Improve operations with AI/ML Powered Analytics

Jack Wilkins

September 2023

Agenda

Technology Stack

Improve forecasting and asset effectiveness

Exploration of time-series data

Transmission grid balancing

Using AI/ML to improve alarm management and prioritization

Closing

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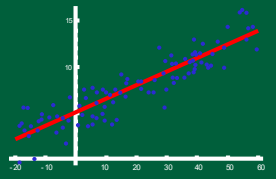
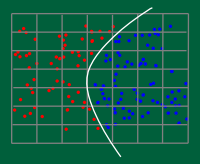
Technology Stack - Fitting Tools to Challenges

Supervised Learning

Learn patterns in data w.r.t. known response



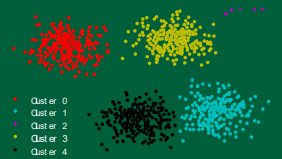
Regression



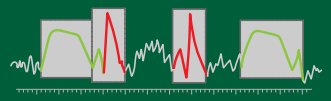
Classification

Unsupervised Learning

Learn patterns in data without response



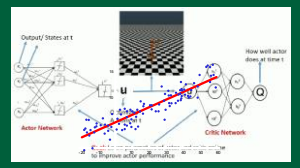
Clustering



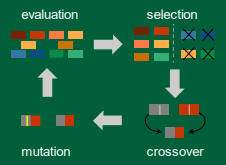
Pattern Recognition

Sequential Learning

Optimize by learning reward from actions



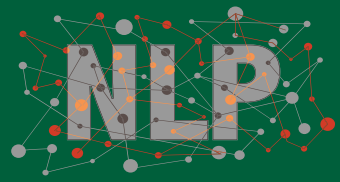
Reinforcement Learning



Evolution Strategies

NLP & Speech Recognition

Engage in verbal and written communication

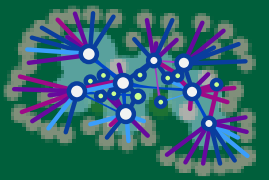


Natural Language Processing

Speech Recognition

Cognitive Computing

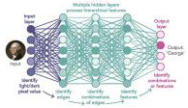
Replicate human decision-making process



Knowledge Graphs

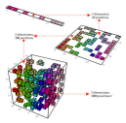
Connect Context with Data

Core Tech

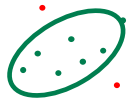


Deep Learning

Probabilistic Network

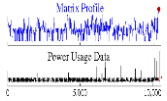


Dimension Reduction



Anomaly Detection

Local Embedding



Matrix Profile

Tools

PyTorch, TensorFlow, Pandas, python, theano, R, TORCH, flux, NumPy, julia, OpenCV, pomegranate, scikit learn

Analytics begins with a Data Foundation

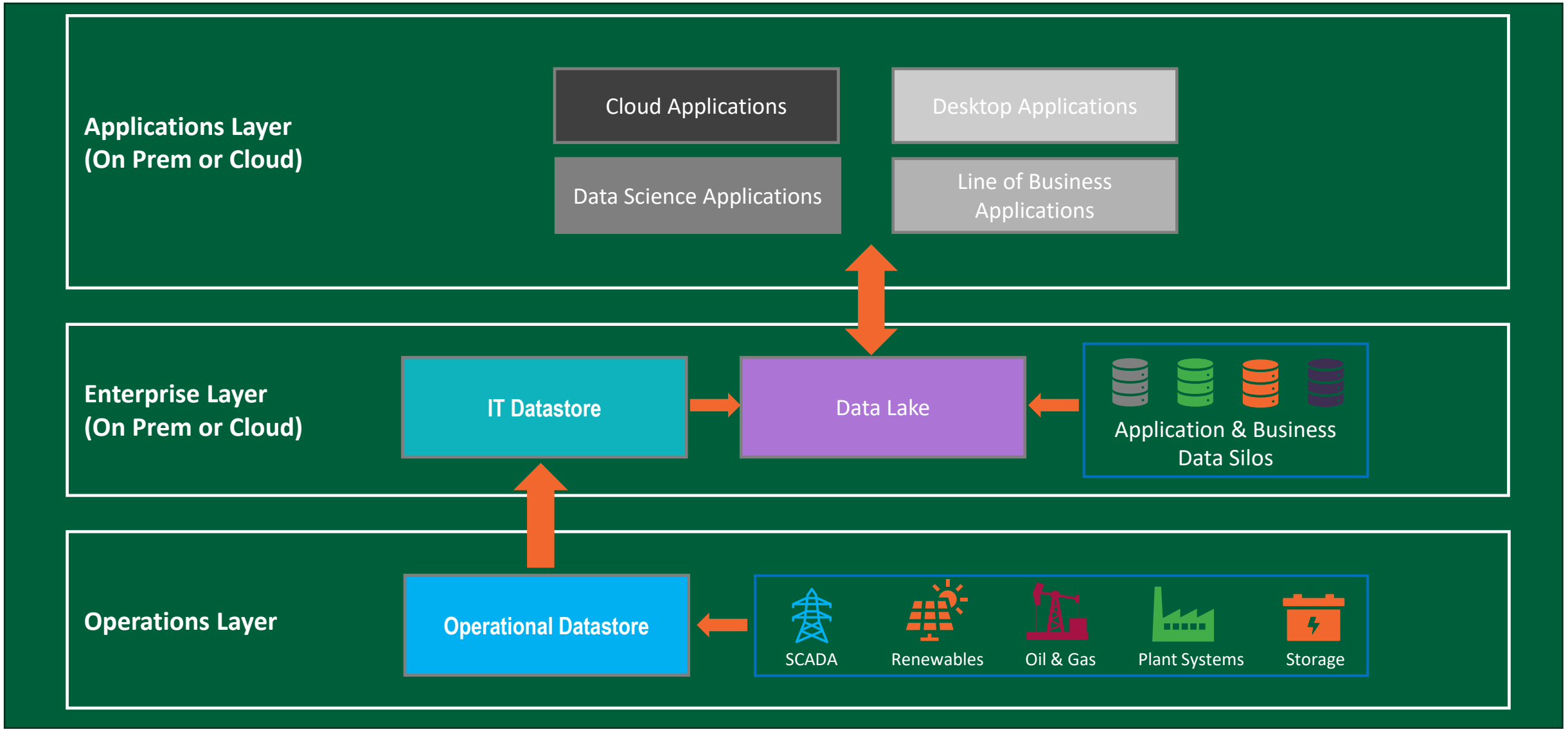
Key functions

- Aggregate process data across the enterprise with cloud scalability
- Visualization and Analysis with a modern, web and mobile environment
- Vendor-neutral connectivity for end-to-end data collaboration
- Contextualize operational data across the entire enterprise
- Analyze alarm & event data for patterns and predictive outcomes

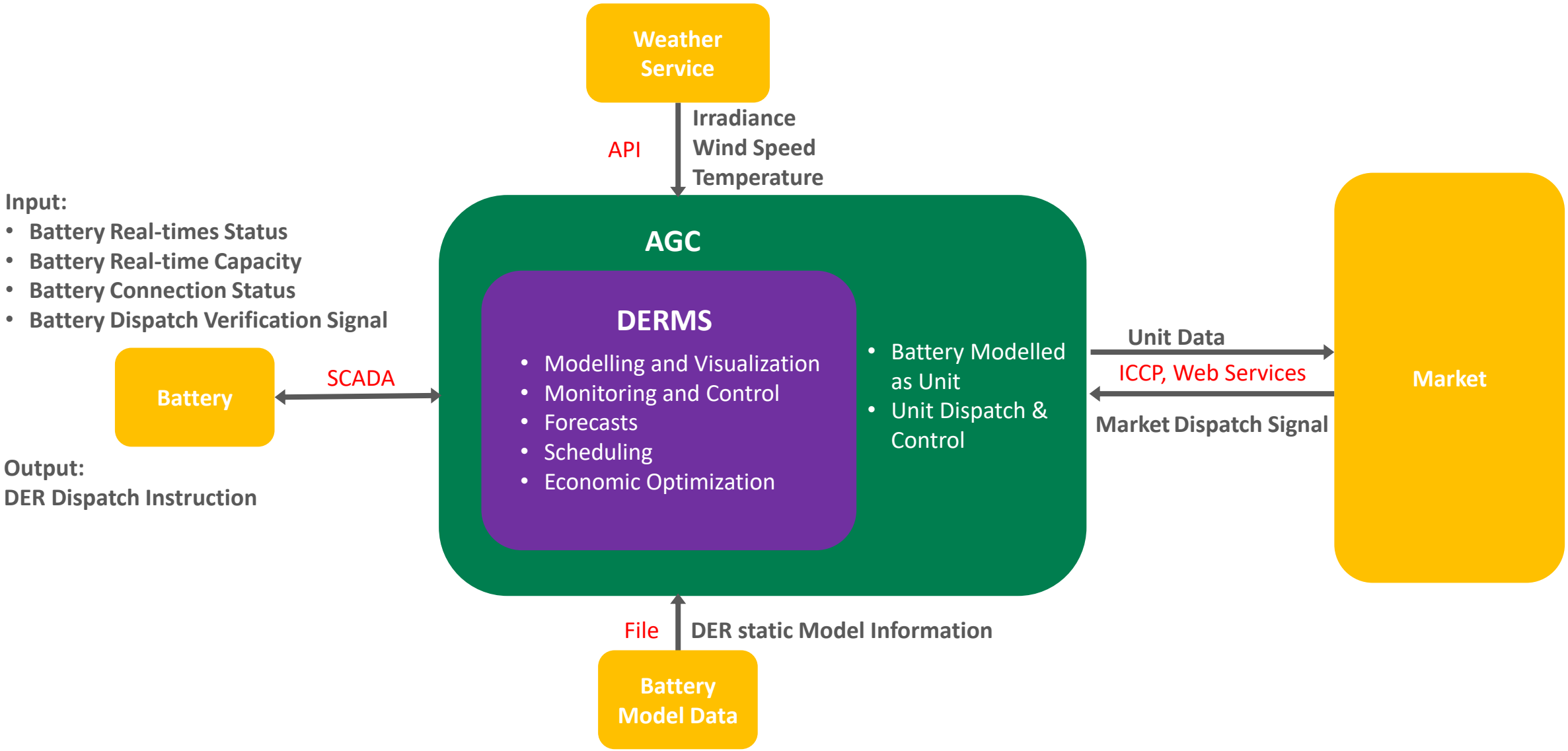
Value drivers for utilities

- Improved process understanding
- Ability to manage data from multiple sites allowing for operational comparisons
- Flexibility of implementation with growth avenues from small to large scale cloud
- Secure data storage and retrieval
- Built in reporting and analysis improves regulatory compliance evaluations
- High availability in redundant mode

Integrating OT & IT Data Repositories for Analytics



DERMS Battery Management and EMS/GMS



Forecasting of renewables and battery management

Detailed modeling of battery resources

- Physical parameters
- Smart inverter operating modes
- Contractual limitations on use

Real-time monitoring of battery assets

Automatic dispatch for local control objectives

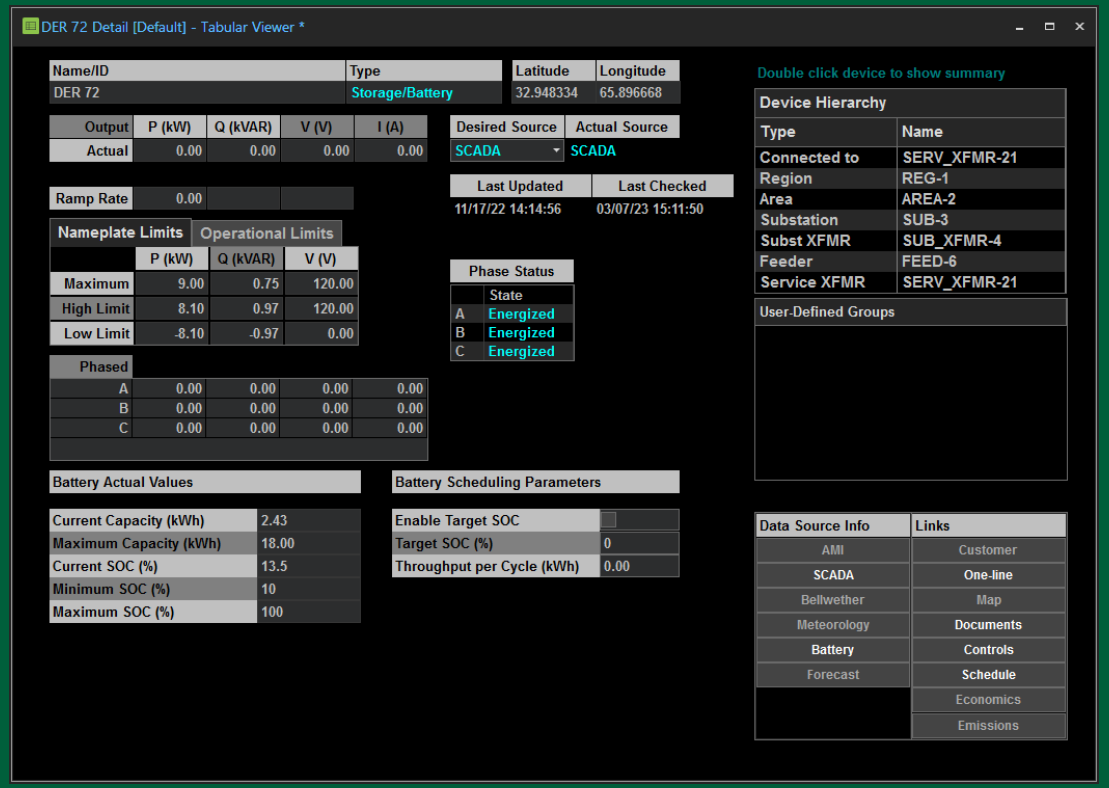
- Solar + storage management
- Point of Interconnection loading control
- Substation peak shaving/backfeed avoidance

Optimal scheduling of real-power for local objectives

- Manual scheduling for enabling operating modes

Integration with GMS for remote dispatch

Market integration through GMS

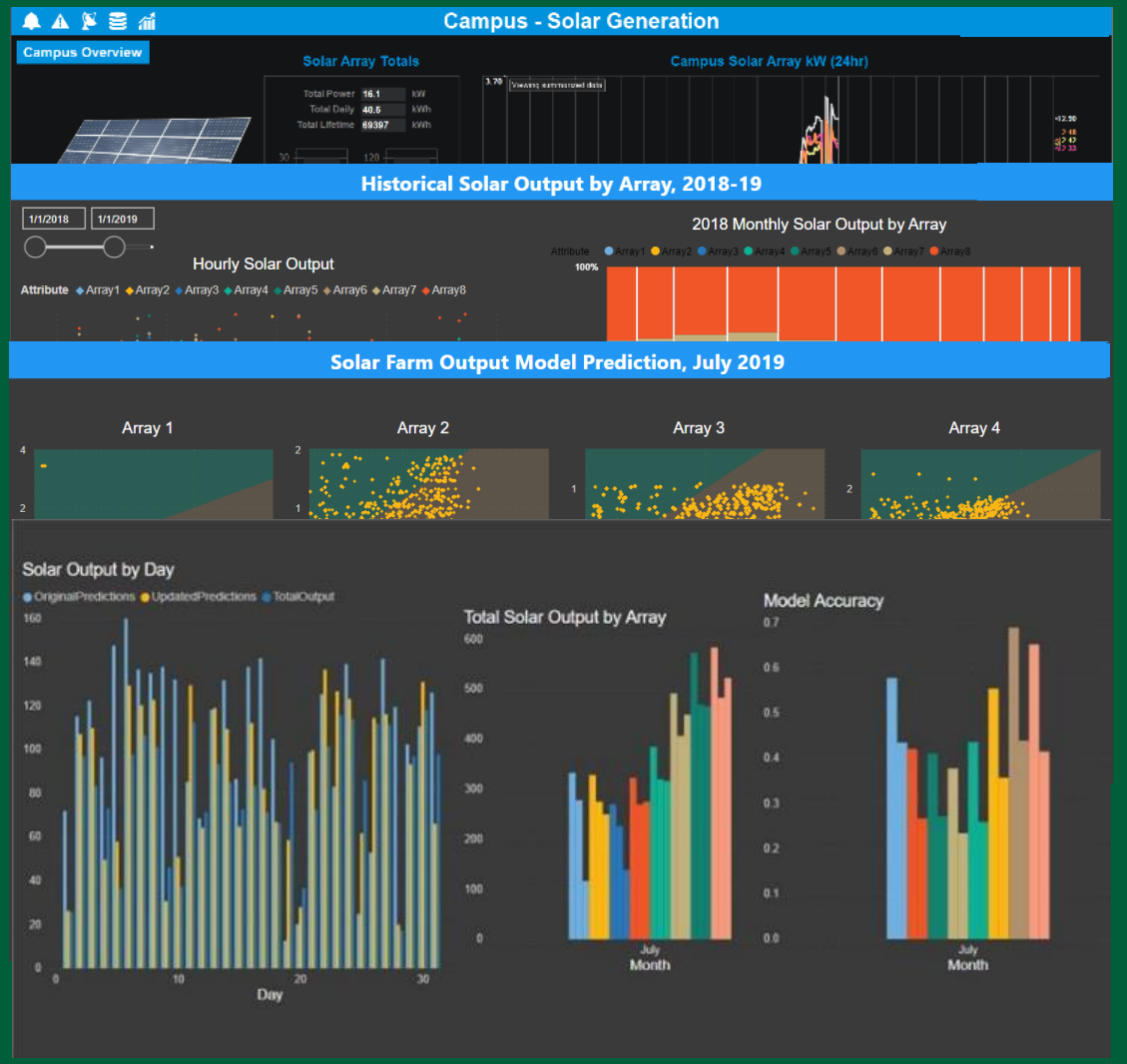


Maintain DERs using Predictive Analytics

Challenge: Reduce cost and effort to maintain campus solar farm.

Solution: Use cloud-based predictive analytics to forecast inverter fuse failures and panel degradation.

- Process begins with storing raw data from SCADA system in a cloud based operational datastore.
- Review and cleanse data.
- Build and train model.
- Apply model to real-world data.

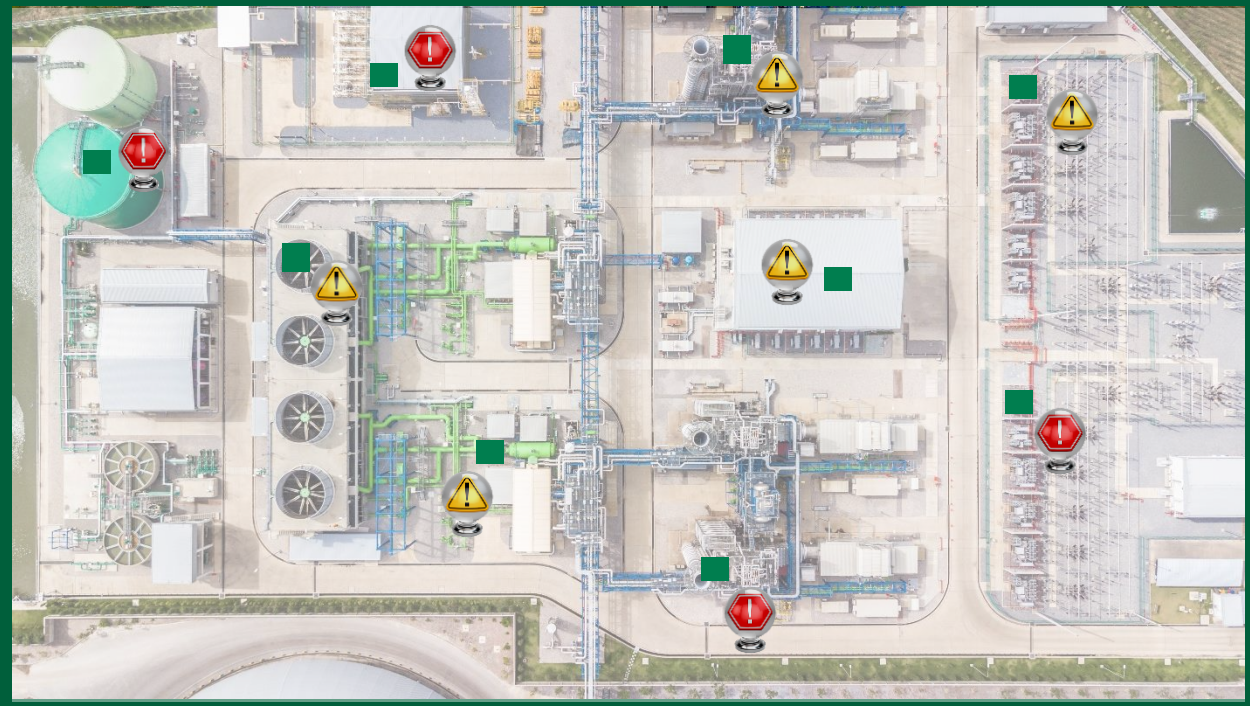


Improve Asset and Production Effectiveness

Autonomous Asset Agents

- **Monitor assets in the context** of their usage to provide the earliest possible warning of asset damage and failure
- Enables Engineers to **rapidly build autonomous agents** that protect assets
- Provides **precise prescriptive guidance** for mitigating alerts
- **Self-learning, adapting** over time
- Compliments existing workflows and helps **optimize business processes**

Avoid unplanned downtime by identifying the earliest possible indicators of potential asset damage and failures using machine learning



Sensors “on and around equipment” ensure agents alert root cause of issues

Agents Do Things That Others Cannot and Do Not

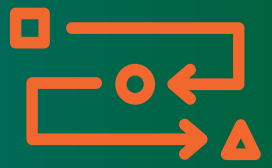
See things earlier
Months vs. days (more time for investigation and planning)

Analytics to predict when maintenance is unavoidable

See things they cannot
To prevent process-induced damage

Analytics to prevent operations activities from causing equipment damage – “do no harm”

Attach failure to root cause
In EAM system for both O&M guidance



Prescriptive: integrates digital work-scope from work order systems. You know what’s wrong and how to fix it

AGENTS KNOW HOW TO STOP EQUIPMENT FAILING

Sample Business Use Cases

- Decrease Customer outages by improving Equipment Availability and Reliability
- Reduce Operating Expenses by eliminating over maintenance and excess spare parts
- Reduce Safety and Environmental Incidents by transforming Emergency work into Planned work

Data Exploration

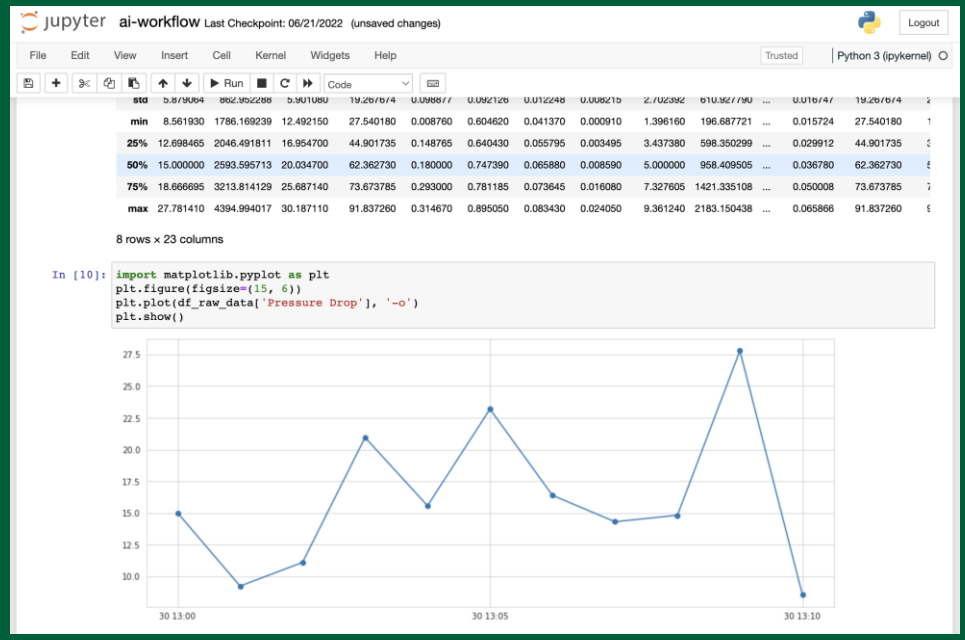
VISION

Opportunity

- Allow custom data pre-processing
- Support more advanced exploratory data analysis
- Enable growing data scientist persona at our customers

Business Value

- Additional flexibility: Support custom use cases
- Better user experience with less context switching



Power Grid Congestion Management

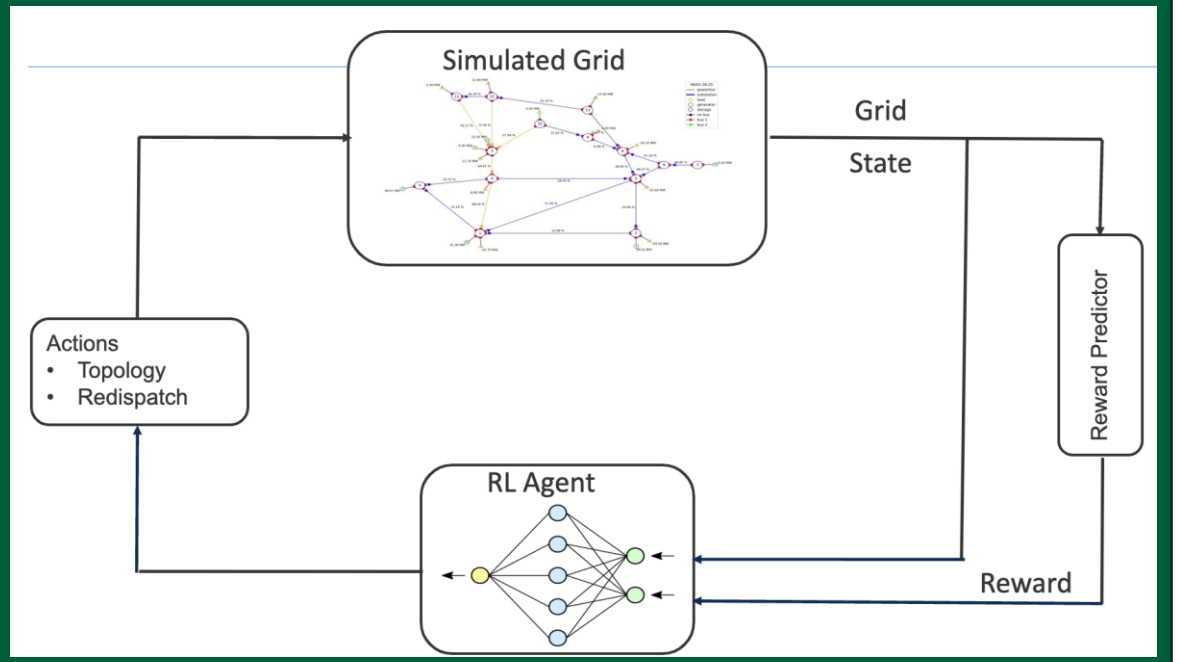
VISION

Opportunity

- Autonomous balancing of power transmission grid
- Alleviating congestion in network by topologic switching
- Assist grid operator by proposing action

Business Value

- Combine topologic switching with traditional measures
- Improve the grid resilience and reduce costly measures
- Identify under-utilized, cost-effective flexibility in the network



Distribution grid balancing using quantum computing

VISION

Opportunity

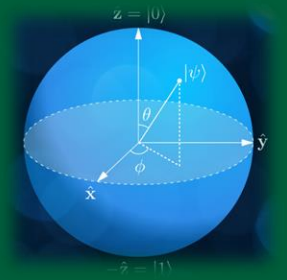
- Build awareness to validate opportunities and readiness
- Explore new use cases based on combinatorial problems
- Identify strong technology partners

Business Value

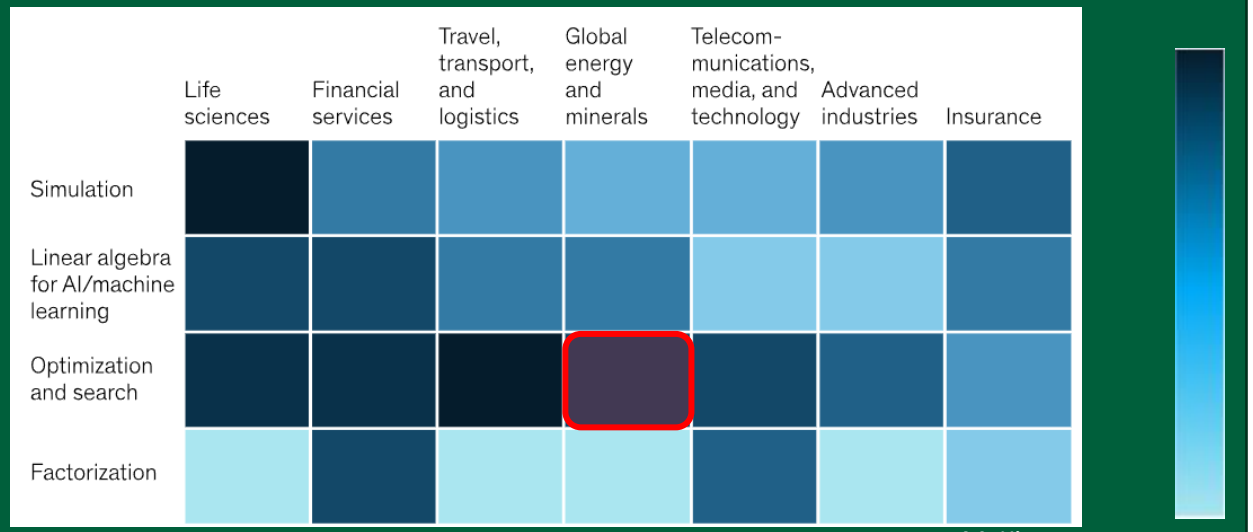
- Exponential acceleration of compute possible
- New applications based on combinatorial problems

Exponential Acceleration

Classical $O(n)$



Quantum $O(2^n)$



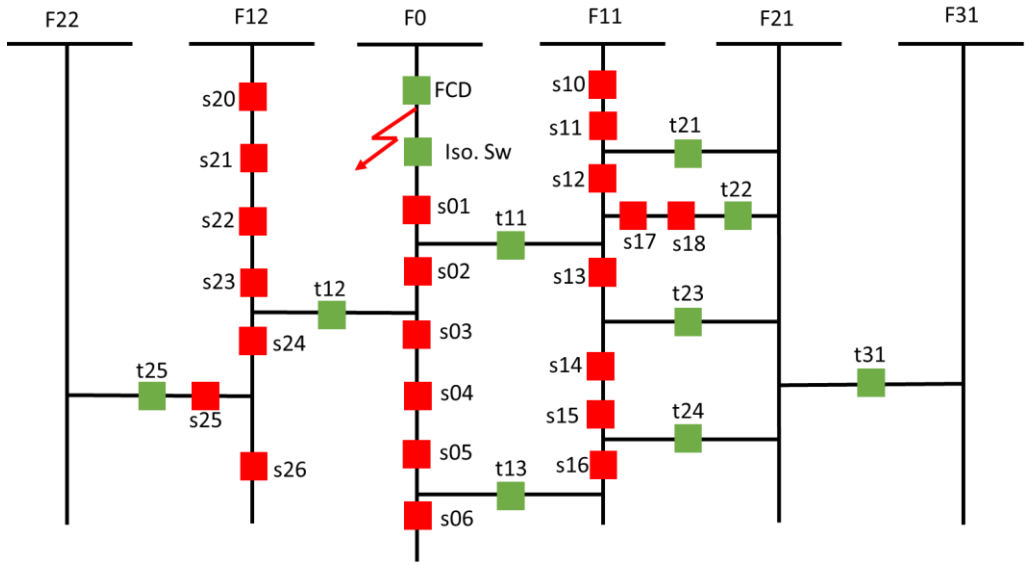
McKinsey

Optimization of electric distribution grid

< 100 Binary variables

Switching capacitors (on/off)

Power flow simulator



Compute the states of each node (10^6)

Objective function value

Soft constraints penalty value

Target: find the best combination of active capacitors

Predictive transformer monitoring at the edge

VISION

Opportunity

- Include asset health monitoring in operational insights
- Enable distributed transformer monitoring close to the device
- Consider transformer health in decisions e.g., switching

Business Value

- Enhanced operational insights with predictive maintenance
- Lower costs when using available, distributed compute
- Increased grid robustness by considering asset health

Alarm Analytics and Prioritization

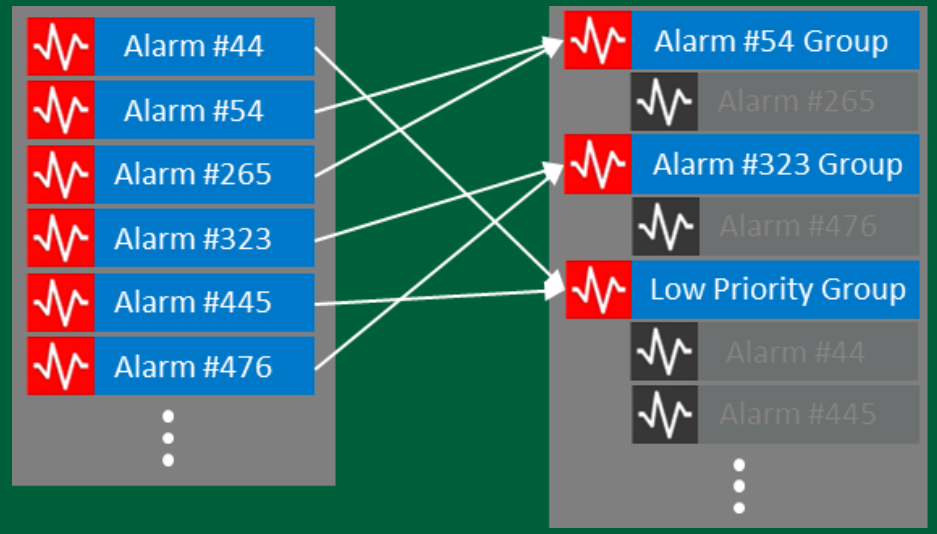
VISION

Opportunity

- Reduce response time by prioritizing and grouping alarms
- Identify alarm patterns and correlations for root cause analysis
- Automatically recommend possible corrective actions

Business Value

- Enhance operational efficiency by focusing on the most critical issues first
- Improve decision-making by clarifying the alarm root causes
- Save cost by identifying and addressing high priority alarms swiftly



Closing

Leverage the variety of tools

- Open Source
- Vendor specific applications

Proven data repository

- Highly scalable
- High performance

Explore your data

- Opens new methods to transform data
- Cloud based services provide elastic compute resources

Think outside the box

- Revisit legacy challenges
- Deliver increased business value

Thank You
cigre
For power system expertise