Outline

Common SimCenter Applications Features
EE-UQ
Common Features

1. Workflows
2. UQ
3. Run in The Clouds
Business Workflow: “Progression of steps (tasks, events, interactions) that move something from an initial state to a final state. In a sequential workflow, each step is dependent on occurrence of the previous step; in a parallel workflow, two or more steps can occur concurrently.”
Implementation Details

The SimCenter is providing a framework that will enable workflow applications to be built that will enable research in Natural Hazards engineering. The framework will allowing researchers with different applications to work together to build more powerful applications.
Existing Applications of course do not of Course work together

SimCenter defining interfaces they must meet!
And Writing Code to incorporate Existing Applications into Workflow

Additional Data Needed not part of Interface
Input File for Regional Earthquake Simulation
"Events": [
  {
    "EventClassification": "Earthquake",
    "EventApplication": "LLNL-SW4",
    "ApplicationData": {
      "pathSW4results": "/Users/fmckenna/NHERI/Hayward7.0/",
      "filenameHFmeta": "/Users/fmckenna/NHERI/Workflow1.1/createEVENT/HFmeta"
    }
  }
],
"Modeling": {
}
},
"Events": [
  {
    "EventClassification": "Earthquake",
    "EventApplication": "SHA-GM",
    "ApplicationData": {
      "scenarioConfig": "/HayWired7.25.json"
    }
  }
],
"Modeling": {
}
SimCenter applications are in actuality **Scientific Workflow Systems**

- They provide an interface to allow users to select from different applications to run in a scientific workflow.
- The interface also allows users to specify specific inputs, schedule and run the workflow, and to monitor the progress.
- They allow the user to utilize their own application in the workflow.
e.g. EE-UQ Presents Users With a Lot of Options
allows User to Mix and Match

Chain a set of applications into a building workflow

**Workflow 1**
- MDOF
- Seismic Hazard Analysis
- OpenSees
- DAKOTA
- Standard Earthquake

**Workflow 2**
- MDOF
- Stochastic
- OpenSees
- DAKOTA
- Standard Earthquake

**Workflow 3**
- OpenSees
- Stochastic
- OpenSees
- DAKOTA
- User Defined
Common Features

1. Workflows
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“An estimate without a standard error is practically meaningless”

source: “Theory of Probability”, Thomas Jeffers
“Today, however, the phenomena and processes we ask computer models to predict are of enormous importance to critical decisions that affect our welfare and security—concerning, for example, climate change, the performance of energy and defense systems, the biology of diseases, and the outcome of medical procedures. With such high stakes, we must insist that the predictions include concrete, quantifiable measures of uncertainty. In other words, we must know how good the predictions are.”

source: “Computer Predictions With Quantified Uncertainty”, Tinsley Oden, Robert Moser, and Omar Ghattas
the SimCenter Applications ARE NOT Deterministic Applications

i.e. they not produce a single output result for every response parameter

they ARE UQ Applications

i.e. for each output response they produce information on the response and some measure on the uncertainty in the computed response, e.g. mean and std. dev
Because they are UQ applications

User has to identify certain parameters as being Random Variables

User then has to define the Distribution associated with these Random Variable
Common Features

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To generate UQ requires more computation – applications enable cloud based computing

• they can run these computations in parallel using the cores of your local computer;

• they also allow you to run the simulations through the Cloud on the HPC resources provided through DesignSafe-ci.
How Do We Do This?
EE-UQ is split into 2 applications:

- **Front End UI**
- **Backend Workflow**

- Front end is an application runs on your desktop
- Backend workflow applications run on either your desktop or HPC at TACC
Outline

Common SimCenter Applications Features

EE-UQ
Purpose: To Determine Response of a Building subjected to an Earthquake Event

Unique Features
• Uncertainty Quantification
• Local or Remote Execution
• Ground Motion Selection
e.g. EE-UQ Presents Users With a Lot of Options
Models

Model

MDOF
Shear Building Model

OpenSees
Provide OpenSees input file
Ground Motion Selection

Event

- **PEER**: Provide list of PEER ground acceleration (.AT2) files
- **SHA**: For specified location obtain ground motions
- **Site Response Analysis**: Given motion at rock, propagate motion to surface to obtain input motion
- **Stochastic**: Given input parameters, generate synthetic ground motions
- **SimCenter**: Provide list of SimCenter Motions
FEM Options – fe code that performs analysis

FEM

specify analysis options (integration scheme, convergence test, ..)
UQ Engine

1. Specify UQ method (forward propagation of uncertainty)
2. Specify random variable distribution
Engineering Demand Parameters (the Response Quantities of Interest)

EDP

- Standard Earthquake
- User Defined