

# Hybrid State Estimation Combining SCADA and Synchrophasor Data



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# Acknowledgement

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# Outline

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- **About NYPA**
- **NYPA past experience with hybrid state estimation.**
  - Electric Power Research Institute
  - Siemens Power System Control
- **NYPA current state estimation project.**
  - US Department of Energy
  - Quanta Technology
  - Electric Power Group

# About NYPA – NYPA Generation



- Wholesale power supplier throughout New York State and neighboring states as required by law.
- Provides, with generation and power purchases, about 25% of New York State's electricity with a mix of 70% hydro and 30% gas/oil



- Niagara Power Project  
**~2,675 MW**
- St. Lawrence Power Project  
**~800 MW**
- Blenheim-Gilboa Pumped Storage  
**~1,160 MW**
- Flynn Power Plant  
**~167 MW**
- Astoria CC Plant  
**~500 MW**
- Small Hydro Plants  
**~83 MW**
- Small Clean Power Plants  
**~461 MW**

# About NYPA – The NYPA Transmission Assets



More than 1,400 circuit miles of backbone transmission throughout New York state



- 765 kV Transmission  
**~155 circuit miles**
- 345 kV Transmission  
**~928 circuit miles**
- 230 kV Transmission  
**~338 circuit miles**
- 115 kV Transmission  
**~35 circuit miles**
- Total Transmission  
**~1,456 circuit miles**
- Bulk Transmission Substations  
**21 substations**
- Portion of Bulk NYS Grid  
**~13% (>115kV)**  
**~34% (>230kV)**

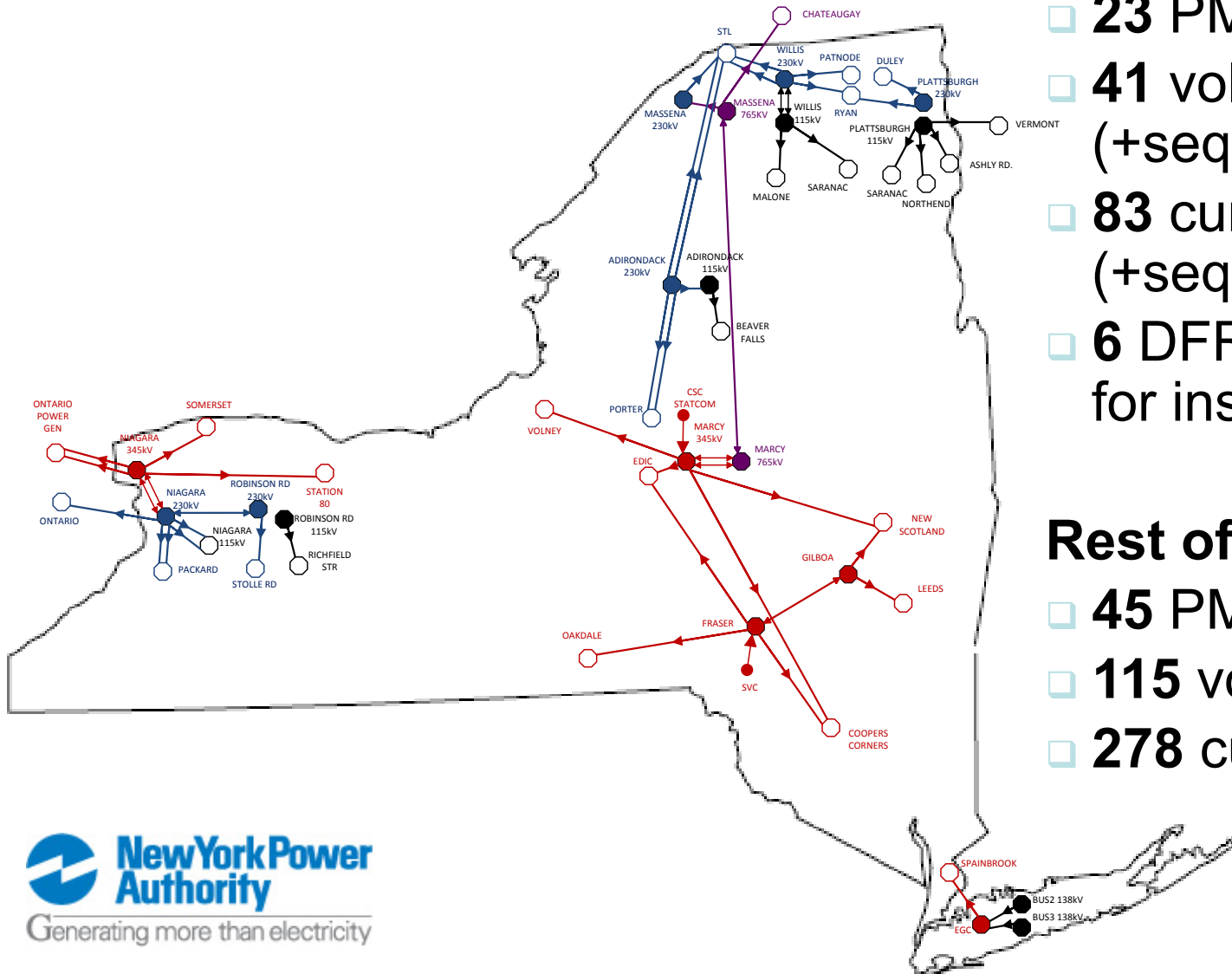
# NYPA Phasor Measurements

## NYPA

- 23 PMUs
- 41 voltage phasors (+seq)
- 83 current phasors (+seq)
- 6 DFR/PMU planned for installation

## Rest of NY TOs

- 45 PMUs
- 115 voltage phasors
- 278 current phasors



# Use of Phasor Measurements in Commercial SE

## Collaborators

- NYPA
- EPRI
- SIEMENS

## Synchrophasors

- 34 phasor measurements (10 voltages, 24 currents)
- Data down-sampling to match SCADA rates

## EMS

- 1538-bus network
- 850 SCADA telemetry data
- Additional pseudomeasurements
- SE execution at EMS standard rates

## Project Conclusions

- ❑ Nine distinct tests to assess effects on SE quality, impact of noise levels, bad data detection, reference bus impact, impact on convergence and iterations etc.
- ❑ Minimal effect of synchrophasors because of the low number of available data (about 4% PMU/SCADA ratio)
- ❑ Minimal effect on convergence properties
- ❑ Minimal effect when phasors were included as part of initial state vector estimate
- ❑ PMU data improve observability
- ❑ Accuracy of PMU measurements affects SE
- ❑ Time skewness effect between SCADA and PMU data
- ❑ Crucial selection of reference bus



# DoE Synchrophasor Demo Project of DNSE

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## Collaborators

- Quanta
- NYPA
- EPG
- DoE

## Synchrophasors

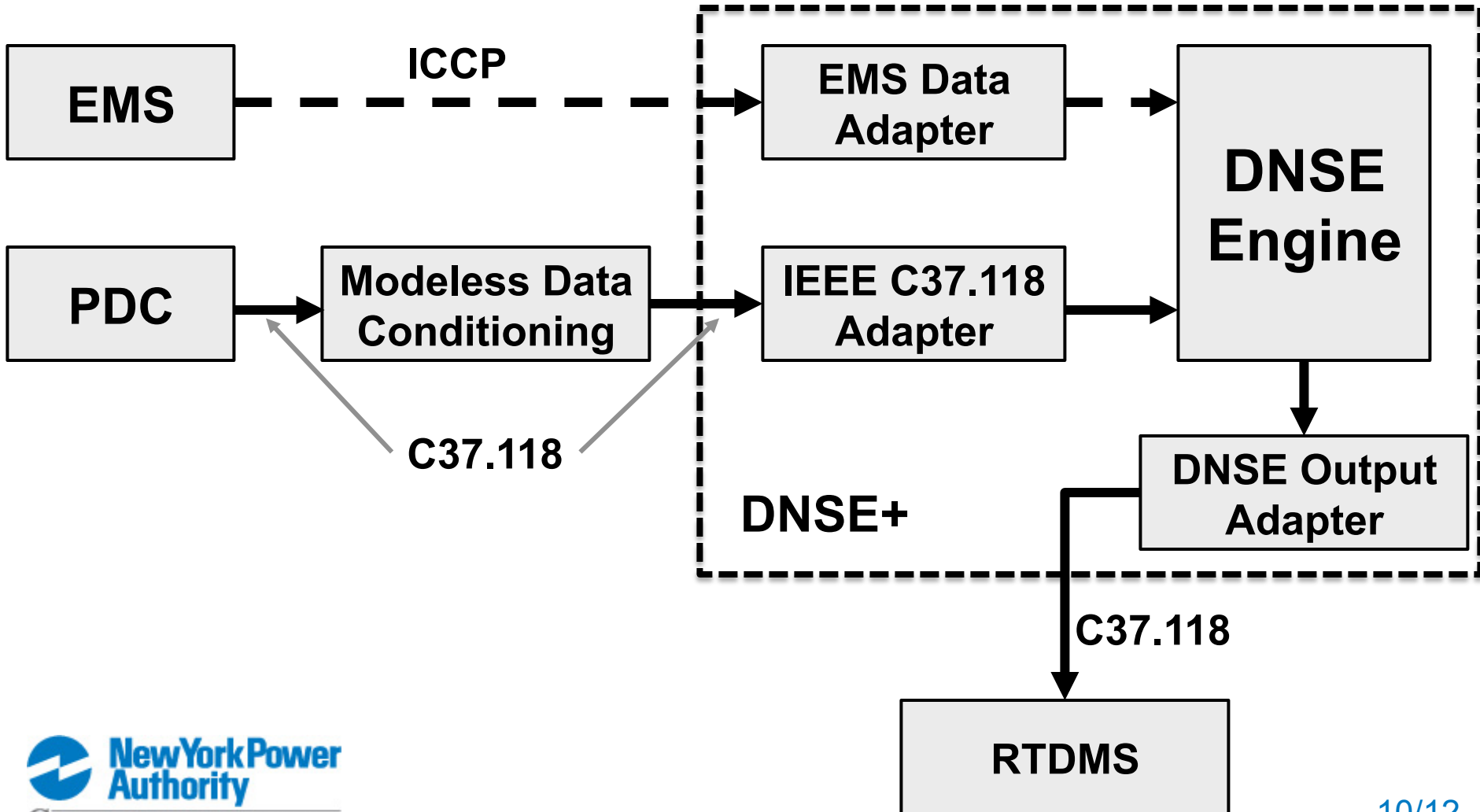
- 124 NYPA phasor measurements
- 393 other TO phasor measurements
- 40% PMU/SCADA data ratio
- SE execution at near synchrophasor rate

## EMS

- 1600-bus network (960 NY buses)
- 1300 SCADA telemetry data
- Additional pseudomeasurements
- Digital status points

# DoE Synchrophasor Demo Project of DNSE

## Conceptual System Architecture



## Key Features and Challenges

### DNSE+ Features

- ❑ Hybrid SE: Combines both SCADA and PMU data to obtain the complete state of system using redundant information
- ❑ Non-linear formulation; Non-iterative solution
  - ❑ Based on Kipnis-Shamir re-linearization technique
- ❑ Executed at nearly phasor data rate

### DNSE+ Challenges

- ❑ Very large, sparse linear systems to be solved
- ❑ Computational intensity of equation formulation
- ❑ Sensitivity to measurement noise
- ❑ “Synchronization” of data



# New York Power Authority

Generating more than electricity

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