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Power & Process Dynamic Simulation

David Gaertner

Babar Iftikhar

AVEVA

David Gaertner

Global VP Partnerships & Analytics – Process Automation

Schneider Electric

David.Gaertner@se.com

Babar Iftikhar

EcoStruxure Power and Process Program Manager

Schneider Electric

Babar.Iftikhar@se.com

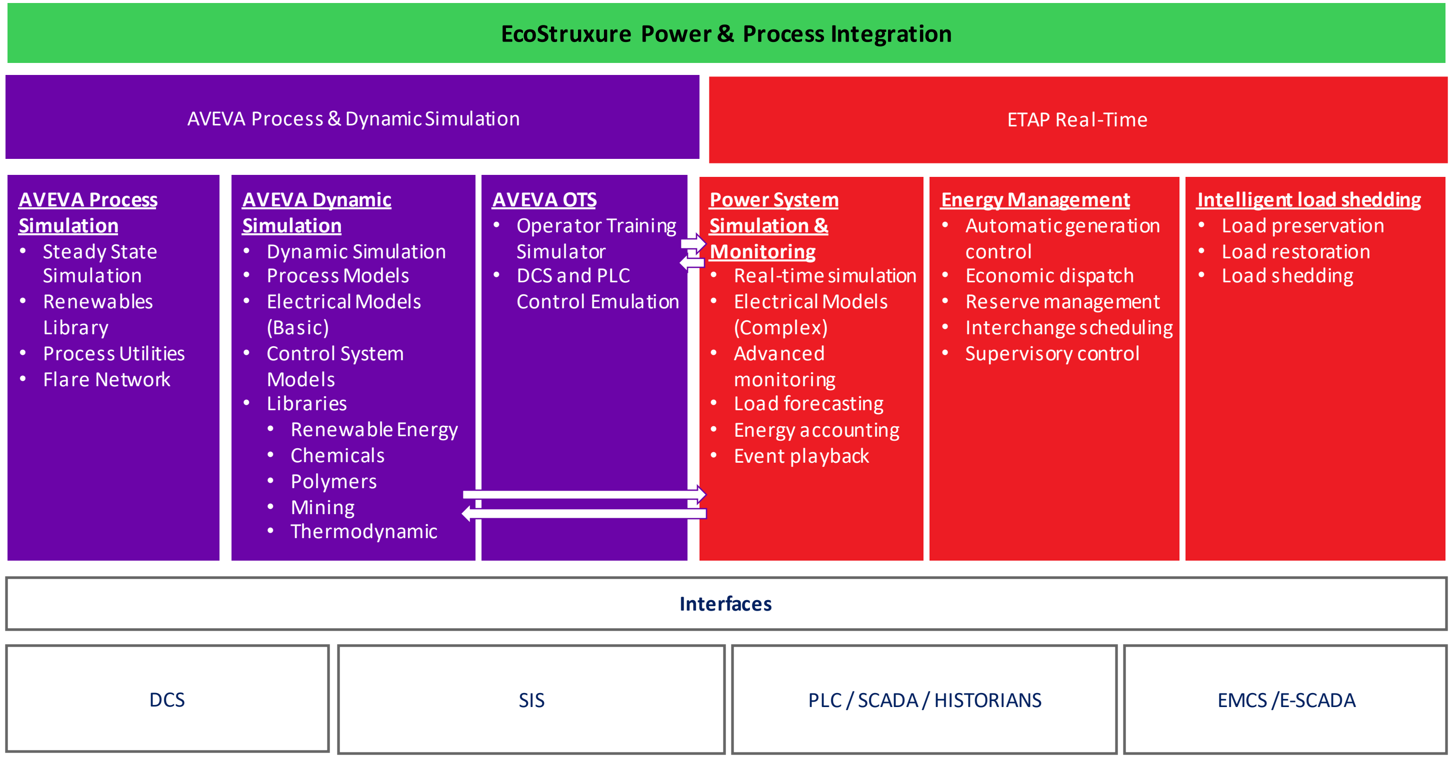
Agenda

- Integrated Power, Process & DCS platforms
- Offline study: LNG Train – Power Flow Optimization
  - Process Model – Before Optimization
  - Electrical Distribution Model – Before Optimization
    - Zoom In View
  - Combined Process & Power Display
  - Optimized Zoom In View
- Q & A

Power & Process Dynamic Simulation
AVEVA Dynamic Simulation, ETAP Real-Time & Foxboro DCS

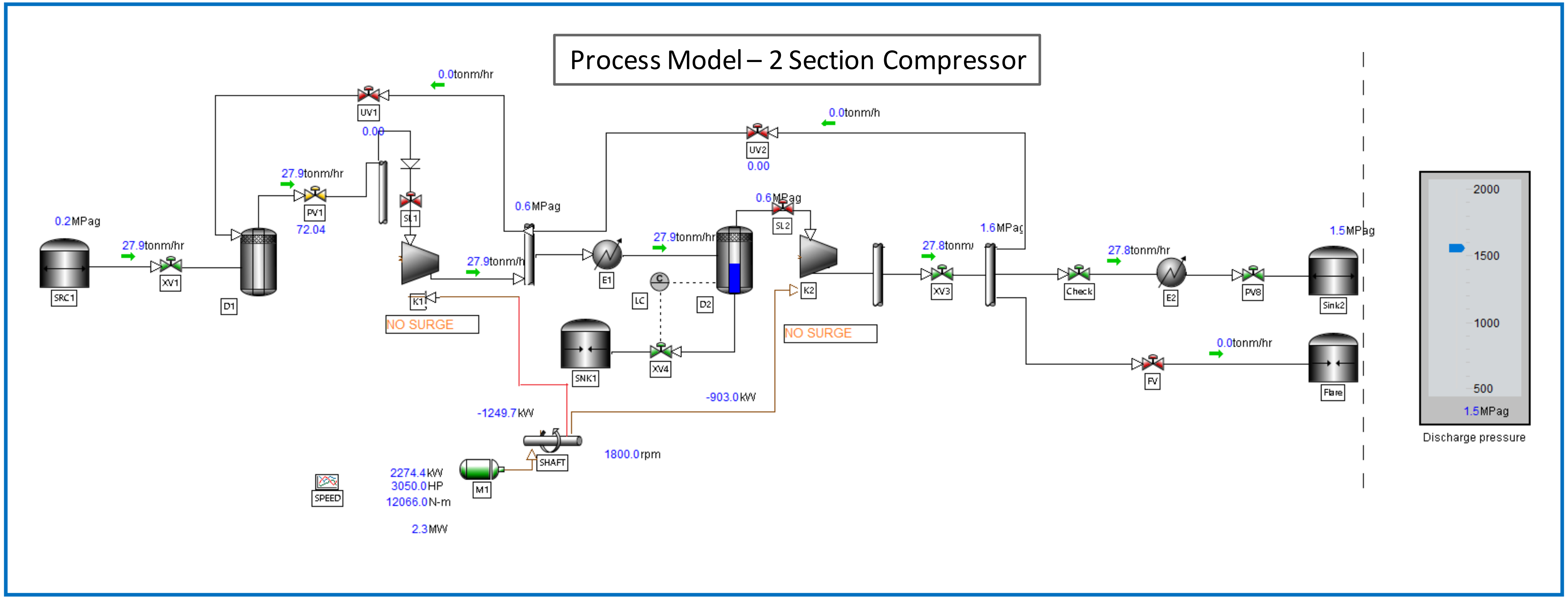
New value from Power & Process Integration

- **Current: Offline Studies & Operator Training Simulators**
  - Study effect of process disturbances on electrical distribution
  - Study effect of electrical disturbances on process operation
  - Optimize power flow based on process demand & objectives
  - Minimize reactive power losses with variable capacitance
- **Future: Online Real-time Applications**
  - Look-back – post-trip analysis to create new OTS scenarios
  - Look-ahead – use model to evaluate future impact of potential operator moves
  - Combine AI & first principal modelling – operator advisory, etc



Offline Study: LNG Train – Power Flow Optimization

Process Model – Before Optimization, Stand-Alone

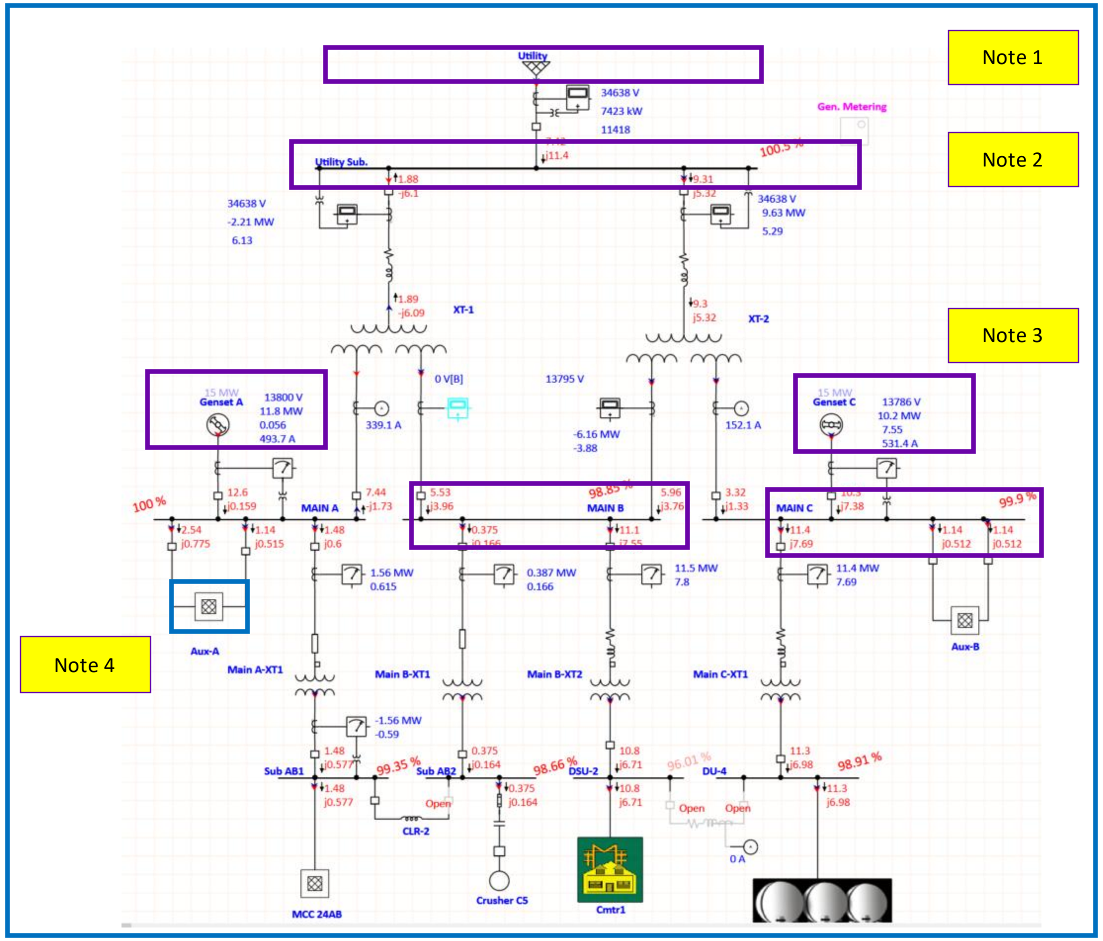


Notes

1. Compressors **K1** & **K2** are connected to Motor **M1** by a single **SHAFT.**
2. **The compressor LNG load is communicated from the compressors to the motor through the shaft in the physical realm. It is communicated in the models by passing the process model compressor power and torque to the electrical distribution model of the motor.**
3. **K1 & K2** throughput is at **27.9 tonm/h** by controlling **K1** suction pressure at **0.2 Mpag** by throttling **PV1** to **72.04**% open.
4. Power flow is not optimized based on this snapshot of the operational parameters.

Offline Study: LNG Train – Power Flow Optimization

Electrical Distribution Model – Before Power Flow Optimization



1. The electrical distribution model has three main power sources: **Utility Grid**, **Genset A & Genset C.**

2. The Utility Generation substation is connected to three busses **Main A, Main B** and **Main C** via two redundant inter-bus transformers **XT-1** & **XT-2**. Power can flow bidirectional with power arbitrage.

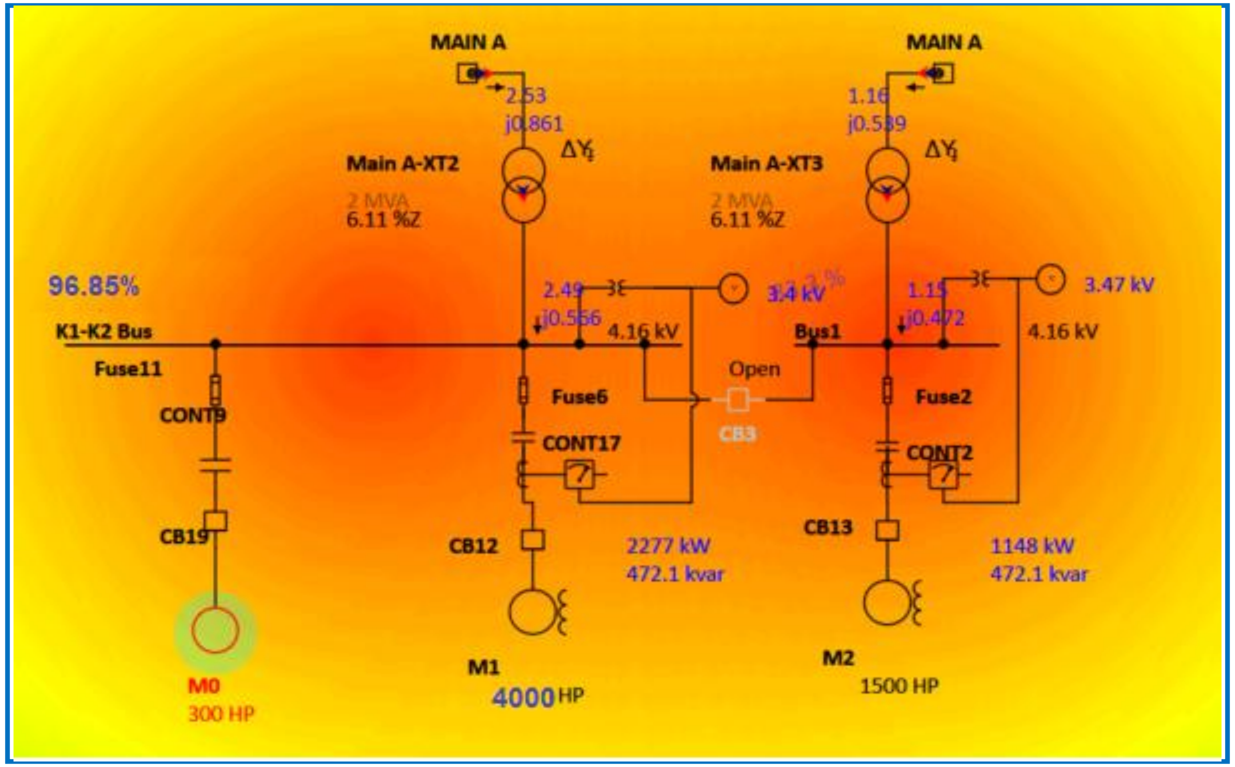
3. Genset A & **Genset C** have 15 MW capacity and are operating at 11.8 MW & 10.2 MW active power respectively which is distributed across **Main A** and **Main C** respectively.

4. Aux A is one of the significant power consumers of **Genset A**. Let's zoom into **Aux A** in the next slide.

Offline Study: LNG Train – Power Flow Optimization

Electrical Distribution Model – Before Power Flow Optimization

- K1-K2 Bus Condition
  - Bus is under voltage at 96.85% of Rated 4.16 KV
  - This bus is generating a critical alarm
  - The other loads on the bus are also being affected
- Overall Apparent Power Losses
  - Active Power: 0.56 MW
  - Reactive Power: 2.96 M Mvar



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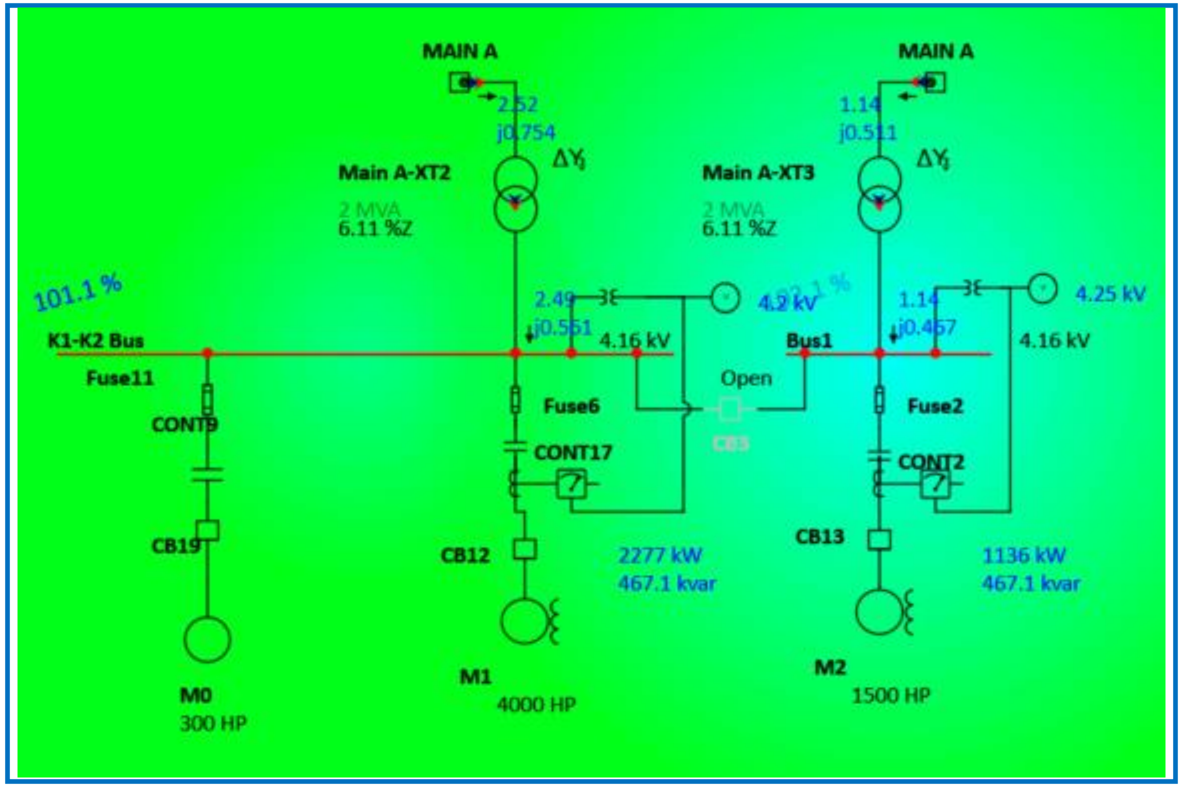
Offline Study: LNG Train – Power Flow Optimization

After Integration & Optimization

Power Flow Optimization

- Balances power flow to minimize power losses
  - Total active power losses reduced
    0.56 MW → 0.469 MW
  - Total reactive power losses reduced
    2.96 Mvar → 2.27 Mvar
- **K1-K2 Bus** under voltage problem is corrected from 96.85% to 101.1% of rated voltage.
- Control **Utility Grid**, **Genset A** & **Genset C** to optimize power economics.
- Control power sources and sinks within ranges & constraints.
- Satisfies process compressor **K1** & **K2** demand loads up to electrical distribution constrains.
- Additional optimization could consider variable capacitance capacitor banks to reduce reactive power in fluctuating reactive power operating scenarios.



Questions?

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linkedin.com/company/aveva

@avevagroup

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