The Evolution of Planning Software

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GE Energy Consulting

Since the early 1900’s our consulting team has provided industry expertise on:

Studying and understanding the economic and physical operation of electric power systems including generation and grid planning, system optimization, asset valuation, competitive power markets, and energy policy implications.
Concorda Suite from GE Energy

Comprehensive software for power systems planning

**PSLF**
performs fast and accurate analysis of large-scale power systems using a powerful load flow, dynamics, and short circuit simulation engine.

**MARS**
provides accurate generation system reliability assessments and is widely used for ensuring system resource adequacy.

**MAPS**
allows highly detailed generation and transmission modeling while performing full nodal and zonal economic analyses.

For more information please visit www.ge-concorda.com or email us at concordasuite@ge.com

GE imagination at work
Planning Trends – A Complex World

- Intermittent Resources
- Market Drivers
- Transmission Build out
- Generation Build out
- Operating Conditions
- Area Load
- Regulatory Drivers
- Demand Response

Planning Models
Planning Trends - How we see things changing?

**Availability of data** – Obtaining good, consistent data from sources is becoming increasingly difficult

**Larger scope and size** - ISO’s are performing large-scale analysis and inter-ISO planning groups are forming (FERC Order 1000)

**More uncertainties** – Driving towards simulation of exhaustive scenario lists...places premium on execution performance

**Diverse applications** – No longer involving single application analysis...multiple applications interacting to determine results...close coupling of applications and focus on usability is valuable

**Compliance standards** – Reliability organizations are demanding higher fidelity models, consistent data, and more detailed analysis. Examples: small signal analysis and comprehensive contingency analysis.
Planning Software Trends

Advanced modeling
Integration of demand response into simulations/modeling
Advanced load modeling (single-phase load representation)
New HVDC models

Renewables modeling
Large-scale integration analysis
Accurate modeling of dynamic response of renewables
Environmental modeling

Market modeling
Participant behavior modeling
Ancillary services modeling
Economic transmission planning
Value of demand response and dynamic pricing
Portfolio optimization
Load as a market participant (PHEV, appliances, etc.)
Impacts of renewables on market prices

Data Visualization and Exchange
GIS visualization of results
Advanced/customized data searches
Standard exchange formats
Tighter EMS integration

Simulation Performance
Parallel Computing
Sensitivities/scenarios increasing
Contingency lists increasing
System complexity increasing

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Operations to Planning Example

Breaker-Node Modeling

Bus-Branch Modeling
Planning Tools Data Model Example

Load Flow
- PSLF
  - DB1

Dynamics
- PSLF
  - DB2

Production Simulation
- MAPS
  - DB3

Reliability
- MARS
  - DB4
## Common Planning Data

<table>
<thead>
<tr>
<th>Sampling of Data Elements</th>
<th>PSLF</th>
<th>MAPS</th>
<th>MARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission equipment data</td>
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<tr>
<td>Maintenance data</td>
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</tbody>
</table>
Our HPC experience

Internal HPC for ~5 years

Used for MAPS (production simulation) and MARS (reliability simulation)

Developed commercial solutions for all 3 products (PSLF, MAPS, MARS) with licensees

Continued R&D effort
HPC Research – LLNL HPC For Energy

GE Energy Consulting

GE Energy works connecting people and ideas everywhere to create advanced technologies for powering a cleaner, more productive world. Solving our customers' toughest challenges is at the center of our business, as we build powerful partnerships that help achieve mutual growth and success. With a commitment to quality and innovation, the company continues to invest in breakthrough ideas to help our customers be more competitive and strengthen local capability to support economic growth.

Headquartered in Atlanta, Georgia, U.S., GE Energy provides a diverse portfolio of product and service solutions and deep industry expertise to help our customers solve their challenges locally. With more than 100,000 employees in over 100 countries, we serve the energy sector with technologies in such areas as natural gas, oil, coal and nuclear energy; wind, solar, biogas and water processing; energy management; and grid modernization. We also offer integrated solutions to serve energy- and water-intensive industries such as mining, metals, marine, petrochemical, food & beverage, and unconventional fuels.

Improving PSLF Simulation Performance and Capability

Today's power system planning tools simulate systems that are far larger and more complex than those just a few years ago. Advances in renewable technologies and more pervasive control technology are driving planning engineers to analyze an increasing number of scenarios and system models with much more detailed network representations. By developing and customizing GE's Concordia Positive Sequence Load Flow Software (PSLF), our software experts provide clients a comprehensive set of state-of-the-art tools to assess the economic and technical performance of interconnected power systems.

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Typical Workflow...

- Shared machines (or worse, personal machines)
- No failover if a machine dies
- Everyone works just a little bit different
- No centralized data storage
- Support challenges
Performance Benefits MAPS/MARS

MAPS HPC:
Full EI studies, with post processing, one year finishes within approximately 2 hours
Would take >70 hours on a single desktop machine

MARS HPC:
One licensee went from 16 hours to 30 minutes

PSLF HPC:
Specialized contingency analysis went from 4 hours to 7.5 minutes
Performance Benefits

Don’t decide how to trim down your study system... model it all!

Detailed modeling of neighbor interaction

Hourly resolution

Details for every component in your system
Cloud-based HPC Solutions (HPCX)

Currently performing groundwork to ID most cost effective solutions

Not tying ourselves to a specific "cloud"

Custom GUI for job scheduling

Scheduler divides work to maximize performance

Output data storage on cloud

Fast data transfer

Potential post-processing on cloud

Working on analytics for viewing results
Conclusions

The Power System is becoming increasingly complex.

New planning tools will need to be developed to support complexity.

Standards and interoperability are critical enablers.

Available data will increase exponentially...how will it be leveraged?

Market rules will likely be modified and must be reflected in tool development.

Power systems analysis is data intensive...applications need to allow easy data viewing and editing.

Developing solutions to take advantage of advances in hardware are essential.
Questions, Comments?