Synchrophasors on the Edge

Edge Computing Solutions using Synchrophasors

The Power of Edge-To-Cloud Streaming Analytics

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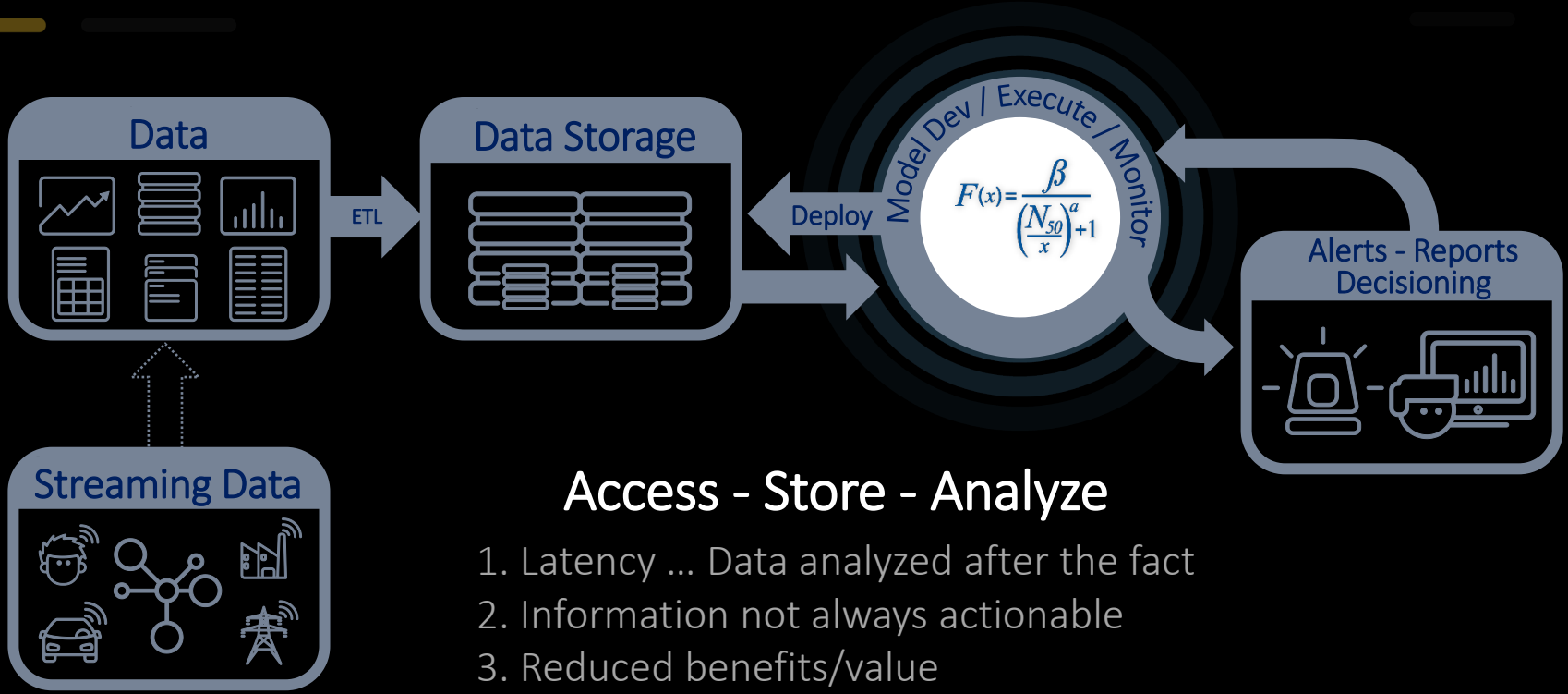
Analytics Lifecycle

Traditional Analytics Lifecycle

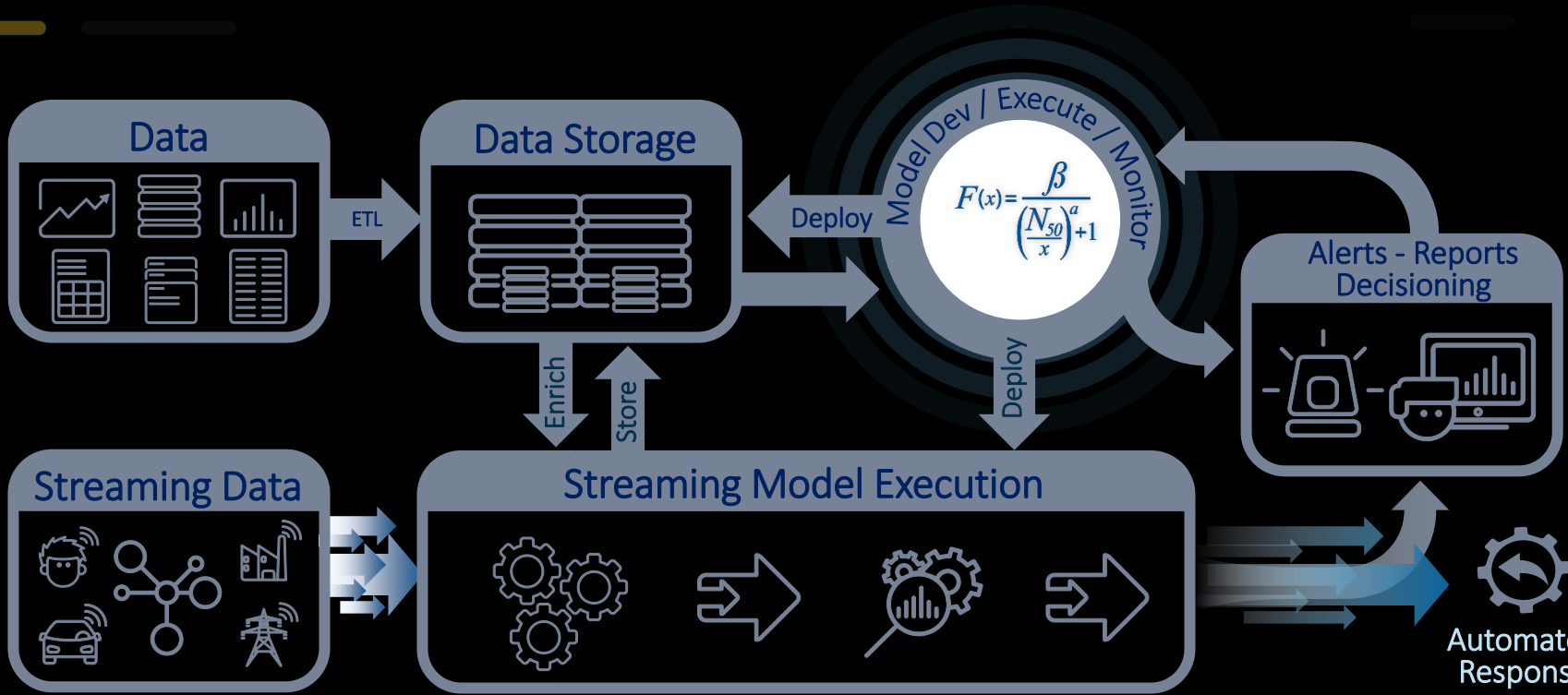


Access - Store - Analyze

1. Latency … Data analyzed after the fact
2. Information not always actionable
3. Reduced benefits/value

Analytics Lifecycle

IoT Analytics Lifecycle



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Streaming Analytics
Key Points

Fast – Millions of events/second – sub-millisecond latency on commodity hardware

Agile – From lightweight embedded technology to cloud distributed architecture

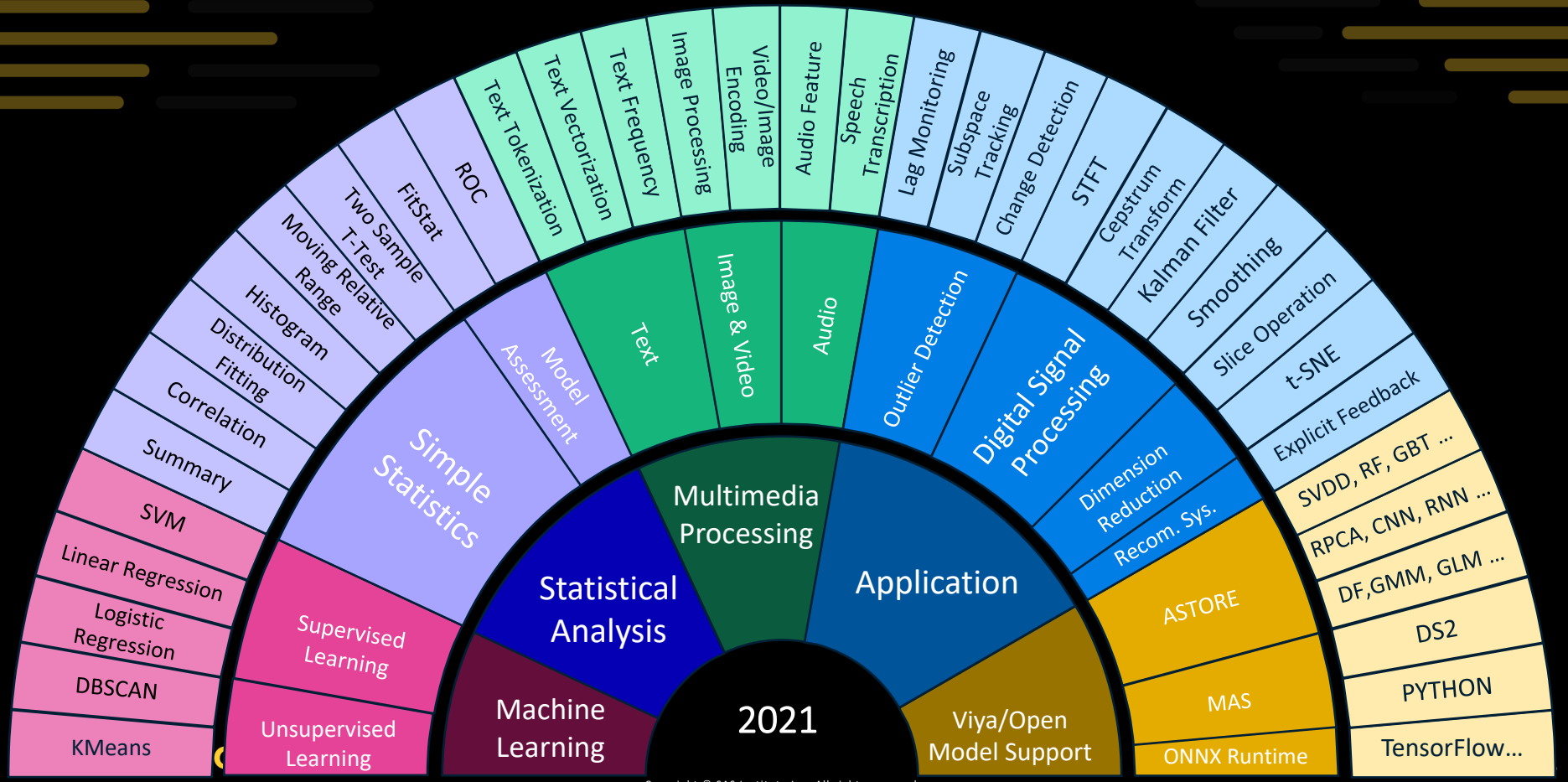
Flexible – Flow Based Modeling for fast adaptation to change

High End Analytics – SAS® advanced analytics and machine learning

Analytics at the Edge – Brings analytics closest to the event source.

Enterprise Class – Seamless integration with existing IT architecture and open source

Streaming Analytics Depth and Breadth

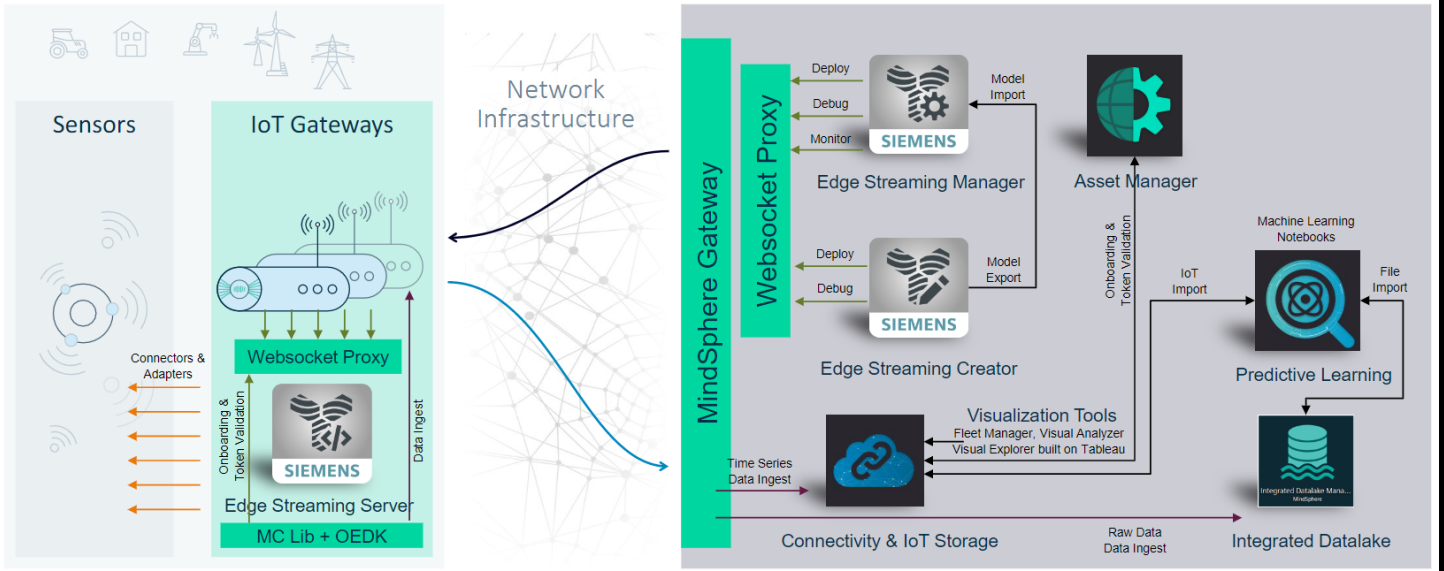


Mindsphere & SAS

Edge Streaming Analytics Reference Architecture

Edge (Download package via SIOS)

MindSphere Apps (Deployed via Launchpad)



SAS analytics integrated with MindSphere

Value facts

- ✓ Start easy to go big: Analytics platform for business people
- ✓ Easily interfaces with open source data analysis tools
- ✓ Easy deployment of Analytic models
- ✓ Model Management/Version management

- ✓ Access to advanced features including:
  - Cascaded analytic models
  - Model training/scoring on the edge
  - Image processing

- ✓ Full access to all MindSphere features including:
  - Secure IoT data management
  - Easy plug-and-play connectivity
  - Multitude of MindSphere applications

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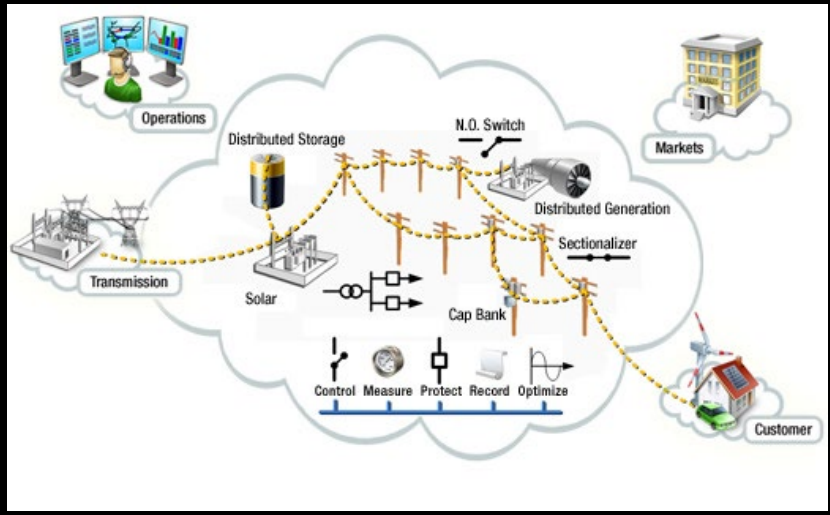
PMU Edge Streaming Analytics Use Cases

Importance of Electric Grid Stability

Issue:
The inherent latency in grid monitoring is an important issue; a delay of 3 seconds or more before a grid operator sees an event is not uncommon, and this may be too late to take action to control system stability, leading to a blackout.

Background:
In the US, the electrical grid operates at 60 cycles per second. Typically, measurements are taken once every 2 or 4 seconds offering a state view into the power system behavior.

With Phasor Measurement Units (PMU's), measurements taken are precisely time-synchronized and taken many times a second (i.e. 30 to 120 samples/second) offering dynamic visibility into the power system.



Source: NIST Smart Grid Framework

Cost of August 2003 blackout in Northeast US/Canada … Est. $7-10B

Edge Streaming Analytics

Use Case #1

- Event detection challenge
  - SCADA observability versus PMU measures at edge
    - Samples per second (PMU 30-120 samples per sec)
    - Time Synchronization (GPS)
    - Measured Aspects (SCADA – Magnitudes ; PMU – Synchronized voltages and phase angles)
  - Challenge: detect events that occur during normal operations
    - Frequency varies within allowed limits
    - Data points are highly auto-correlated
- Solution:
  - Detect deviations from real-time forecast
    - Expected value based on time series model
    - Residual differences from expected values outside upper & lower control limits

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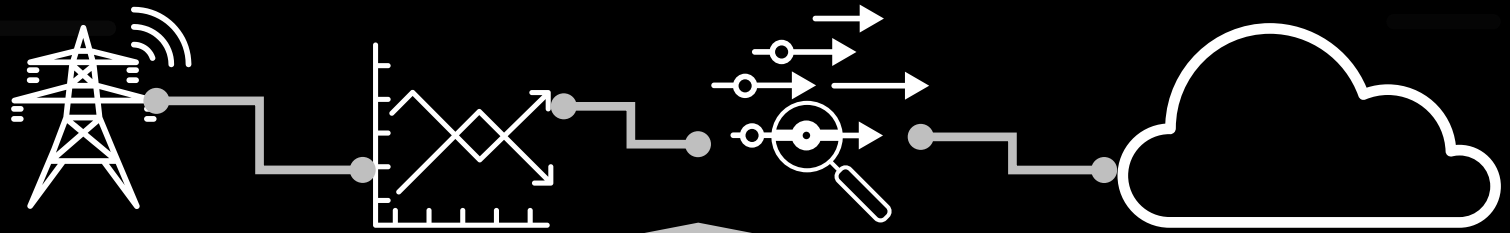
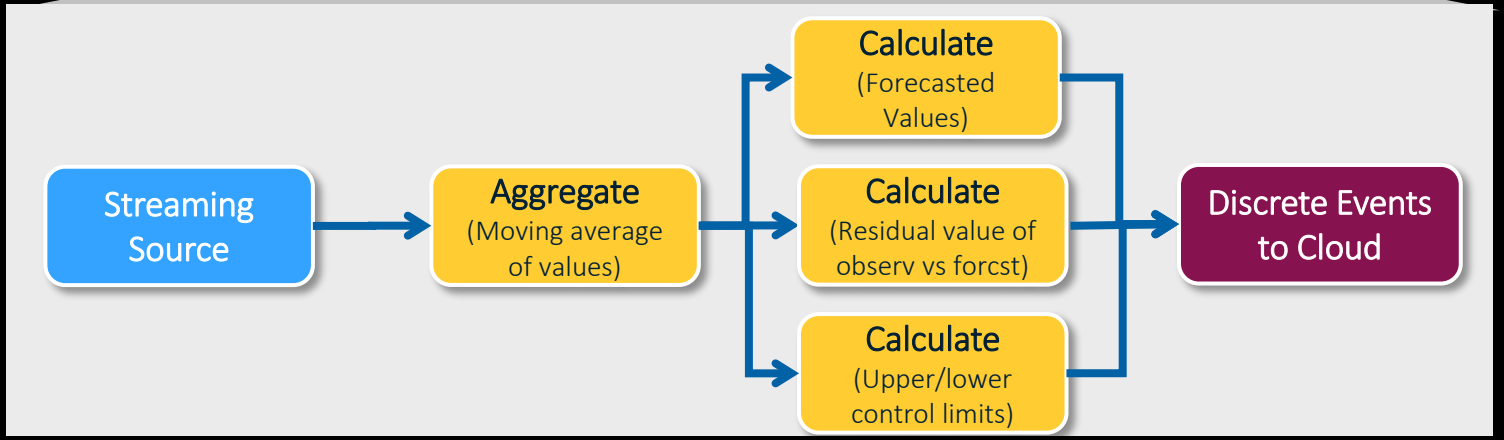
Edge Streaming Analytics

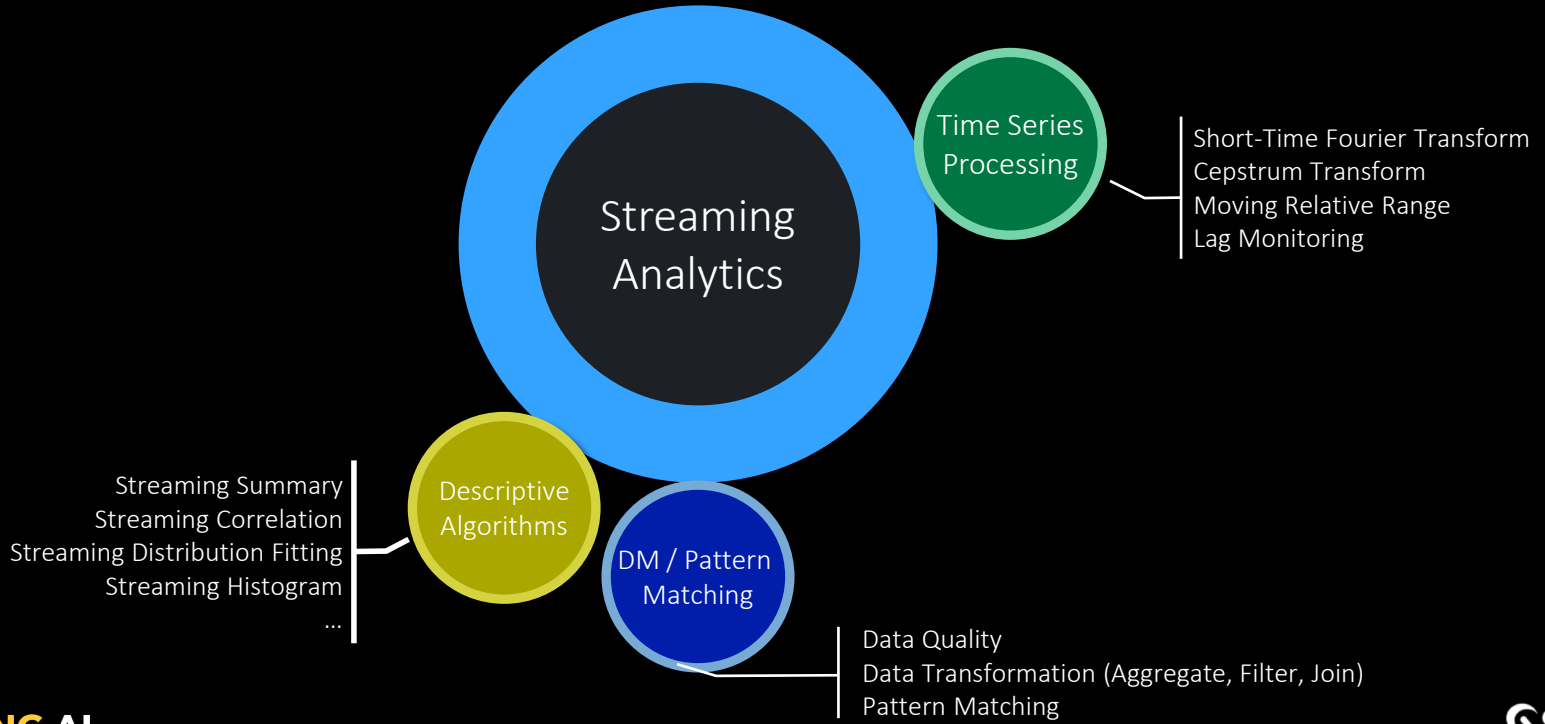
Processing PMU High Speed Data





Edge Streaming Analytics

Processing PMU High Speed Data



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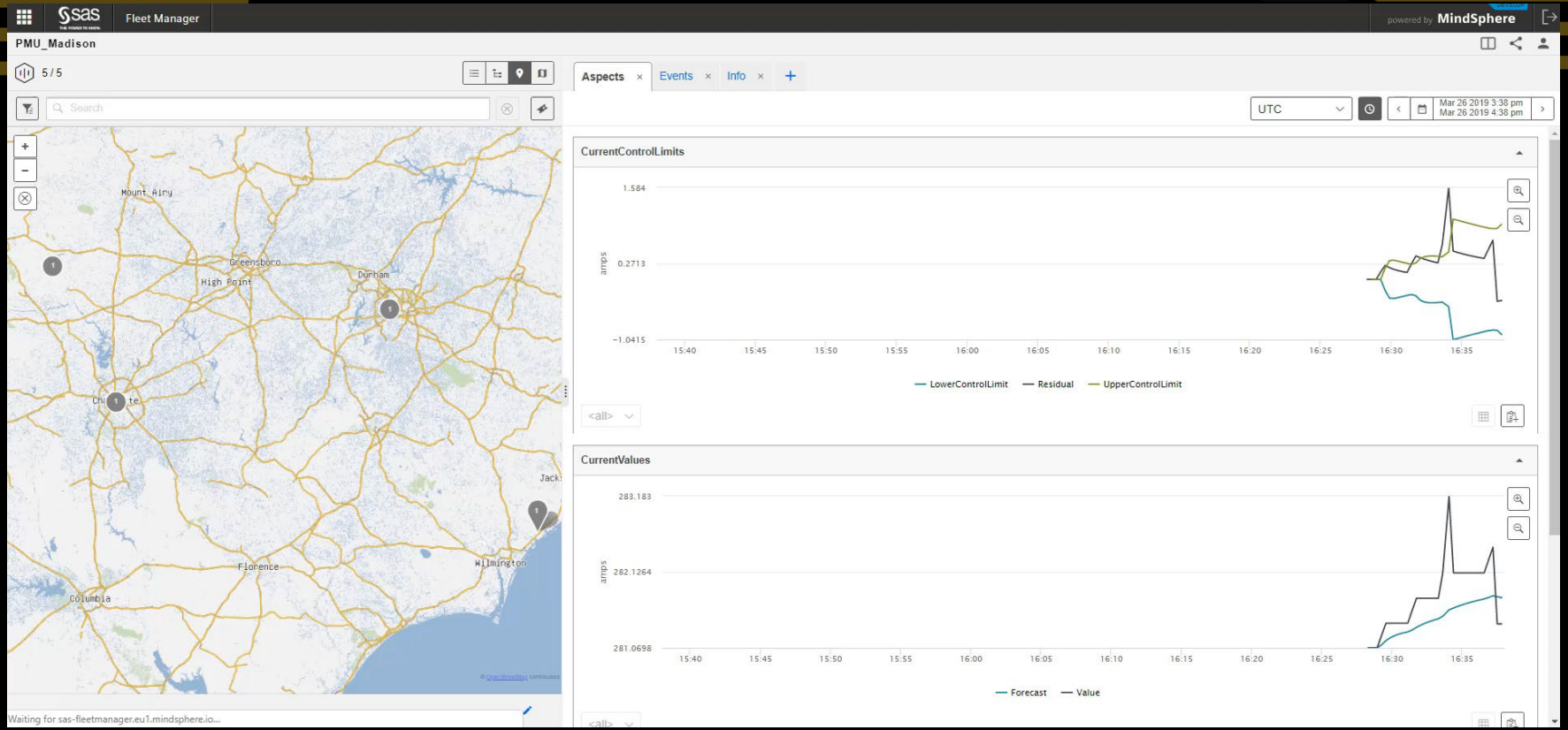
Edge Solution: Processing PMU High Speed Data



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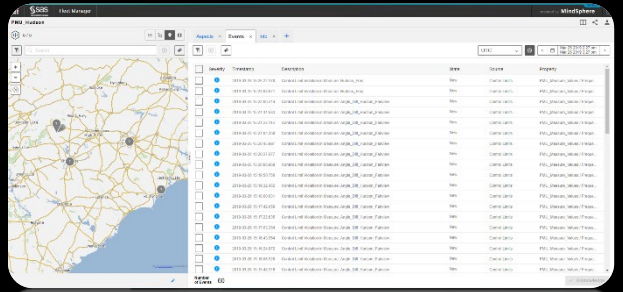
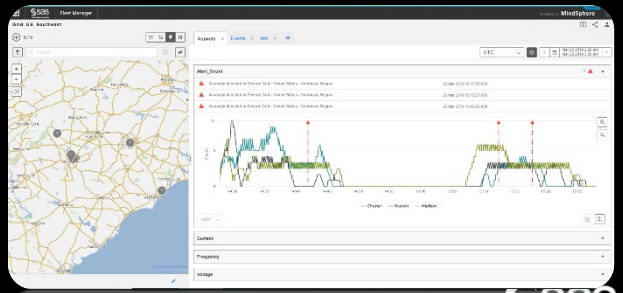
Cloud Streaming Analytics

Use Case #2

- Improve event detection accuracy:
  - False Alarms
    - A single PMU not indicative of broader system reliability issue
    - Context around alarms for further diagnosis and corrective actions
- Solution:
  - Machine Learning
    - DBSCAN - a density-based clustering approach
    - Tries to find connected high-density regions as clusters
    - Machine learning of neighboring PMU events
  - MindSphere Asset Management
    - Asset manager to define hierarchy of regions to PMU's
    - Fleet manager to provide supporting evidence of escalated alerts





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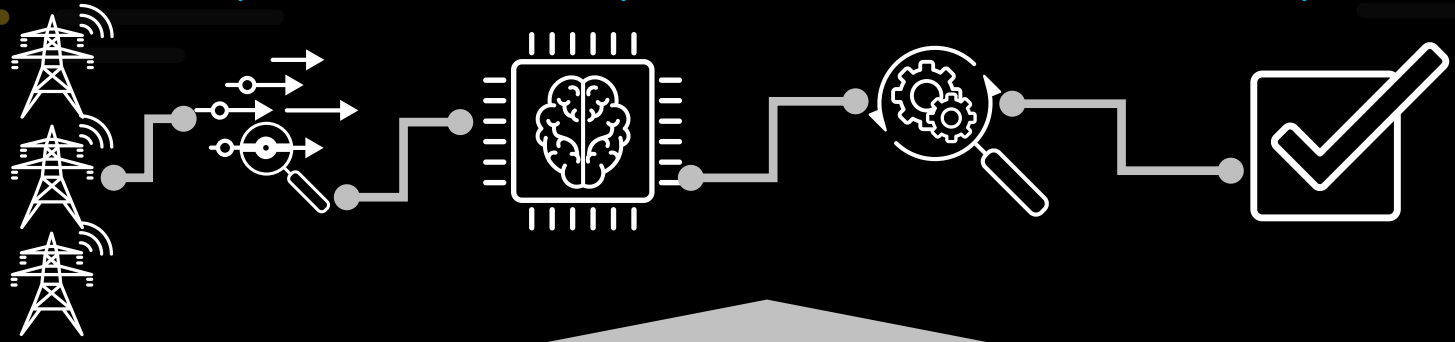
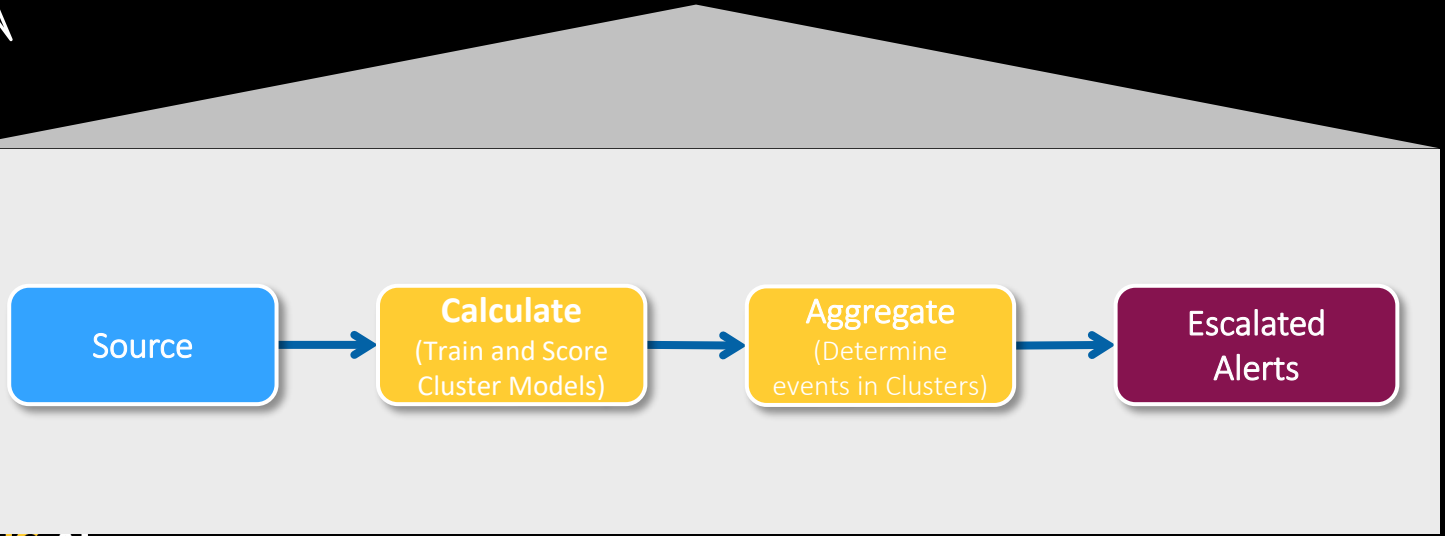
Cloud Streaming Analytics

Improve Reliability Event Detection Accuracy





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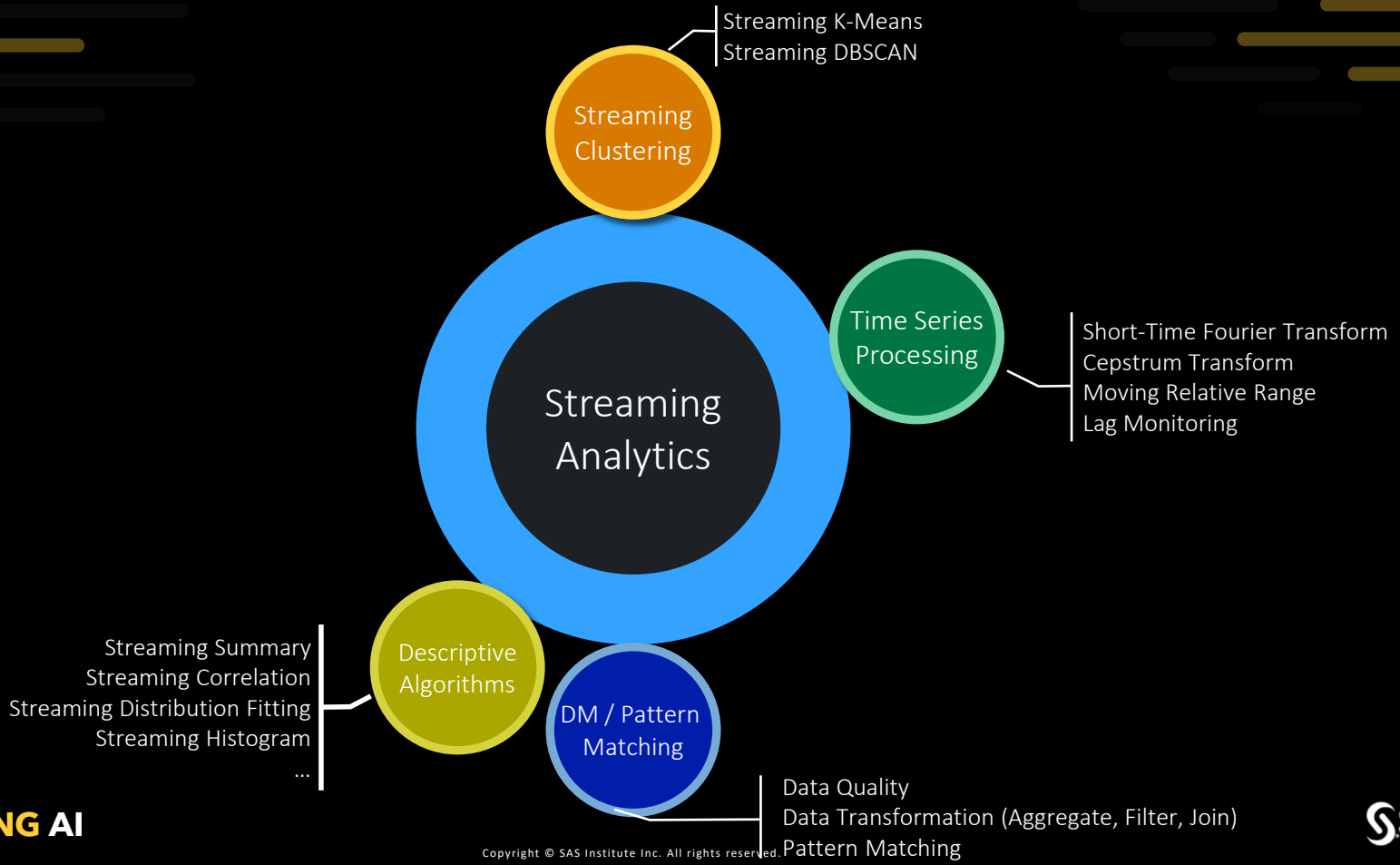
Edge to Cloud Streaming Analytics Solution



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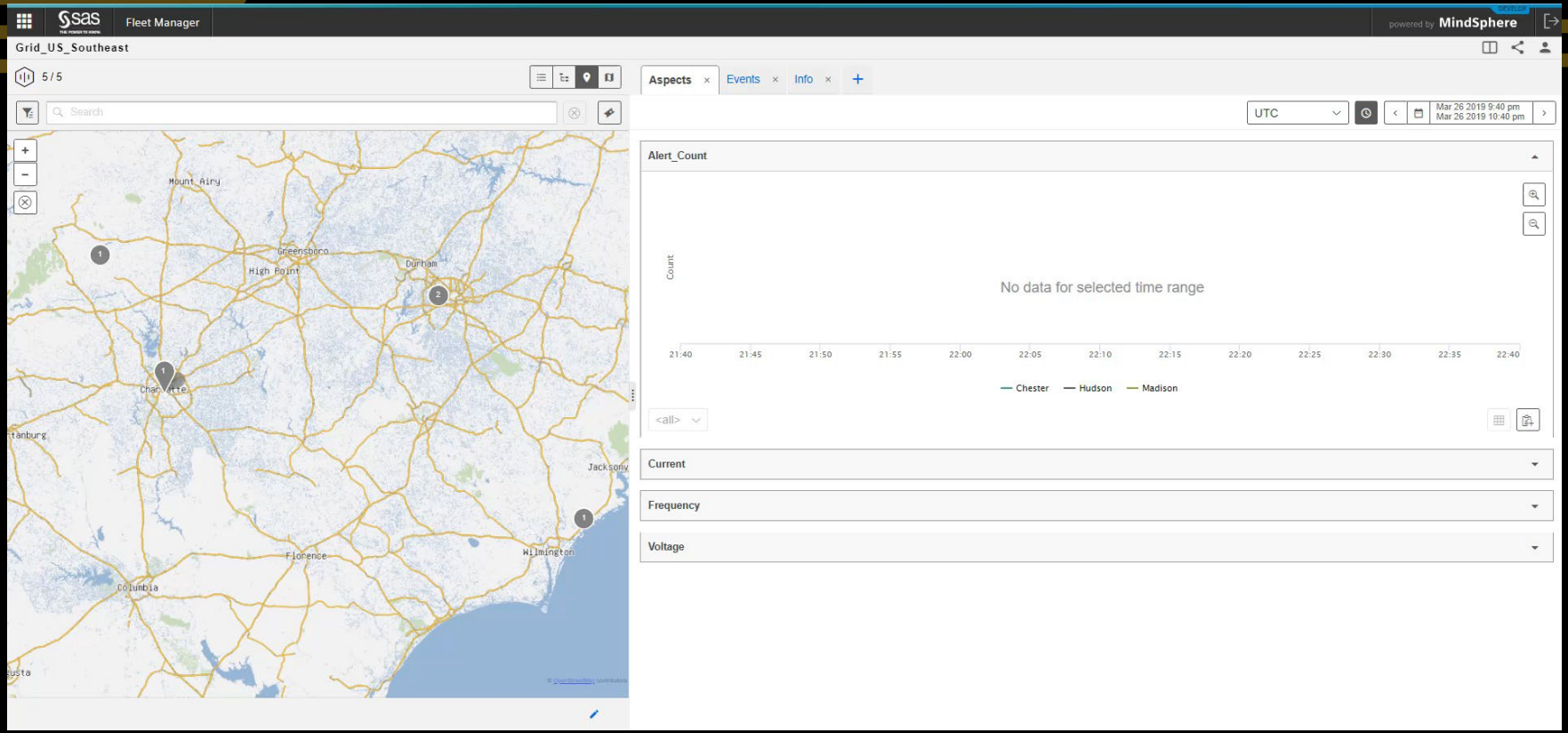
E2C Solution: Multi-Phase Analytics – Machine Learning



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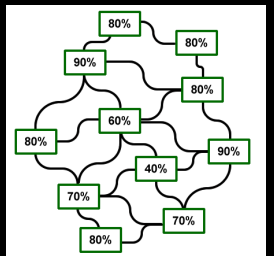
Drive Corrective Action

Goal:
Initiate appropriate corrective action strategy to avoid/minimize grid instability

- Predict potential mechanical failures to allow for planned outage activity
- Dispatch repair crews to isolate/correct observed grid issues
- Take appropriate operator actions to prevent grid failure/blackout

(1)

(2)



Network running normally

(3)

Source: 1) http://baycitytribune.com/news/image_f5601434-11ac-11e3-8dde-0019bb2963f4.html
2) http://www.cp24.com/news/qew-reopens-near-burlington-after-transformer-fire-1.2252389
3) "Networkfailure" by Stickulator - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Networkfailure.gif#/media/File:Networkfailure.gif

Streaming Analytics

Multi-Phase Analytics in-stream, out-of-stream, and edge

Reduce time to decision for better business outcomes

High-Performance execution

Open APIs, SAS and Open Source model support

Event Stream Processing delivers streaming analysis for low-latency decision making in-stream, out-of-stream, or on the edge

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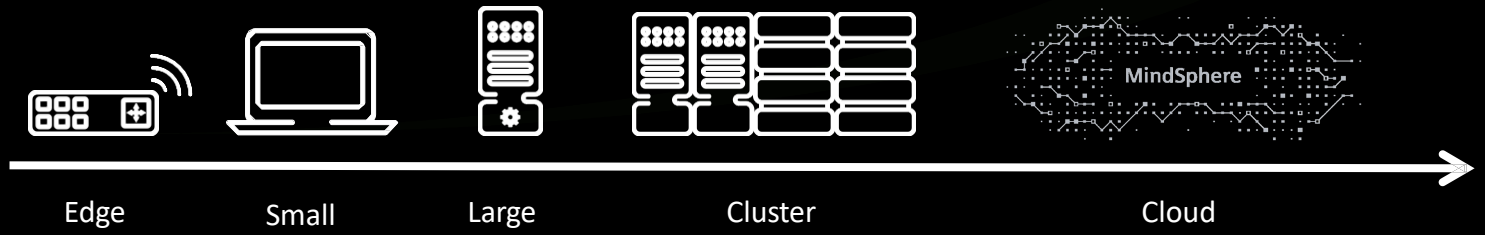
SAS analytics integrated with MindSphere

An extremely powerful yet easy to handle analytics solution

- ✓ Easily apply analytical business knowhow
- ✓ Actionable insights directly from asset streaming data
- ✓ Small footprint → runs on existing hardware
- ✓ Supports lightweight embedded technology and cloud distributed architecture for IoT needs



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Thank You