Enabling the Edge Use Cases for Smart Manufacturing

Dell Technologies Validated Design for Manufacturing Edge with Litmus

Aligning IT, OT and the business to act on the edge insights in real-time can accelerate your smart manufacturing outcomes and give you a competitive advantage in the age of Industry 4.0.
Executive summary

Edge computing is an essential element of smart manufacturing strategies. The Dell Technologies Validated Design for Manufacturing Edge with Litmus is built to help you overcome challenges at the manufacturing edge and give you greater visibility into actionable key performance indicators (KPIs) for multiple use cases. This document describes key smart manufacturing use cases and how this solution can help simplify your edge.
Industrial firms are already using edge computing for competitive advantage, with 76% of manufacturers analyzing machine and operational data at edge or near-edge locations.² Analysts predict that the number of new operational processes deployed on edge infrastructure will grow to over 90% by 2024.² With billions of Internet of Things (IoT) and connected devices in operation³ — and growing at a rapid pace — advanced edge analytics capabilities are table stakes for a seat at the Industry 4.0 table.

Drivers of human progress

The manufacturing industry has been driving human advancement for centuries. The history of modern society is tied inextricably to manufacturing progress. When the First Industrial Revolution captured the power of water and steam to mechanize manufacturing, goods that had once been painstakingly crafted by hand could be mass-produced by machines in factories. Steam power and machine tools, including steamships and railroads, transformed largely rural, agrarian societies into industrialized, urban nations.

During the Second Industrial Revolution, the use of electricity further expanded the production of mass-produced consumer goods. Manufacturing innovations and improvements in steel and chemical production advanced the railways and fueled the budding auto industry, helping populations become more mobile. Increasing urbanization along with more widespread use of electric lighting, radios and the telephone transformed society once again.

The Third Industrial Revolution leveraged electronics to enable robotics and automation. The move from mechanical devices to digital technology dramatically disrupted industries. Supply chains became global, as did production. Offshoring significantly changed societies around the world.

Each of these first three industrial revolutions represented profound change — a major societal transformation. Today, the Fourth Industrial Revolution, referred to by many as Industry 4.0, is here and promises to change society just as profoundly as the first three. The hallmarks of Industry 4.0 are the convergence of IT and operational technology (OT); an abundance of IoT devices and data; and data analytics, artificial intelligence (AI) and machine learning (ML) fueling smart factories. This revolution is both enabled and driven by the emergence of sophisticated and powerful edge technologies.

Industry 4.0: The Next Revolution

Enable smart manufacturing outcomes.

**Edge computing will revolutionize manufacturing — and the world.**
Just as the First Industrial Revolution was powered by steam, the era of smart manufacturing is powered by new technologies for capturing and analyzing data at the edge for new insights and efficiencies. There’s no doubt that edge computing will revolutionize the manufacturing industry. But like the three revolutions preceding it, Industry 4.0 won’t just revolutionize the factory floor. It will revolutionize the world.

While it’s impossible to determine all the possible use cases or their ultimate impact on society, several use cases have already been adopted by a vanguard of forward-thinking manufacturers. These include overall equipment effectiveness (OEE), predictive maintenance, yield optimization and production quality.

You can gain the business agility enabled by these use cases by putting systems in place that provide live insights at the edge. This requires supercharged data connectivity at the edge and can benefit from pre-built and custom data visualizations and AI/ML trained models. These capabilities help you build a complete data picture from OT to IT, for better and faster decisions that align with business imperatives.

### Overall equipment effectiveness
OEE measures manufacturing productivity using the metrics of quality, performance and availability. The gold standard is 100% OEE, meaning the plant is producing only good parts, as fast as possible and with no stop time. Smart manufacturers are using diagnostics and prescriptive analytics at the edge to enable intelligent asset optimization. This helps reduce unplanned downtime while maximizing asset utilization and product quality. A KPI dashboard tuned to OEE metrics can make it simpler for teams to gather the right data, visualize it and use it to make improvements that keep the factory on track toward 100% OEE.

### Predictive maintenance
Predictive maintenance refers to using advanced analytics to proactively identify equipment and process defects so they can be addressed before they cause a failure. ML, a subset of AI, can dramatically increase the accuracy of predictive models, identifying more issues sooner to increase the efficacy of predictive maintenance efforts. Many manufacturers use edge systems to collect data from assets and sensors, normalize it and send it to the cloud or core for deeper analytics and ML. However, OT teams typically do not want to move operational data between the factory floor and public cloud due to data latency and security concerns.

### Yield optimization
Yield optimization refers to predicting production issues before they occur so that steps can be taken to minimize downtime of equipment and processes. This includes both analyzing the optimal flow of a product through the assembly process and detecting anomalies before they result in production pauses.

### Production quality
Production quality is the practice of evaluating the production process to ensure manufactured goods are meeting quality standards. Edge systems with computer vision capabilities can help speed up and automate the inspection of work in process throughout the entire production cycle to detect defects in products, parts or packaging to improve safety, decrease liability and keep customers coming back for more.

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4 69% of manufacturing infrastructure will be deployed at the edge within the next 24 months.4

60% of manufacturers perform AI/ML training at the edge.4

57% of manufacturers perform AI/ML inferencing at the edge.4

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Simplify your path to smart manufacturing.

Adopt a validated, end-to-end edge solution.
The Dell Technologies Validated Design for Manufacturing Edge with Litmus combines several proven technologies to win at the edge. The solution is offered in three different configurations, based on workload sizes, each with the flexibility of a subscription-based or CapEx consumption model. It is designed to centrally manage and orchestrate industrial edge devices, data and applications from the factory floor to the enterprise cloud, helping you deliver optimal business outcomes.

The solution is validated to readily support the key manufacturing use cases, simplifying your transition to smart manufacturing by providing:

• An easy way to take control of your OEE metrics by simplifying OT data collection, creating analytical capabilities and outputting the metric to the visualization of your choice
• An ideal solution for predictive maintenance that simplifies connectivity to OT assets, delivers insights through analytics and streaming data capabilities and allows for scale and resiliency across diverse systems and platforms in manufacturing
• The ability to build visualizations that help you understand the data coming out of your manufacturing operations and help optimize your yield based on data coming directly from manufacturing assets and processes
• The ability to expedite and automate the inspection of work in process throughout the entire production cycle, allowing you to run your quality inspection applications (as Docker applications) to detect defects in products, parts or packaging. This helps you improve safety, decrease liability and keep your customers coming back for more.

End-to-end solution to power manufacturing edge use cases

Overall Equipment Effectiveness
Using Dell Technologies Validated Design for Manufacturing Edge with Litmus, you can easily build and optimize the OEE calculation for a given asset or manufacturing process via an easy, graphics-driven approach that helps you quickly and easily visualize your OEE. The following is an example of an OEE visualization. It shows OEE at the:

- **Plant level:** Top horizontal pane
- **Line level:** Second horizontal pane
- **Build cell level:** Third horizontal pane
- **Asset level:** Bottom pane
Predictive maintenance
The Dell Technologies Validated Design for Edge Manufacturing with Litmus is an AI-enabled system that allows data scientists to train the ML models at the edge without sending data to the public cloud, for faster results and enhanced data security.

Predictive maintenance is dependent on condition monitoring of manufacturing assets. The following Grafana dashboard represents “Predictive Maintenance Monitoring.”

The “Line Runtime Status” chart provided at the top of the dashboard plots runtime of a specific production line over time. In the example, the line is typically inactive for 10 minutes every hour. The two tiles below show performance and predictive maintenance projections for two build cells on the line. Some of the fundamentals visualized here include:

- **Lifetime runtime**: The amount of time the machine has been running since it was commissioned
- **Maintenance interval**: The machine builder’s maintenance interval recommendation
- **Current runtime**: Runtime since the last service
- **Maintenance due in**: Time to next recommended service

Most importantly, you can see the “Predicted hours to maintenance” at the end of each tile. This is the optimal recommended maintenance time based on historical runtime and performance as well as the condition monitoring being obtained directly from the asset. The Dell Technologies Validated Design for Manufacturing Edge with Litmus delivers the statistical analytics capabilities required to deliver this predictive maintenance capability. This enables you to maximize productivity, improve ROI on assets and plan production in confidence. In addition, within the “Flows and Analytics” capability of the solution, you can define the maintenance tickets to be raised via REST API based on specific thresholds within the predictive maintenance calculations.
**Yield optimization**

The Dell Technologies Validated Design for Edge Manufacturing with Litmus provides predictive analytics and intelligent automation at the edge, leveraging a combination of industrial IoT sensors, machines, systems and people to maximize performance and quality while minimizing outages and losses.

Here, you can use an analytical flow similar to OEE to understand your yield performance, using analytics to complete the necessary calculations, with the results output to the visualization platform of your choice. The following dashboard represents yield at a line level within a manufacturing environment over seven days.

The data from manufacturing operations is being normalized and calculated instream as production output and/or scrap is being reported. The analytics are performed within Litmus Edge and then written out to the Dell EMC Streaming Data Platform (SDP). In the chart above, the trending line is a calculation of yield based on the number of “good” parts manufactured out of total parts made. The dashboard clearly shows a downward trend, indicating an issue in production.

The different colors represent different shift times, and the vertical lines represent annotations made within Grafana by production operators or shift personnel such as maintenance teams. The vertical lines from left to right represent the following:

- The first line indicates that at midnight on 6/24, a significant yield issue was reported.
- The second line shows that 24 hours later, maintenance teams discovered an issue on an extruder on a specific asset and noted it as the root cause. Yield was continuing to decline.
- On the third annotation, 24 hours later, production supervisors identified that scrap and yield began to level out.
- On the fourth annotation, maintenance was working on the issue and yield continued to see the impact.
- Finally, maintenance reported the extruder issue as resolved, and yield picked up at 4 p.m. on 6/26.
- Yield returned to “typical” values by the sixth annotation.

**Production quality**

The Dell Technologies Validated Design for Manufacturing Edge with Litmus can help you speed and automate the inspection of work in process throughout the entire production cycle, allowing you to run your computer vision applications (as Docker® applications) to detect defects across the entire production cycle.
Proven technologies to enable the smart manufacturing use cases

High-level solution overview
The solution architecture uses an award-winning hyperconverged infrastructure — Dell EMC VxRail — or edge-hardened Dell EMC PowerEdge servers to offer a scalable, unified technology architecture that is validated to work with Litmus Edge, Litmus Edge Manager, and Dell EMC Streaming Data Platform (SDP). Together, these technologies support the use cases and workloads for smart manufacturing outcomes.

- **Dell EMC VxRail**: The VxRail hyperconverged infrastructure (HCI) offers a turnkey edge deployment with maximum flexibility for high availability (HA), scale and consolidation of OT workloads and applications. Litmus Edge, Edge Manager and SDP run on virtual machines (VM) on the VxRail HCI.

- **Dell EMC PowerEdge servers**: For scenarios where HA is not required at the edge, the solution can run on a single Dell EMC PowerEdge server running VMware® ESXi™. Validated Dell EMC PowerEdge XR11 and XR12 ruggedized servers offer deployment flexibility for solutions outside of the data center.

- **Dell EMC SDP**: SDP provides ingestion and storage capabilities for OT data streams and has built-in analytics capabilities. SDP is built on open-source platforms and runs on the VxRail as a VM specifically for this solution. SDP acts as the aggregation point for the data ingested across Litmus Edge instances. One or more SDP instances can be deployed, depending on business requirements.

- **Litmus**: Litmus Edge is a Linux®-based operating system that provides IT/OT connectivity and the capability to contextualize and normalize OT data. It can be run within a VM or on a Dell EMC Gateway device. Litmus Edge Manager is the management solution that allows you to manage all of the Litmus Edge deployments within the environment.

In the diagram, all the OT data sources are represented as the industrial edge. Gateway devices are connected to IoT sensors via technologies such as Bluetooth, Wi-Fi or IoT-specific protocols such as Zigbee or LoRa. You could also have gateways interfaced directly to industrial equipment via industrial platforms using parallel, serial or ethernet cabling. This might be using protocols such as OPC-UA, CAN or another industrial protocol. A gateway will typically be used to interface IoT sensors or industrial platforms to IT systems and networks. Finally, there is a VM, running Litmus Edge, that may connect directly to an industrial device via ethernet if the device can use ethernet and TCP-IP for connectivity. In this scenario, you can achieve high levels of consolidation by running the required translation/applications on Litmus Edge in a VM directly on the enterprise edge. In the Dell Technologies Validated Design for Manufacturing Edge with Litmus, the enterprise edge runs on either Dell EMC VxRail or Dell EMC PowerEdge servers.
Finally, it is important to note that the Dell Technologies Validated Design for Manufacturing Edge with Litmus will fully integrate with existing on-premises data centers and cloud platforms. This allows optimal placement of capabilities like analytics and AI across your IT infrastructure for maximum value.

Your manufacturing edge computing environment can be further expanded with the latest Dell Technologies portfolio of edge-ready offerings, including Edge Gateway devices, Latitude Rugged Tablets and PCs, Dell EMC PowerEdge servers and more.

Simplify your edge to accelerate smart manufacturing outcomes.

Edge computing is an essential element of smart manufacturing. The Dell Technologies Validated Design for Manufacturing Edge with Litmus gives you the operational intelligence to transform silos of people, assets and processes into a data-driven, synchronized plan that gives OT unmatched visibility into actionable KPIs for multiple manufacturing edge use cases.

What's more, Dell Technologies has the expertise and portfolio to help you continue to evolve and simplify your edge so you can harness the value of data from the core to the cloud to the edge.