6 steps to optimizing real-time quality control using the IoT

In many industries manufacturing is constantly having to retool and recalibrate production lines for new products, variations in raw materials, deviations or substitutions in parts, and general process drift. Production runs are often cyclical, and consumer demand and competition is driving the need for greater differentiation and variation in product output, with shorter and faster production cycles.

As a result, manufacturers face significant external pressures to constantly adapt to these forces, increasing cost of goods sold, and diminishing return on investments. The challenges are especially acute with OEM suppliers where efficiency is often sacrificed in order to minimize time to market and avoid shipping deadline penalties. This causes significant inefficiency throughout the production process:

- **Dependence on intuitive engineering** – process optimization is often attempted through trial and error
- **Reliance on manual quality control** – high rates of scrap and defect rejects occurring at post-production quality inspection
- **Disconnected data silos** – available data is not used to maximize efficiency

Every manufacturer has an institutionalized level of ‘acceptable loss’. This is a barrier that has become difficult to overcome as manufacturing has grown more complex. Often manufacturers believe the cost to overcome these barriers outweighs the benefits.

The Internet of Things (IoT) and advanced data analytics have created opportunities to conquer efficiency barriers by discovering insights and optimizations that can yield new benefits to manufacturers.

A connected IoT solution that optimizes Edge-based real-time analytics with the power of cloud-based advanced computing gives manufacturers the ability to maximize their in-process real-time quality control (RtQC) by providing the following benefits:

- Taking immediate action on perishable data inline with the manufacturing process
- Retaining insights from production engineering to optimize in-process manufacturing
- Learning and adapting continuously from product output
- Continually optimizing for production variance and process drift

RtQC Optimization Comparison

The following example illustrates the quality optimization gained by detecting and preventing defects earlier within the manufacturing process. Consider a typical manufacturing process for automotive involving plastic welding which may produce a new part as frequently as every 45 seconds. With dozens of inputs to calibrate, sensor readings to process, frequent product changeover and retooling, and complex output to inspect, it is difficult to automate quality control beyond ad hoc and end-of-run inspections. However, adopting a real-time quality control solution that connects and analyzes all of this data can provide greater efficiencies and cost reduction by automatically and continuously managing the variability to optimize quality and prevent defects from occurring earlier in the production lifecycle.

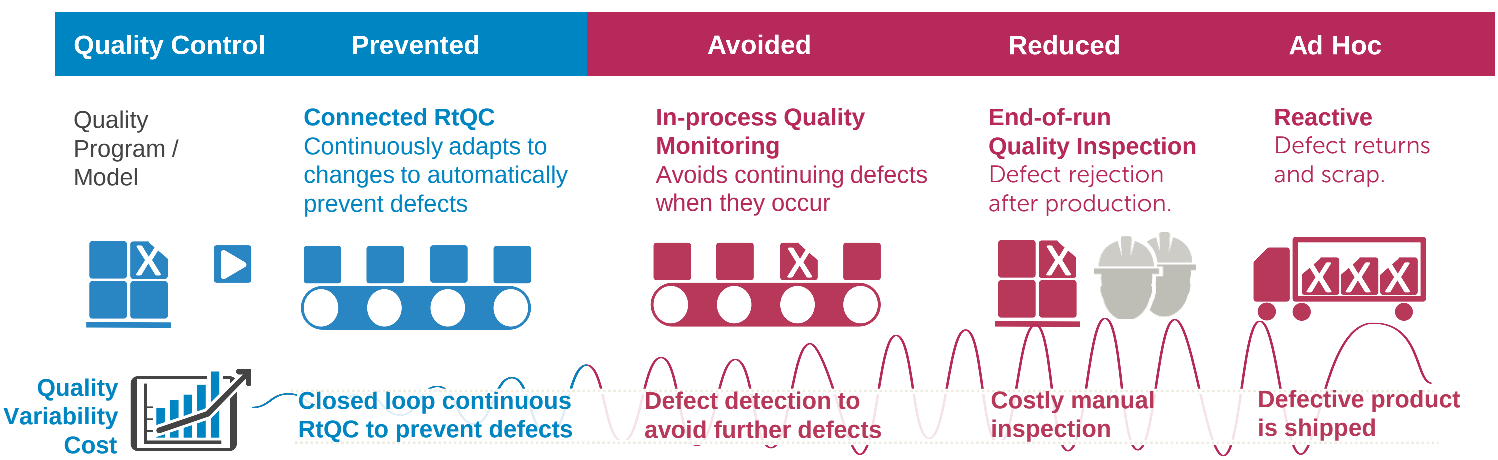


Figure 1: Example of variability in quality and cost

Follow these 6 best practice steps to plan your RtQC implementation

1 | Target the production process to optimize

Process engineers often have multiple quality control issues within their production operation. It is important to take a disciplined assessment of where to focus efforts to optimize the process, and determine where the highest cost benefit is to be gained. It is usually beneficial not to focus on the point of failure within the production operation, but consider the upstream inputs and variables that can affect the optimal yield in production quality. Variables to consider when selecting where to invest in quality optimization include:

- Which production operations are currently performing below standard in terms of quality output or in-process defect rates?
- Where are you spending significant amounts on human intervention to control quality that could be otherwise automated?
- Where might you have access to the most data to observe real-time performance that can contribute to variability in quality?

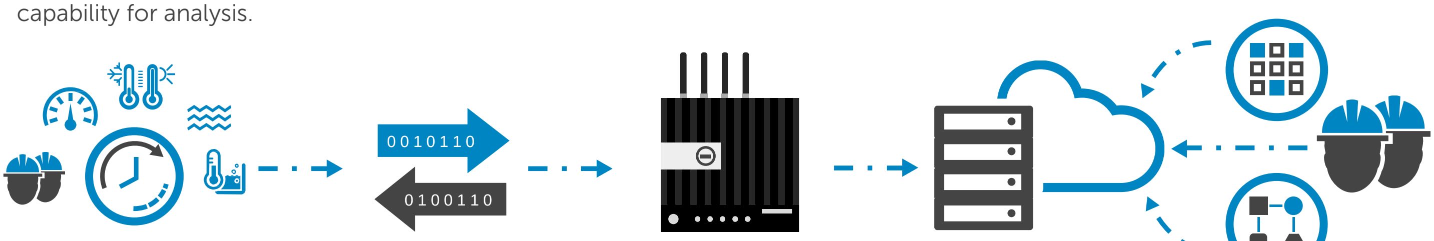
2 | Select the data

The traditional approach to performing quality control on a production line is to process basic signals in order to identify when a defect is occurring. The approach with a real-time analytics solution is to detect signals that correlate to defects before they happen, in order to prevent them from occurring. In this regard, it is important to take a non-discriminating approach in the initial data selection – capturing more data creates a more heterogeneous dataset from which to correlate patterns and signals that contribute to poor production quality and defects, in turn enabling the creation of more accurate rules to prevent this inefficiency. To develop and optimize real-time analytics for your process, consider the following sources and types of data that may be available.

Type	Real-time Streaming	Structured / Unstructured	User / Operator Input
What	Measurement, control, video, temperature, ambient	Asset identification, performance, uptime, tags, hours, parts, signals	Test input, calibration data, pass/fail data, workflow, free-text
Where	Sensors, PLCs, SCADA, controls, machine I/O	Historians, ERPs, MES systems, data warehouses	Web input capture, operator machine input, business systems, spreadsheets

3 | Capture and stream data

In order to optimize real-time analytics, consider that a production operation cycles through phases for initial production line scrubbing, startup cycle, full-scale production, and shutdown. Plan to stage your data collection bounded to these types of phases of the production operation in order to develop baselines for expected and unexpected operation. Capturing and naming data from each of these phases provides unique variabilities and opportunities to discover efficiency improvements. Consider simulating defects or variabilities that emulate real-world scenarios to capture. At this stage, data variability is more valuable than data volume. Ensure that any data captured is cleaned and synchronized across all inputs such that data integrity is ensured once aggregated. The Dell Edge Gateway is an intelligent, industrial-grade, scalable solution for the Edge that works with a variety of critical protocols, data sources, and types of data. Capturing data through the Gateway ensures data synchronization and provides routing capability for analysis.



Collect Real-time streaming sensor data and user input

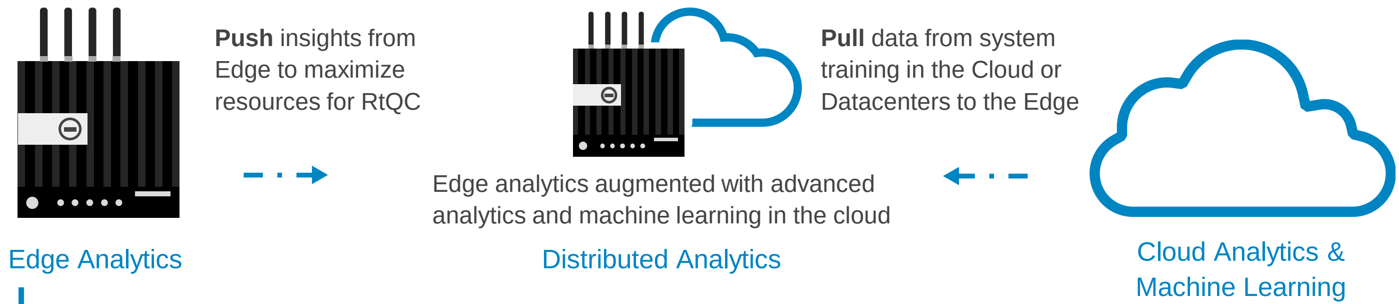
Translate protocols to access critical data

Collect data with Dell Edge Gateway

Collect structured / unstructured data and user input to generate real-time analytics to push back to the Edge

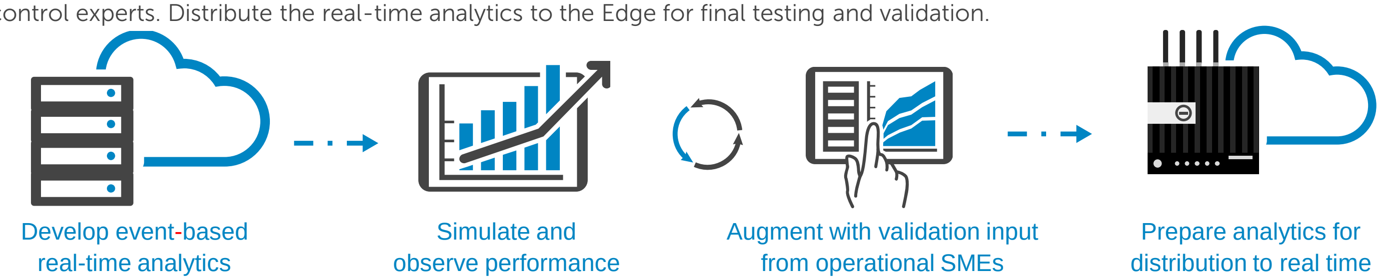
4 | Aggregate and analyze data

Within a manufacturing production operation, it is critically important that the Edge computing power is reserved for real-time data analytics. To optimize for this, data intended for system training is distributed away from the Edge using basic data collection rules in order to take advantage of cloud computing power for advanced data processing such as clustering analysis, correlation analysis, and machine learning. For manufacturing environments requiring extremely low latency, real-time, advanced topologies can be used to dedicate primary gateways for real-time analytics, and secondary gateways for data collection. In addition, some may choose to utilize on premise data centers for advanced analytics as opposed to cloud services. The Dell Edge Gateway can be dedicated to both real-time analytics and data streaming for most production operations. It is also a best practice to plan for computing headroom at the Edge for increasing real-time data volume.



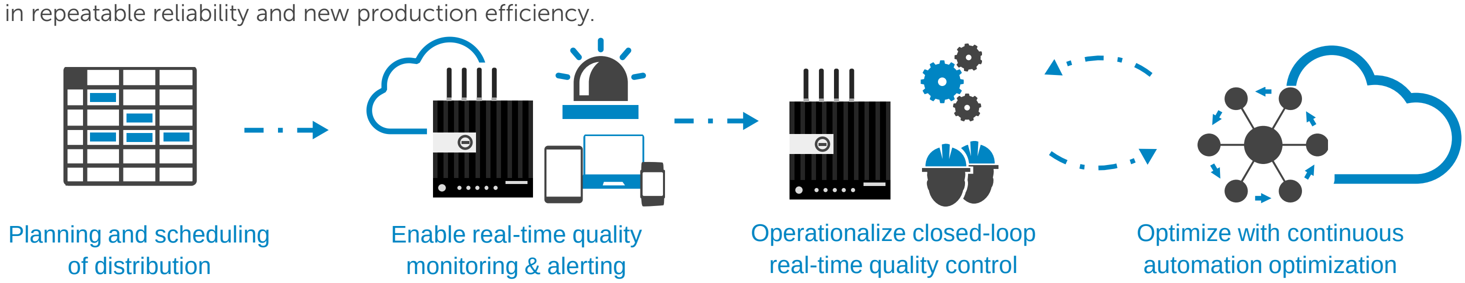
5 | Develop and test real-time analytics

Segregate the aggregated data into baseline training and testing datasets. This approach allows the advanced computing techniques to learn patterns and anomalies on a controlled set of data, and test against an unseen set of data. Develop the real-time analytics that detect events related to anomalies or defects being trained for by iterating through the various sets of data, training and testing the rules being developed until the optimal performance is observed. Augment this development cycle by capturing user input from in-process experts in order to help validate and continually improve the accuracy – ideally, these are operational subject matter experts closest to the manufacturing process such as the most experience machine operators or quality control experts. Distribute the real-time analytics to the Edge for final testing and validation.



6 | Operationalize real-time quality control

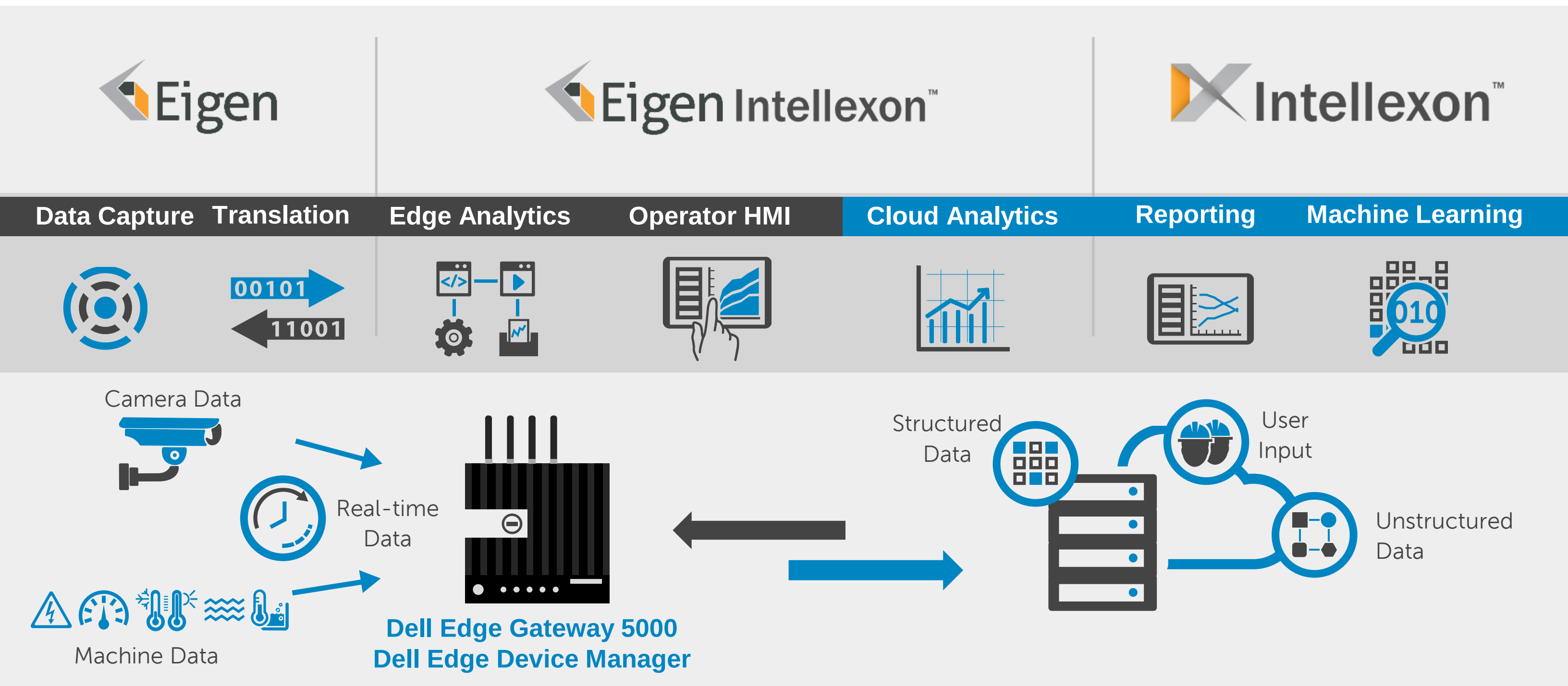
The steps involved in operationalizing the system is largely dependent on the type of manufacturing process, (such as real time vs. discreet), and the assets involved in the operation. In any scenario it is important to plan and tightly control versions, and operationalize the system in stages that mitigate any associated risks. Typically, systems will be brought online by iterating through inputs and outputs, leaving the system in an open-loop state until observable risks are mitigated and an optimized performance yield is observed to productionize closed-loop automation. This approach allows operators to layer the solution over the current operation and quality control process, opting in to the closed-loop automation when risks are mitigated and expected performance is achieved. For example, real-time input/output signals can be routed to the machine control layer through the Dell Edge Gateway to drive the automatic ejection of defects from a production line after the system is accurately inspecting and detecting defects to an acceptable level of accuracy. Continually iterating through data definition, collection, aggregation, analysis, and automation allows you to develop and distribute continuous quality optimization across the end-to-end production process in a way that layers in repeatable reliability and new production efficiency.



Real-time Quality Control Solutions Example

This RtQC Blueprint represents a single solution provided by the industry leading partners below as a reference. Your specific RtQC 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 RtQC 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 I/O and sensors, such as infrared cameras, to optimize end-to-end quality control within your manufacturing process. The Dell Edge Device Manager running on the gateway allows managers to deploy, group, and securely manage connected gateways regardless of their physical location. With Eigen's Intellexon® platform you get the ability to combine data created from traditional factory floor operational technology and video analytics with the power of advanced data analysis to yield significant optimization of your real-time quality control. Eigen's Quality Workbench HMI lets operators monitor in-process production and alerts the factory floor to events and escalations that require attention. Streaming real-time event data and operator input into Eigen's Intellexon® machine learning platform enables the RtQC to adapt to changing conditions on the factory floor with continuous adaptive programming that provides the real-time analytics capable of detecting highly variable and complicated quality issues. The distributed architecture lets you maximize the real-time analytics for quality control at the edge, while leveraging the cloud for deep analytics and machine learning to power a real-time quality inspection system capable of detecting highly variable and complicated quality issues that learns to predict quality variations before they occur, resulting in true defect prevention.



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

IoT Solutions
Partner Program

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.

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