Answers for energy.

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Smart Planning with Smarter Tools

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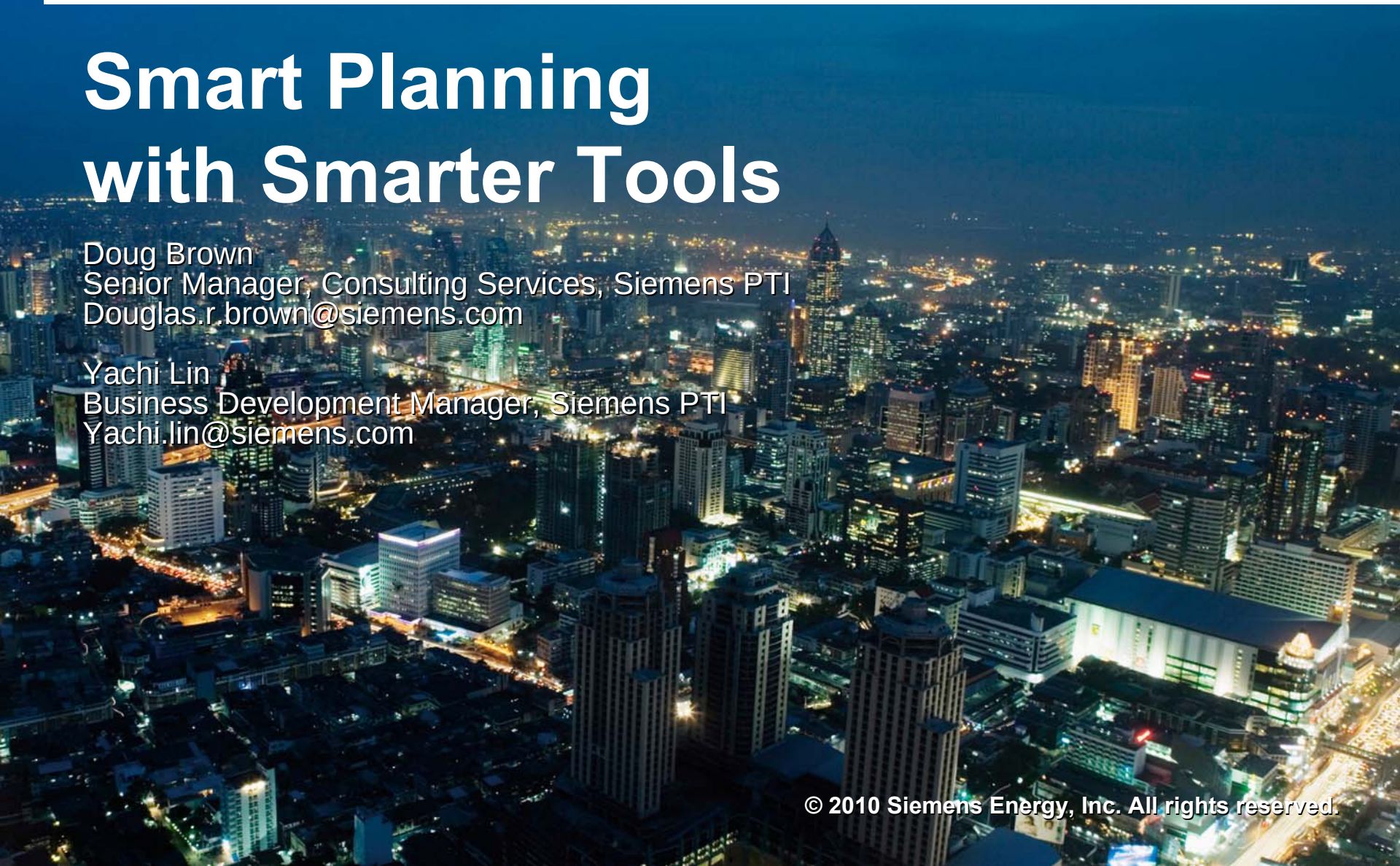

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Characteristics of Today's Transmission Systems

Reliable on a system-basis

- Reliability may vary by location
- Prevalence of remedial measures to relieve potential cascading problems

Designed to survive severe, probable events

- Deterministic criteria, typically
- Without explicitly predicting likelihood of occurrence

Different methods for different levels

- Generation level, using probabilistic methods
- Transmission level, using deterministic methods
- Distribution level using performance-based decisions

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Understanding Margins in Transmission Systems

Mapping the Challenges with the Tools

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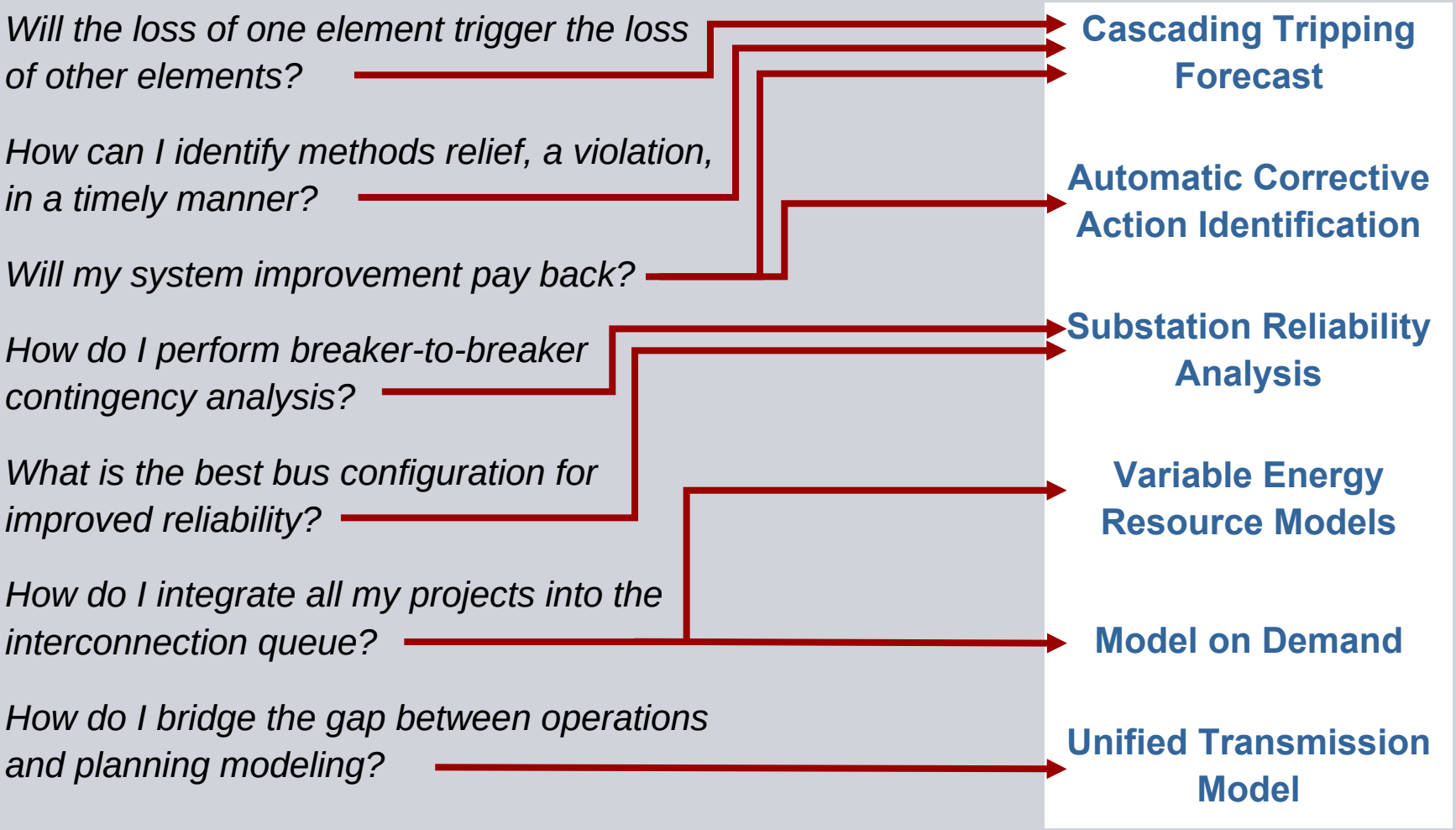

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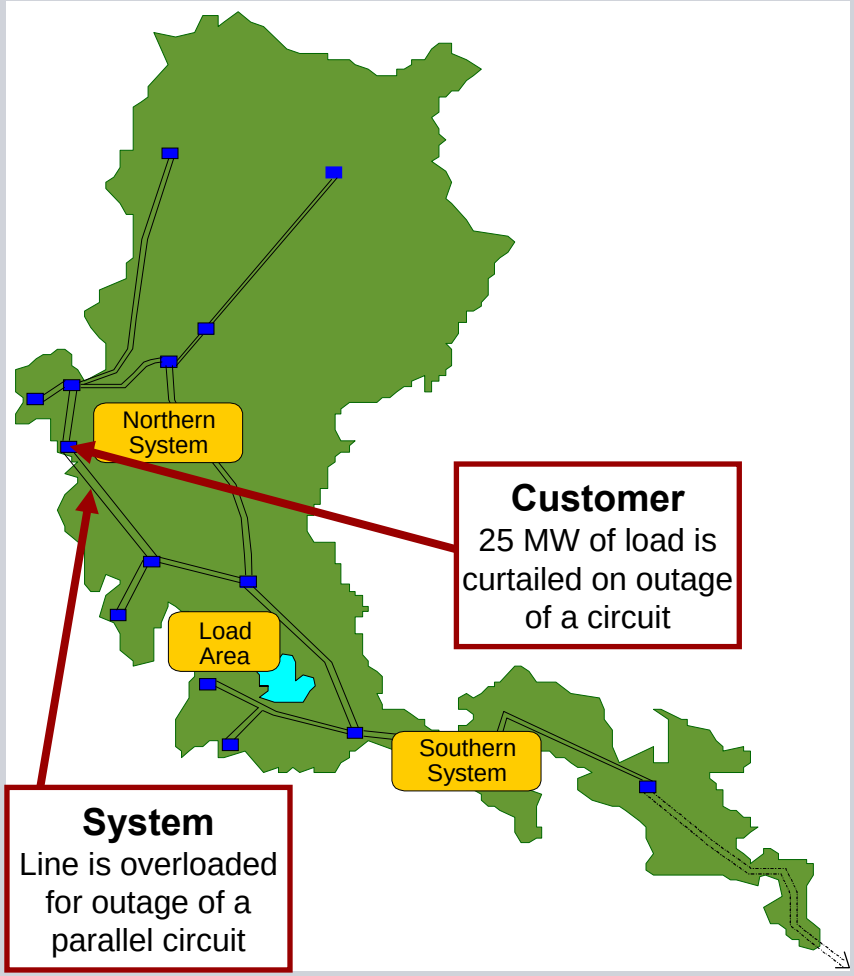
Different Perspectives in Contingency Planning

System modeling considerations

- Load/generation imbalance
- Network separation
- Special protection systems, remedial action schemes
- Operator actions
- Cascading tripping

Customers impact considerations

- Isolation of load supplying substation from network.
- Initiation of a trip sequence, which isolates or trips loads.
- Load Curtailment



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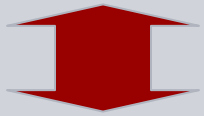
Deterministic vs Probabilistic Approaches

Deterministic

- Tests system performance under different conditions (N, N-1, N-2, etc.)
- Determines contingency outcome
- Makes “Pass/Fail” decision

- 12 contingencies result in overload
- 2 of the contingencies involve line A
- Maximum overload is 12%



Probabilistic

- Reflects risk of equipment failures
- Multiple component failures may have more severe consequences, but are less likely to occur (have lower probabilities)

- Frequency of an overload within system is .2658 times/year
- Frequency of overloading line A is 0.027 times/year
- Average duration of overload is 4.6 hr

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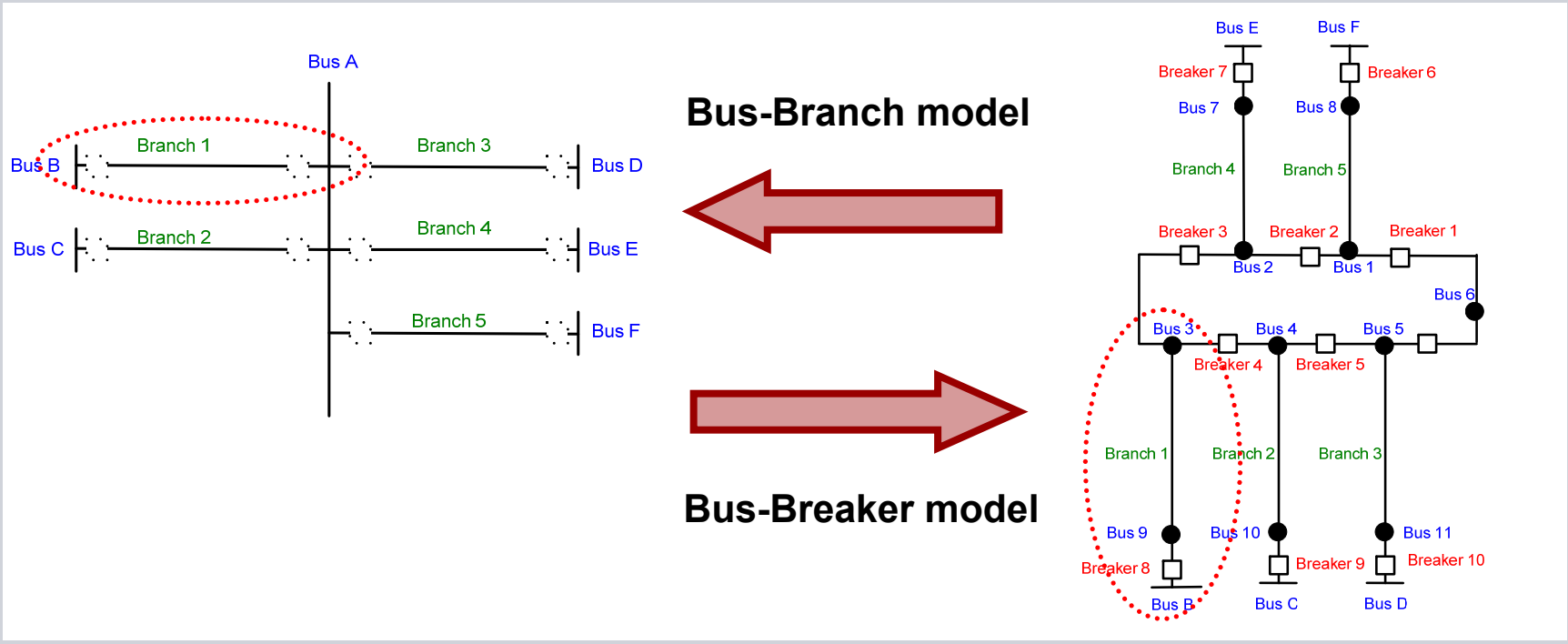
Substation Reliability Analysis

- Assess substation reliability
  - Compare substation configuration alternatives
  - Evaluate the sensitivity of substation performance to outage statistics, equipment rating, load level
- Breaker-to-breaker contingency analysis (PSS®E Version 33)



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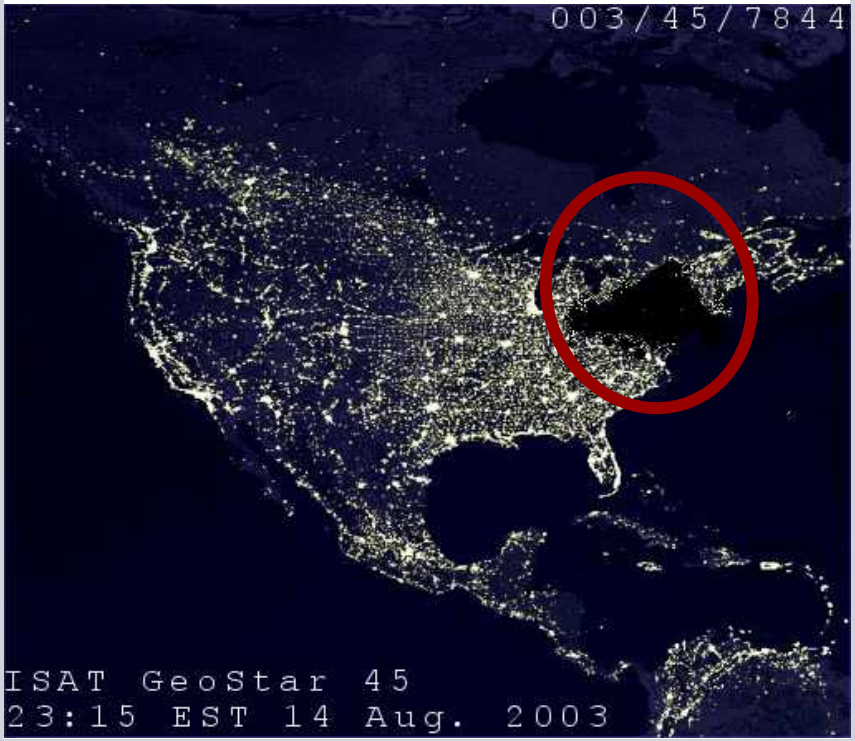
Cascading Tripping Forecast

Blackout

Tripping of one or multiple elements leads to outage of a wide area



Modified Satellite Picture

Modeling concerns

- Network condition checked after each contingency power flow solution for possible tripping action
- If tripping action activated, power flow solution repeated and checked again for more trips

Engineering applications

- Integrated contingency analysis by specifying:
  - Tripping Label
    - Monitored element list
    - Trip element list
  - END

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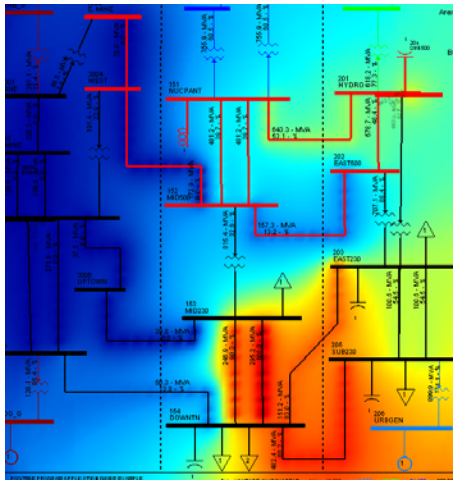
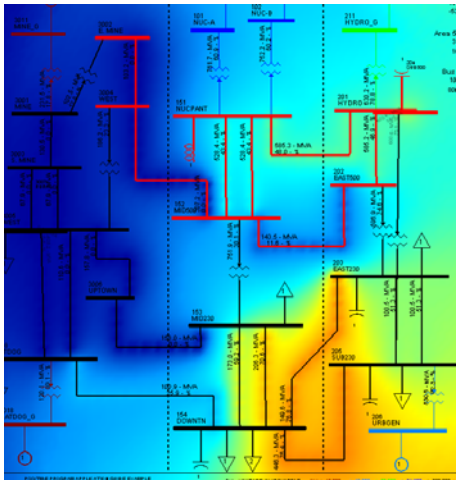
Corrective Action Analysis

Contingency Solution



Before ► After

Corrective Action Solution



Power flow solution identifies constraints:

- Branch loading violations
- Bus voltage violations
- Interface flow violations

Automatic calculation that adjusts controls to correct violations:

- Combination of controls such as generation redispatch and load curtailment
- Objective is to correct violations while minimizing control adjustments

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N-1-1 Contingency Analysis

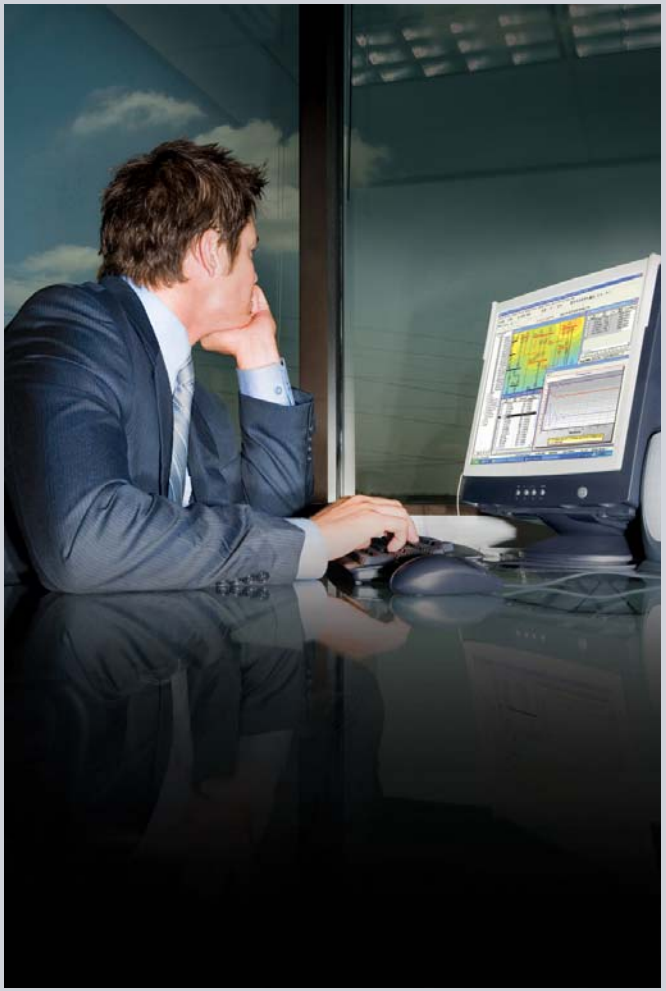
Definition

Category C.3
Defined as loss of one element, followed by system adjustments, and then the loss of another element

Solution

Requires combination of analysis

- Automatic contingency enumeration
- Automatic corrective action identification
- Cascading tripping modeling



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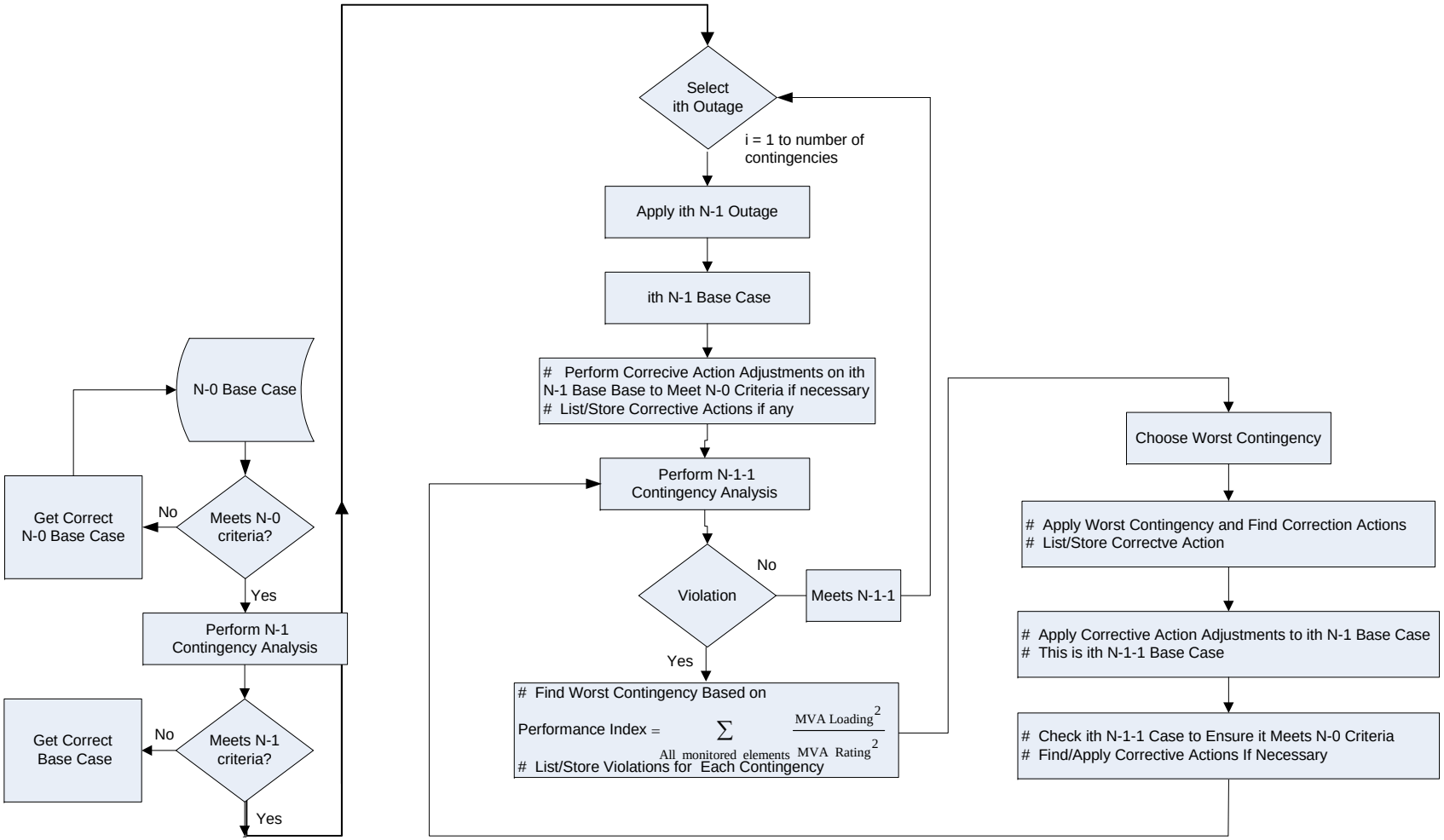
N-1-1 Contingency Analysis



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Variable Energy Resource Models

Wind Generation

- Power flow
  - Wind machine control mode used to indicate that machine is a wind machine, and the type of reactive power limits to be imposed
- Stability
  - Generic wind models with generator, electrical, and aerodynamic controls (standard PSS®E models)
  - Manufacturer specific wind models (user-written models)

Solar

- Photo Voltaic Stability Model (PSS®E Version 33)

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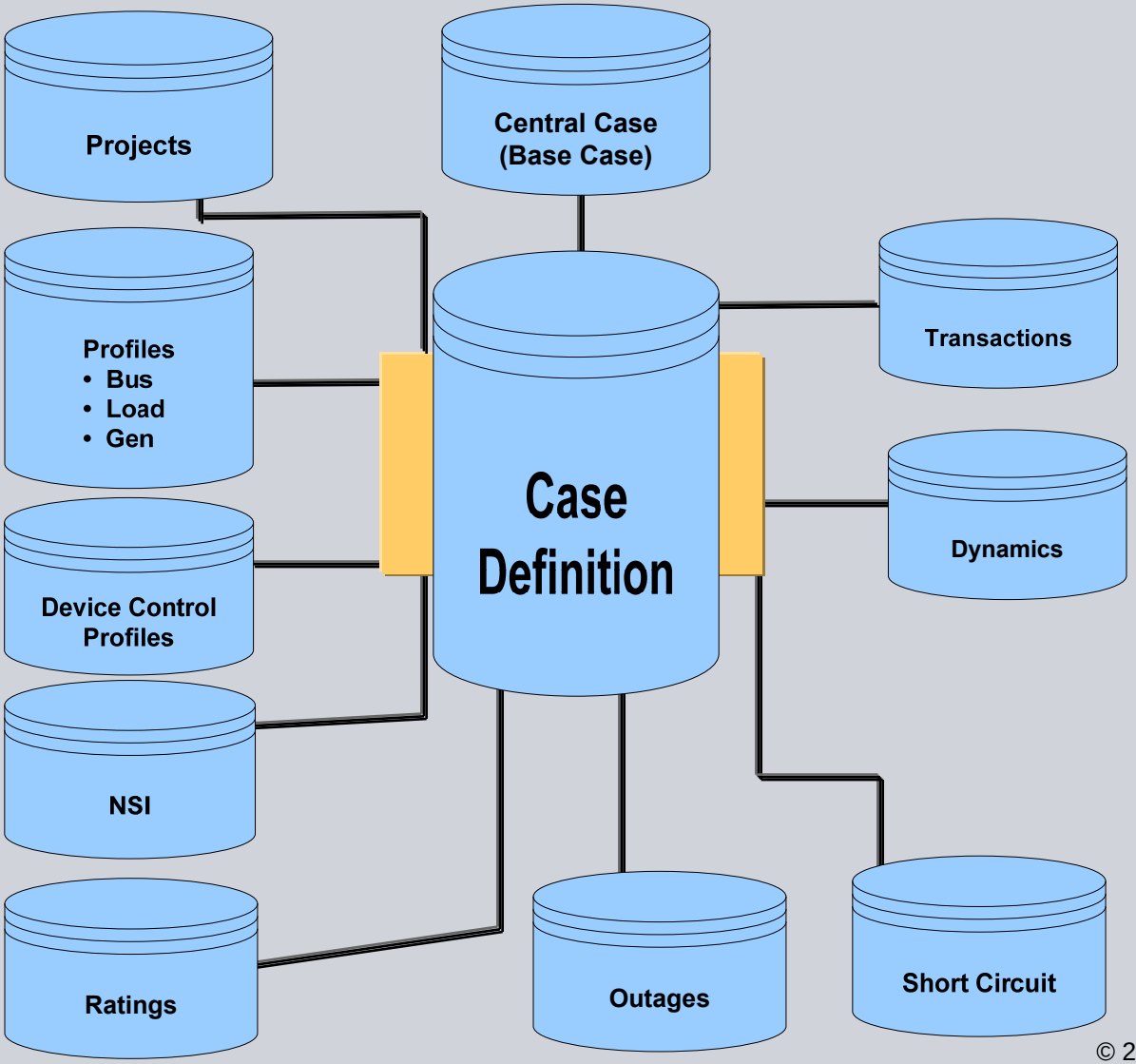
Beyond One Base Year, One Base Case



Model on Demand®

- Improves model quality and ensures data consistency among users
- Manage model data inputs from multiple sources
- Manage generation interconnection queues and associated model needs
- Allows access to models and model data from remote sources
- Built-in file submittal review process
- Remote user access via the web

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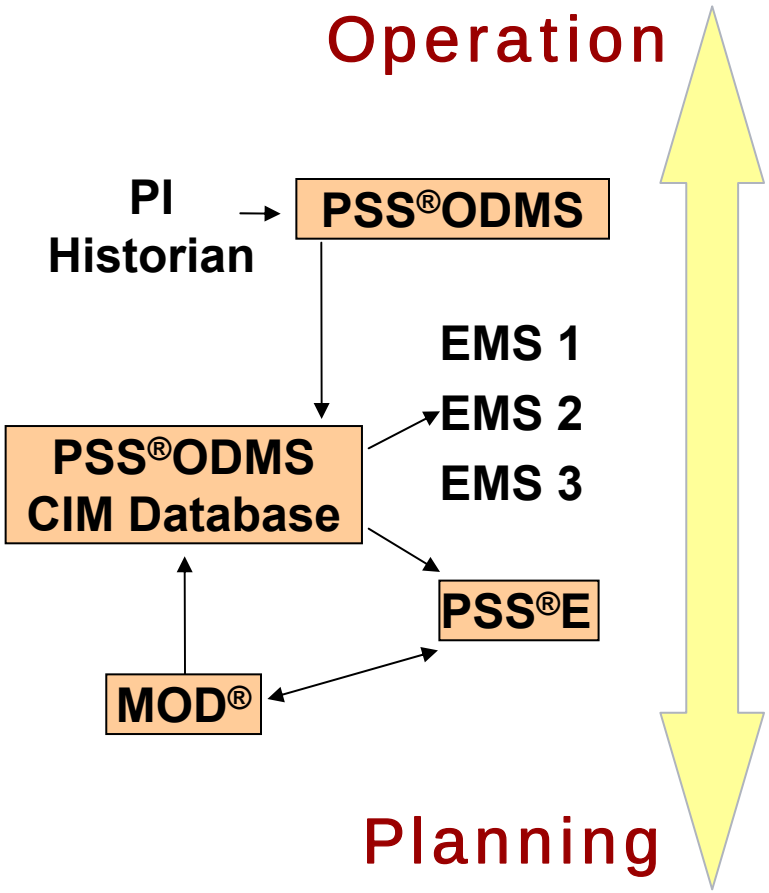
Unified Transmission Model



Case Study of PowerLink, Australia

Description

Seamlessly Integrated PSS® products help customers to harmonize operation and planning, from the past, present to the future.

Customer Benefits

Understand the Past with PSS®ODMS + PI Historian

- Re-enact the sequence of events in the network
- Investigate how to avoid future contingencies

Manage the Present with PSS®ODMS + EMS/SCADA

- Improve reliability though CIM/XML format real-time data from multiple EMS/SCADA systems

Secure the Future with PSS®E + MOD®

- Model, preview and verify planned network changes in advance of commissioning
- Identify the system reliability limits and plan for reinforcements

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Thank you!

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