

# Synchrophasor-based Voltage Stability Assessment of Load Centers at Entergy

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**NASPI Working Group Meeting**  
**San Mateo, CA**  
March 23<sup>rd</sup>, 2015



# DOE Funding Acknowledgement

Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number(s) DE-OE0000375

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# Project Team

- Entergy Program Manager: Floyd Galvan
- Entergy Team Supporting:
  - Angela Nelson, Mark Thomas, KC Rubal
  - Sharma Kolluri, Cat Wong, Jay Raymamurthy, Adrian Lazo, Maryclaire Peterson

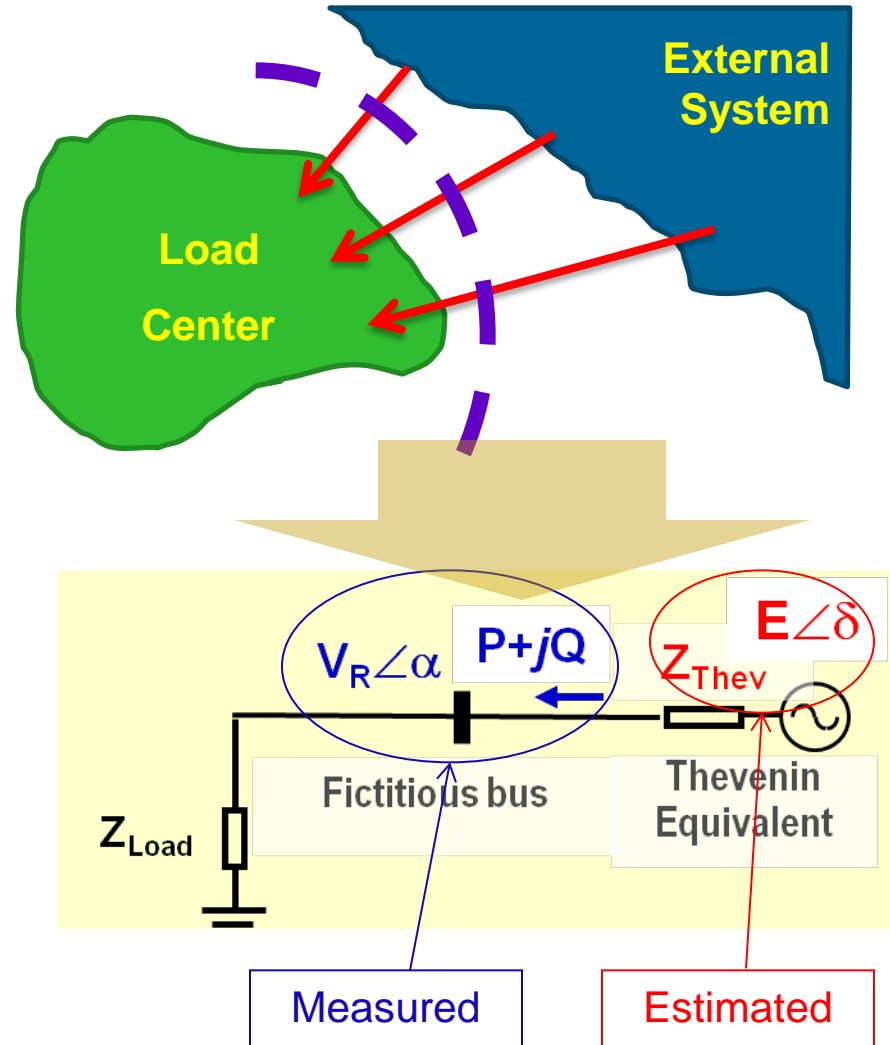


# Background of EPRI's MBVSA Approach

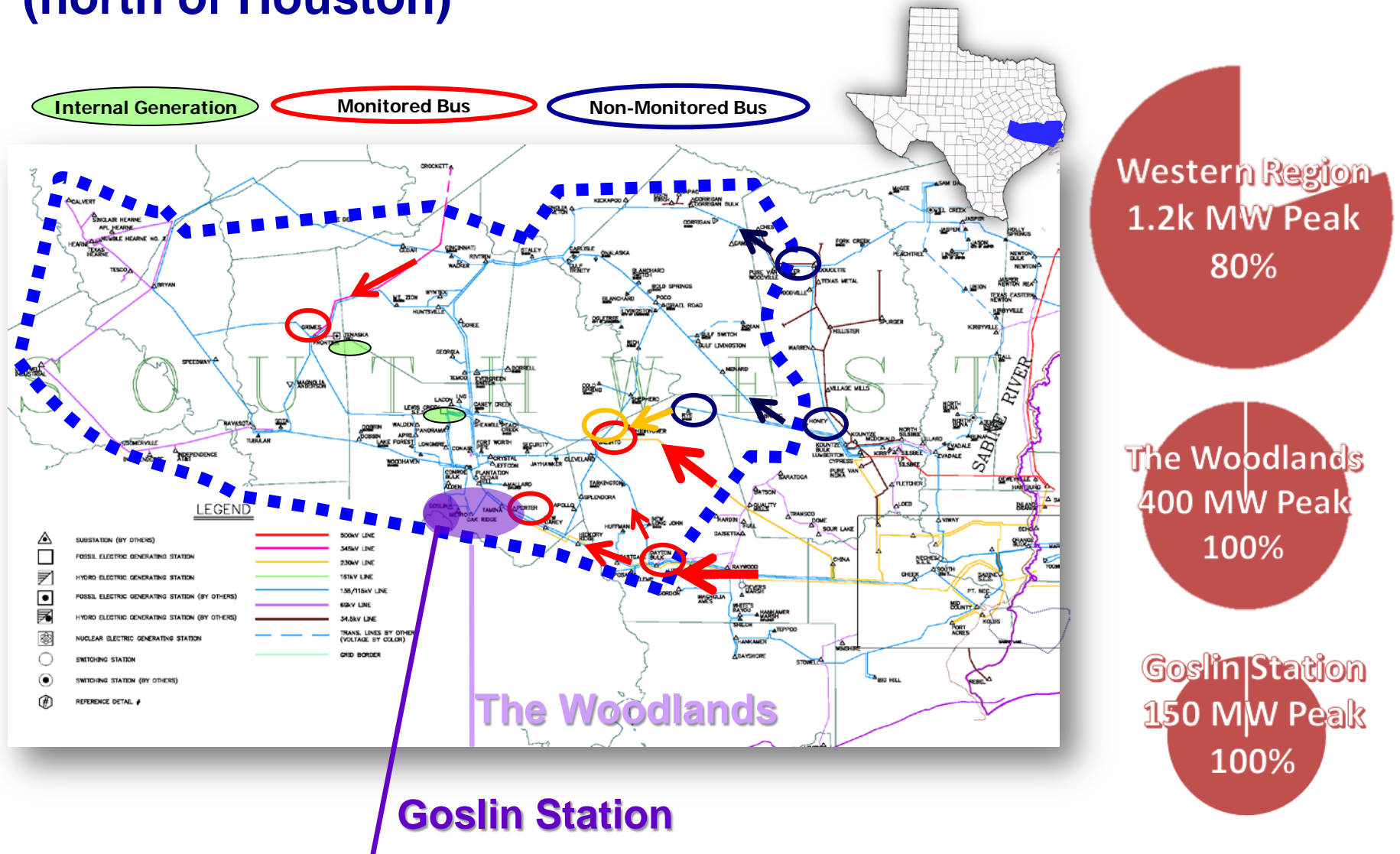
## Measurement-Based Voltage Stability Assessment (MBVSA)

### 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



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



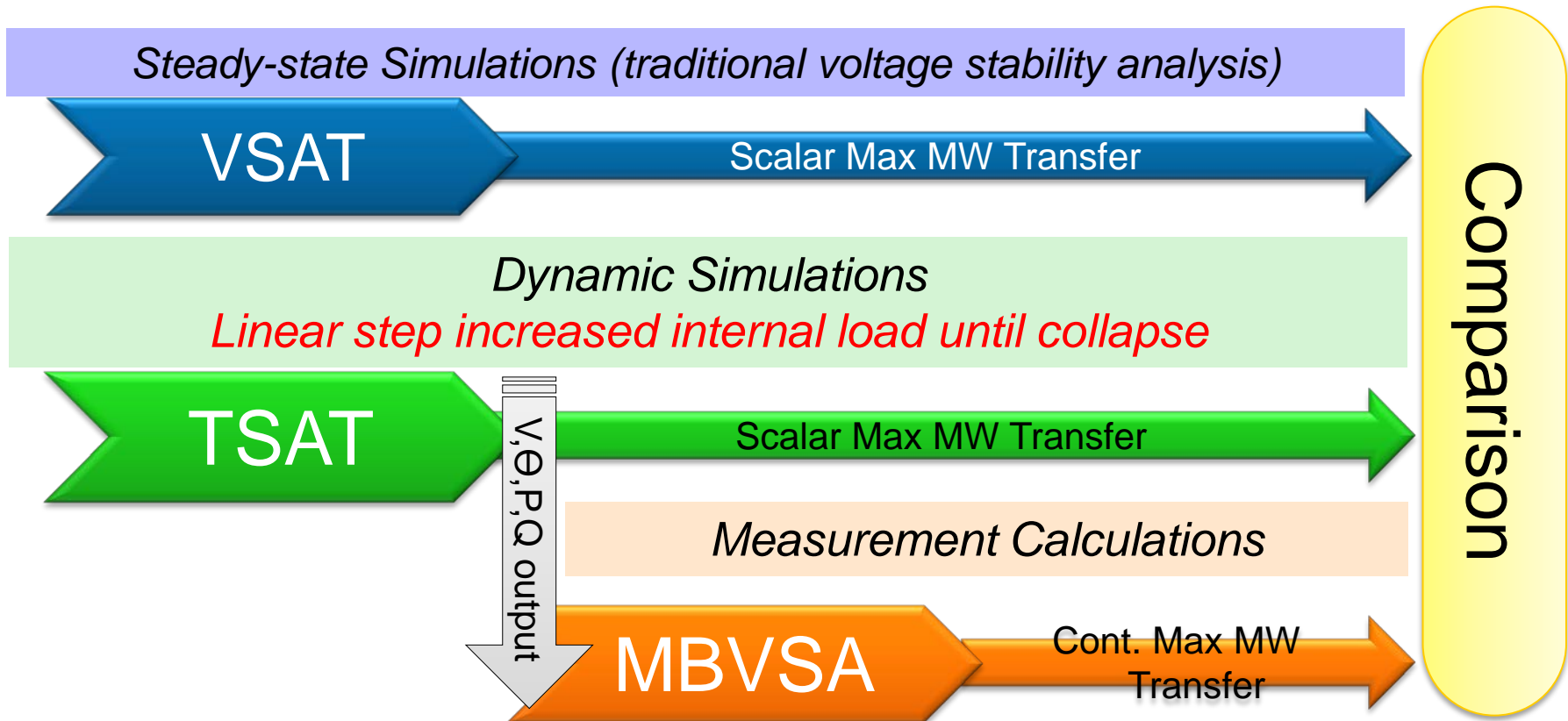
# Offline Verification Study Process

## 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

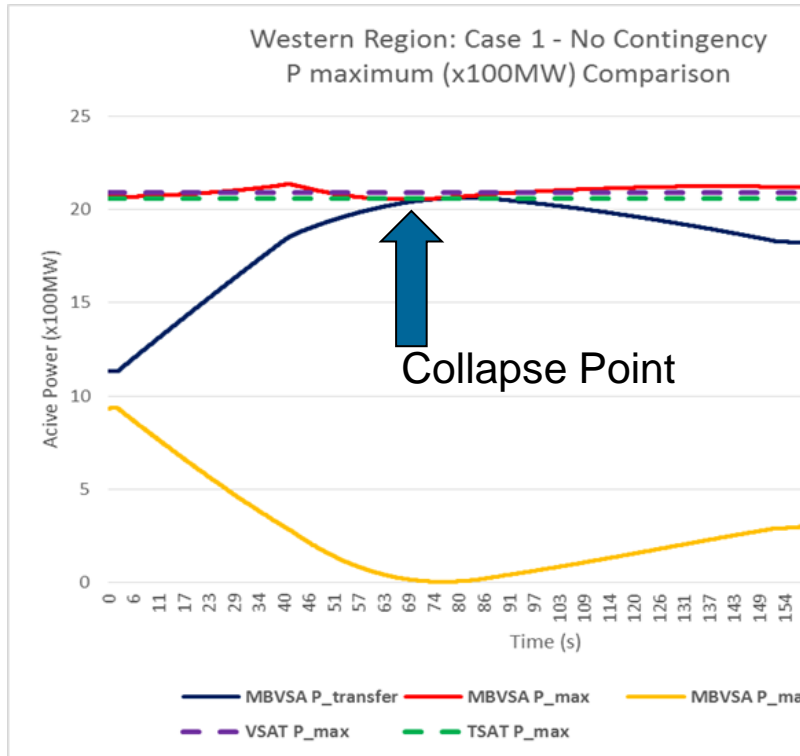
Thus, actual model parameters not accurate, *limit applicability of study*

## COMPARISON OF MAX MW TRANSFER

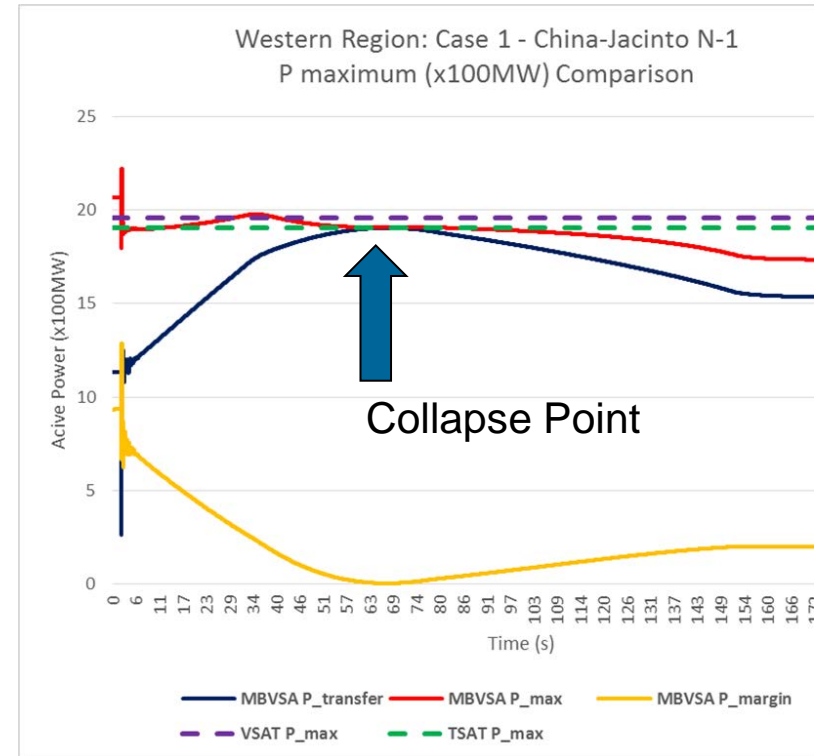
	Western Region				Goslin Station		
<b>TOOL</b>	Base Case N-0	Boundary Line N-1	Internal Gen N-1		Base Case N-0	Boundary Line N-1	Internal Gen N-1
<b>VSAT</b> (SS sim)	2091	1960	2000		187	176	165
<b>TSAT</b> (dynamics sim)	2062	1904	1999		179	168	159
<b>MBVSA</b> (from TSAT data)	2058	1907	1953		180	168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

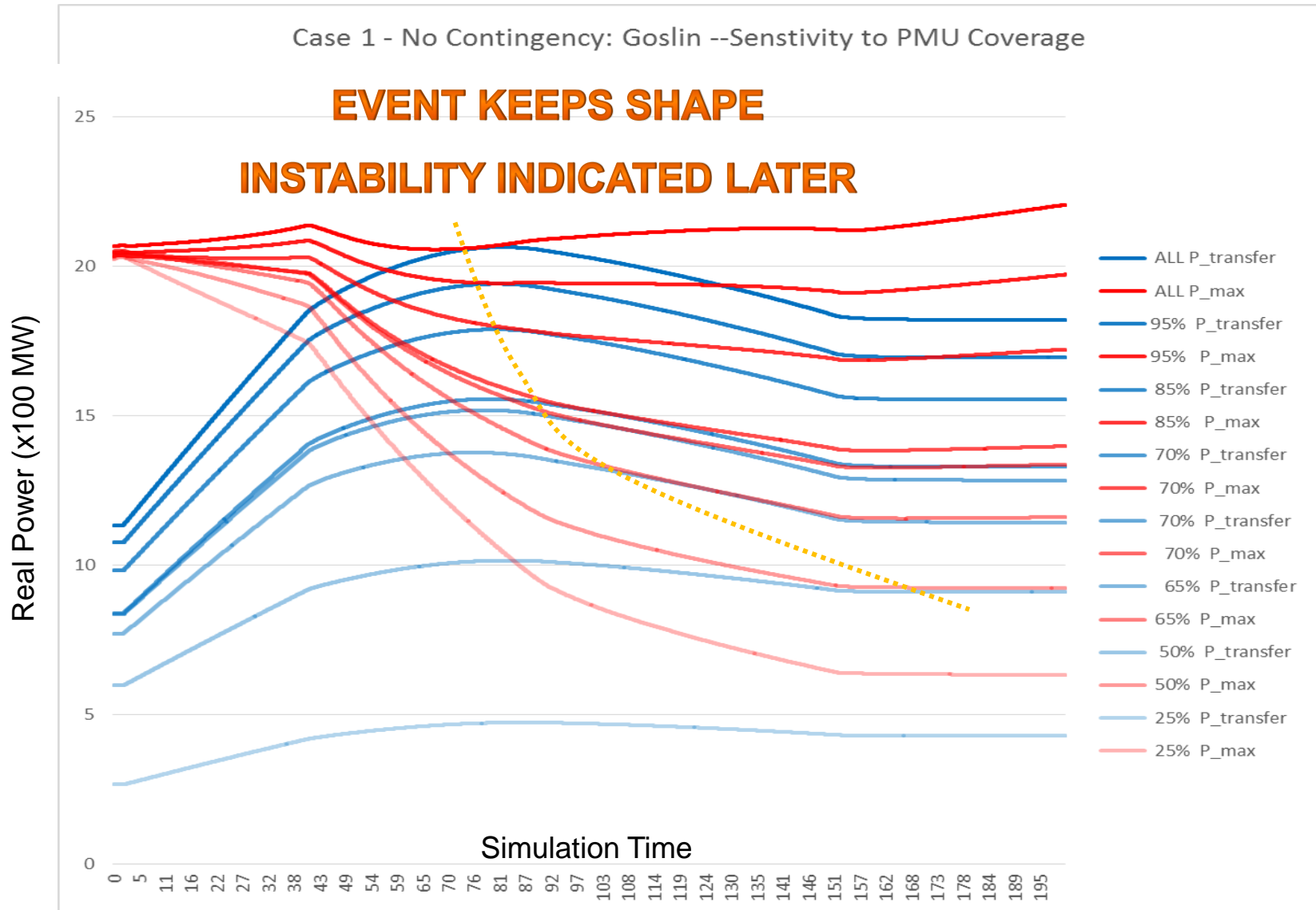


**MAX MW TRANSFER CALCULATED IS  
REASONABLY CONSISTENT**

**REDUCED ACCURACY IN SOME OTHER  
SCENARIOS (GEN TRIP)**



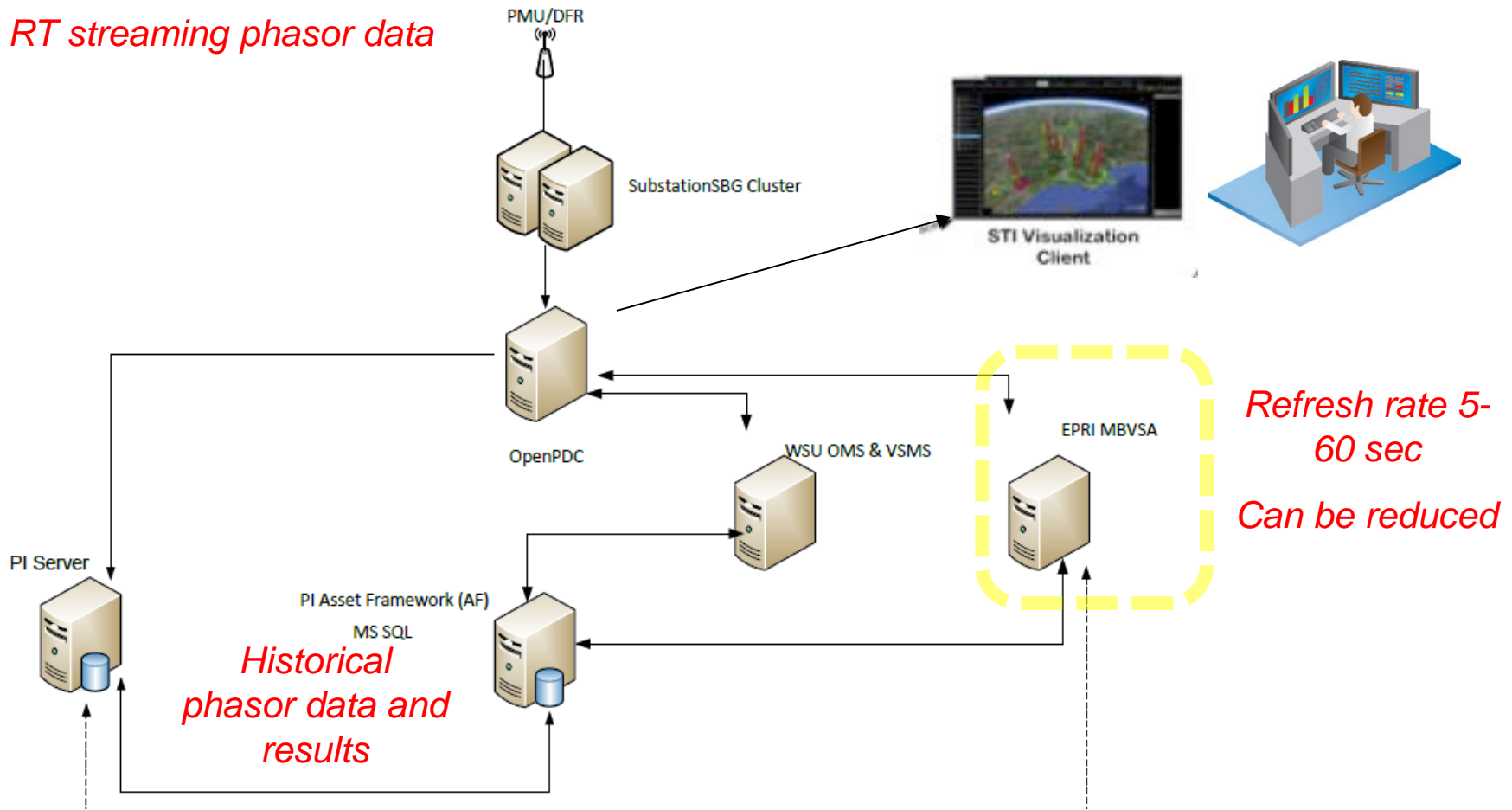
# Sensitivity to PMU Boundary Coverage



# Integration in the Online Testing Environment

## SynchroPhasor System

*RT streaming phasor data*



# 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

