

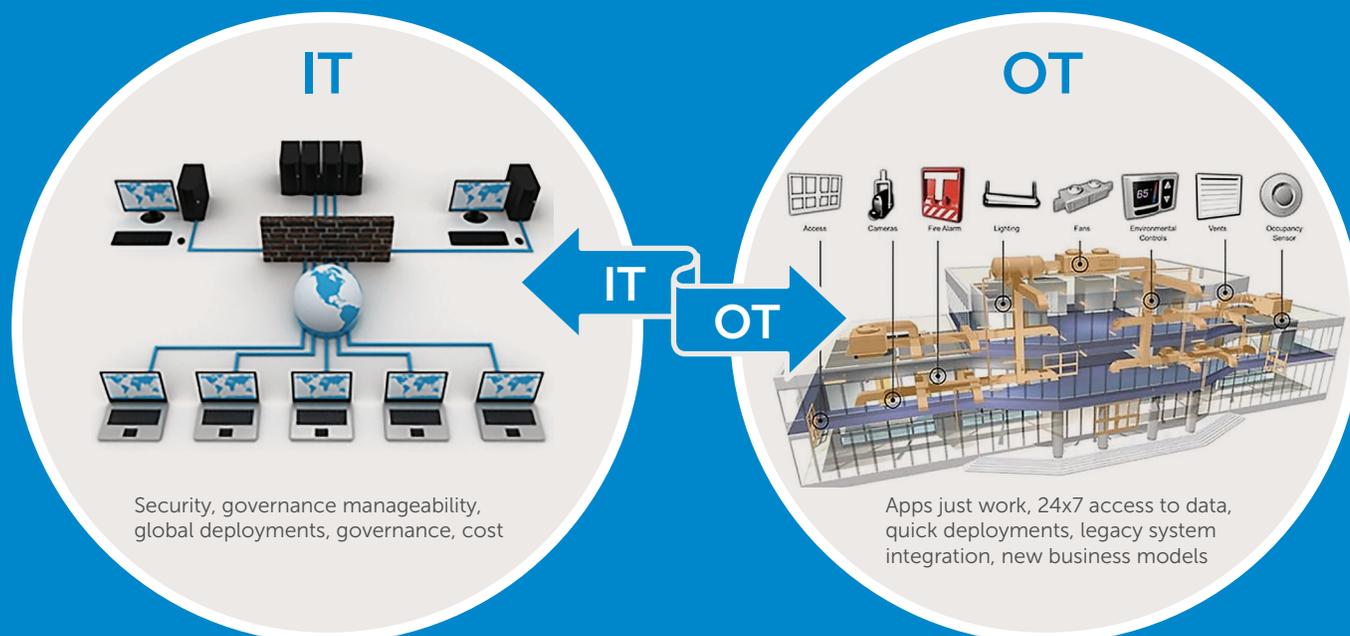


Key to the profitability of predictive maintenance: Linking IT to OT

Dell Global SAP Center of Excellence

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The IoT: Information Technology Meets Operations Technology



A cure for downtime, a boost for profits

In manufacturing, transportation, construction, or any machine-heavy field, downtime and shrinking MTBF (mean time between failures) are the enemies, topped only by outright system failure. All three greatly increase overhead. And so does crisis maintenance.

One large U.S. automotive manufacturer reported that for its maintenance staff of 15,000 to 18,000, "85 percent to 90 percent [of their maintenance work] is crisis work."¹ A 19:1 ratio of planned to unplanned maintenance is commonly

¹ Hai and Lee, "Near-zero downtime: Overview and trends," *Reliable Plant*, June 2007.

considered to be world-class by manufacturers. But this ratio raises the question: even if the plant is operating at 19:1, is all the planned maintenance that is being done really necessary?²

In equipment-heavy fields, Operations traditionally works to prevent machinery failures and predict equipment replacement or maintenance cycles to keep costs down. Prediction is the key, but it's also the toughest part of the job. Today, replacing reactive maintenance with predictive maintenance (PdM) is the way to reduce downtime and the phenomenal cost of operations shutdowns. It also is a surprisingly effective way to increase profitability.

² Ibid.

“There is a great opportunity for new solutions that will change the directions of whole industries.”

— Bill Ruh
Vice president,
GE Global Software Center



Because there is an extensive operations technology that can be used in predicting machine maintenance, Operations staff may think the whole task rests on their shoulders. It might surprise them to find that IT can help by providing predictive analytics.

In the simplest terms, the purpose of predictive maintenance systems is to shift maintenance practices from reactive to predictive in order to reduce unexpected downtime and increase productivity.

What is predictive maintenance?

Predictive maintenance (PdM) is analysis of equipment sensor data to predict equipment failures and increase uptime while minimizing costs. Any industry that operates machinery — including transportation, building automation, and many others, in addition to manufacturing — can benefit from predictive analytics enabled by sensor-generated data.

The value of predictive maintenance over any other maintenance model is that PdM empowers maintenance and operations decision-makers to “see” when an asset will need intervention well in advance

of its failure. PdM provides the highest possible visibility of the asset by collecting and analyzing various types of data. Here are some of its capabilities:

- **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

It’s predictive analytics — the ability to collect and analyze information to identify risks and opportunities — that enables predictive maintenance.

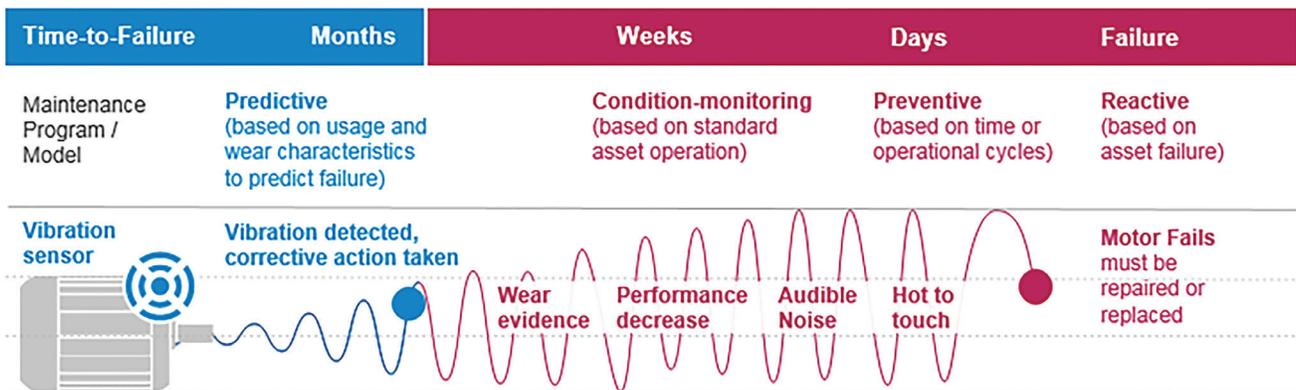
Comparing maintenance methods

The following diagram illustrates four common maintenance methods with corresponding effectiveness.

The key to excellent predictive maintenance is bridging the gap between information technology and operations technology. And today, the technology to bridge that gap is the Internet of Things.

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.



General Electric, which employs some of the best mechanical engineers in the world, is investing in predictive analytics for its for-sale heavy machinery. Bill Ruh, vice president of GE's Global Software center, affirmed that even a one percent gain in efficiency can be a huge boost to profits. For GE's natural gas firing generators, that one percent could save \$66 billion. Said Ruh, "It's really important to get the most out of [predictive analytics]. It's not just about the technology. There is a great opportunity for new solutions that will change the directions of whole industries."³

³ Murphy, "Gartner Researchers: Predictive Analytics to Gain Traction in Business," *DataInformed*, March 2013.

IoT growth

The Internet of Things (IoT) is an ecosystem where sensors, devices and equipment are connected to a network so they can transmit and receive data for tracking, analysis and action.

Today there are billions of objects connected to the Internet of Things. By 2020, researchers predict that 212 billion objects will be connected. And by 2020, there will be 9 billion mobile users in the world.

During the last two years, 90% of the world's data has been generated and there has been a 40% growth in the adoption of business networks, with 51% of workloads processed in the cloud as of 2014.

It is evident that the Internet of Things will be a prominent feature of business processes within the next few years.

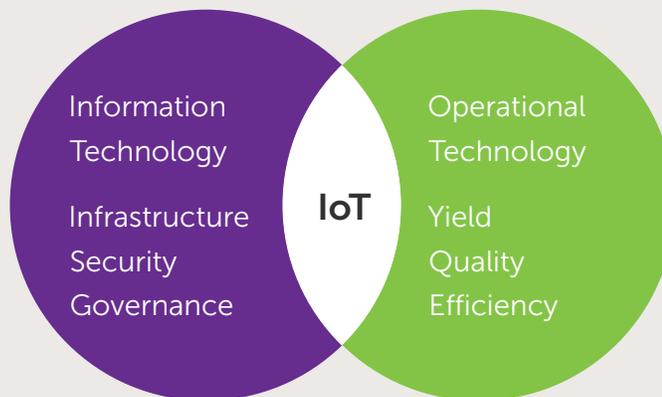
A view of IoT

The Internet of Things is where information technology meets operations technology. It is where it is possible to have information technology that provides well-managed global deployments, with security and governance at a viable cost. Operations uses quickly-deployable applications that simply work, with 24x7 access to vital data and good integration of legacy systems into new business models.

To turn this possibility into a reality for predictive maintenance, it is necessary to create an effective connection between information technology and operations technology utilizing the Internet of Things to get outstanding results.

It's not new and not new to Dell.

It is the integration and extension of IT and OT technologies that have been around for decades





Best practices for predictive maintenance:

1. Establish the business case for PdM.
2. Identify and prioritize data sources.
3. Collect selected data.
4. Determine where to run your analytics.
5. Combine and analyze data for insights.
6. Take action.

Best-in-class predictive maintenance

The Internet of Things offers 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 to implement predictive maintenance models that address their top operational challenges in order to improve their use of assets. Some advanced solutions even include automated work orders in coordination with ERP systems.

Results show that such predictive maintenance practices:

- Reduce unplanned downtime by 3.5% – The amount of unscheduled downtime against total availability
- Improve Overall Equipment Effectiveness (OEE) 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

Best practices for predictive maintenance

As an increasing number of enterprises adopt the use of IoT and big data for predictive maintenance, some valuable best practices have emerged for designing and creating a PdM implementation:

1. **Establish the business case for predictive maintenance (PdM).** It's important to understand what metrics the organization is focusing on and which of them need to be improved.

Consider these questions:

What critical assets are likely to fail?

When and why do we believe they will fail?

What will be the impact of failure and what will downtime cost?

How can data-driven decisions be integrated into the existing maintenance process?

2. Identify and prioritize data sources.

All possible data sources do not have to be included. The operation can begin to predict failures on a single asset by focusing on the existing, available data sources related to that asset, as in the motor vibration analysis example diagrammed on page 2. Consider real-time data as well as big data – both structured (located in your databases) and unstructured (from various locations; for example, operator logs).

3. **Collect selected data.** An ideal PdM solution should be flexible enough to enable you to collect from all of these data sources so you can continually make better, more informed business decisions.

4. **Determine where to run your analytics.** Edge (or local) and enterprise-wide analytics can be balanced to reduce the burden of streaming perishable PdM data on your enterprise system. A distributed approach allows you to detect and respond to local events right when they happen.

5. **Combine and analyze data for insights.** Start by analyzing data to define "normal operation" for a machine. After analyzing real-time data, add historical and third-party data such as reliability models and logs to uncover meaningful correlations and patterns.

6. **Take action.** Turn insights into action by integrating an aggregated risk assessment for all your assets into your operation through a single dashboard. Then, when a potential problem is visible, you can send out automated alerts to concerned parties recommending applicable replacement parts and take corrective action to avoid catastrophe.⁴

For more information these best practices, see Dell's Predictive Maintenance Blueprint, "[Six steps to using the IoT to deliver maintenance efficiency.](#)"

Why a Dell IoT solution for SAP

Dell research shows that getting and accelerating access to the right data is the key to faster analytics and improved corporate decision-making – both big factors in the organization's success.

Sensors alone do not transform operations, and data points without connectivity do not transform business activity. It takes experience to put together a solution that embraces all of the preceding best practices for predictive maintenance.

It was with these best practices in mind that Dell and SAP collaborated on a SAP IoT solution to bring predictive maintenance quickly to life in an operations environment.

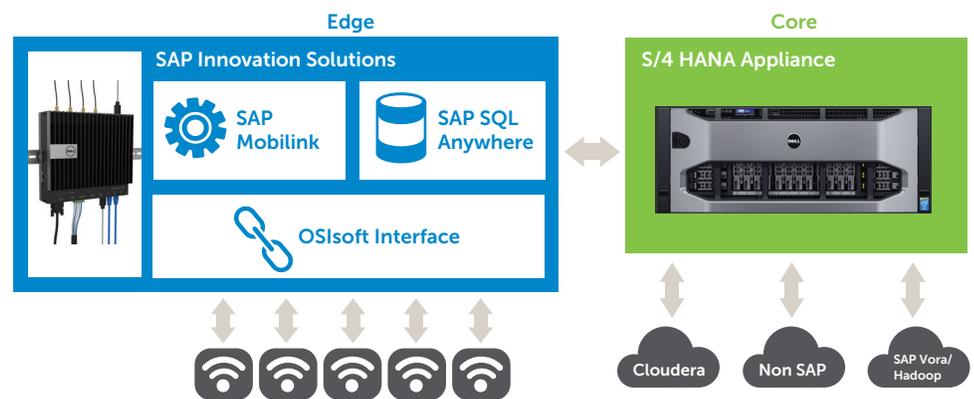
⁴ Dell Predictive Maintenance Blueprint, "Six steps to using the IoT to deliver maintenance efficiency," April 2016.

Dell IoT solution for SAP

The solution combines Dell's Gateway with SAP HANA and SAP HANA Vora for real-time analytics and Hadoop for unstructured data storage.

SAP enables the move from reactive to predictive maintenance and service by analyzing large volumes of operational data along with business data. It provides in-depth insight into asset history and trends to help predict maintenance and service needs.

With Dell's IoT solution for SAP, you can collect data via IoT gateways and connect them to SAP HANA for effective action.



Benefits

The Dell IoT solution for SAP provides the highest possible visibility of each asset by collecting and analyzing various types of data. The Dell IoT solution for SAP:

- Identifies key predictors and determines the likelihood of outcomes
- Optimizes decision-making by systematically applying measurable real-time and historical data
- Is a pre-tested, pre-configured solution that includes IoT gateways and appliances for SAP HANA, SAP Vora, and Hadoop
- Uses infrastructure standardized for deployment worldwide
- Includes Dell global hardware and support services



Combination of strong components

Each element has unique strengths.

Dell Edge Gateway 5000 supports best practices for PdM in several ways. First, it permits the collection of the predictive data you need. It is an industrial-grade, scalable solution that works with a variety of critical protocols, data sources, and types of data.



Dell intelligent gateways provide:

- **Native wired and wireless I/O** to minimize cost and simplify setup
- Optimization for **wall and DIN-rail mounting** including cable routing
- Engineering for **constant and long-term operation** from -30C to 70C
- **Flexibility** to support legacy + modern sensor protocols
- **Gateway-oriented security and manageability** with best practices from PC, server, and routers and new functionality for OT

To support SAP predictive maintenance, the Dell Edge Gateway can host:

- SAP SQL Anywhere remote database with Mobilink Client to enable database synchronization
- Interface to OSIsoft

SAP HANA in-memory platform

receives equipment performance data from non-SAP metering systems. It analyzes performance and uses predictive algorithms to forecast future performance failure. It uses predefined models to automate decision-making and recommendations.

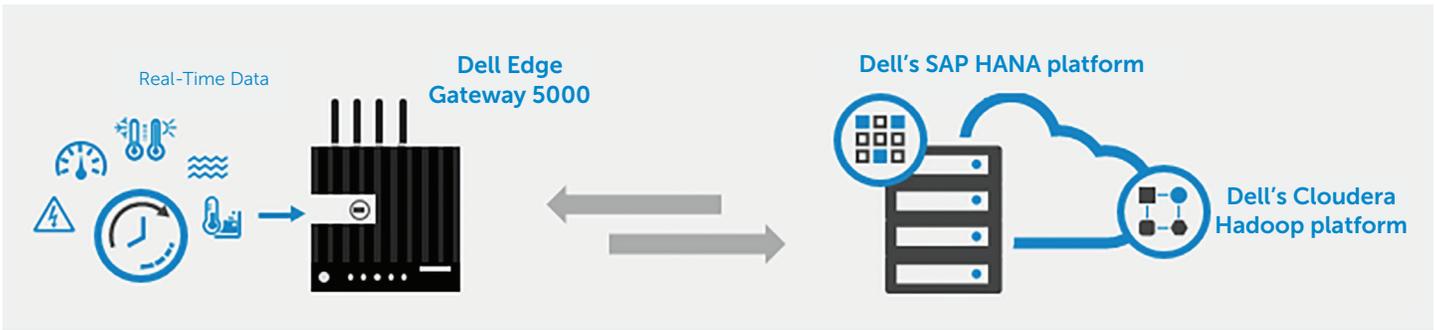
SAP HANA, along with SAP HANA Vora, enables data analytics on unstructured sensor data, as well as data from enterprise sources to identify patterns that help predict failures earlier.

SAP HANA also provides integration with Enterprise Asset Management systems for reporting, generating alerts, and automating maintenance dispatching.

For the asset manufacturer, SAP HANA can improve service profitability due to lower service costs and new revenue streams. It can deliver a higher first-fix rate and a higher percentage of calls resolved — resulting in higher customer satisfaction and retention rates, as well as higher service contract renewal rates.

For the asset operator, SAP HANA can provide higher equipment effectiveness; that is, greater availability, performance, and quality. It can lower maintenance costs and mean time to repair, while it raises mean time between failures and enables faster reaction to alarms or failures that do occur.

Dell enables SAP HANA with a robust platform tested for high availability and disaster recovery. In this solution, every SAP HANA configuration is based on the performance-leading Dell PowerEdge R930 server. The Dell PowerEdge R930 provides a solid base for future expansion, without the need to “rip and replace” as system needs evolve.



Hadoop open-source software framework is ideal for distributed storage and distributed processing of very large data sets on clustered hardware. Its contribution to Dell's SAP IoT solution is provision of a persistent storage layer for the unstructured sensor.

The Dell Hadoop platform with Dell PowerEdge R730xd servers is thoroughly tested and validated for use in the acceleration of big data deployments.

Sizing

To permit planning based on the scope of your organization and operation, the following are system sizes to act as configuration guidelines.

| Solution Component | Small | Medium | Large |
|-----------------------------------------|-------------------------------|-------------|--------------|
| Dell Edge Gateway 500 | 10 Gateways | 50 Gateways | 150 Gateways |
| HANA platform (Dell PowerEdge R930) | 256GB RAM | 768GB RAM | 2TB RAM |
| Hadoop platform (Dell PowerEdge R730xd) | 5 nodes (50TB raw data store) | 25 nodes | 100 nodes |

Conclusion: the potential

True predictive maintenance, based on the Internet of Things, has the potential to transform the industrial world. In the words of GE's Bill Ruh, "There is a great opportunity for new solutions that will change the directions of whole industries."

Organizations that understand and utilize this technology will have the competitive edge, moving forward into the next decade. Utilization of IoT to link the rich information stores of operations with the analytical power of IT will be the key to this competitive edge, and Dell's IoT solution for SAP now makes the key more accessible.

To learn more, visit Dell.com

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