Panelist Comments
Technology Session 6: Computational Challenges

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Simulation Challenges

1. Representation of continuous and discrete dynamics behavior in transient and midterm stability analysis
2. Representation of uncertainty (probabilistic/unknown-but-bounded) across different spatial and temporal scales
3. Characterization of tight interaction between cyber layer (sensing, control, communication) and physical layer (generation, transmission, distribution)

Real-Time Monitoring and Control Challenges

1. Distributed architectures/algorithms for information processing and decision making
2. Measurement-based approaches to real-time monitoring with minimal reliance on system models
3. System-wide self-healing mechanisms fully adaptable to system operating conditions

Brian Gaucher, Smart Energy Program Manager, IBM

1. **Data:** Unprecedented scale, volume and speed of data, to be analyzed and optimized across domains with uncertainty in near real-time. Includes new data mining, pattern recognition, anomaly detection, prediction and analytics
2. **Mixed/cross domain analytics:** Mixed transmission, distribution and cross domain analysis with the ability to address optimized use of prediction, forecasting and storage for e.g., Distributed Energy Resources
3. **Real-time dynamic analytics:** Development of dynamic real-time AC Optimal Power Flow and modeling for stability analysis, state estimation, (N-x) contingency analysis
4. **Oversight/automation:** Secure, reliable efficient systems, will require broad, deep and 'real-time' oversight, w/ feedback control with increased automation driven by the shrinking timescales and complexity
5. **Visualization:** New visualization is needed to enable operators ‘easy’ Wide Area Situational Awareness to intuitively act upon events within the human time scale
6. **Computational**
    - New approaches to ‘real-time’ physical modeling
    - Improved solution to prescriptive/stochastic optimization (LP, IP, MILP, MINLP…) and machine learning for energy systems
    - SG Virtual Power Grid (VPG) and Energy “Nervous System”

Kip Morison, Chief Technology Officer, BC Hydro

1. **Management and value extraction from big data**: Conventional SCADA data is now being augmented by high volumes of often disparate data from smart meters, PMUs, numerous intelligent devices, and other sources from the environment and social sources. Advanced technologies, including analytics will be required to manage this data and to use it to achieved utility strategic objectives.
2. **Risk-based planning and operational tools**: Deterministic planning and operations has been the mainstay of utility operation. Given the growing complexity of systems due to deployment of smart-grid technologies (distribution automation in particular) combined with a higher penetration of distribution generations will require the development of advanced risk-based tools using probabilistic techniques.
3. **Advanced real-time dynamic security assessment tools**: This domain includes many sophisticated technologies today, but advances in computation will be needed to deal with larger system modes, the need to assess more scenarios, and to utilize new inputs such as PMU data. It is expected that new hardware architectures will be needed (some distributed systems have scaling limitations) and algorithms (speed and modeling).
4. **Optimization tools:** The use of optimization is limited in today's utility operation (optimum powerflow and some control tuning are some of the few examples). Two significant factors are driving the need for new optimization computational capabilities 1) the need for coordination and optimization of the widespread use of "smart-grid" controls (such as VVO or FLISR) and 2) the need to optimize many aspects of system operation and planning in order to defer capital needed for new or replacement infrastructure.

Sarah Ryan, Iowa State University

Need for tractable computational models and methods that include:

Element	Dimensions in short-term operations	Dimensions in long-term planning
Uncertainty	Day-ahead forecasts of renewable generation, availability of dispatchable resources, and demand	Technology development, fuel costs, climate change, demographics, and macroeconomics
Distributed decisions on supply and demand	Generator offers and price-sensitive demand bids in wholesale markets	Investments in generation and transmission, consumer technology adoption and responses to incentives
Decision-making stages	Forward, day-ahead, and real-time markets	Adaptation to realizations of uncertain elements and decisions by other actors