Smart Grid Dispatch Optimization Control Techniques for Transactive Energy Systems

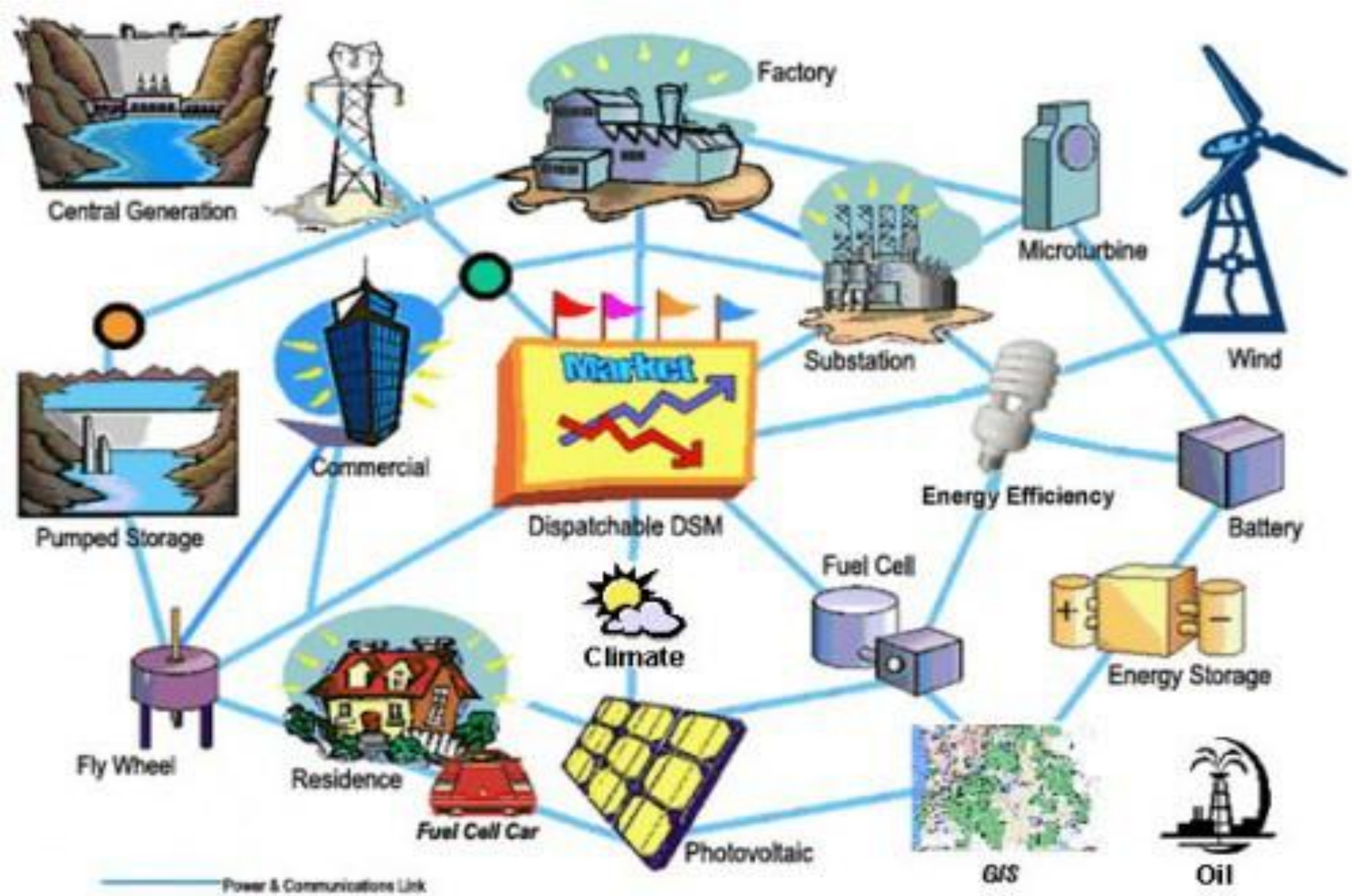
Shawn Chandler
Department of Electrical and Computer Engineering
Portland State University

IEEE Sustech 2014

Transactive Systems

- Transactive systems
  - Use an economic signal to integrate systems across the electrical power system interconnect
  - If the price is low, participants draw power from the grid
  - If the price is high, participants draw or reduce power from local resources such as distributed generation, demand response and so forth
- Demonstrated in the Pacific Northwest Smart Grid Project – PNNL / Battelle

Transactive System is a Complex System



Source: Cleantechnica.com 2012

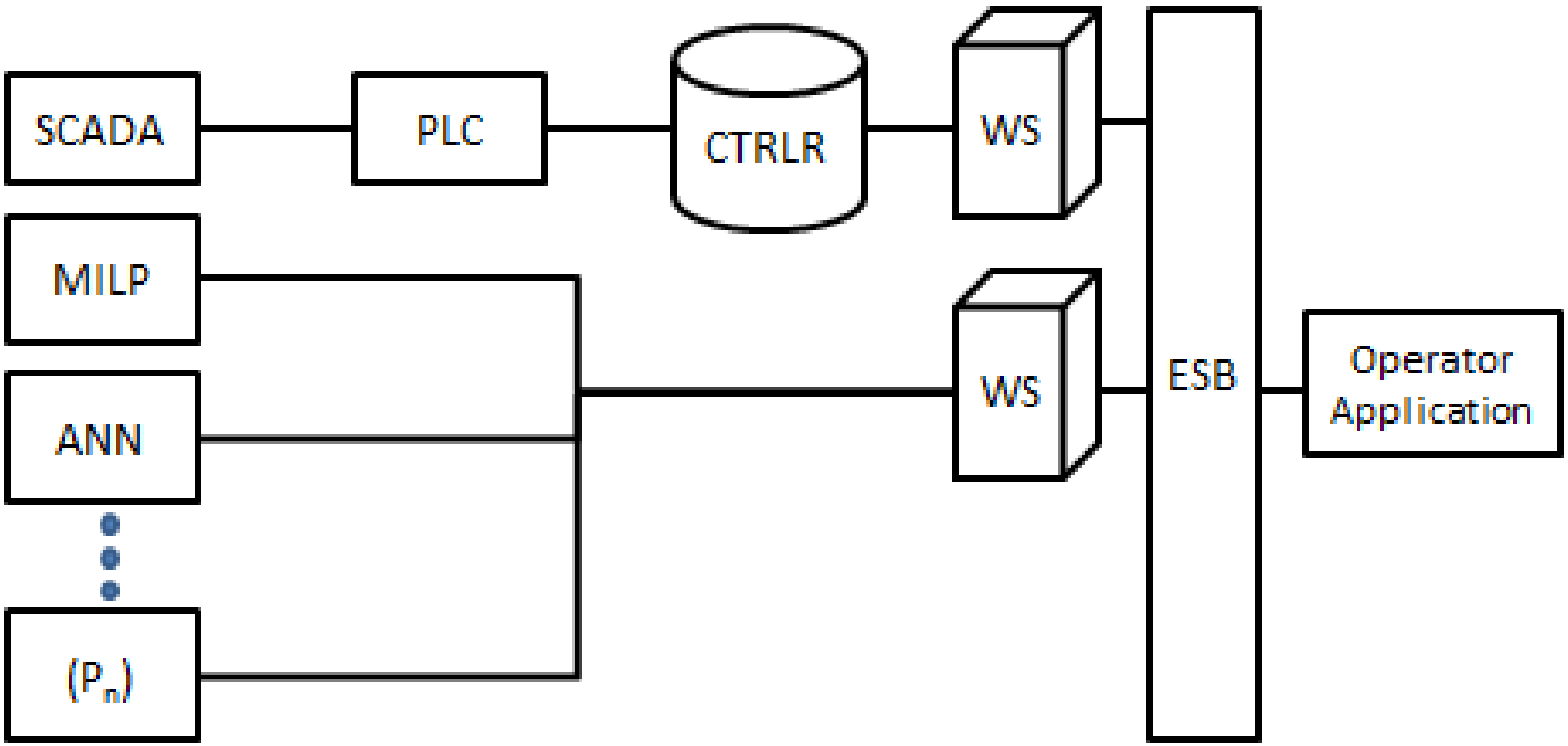
Smart Grid Control Challenges

- Transactive systems require *comprehensive integrated* control techniques
- Utilities show a tendency to build separate infrastructures based on programmatic interests, so resource management tools end up separated across the grid (or enterprise):
  - Forecasting (real-time operations concern)
  - SG System Dispatch (customer program concern)
  - Distribution automation (distribution / system protection concern)

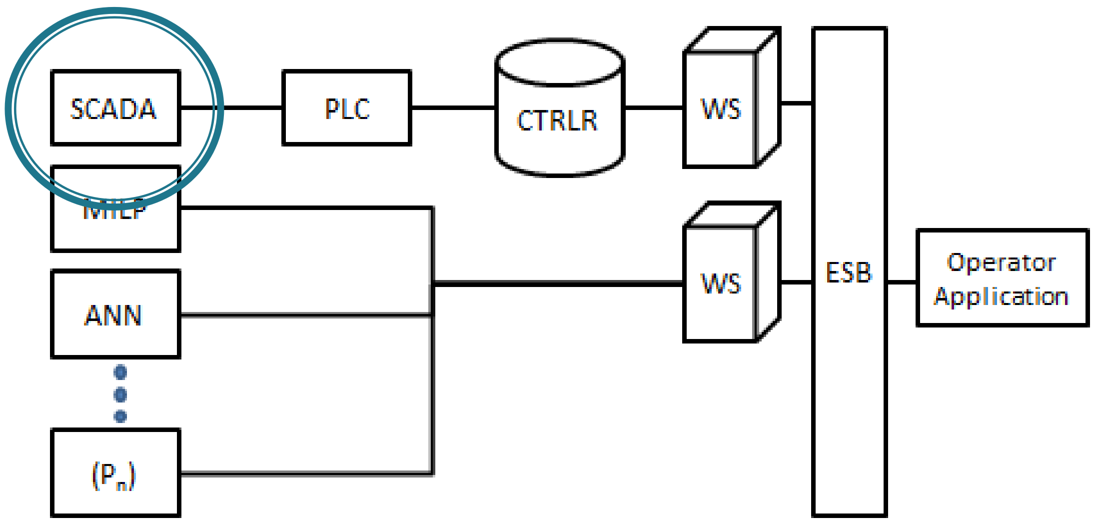
Research Approach

- A software based controller to compare outputs from separate dispatch optimization tools resulted in a management platform
- Integrated two separate optimization tools:
  - Mixed integer linear programming (MILP) microgrid dispatch tool (courtesy of University of Colorado – Boulder and funded by Intel – Labs: Power Systems R&D)
  - Artificial neural network (ANN) microgrid dispatch tool (funded by PGE & courtesy of PNWSGD)

IEC-61970 System Approach

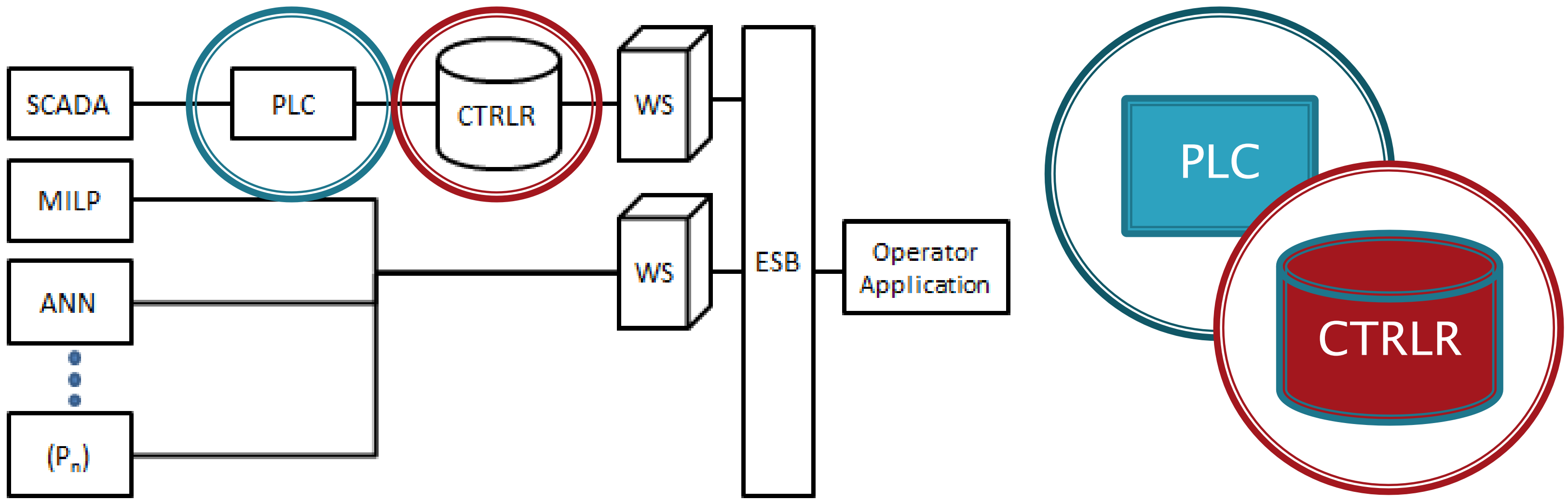


IEC-61970 System Architecture



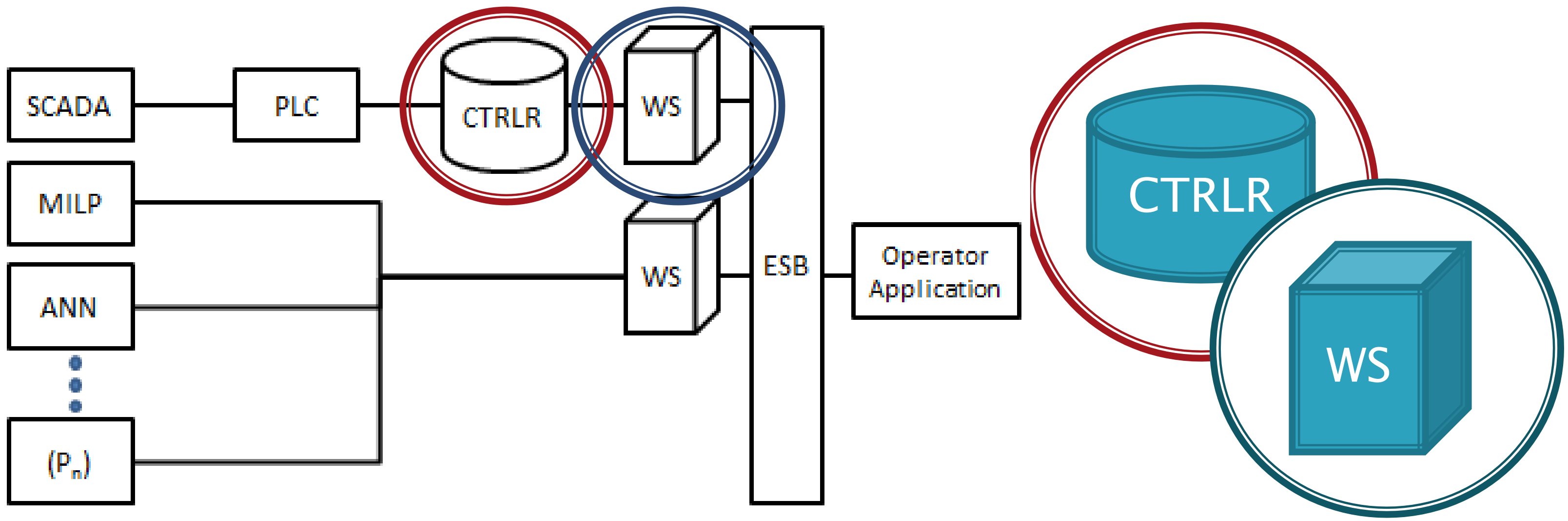
- SCADA system may provide real time connectivity to distribution components, real-time systems, metered systems, environmental sensing, and so forth

IEC-61970 System Architecture



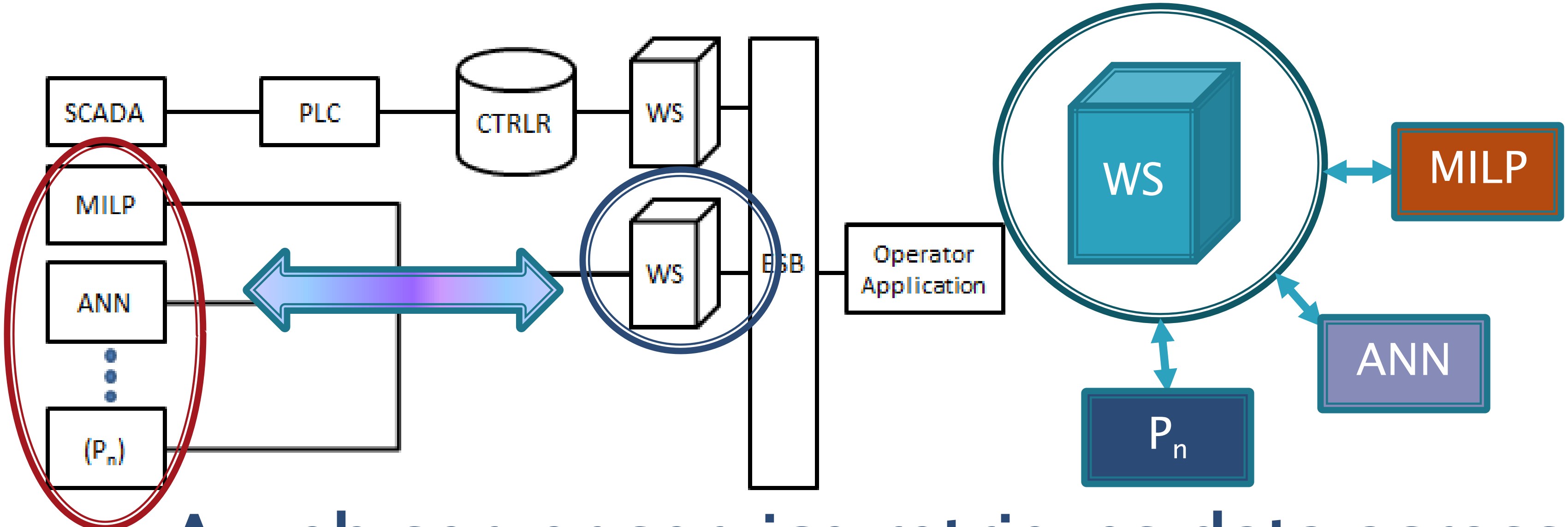
- PLC may provide real time connectivity using a SCADA bridge software application :subscribes to registers
- SCADA bridge populates controller tables in real-time

IEC-61970 System Architecture



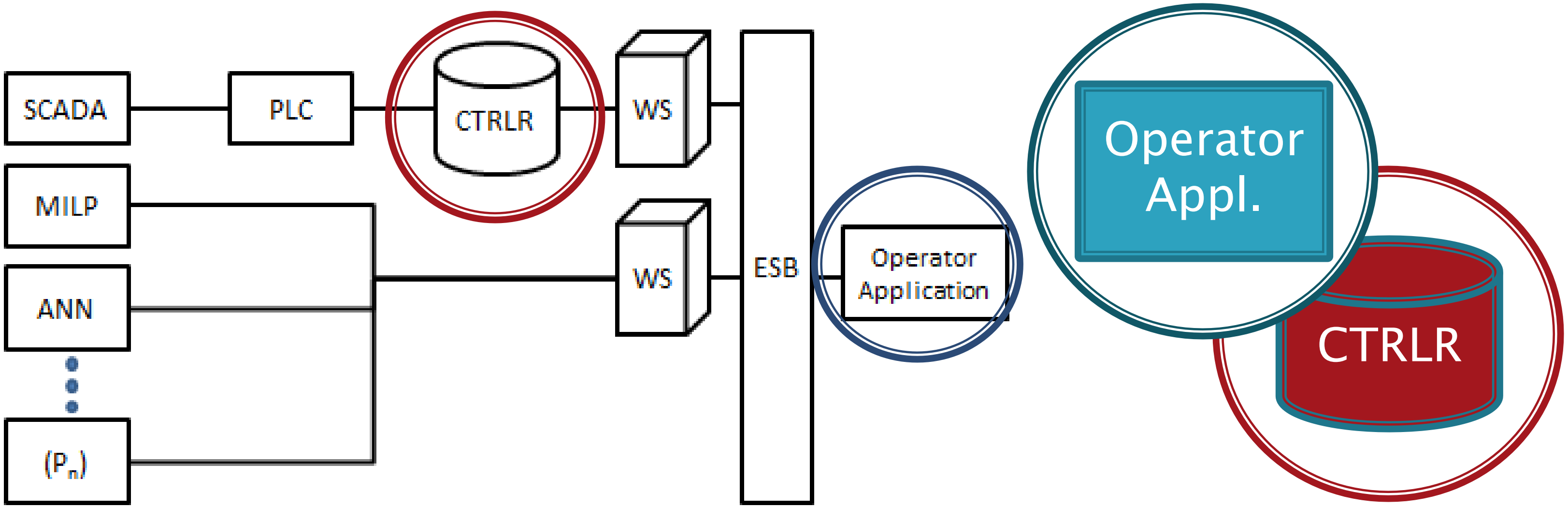
- The controller system exposes control data for web services use (read/write)
- A web server publishes data to an enterprise service bus as XML messages

IEC-61970 System Architecture



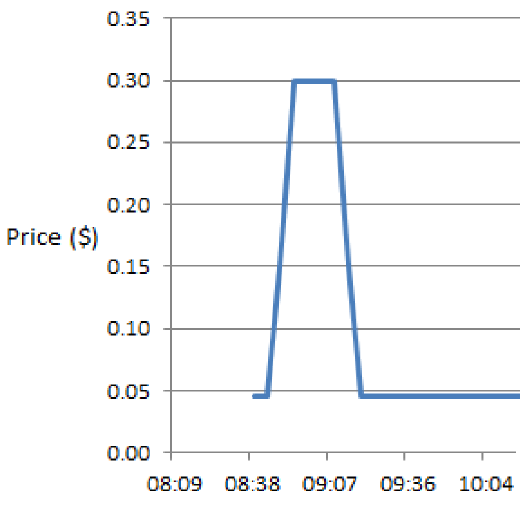
- A web server service retrieves data across the enterprise service bus
- Computational intelligence systems may subscribe and / or publish data to the web server (dispatch & optimization, etc.)

IEC-61970 System Architecture



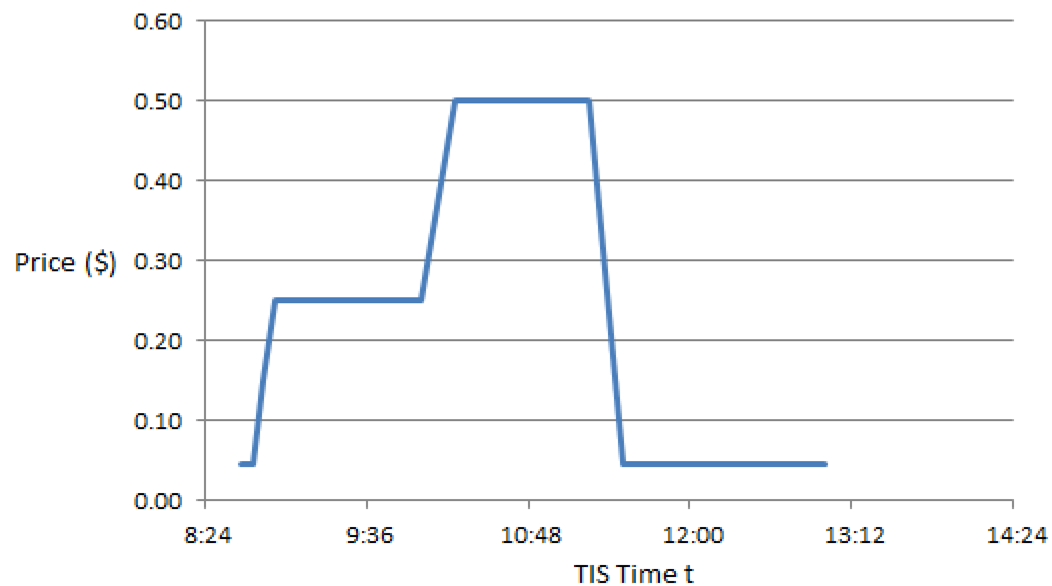
- Operator application interacts with the controller : commit strategy / review data
- Contextual logic as a meta-layer above any number of platforms: controls system response in SCADA assets

System Testing



- Scenario driven testing

- Allow operator to test future scenarios with different tools



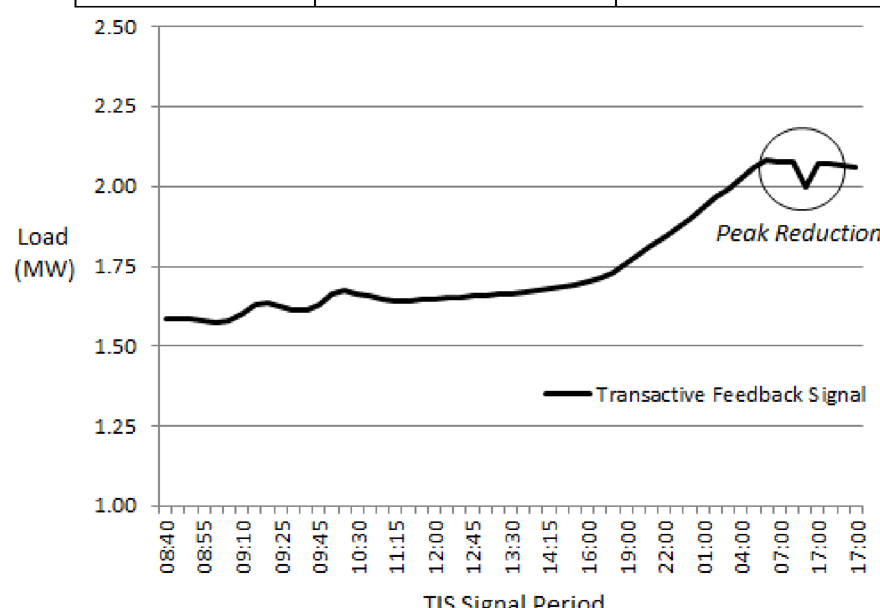
System Comparison Criteria

- **By Simulator P**
  - Total and average simulation time
  - Total and average cost avoided
  - Total reduction of peaks
  - Total dispatches by feeder asset (DR, energy storage, etc.)
  - Total cost of asset dispatches
  - Failures to write schedule by next cycle
- **By interval forecast period** –by feeder N
  - Total load and load shed
  - Asset constraint violations

System Comparison Sample Data

- Grid operator may interact with the controller and choose a specific dispatch from separate optimization platforms

TIS Interval	P_1 TFS (MW)	P_2 TFS (MW)
13:00	1.212	1.658
13:15	1.273	1.662
13:30	1.334	1.667
13:45	1.395	1.672
14:00	1.457	1.677



Conclusions and Lessons Learned

- Successfully demonstrated that independent simulator results may be compared in real-time for use in low-latency control applications
  - An assessment of operations strategy or operator strategy may be automated or applied, respectively, using such an approach
- Difficulties and challenges
  - Transforming data for direct comparison, i.e. inputs scaled correctly, outputs scaled correctly from separate platforms
  - Platforms are generally “fixed” to control their resources and must be disconnected

Thank You

Contact info:

Shawn Chandler – scha@pdx.edu

Instructor, Power Systems Graduate Program
Dept. of Electrical and Computer Engineering
Portland State University

Dr. Robert Bass – bobbass@ece.pdx.edu

Program Chair, Power Systems Graduate Program
Dept. of Electrical and Computer Engineering
Portland State University

Portland State University