Estimation of the Secure Range for Dynamic Interchange Adjustment

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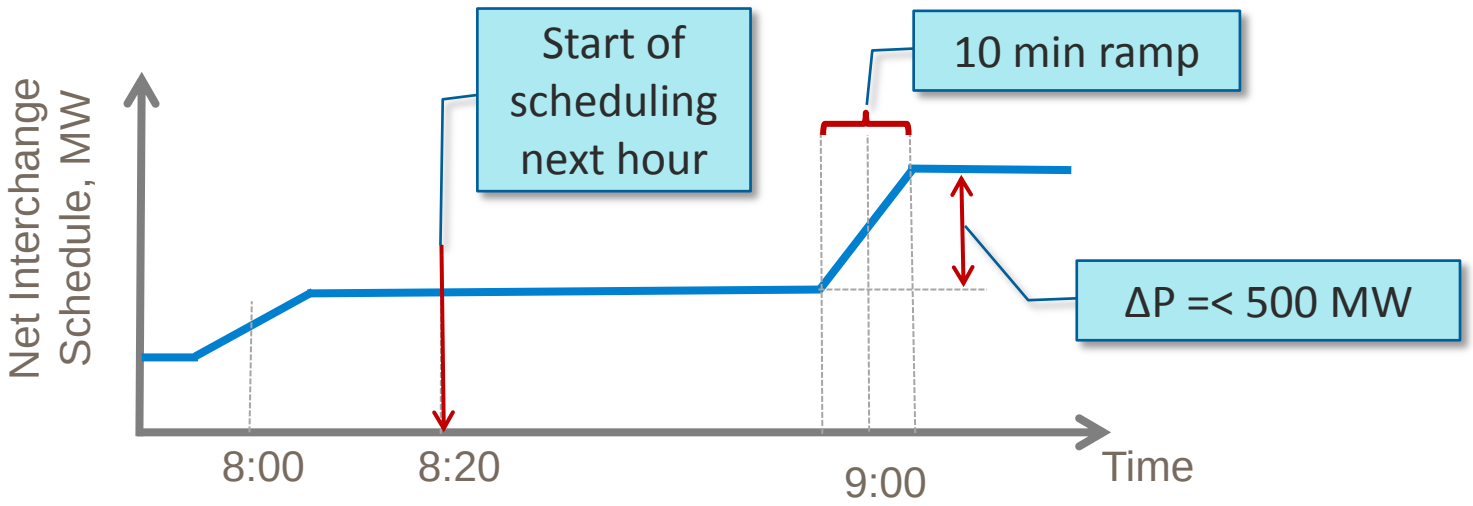
Outline

- Existing Intertie scheduling in Real-Time
- Methodology of prediction
- Statistical tool DINA
- Examples of use cases
- Future plans and conclusions

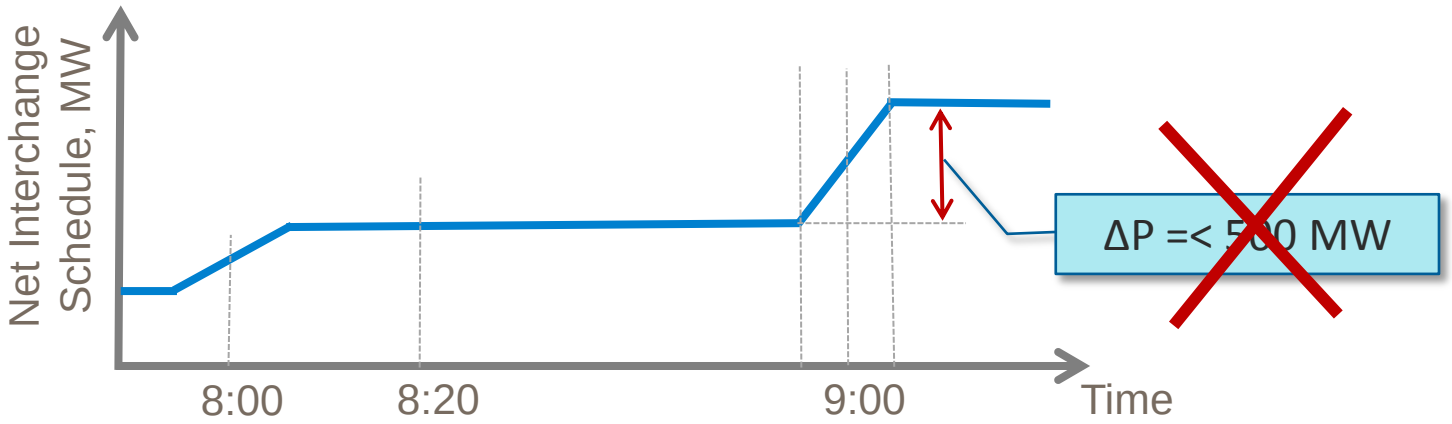
Existing Real-Time Intertie Scheduling Process

- Hourly process starts about 40 minutes before scheduled hour.
- Linear ramp around top of hour; 10 min typical.
- Hourly change of schedule is administratively limited by 500MW.



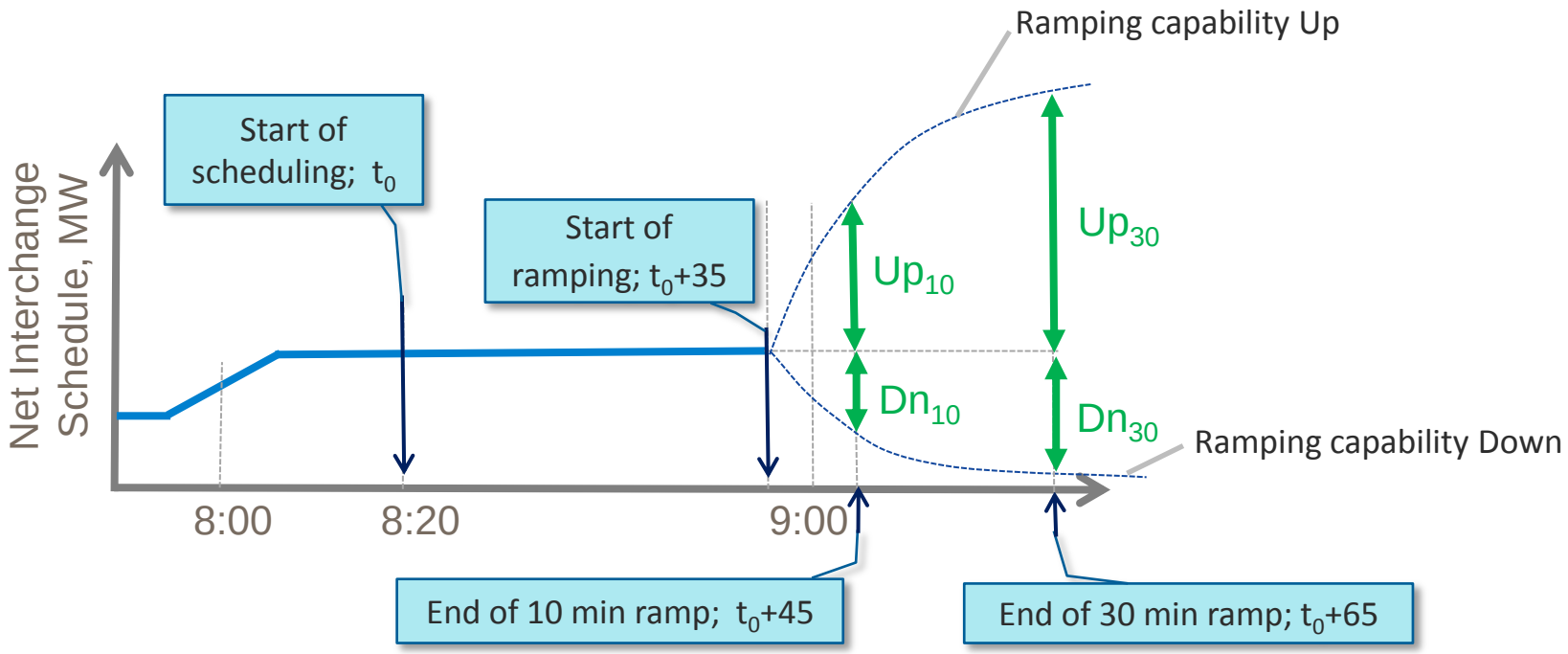
Motivation for Change

- 500 MW limitation of hourly change in schedule:
  - Was established long time ago based on conservative estimation of available 10 min system ramping capability.
  - Limits the use of more economical generation in neighboring areas.
  - Does not reflect actual system ramping capability.
- Objective: Replace fixed 500 MW limitation by prediction of secure 10 minutes and 30 minutes system ramping capability.



Approach

- At the beginning of a scheduling interval (t_0), estimate the secure range for possible net intertie adjustment for the next interval, with user specified confidence level. Output: Up_{10}, Up_{30}, Dn_{10}, Dn_{30}



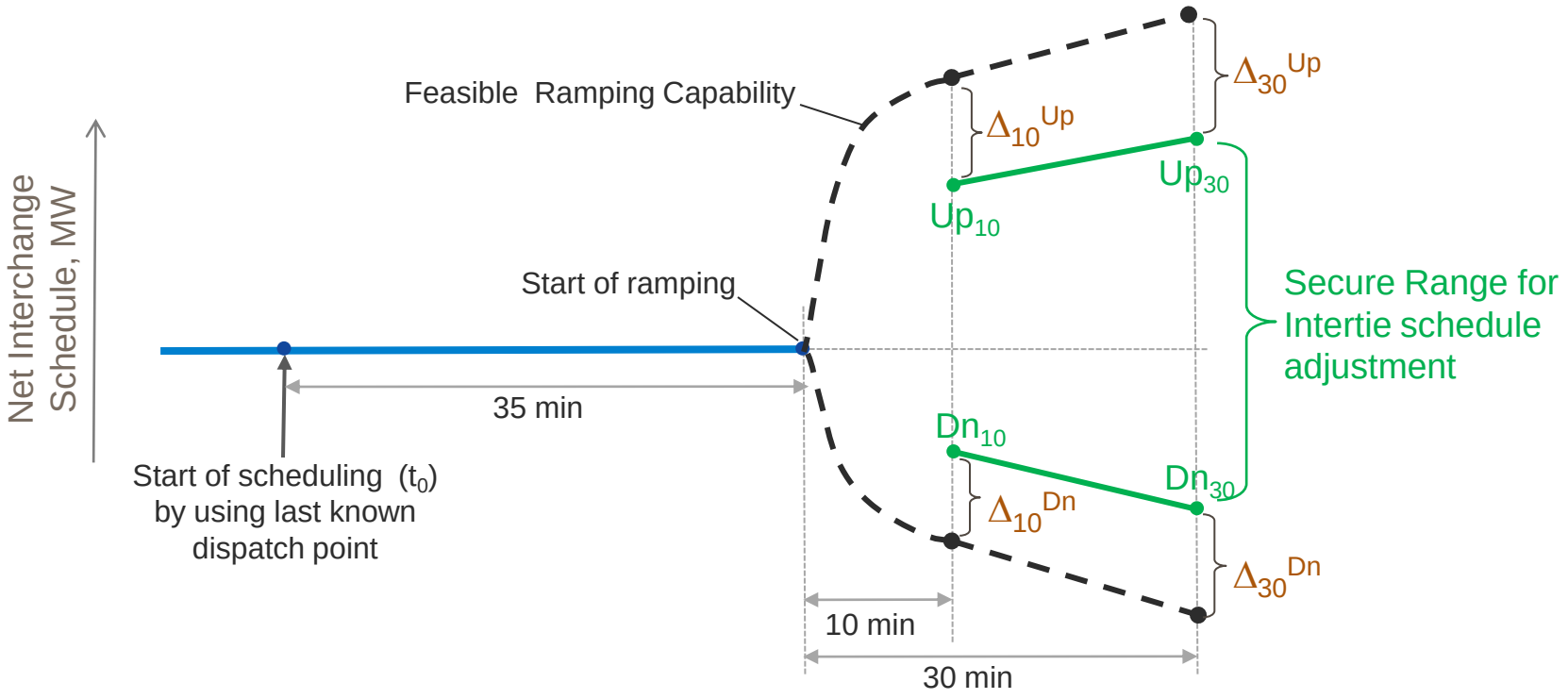
Approach, cont.

Secure adjustment range should consider all contributing factors:

- Uncertainty of the system state at the beginning of ramping
  - Load forecast error.
  - Status of generators and dispatch point.
  - Deviation of actual intertie flow from schedule.
- Variability of load and actual intertie flow after the start of ramping.
- Reserve requirements, 10 min and 30 min.

Secure intertie adjustment range

SecureRange = FeasibleRampingCapability - SecurityMargins



Δ_{10}^{Up}, Δ_{30}^{Up}, Δ_{10}^{Dn}, Δ_{30}^{Dn} are 10 min and 30 min security margins Upward and Downward

Feasible Ramping Capability

- Deterministic calculation of Up and Down ramping capability starting from the latest dispatch point available at t_0.
- Calculation includes
  - All dispatchable on-line and off-line generators within normal and emergency dispatchable MW ranges.
  - Hydro-pumping generators in pumping mode and Limited Energy Generators (LEG).
  - Generator's Ramp Rate (MW/min) as a function of generator MW output.

Security Margins

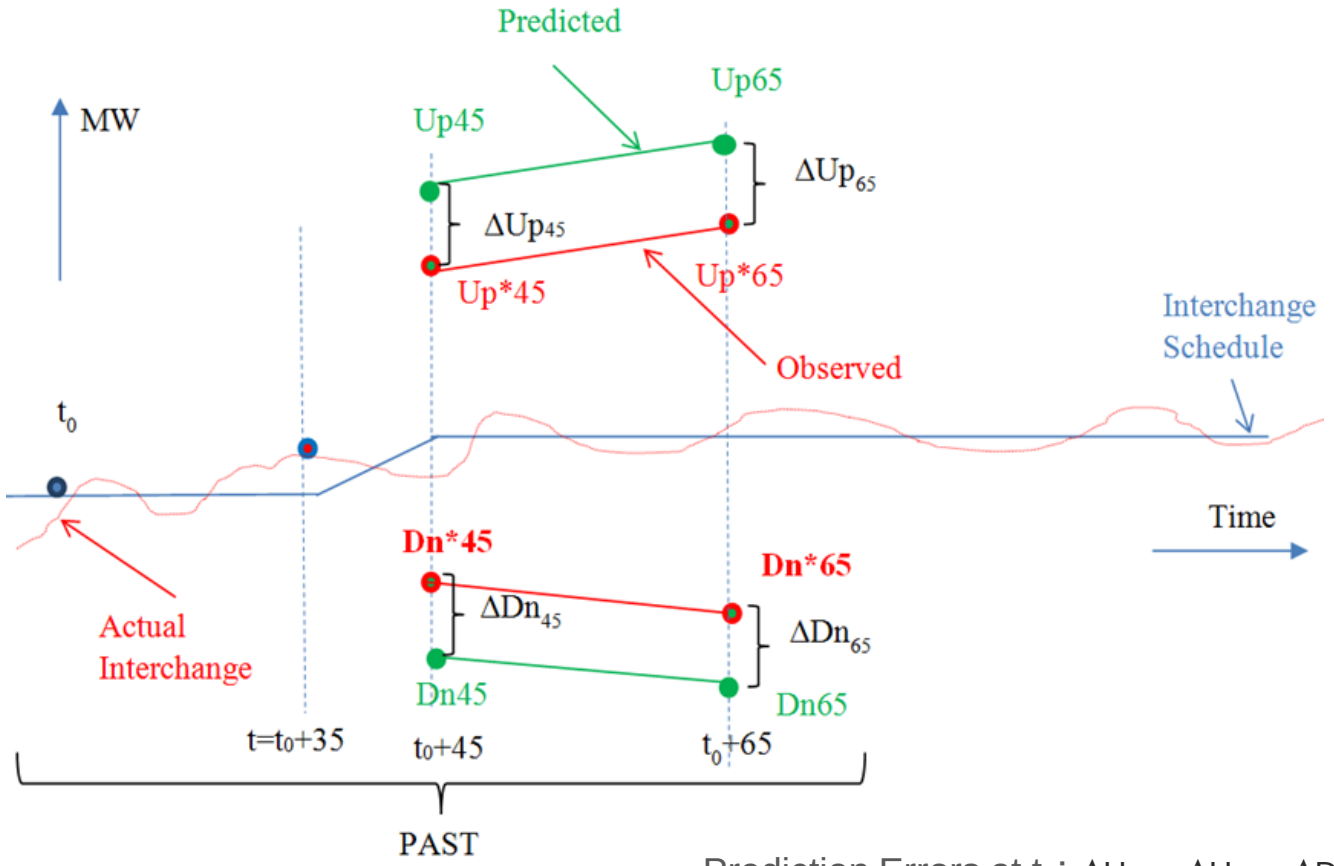
$$\Delta = \text{PredictionError} + \Delta\text{Load} + \text{ReserveRequirement}$$

- Prediction error is due to deviation of the system state in the "Latest known dispatch point" from the system state at the start of ramping for new intertie schedule.
- ΔLoad is the change of load after the start of ramping
  - Is taken from load forecast
- ReserveRequirement is the 10 min and 30 min reserve requirements after the start of ramping
  - Assumed to be equal to the same values as in t_0.

Prediction Error for historical data

Calculate Prediction Error for every 5 minutes of historical data:

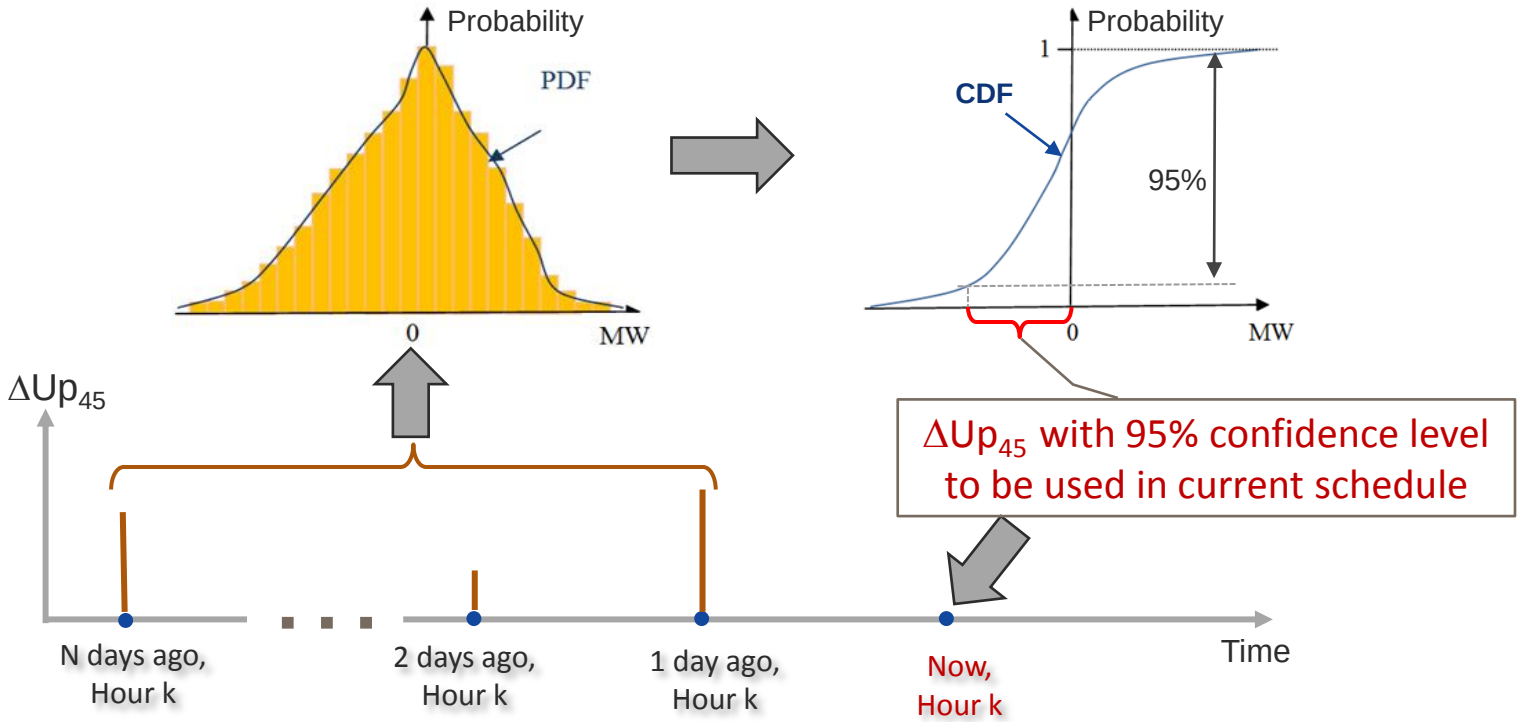
Prediction Error_t_0 = RampingCapability_t_{0+35} - RampingCapability_t_0



Prediction Errors at t_0: ΔUp_{45}, ΔUp_{65}, ΔDn_{45}, ΔDn_{65}

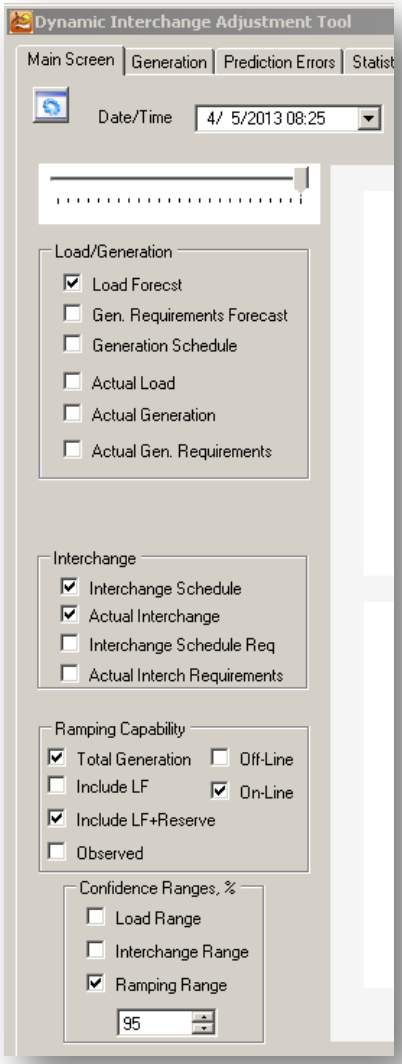
Estimation of current Prediction Error

- Historical Prediction Error values for the same hour, N days in the past create a statistical set for estimation of current Prediction Error with desired confidence level.



- Repeat process for all ΔUp_{45}, ΔUp_{65}, ΔDn_{45}, ΔDn_{65}

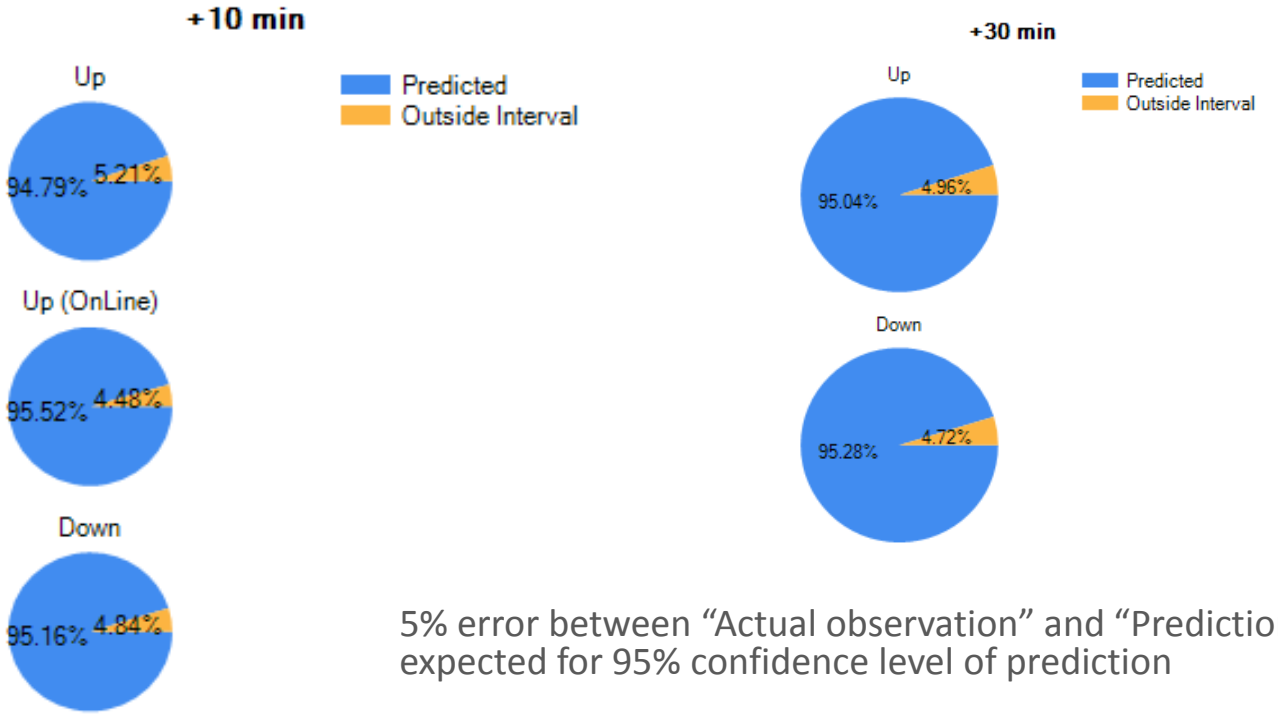
Dynamic Interchange Adjustment (DINA) tool



- Pacific Northwest National Laboratory has developed the methodology and standalone off-line version of DINA.
- The tool estimates secure range of net interchange flow for the next scheduling interval.
- Input: ISO-NE historical power system and market data.
- Configurable settings to adjust look-ahead time and parameters for statistical analysis.

Validation Procedure for Results

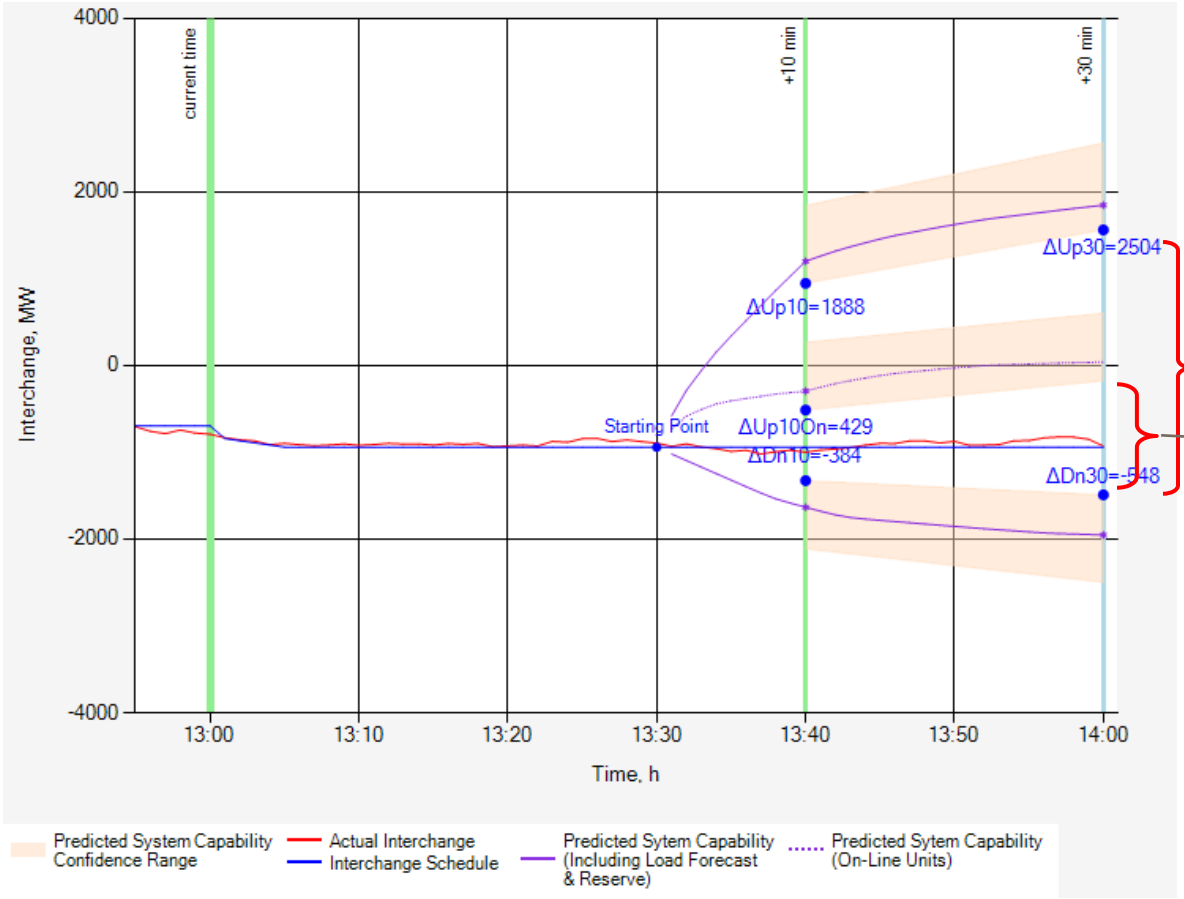
- Build-in the self validation process. Uses historical data to compare “Actual observed” and “Predicted” system capabilities.
- Error value consistent with user assigned confidence level for prediction indicates good quality of prediction.
- Performance was tested with two years of ISO-NE historical data.



5% error between “Actual observation” and “Prediction” is expected for 95% confidence level of prediction

Use case: typical, normal situation

- Area between pink zones is the secure range for intertie flow schedule supported by available upward and downward system ramping capability.

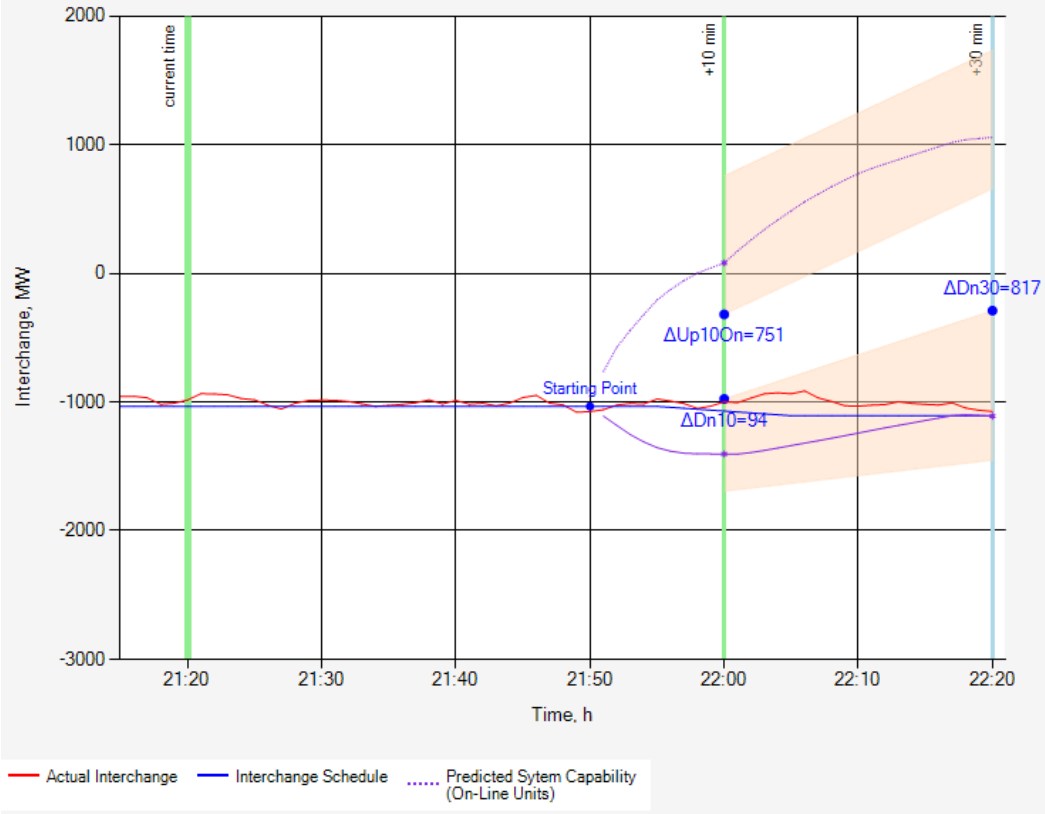


Secure area provided by on-line and off-line generators

Secure area provided by on-line generators only

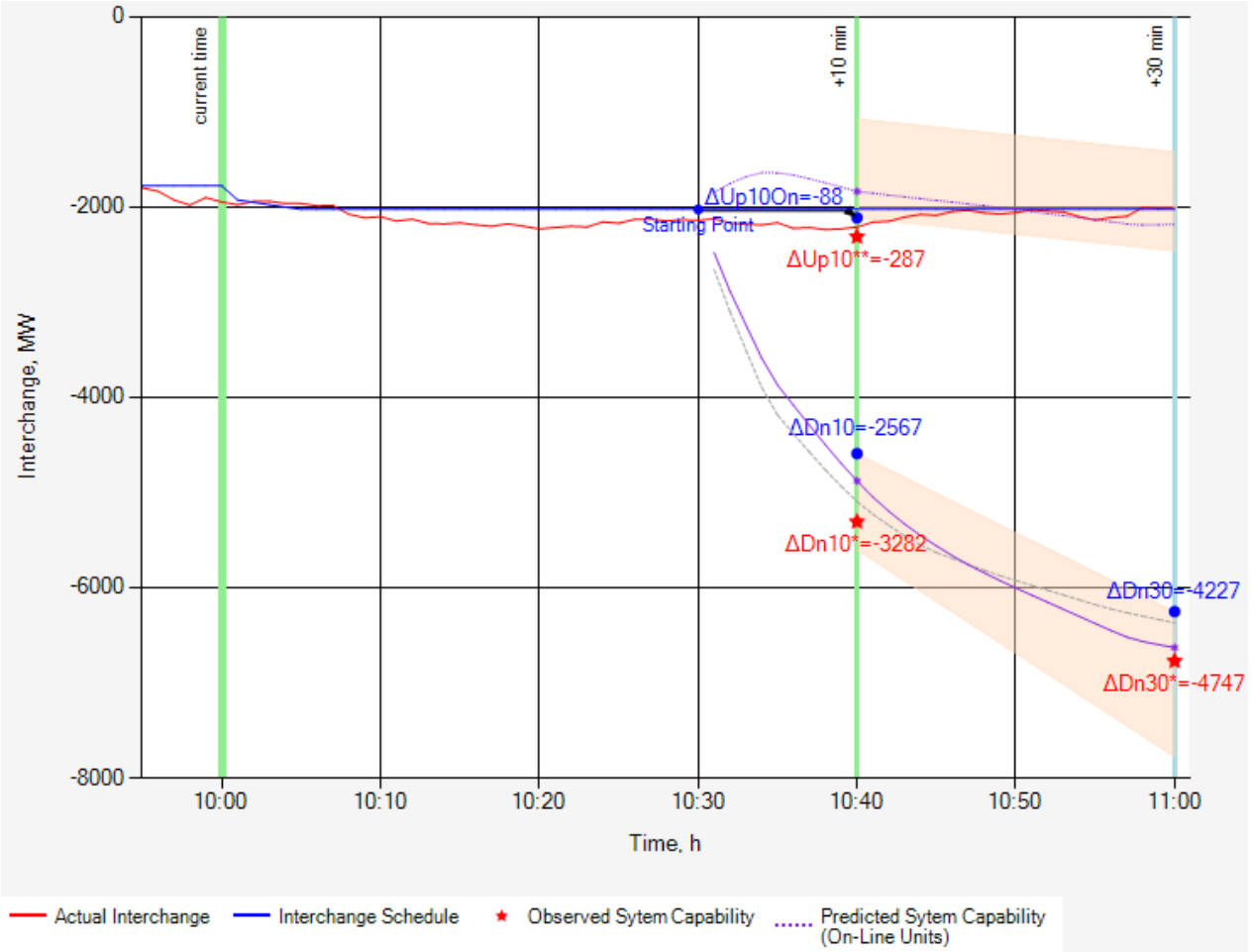
Use case: Minimum Generation conditions

- Limited downward capability due to rapid load reduction and insufficient ramping down capability by on-line dispatchable generators.
- Net interchange can be increased to stay inside of the confidence interval and alleviate Minimum Generation conditions.



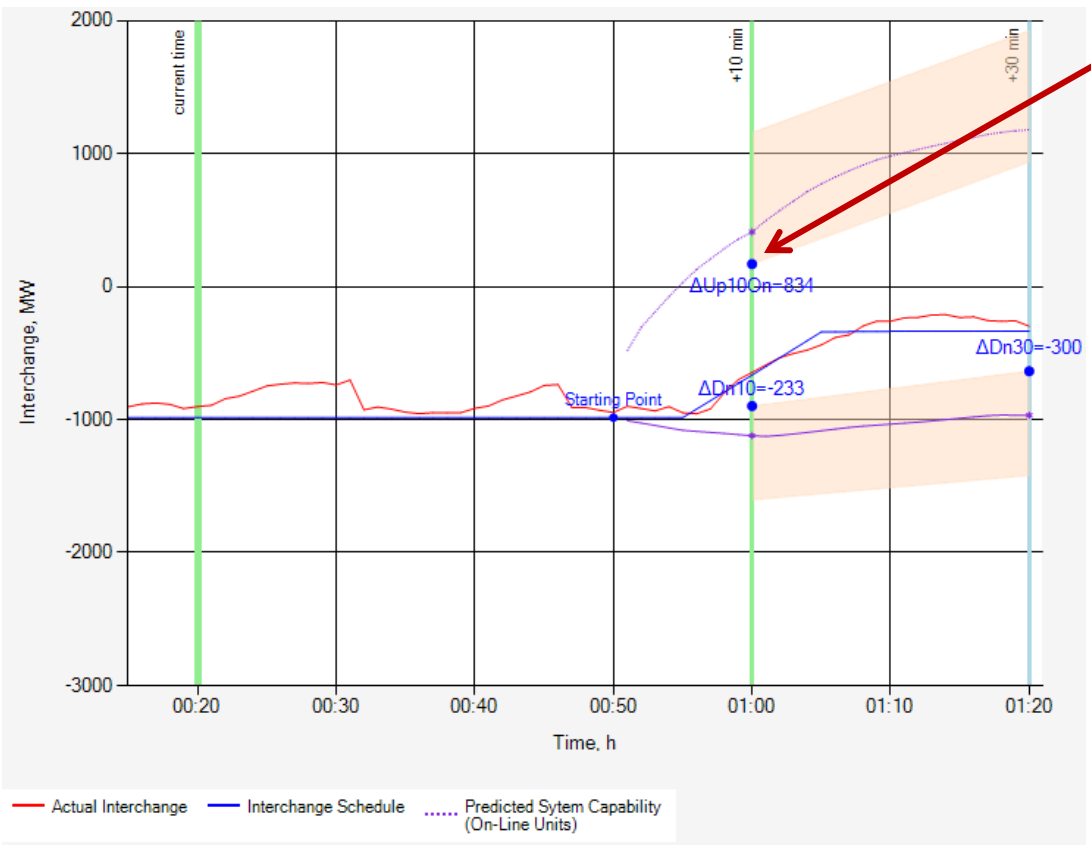
Use case: Deficiency of ramping upward capability

- The tool predicts deficiency of on-line generation starting at 10:40AM



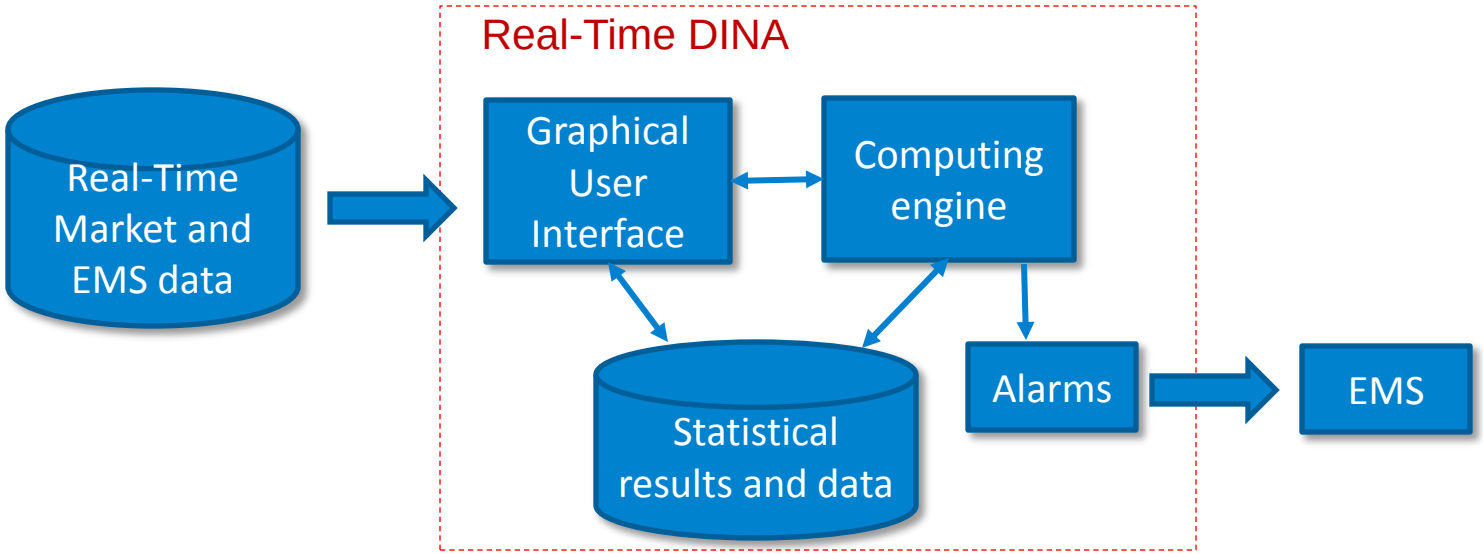
Use case: Unnecessary interchange cuts

- Actual increment of net interchange schedule at 1AM was curtailed by 500 MW limit rule
- That was unnecessary as predicted ramping Up capability was 834 MW



Future Plans

- DINA was tested with two years of historical ISO-NE data and recommended for implementation as an advisory tool for Real-Time operation.
- The tool will continuously predict the secure range of net intertie flow for the next scheduling interval.



Conclusions

- The methodology and off-line tool for evaluation the secure range of dynamic interchange adjustment have been developed.
- Efficiency of the tool was verified with two years actual ISO New England data.
- Control Room has requested to develop on-line version of the tool to be used in advisory mode for real-time operation.

Questions