Six steps to using the IoT to deliver maintenance efficiency

The Internet of Things (IoT) and Big Data offer companies the ability to aggregate existing data sources, gain visibility into new data, and identify patterns through analytics to make better business decisions.

According to a recent survey report conducted by the Aberdeen Group, "Best-in-Class" companies are increasingly utilizing IoT and Big Data to implement Predictive Maintenance (PdM) models to address and improve their top operational challenges:

- **Reduce unplanned downtime to 3.5%** – Amount of unscheduled downtime against total availability

- **Improve Overall Equipment Effectiveness to 89%** – Availability x Performance x Quality = OEE

- **Reduce maintenance costs by 13% YoY** – Total maintenance costs including time and personnel

- **Increase return on assets (RoA) by 24%** – Profit earned from equipment resources through improved uptime

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Any industry that operates "machinery" – manufacturing, transportation, building automation – can benefit from PdM enabled by sensor-generated data.

The value over any other maintenance model is that PdM empowers maintenance and operation decision makers to predict when an asset will need intervention well in advance of its failure impacting personnel, operations or production.

PdM provides the highest possible visibility of the asset by collecting and analyzing various types of data to provide the following benefits:

- Identifying key predictors and determining the likelihood of outcomes.

- Optimizing decision-making by systematically applying measurable real-time and historical data.

- Planning, budgeting and scheduling maintenance repairs, replacements and spares inventory.

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PdM comparison example

The following example illustrates the amount of time that it takes to detect a potential failure interval for each of the four maintenance models commonly used today. PdM enables you to save time and money by detecting the failure based on data sources before damage to the machine occurs.
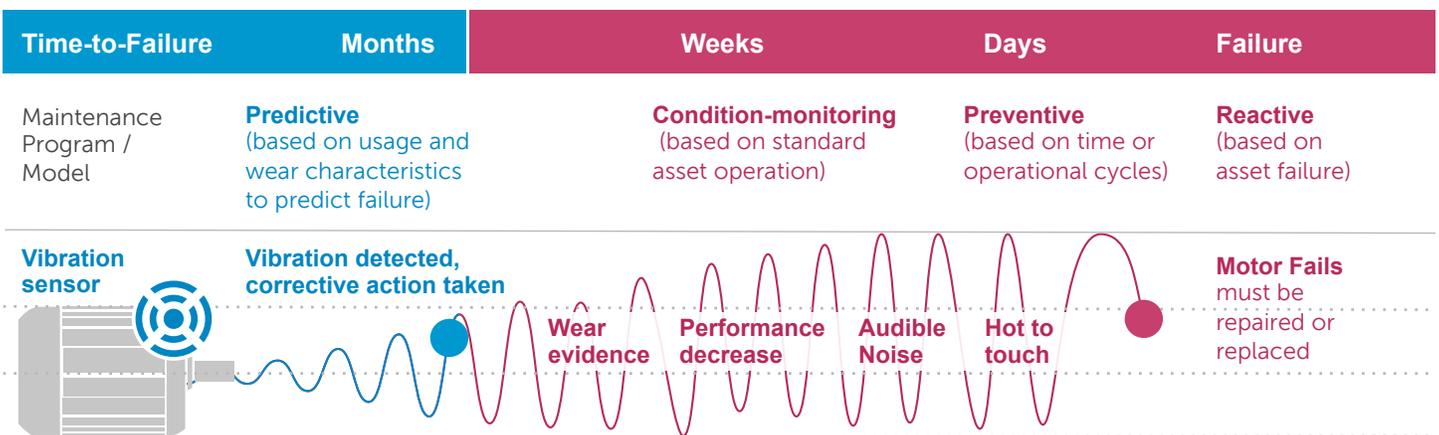
Time-to-Failure	Months	Weeks	Days	Failure
Maintenance Program / Model	**Predictive** (based on usage and wear characteristics to predict failure)	**Condition-monitoring** (based on standard asset operation)	**Preventive** (based on time or operational cycles)	**Reactive** (based on asset failure)

Vibration sensor

Vibration detected, corrective action taken

Wear evidence

Performance decrease

Audible Noise

Hot to touch

Motor Fails must be repaired or replaced

Figure 1: PdM Motor vibration analysis example

Follow these 6 best practice steps to plan your PdM implementation

1 | Establish the business case for PdM

To make the case for a PdM implementation, the focus should be on the unique problems that affect optimizing operational and production impacts while managing risk. It's important to understand what metrics the organization is focusing on and which need to be improved. Consider these questions to identify key goals of your PdM project and ensure success:

- What critical assets are likely to fail? When and why do we believe they will fail?
- How would the assets' failure impact personnel, operations or production costs? What does downtime cost?
- How can data driven decisions be integrated within the constraints of your existing maintenance practices?
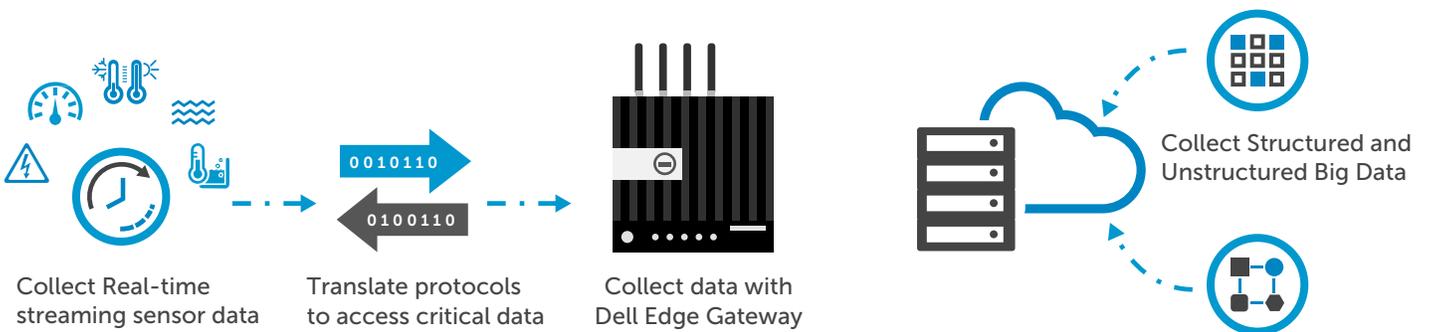
2 | Identify and prioritize data sources

The increase in asset connectivity and use of smart devices may have generated large amounts of available data. It is not needed or recommended to address this whole universe of possible data. Instead, begin to predict failures on a single asset by focusing on the usable, existing data sources related specifically to it. Figure 1: "PdM motor vibration analysis example" illustrates how capturing the real-time data from just one sensor resulted in avoiding costly damage, downtime and emergency response. Below is a list of the various types of data sources available and where they are typically found.

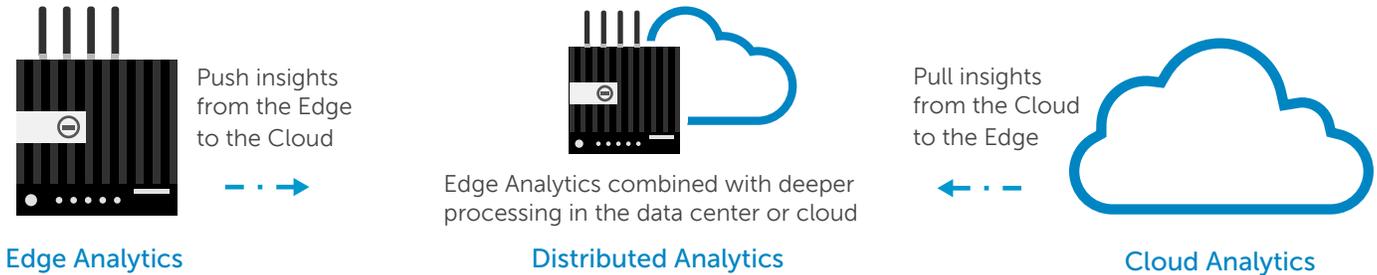| Type	Real Time Structured/Unstructured (Streaming from asset)	Big Data (Batch) Structured (Databases, systems)	Big Data (Batch) Unstructured (Free-form, raw text)
What	Measurement, control, videos temperature, sequences, tweets, telematics, environmental,	Asset name, location, production line information, spares inventory, costs	Inspection reports, maintenance and operator logs, survey reports
Where	Sensors, PLCs, DCS, HMI, SCADA systems, drives, controls, instruments	ERP, EAM, MES systems, ICS databases, SCADA, financial systems, data warehouses	Business systems, workstations, email, social media, notes

3 | Collect selected data

The selected data may reside in disparate locations from a device at the network edge to the server room to the enterprise cloud, including sensors, meters, enterprise asset management systems, and supervisory control and data acquisition (SCADA) systems. An Ideal PdM solution should be flexible enough to enable you to collect from all of these data sources to learn and continually make better, more informed business decisions. The Dell Edge Gateway is an industrial-grade, scalable solution for the Edge which works with a variety of critical protocols, data sources, and types of data.

Collect Real-time streaming sensor data

`0010110` `0100110` Translate protocols to access critical data

Collect data with Dell Edge Gateway

Collect Structured and Unstructured Big Data

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4 | Determine where to run your analytics

Establish an advanced analytics foundation based on your specific operation. For example, Edge (or local) and Cloud analytics can be balanced to reduce the burden of streaming perishable PdM data on your cloud deployment. A distributed approach enables you to detect and respond to local events at the edge as they happen, taking action immediately on streaming data, while simultaneously integrating additional data sources in the cloud. The Dell Edge Gateway can analyze streaming data in memory for real time response and filter out unnecessary data rather than relaying it to the cloud.

Push insights from the Edge to the Cloud

Edge Analytics combined with deeper processing in the data center or cloud

Pull insights from the Cloud to the Edge

Edge Analytics

Distributed Analytics
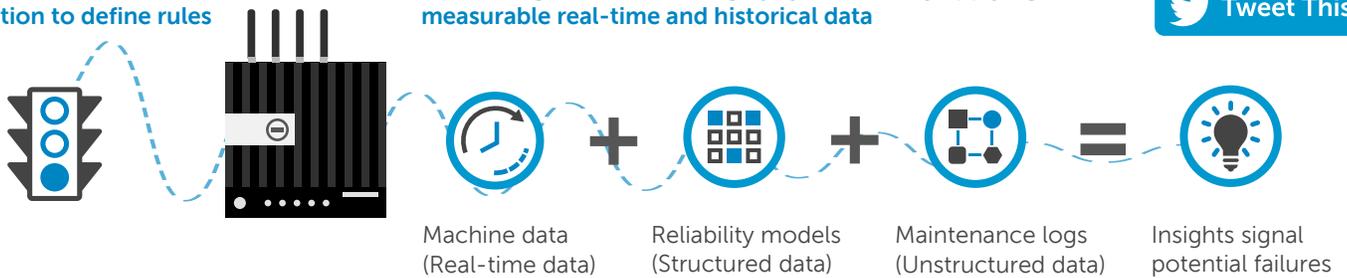
Cloud Analytics

5 | Combine and analyze data to gain precise insights

Start by analyzing available data to define the parameters of normal operation for a machine. This enables the creation of rules through condition monitoring for analyzing the real-time data coming directly from machine sensors on the Dell Edge Gateway. With the Edge Gateway, analytics can happen as close to the machine as possible with the native I/O to collect data from industrial equipment and the ability to operate in harsh environments. After analyzing the real-time data, add historical and third party data such as reliability models and logs to uncover meaningful correlations, patterns and trends with the anomalies generated by the real-time data rules, to signal potential failures. The patterns can be used to further refine your rules and offer actionable insights in real time.
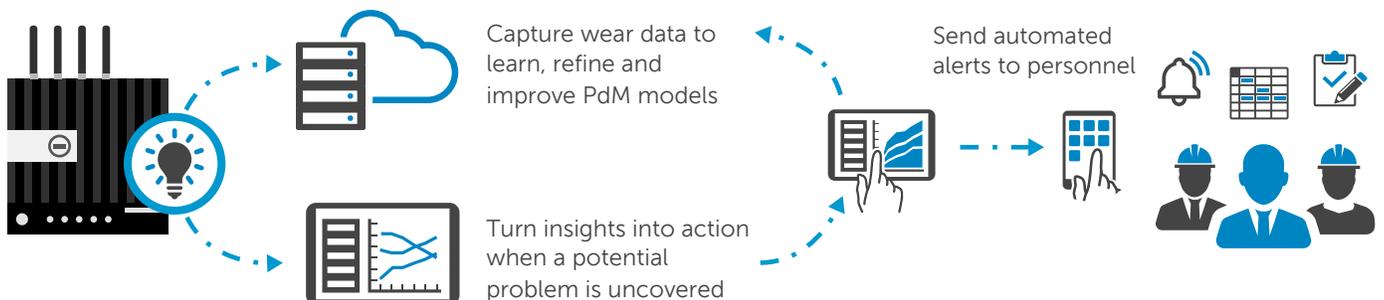
Parameters of normal operation to define rules

Optimizing decision-making by systematically applying measurable real-time and historical data

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Machine data
(Real-time data)

Reliability models
(Structured data)

Maintenance logs
(Unstructured data)

Insights signal potential failures

6 | Operationalize and take action

Turn insights into action by integrating an aggregated risk assessment for all assets into your operation through a single dashboard. For example, when a potential problem is uncovered the Dell Edge Gateway triggers an event that allows you to send out automated alerts to concerned parties, such as location, estimated replacement parts and recommended corrective action to avoid a catastrophic event. Then, by capturing wear characteristics data from the replaced parts, you are able to continuously refine your PdM models and learn from performance insights. Finally, explore additional uses for your PdM data such as automating inspection reports and enhancing component supplier evaluation.

Capture wear data to learn, refine and improve PdM models

Send automated alerts to personnel

Turn insights into action when a potential problem is uncovered

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Predictive Maintenance Solution

This PdM Solution example represents a single solution provided by the industry leading partners below as a reference. Your specific PdM application may involve a combination of these and other technology providers within our IoT Partner ecosystem.

To provide a blueprint for you to build your PdM deployment around, Dell has developed a flexible architecture centered around the Edge Gateway 5000 with qualified partners for a complete solution. The **Dell Edge Gateway 5000** enables you to collect, analyze, relay, and act on real-time data from machine sensors and generate accurate, dynamic predictions. With Kepware's KEPServerEX® connectivity solution you get protocol translation that provides visibility to diverse data sets from PLCs, RTUs, meters, and SCADA systems which provides the foundation for PdM applications. KEPServerEX® feeds the data to Software AG Big Data Streaming Analytics Platform running on the Intel® Atom™ processor in the Edge Gateway. This ensures that perishable data is acted on immediately by generating alerts, and also makes certain that only meaningful data is sent to the cloud to minimize consumption of expensive network bandwidth. You can complete your PdM deployment with only real-time data utilizing these edge elements, but Dell recommends that you also integrate structured and unstructured data to refine your PdM model. In the cloud or data center the SAP HANA solution enables you to run big data analytics on the structured and unstructured data to identify even more granular patterns to predict failures earlier. SAP HANA also provide integration into your Enterprise Asset Management system for reporting, generating alerts, and automating maintenance dispatching.

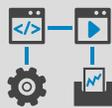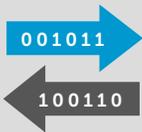| Kepware KEPServerEX®	Software AG Apama®	SAP HANA®

Protocol Translation	Stream Analytics	Visualizations	Backend Analytics	Reporting	Big Data Analytics

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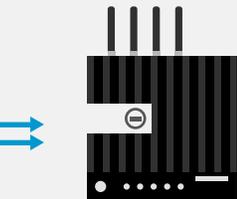
Real-Time Data   **Dell Edge Gateway 5000**

Structured Data

Unstructured Data

Dell Data Center/Cloud Solutions

Along with our IoT Solutions Partners, we provide technology you can trust to help you get started quickly and efficiently.

Dell takes a pragmatic approach to the Internet of Things (IoT) by building on the equipment and data you already have, and leveraging your current technology investments, to quickly and securely enable analytics-driven action.

The Dell IoT Solutions Partner Program is a multi-tiered partner ecosystem of technology providers and domain experts to complement Dell's broad portfolio of IoT-enabling technologies.

To learn more visit us online at: www.delliotpartners.com

Contact Dell Sales to learn more about the Dell Edge Gateway 5000, our ecosystem of qualified partners, and to deploy this flexible predictive maintenance solution today.

DELL IoT Solutions
Partner Program

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