Real World Transition to On-Condition

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Abstract - Real World Transition to On-Condition

For years, the Data Center industry has struggled with practical ways to leverage data to better manage maintenance decision risks and costs. Data infrastructure and process control barriers – as well as the practical application of domain knowledge – result in defaulting to time-based interventions.

In 2020, Schneider Electric and Compass Datacenters signed the first true full system level “On-Condition” service contract for their flagship campuses’ power centers. In cases where no silver bullet “AI” exists, On-Condition can serve as a pragmatic risk-driven strategy combining best-in-class machine learning, randomized sampling, and time-based preventative maintenance visits on a subset of assets.

A fully connected, On-Condition maintenance contract helps companies reduce risk and human intervention. This was essential during the Pandemic – and continues to be vital as we move into and evolve in the post-Pandemic era. During this session, we discuss the deployed solution and value created with a system level On-Condition service approach.

Real World Transition to On-Condition

- Overview of background & business challenges.
  - Key value drivers.
- System Level Data Approach.
- Analytics - Crawl > Walk > Run.
- Transition to On-Condition – A Data and Risk-based approach.
- Examples & Catches.
- ROI …
- On-Going Development.
  - Transition of People & Process.

Overview of background & business challenge

- Operational risk and cost within Data Centers are initially driven by design but as redundant configuration has matured operational and maintenance practices are now driving.
- Uptime Institute research indicates greater than 60% of facility incidents are caused by Human Error.
- As Data Center infrastructure ages reliability and cost performance must be managed better to maintain competitive with newer footprint.
- Reactive PM management - a combination of calendar-based service interventions and real-time monitoring through a BMS or dedicated system for the data center infrastructure is costly and risky.
- Disparate OEM Standards across different industries and geographies mean it has been difficult to build comprehensive data analytics as data access and quality vary.
- Growth of DC market exploding with new builds. New builds going into remote locations without operations staff.
- Need to find ways to reduce risk and cost - Need to remove humans from process as we have an aging workforce issue and humans inject risk of downtime.

Transition to On-Condition

- We think of Condition-based maintenance as the next step on the journey of Optimal Maintenance. Historically, the airline industry perfected what is known as RCM. RCM was optimized for built-in resilience and tolerable downtime but was still calendar based.
- A Data Center is not a collection of assets – it's a number of systems and subsystems containing assets. In redundant configuration an asset can fail and a system can still operate. Failure in the system is rarely an isolated event – interaction between the assets in the system means there are key data to help deliver that predictive capability at the system level.
- New tools and new service models from Schneider have allowed us to truly transition on the key assets.
- Systems and assets with systems can be serviced optimally by using the abundance of data available but sometimes we have to augment this data to drive out the outcomes we need…
- Using data and a statistical approach to risk we can reduce truck rolls, Optimize interventions & really move forward on this transition.

Transition to On-Condition

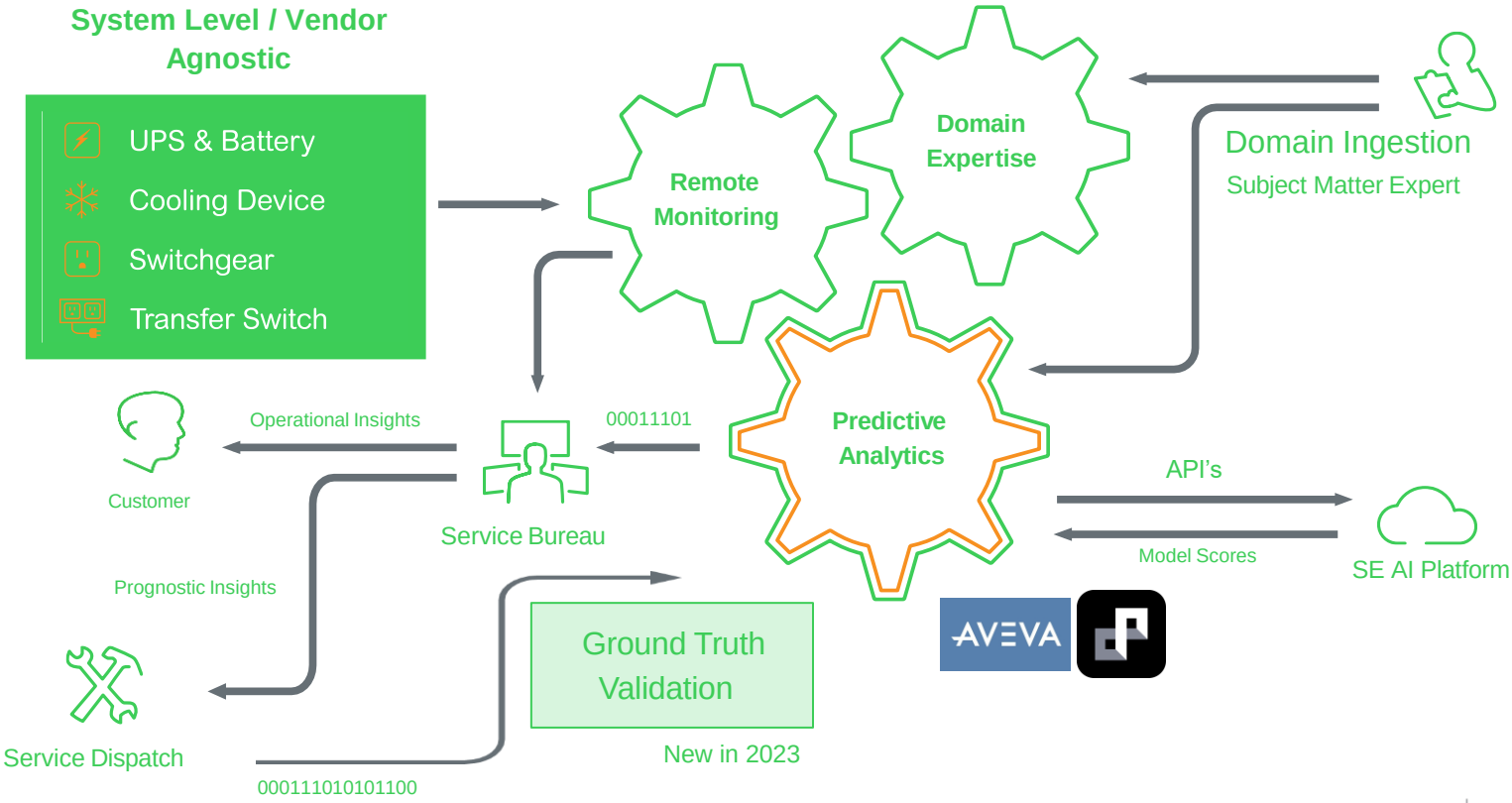
- The industrialized Asset framework allows for multi-variable and cross-system data analytics to determine the correlation and/or causality of anomalies.
- Real-time, high-frequency data stream generates Power Quality information that can indicate faults originating outside of the module.
- Ambient module and localized asset temperature data coupled with power data create a thermodynamic model for the overall module cooling health. Allows for operating mode, weather, and dynamic IT loading to be modeled, benchmarked, and optimized.
- Reduction in FSR inspections reduces risk to uptime. Planned FSR visits allow for ground truth validation of the analytics and improve model confidence index.

Remote asset monitoring enables 3 levels of interventions

Shifting from reactive to predictive

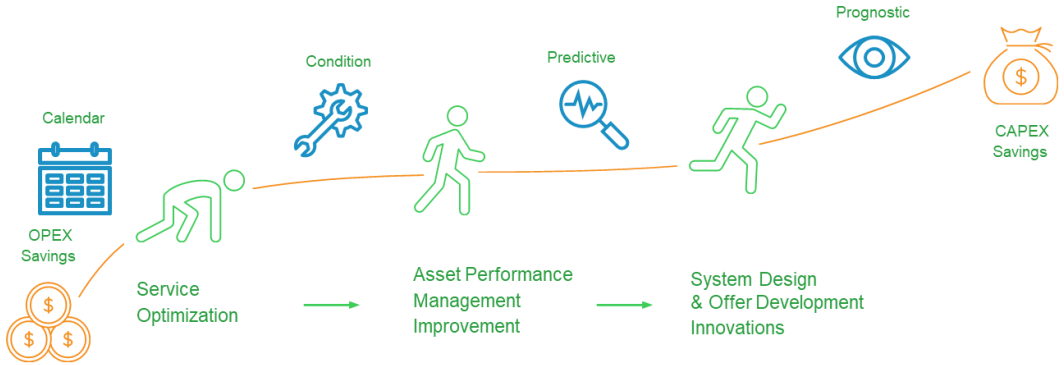
	Reactive	Preventative	Predictive
Type	Event-triggered	Data-guided	Data-driven
Source	Client BMS & DCIM alarms	Asset Rules & thresholds	ML models scores
Horizon	Short to none	Medium to short	Long
Value	Low: “safety net” enabling reaction to unanticipated issues	High: enables intervening before failure	Highest: enables deferring regular interventions

System Level Service – Value Creation



Crawl, Walk, Run

- Reactive and Preventative rules & models usually don't deliver the depth of insight required to drive intervention.
- Developing complex analytics takes assets and systems data as well as contextual data.
  - For a Model to learn it has to be used, applies, and validated – this is also data.
- This takes time but value can be increased over time.
- Domain expertise enriches these models and adds value – this "process' also takes time.



Value Creation – Outcome Analytics

Core Objectives Remain:

- OPTIMIZE INTERVENTIONS
- REDUCE ROLLS
- REDUCE RISK
- ELONGATE ASSET LIFE

Transition to On-Condition

- Reactive, Preventive & Data Driven Predictive – The right tool for the job & supporting Data.
- Performance Analytics drive real value & reduce risk.

Real Analytic Insights

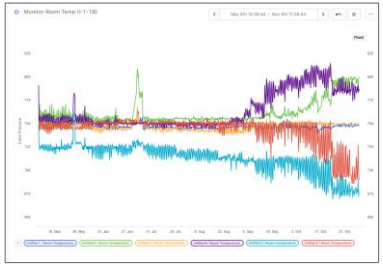
- Developed from real Co-Lo Data & Domain expertise.
- Advanced Machine learning to drive when & when not to intervene.
- System-level analysis of Cooling / Gear / Battery / UPS interventions.

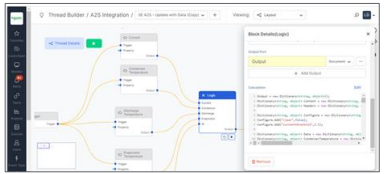
Planning Integration - On-Condition in Action

- Integration & Optimization in Master Maintenance Schedules and planning windows.

People & Process…

- Transition with Virtual Inspections driven by data rather than PM's
- Manage Capabilities & learn from the real "Ground Truth".





- ✓ Reduction in Cooling Interventions
- ✓ Major Gear inspections from 3 to 5 Years based on Data Analytics

***Initial Results*

Cooling Optimization – Advanced Models – CIPP

Rules & Alerts

- The First Line of analytics covers normal operational parameters and operational modality.

  CIPP Model

  Machine Learning Model-based approach to deliver real Asset performance insight (Compressor Input Power Predictor).

- Scores each unit based on thermodynamic performance and power draw.
- Sampling Thermodynamic data at 1-3 second intervals, current data at 1-second intervals to drive relative performance.
- Model runs every hour on every unit – data then triggering alerts and alarms to the Schneider Service Bureau and the Compass CSM.

Cooling Optimization – Advanced Models – CIPP

- Score and rate of change indicate issues and rate of progression.
- Common issues that can be determined.
  - Loss of Coolant.
  - Clogged filter.
  - Dirty Evaporator.
  - Compromised evaporator / Airflow.
  - Progressive Mechanical Failure.
- Absolute & Relative reporting.
  - Single-unit performance enables relative performance.
  - Multi-Unit analysis allows for relative efficiency performance calculation.
- rCOP model run in parallel – measures relative efficiency & potential to score units in Rank order – 2023 Pilot outputs.

Cooling Optimization Process

CIPP Model Scores

The CIPP model scores will drive either an alert or an alarm – Alerts are far more likely as most of the failure modes involved display progressive mechanical failure curves.

Slim down – Takeaway….

CSM/CSH Assessment

The Service Bureau assesses the Alert – rate of change of CIPP score & determines optimum intervention.

- At scale, only a small subset of the population will display CIPP score necessitating intervention.
- To mitigate risk we randomly sample a further % of the population to reduce risk & gather unknown variables.

Ground Truth Validation

Key to this whole exercise is GROUND TRUTH VALIDATION

- The process of re-enforcing the model and developing deeper prognostic insight.
- Field Service team use the models to guide the intervention – feedback to the model what they find then after the repair is complete – re-run the model to confirm the repair.

Power Anomalies

Modal Operation – Power Anomalies

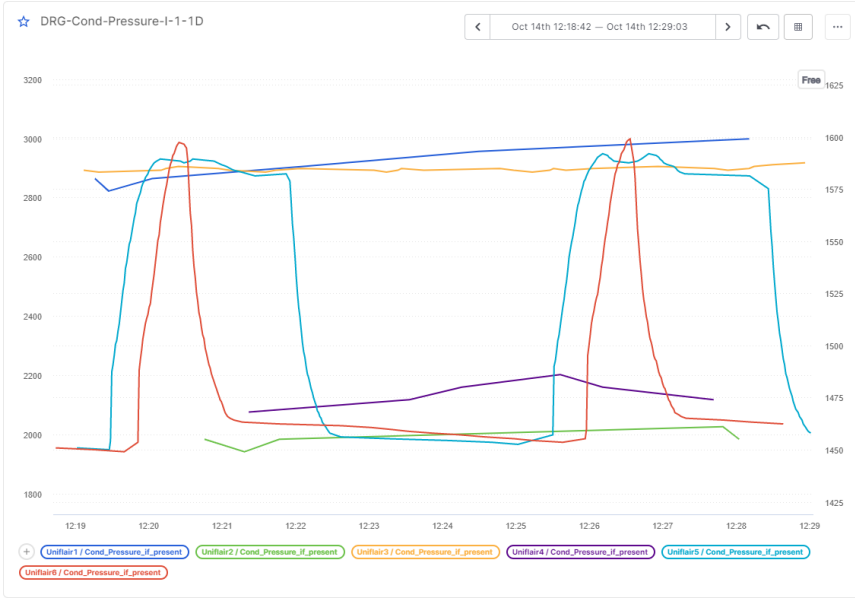
- Loss of Air flow alarm on Cooling units leading to shut down as a result of upstream power anomalies from the Utility.
- Coloration between unit failures and power anomaly logs from the ION power meters.
- Evidence presented to the Utility to identify the issue – The utility admitted responsibility.
- Corrections.
  - Utility-initiated behavior modifications to prevent/reduce power anomaly.

Analytics results in the potential reduction of risk and equipment uptime for Compass

Short Cycling

Modal Operation – Short Cycle

- Normal operation compressor needs to run >2mins to reach normal operation/efficiency.
- Anomalous behavior affecting units 1, 2, 6 – “Short Cycling” where the unit comes on for a brief period then shuts down before impacting net cooling load.
  - Premature wear.
  - Low System Efficiency.
- Control and “Deadband” Review to fix the issue.



Analytics results in potential energy efficiency gains and equipment life elongation for Compass.

Hot Spots

Modal Operation – “Hot Spots”

- Lack of air circulation/flow results in localized high temps around the central units.
  - Not operating outside design parameters but are elevated.
  - Given the relative load on UPS, we need to continue to observe and understand the longer-term impact on unit/system performance.
  - Possible impact on asset life & system efficiency – Again more data required to fully asses long-term impact.

Analytics results in potential energy efficiency gains and equipment life elongation for Compass.

Switchgear Service Optimization

System Thermal model to predict core Switchgear performance with the aim to accrue enough information to review the 3-year major gear intervention

- Thermal Monitoring Main U, G, Transfer – 18 Thermal + Humidity Data
- Into BMS & Outcome Analytics platforms.
- Predictive Model in Outcome Analytics.
  - Combining Thermal, Load, and Thermodynamics in an ML model to again score risk on a unit-by-unit model.
  - Only a small subset of the population displays a score suggesting intervention.
  - Again, further statistical sampling of a further % of the population to reduce risk & gather unknown variables.
  - The key to this whole exercise is again – GROUND TRUTH VALIDATION.
  - The process of re-enforcing the model and developing deeper prognostic insight.

Analytics results in potential energy efficiency gains and equipment life elongation for Compass.

Key Take Aways

- The Industry need to embrace this transition as a key tenant of growth and risk management.
- A new approach to Data and Systems is Key.
- Higher value analytics require a different approach.
- The People and Process are key to drive the outcomes ... not just the tech.

Questions?


COMPASS
datacenters
THANK YOU.
Life Is On
Schneider
Electric