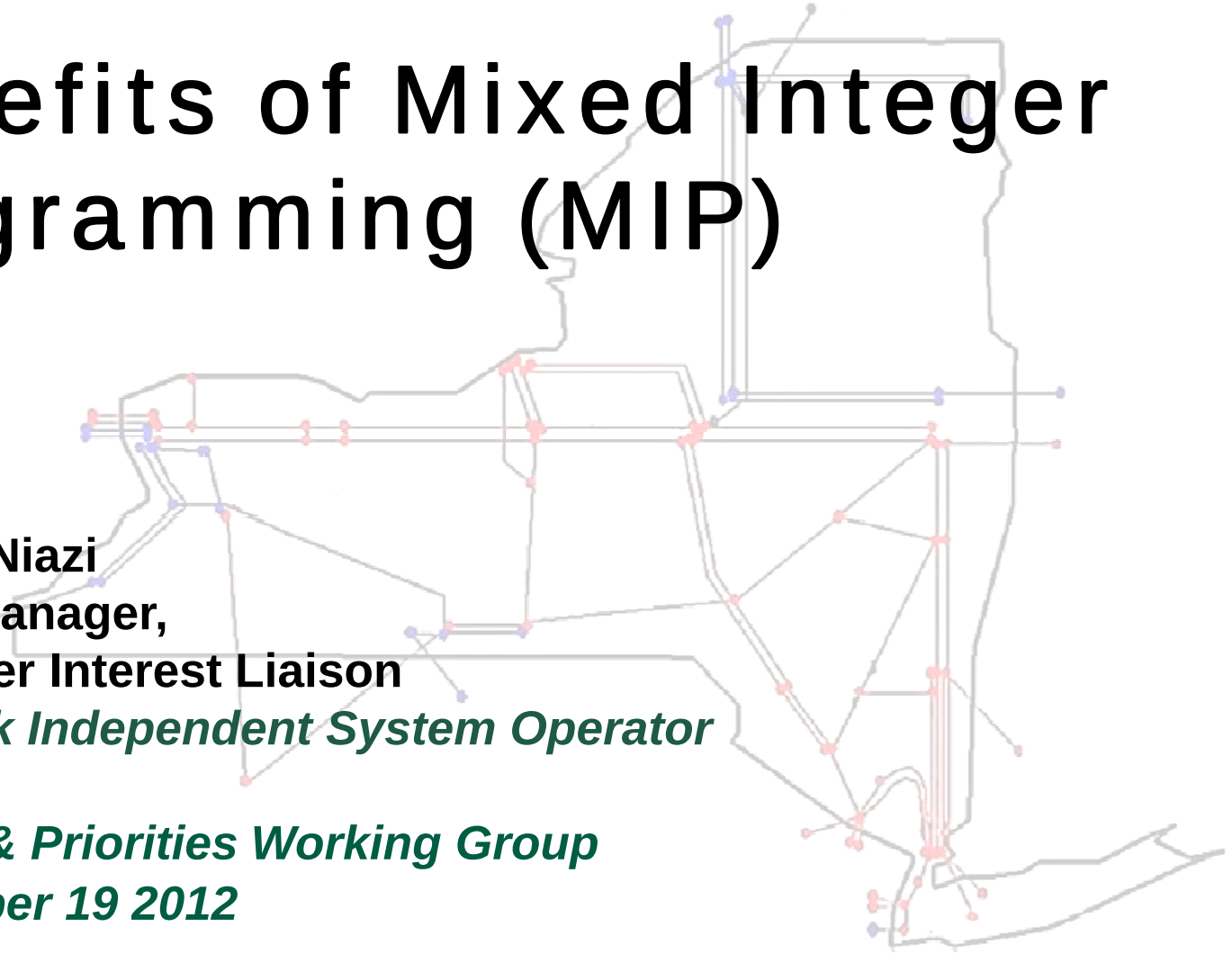
Benefits of Mixed Integer Programming (MIP)



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KCC

Background

- **Mixed Integer Programming (MIP) is a proposed project in the 2013 Project Prioritization and Budgeting process**
- **The cost of implementing MIP is approximately $3.966 million with a targeted launch date of Q2 2014**
- **At the September 7, 2012 BPWG meeting, stakeholders requested that the NYISO provide additional justification for this project**

Benefits of MIP

- **Total Production Cost Savings**
- **Experience from other RTOs/ISOs**
- **Combined Cycle Generator Modeling**
- **Other Benefits**

Total Production Cost Savings

- **The NYISO conducted a study comparing Total Production Cost differences between using MIP and the Lagrangian Relaxation (LR) method that is currently used to solve unit commitment optimization**
- **Extensive study based on approximately one year of DAM solutions**
- **Almost daily runs from May 2009 to mid-April 2010, covering 342 days in total**
- **Ran the same DAM using LR and MIP**

Total Production Cost Savings

- **The Objective Function of both the MIP and LR algorithms is to minimize Total Production Cost**
- **In 67% of the days run, MIP achieved a more economic solution that LR**
- **Over the approximate 342 days, the Total Production Cost using MIP was approximately $3.5 million less than using LR**

Total Production Cost Savings

- **The $3.5 million is a conservative estimate that will almost certainly be exceeded when Savings in real-time are also taken into account**

- **The NYISO study was a proof of concept (feasibility) and did not focus on tightening MIP tolerances to maximize total production cost savings. Further modeling before deployment should also improve results**

- **Discarding days that did not provide a more optimal production solution would increase the estimate of production cost savings to approximately $9 million**

Experience in Other RTOs/ISOs*

- **In 2004, PJM implemented MIP in its day-ahead market based on estimates of annual production cost savings of approximately $60 million**
- **In 2006, PJM implemented MIP in its real-time market look-ahead with test findings of $100 million in annual savings**
- **In April 2009, CAISO implemented MIP as part of its Market Redesign and Technology Update, with estimated savings of $27 million that were increased to $52 after reducing MIP gap tolerance**
- **In 2009, the Southwest Power Pool (SPP) estimated that MIP and other enhancements to its day-ahead market would results in $103 in annual benefits**

*** FERC Staff Report, 2011 (Recent ISO Software Enhancements and Future Software and Modeling Plans)**

Combined Cycle Generator Modeling

- **Combined cycle and some other generators can operate in several different configurations**
- **Under LR only a single configuration may be offered for a combined cycle generator. This limits the ability to account for time and cost dependencies between different configurations**
- **MIP will allow for a multi-stage generation modeling approach and optimally select the appropriate configuration to use**

Example of Cost Savings for Combined Cycles under MIP

- **Key Assumptions:**
  - ***Heat Rate with one unit on: 8000***
  - ***Heat Rate with two units on: 7200 (10% efficiency gain)***
  - ***Heat Rate with three units on: 6984 (3% efficiency gain)***
  - ***Cost of Natural Gas: $3.50***
  - ***Other Costs: $3.0***
- **Under LR (current technology), each unit will bid assuming a heat rate of 8000. If all three units are scheduled by SCUC and one is the marginal source, the resulting cost of energy in NYCA would be $31/MWh**
  - ***$28($3.50*8000) + $3 = $31***

Example of Savings under CC, Contd.

- **MIP would accommodate multi-stage generation modeling and select the optimal configuration, allowing an asset owner to bid the following:**

# of Units Scheduled	Heat Rate	Cost
1	8000	$31.00
2	7200	$28.20
3	6984	$27.44

- **If SCUC schedules all three units the cost of energy in NYCA would be $27.44, representing an approximately 11% decrease in LBMP**
- **The SOM for Q2 2012 reported that natural gas and dual fuel units set price in NYCA over half the time. That would indicate that LBMPs could be approximately 10% lower, nearly half the time.**

Other Benefits

- **Improved reliability and support for MIP software**
- **Industry trends are leaning towards MIP**
  - ***Most ISOs/RTOs use MIP***
- **Increased constraint modeling flexibility**
- **Increased support for future market design changes**
  - ***Critical for BRM and Other Potential Changes***
- **Improved performance and Commitment analysis**
- **Increased support for prototyping and development of market rules**

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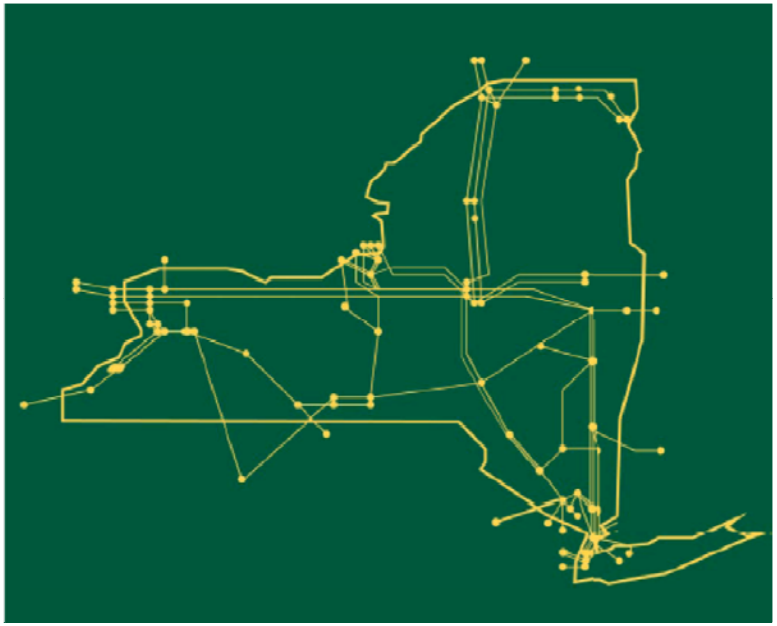

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