

# The Natural Evolution of Transmission Planning Software

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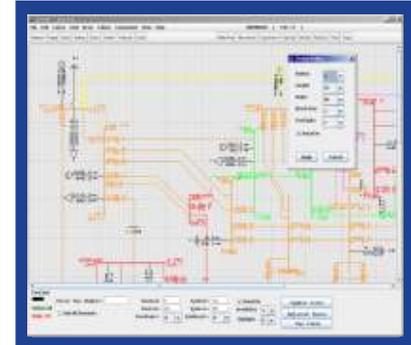
# GE Energy EA&SE



Global team  
of experts



Understand  
customer needs



Create  
solutions

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



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# GE Energy - Software Tools

## Concorda Software Suite



### MAPS

- Evaluates power system economics and impact of congestion
- Provides locational prices, unit schedules, line flows, emissions
- Used in high wind penetration and standard market design studies
- Supports economic evaluation of transmission additions



### PSLF

- Simulates physical behavior of the grid and connected equipment
- Provides voltages and line flows, system dynamic behavior
- Extensively used to study 2003 Northeast US blackout
- Mechanism for ensuring that GE equipment is properly modeled



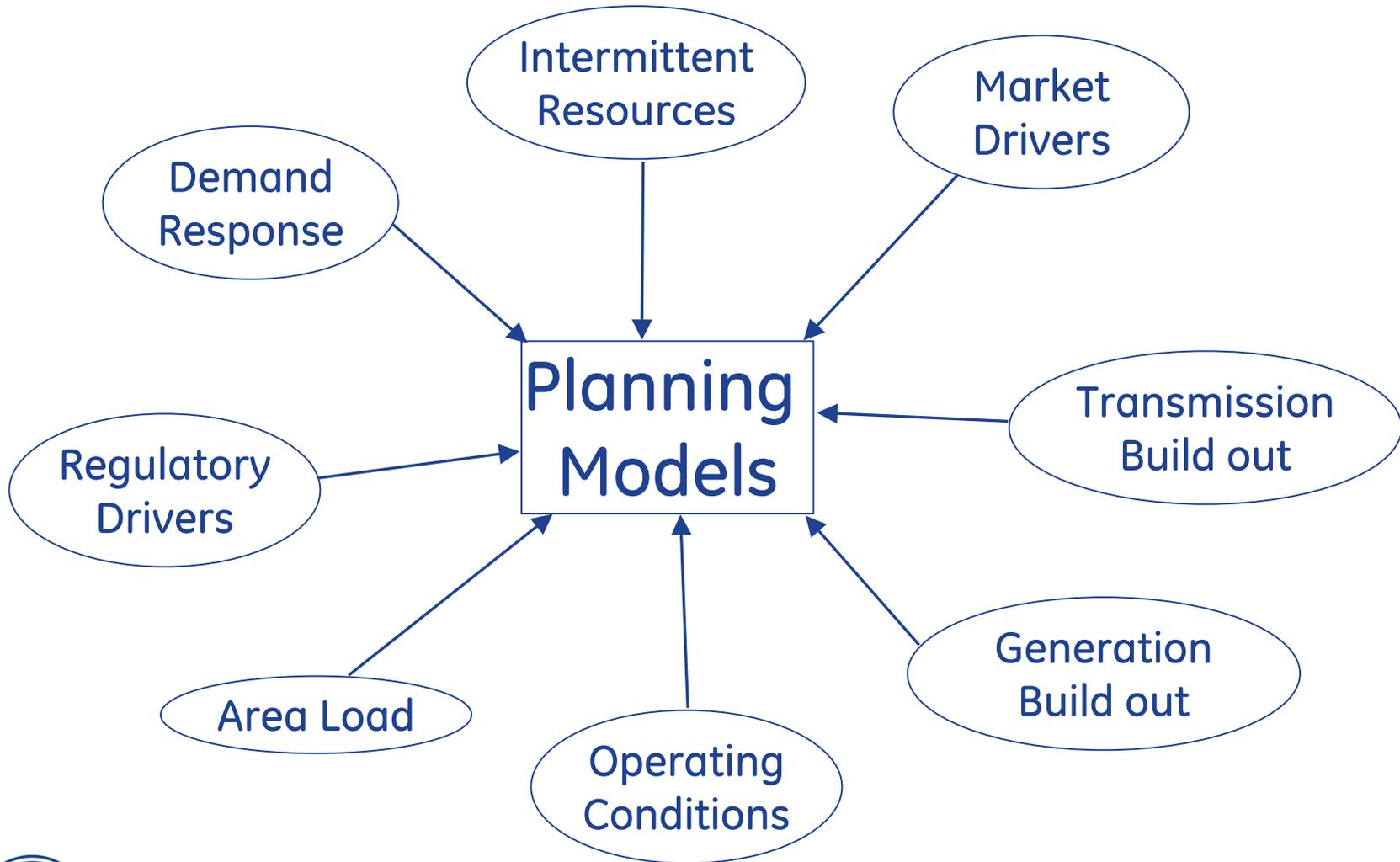
### MARS

- Assesses reliability of supply in meeting energy demand
- Provides loss of load expectation (LOLE) and other reliability indices
- Applied for major regional reliability and reserve margin studies
- In use at most ISO's in the US



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# Transmission Planning Trends



# Transmission 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

**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.

# Transmission Planning Trends

## Load modeling

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

## Renewables modeling

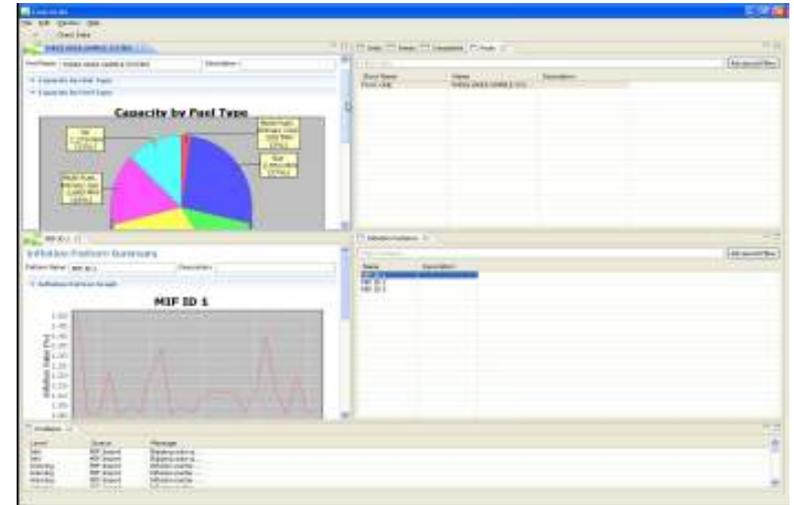
Large-scale integration analysis  
Accurate modeling of dynamic response of renewables  
Environmental modeling

## Market modeling

Least costs vs. max profit objective functions  
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



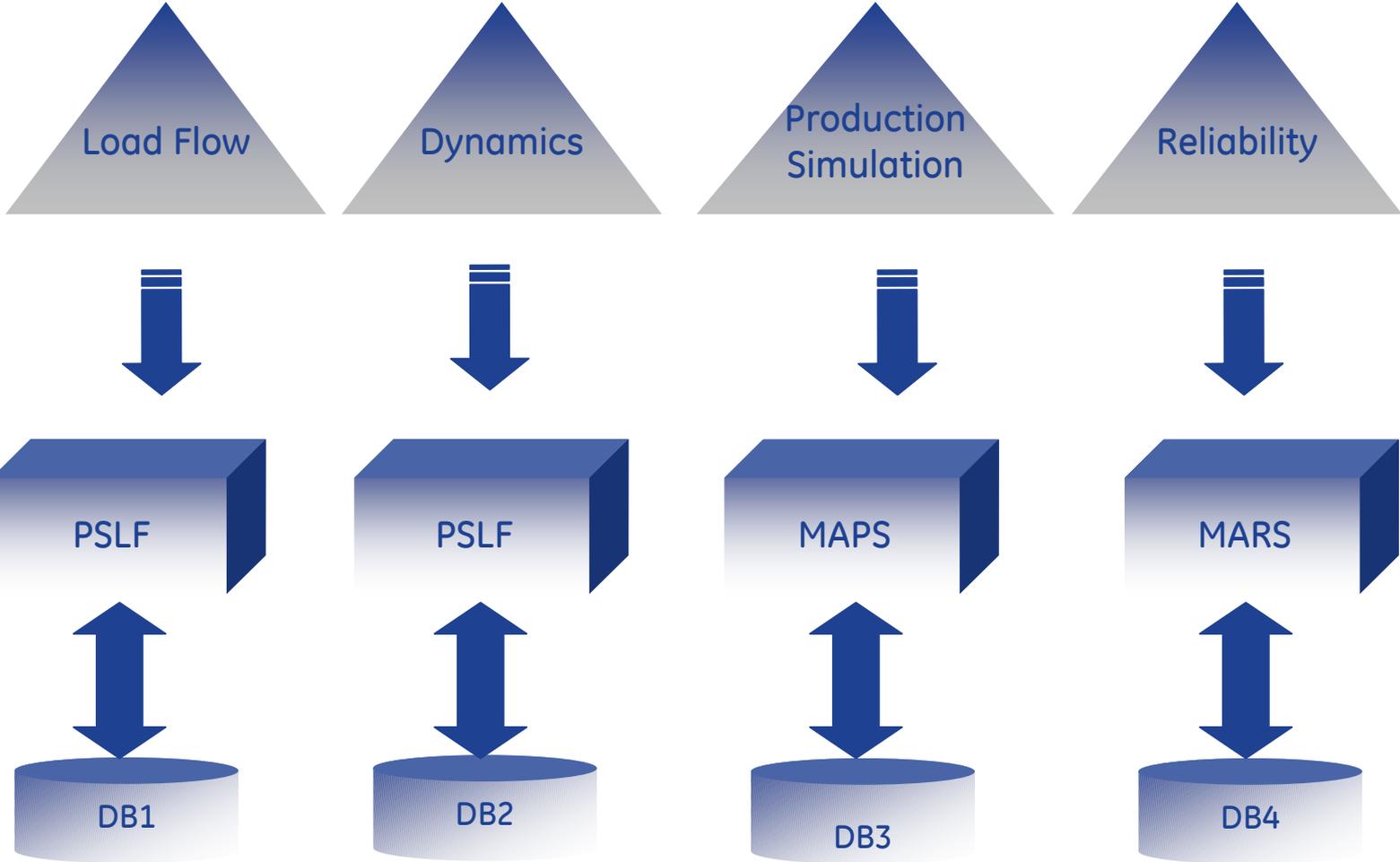
## Simulation Performance

Parallel/Super Computing  
Sensitivities/scenarios increasing  
Contingency lists increasing  
System complexity increasing



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# Power System Planning Tools



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# Common Planning Data

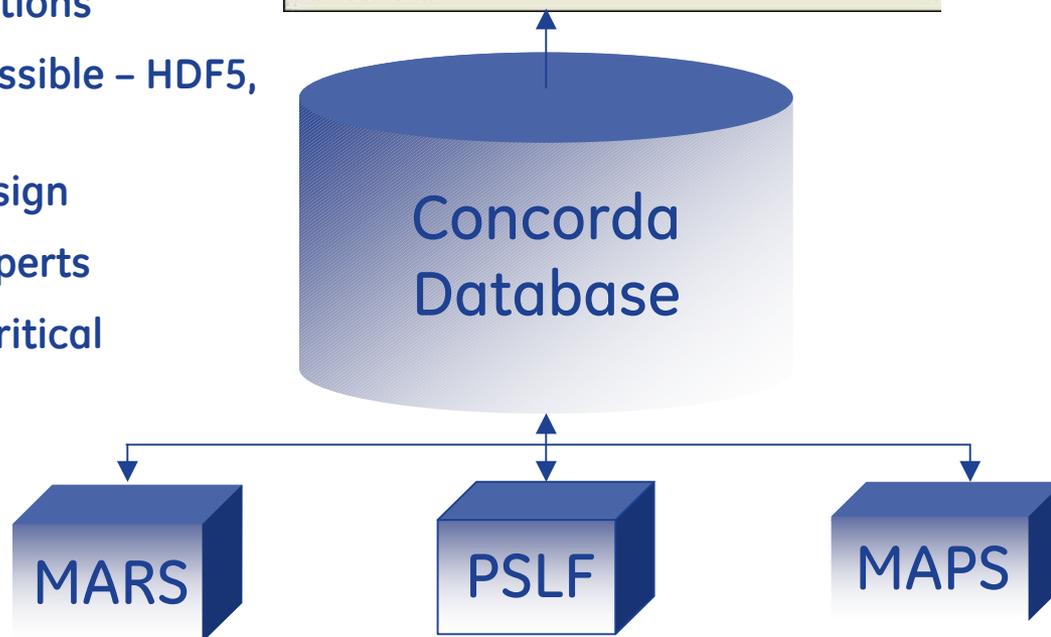
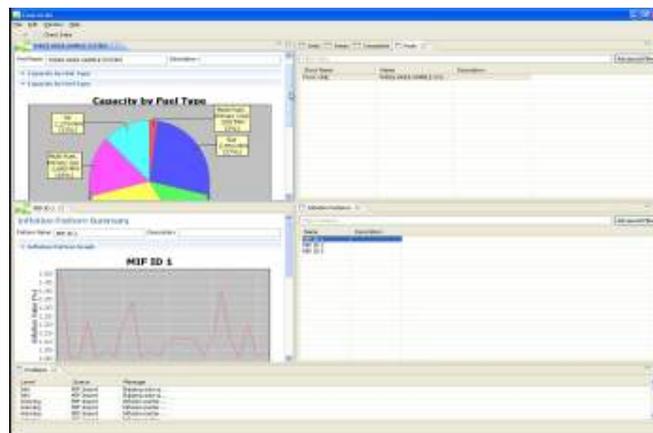
Sampling of Data Elements	PSLF	MAPS	MARS
Transmission equipment data	X	X	
Transmission topology	X	X	
Interface Limits	X	X	X
Area load data	X	X	X
Generation dispatch	X	X	X
Forced outage data		X	X
Operating nomograms		X	X
Generation data	X	X	X
Maintenance data		X	X



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# Software Development Philosophy

- Actively engage customers during development
- Build robust data model to support engineering needs
- Continue to develop and improve core algorithms to meet changing industry needs
- Model-Viewer-Controller (MVC) design philosophy
- Exploit similarities between applications
- Leverage open standards where possible – HDF5, CIM, RCP
- Embed significant flexibility into design
- Actively engage user experience experts
- Traceability and error checking is critical
- Leverage computing hardware



# Simulation Performance Activities

## GE MAPS Execution on 192 node HPC

Modeling full Eastern Interconnection - ~6,000 units, ~60,000 buses

Single node (~70hrs.) vs. HPC (~2.5hrs.)

Split into weekly "jobs"

Utilize HDF5 output file format and merge results

## GE MARS Execution at BNL (IBM Blue Gene/P)

1024 nodes, each with 4 processors and 2 gigs of memory

Porting MARS code to Blue Gene

Developing runtime environment

Need to establish performance benefit

## Exploring partnerships to leverage HPC for contingency analysis



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# Conclusions

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

“The number one benefit of information technology is that it empowers people to do what they want to do. It lets people be creative. It lets people be productive. It lets people learn things they didn't think they could learn before, and so in a sense it is all about potential.”

Steven Ballmer, Microsoft



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Questions, Comments?

