The Evolution of Planning Software

“Get it done... Faster.”
July 29, 2015
Software Products
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 GE’s multi-billion dollar energy investment portfolio

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 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

Proven tools used extensively in the industry
Our HPC Experience

Internal HPC in production since 2006
Used for consulting studies with MAPS and MARS
MAPS HPC, MARS HPC, and PSLF HPC commercial products
Custom HPC application development
MAPS – The Early Days

Initial release in the early 1970s

Targeted the IBM System/360s, eventually GE and Honeywell machines

Batch job submission...

- Input case sent to computer center as a deck of cards by courier
- Results returned by courier as a paper printout
- Model dimensions (circa 1970): 11 areas, 225 generators, bubble model
- Runtime: ~ a day
MAPS – Intervening years

MAPS transitioned through several generations of machines:

- GE/Honeywell mainframes; Digital VAX microcomputers; PRIME microcomputers; Sun desktop workstations

Finally ending up on Windows/Intel through the late 1990s and early 2000s

Model dimensions (2006): 130 areas, 4000 generators, nodal model, bihourly

Runtime: ~ 48 hours
Problems

Limited sensitivity analysis
• Computer charges and runtimes prohibitive

Seems issues
• Eastern Interconnect cut into 4 regions
• Caused issues modeling details of border regions

Turnaround times
• Client had time sensitive needs, could not tolerate 48 hour turnaround
Introduction of MAPS HPC

Started in 2006

First cluster: ~100 cores, about 20% of the current generation’s capability per core

Runtimes: 48 hours -> 6 hours

Current cluster: ~8,500 cores (Xeon E5, 3GB RAM/core)

Model dimensions: 150 Areas, 8000 generators, nodal model, bihourly

Job turnaround limited by the slowest time slice, currently ~90 minutes
PSLF HPC

Low hanging fruit: contingency analysis
Many small, independent tasks (1 contingency)
Spawn PSLF instances to receive contingency descriptions and evaluate
PSLF HPC Runtimes

WECC Model, 30,000 N-1-1 contingencies
• Conventional desktop: ~2 days
• 2 x 8 core machines: 90 minutes

Custom contingency processor for a utility (used intraday to support ops):
• 3.2 hours -> 18 minutes
MARS

Model created in the late 80s to support New York Power Pool

Sequential Monte Carlo model – state in one hour depends on the state in the previous hour

Customer 1:
• Workstations: 11 hours; 100 core HPC: 25 minutes

Customer 2:
• Server grade AMD: 100 hours; 12 core HPC: 5 hours

Our internal use:
• Model dimensions: 64 areas, 9 pools, 4200 units
• 120 cores: 2 hours
MARS Runtimes

MARS Processing Time (1000 Iterations)

Number of Cores

Processing Time (Minutes)
How?
MAPS

Split into 1 week time slices
Heuristics used for approximating the previous and next week
MARS

Program can “skip” replications
Advances random number generator with a known pattern
Provides identical results when run in parallel or sequential
PSLF

Two pronged approach:

• Parallelization of contingency processing across HPC hardware
• Take advantage of SMP hardware
  – Ordering algorithms
  – Parallel simulation of dynamic models
Speed-up of 2.21x on 12 threads using PNNL’s PIC computer and EI case

20s simulation with fault - results from PNNL PIC computer
My jobs are done faster...
So?
Model Fidelity

Improved runtimes make running a more detailed model more palatable.

Run the entire Eastern Interconnect in the time it used to take to run the North East region

Sensitivity Analysis

Less time computing base case

More time for sensitivity analysis

• Paint a more complete picture
Automation Benefits

Consistent process

• Build up a repeatable workflow for all cases to use
• Same versions of tools are used by all users
• Tracking of input files, assumptions, etc.
Our Consulting Group’s MAPS Workflow

Internal tool developed to assemble data files and prepare jobs

As weeks complete on the HPC, post processing is done to create final deliverable

Excel tool to read the final deliverable
Our Consulting Group’s MAPS Workflow

Everything is “hands off”… the user just clicks “Start”
Versions of all of the tools are kept the same from run to run and pulled from a central source
Allows for a repeatable process
Centralized Tool Versioning

Have the current versions of all tools in a known place, grouped together in a folder.

When ready to migrate to a new version of your tools, create a new folder and use it.

Allows you to re-run against older versions (benchmarking, rework).

Versions become immutable.
Resource Utilization

One scheduler – multiple compute resources
Automatically starts next task, schedule backlog
Balance work among available resources
Retry failed tasks, automatically handle failed hardware
Questions?
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