Synchrophasor-based Voltage Stability Assessment of Load Centers at Entergy

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Project Team

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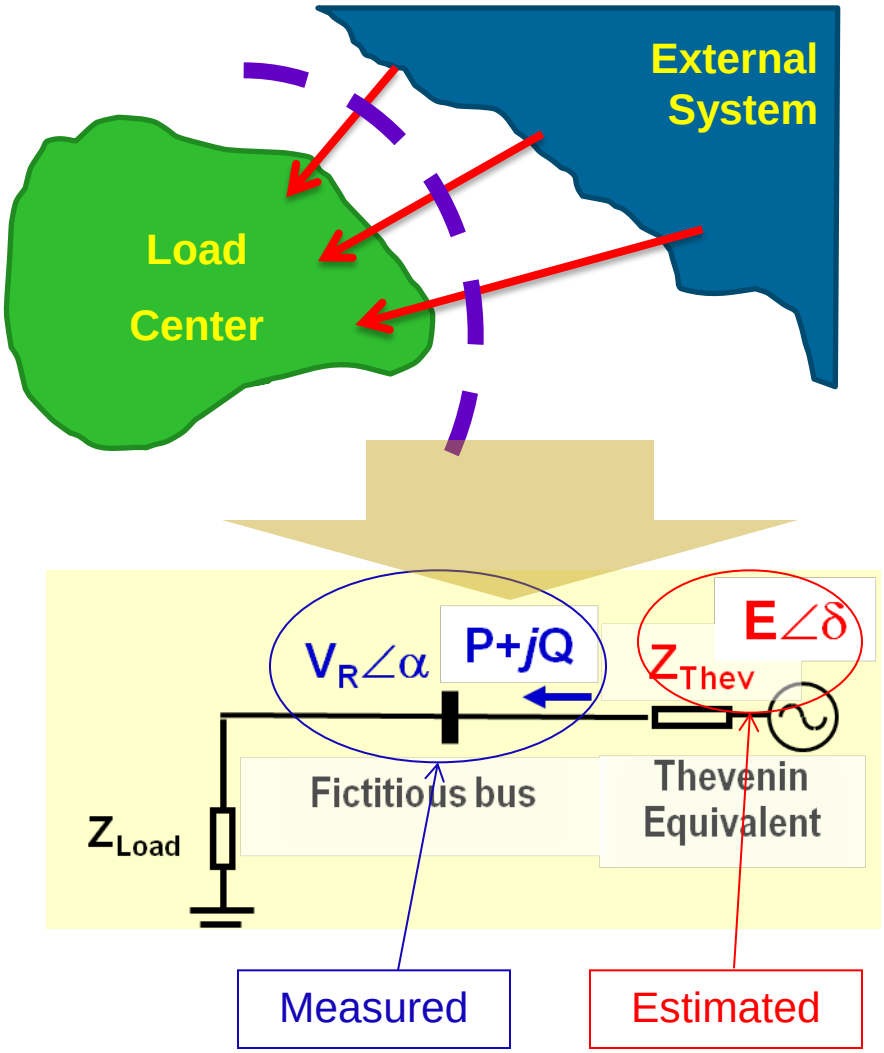
Background of EPRI's MBVSA Approach

Measurement-Based Voltage Stability Assessment (MBVSA)

Key Ideas

- Measurements only (no system model)
- Phasor measurements monitor boundary lines
- Thevenin equivalent for an area of one directional flow
- Calculate real and reactive margins for the boundary



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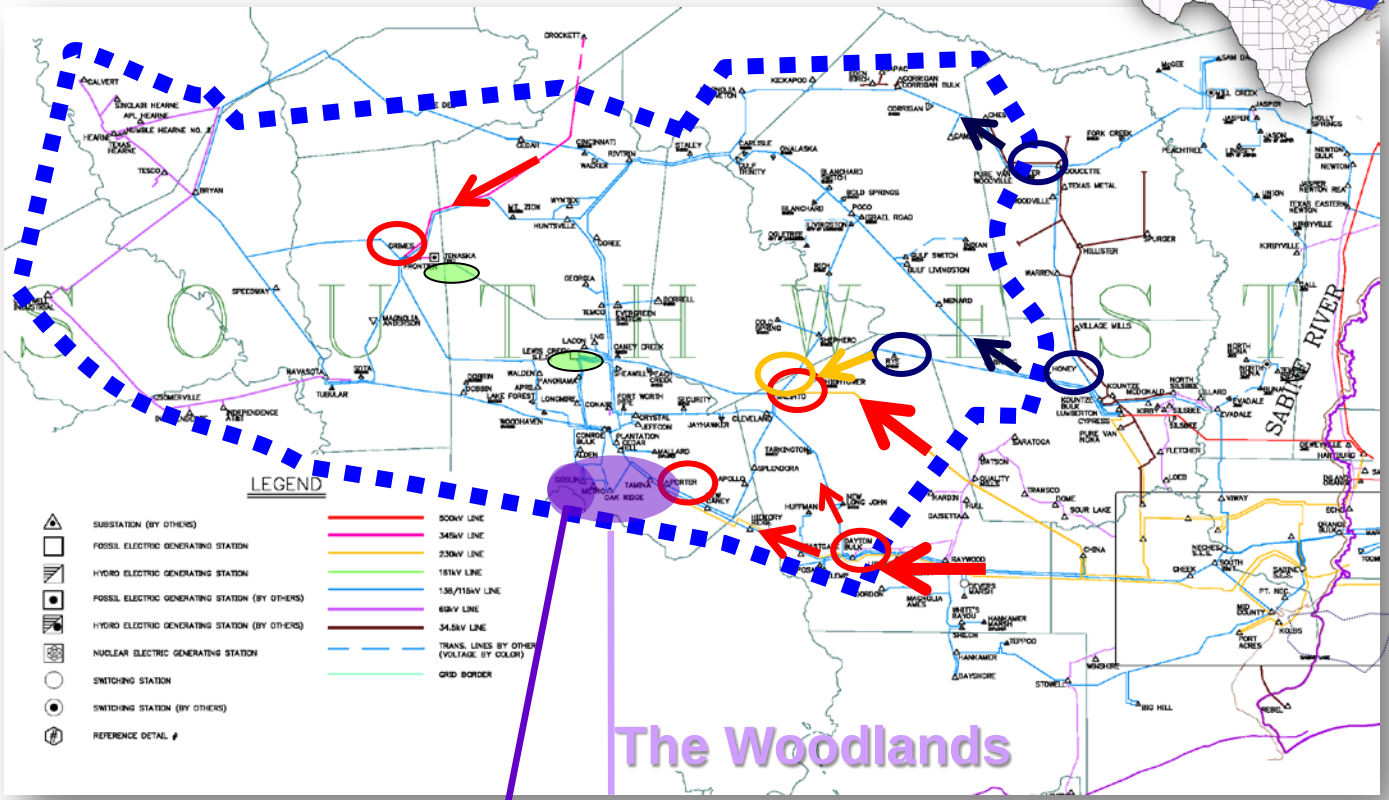
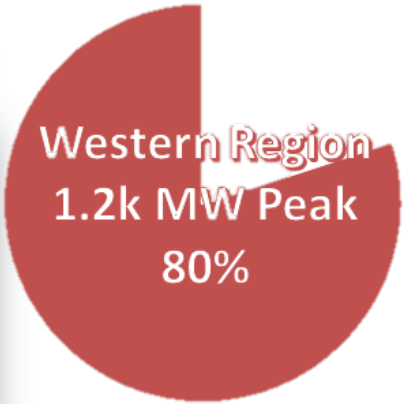
Application Area Entergy's Western Region (north of Houston)

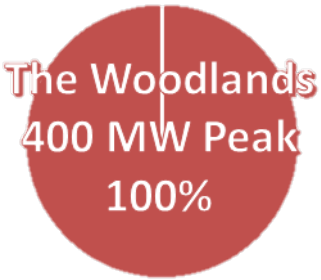
Internal Generation

Monitored Bus

Non-Monitored Bus







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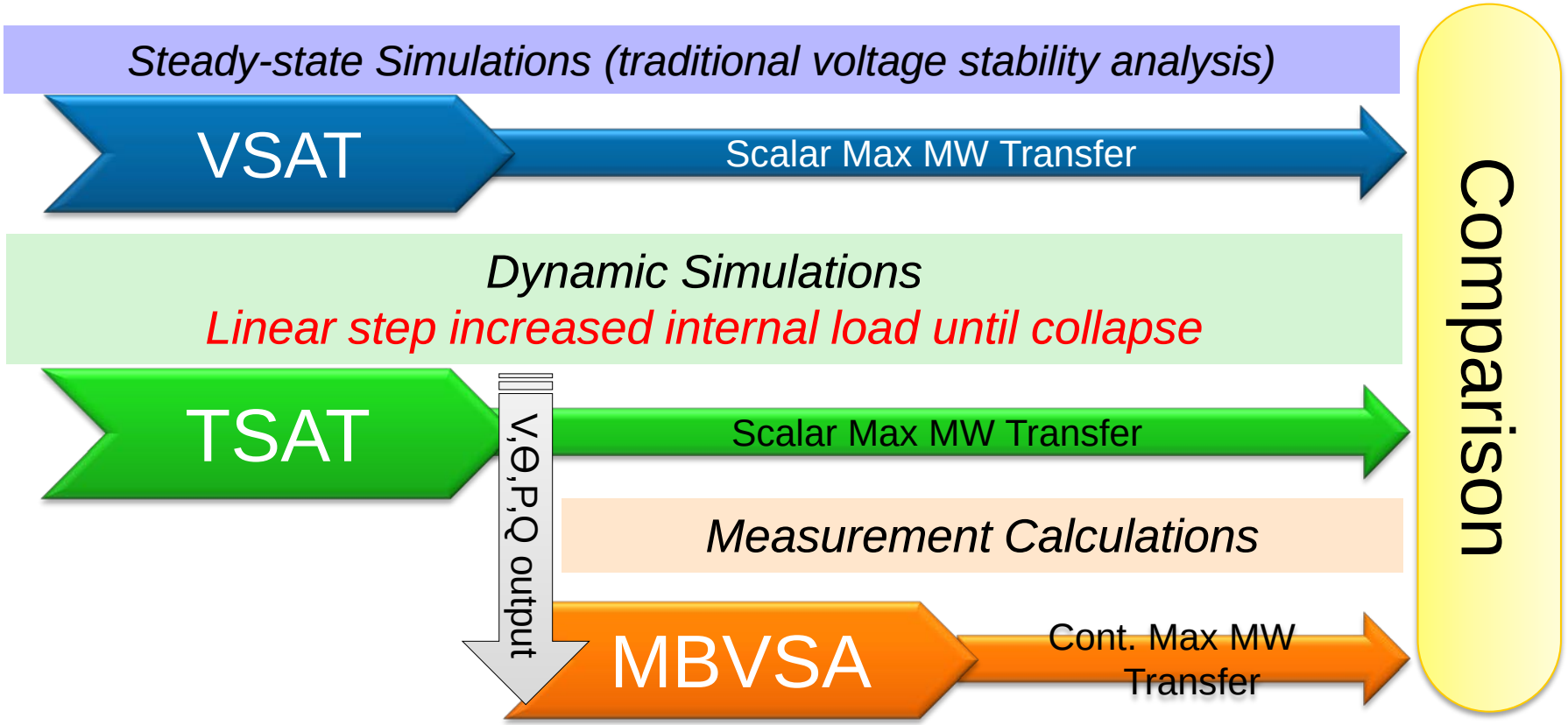
Offline Verification Study Process
2015 Summer Peak Case

PURPOSE: validate measurement-based applications with simulations

Steady-state (SS) and dynamic models are different.
SS provides a ballpark comparison.

Use only ZIP loads.
Long-term VS



Model Adjustments and Comparison of Max MW Transfers Between Tools

Initial max transfers significantly off between SS and Dynamics models

Tailored Dynamics: adjusted 6 exciter models s.t. Q at SS limits

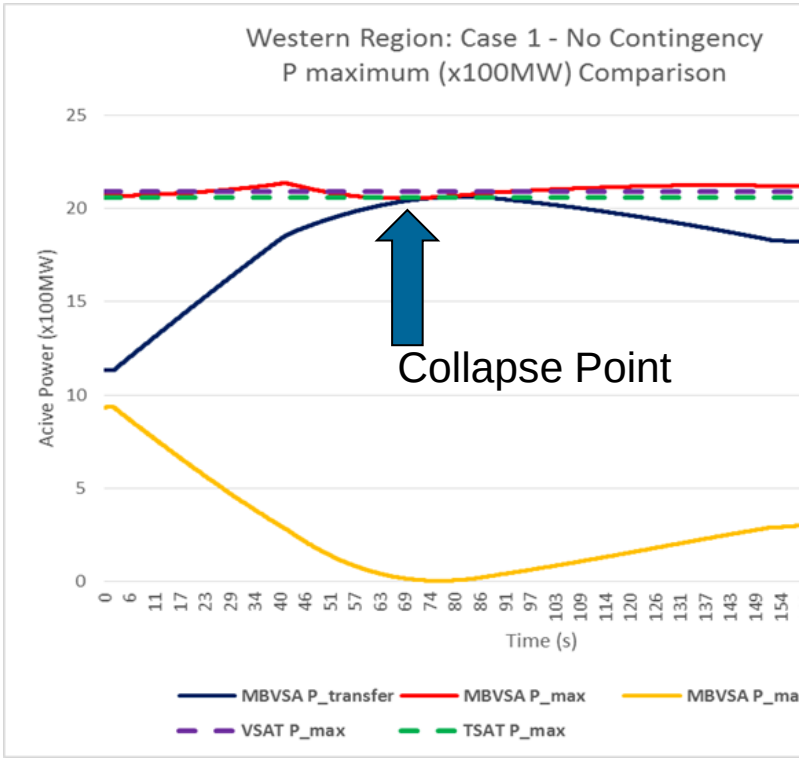
Thus, actual model parameters not accurate, *limit applicability of study*

COMPARISON OF MAX MW TRANSFER

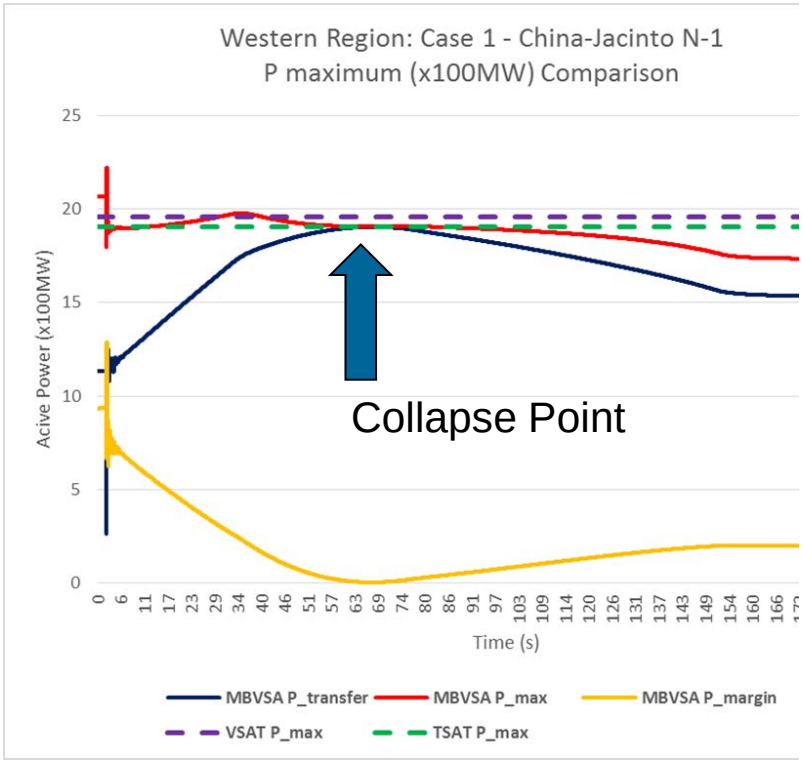
	Western Region			Goslin Station		
TOOL	**Base Case N-0**	**Boundary Line N-1**	**Internal Gen N-1**	**Base Case N-0**	**Boundary Line N-1**	**Internal Gen N-1**
VSAT (SS sim)	2091	1960	2000	187	176	165
TSAT (dynamics sim)	2062	1904	1999	179	168	159
MBVSA (from TSAT data)	2058	1907	1953	180	168	159
Δ VSAT-TSAT	29	56	1	8	8	6

Examples of Western Region Results (using adjusted model)

Base Case (N-0)



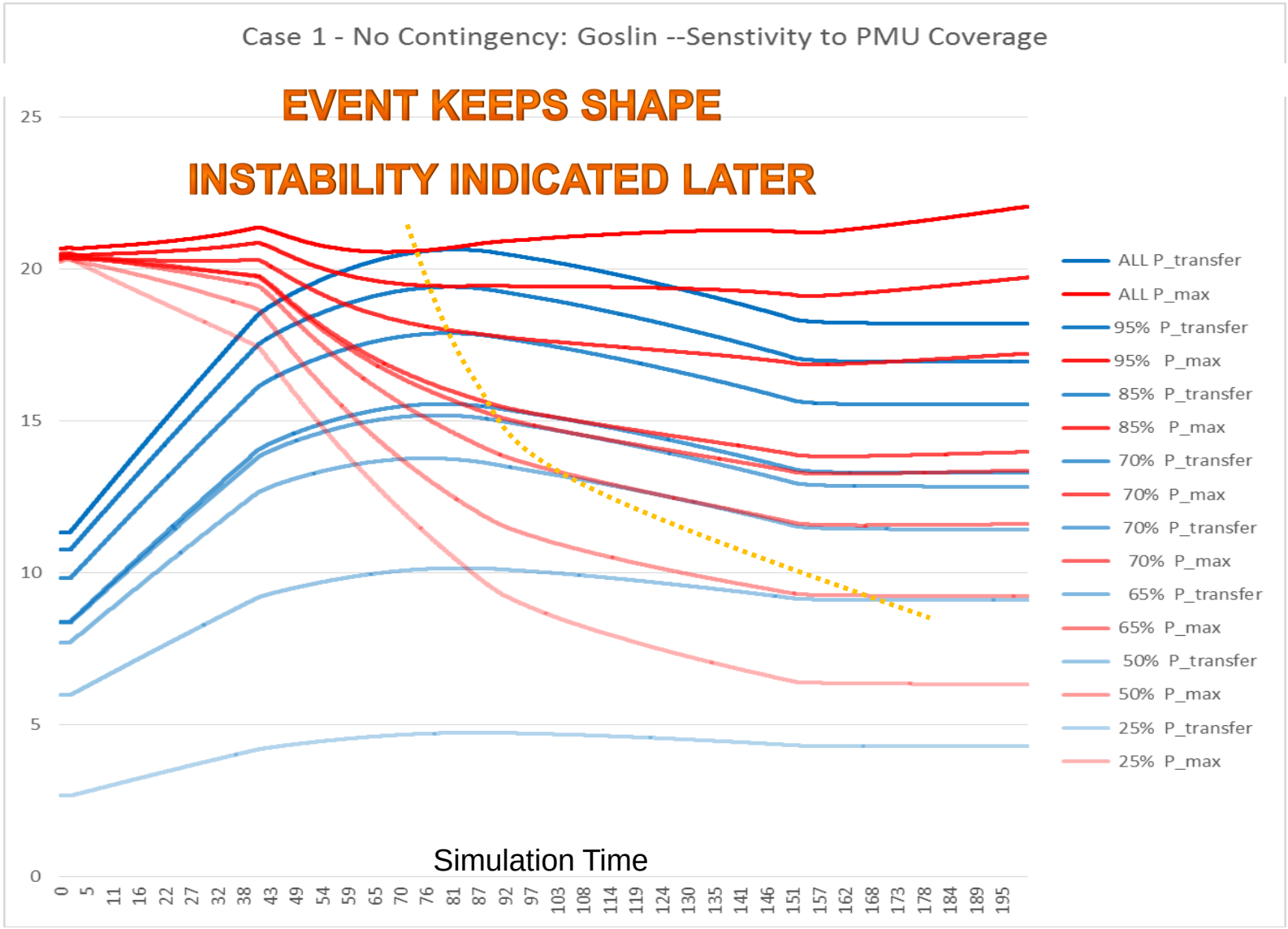
Trip of a Boundary Line (N-1)



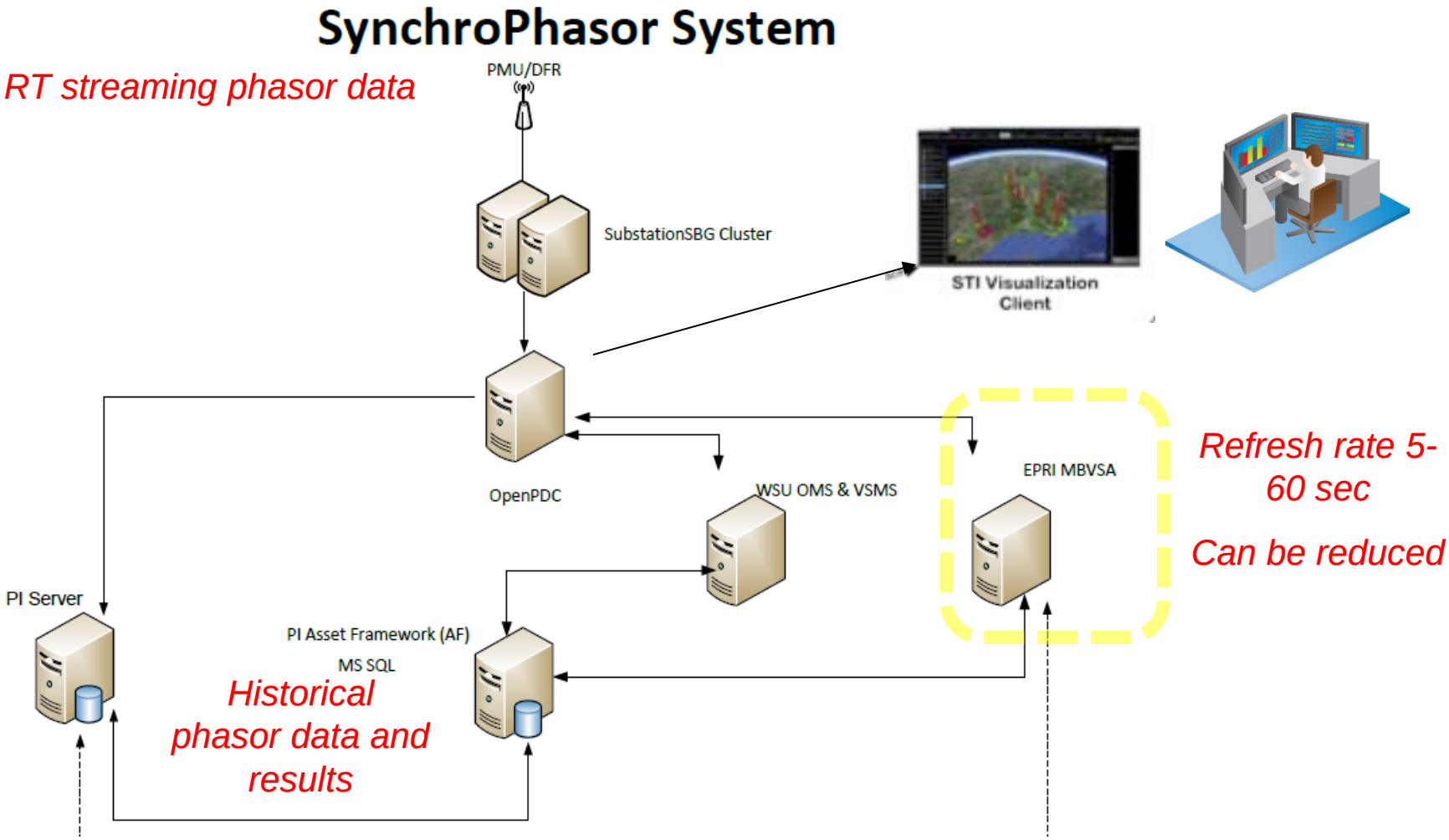
MAX MW TRANSFER CALCULATED IS REASONABLY CONSISTENT

REDUCED ACCURACY IN SOME OTHER SCENARIOS (GEN TRIP)

Sensitivity to PMU Boundary Coverage



Integration in the Online Testing Environment



Next Steps

- PMU Coverage
  - Look for opportunities to increase
- Refine Data Quality Checks
- Further Offline Studies
  - Include OLEs
  - Complex load models
  - Fast VS
- Integration
  - Streamline PI/OpenPDC interfacing
  - Further improve program stability
- Monitor Online Performance
  - Metrics
  - Event analysis
- Interpretation
  - Operator support
  - Training

Together…Shaping the Future of Electricity

Generator Reactive Power Before and After Adjustments