Review of Economic Consequences of Alternative Solution Methods for Centralized Unit Commitment in Day-Ahead Electricity Markets (Sioshansi, O'Neill et al. 2008)

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What is Unit Commitment (UC)?

Unit commitment (UC) in electric power systems is to optimize generating resources to supply system load while satisfying prevailing constraints, such as minimum on/off time, ramping up/down, minimum/maximum generating capacity, and fuel and emission limit (Tao and Shahidehpour 2005).
Another Definition of UC

Fundamentally, unit commitment has the responsibility to find the least-cost commitment and dispatch of a set of generating units to meet expected load over a time horizon consisting of a fixed number of periods (e.g. a 24 hour day)(Sioshansi, O'Neill et al. 2008).
Types of Unit Commitment

- Security-Constrained Unit Commitment (SCUC): SCUC is utilized by an independent system operator (ISO) to clear the day-ahead market (Tao and Shahidehpour 2005).

- Price-Based Unit Commitment (PBUC): PBUC is used by individual generating companies (GENCOs) and refers to the optimization of generating resources in order to maximize GENCOs’ payoffs. This UC has a different objective than that of SCUC and emphasizes the importance of the price signal (Tao and Shahidehpour 2005).
Means of Solving Unit Commitment

Many efficient near optimal methods have been developed. The most successful approaches are:

1. Up until recently, the Lagrangian relaxation (LR) algorithm was the only practical means of solving an ISO-scale unit commitment problem (Sioshansi, O'Neill et al. 2008).
2. Recent advances in computing capabilities and optimization algorithms now make solution of the mixed-integer programming (MIP) formulation by means of branch and bound (B&B) tractable (Sioshansi, O'Neill et al. 2008).
MIP Advantages

the advantages of the MIP method over LR include:

1) Global optimality;

2) Direct measure of the optimality of a solution;

3) More flexible and accurate modeling capabilities

4) Adding constraints in MIP does not require modifications to the solution algorithm as required in the LR method (Tao and Shahidehpour 2005).
MIP Disadvantages

The disadvantage of the MIP approach is the computational complexity. For the UC problem, the computation time of LR is almost linear to the product of the number of units and the scheduling period. (Xiaohong, Qiaozhu et al. 2003)(Tao and Shahidehpour 2005)
Arising Issues From LR Solutions

(Johnson, Oren et al. 1997)

1. Equity: Different payoffs to individual resources
2. Incentive: Generators may profitably mispresent their cost and constraint to affect the outcome of the market.
3. Efficiency: Without submitting truthful offers, the efficiency of the underlying unit commitment solution is questionable.
Conclusion

The raised issues remain regardless of the solution technique used. This market design issue will loom regardless of how accurate the unit commitment solution is, unless an optimum can be found (Sioshansi, O'Neill et al. 2008).
References:

