NEESgrid: System Overview

Carl Kesselman, USC/ISI
Chief Architect, NEESgrid

Director
Center for Grid Technologies
USC/Information Sciences Institute
The Role of the NEESgrid System Architecture

- Define the core capabilities of NEESgrid
- Facilitate interoperability, extensibility and scalability
- Provide a foundation on which the diverse NEES usage scenarios can be supported
  - Not single point solution
Architecture Approach

- Common infrastructure that can be used across all NEES applications
  - Balance generic mechanisms, extensibility for future growth, efficiency for application specific tasks
- Validate against user requirements
  - Input from user requirements analysis
  - MOST, EBD build on proven technology base
NEESgrid and the Grid

- Grid is infrastructure to support
  - Data sharing, numeric simulation, remote observation and control, collaboration

- Maps well into NEES requirements
  - Similarity of problem space and objectives

- Synergistic with many other projects
  - E.G. SCEC, ETF, …
  - Minimizes risk
Open Grid Services Architecture

- Builds on Web Services technology
  - A Grid service is a Web service with extras
- Significant industry buy in
  - IBM, HP, Oracle, SGI, …
- High-quality open source implementation
  - Globus Toolkit®
NEESGrid and NSF Middleware Initiative

- CISE program to harden, test and support national middleware infrastructure
- Significant NMI presence in Grid space
- Plan to eventually fold NEES specific services into NMI releases
Software Components

■ Extant software
  – particularly significant elements of the NSF Middleware Initiative (NMI) software system

■ Custom software to address general NEESgrid issues
  – Produced by SI team

■ Site-specific, and application specific software
  – to be produced by the equipment sites, other NEES participants, or other sources.
Physical Elements

- A moderate number of *equipment sites*,
- A moderate number of *resource sites*,
  - data repositories and/or computer systems
- A potentially large number of *users*
  - including earthquake engineers, students, and others.
- Campus and wide area *networks*
- An *operations center*,
  - provides monitoring and diagnostic facilities for NEESgrid as a whole
NEESgrid Core Capabilities

- Tele-control and tele-observation of experiments
- Data cataloging and sharing
- Remote Collaboration and visualization tools and services
- Simulation execution and integration
NEESgrid High-level Structure

- **NEES Equipment Site**
  - Local computers & storage
  - NEES POP
  - Shake table with instrumentation

- **Wide Area Network**
  - Gigabit Ethernet
  - Edge Router
  - > Gb/s WAN

- **Equipment Site**
- **User Site**
- **Resource Site**
- **NEESgrid Operations**
Centralized NEES-Wide Services

- NFMS
- NMDS
- GridFTP

Data Management

Central Data and Metadata Repository

- MyProxy
- CAS

Credential Repository

Community Authorization Server

- MDS

Information (Index) Server

- HTTP

CHEF web portal

NEESgrid
Non-Centralized NEESgrid Services
Architecture of NEESgrid Equipment site.
Globus Toolkit V3

- High quality open source OGSI implementation
  - Developed by The Globus Alliance
- Commercial support available
- Globus services include:
  - Security
    - Authentication and authorization
  - Status and configuration
  - Resource management
  - Data services
    - Data movement
    - Data access
NEESgrid Software Stack

Browsers/User Interfaces

Applications/CHEF

Programming Interfaces (Java, C APIs, Matlab toolboxes, OpenSEES…)

NTCP
GridFTP
Other Globus Services
Computational Services
NSDS

Plugins
OGSI Core

RBNB
NEESgrid Core Data Transfer Components

- NEESgrid data transfer for both experiments and simulations is achieved through a forked data path.
  - Streaming Data (for live viewing during events)
  - Transfer to Repository (for guaranteed storage and retrospective access)
- The “Transfer to Repository” path is well-defined and in place; equipment sites are installing and customizing our implementation through our EBD process.
- The “Streaming Data” path is currently being redesigned following successful implementation and use in early experiment and EBD activities.
Transfer to Repository

- The NEESgrid Repository (running on the NEES-POP) mandates conventions for data collection from simulation components and physical DAQ implementations.
  - Shared filesystem (e.g., NFS, Samba)
  - File location and naming conventions
  - File format conventions
- The Repository’s Data Ingestor detects new files and ingests them into the repository with appropriate metadata.
Tele-Control Services

- A single, transaction-based protocol and service (NTCP) to control physical experiments and computational simulations.
- OGSI based implementation (GT3.0)
- Plug-ins to interface the NTCP service
  - A computational simulation written in Matlab
  - Shore Western control hardware
  - MTS control hardware (via Matlab and xPC)
  - Labview
  - C
- Security architecture, including GSI authentication and a flexible, plug-in-based authorization model.
Plug-in approach
Programming Interfaces

Applications
- Matlab/Simulink Application
- ICES Application
- OpenSEES Application

High-level APIs
- Matlab/Simulink Interface
- ICES Interface
- OpenSEES Interface

Low-level APIs
- NTCP APIs

NEESgrid
NEESgrid System Summary

- Data, simulation, collaboration, visualization, teleoperation/control, delivered via
  - APIs and tools for users
  - Services and interfaces at equipment sites
  - Services and interfaces at resource sites
  - Management services for operation

- Demonstration via MOST and EBD
  - Used to evaluate and refine capability

- System software converging on versions for handoff to consortium
Hybrid Experiments

Computational Simulation

Control / Data Acquisition System

Physical System
The MOST Substructures

UIUC Experimental Model

NCSA Computational Model

U. Colorado Experimental Model

Slide courtesy of Bill Spencer and Narutoshi Nakata, UIUC
MOST Components

Colorado

NTCP Server

Mplugin

Matlab (xPC host)

Matlab (xPC target)

Mplugin

NTCP Server

NCSA Simulation

NCSA

Coordinating Simulation

NTCP Server

Shore-Western Plugin

UIUC
The MOST Event