Model-Centric Smart Grid: Modeling as a Community with Model Servers

Robert Broadwater

Stephanie Hamilton

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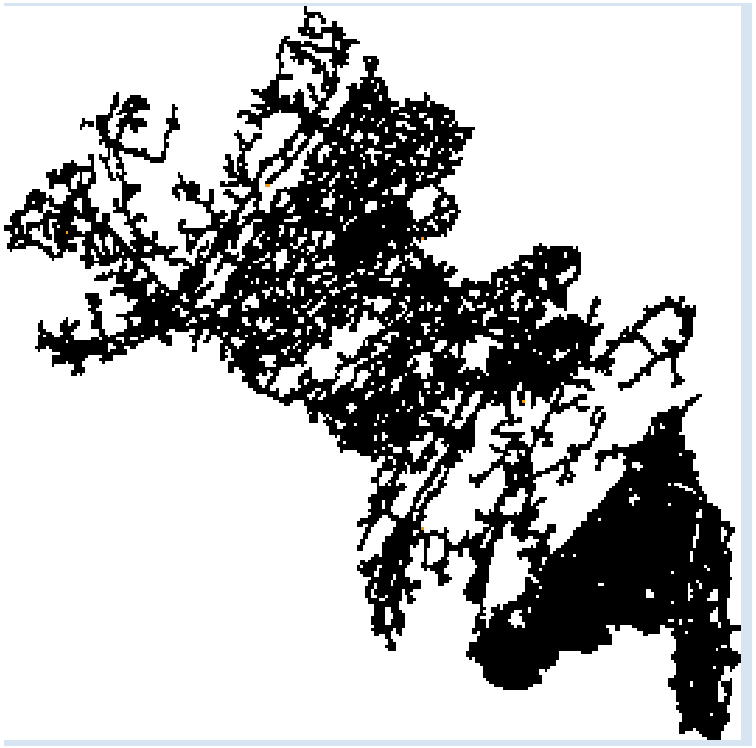
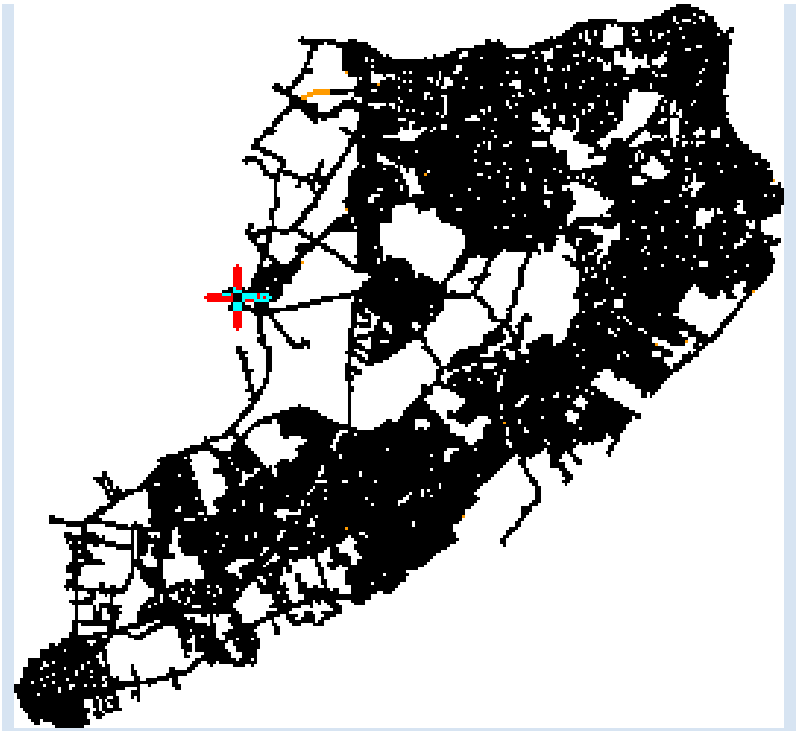
Integrated System Models



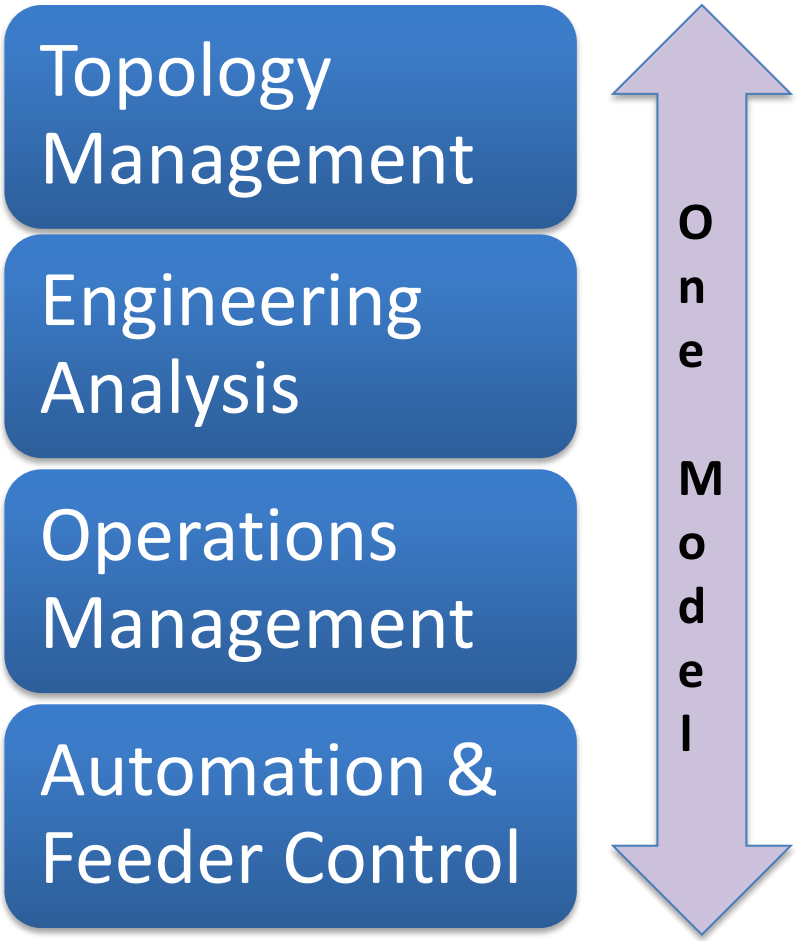


Merge many existing models together, relating all measurements in context of ISM

Robert Broadwater, dew@edd-us.com

BNL ISM Demo

Model Centric Smart Grid



Integrated System Model: manufactured model

Requires continuous effort to fix errors from other models, SCADA measurements and others

Model for holistic solutions, not point or scenario based solutions

Community Model that is Shared

- ISM *maintained in memory 24x7*
  - Planning model server
  - Real-time model server
  - Automation of analysis
- Brookhaven National Laboratory Model Server
  - Multi-organizational research
  - Shared models from around the world
  - Shared experimental measurements

Demo of BNL Model Server on IEEE 39 Bus Transmission System and 123 Bus Distribution System

Graph Trace Analysis

- GTA derives from generic programming, where containers storing data to be processed offer iterators to algorithms
- In GTA topology is knowledge owned by objects in the form of "***topology iterators***"
- With topology changes (e.g., switch operation or equipment failure) updating topology iterators is a constant time process independent of system size
- Algorithms are written in terms of topology iterators

Model-Centric Concepts

- ***"manufacture the analysis model"***
- ***"the best equivalent is no equivalent"***
  - ***"avoid scenario based or point solutions"***
- ***"push algorithms to data"***
- ***"design for time varying conditions"***
- ***"couple time series engineering analysis with economics"***
- ***"automate analysis"***

Model-Centric Smart Grid Course

- Course meets for 2 hours per week over the Internet for 16 weeks – 3.2 CEUs
- Proposed cost is $1500 per student
- Full time university students can attend free with a sponsoring, paying attendee

Model-Centric Course Major Topics

- ISMs, GTA, and model-centric paradigm shifts
- Distribution automation and control
  - Model-based
  - Economic justification
- Analyzing renewable generation
  - Managing big data
- Holistic analysis of transmission and distribution
  - Unbalanced transmission system analysis
- Flow control with Distributed Series Reactances

Next Steps?

- Proposed model-centric smart grid class as a stepping stone to enabling model server collaborations
- Volunteers who would like to add models to the BNL Model Server
- Research projects that would benefit from sharing data (attached to system model) that results from experiments
  - Smart inverter system testing
  - Microgrid testing
- Sharing of economic justifications based on smart grid data sets (AMI, PMU, 1 sec PV generation)

Model-Centric Smart Grid

- Intelligence derives from measurement-driven calculations run on *one-to-one replica* of system
- "Aha" understanding and insight
- Evaluate alternative designs against policy goals
- Precise economic measurements (of incremental investments)
- System testing of new devices prior to field pilot projects

Model-Centric Smart Grid Courses

- Each course is targeted toward a specific topic of interest
  - Hard dollar economic justification of distribution automation
  - Analysis of large scale PV generation adoption
  - Flow control with Distributed Series Reactances
- Each course meets approximately 2 hours per week for 10 weeks – 2.0 CEUs
- Proposed cost is $1500 per student
- Full time university students can attend free with a sponsoring, paying attendee