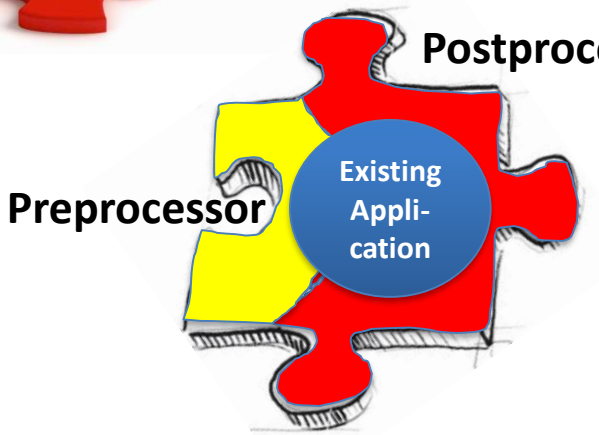
NHERI SimCenter

SimCenter Framework for Building Workflow Applications



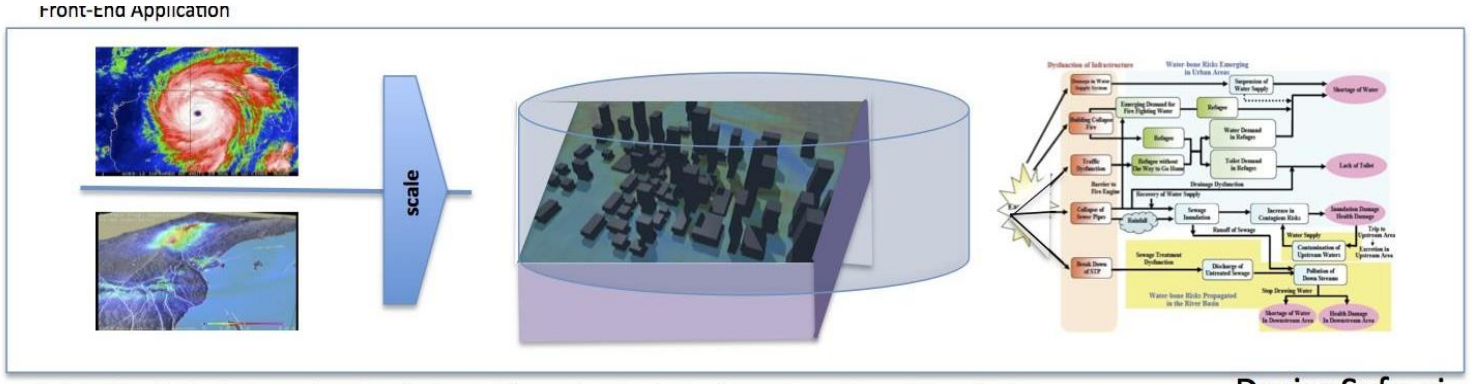
Each component is a software application: it does something and has clearly defined interfaces (input and output APIs).

We will use Scientific Workflow Management Software to schedule components & manage the passing of data between the components. The software we will use is **Pegasus**.



Our goal is to define the interfaces so existing and future applications of the users choice can be used.

Facilitating complex regional-scale workflows



NHERI SimCenter

High profile early deliverables

Time needed to get the framework "backend" developed

Year 1 Highlights

- App 1: Integrated performance-based engineering workflow application
- App 2: Integrated uncertainty quantification workflow
- Educational apps illustrating sensitivity of dynamic response to excitation and structure characteristics.
- Kick start education activities, including programming boot camp and (M)OOCs (modeling best practices)
- Development and assessment of framework building blocks (metadata, ontologies, APIs, wrappers, user interfaces, etc.)

To Achieve Our Broad Vision for the SimCenter

We need your advice, help and collaboration, so we can effectively address community needs

Our framework is a skeleton, and needs users to provide it with the data necessary to make it useful

We are happy to work with researchers and other NHERI Components in developing proposals to use our framework and exploit capabilities of HPC

Thanks!

Questions?

- For more information contact:

Stephen Mahin

mahin@berkeley.edu

510-693-6972