

# Mixed Integer Programming (MIP) Validation

A faint background image of the state of New York is overlaid with a network diagram. The diagram consists of a grid of lines representing transmission lines, with various nodes marked by small colored circles (red, blue, purple) at the intersections and along the lines.

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# MIP Project History

- ◆ NYISO performed a MIP study in 2010 to evaluate feasibility for the NYISO.
- ◆ Market participants approved a 2013-2014 project to implement a complete solution.
- ◆ Improved supportability, performance and market efficiency were stated goals.
- ◆ Development completed Q4 2013.
- ◆ Expected activation on December 2<sup>nd</sup> for market day of December 3<sup>rd</sup>.

# What is MIP?

- ◆ **Mixed Integer linear Programming**
  - *MIP is a solution methodology, an algorithm*
  - *Linear Programs can be solved directly and efficiently*
    - Economic Dispatch is a Linear Program (LP)
    - Unit Commitment (UC) is an Integer Program
  - *When you introduce integer constraints the math gets hard*
    - A generator cannot be 0.72386 on. It can either be 0 (OFF) or 1 (ON)
    - MIP is one of several mathematical methods and offers several advantages.

# Goal 1 – Improved Support

- ◆ **MIP has already proven itself to be much more flexible.**
  - *Internal prototyping is now possible.*
  - *Vendor knowledge and breadth of support resources has improved greatly over our legacy solution (Lagrangian Relaxation).*
  - *Improved transparency by way of human readable model.*

## Goal 2 – Improved Performance

- ◆ **High Performance Computing (HPC) systems used to offload optimization ‘heavy lift’ computations.**
  - *A 300% raw computational improvement improved elapsed times by 167% over the entire Unit Commitment portion of the Day Ahead process including data read and write overhead.*
  - *Provides capacity for new market features in same time constraints.*
    - Fixed read/write overhead.
    - Optimization is 300% faster and is most affected by new features.

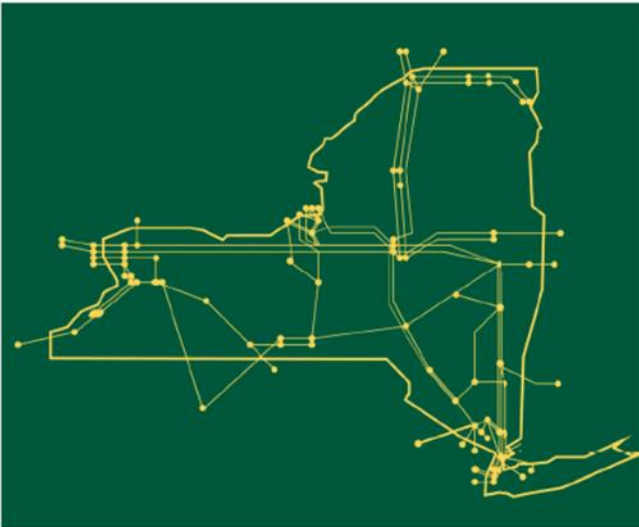
## Goal 3 – Improve Market Efficiency

- ◆ **The objective function is identical in LR and MIP**
  - *Serve the load with the least total production cost while honoring transmission constraints.*
  - *In other words, find the mix of energy resources that can provide for the reliable delivery of power with the lowest production cost.*
  - *LR and MIP both observe the same physical limitations.*
    - **Generation operating limits, bids, transmission limitations, reserve requirements, Etc.**

# Improve Market Efficiency (cont)

- ◆ **Over 5,000 cases have been rerun and benchmarked**
- ◆ **Day Ahead (757 days validated)**
  - *On average, MIP produced a more optimal solution of ~\$10k per day or ~\$3.7M per year.*
  - *Zonal LBMPs are on average \$0.01 lower with the MIP solution or ~\$1.6M per year.*
- ◆ **RTC and RTD (~4,300 cases)**
  - *Statistically insignificant changes as generation is mostly fixed day ahead.*

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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