DSATools™
Dynamic Security Assessment Software

VSAT Voltage Security Assessment Tool

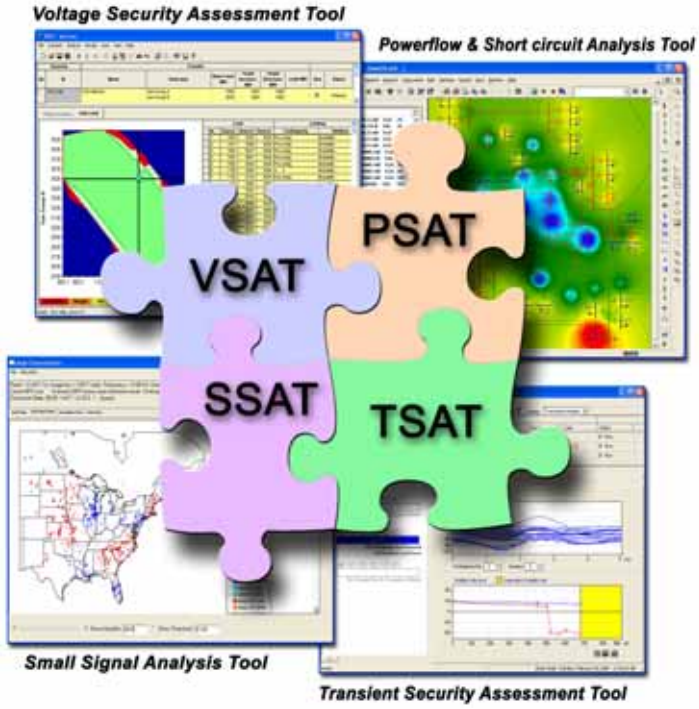
VSAT is a software tool developed by Powertech Labs Inc., for voltage security assessment of power systems. This tool is designed to meet the growing challenges facing the power industry as witnessed with the widespread smart grid development and applications. Its extensive computational capabilities allow comprehensive analyses of system operating conditions for predicting and preventing voltage insecurity problems.

VSAT uses static analysis methods for voltage security assessment and transfer limit computations subject to voltage security criteria and contingencies. Its modal analysis feature provides valuable information regarding the location of instability and participation of buses in specific mode of instability. Its remedial action module determines the most effective controls for prevention and correction of security violations. A comprehensive model library is available for all analyses to consider important factors for voltage stability, such as generator reactive capabilities, switchable shunts, automatic transformer tap changers, special protection systems, etc.

Complemented by PSAT (Powerflow & Short circuit Analysis Tool), TSAT (Transient Security Assessment Tool), and SSAT (Small-Signal Analysis Tool) of **DSA*Tools***™, VSAT helps system planners and operators in accurate and complete assessment of security of a power system.

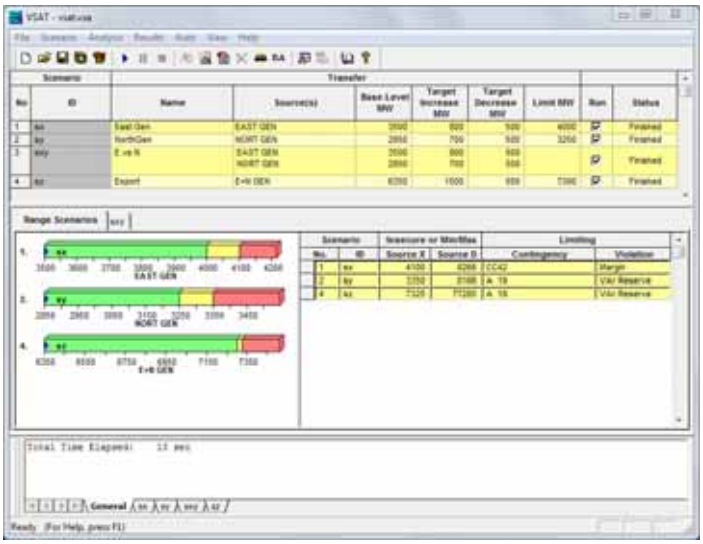
Product Features

- Powerful off-line analysis capabilities
- Readily configured with EMS for on-line use
- Selection of various security criteria,
  - thermal overloads
  - voltage declines
  - reactive power reserves
  - voltage stability margin
- Comprehensive modeling support
- Contingency screening
- PV curve and VQ curve computation
- 1- and 2-dimensional transfer limit search
- Modal analysis
- Remedial measure identification
- Scalable distributed computation engine



As an **off-line** analysis tool, VSAT greatly facilitates the voltage stability analysis of a system under various operating conditions, contingencies, and power transfers. In deregulated environments, because of the uncertainty associated with generation, load, and power transactions, the number of conditions that must be analyzed may become unmanageable with conventional tools. But with VSAT a large number of scenarios can be set up and analyzed very quickly, providing detailed information regarding critical contingencies, voltage security violations, locations and mode-shape of instability, etc.

In the **on-line** application, VSAT determines the security of the current system state (as obtained from the EMS state estimator) and forecasts future states (such as hour-ahead or day-ahead) for a large number of contingencies. In addition, as in off-line mode, it computes thermal and voltage security limits of any given number of power transfers. These limits, together with transient and small-signal security limits, determine the Total Transfer Capability (TTC) of various flowgates in the system.



Scenario Definition

In VSAT you can specify a large number of scenarios to be analyzed, each defined by the following:

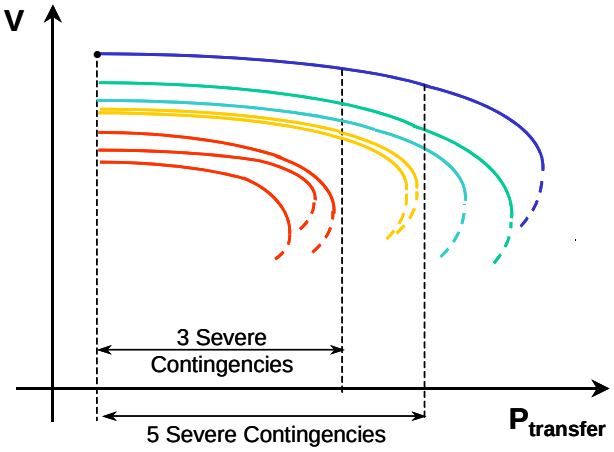
- Basecase condition (powerflow).
- Power transfer definition.
- Contingencies.
- Security criteria.
- Analysis and solution control options.
- Other applicable models.

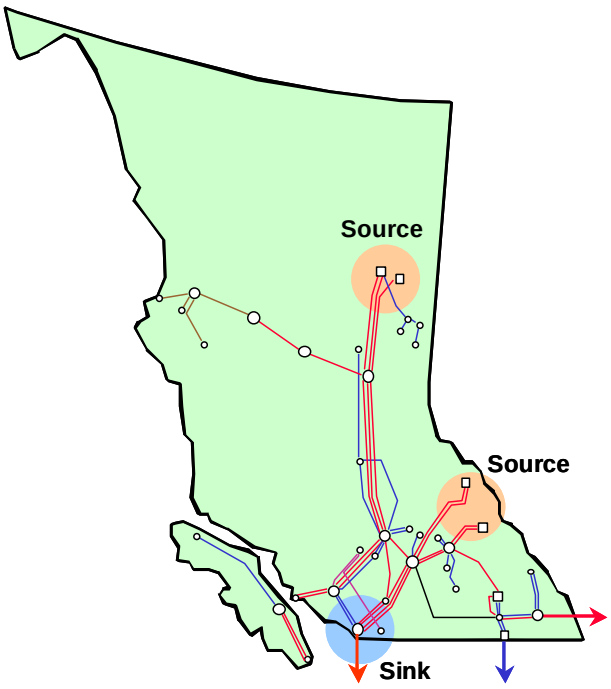
For scenarios with a power transfer, VSAT determines the voltage security limit of the transfer. Without a transfer definition, VSAT determines whether the basecase is voltage secure or insecure. In either case, a variety of reports are produced to show security violations, PV curves, voltages, flows and other system information.

Contingency Screening

To reduce the number of contingencies to be fully analyzed, VSAT uses a special powerflow-based contingency screening method to select a number of critical contingencies from the full list. The main features of contingency screening are:

- The method accounts for all non-linearities (i.e., not based on inaccurate linearized indices or interpolated trajectories).
- The method always accurately classifies the contingencies based on their true voltage stability margin.
- Screening is performed for specified power transfer.





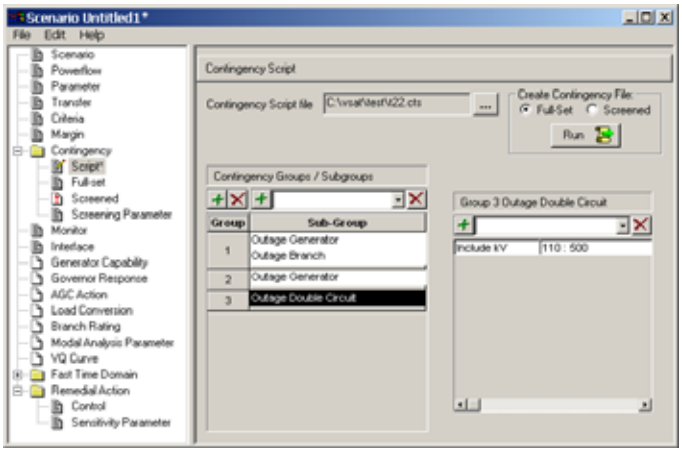
Security Assessment and Transfer Limit

VSAT finds the security limit of any number of specified **one-dimensional transfers** (defined in terms of one source and one sink) and **two-dimensional transfers** (three sources/sinks). Each source or sink may be defined as any combination of load and generation groups. Generation in each group can be scaled or rescheduled based on the user-defined order or share. There are more options to use when scaling generation to meet various dispatch requirements.

The security of the system and the transfer limits are based on the user-defined security criteria, which may include:

- Thermal limits.
- Voltage decline/rise limits.
- Reactive reserve margins.
- Voltage stability margin.

VSAT displays the limit of each transfer and identifies the limiting contingency as well as the criteria that are violated under that contingency.



Modeling and Monitoring

VSAT offers advanced modeling capabilities required for voltage stability analysis:

- Generator reactive power capability (D curves).
- Inclusion of AGC actions and governor responses in powerflow solution.
- Load models.
- ULTC control modes for pre and post-contingency.
- Special protection scheme (SPS) models.
- Combined cycle plant models.

In addition, different quantities can be monitored while perform PV analysis;

- Bus voltages.
- Circuit interface flows.
- MW and/or MVAR in groups of generators.

Solution Options

The VSAT engine uses a specialized powerflow solver designed to handle large complex systems and large number of contingencies. While achieving high computational performance, VSAT engine can also be set to respect various solution options, such as switched shunt controls, ULTC controls, AGC, area interchange controls, FACTS controls, etc.

Modal Analysis

Modal analysis (eigenvalue analysis of the system Jacobian) determines the areas prone to voltage instability. It provides lists of buses ranked by their participation in the critical modes. VSAT performs modal analysis at the voltage stability limit of the critical contingency, or any other user-specified operating point.

VQ Curves

VQ curves can be computed at user-specified buses, for all or selected contingencies, and at one or several points along the PV curve.

Remedial Measures

When VSAT indicates that an operating point is insecure, or the voltage stability margin is insufficient, the remedial measure (RM) module can be called to determine the most effective controls to remove all or selected security violations, or to increase the voltage stability margin to a desired value.

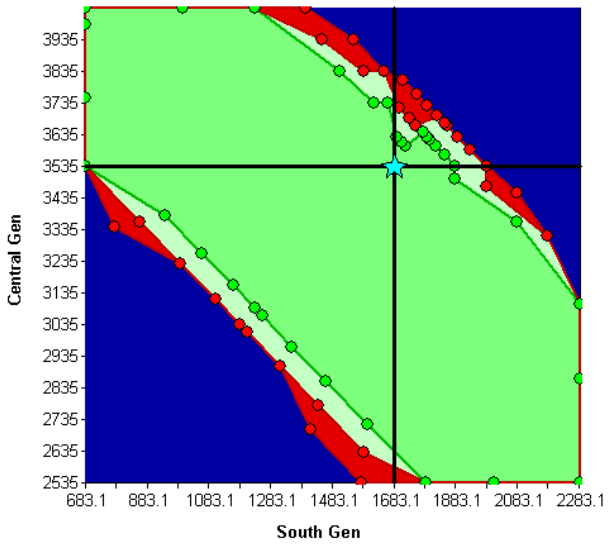
The RM module has the following salient features:

- It computes preventive, and if necessary, corrective actions required to achieve the objectives.
- Preventive actions include generator voltage adjustment, SVC/switchable shunt voltage scheduling, capacitor/reactor switching, ULTC tap adjustment, and generator redispatches; corrective actions include load shedding.
- Actions are selected based on sensitivities and their user-defined priorities.

Output Analysis

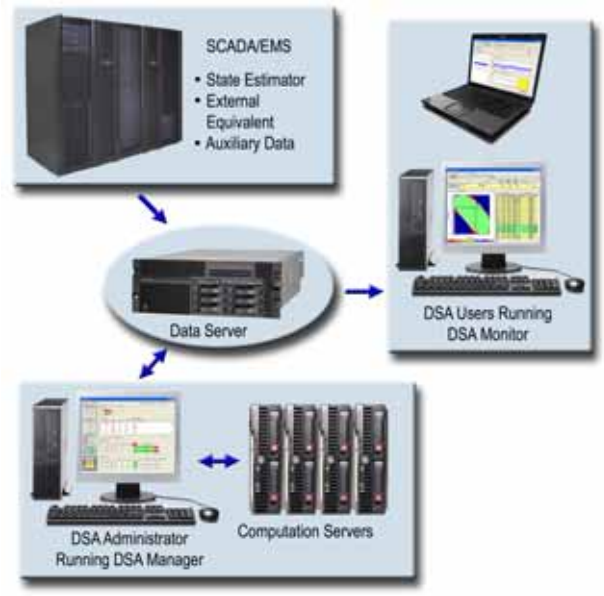
The output analysis module (DSAOA) is a tool for managing, viewing, and plotting the results of VSAT.

DSAOA displays all reports and outputs for each analysis scenario. The monitored variables (PV curves, QV curves, Interface flows, MVAR reserves, etc.) can be plotted in various combinations. 1-dimensional and 2-dimensional transfer limit plots can be created for all monitored quantities. Output plots can also be created in batch mode using scripts.



Other Features

- Connection with PSAT for viewing and editing base powerflow data.
- Powerflow case at any point on a P-V curve can be saved.
- Contingency script utility to automatically create single and multiple contingencies.
- Power system components can be identified using bus numbers, bus names, or equipment names.
- Case archive feature to store or to share study cases.
- Data conversion tool to import powerflow data in third party formats including PSS/E, PSLF, etc.
- Distributed computation to enable simultaneous analysis of a case with multiple contingencies and multiple scenarios on multiple servers, with scalable performance in terms of servers available.
- On-line VSA application with DSA Manager™ for connection with EMS system.
- Analysis of power systems of up to 100,000 buses.
- Runs on MS Windows 2000/XP/Vista/7 platform.



On-line dynamic security assessment using DSATools™

Other Powertech Services

- Evaluation of transfer capability and security limits
  - Powerflow analysis
  - Transient Stability analysis
  - Small-Signal Stability analysis
  - Voltage Stability analysis
- Post-mortem analysis of system disturbances
- Frequency control assessment
  - Islanding studies
  - AGC & governor performance
  - Design and evaluation of under-frequency load-shedding schemes
- Increasing transfer capability
  - Control-tuning and design
  - Load shedding schemes
  - Reactive compensation planning
  - Special protection system design and verification
- Assessment of planning alternatives
- Custom modelling & dynamic model reduction
- Reliability Assessment of power systems
- Generator field testing, model development & validation
- Load characteristic measurement and model development
- Custom software and model development
- Training

In addition to extensive power system study capabilities, Powertech has a $50 million lab and test facility which includes high voltage, high current, and high power labs, as well as capabilities in hydrogen technologies, chemistry, metallurgy, and materials engineering.

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