Long Island Power Authority

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LIPA Implementation of Real-Time Stability Monitoring in a CIM Compliant Environment

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Overview of the LIPA T&D System

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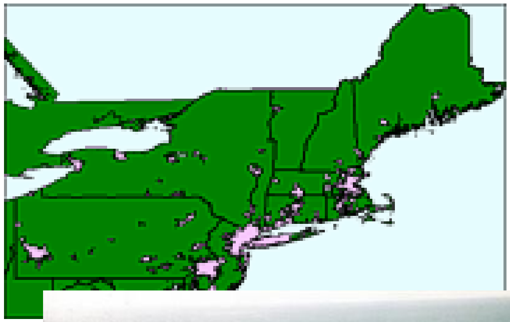
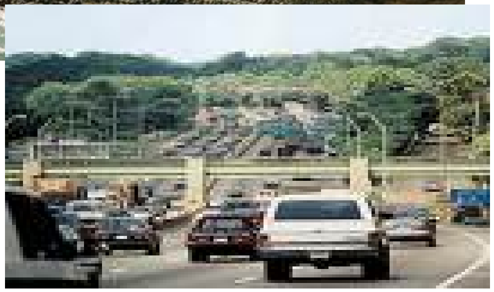
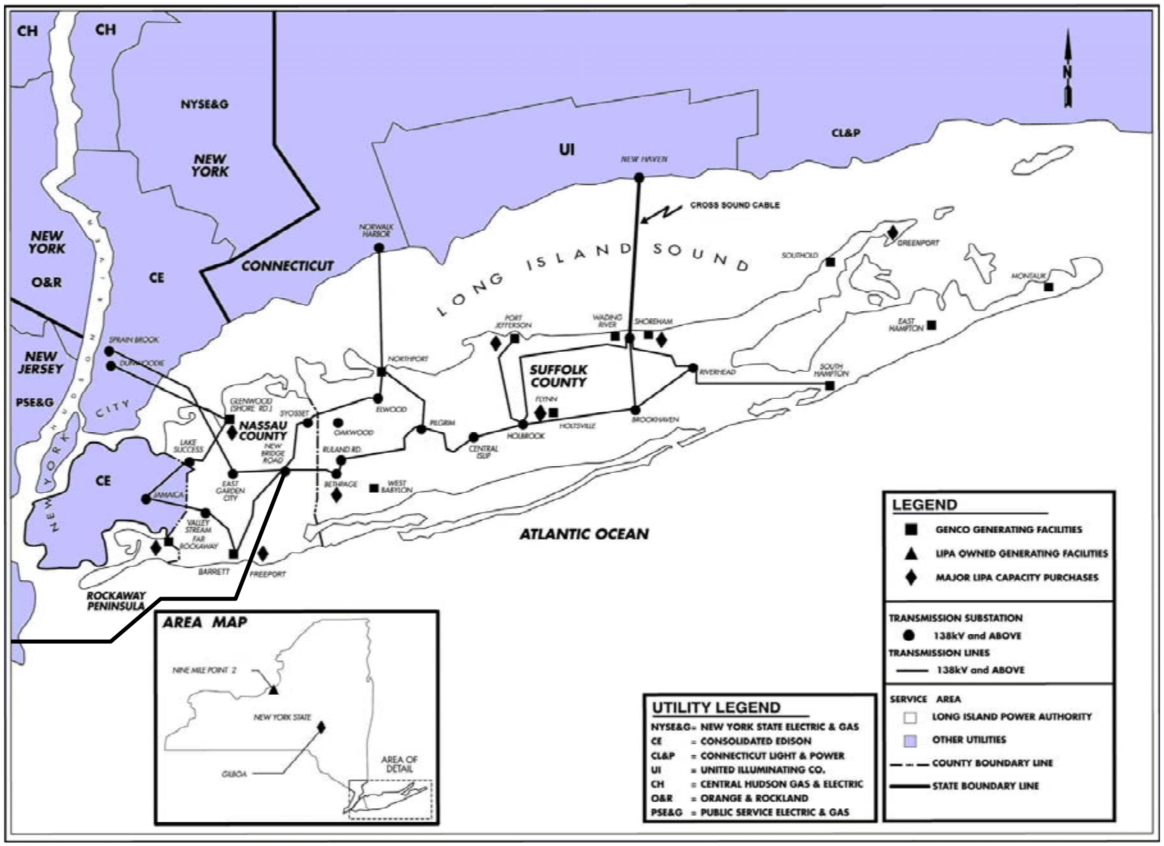
Company overview

Customers	1,103,162
Population:	~3 M (est. 2005)
Peak Demand:	5,792 MW (Aug. 2006)

Seven Ties: 2 DC, 5 AC







Company overview (cont'd)

Facilities

Substations	177
Distribution Circuits	848

Overhead ~75%, Underground ~25%
Distribution Automation >1200 switches

System Voltages

Transmission	345kV, 138kV, 69kV
Sub-Transmission	34.5kV, 23kV
Primary Distribution	13.8kV or 4.3 kV
Secondary Distribution	120/208, 120/240, 277/480

Generation

National Grid Generation...……….5461 MW
Total Available Generation……….5656 MW
Seven Interties…………………….2062 MW

Standard Area Substation Design

2-4 bank, design
28, 33, 56 MVA transformers

Southampton Substation

Canal Substation, 2005

What is CIM?

- CIM is an abstract information object-oriented model which:
  - Represents real-world objects (or classes) found in transmission and distribution operation and management
  - Defines classes, their attributes and their relationships to other classes
- CIM provides a comprehensive, logical view of EMS information for:
  - Transmission network analysis
  - Generation control
  - SCADA
  - Operator training simulation

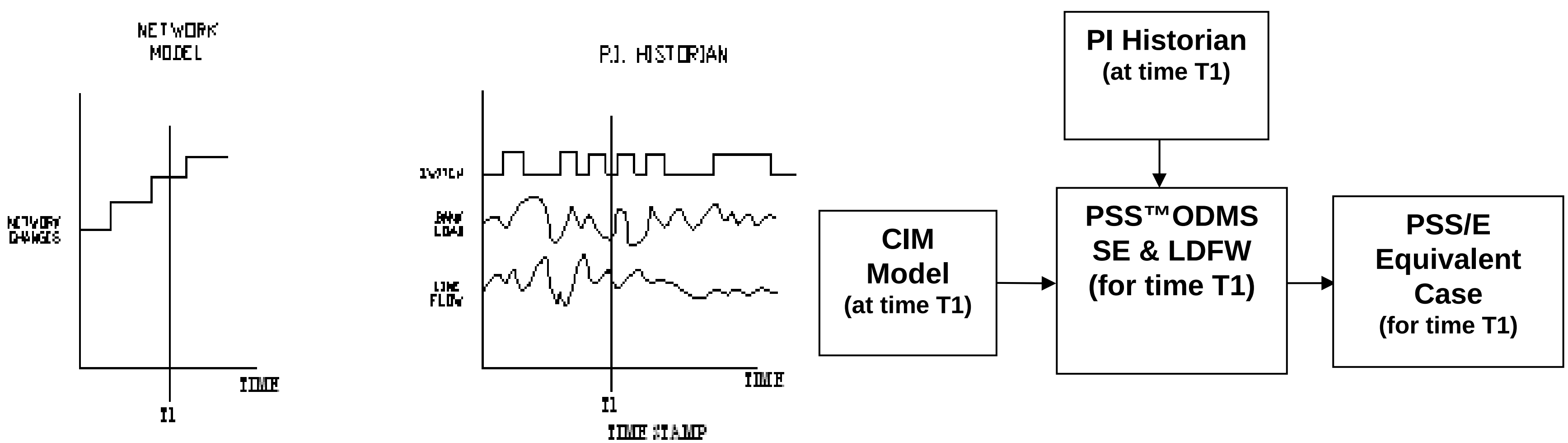
What is CIM (cont'd)?

- CIM enables data access in a standard way:
  - Common language to navigate and access complex data structures
  - Provides a hierarchical view of data for browsing and access
- CIM enables integration of applications/systems:
  - Provides a common language for exchanging messages between systems

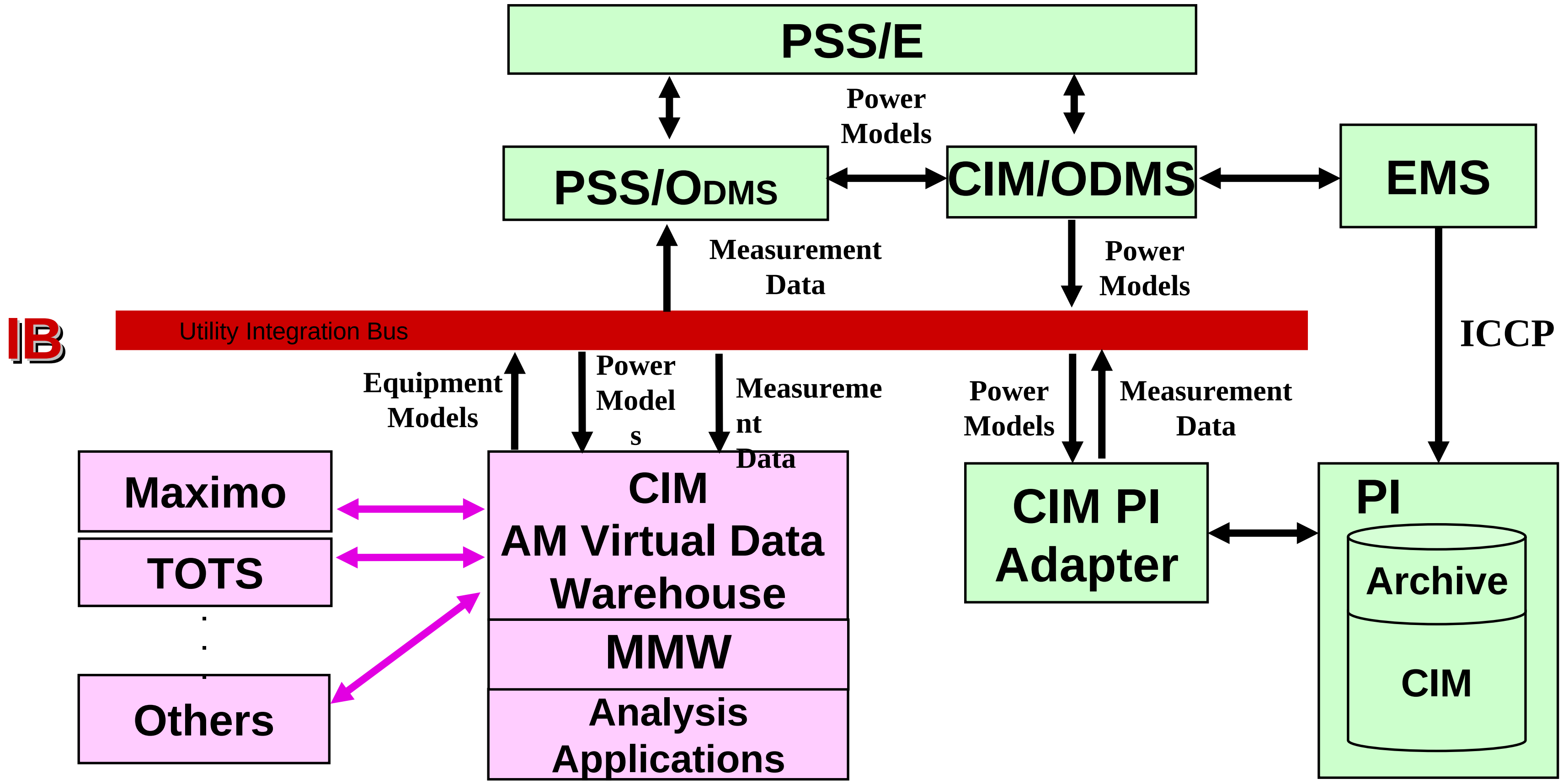
CIM Compliant PSS/ODMS - SCADA/EMS Integration at LIPA

Initial Project

- Build CIM model from GE Harris EMS
- Retrieve Measurement Data from PI Historian
- Track network changes to recreate historical model
- Run PSS/O to support Operations with real-time load flow analyses
- Create current and historical PSS/E load flow cases for Electric Planning
- Establish access to asset condition data via CIM Integration Bus



Architecture



Note: Link between EMS and CIM/ODMS was used only once to establish database network

Expanded requirements:

Real-Time System Stability is what System Operations Wanted

- The System Operator had a very good handle of thermal constraints, however he had less of an understanding of system stability during normal operations and in case of contingencies

Expanded requirements:

- Requirement to perform real-time voltage stability for the current state and for contingency scenarios
- Request for easy interpretation of stability analysis results
- Support ESO with stability runs:
  - Real-time voltage stability runs (5 minutes intervals) using QuickStab
  - Real-time monitoring of the risk of instability on trending charts by using the QuickStab calculation results stored in PI Historian
  - Day ahead off-line transient stability assessment using POM-TS to support ESO during major construction project clearances
- Model On Demand:
  - Enable using the current system configuration as base to maintain future planning system configurations (PSS/O optional feature)
- Use the historical data from PI Historian for auditing and event reconstruction

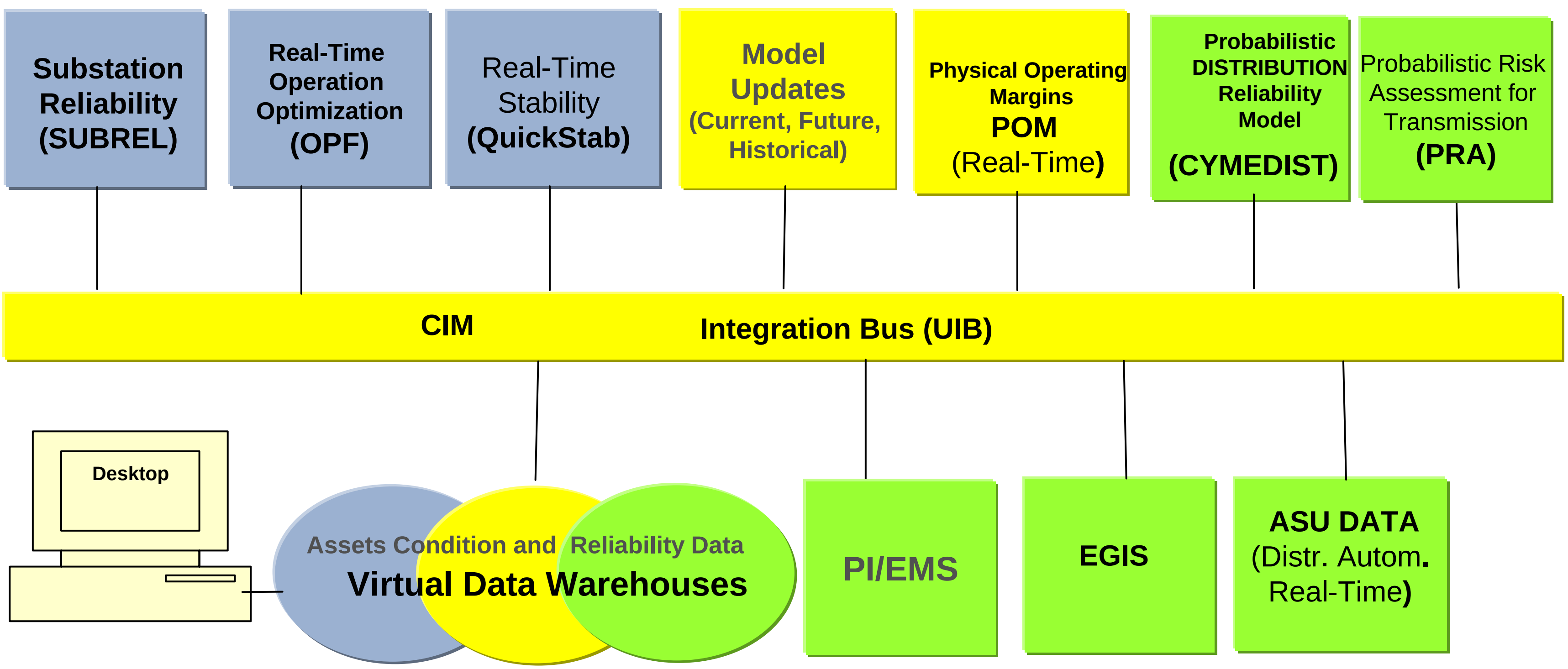
Real-time voltage stability requirements

- The stability application should be capable of running in real-time as well as in study-mode
  - In real-time, it should be triggered automatically after each state estimate
- The solution technique must be fast and reasonably accurate
- The results must include indicators, such as distance to instability
- The output must be presented graphically in simple format
- The software must be capable of evaluating single and multiple contingencies

Steps needed to support ESO with daily clearances

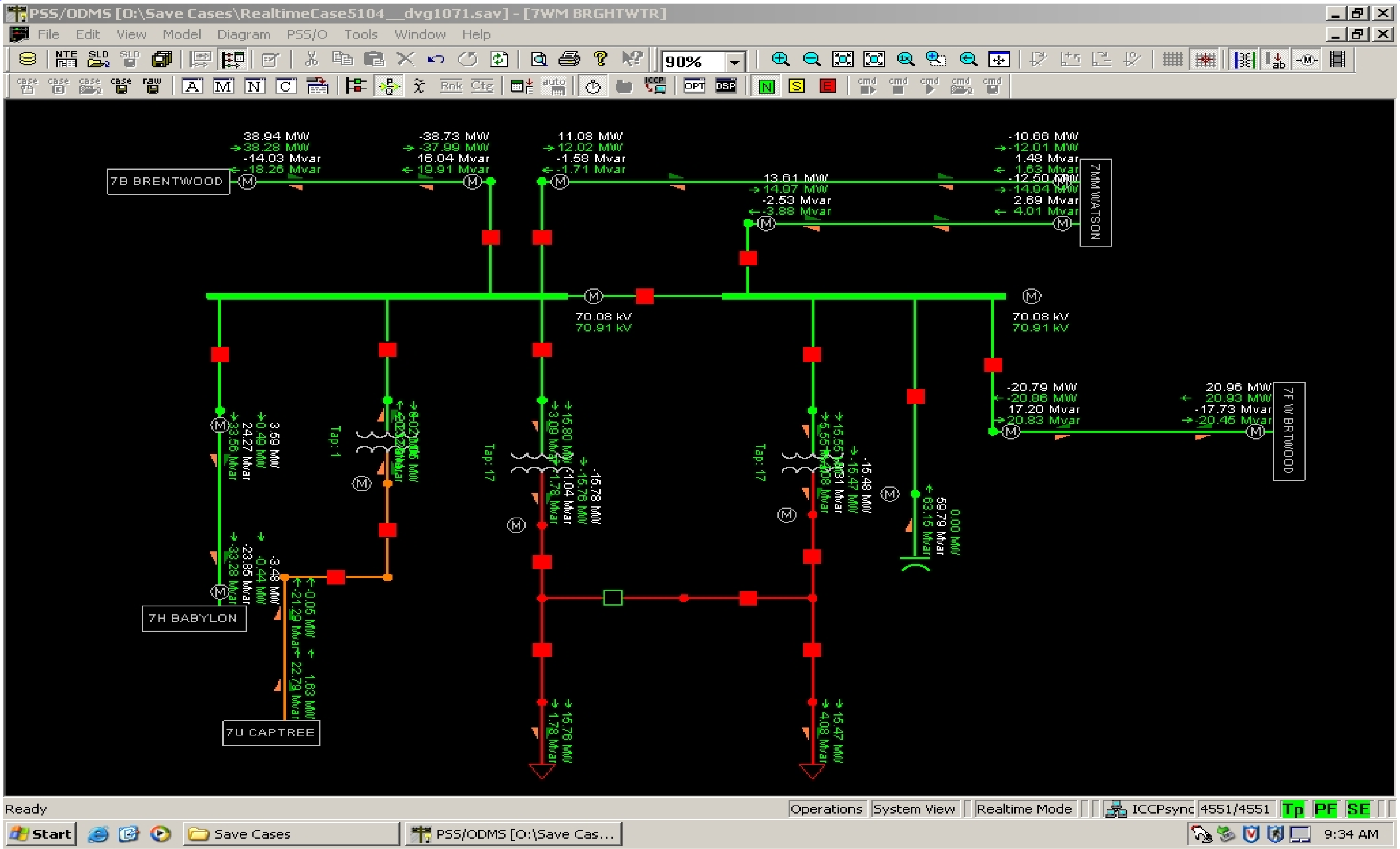
- Select previous day peak system conditions by entering date and time or retrieving a saved case
- Execute next day system load forecast and apply to load flow
- Model next day generation dispatch
- Model next day scheduled clearances
- Run Load-Flow, Security Analysis, Voltage Stability (QuickStab) and Transient Stability (PSSE or POM-TS) calculations
- Cancel or modify clearances as necessary

System planning vision of CIM IB

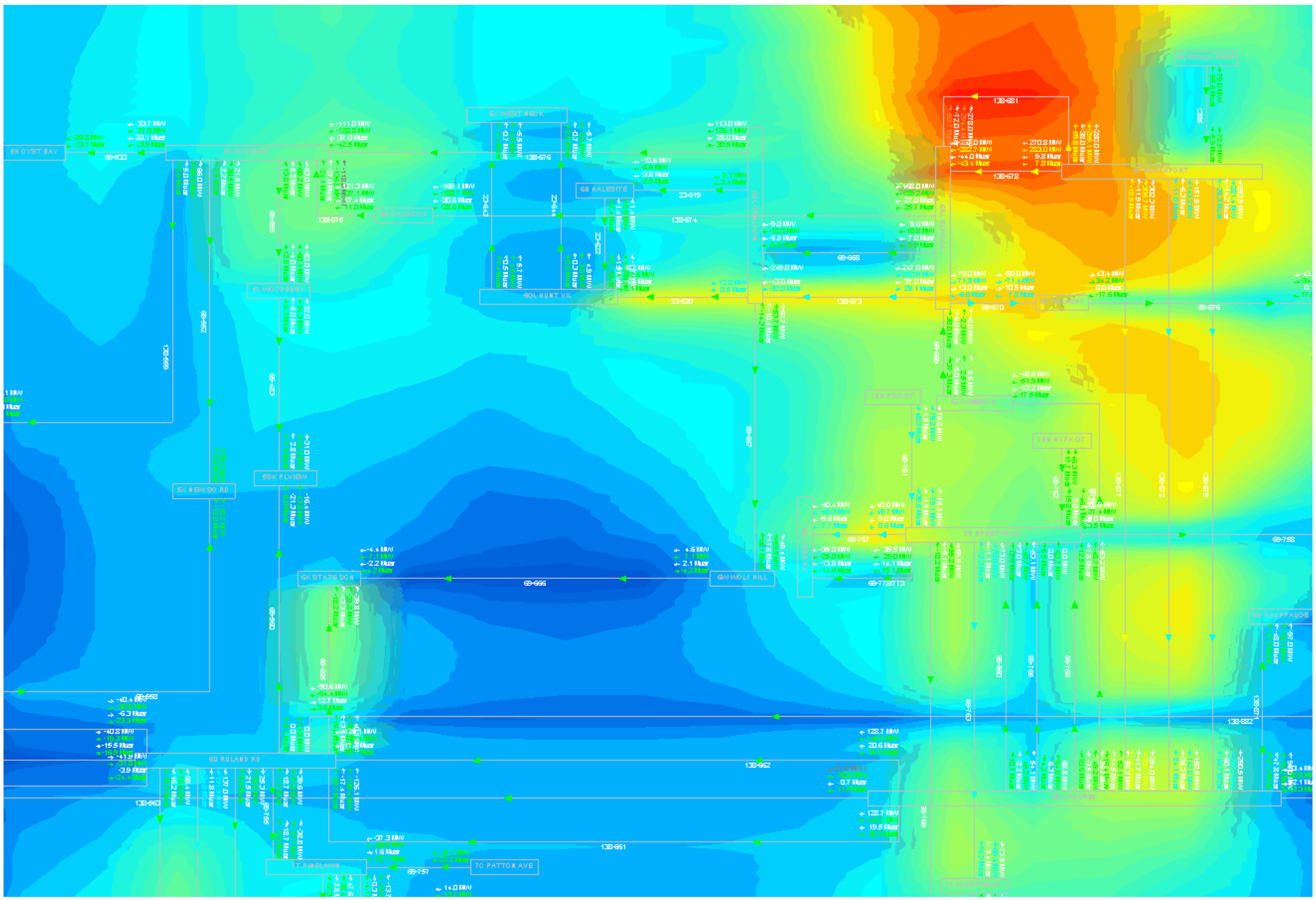


Example of real-time substation modeling

includes distribution transformers to capture losses



Contours display



View of QuickStab Real-Time Stability Application

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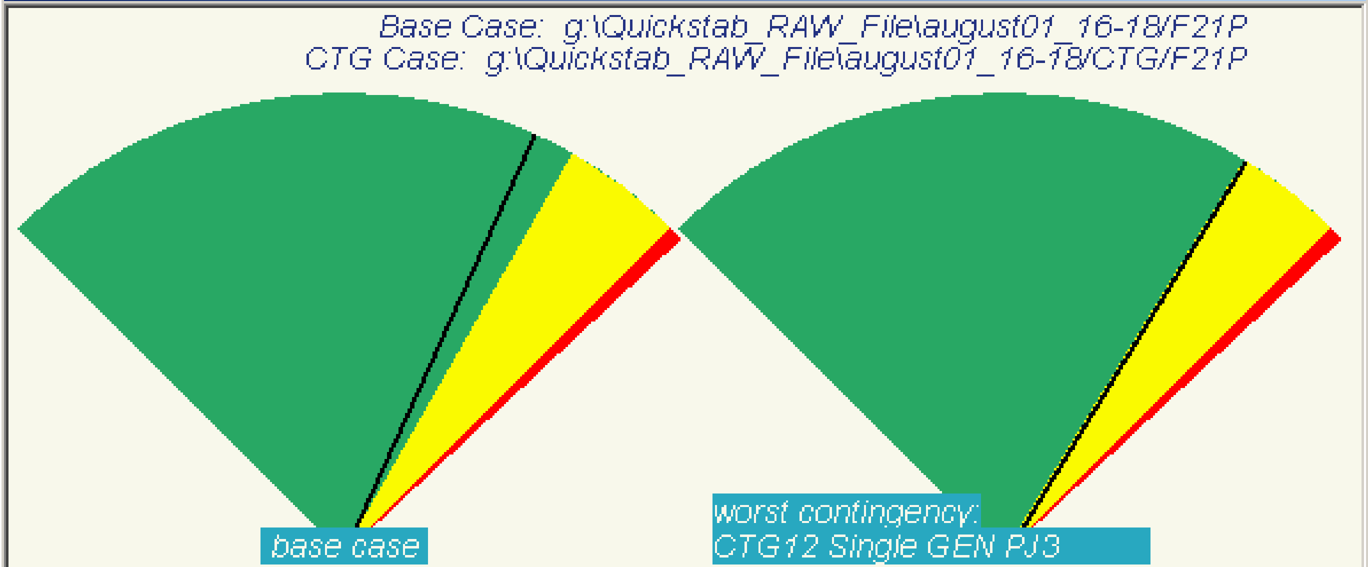
BASE CASE
Steady State Stability
Representation Used to
Asses System Stability

WORST CONTINGENCY
Stability Representation
from Selected
Contingency List

15% Security Margin

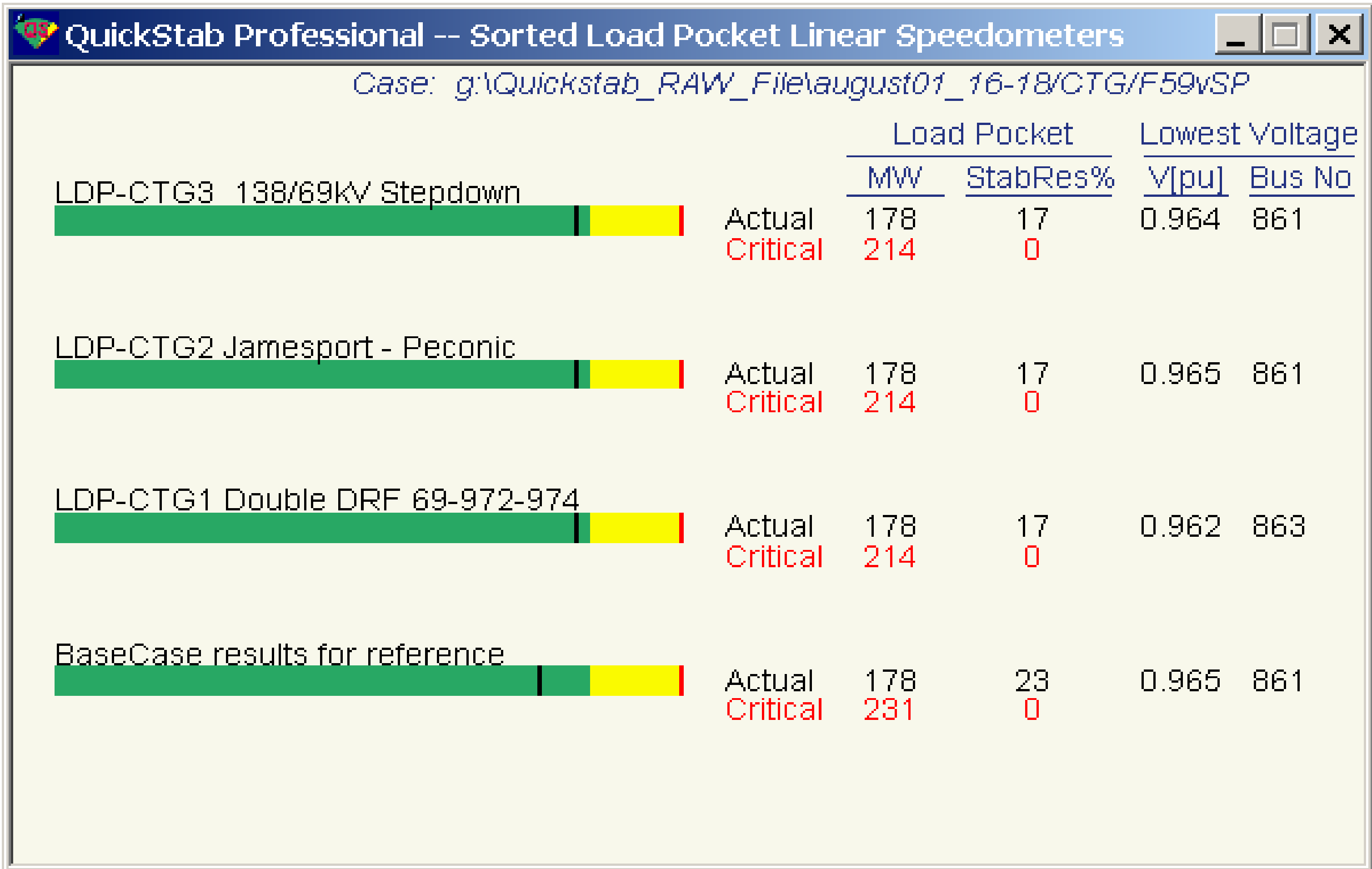
System Unstable

QuickStab Professional -- Speedometers Base Case & Worst Contingen...

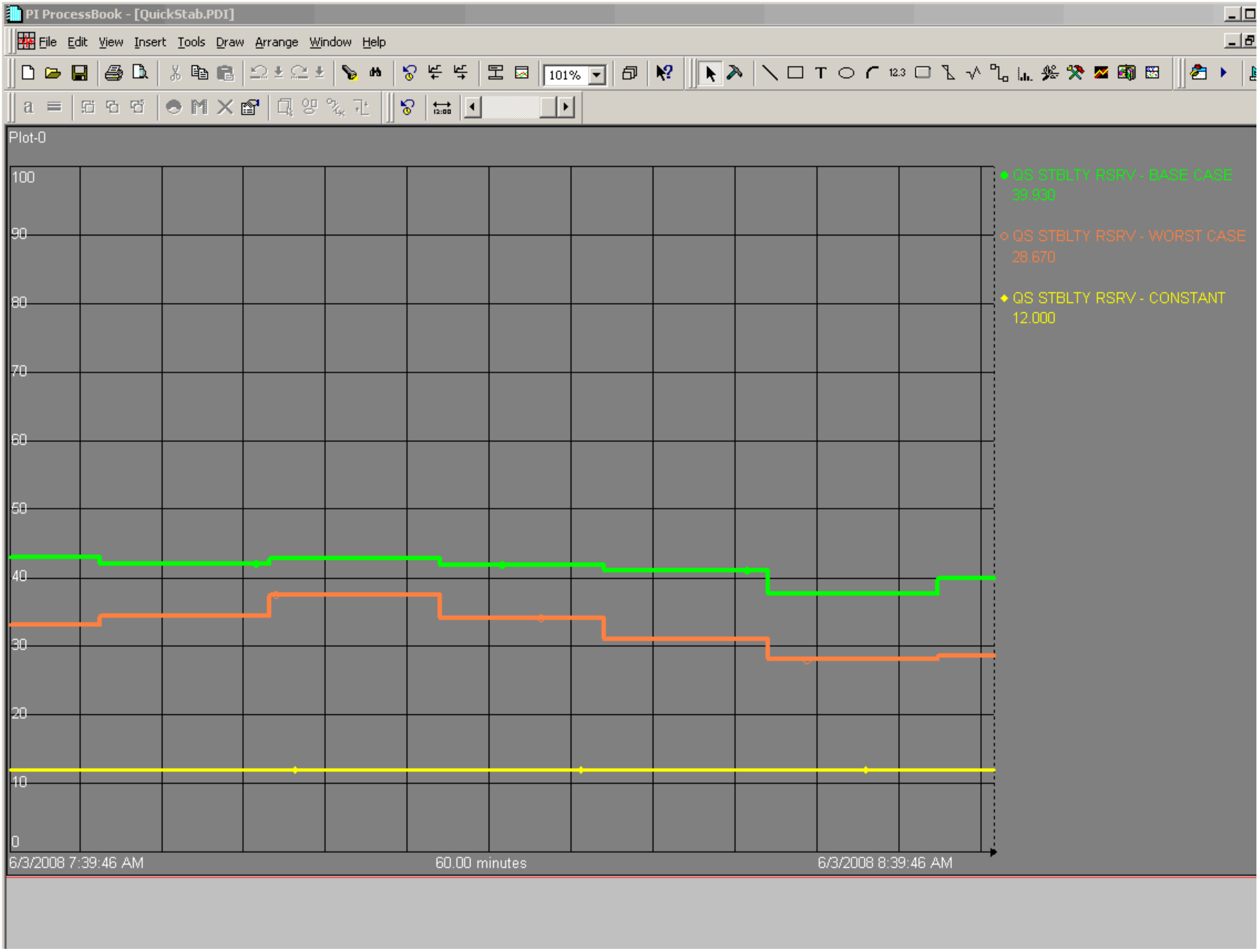


	Total Grid Utilization Base	Total Grid Utilization Contingency	Total MW Generation Base	Total MW Generation Contingency	Stability Reserve [%] Base	Stability Reserve [%] Contingency
Actual:	5109	5070	3978	3978	23	15
Security Margin:	5520	5070	4163	3978	17	15
Critical (unstable):	6623	5972	4681	4393	0	0

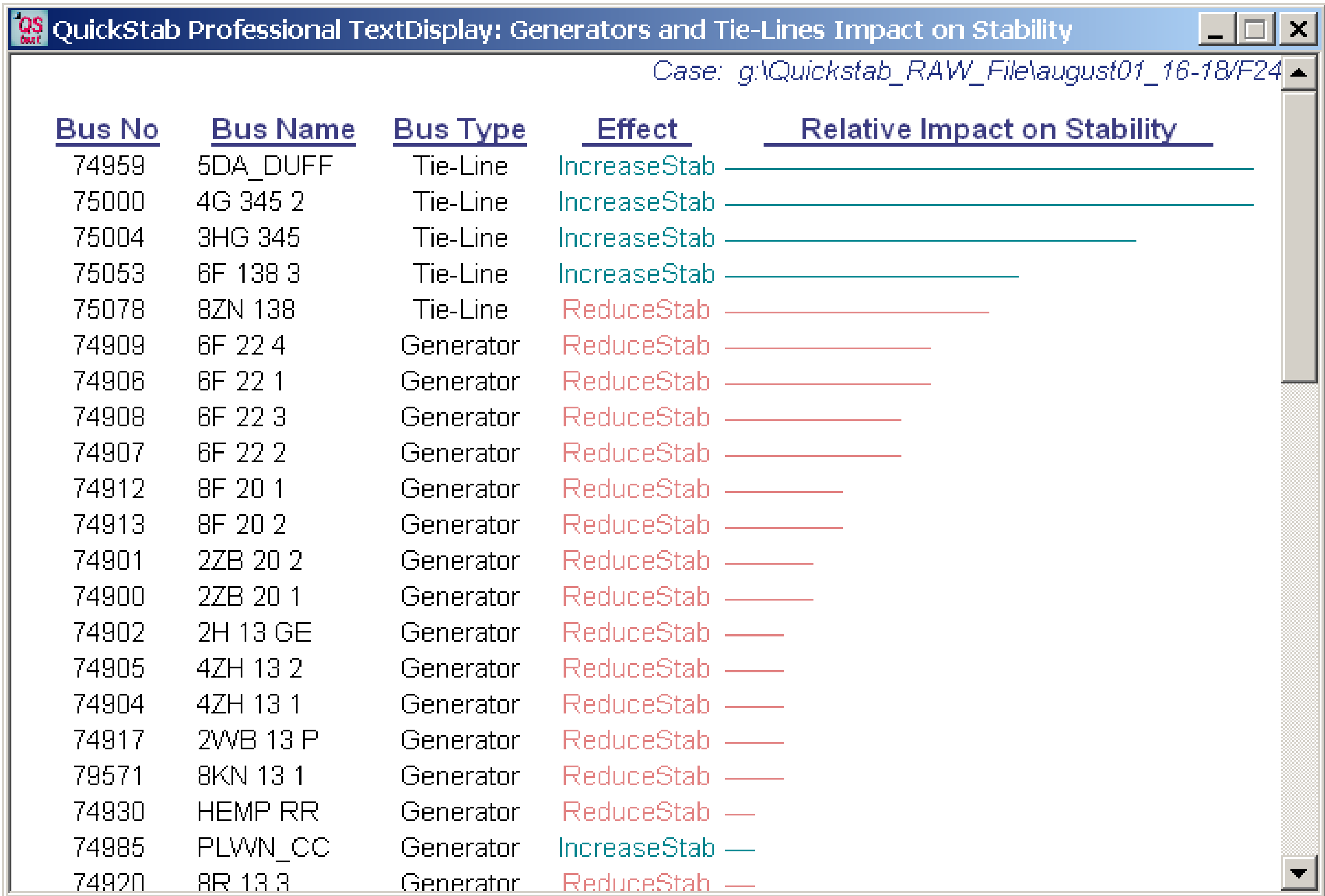
Linear Representation of East End Load Pocket Stability



Real-Time Trending of the Distance to Instability



Bar chart ranking of generators and tie-line injections in the order of their impact on stability



Bus No	Bus Name	Bus Type	Effect	Relative Impact on Stability
74959	5DA_DUFF	Tie-Line	IncreaseStab	
75000	4G 345 2	Tie-Line	IncreaseStab	
75004	3HG 345	Tie-Line	IncreaseStab	
75053	6F 138 3	Tie-Line	IncreaseStab	
75078	8ZN 138	Tie-Line	ReduceStab	
74909	6F 22 4	Generator	ReduceStab	
74906	6F 22 1	Generator	ReduceStab	
74908	6F 22 3	Generator	ReduceStab	
74907	6F 22 2	Generator	ReduceStab	
74912	8F 20 1	Generator	ReduceStab	
74913	8F 20 2	Generator	ReduceStab	
74901	2ZB 20 2	Generator	ReduceStab	
74900	2ZB 20 1	Generator	ReduceStab	
74902	2H 13 GE	Generator	ReduceStab	
74905	4ZH 13 2	Generator	ReduceStab	
74904	4ZH 13 1	Generator	ReduceStab	
74917	2WB 13 P	Generator	ReduceStab	
79571	8KN 13 1	Generator	ReduceStab	
74930	HEMP RR	Generator	ReduceStab	
74985	PLWN_CC	Generator	IncreaseStab	
74920	8R 13 3	Generator	ReduceStab	

Benchmarking the stability application

- After integration with PSS/ODMS and preliminary testing with actual real-time cases, the voltage stability tool was benchmarked before starting its use in daily system operations
- Main purpose of benchmarking: determine how accurate is the prediction of the "distance to instability“
  - Gain confidence that states predicted to be unstable would, indeed, be unstable or closed to instability, and vice-versa
- Additional goal of benchmarking: fine tune the value of the "security margin“
  - Amount of “stability reserve" that needs to be maintained to ensure that none of the critical contingencies that can reasonably be envisioned would cause the power system to become unstable
- Benchmarking results:
  - Found consistent with testing and validation results obtained by other users
  - Demonstrate that the stability limits computed with the tool depict reliably the maximum grid loadability
  - Documented in the chapter "LIPA Implementation of Real-Time Stability Monitoring in a CIM Compliant Environment", in *Real-Time Stability Assessment in Modern Power System Control Centers*, John Wiley & Sons and IEEE Press, New York 2009

Questions and Answers

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