Transfer Capability Evaluation
TRACE

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Presentation Overview

- **Objective:**
  - Need for a high performance transfer capability tool
  - What is TRACE?
  - How WestConnect may benefit from TRACE?

- **Outline:**
  - Industry changes and their effect on transfer capability
  - TRACE capabilities
  - TRACE features and benefits
  - Services

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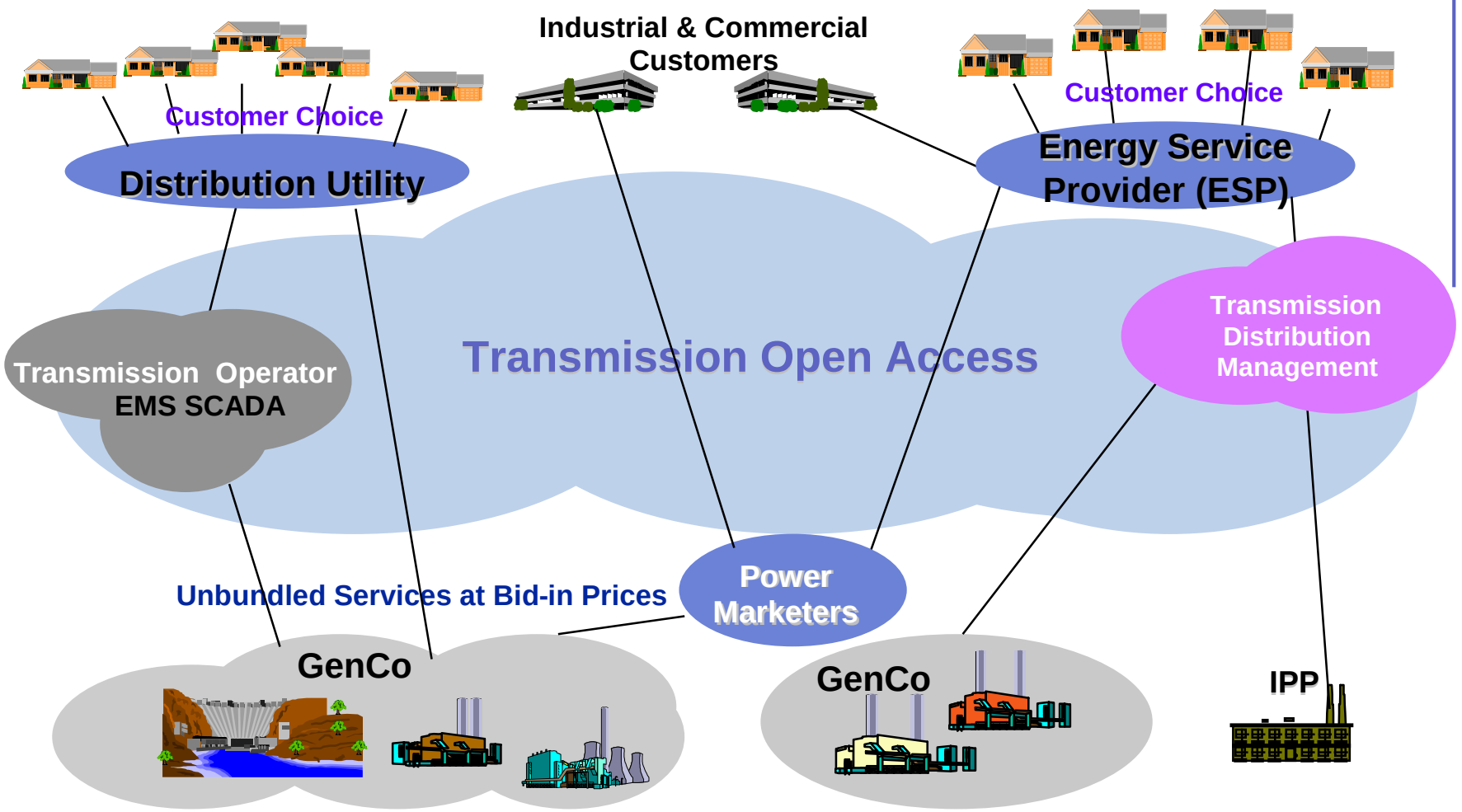
Utility Industry Restructuring



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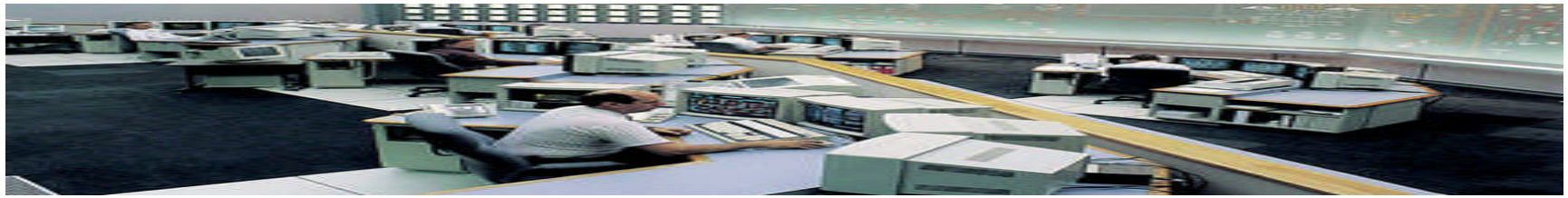
What has changed in the field?

- More transactions
- Voltage problems
- Simultaneous transfers
- “Irregular” transmission usage patterns
- Equipment being operated closer to their limits



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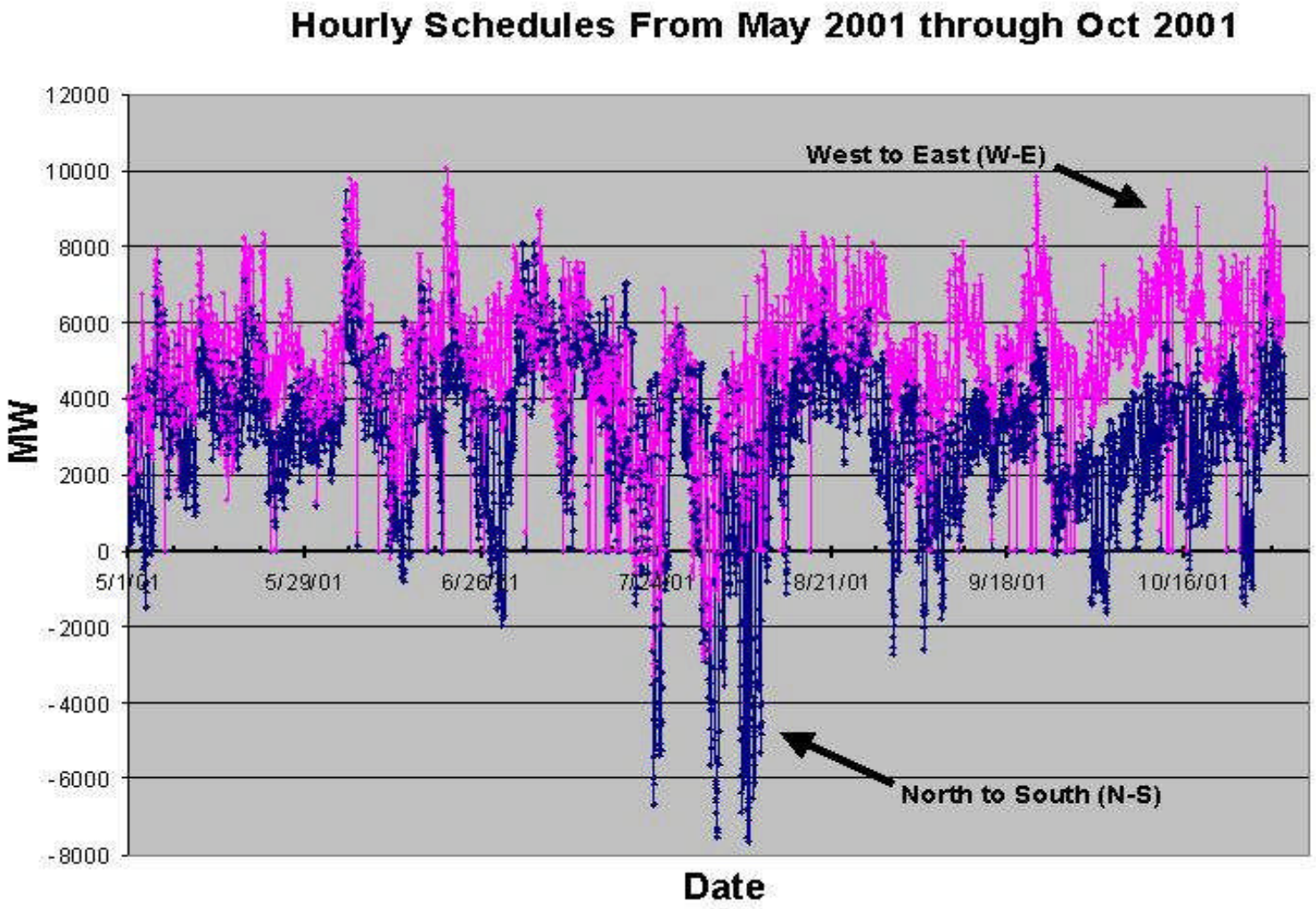
Increasingly Volatile



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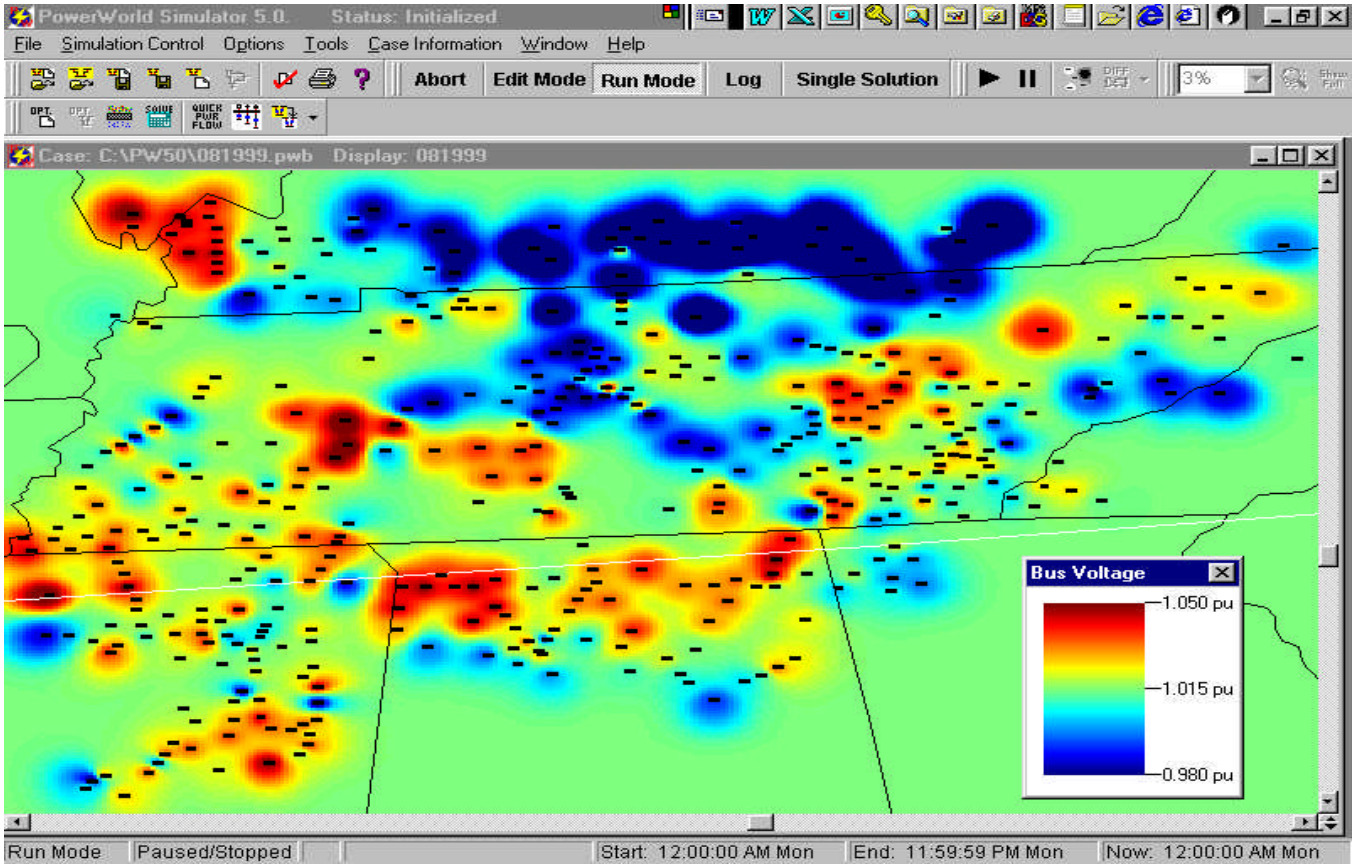
Typical Summer Voltage Problems



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Regulatory Requirements

- **Reliability Coordinators have a degree of responsibility for the reliability of the Interconnected Transmission System beyond their own Area.**
- **Each Reliability Authority must establish a reasonable scope of information and monitoring beyond their own area for their Reliability Coordinators, and establish daily procedures to coordinate and cooperate with other Reliability Authorities in day-ahead-planning and real time operations.**

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NERC - Key Requirements

- Simultaneous transfers
- Consideration of major contingencies, i.e. N-1 and severe multiple contingencies
- Reasonable and dependable transfer capability values
- Consideration of time variant power flows

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Industry Needs – Transfer Capability

- Flow based transfer capability/reliability
- Transfer/flow-gate limits
- Bottlenecks:
  - limiting contingencies
  - Limiting equipment
  - Other
- Best use of transmission assets
- Timely results

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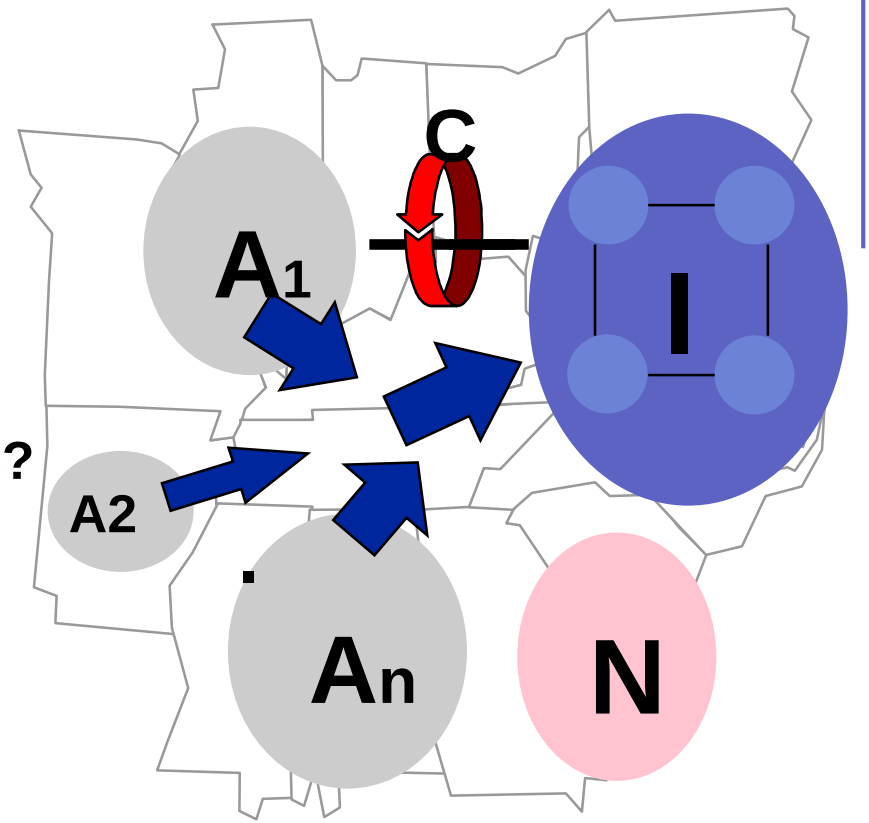
What is Transfer Capability?

Maximum MW Transfer:

- From A1 to I?
- From A1,A2,..& An to I?
- Through corridor / flow-gate C?



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Transfer Capability Measures

ATC/AFC = Available Transfer/Flowgate Capability

= TTC - Committed Capability - Required Margins

TTC = Total Transfer Capability

= ITC (Incremental Transfer Capability) + Base Transfer

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What is TRACE

- TRACE calculates the Maximum Simultaneous or Non-silmultaneous Transfer Capability between any parts of the power system, i.e. blocs, subject to operating and contingency security constraints.
- A bloc may include one or more buses, zones, areas.
- Uses technologies from ABB and Nexant sponsored by EPRI.

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TRACE Modeling Flexibility

- **AC Power flow**
  - Enables inclusion of voltage constraints
    - Optional DC model using the input AC power flow
- **Any size network**
  - 50,000 buses
  - Over 10,000 contingencies
- **Multiple simultaneous transfers**
  - Multiple areas/zones/buses
  - Bus-to-bus, area-to-bus, etc.
  - 1000’s flow-gates/corridors

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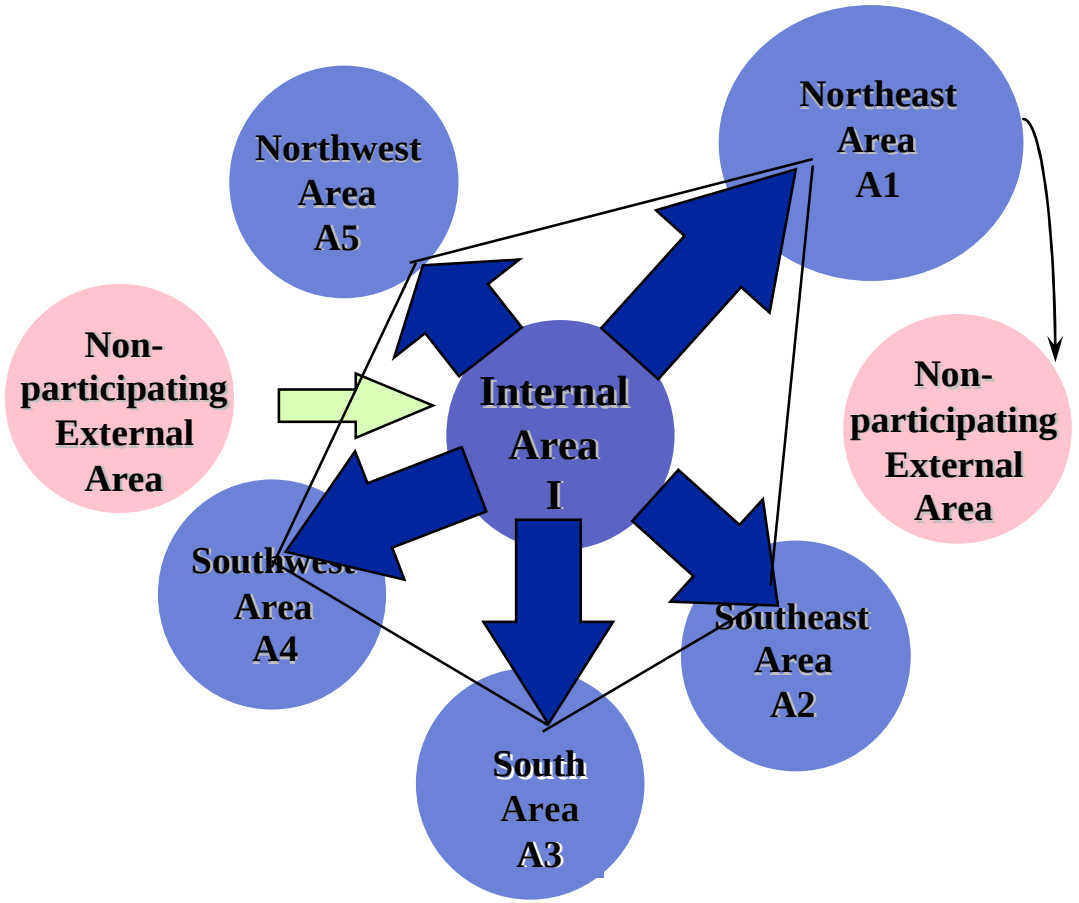
Simultaneous Transfers and Impact of Coincident Transfers



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TRACE Engine

- **Maximize transfer between parts of the system, e.g.**
  - **Import into a bloc from one or several blocs**
  - **Export from a bloc to one or several blocs**
  - **Flow through a corridor/flow-gate**

- **Subject to:**
  - **Power flow equations**
  - **Thermal limits**
  - **Voltage constraints**
  - **Stability limits (static)**
  - **Security constraints (contingencies)**

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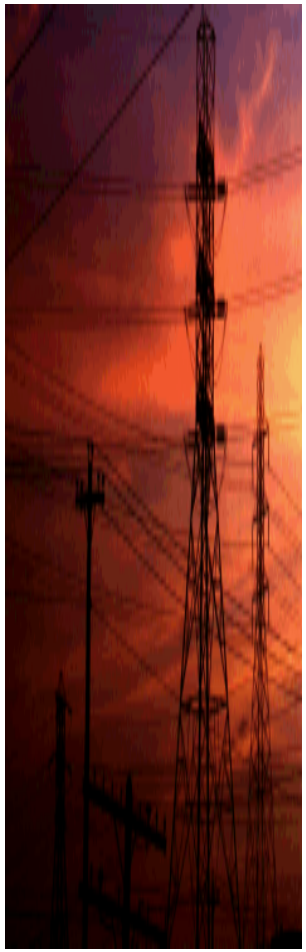
Active Power Controls (global)

- Generator MW output
  - 5 different generator participation methods
- Loads
- Phase shifter angles
- HVDC link flows



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Control: Generator Participation

Method 1 - The MW output of the units in the bloc vary in proportion to user-specified participation factors. No MW limits are enforced on each unit.

Method 2 - Same as method 1, except the participation factors are automatically calculated so that each unit participates in proportion to its initial spare capacity.

Method 3 - Each unit is a control variable subject to its own upper and lower limits.

Method 4 - Applies to internal units and only in an import study. Similar to Method 3, but attempts to de-load the lowest "priority" generator first.

Method 5 - Applies to internal units and only in an export study. Similar to Method 4, but attempts to load the highest "priority" generator first, and so on.

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Local controls

- **Active Power**
  - Area slack generator control to maintain net interchange
  - Generator post contingency automatic MW response, etc.

- **Reactive power**
  - Bus voltage control by:
    - Transformer tap
    - Shunt VAr switching
  - Generator voltage control within MVAr limits (may include SVC and synch capacitor equivalents)

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Realistic Constraints

- Branch MVA/Amp limits
- Flow-gate MW flow limits
- Pre- and post-contingency
- Operating procedures
- Voltage and voltage change limits
- Voltage phase angle difference limits
- Reserve requirements (area, unit, etc.)
- Area participation (% or MW)
- Impact of coincident transfers

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All Possible Contingencies

- **Single contingencies (N-1)**
- **Complex contingencies:**
  - Combination of outages, inages, bus splits and generator / load MW rescheduling
- **Pre- and post contingency constraints**
- **Operating procedures**

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Post-Contingency Operating Procedures

- **Operating procedure can be triggered by post-contingency branch overflow or flowgate overflow**
- **Examples of operating procedures:**
  - Generator outages
  - Branch outages / in-ages
  - Generator MW rescheduling
  - Load rescheduling
- **Multiple operating procedures for complex contingencies**

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TRACE Output

- **Various output:**
  - Displays (detailed tabulars, bubble diagrams)
  - Reports (**Oracle** and detailed file-based output)

- **Extensive results**
  - Power flow
  - Limiting contingencies/equipment and binding constraints
  - Various transfer capability results
  - Useful information on system capabilities:
    - transfers vs. constraints and transfers vs. controls

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Muti-tier Limiting Contingencies Evaluation

- Identify new limiting contingencies for various transfer levels by deactivating existing limiting contingencies and repeating the TRACE calculations
- Up to 15 tiers – each tier defined by limiting contingency(ies) constraints that are relaxed for calculating the next one
- Useful feature in operational planning study

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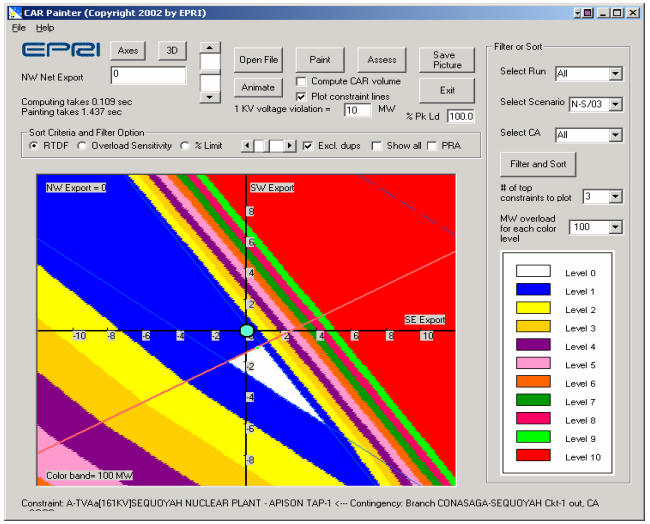
Open System – Various data interfaces

- **Industry Standard interface**
  - PSS/E
  - IEEE
  - PSADD
- **Oracle database**
- **Interface to any EMS**
- **Output for EPRI CAR program**
- **Import WECC Interfaces using GE Interface data format**
- **Import WECC contingency data**



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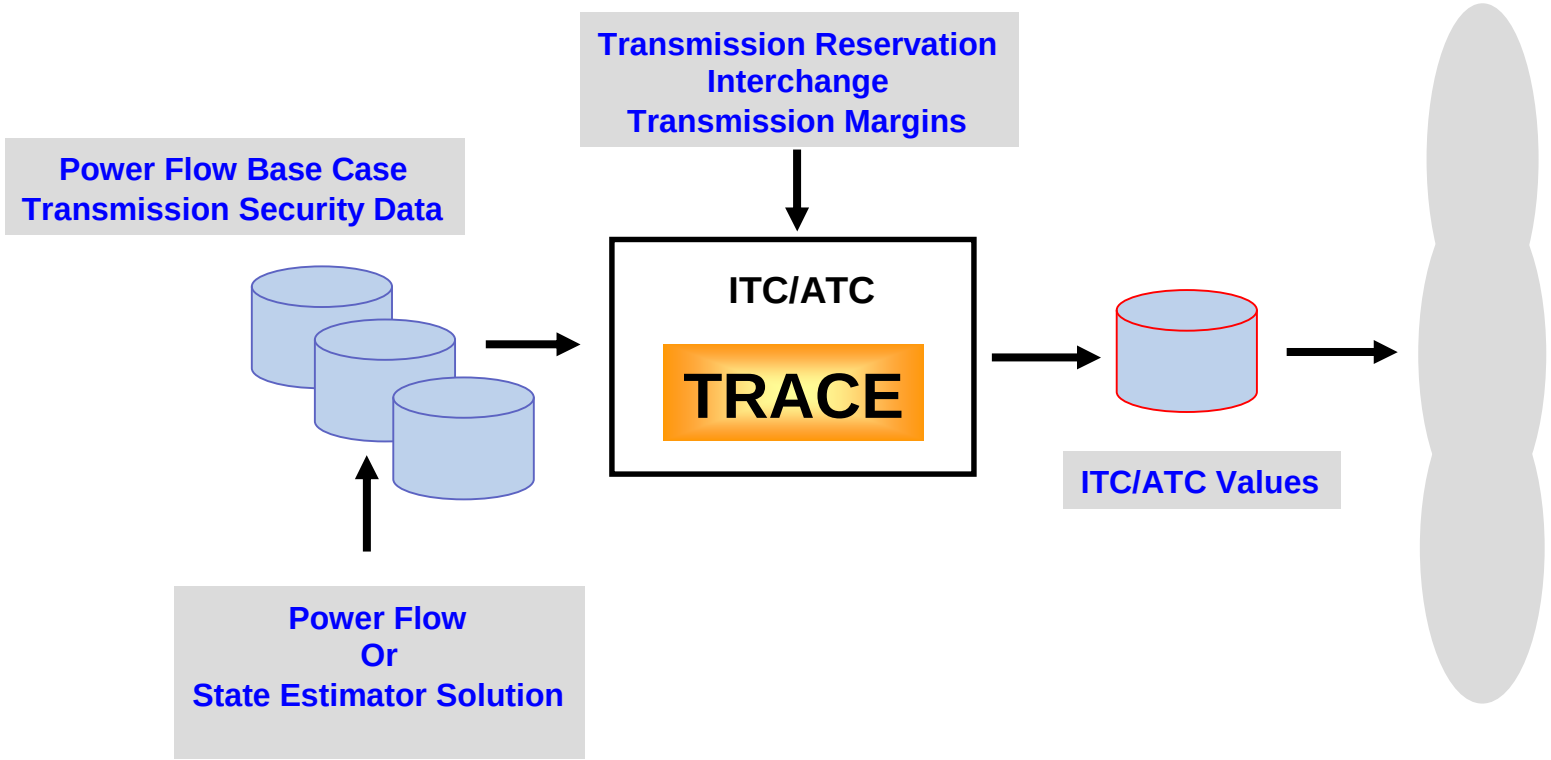
TRACE interface with existing EMS



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Data Engineering

- Import and export of power flow data
- Facilitate creation and modification of base data
  - Setup data
  - Constraint data
  - Contingency data
- Import and export of TRACE input data
- Import contingency data
- Import flowgate/Interface data from GE Interface format
- Import NERC flowgate data
- Perform extensive data validation
- Copy selected input data to create a new set of input data

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Summary – TRACE Application

- Calculate flow-based simultaneous or non-simultaneous transfer capability
- Identify:
  - System bottlenecks & limiting contingencies
  - Identify potential voltage problems
- Evaluate:
  - Operating procedures
  - Control strategies for congestion management
- Perform reliability analysis for outage evaluation/approval
- Evaluate security impact of coincident transfers
- Calculate constraint-control sensitivities for limiting contingency and non-limiting contingency constraints.

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Summary - User Benefits

- Flexible and powerful tool
  - Any size system
- Timely results at lower cost
- Reliable and repeatable results
- System insight
  - More accurate model
  - Rich analytical capabilities
- Optimal utilization of transmission asset
- Multi-user environment

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Software Services

- Deliver TRACE:
  - As a stand-alone application
  - Interfaced with operational planning tools
  - Integrated with the EMS
- Implement custom features
- Provide necessary training
- Set up TRACE study environment
- Provide maintenance and technical support

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Technical Support Services

- Set up database and validate data
- Perform reliability assessment
- Identify network bottlenecks (limiting contingencies and facilities, etc.) and voltage problems
- Evaluate enhancements
- Verify the effectiveness of various corrective measures including operating procedures
- Perform simultaneous/non-simultaneous transfer studies using AC or DC models

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