

NHERI Center for Computational Modeling and Simulation of the Effects of Natural Hazards on the Built Environment

NHERI@UC San Diego User Training Workshop

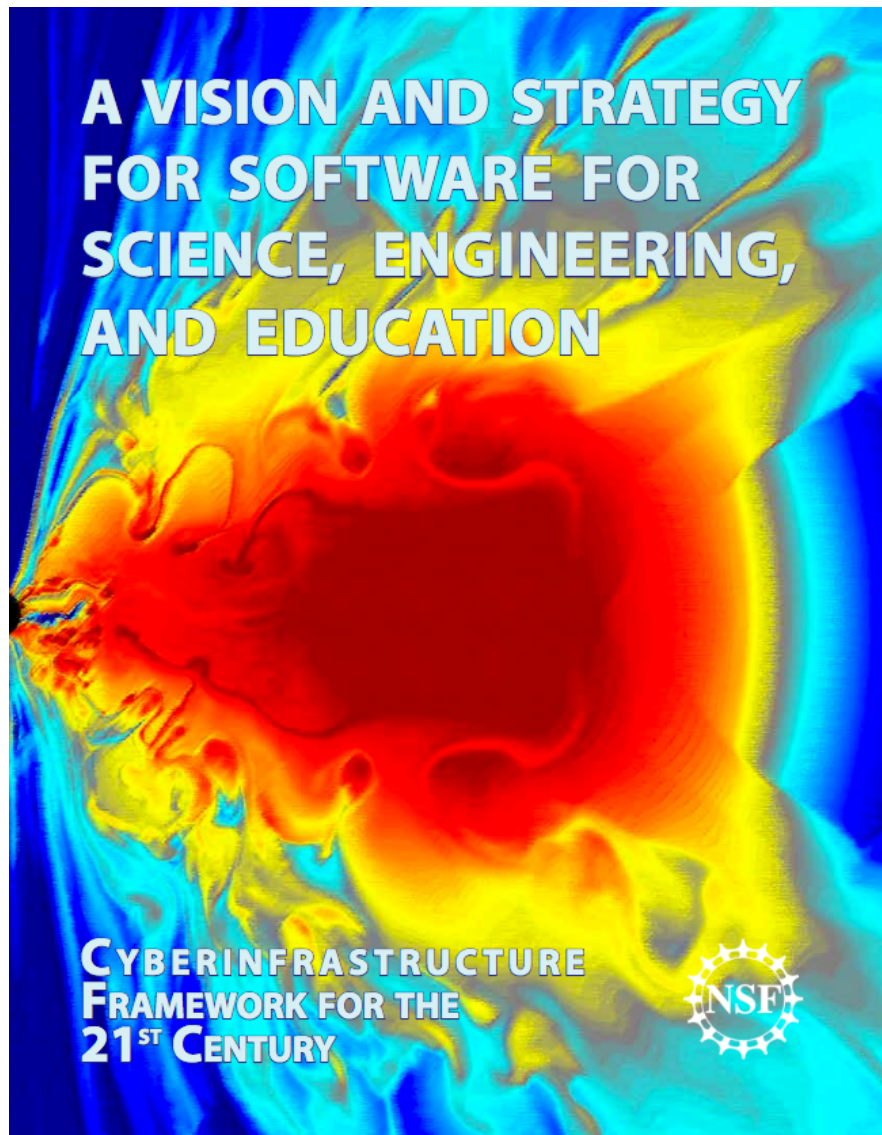
Stephen Mahin, Director

Matthew Schoettler, Associate Director for Operations



NHERI SimCenter Vision

“Transforms the nation’s ability to understand and mitigate adverse effects of natural hazards on the built environment through computational simulation”



Enable transformative, interdisciplinary, collaborative, science and engineering research and education through the use of advanced software and service

Software Elements: small groups create and deploy robust software elements that advance significant areas of science and engineering.

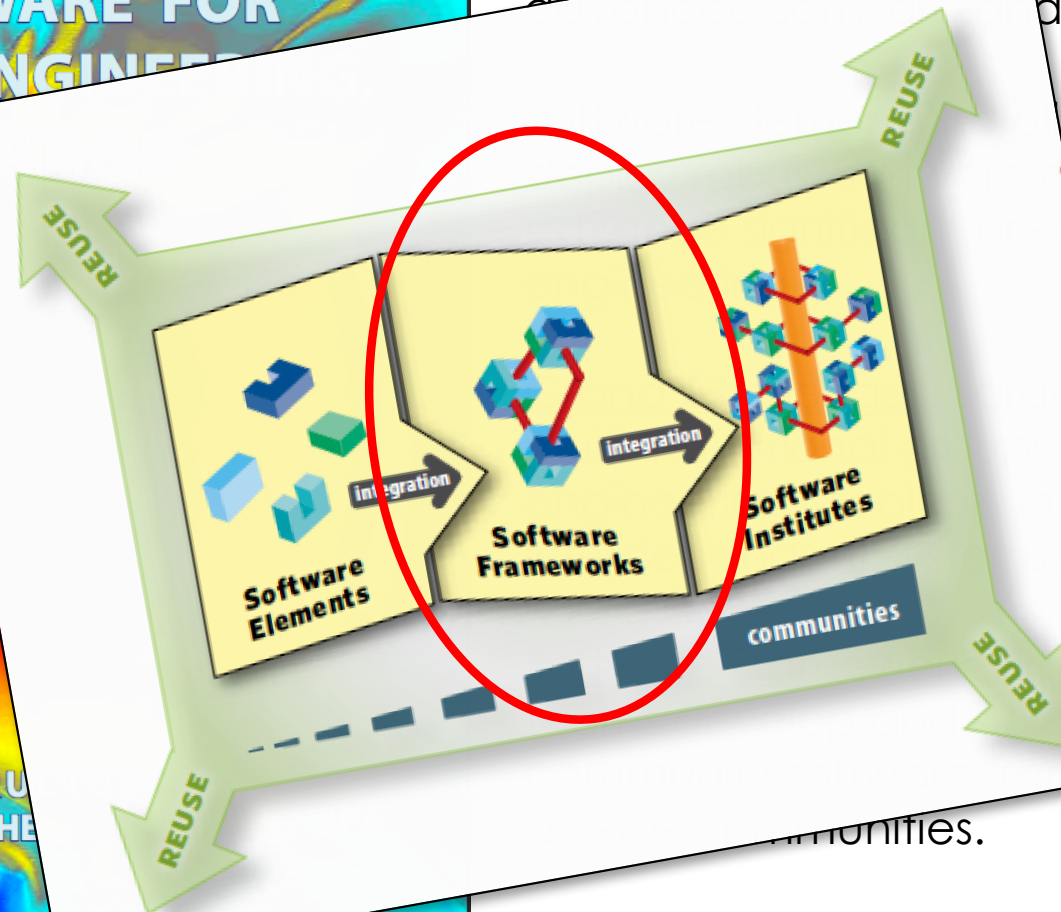
Grand Challenges: Large multi-disciplinary, multi-institutional groups tackle complex engineering problems involving interdependent systems.

Software Frameworks: large, interdisciplinary teams develop and help apply sustainable community software frameworks serving diverse communities.

Reuse mechanisms: Incentivizing individuals and communities to use and build on existing infrastructure frameworks to advance science and engineering.

A VISION AND STRATEGY FOR SOFTWARE FOR SCIENCE, ENGINEERING AND EDUCATION

CYBERINFRASTRUCTURE
FRAMEWORK FOR THE
21ST CENTURY



Enable transformative, interdisciplinary, collaborative, science and engineering research and education through the use of software and service

groups create and elements that of science and

multi-disciplinary, tackle complex solving

interdisciplinary ly sustainable networks serving

communities.

Reuse mechanisms: Incentivizing individuals and communities to use and build on existing infrastructure frameworks to advance science and engineering.

SimCenter Mission

Pivot to a comprehensive, open source, cloud-based, HPC framework 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

- ✓ Treat all natural hazards equally,
- ✓ acknowledge that cities are not just structures, but include infrastructure, lifeline networks and social services,
- ✓ support decision-making of all levels, and
- ✓ integrate seamlessly with other NHERI components to ensure a functional and cohesive national infrastructure.

Work plan formulated to address Grand Challenges

Requirements from these reports carefully mapped onto the initial product development plan for the software to be developed and deployed by NHERI SimCenter

**NATIONAL
COLLABORATORIES**

*Applying Information
Technology
for Scientific Research*

Computer Science and Telecommunications Board
NATIONAL RESEARCH COUNCIL

**ENGINEERING
RESEARCH
CENTERS**

**Best Practices
Manual**

ENGINEERING RESEARCH INFRASTRUCTURE
SCIENCE PLAN
TO MAKE A MORE RESILIENT WORLD

JULY 2017

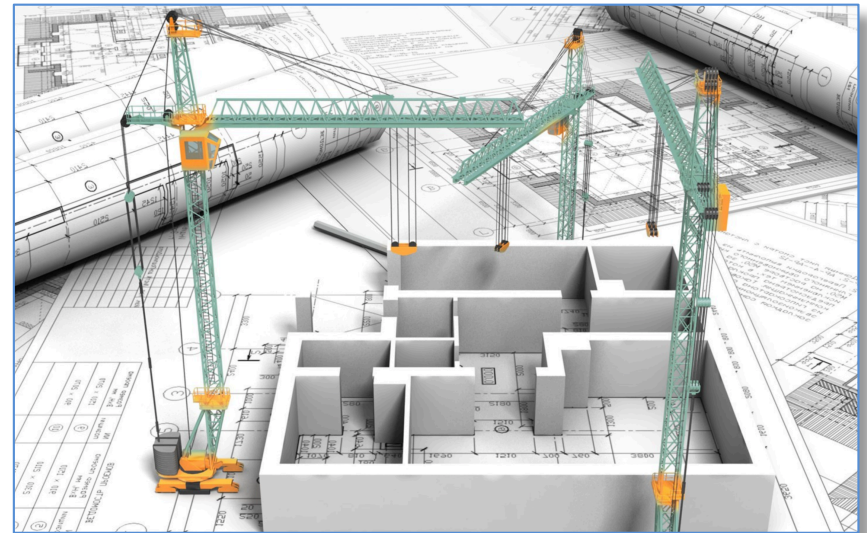
NHERI
Natural Hazards Engineering Research Infrastructure

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

SimCenter is the new kid on the NHERI block



Most NHERI Facilities have been established for a relatively long time



Your help in planning and development is needed!

Leadership Group



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

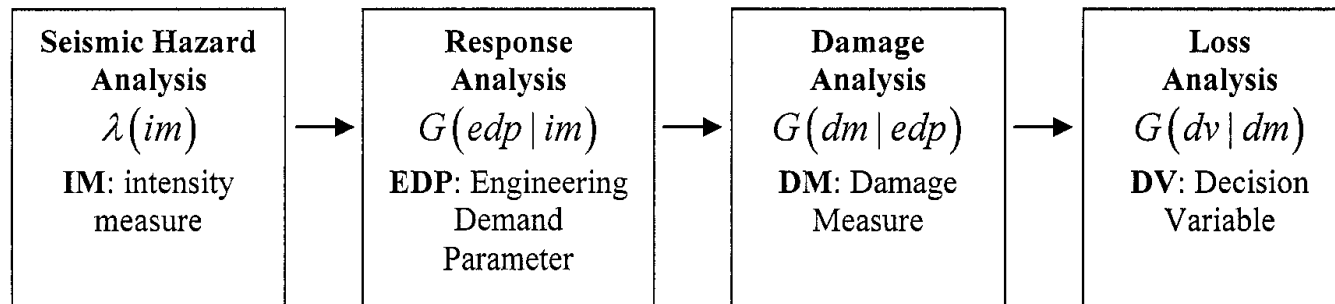
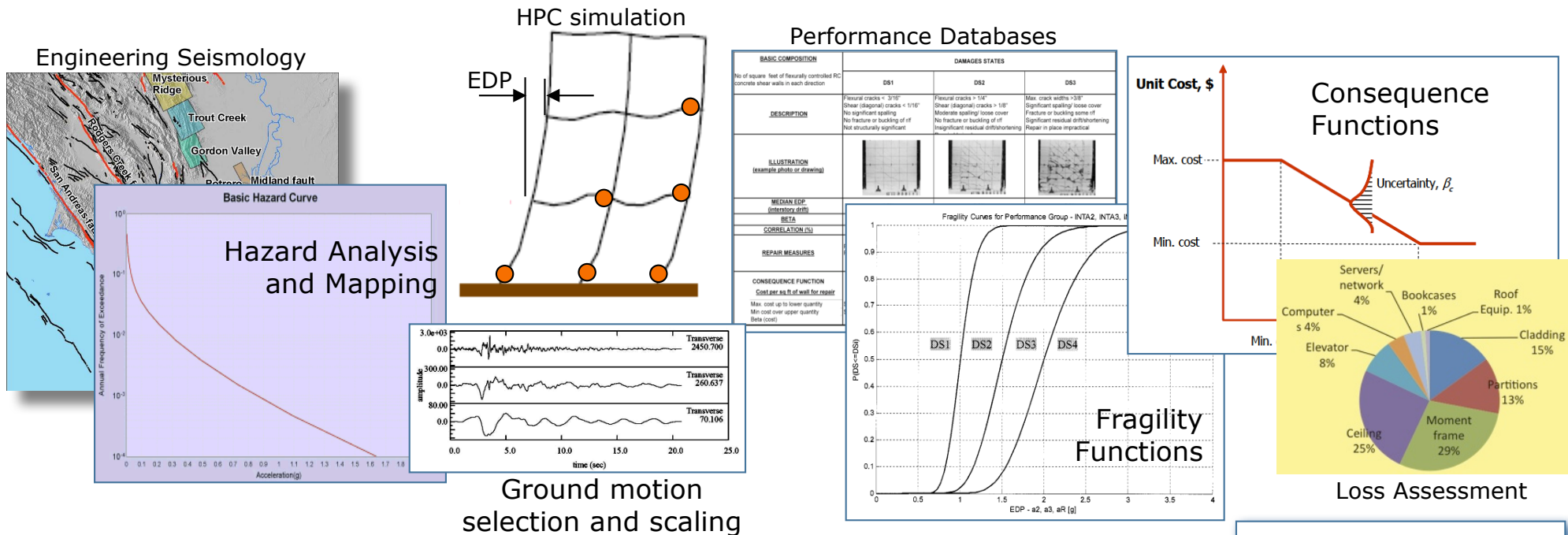
Our Team



SimCenter Consortium

Our DNA

Probabilistic PBE methodologies



Probabilistic Assessment of:

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

$$\lambda(DV > dv) = \int \int \int G(dv | dm) dG(dm | edp) dG(edp | im) d\lambda(im)$$

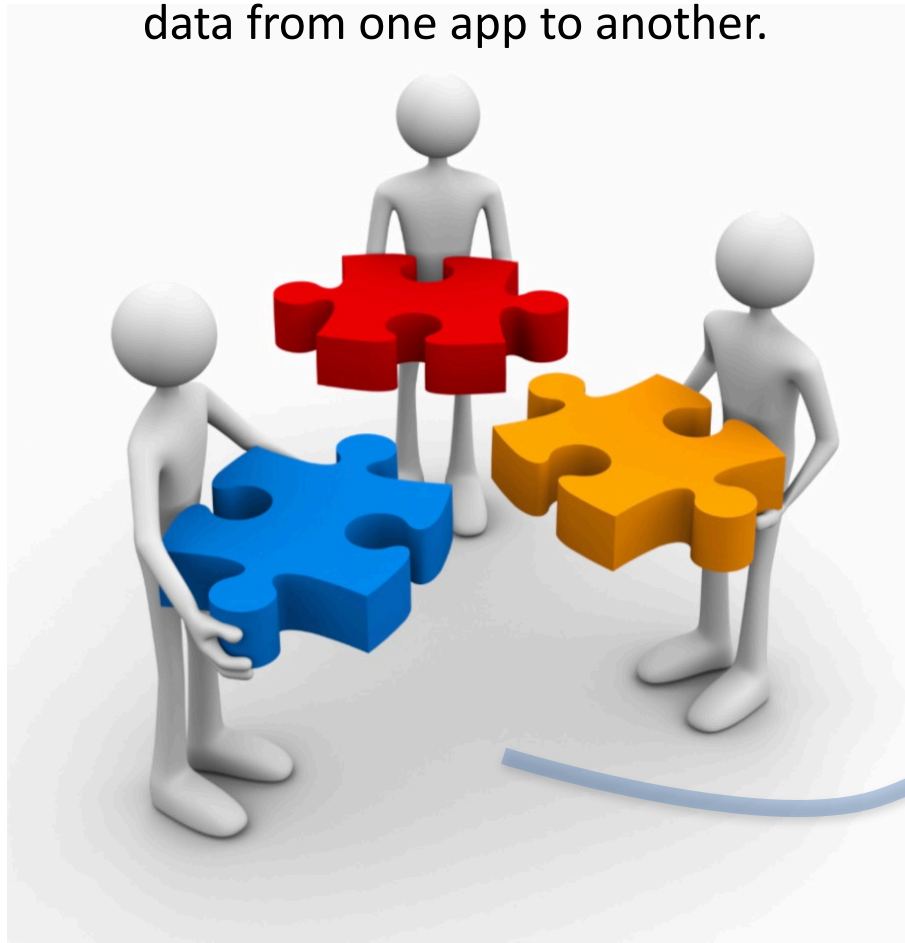


Our plan:

Personal computer class software

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.

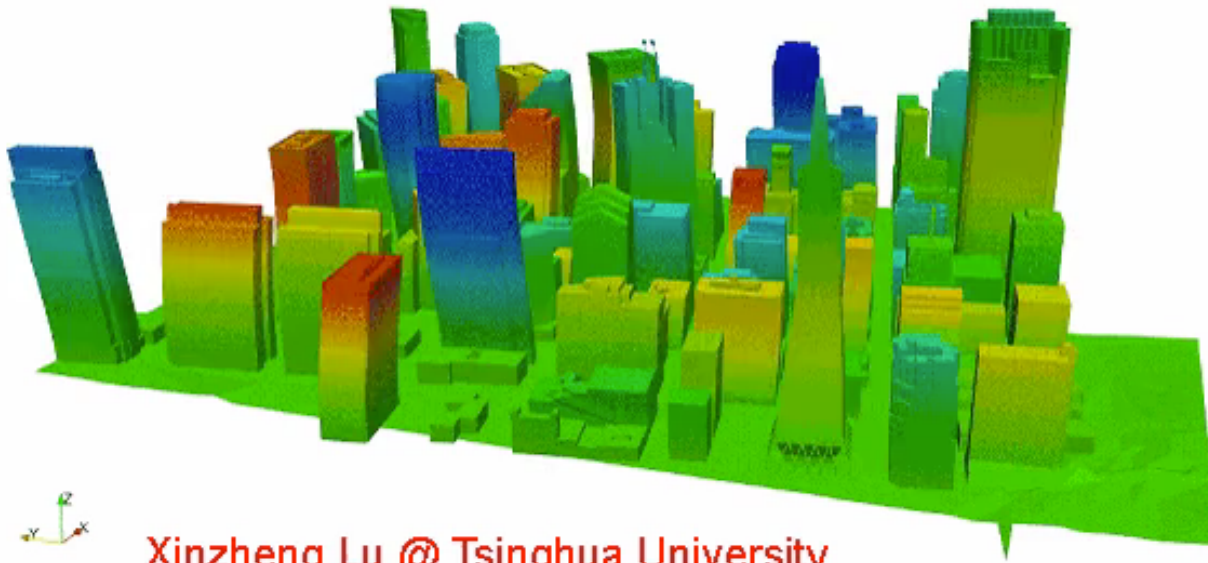


- Move to cloud-based HPC environment,
- Provide integrated “plug and play” capability to link multiple software apps together into workflows

Application of Applications Framework



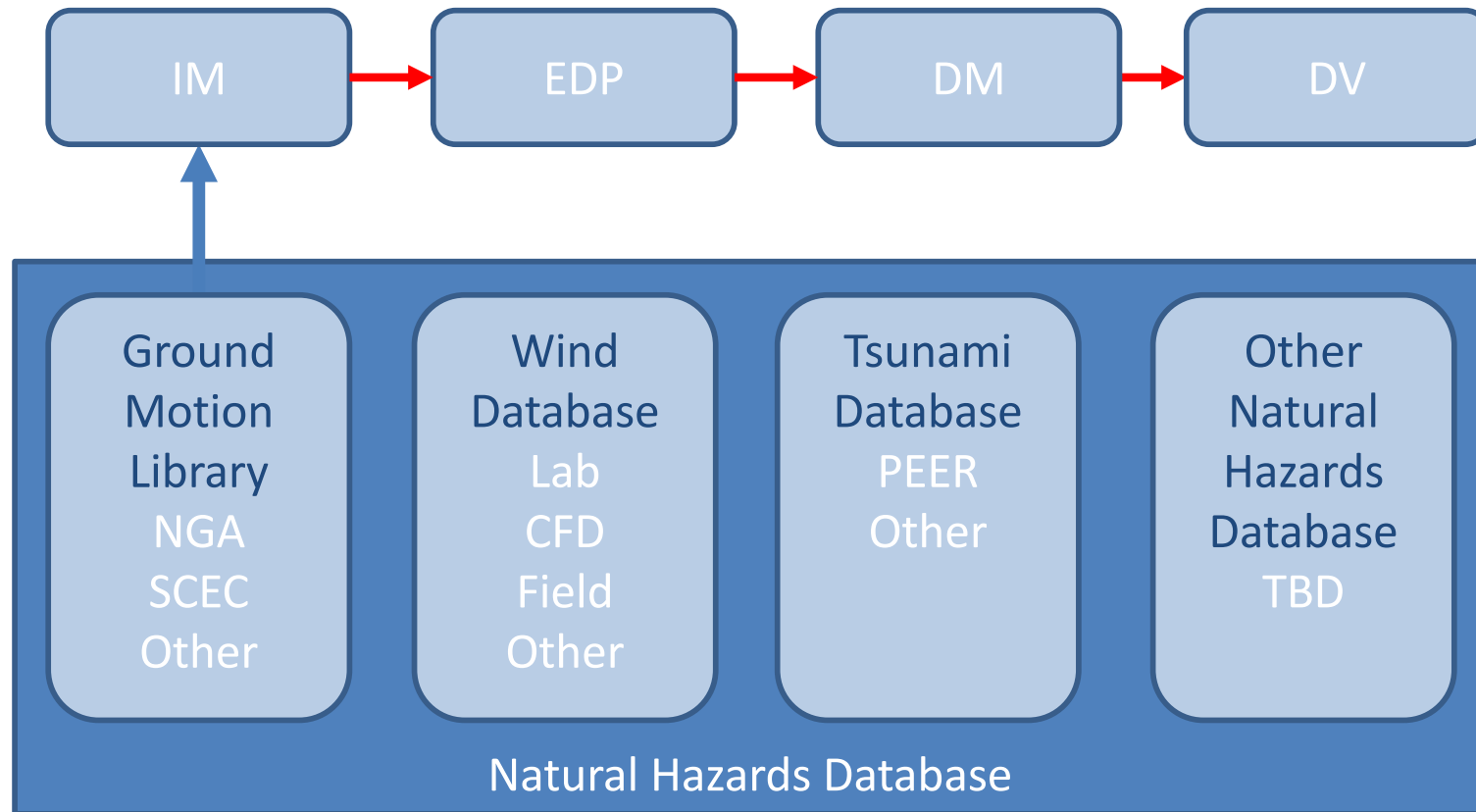
Application of Applications Framework



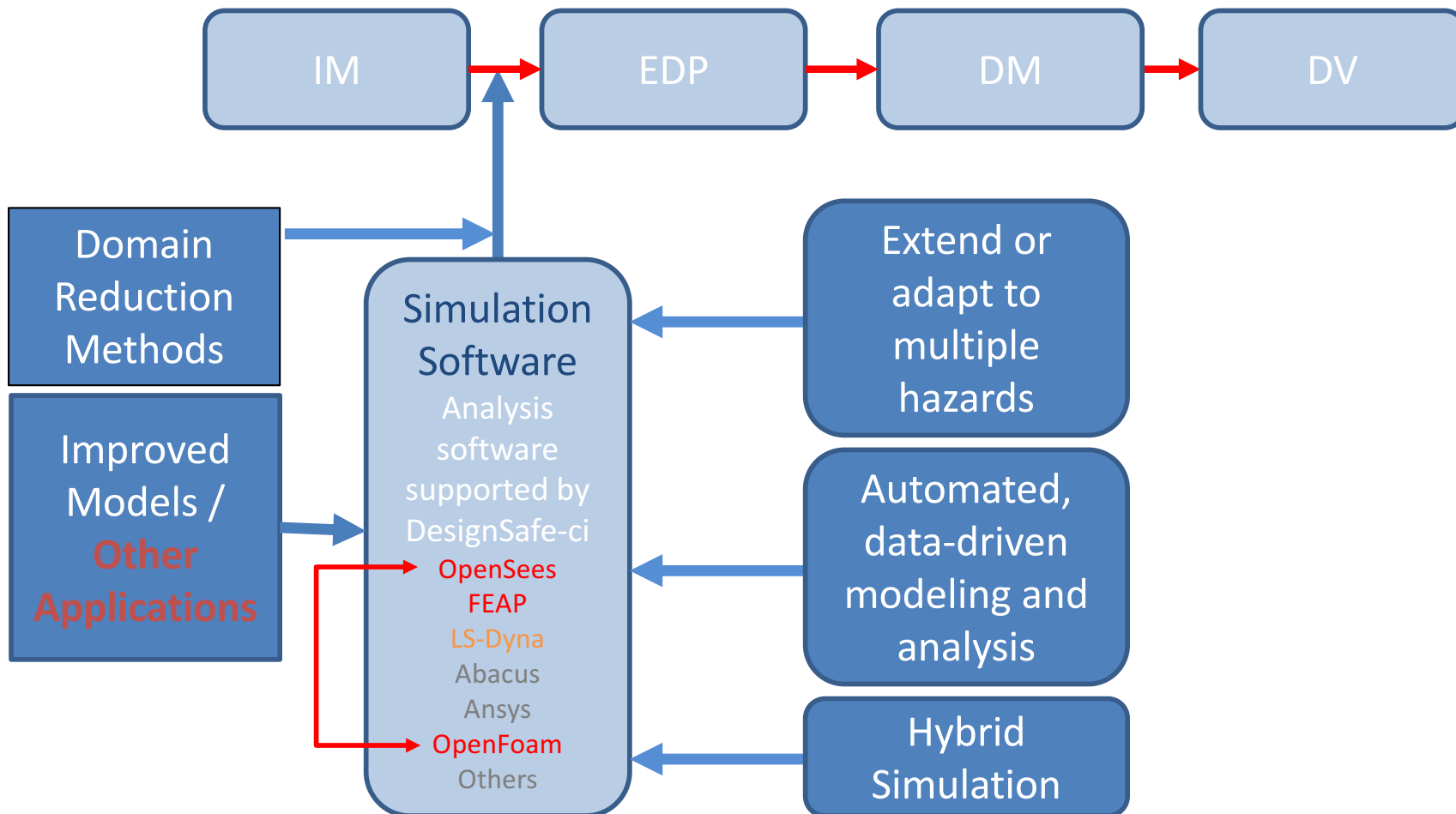
Xinzheng Lu @ Tsinghua University



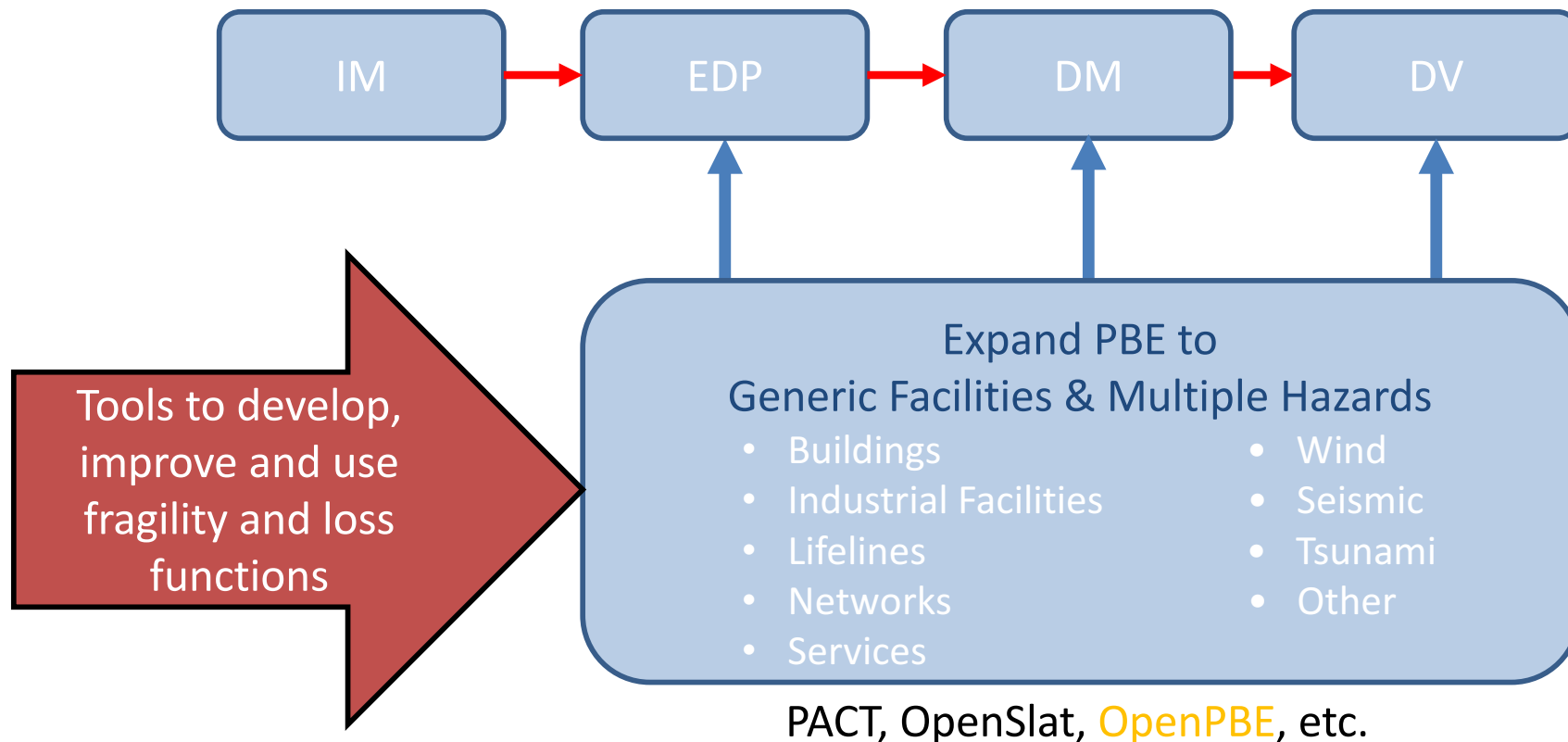
Simplified PBE Work Flow



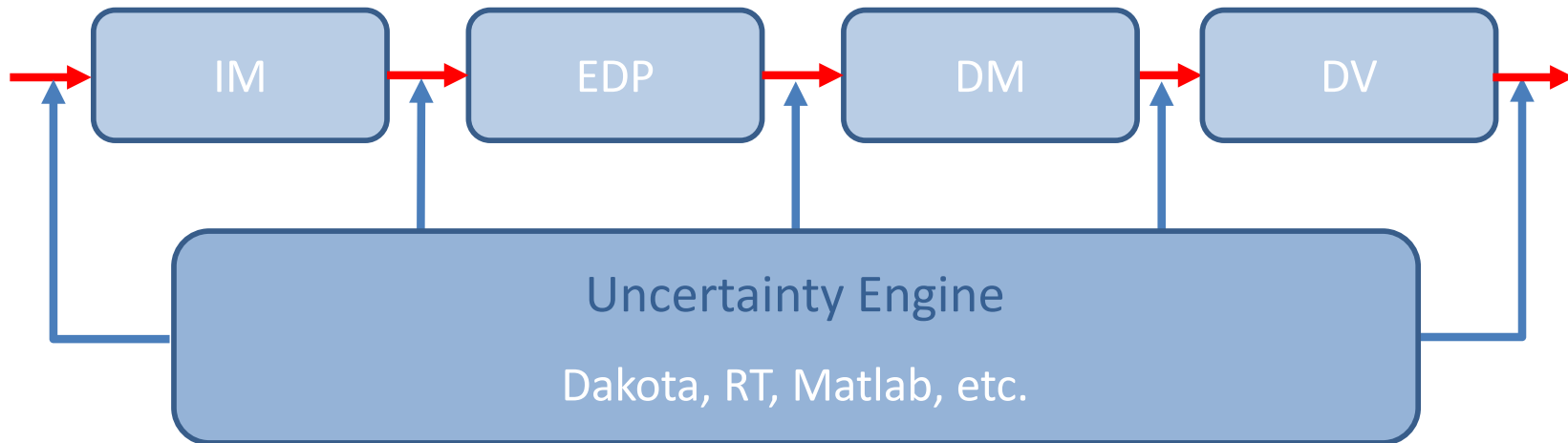
Simplified PBE Work Flow



Simplified PBE Work Flow

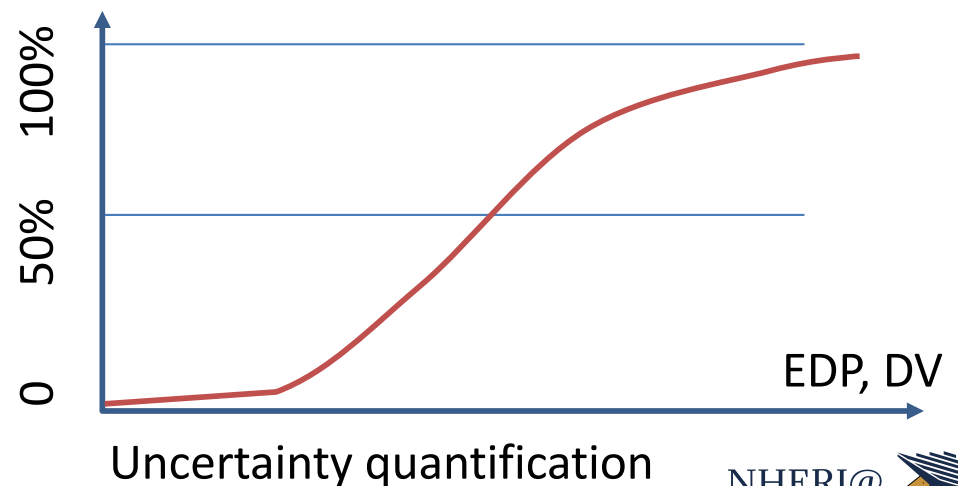


Simplified PBE Work Flow

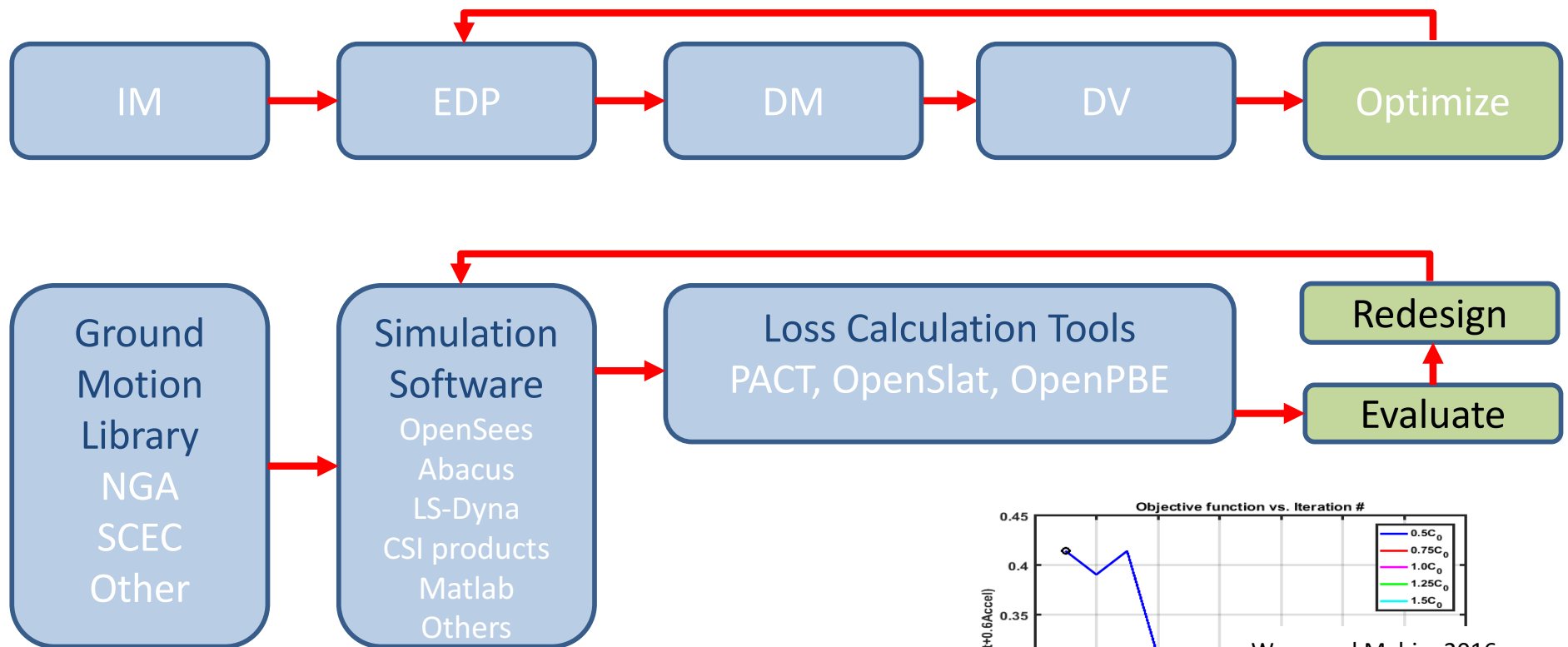


Characterizing effects of uncertainties in theoretical constructs, numerical models, procedures & parameters, analysis methods, etc.

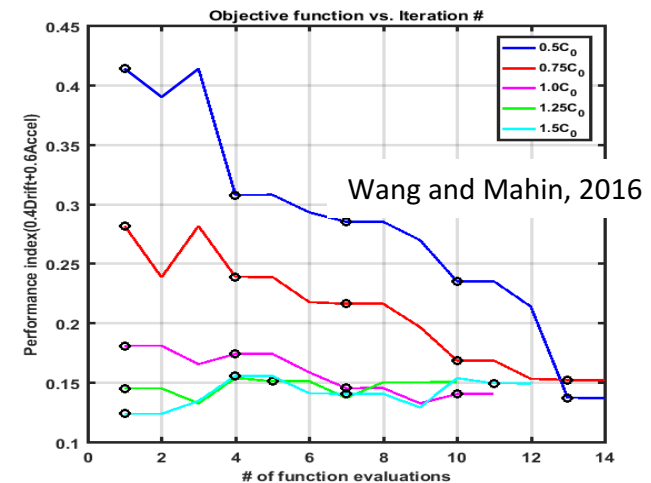
Support for Blind and Insightful Analysis Contests



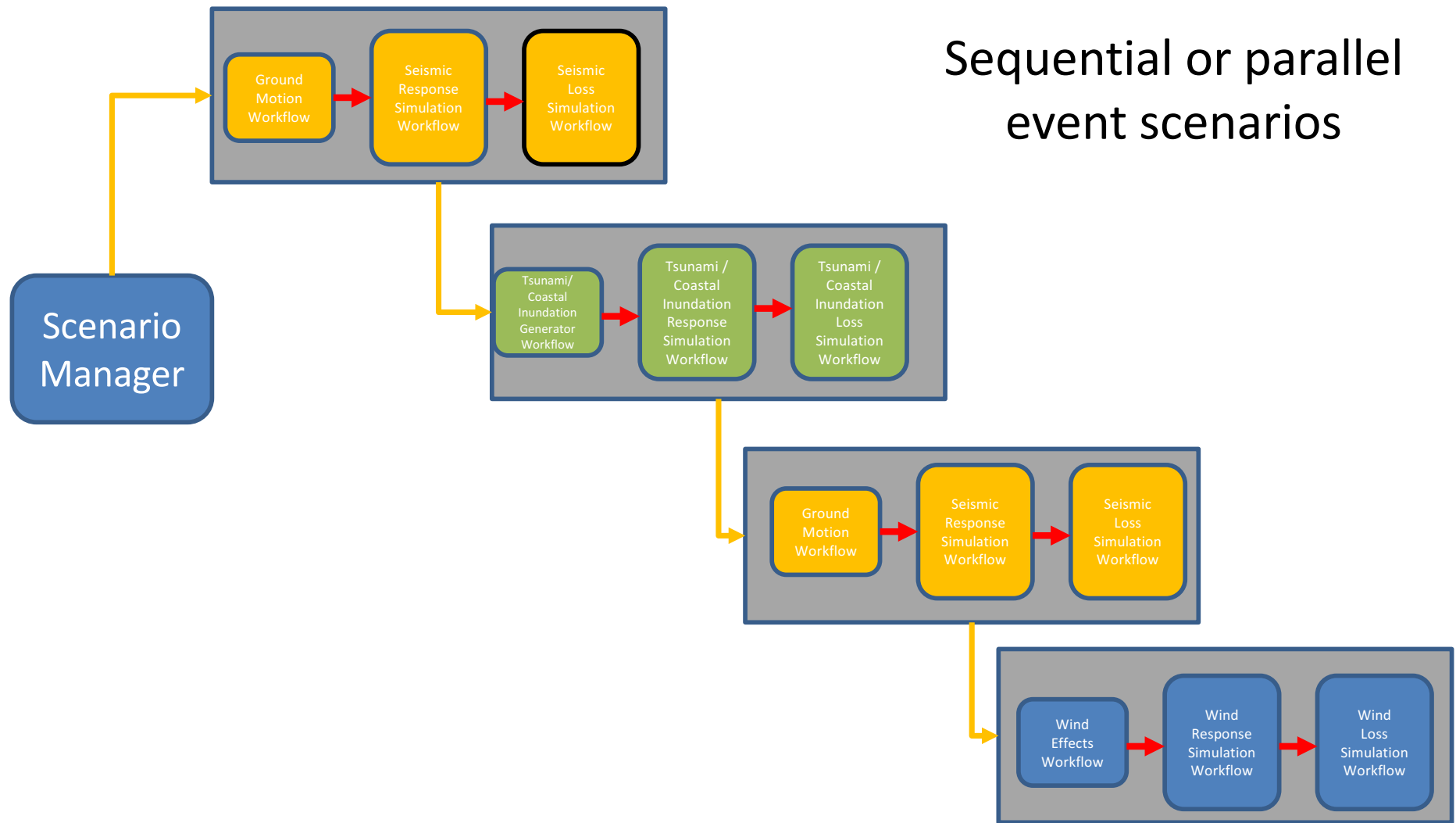
Simplified PBE Work Flow



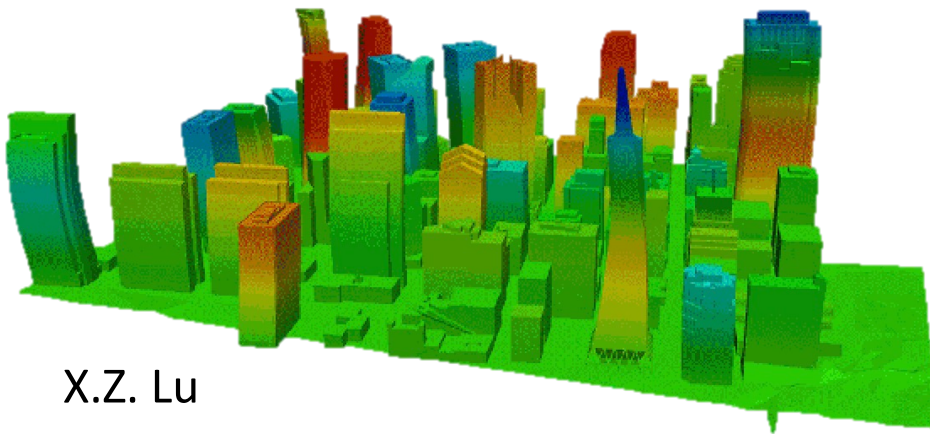
Optimize design decisions to achieve EDP criteria, maximize return on investment, minimize repair costs or down times, etc.



Enabling complex workflows

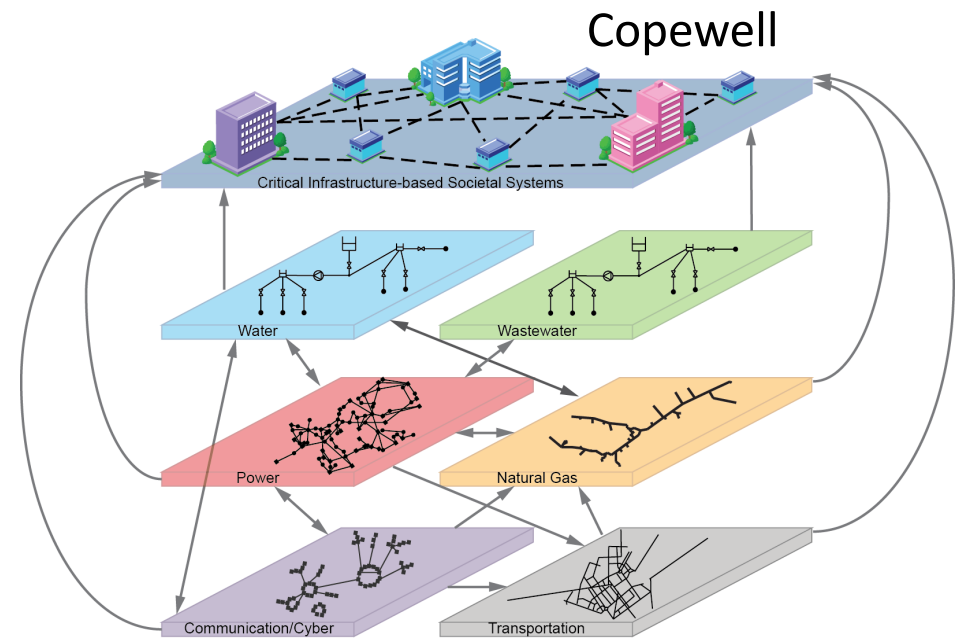


If you can do this for one facility



X.Z. Lu

Portfolio and community simulation models

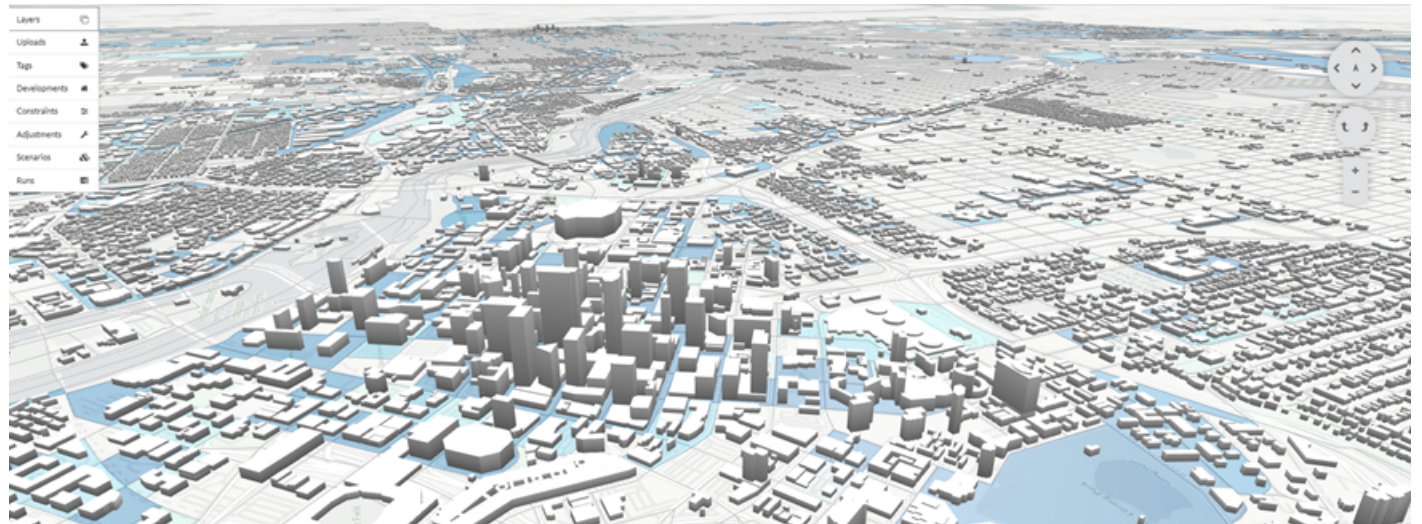
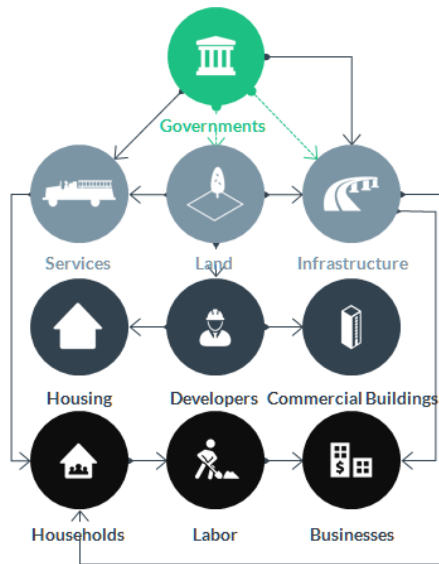


Lifeline, supply chain and service networks

Integrated Tools to Develop and Evaluate Community Sustainability Plans

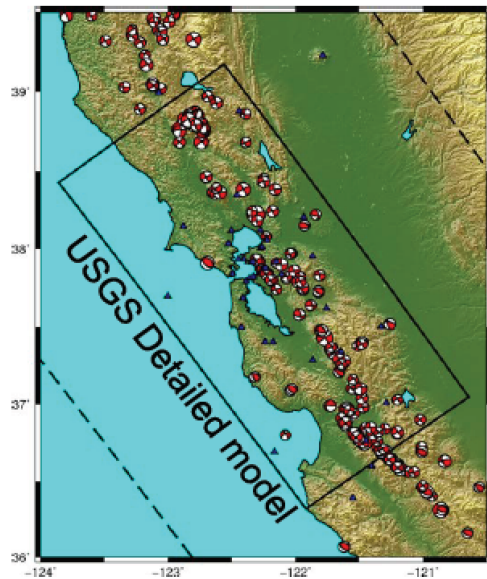
UrbanSim:

A simulation platform for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment.

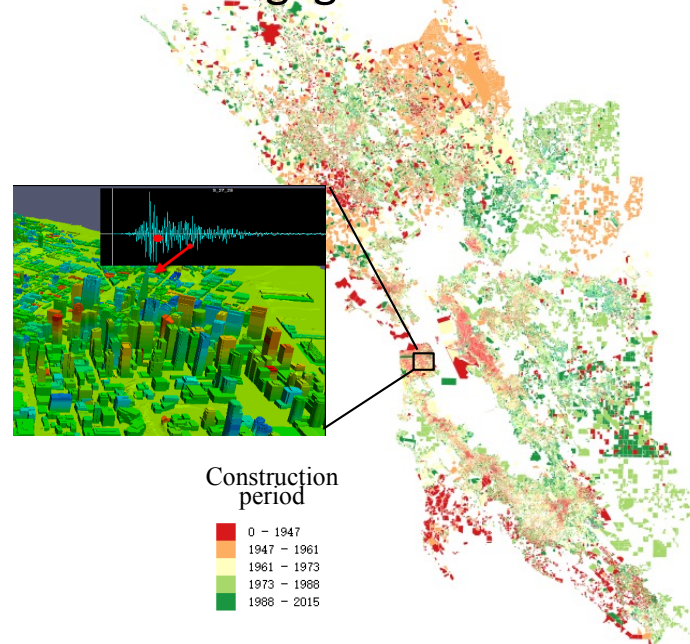


PBE Regional End-to-End Testbed

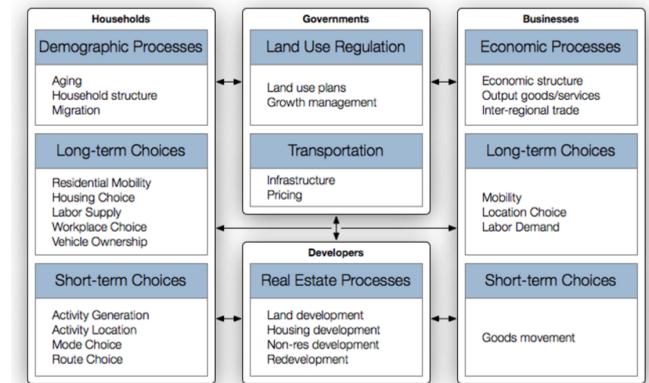
Objective: develop and execute a workflow to connect software models and systems on a challenging computational model that engages a broad cross-section of the NEHRI community



M7.0 Hayward Fault



1.8 million buildings in SF Bay Area

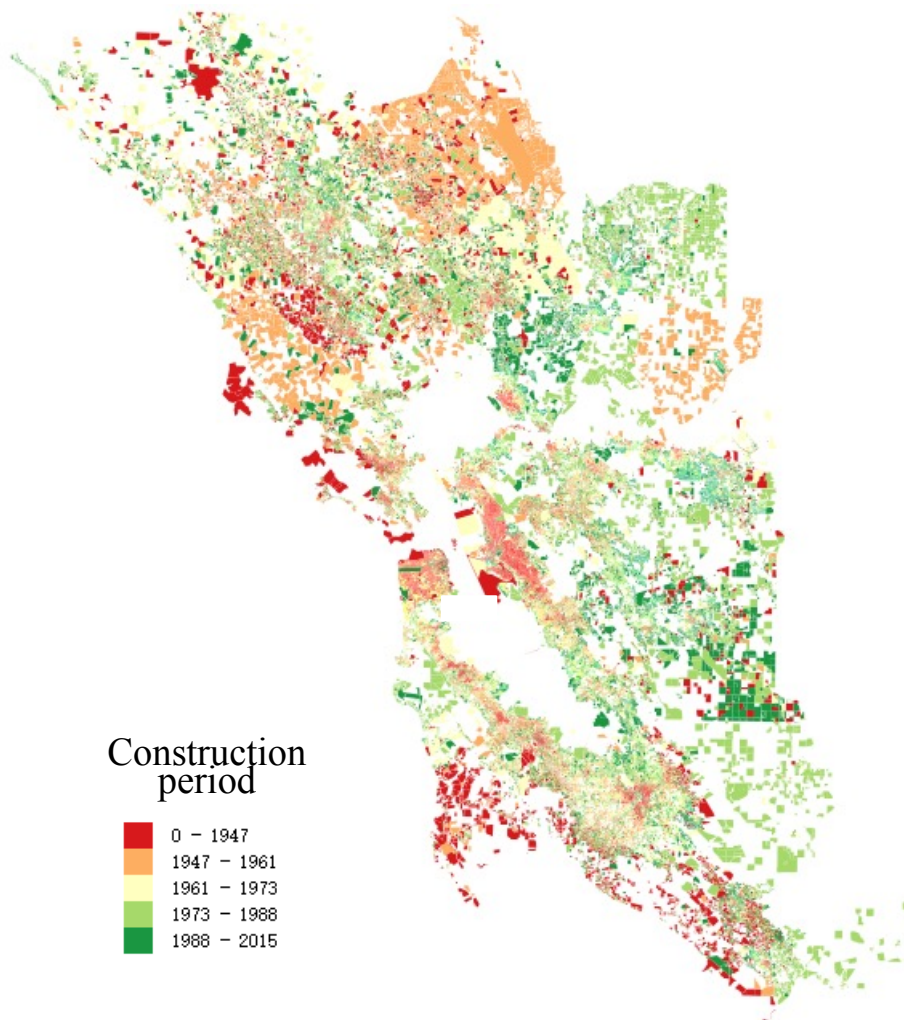


Policy/Planning decision support:
*building losses & downtime in
2010 and 2040*

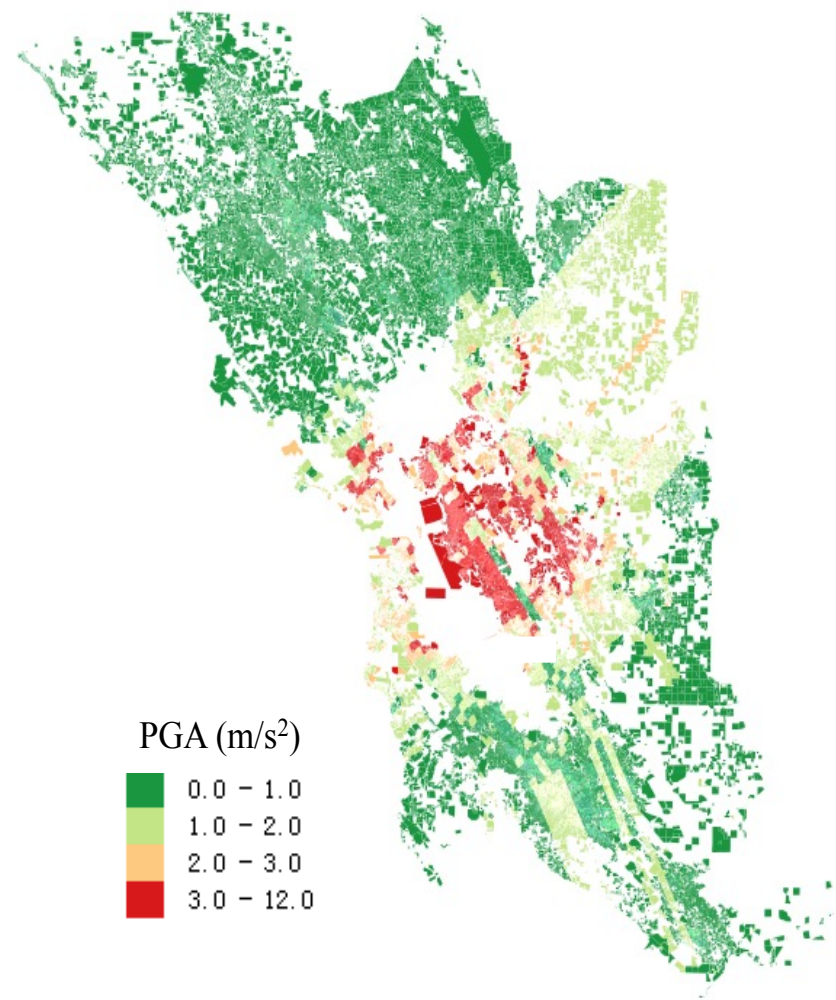
Ground Motions: 3D simulation by LLNL
Building Inventory: UrbanSim and DataSF Portal
Building Analyses: OpenSees, FEMA P58 (w/Cheng & Lu, Tsinghua)
Visualization: UrbanSim, Urban Polygon Modeling (Xiong et al., 2015)
Interpretation: UrbanSim (urban growth, damage/loss, displaced population)

Pegasus
Workflow
Tool

Sample Input Data

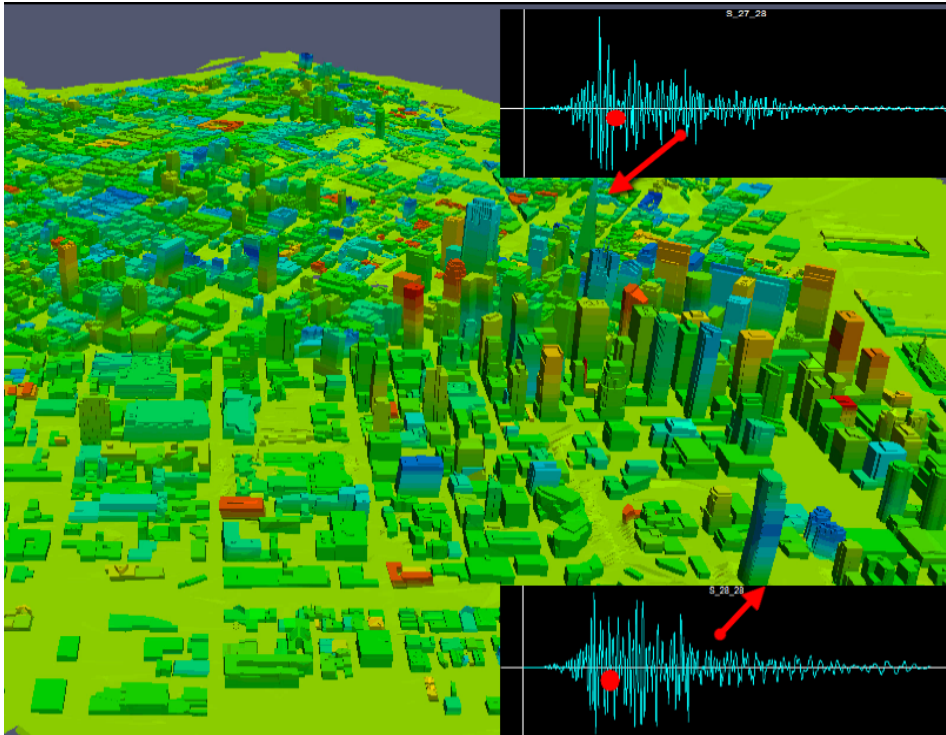


Building Inventory – by Age

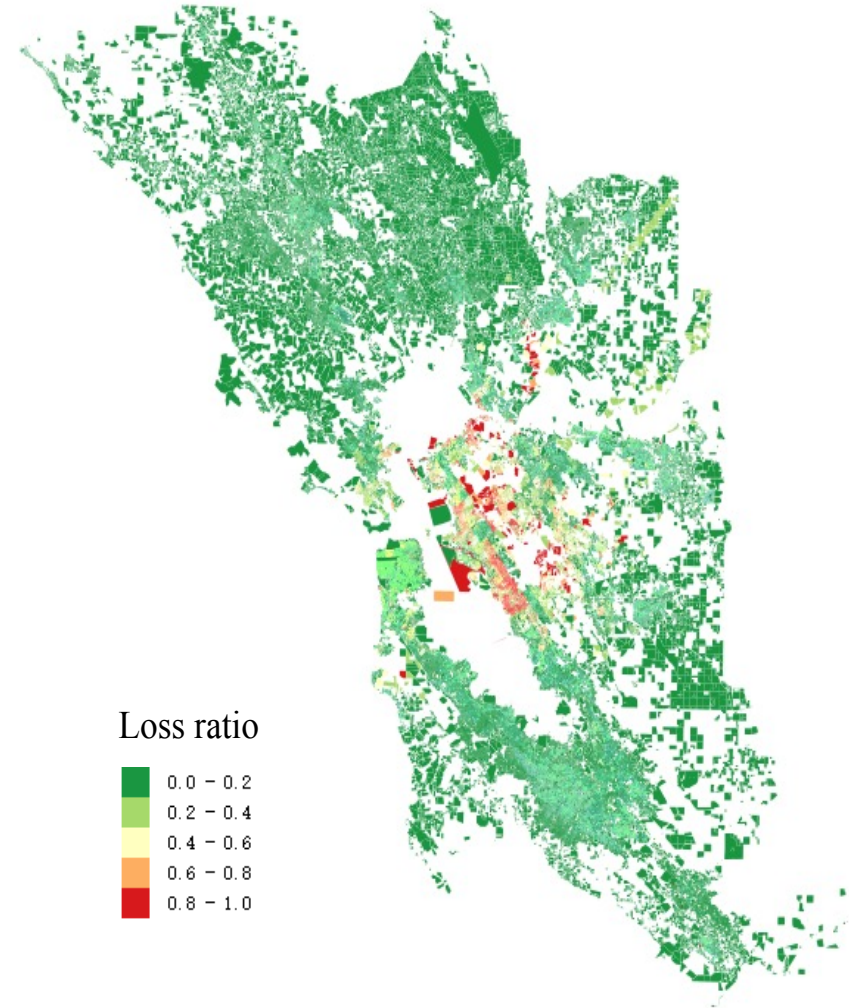


Ground Shaking Intensity (PGA)

Sample Output

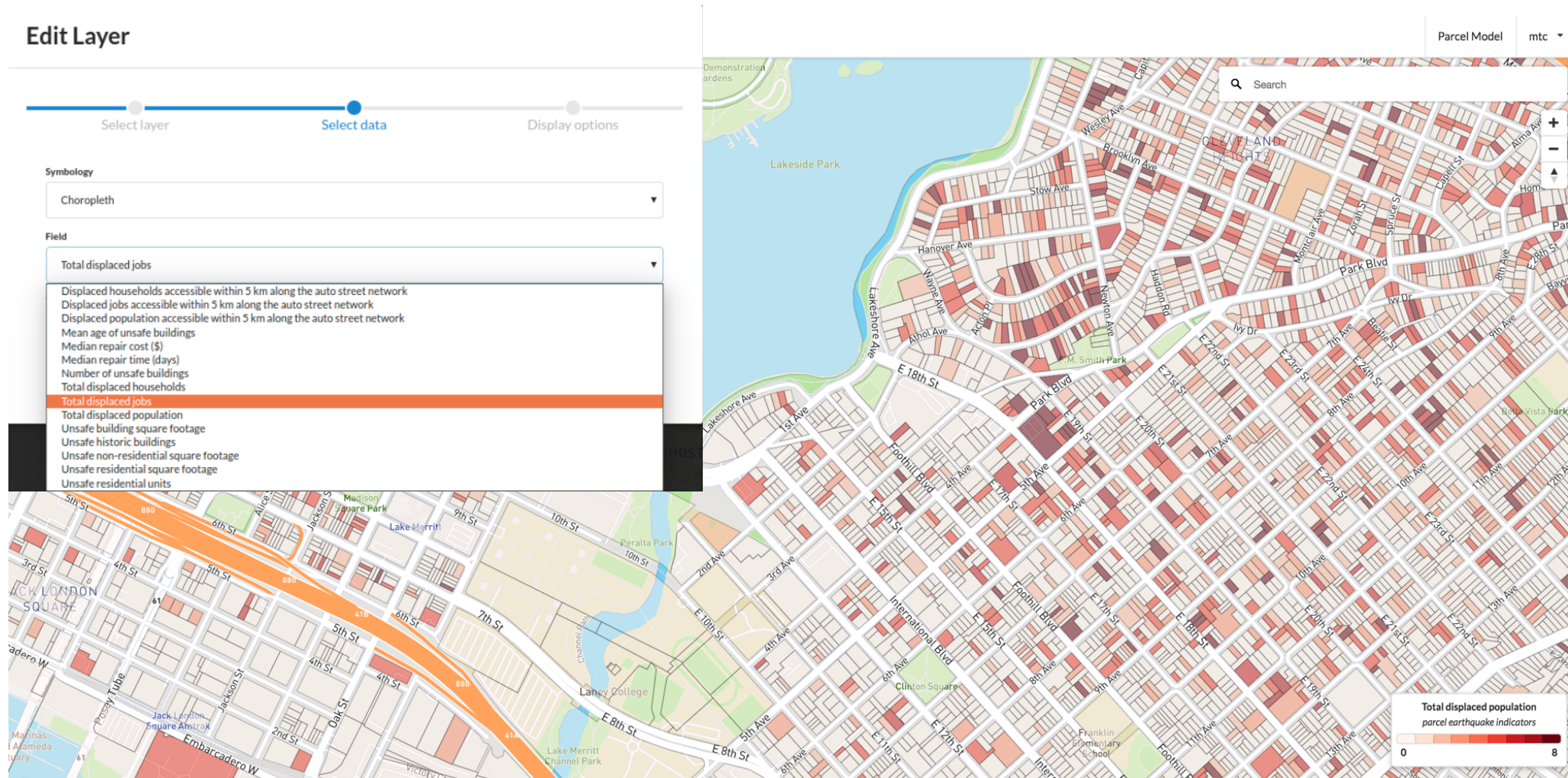


Building Demand Parameters



Building Loss Ratio

Sample Results - UrbanSim Output



Displaced Population in Residential Construction
(person/parcel; Oakland, Lake Merritt Area)

Software As A Service

Researcher



User

Researcher developed application or educational modules

User

Discovery Workspace

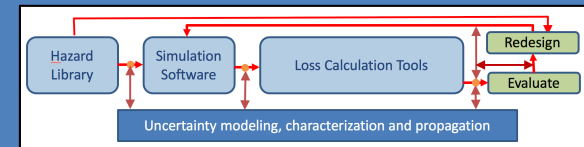
Platform Independent Front Ends

Interacts with User
Define model parameters & workflows
Communicates with SimLab Framework
Manage execution
Display results

AGAVE
restful
interface

SimLab Back End Applications
Communications with Users
Creates models
Manages workflow
Returns results

DesignSafe-CI



Yours
Others



Cloud Systems



High-performance Computers

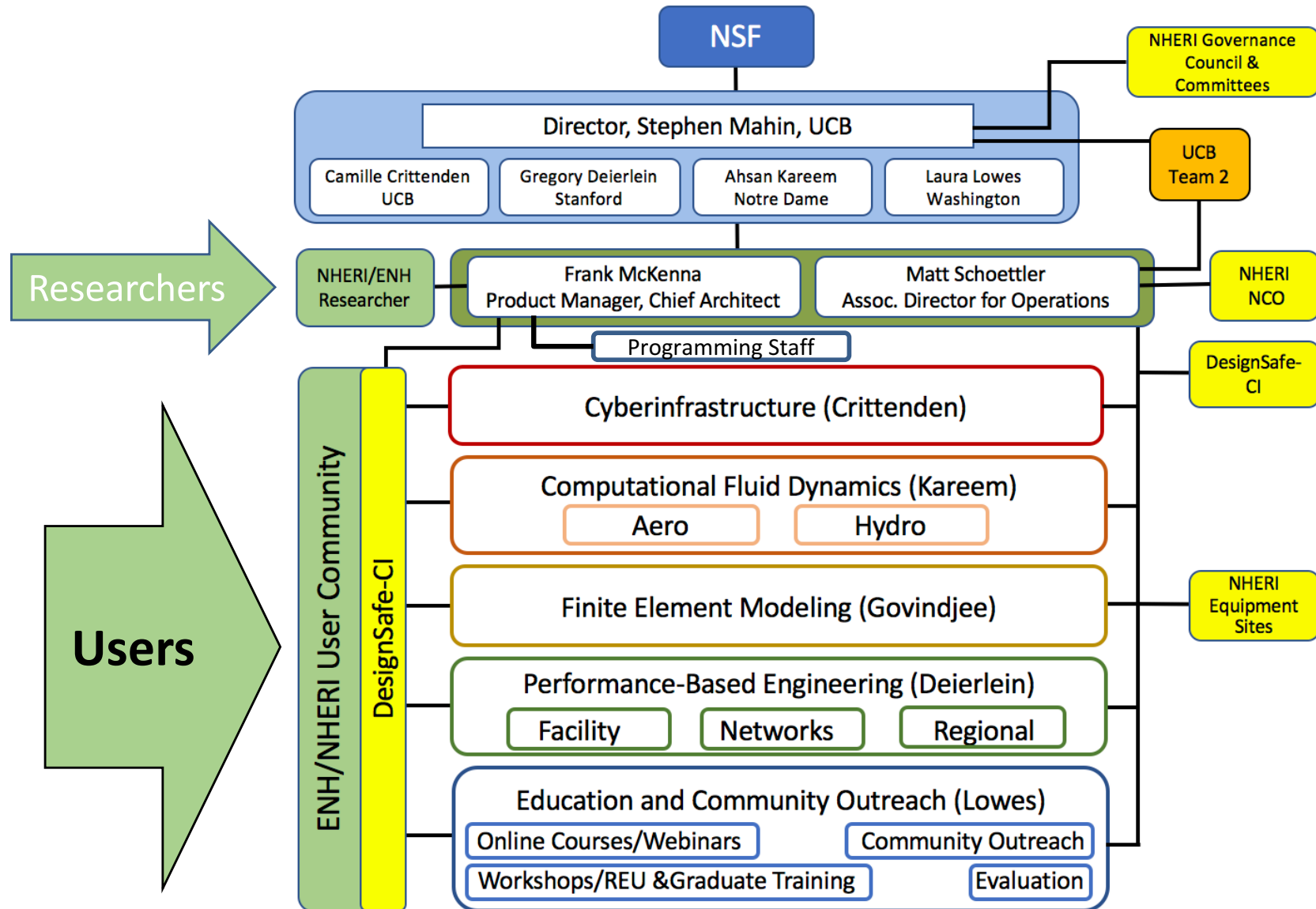


Databases



Storage

Organizational Chart



Let us help you achieve your modeling and simulation goals

- Point of “initial” contact: Matt Schoettler
- We can provide advice on:
 - Proposal Development using SimCenter Framework and Software
 - Carrying out your research using SimCenter provided tools
 - Modifying and enhancing existing tools or adding new ones
- Residencies
 - Send your students/post-docs to work with us
- Assistance with adding your software to the SimCenter Framework
- Partnering: Let us help you
 - Develop specialized APIs
 - Modify, develop or implement your software, databases, workflows to take advantage of HPC and the SimCenter Framework
 - UX and AI development
 - Modifying/extending the Framework to meet your specific needs
 - Integrating SimCenter testbeds into EF tests
 - Ask us what you need....

Thank you!

Questions?

For more information contact:

Matthew Schoettler

nheri-simcenter@berkeley.edu

schoettler@berkeley.edu

559-349-0138

The SimCenter is funded by NSF under Cooperative Agreement CMMI 1612843. Material in this presentation represents the findings and opinions of the authors, and not necessarily those of the NSF.