NYISO Day-Ahead Market Overview

Shaun Johnson
Manager, Energy Market Products
New York Independent System Operator

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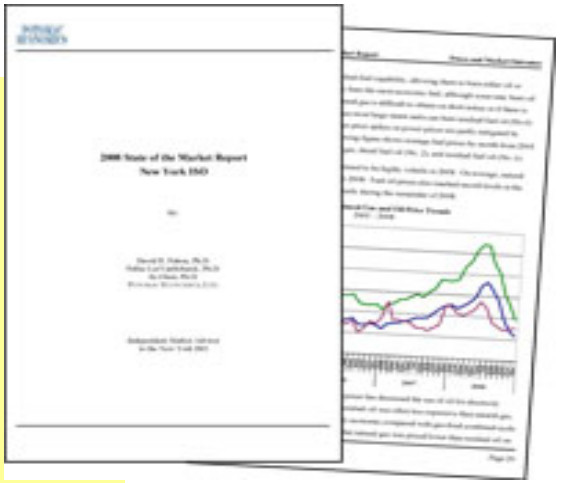
NYISO Markets

A showcase in advanced market design

- **Full two-settlement LBMP market for Energy and Reserves**
  - ***Forward and Real-Time Markets***
  - ***Co-optimization of Energy, Operating Reserves and Regulation***
    - **Bid-Based Security Constrained Economic Dispatch (SCED) and Security Constrained Unit Commitment (SCUC)**
  - ***Scarcity pricing for operating reserves***
  - ***Virtual Bidding***
  - ***Demand Side Participation***
- **Transmission Congestion Contracts (TCC)**
- **Installed Capacity Markets (ICAP)**

State of the Markets

"The NYISO markets are at the forefront of market design and have been a model for market development in other areas."



Dr. David Patton
Potomac Economics
Independent Market Advisor
2009 State of the Market Report for the NYISO

State of the Markets (cont.)

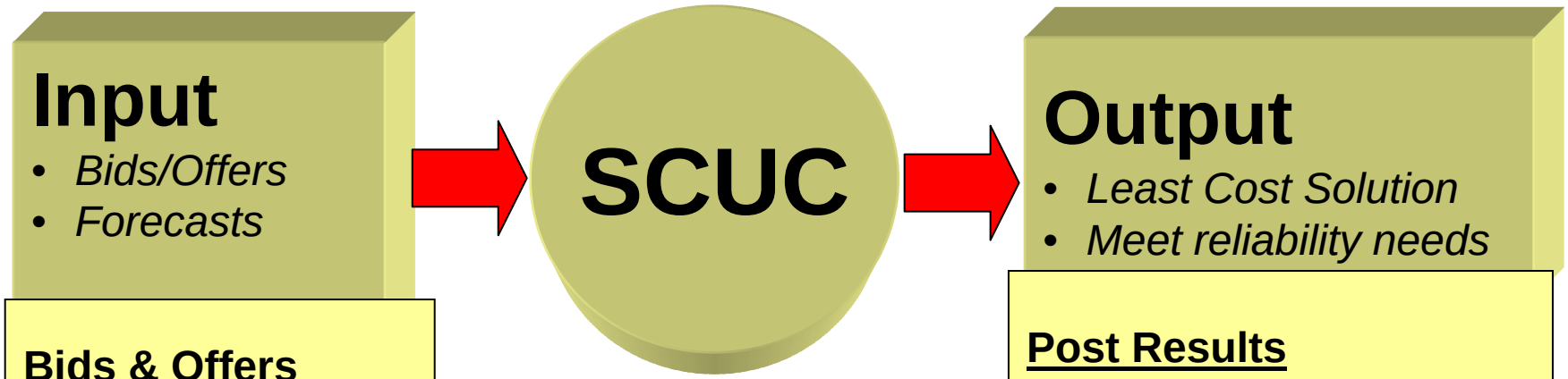
The NYISO was the *first* to:

- ***Jointly optimize the economic selection of energy and operating reserves***
- ***Utilize locational requirements in operating reserve and capacity markets***
- ***Introduce a demand curve to more effectively value incremental capacity and stabilize capacity prices***
- ***Institute operating reserve demand curves that more efficiently determine price during shortage conditions***

The NYISO is the *only* market to:

- ***Implement an optimized system to economically dispatch gas turbines and schedule external transactions***
- ***Institute a mechanism for gas turbines to set energy prices when economic***
- ***Develop a real-time dispatch system that optimizes over several time periods***

Unit Commitment is at the heart of our Market Systems



Bids & Offers
- GEN Supply
- LSE
- Virtual
- Regulation
- Reserve
- Bi-laterals
- Import/Exports
- Demand Response

Security Constrained Economic Commitment and Dispatch

Post Results
- Clearing Prices
  - LBMP (GEN & Zonal)
  - Reserve
  - Regulation
- GEN Schedule
- Transmission Schedule
- Bilateral Transactions
- Reserve Commitment
- Regulation Commitment

Generator Bidding Flexibility

- **Fully featured market bidding capabilities**
- **Hourly bidding flexibility:**
  - ***Startup Cost***
  - ***Minimum generation bid and MW***
  - ***Incremental energy in 11 bid/MW pairs***
  - ***Normal and emergency operating limits***
  - ***Operating reserve bids***
  - ***Regulation reserve bids and availability***
- **Self-scheduling and economic scheduling options**
- **Response rates for normal, emergency and regulation operation**
- **Minimum run time, minimum down time, maximum starts per day**

Load Bidding Flexibility

- Fully featured market bidding capabilities
- Hourly bidding flexibility
- Fixed load requirements
- Bilateral load
- Price capped load in 3 bid/MW pairs
- Demand Response with all generator bid characteristics

Four Pass Methodology

- **Bid load pass**
  - ***Including Local Reliability Requirements (LRR) evaluation***
  - ***Including Automatic Mitigation Process (AMP)***
- **Bulk Power System (BPS) Forecast pass**
- **Forecast Re-dispatch pass**
- **Bid Re-dispatch pass**

Bid Load Pass

- **Evaluates generation bids to solve to the bid load and insure network security**
  - ***Initial Unit Commitment (IUC)***
  - ***Network Data Preparation***
  - ***Network Security Analysis – evaluates impact of contingencies on the IUC or NCUC***
  - ***Network Constrained Unit Commitment (NCUC) – determines schedules that satisfy both commitment constraints and network security constraints***
- **Optimization to minimize total production cost**
- **Includes In-City mitigation evaluation**
- **Load is a combination of fixed and zonal price-cap load/virtual load**
- **Solves for bulk power system (BPS) facilities and contingencies**

Automatic Mitigation Procedures (AMP)

- **Integrated into the Day-Ahead and Real-Time market solutions for generators located In-City**
  - ***Conduct – evaluate generator bids (submitted hourly) for conduct based on specified thresholds and reference bids***
  - ***Impact – if conditions exist that enable the exercise of market power (for example transmission constraints) then generators that have conduct will be evaluated for impact***
  - ***Mitigation – if a generator is found to have impact, its bids will be substituted with reference bids***

Bid Load Pass – LRR Evaluation

- **As of February 2009, the Local Reliability Rules (LRR) are incorporated with the Bid Load Pass.**
- **Solves for additional capacity constraints for New York City network security**
- **LRR capacity constraints are developed and evaluated using the NYISO forecast load**
- **A Day-Ahead Reliability Unit (DARU) may be designated by a TO or the NYISO for commitment for reliability reasons in advance of the DAM**
- **Advantages of including LRR within the Bid pass: Allows economic de-commitment of units that are not required after securing local reliability rules and reduces the potential for SREs**
- **Optimization to minimize total production cost given reliability requirements**

Bulk Power System (BPS) Forecast Load Pass

- **Determines the additional generators required to meet the NYISO forecast load**
- **Price sensitive and virtual resources are not included in this evaluation**
- **Capacity evaluation – modifies generator cost curves to consider start up and minimum generation costs only**
- **Optimization for least additional uplift**
- **Solves for bulk power system (BPS) facilities and contingencies**
- **Wind forecast incorporated**

Forecast Re-Dispatch Pass

- **Economical re-dispatch of commitments determined from previous passes using original cost curves (or mitigated curves where applicable)**
- **Dispatches to NYISO forecast load**
- **Price sensitive and virtual resources are not included in this evaluation**
- **Produces hourly load flows for review by TOs regarding local reliability**
- **Interface flows used in Available Transfer Capability (ATC) calculation**

Bid Re-Dispatch Pass

- **Economical re-dispatch excluding GTs added during either forecast pass (Note: GTs are re-evaluated for commitment in Real-Time)**
- **Dispatches to bid load**
- **Load is a combination of fixed and zonal price-cap load/virtual load**
- **Results in settlement prices and schedules**

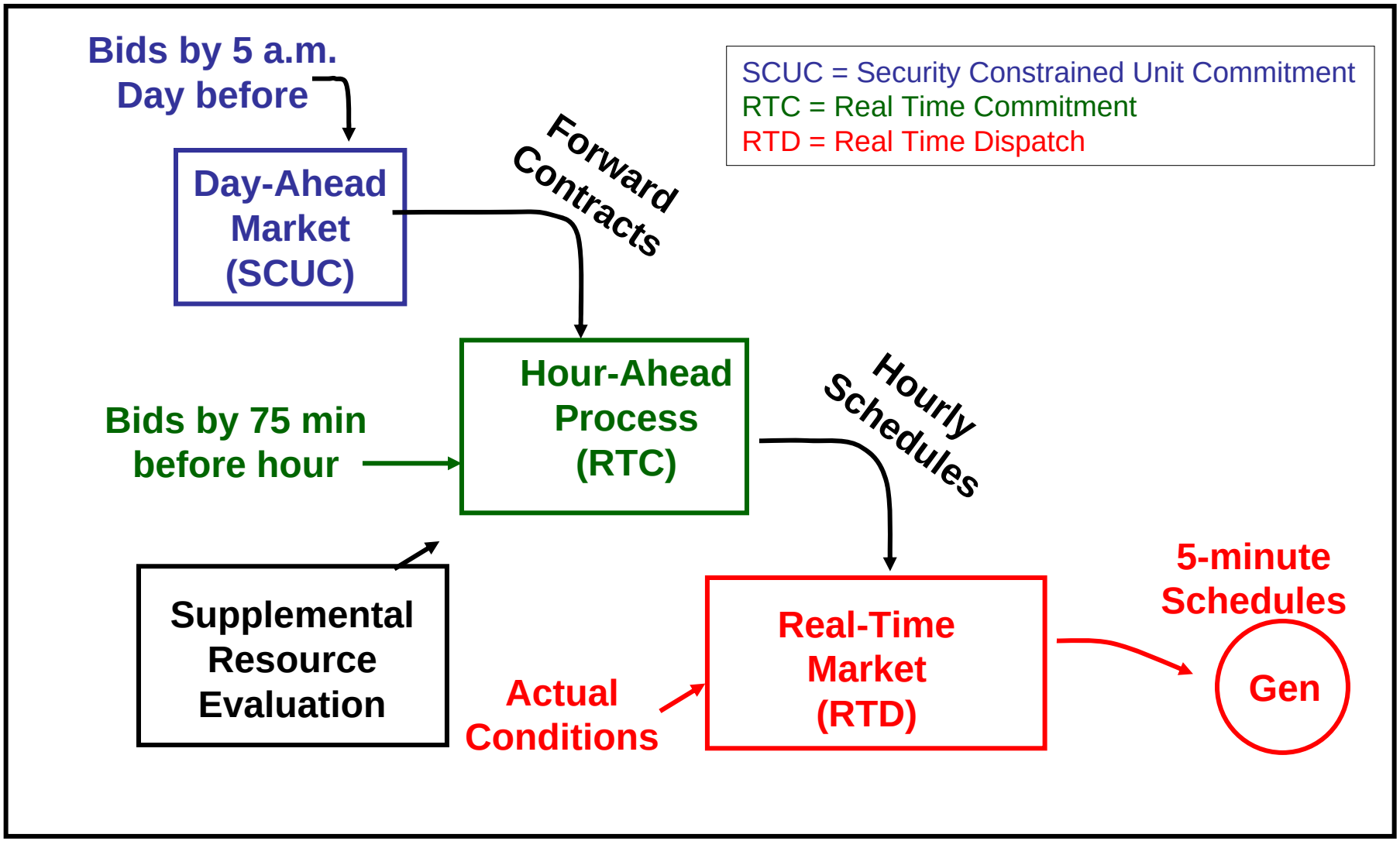
Co-optimizing for Operating Reserve

- **Market based service to ensure backup generation is available in the event of a system contingency**
- **This service is provided by:**
  - ***Generators***
  - ***Demand Side Resources***
- **Establish market based prices for each service and location based upon the results of the competitive auction**
- **Demand procures service from Day-Ahead Market**
- **Suppliers compete in Day-Ahead and Real-Time Market**
  - ***Forward contracts issued from Day-Ahead Market***

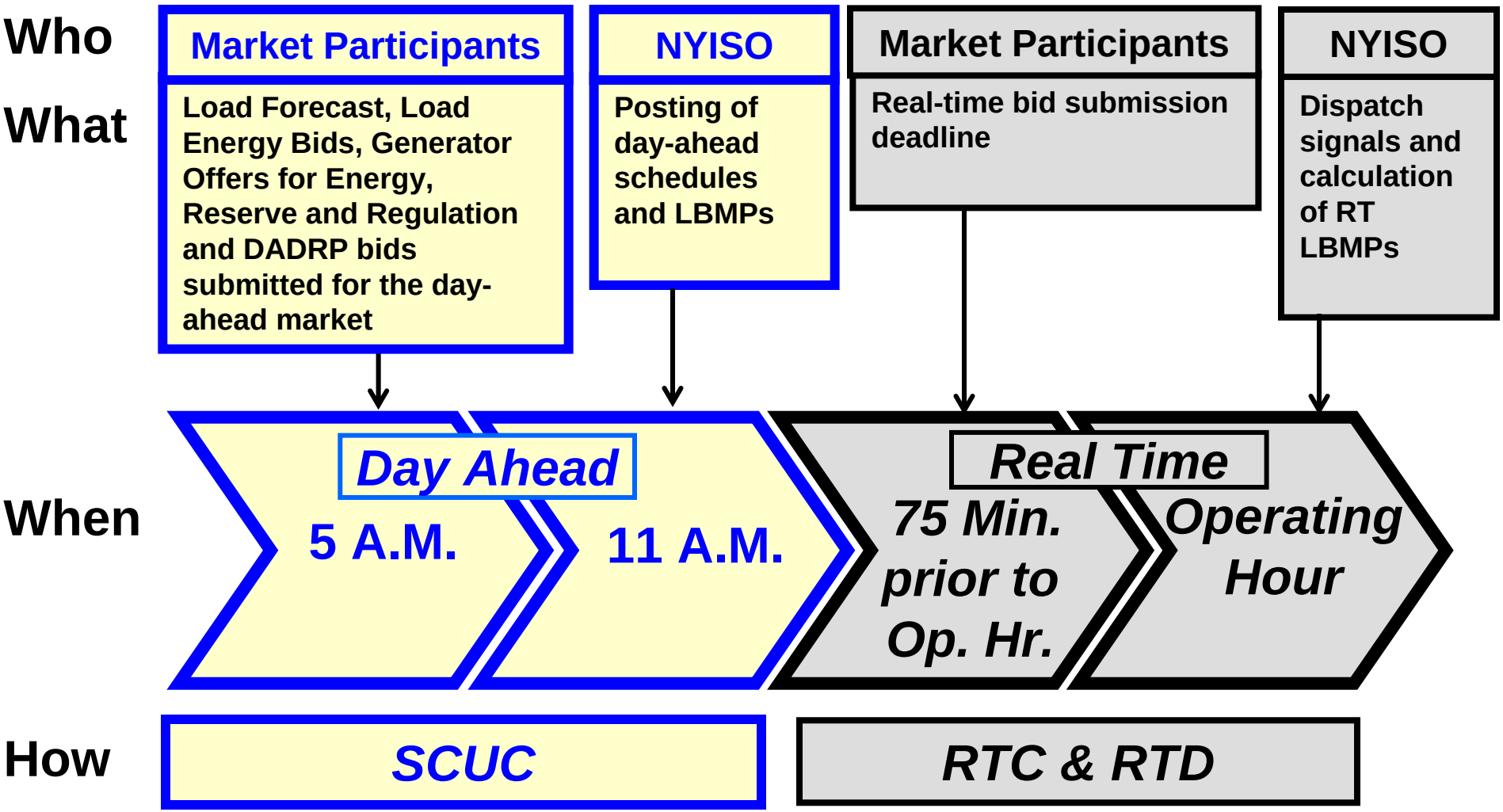
Co-optimizing for Regulation Reserve

- **Market based service for regulation and frequency response to provide for the continuous balancing of resources with demand**
- **This service is provided by:**
  - ***Generators***
  - ***Flywheels and Batteries (LESRs)***
  - ***Demand Side Resources***
- **Establish market based prices for the service based upon the results of the competitive auction**
- **Demand procures service from Day-Ahead Market**
- **Suppliers compete in Day-Ahead and Real-Time Market**
  - ***Forward contracts issued from Day-Ahead Market***

Day-Ahead to Real-Time Transition



Energy Market Timeline



Future Considerations

- **Market Functionality**
  - ***Expanded opportunities for virtual trading participation in the Day-Ahead Market***
  - ***Enhanced Interregional Transaction Coordination with neighboring systems (PJM and ISO-NE) under development.***
  - ***Integration of demand response into the real-time energy market***
  - ***Aggregations of demand response providers in the energy and ancillary service markets***
  - ***Smart Grid and PHEV potential applications***
- **Software Algorithms**
  - ***Evaluating the capabilities and performance of MIPs solution engine***

Future Considerations

- **Achieving necessary execution times may become more difficult with increasingly complex market functionality and volume of participants**
- **Identifying the best way to address in-hour variability in an hourly Day-Ahead Market solution**
- **Capturing increased levels of intermittent generation uncertainly in the most efficient and reliable manner**

NYISO uses ABB's Ranger Platform for its Security Constrained Unit Commitment (SCUC) Function

NYISO SCUC implementation uses the Lagrangian Relaxation methodology for Its Optimization Engine.

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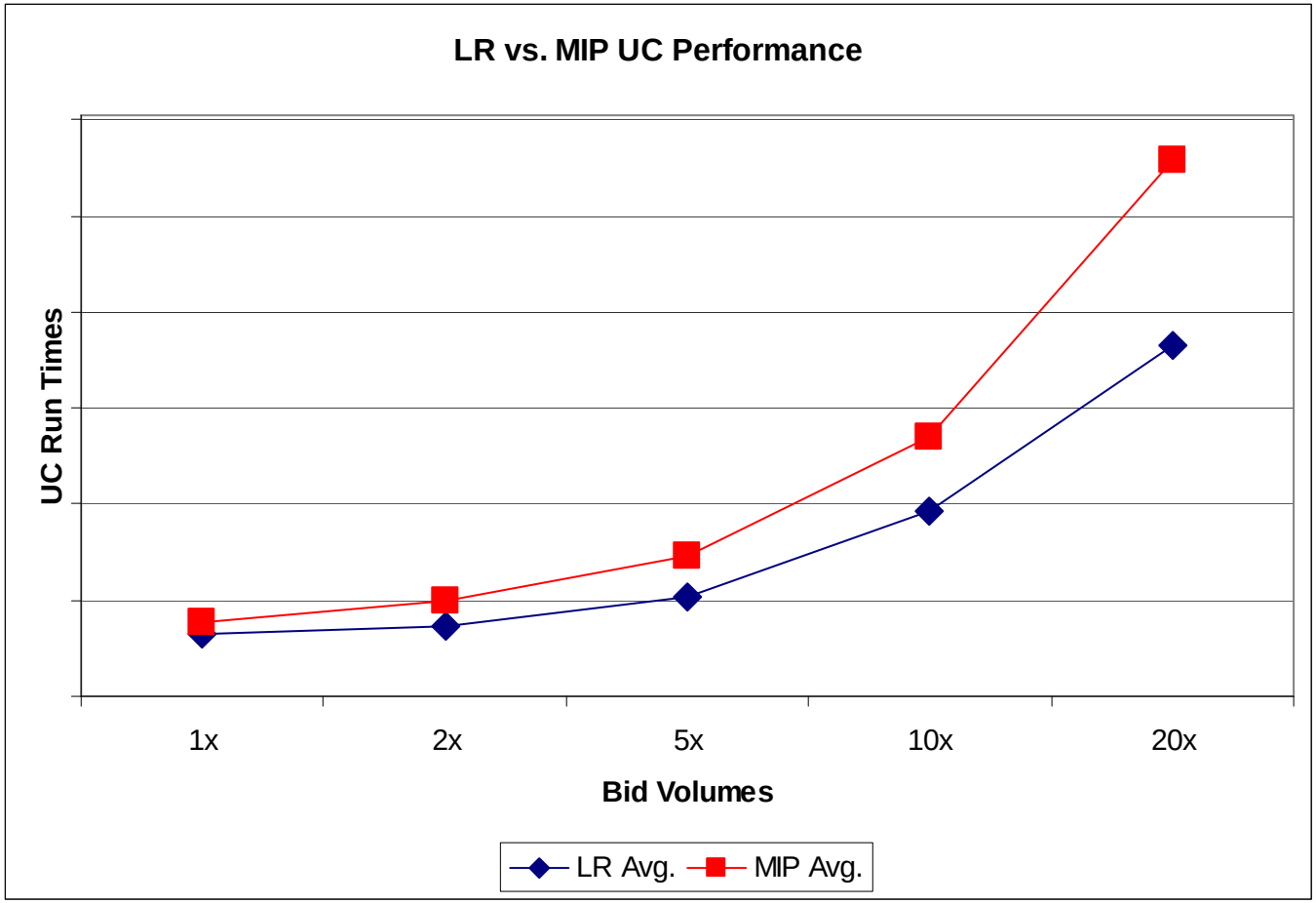
Update on MIP

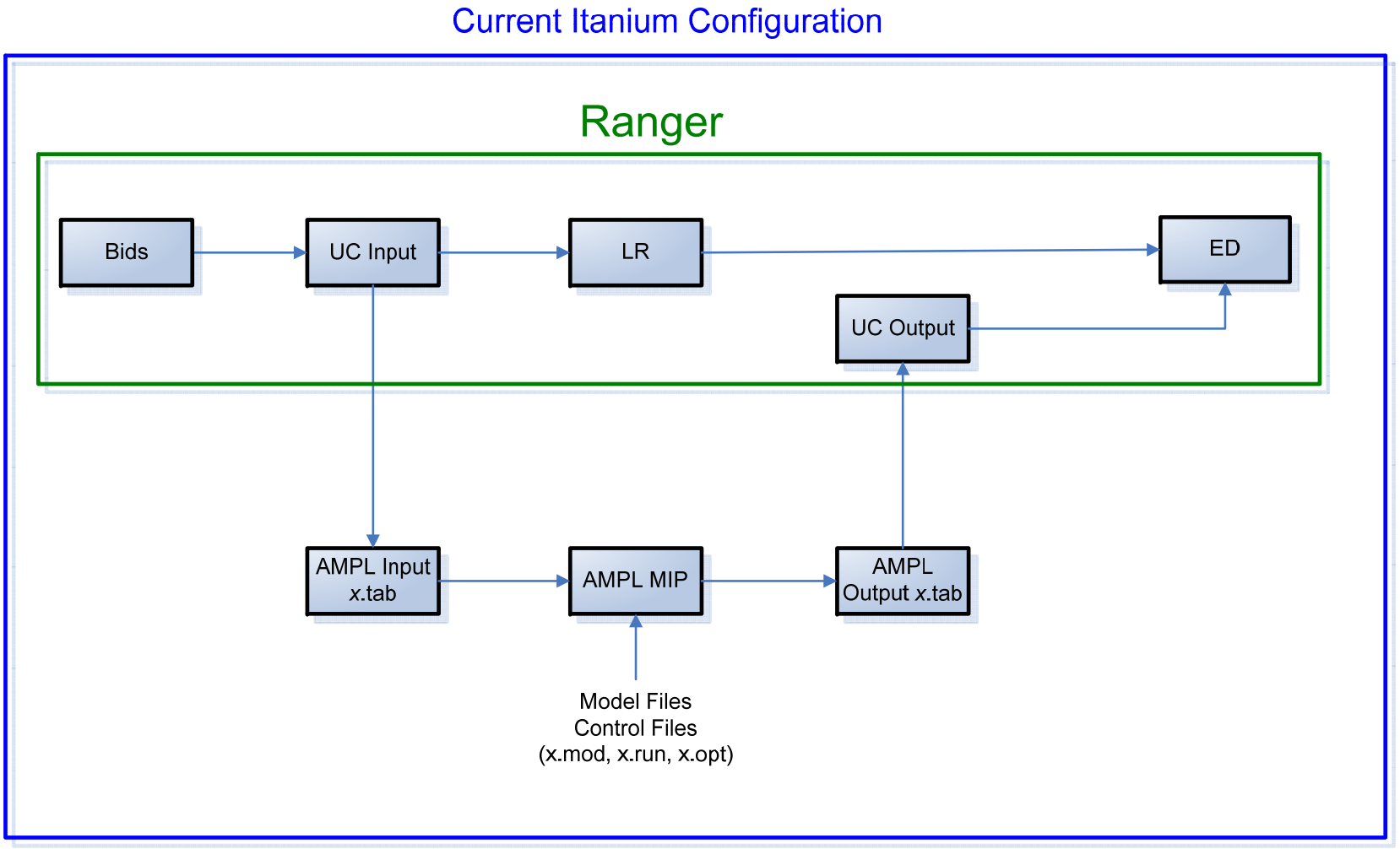
MIP Study

- **Previous performance testing reached infeasible solutions at 4x current virtual bid volume**
- **Technical achievements allowed us to overcome this constraint**
- **Able to test MIP and LR up to 20x current virtual bid volumes**
- **As indicated on the next slide, MIP and LR have comparable run times and results.**

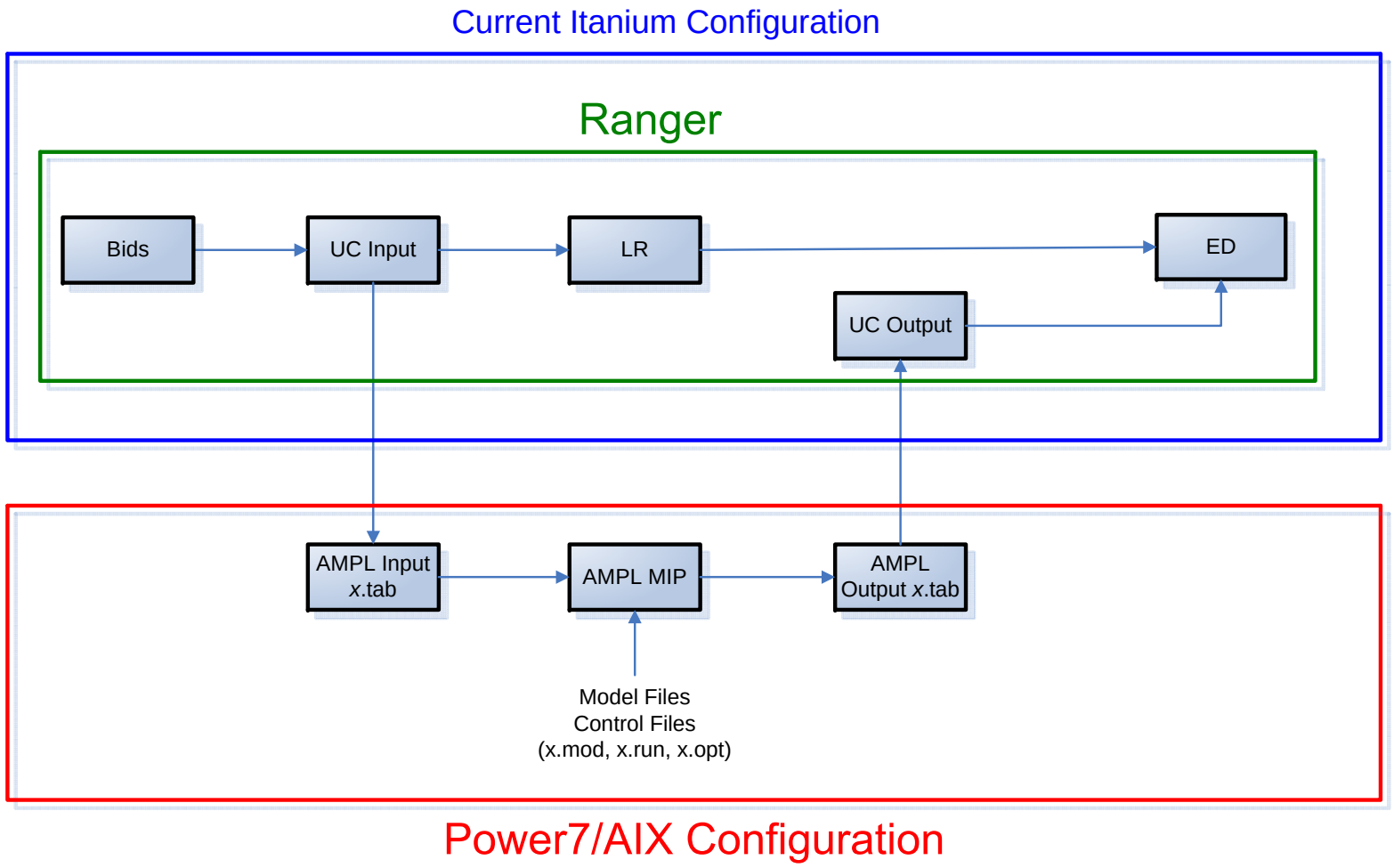
MIP Feasibility July 2010



Current Configuration



Proof of Concept Configuration



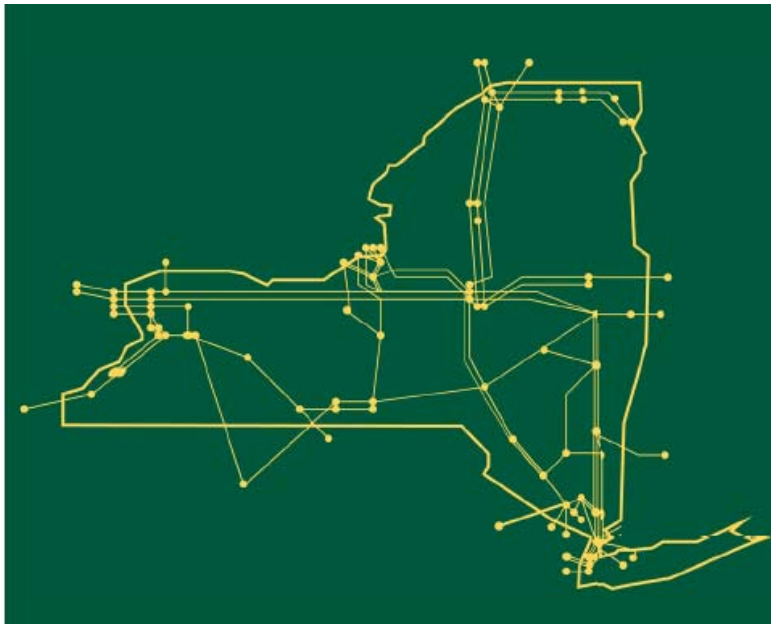
MIP Feasibility Update 2011

- **Background**
  - ***Alternative Hardware being investigated***
  - ***Testing performed on Power 780 and 740***
  - ***Required implementation of AIX (OS) and MIP***
- **Benefits**
  - ***Preliminary test performed using 3 test cases***
    - **Showed promising results from up to 260 - 280% improvement on MIP calculation**
    - **This would put performance within acceptable run times**

MIP & LR Next Steps

- **NYISO will continue to validate the feasibility of MIP's use in the DA process, focusing on 1) optimal commitment solutions and 2) production cost savings.**
  - ***NYISO is evaluating several proposals from our vendor, ABB, which promise to significantly improve run times for MIP implementations.***
- **NYISO will look to implement the MIP solution in the near future.**

The New York Independent System Operator (NYISO) is a not-for-profit corporation responsible for operating the state's bulk electricity grid, administering New York's competitive wholesale electricity markets, conducting comprehensive long-term planning for the state's electric power system, and advancing the technological infrastructure of the electric system serving the Empire State.



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