Real-Time Models for Real-Time Analysis

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Motivation

• Power flow studies are done using a different model than is used in real-time modeling
• On-line power flow study tools do not match planning study tools
• EMS Systems can “spit-out” a planning-like model, but mapping data to this model is manual
  – Topology is constantly changing so keeping up with real-time is not reasonable
• Also, PowerWorld Simulator has features that online tools do not have
  – Conditional Contingency Actions (for RAS)
  – Much easier to use and interpret results (especially when you have a limited time to make decisions)
Problem with “Spit-out” of Planning Model from an EMS System

- Due to breaker status, a substation may end up with one 115 kV bus, or maybe 8 different 115 kV buses
  - Results in different bus numbers, names, etc… every time
  - Trying to match a planning contingency description to this ever-changing model is futile

Conceptual Problem

- You’re trying to “convert” the data to what is needed by another piece of software
- This inevitably leads to an ongoing maintenance task
- EMS data is already a heavy maintenance task that has to be done to operate the system – we can’t change this
- *Don’t change your data, change your software*
**PowerWorld’s Solution:**
Don’t change your data, Change your software

- Build a model in PowerWorld that models *everything* that the EMS models.
  - Every breaker is modeled as a zero-impedance branch
- Model will be huge, but for modern computers this isn’t a problem
- Also, PowerWorld’s filtering, and graphical interface make dealing with a large model much more manageable.

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**Advantages of PowerWorld’s Solution**

- Building an identical EMS model can be done programmatically
  - No human intervention of matching names, numbers, etc..
  - No decisions about what to keep – keep *EVERYTHING*
  - Write software that queries your EMS system and builds an exact replica of the model
  - Generate a PowerWorld Auxiliary file including
    - Interfaces
    - Injection Groups
    - Contingencies (including conditional RAS)
    - Model Conditions, Model Filters, etc…
    - More…

Don’t change your data, Change your software
Problem Encountered

- Initial we experimented with solving the full topology model
  - About 75% of branches are zero-impedance branches
  - Makes for a very large case
- Problem encountered: Solution Speed
  - Solution was successful
  - However, the speed was not very good
- Solution: Topology Processing

Solution to Problem: Topology Processing

- Bring the topology processing inside of PowerWorld (PowerWorld handles two power system models simultaneously)
  - Full Topology Model
  - Consolidated Model
- Presently the user must perform the Topology Process via a dialog
  - Eventually we will handle this automatically with little user-intervention

Don’t change your data, Change your software
Example Substation: Scobie
Full Topology

41 “nodes”
36 energized,
5 disconnected

Close-up of 115 kV nodes

• Could be up to 7 energized 115 kV buses
  – Only 2 in this example, but all depends on breaker status
Example Substation: Scobie
In Consolidated Case

10 “buses”
5 energized
5 disconnected

Example Case Statistics

- Full-Topology Model has 10,437 nodes
  - 9,653 energized (786 disconnected)
- After Consolidation, case has 2,366
  - 1,647 energized (719 disconnected)
- Total is 4.4 times fewer
- Energized Total is 5.8 times fewer
Topology Processing Dialog

- Must specify which branches to maintain and which to throw out
  - Maintain interfaces branches
  - Maintain contingency branches
  - Throw out low impedance branches that represent ties

Continuing Work

- Keeping all the breakers that are involved in a contingency can result in a large amount of extra nodes
- We are looking into performing Incremental Topology Processing
  - Throw out breakers involved in contingency
  - Then dynamically add them back in only for the contingency that needs them
    - Each contingency may add back in several nodes that are needed