Integration of Real-time Unit Dispatching Optimization with SCADA and AGC

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Powel-MiniMax

- Powel-MiniMax is a US-based energy software and services provider of stand-alone and integrated energy solutions.
- Powel ASA is spin-off of EFI, the Norwegian Electric Power Research Institute, established in 1951.
- Over 35 software modules used by more than 1000 customers worldwide covering
  - Generation and Water Management
  - Transmission and Distribution Management
  - Trade and Risk Management
  - Customer Management
  - Geographic Information Systems (GIS)
- Over 25 years of water management experience ranging from hydrological analysis and forecasting, water quality modeling, hydro system planning and operational analysis.

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Integration of Real-time Unit Dispatching Optimization with SCADA and AGC

AGENDA

- The Project
  - Hardware Configuration
  - Data Communication
  - Unit Dispatching Optimization
  - Technical Issues
  - Future Developments
  - Conclusions

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The Project – Overview

- Three hydro plants in a thermal dominated system (hydro provides less than 5% of generation to more than 1 million customers)
  - The hydro plants provide highly valued ancillary services (spinning reserve and up/down regulation)
  - The hydro plants are on AGC to regulate the corporate system

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The Project – Scope

- Hourly scheduling optimization for the next seven days to maximize either generation or revenue
  - Real-time unit dispatch optimization at plant level
  - The optimization models are linked with SCADA and AGC for closed-loop control in real-time

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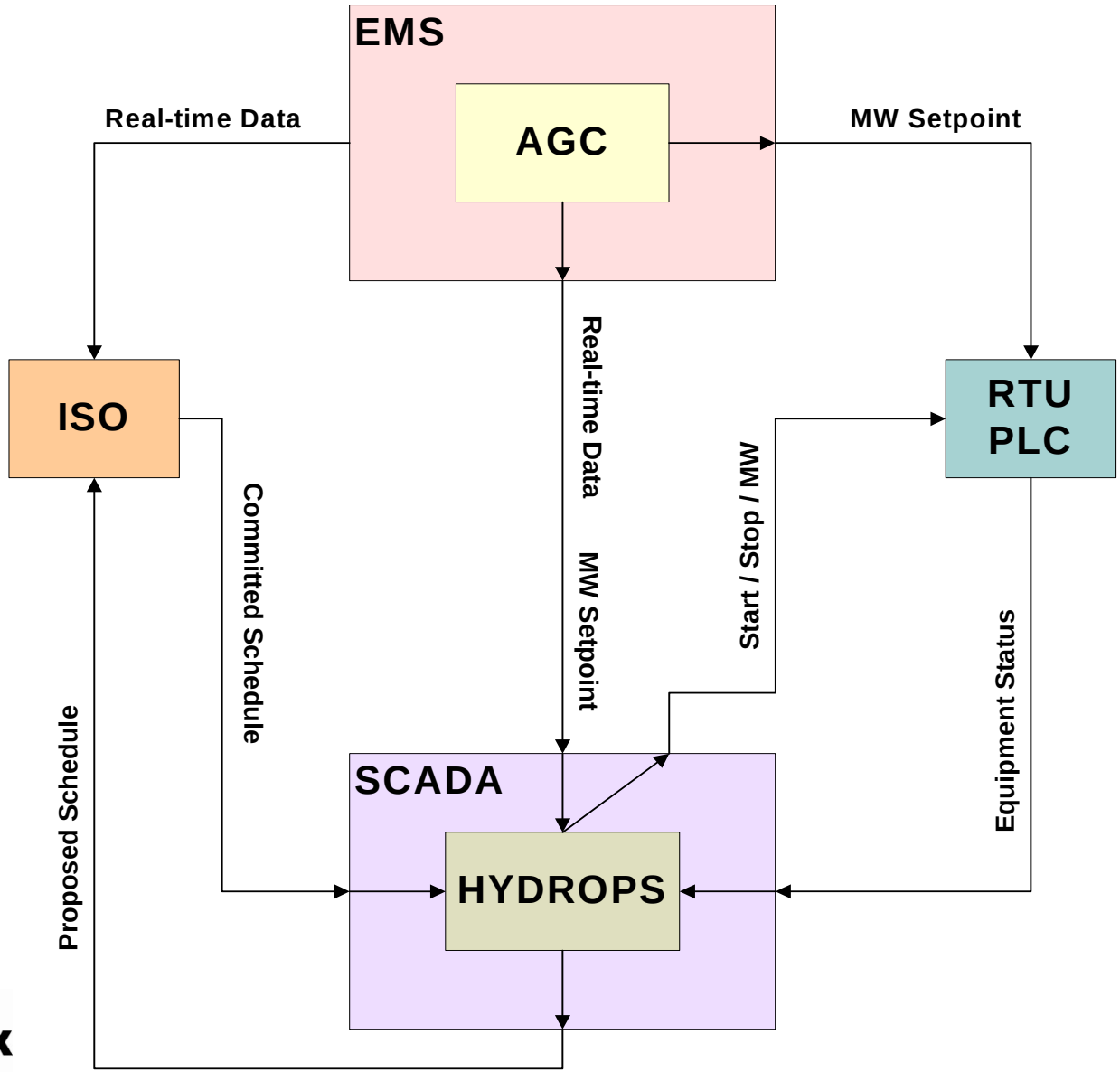
Hardware Configuration



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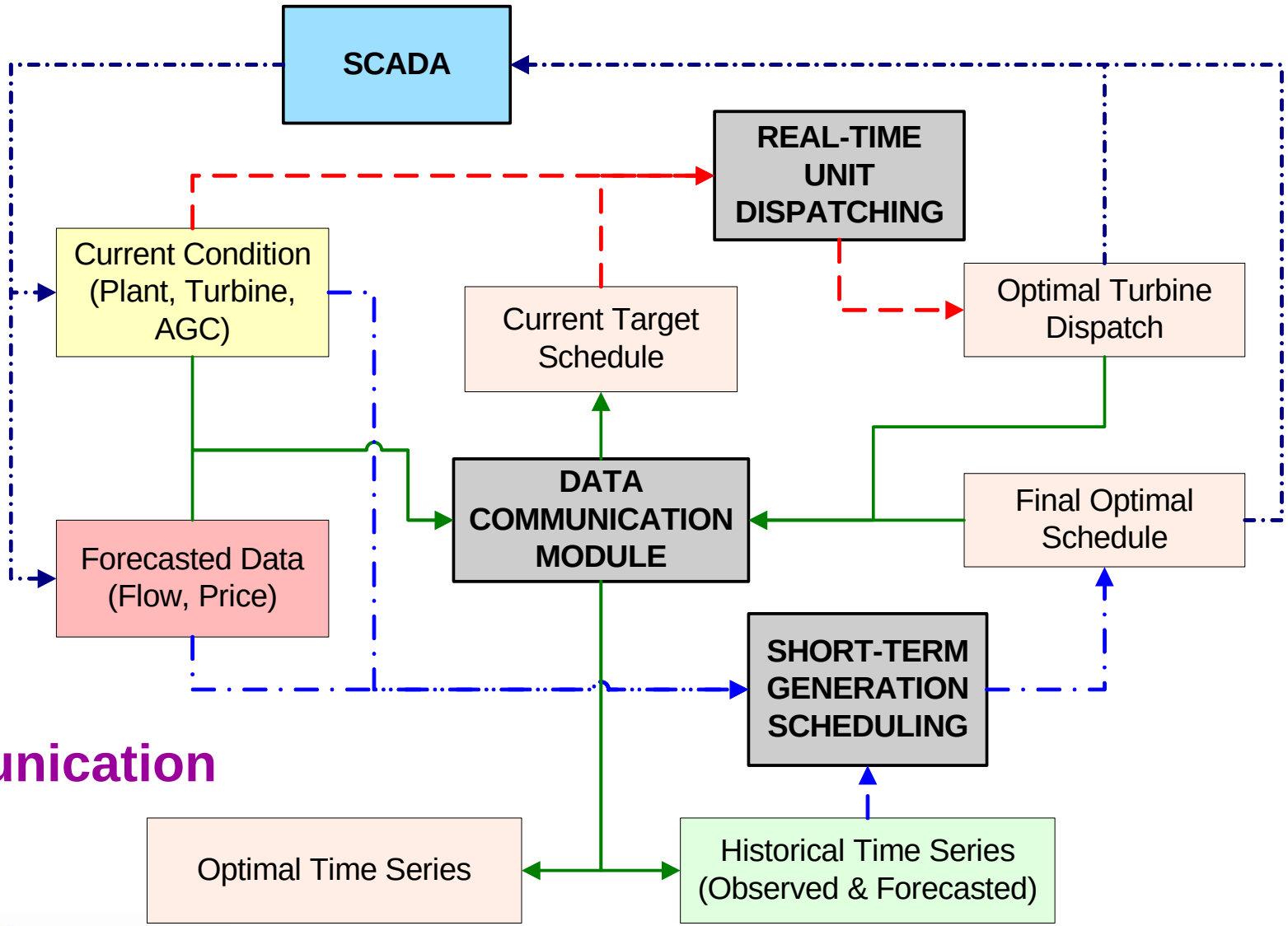

Data Communication

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Unit Dispatching Optimization

- Objective: To produce required power output at maximum efficiency (i.e., minimum water usage)
  - Constraints: Monitoring environmental constraints (i.e., minimum flow, ramping, etc.)
  - Method: Dynamic Programming (modified)
  - Inputs: Turbine data and current system conditions
  - Running modes: Manual (Local, Remote) and Automatic (AGC & STGS)

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Technical Issues

- Running time: Unit dispatching optimization in less than 4 seconds
  - Data communication: Real-time data is updated every second
  - Monitoring constraints: min. flow and ramping
  - Unit cycling:
    - Minimum on/off time
    - Start/Stop cost
    - Efficiency differential
    - Start/Stop order

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Future Development

- Dissolved Oxygen: Automatically meet the DO constraint in an optimal way
  - Real-time monitoring
  - DO vs. Vent opening
  - Vent opening vs. Turbine efficiency

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Conclusions

- Fast execution is important in real-time control

- Bullet-proof features, backup plans and redundancy are critical elements in closed-loop operations
- Simple and effective integration of EMS, SCADA, and optimization models is beneficial for maintenance
- Good compromise between practicality and theoretical optimality

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