A **Micron** WHITE PAPER

Smart Manufacturing: Memory and Storage Considerations for IoT Gateways and Edge Servers

The Rise of Smart Manufacturing

As industry transformation takes hold for Industrial Internet of Things (IoT) and Industrie 4.0 (I4.0), opportunities in the manufacturing industry continue to develop. Smart manufacturing is one such concept. In simple terms, smart manufacturing provides "connected" machines the ability to make real-time decisions, predictions and actions using data collected through sensors—analyzing them locally or in the cloud. Smart manufacturing's goal is to improve efficiency and productivity across an entire ecosystem by turning all data and information from connected machines into meaningful insights. The advent of big-data analytics—machine-learning driven artificial intelligence—is making this feasible now. It should therefore not be a surprise that smart manufacturing will increase the requirements not only for cloud computing, where longer-term analytics continue to rise, but also for more and more processing and storage at the edge—a trend referred to as *edge computing*.

As an example of data growth, Cisco® Global Cloud Index estimates that a connected intelligent factory can generate 1 petabyte of data per day, of which only 0.2% is transmitted back to the cloud[1].

Amounts of data transmitted to the cloud may vary based on cost efficiency of backhaul, data ownership concerns, etc., leading to significant edge-processing and data storage requirements to derive benefits from data analytics.

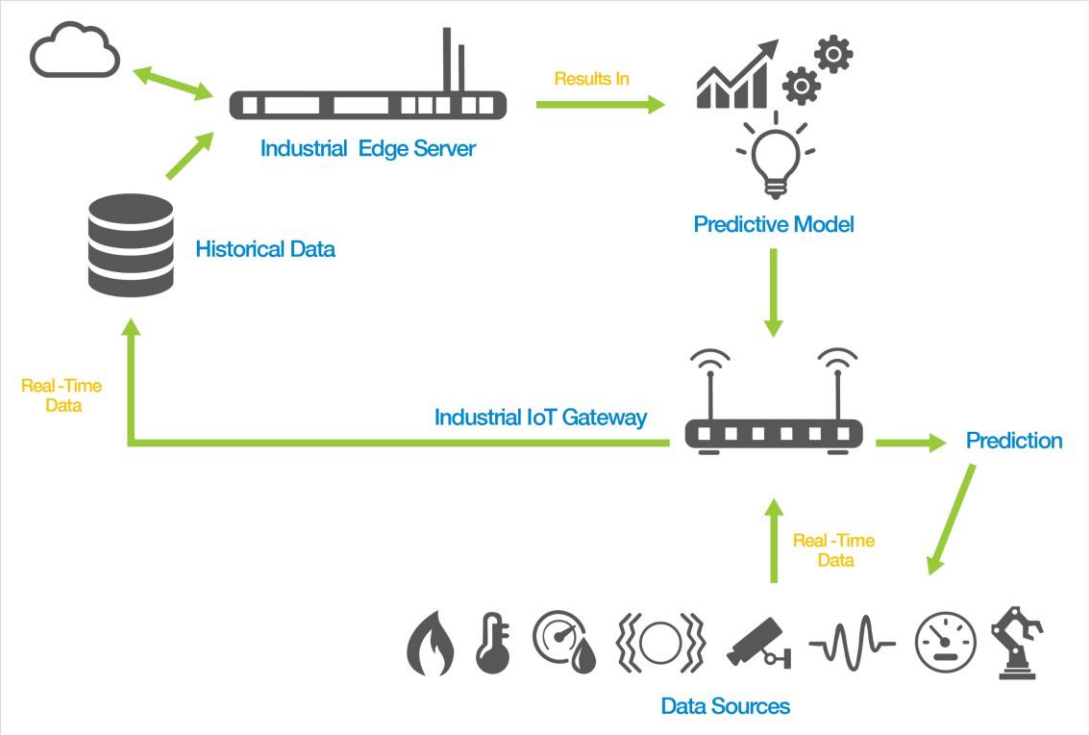

Figure 1: IoT Gateways and Edge Servers in Smart Manufacturing

1. Cisco Global Cloud Index: Forecast and Methodology, 2015–2020 white paper

The Role of Industrial IoT Gateways

A smart factory, or for that matter, most industrial IoT deployments, consist of a combination of highly heterogenous devices, including brown field installations (new hardware and software that coexist with legacy IT systems), and newer sensors, end-points and devices. An Industrial IoT gateway is a way to connect all of these devices and bring them to the IP (Internet Protocol) domain for further edge processing or backhaul to the cloud.

Industrial IoT gateways need to support standard Ethernet, Controller Area Network (CAN) and industrial Ethernet protocols (e.g. PROFINET, Modbus TCP, MQTT) for wired interfaces, and they may support many wireless protocols such as Bluetooth, Wi-Fi, ZigBee, Zwave, ULE etc. Industrial IoT gateways are designed to be always on and are ruggedized to withstand harsh environments that may be encountered on the smart manufacturing floor. And since they may be connecting a factory's internal infrastructure to the outside world, they must support high-level cyber-security features.

Benefits of IoT Gateways in Smart Manufacturing

The once isolated gateway is experiencing a rapid transformation. With more intelligence being shifted to the edge, the role of the IoT gateway will be to provide more advanced features and functionality, including local server/storage features:

- Interoperability: IoT gateways can provide the necessary protocol translation for communication to be established between devices that are not able to communicate with each other in a factory.
- Offload computing tasks: IoT gateways can offload computing tasks from smart devices by caching/storing information and acting as a private cloud that can be accessed remotely.
- Quality of Service (QoS): IoT gateways can maximize the effectiveness of bandwidth while minimizing endpoint bottle-necks.
- Security: IoT gateways can implement much more sophisticated security solutions than those implemented on each individual end-point, creating a good defensive, in-depth strategy for the whole factory network.
- Local storage: Storage at the gateway helps save transmission costs by only sending relevant data to the cloud. For instance, high frequency captures that are large in data size are not ideal to be sent to the cloud for analysis. It is more efficient to have the gateway act as the computing node to capture the data locally and make analytical decision locally. In this way, only summarized data is sent to the cloud. In addition, in environments where connectivity is intermittent, data can be captured and saved locally, ensuring that all the data is captured.

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The Role of Edge Servers

While an IoT gateway can offload computing tasks and provide local storage, it can be more efficient to use a central local server to do this across multiple IoT gateways. Moving the processing and storage to a ruggedized computing unit – that is the edge server – also creates a more scalable architecture where more compute and storage units can be added to deal with higher complexity, independent of the gateway.

An edge server analyzes manufacturing data in motion, speeding up decision making on the factory floor. It also enables application providers to deliver data center performance at the network's edge. Edge servers in a manufacturing environment must typically be available 24/7 with continuous recording and analyzing capabilities. The edge servers may directly communicate with sensor arrays/end-points and not have the need to utilize an IoT gateway as an aggregation node.

Edge servers are typically connected by high-speed Ethernet for high-reliability connection with the IoT gateway/factory network, but they may also support wireless LAN and fiber-based LAN connections. They may rely on external broadband gateway for cloud-connectivity, or they may directly include a cellular communication module to leverage Long Term Evolution (LTE) networks based on deployment needs.

The edge compute layer between end-devices and the cloud provides an opportunity for IT solution architects to optimize data management, analytics and decision making based on business goals. Edge servers can analyze real-time data, stored historical sensor data and factory context data through rules, machine learning and deep learning for predictive maintenance to reduce downtimes as well as improve operational efficiencies of machines and factory workflows. To enable this, most cloud platforms like Microsoft Azure® or Amazon Web Services® (AWS®) or enterprise resource planning (ERP) solutions from companies like SAP or Oracle are working on supporting a unified but distributed deployment between cloud and edge-compute layers. Solution managers can get a unified look at analytics and data between the cloud and the edge through common dashboards, and monitor, learn and optimize to continuously enhance insights and improve outcomes, improving the return on investment (ROI) of their smart manufacturing deployments.

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Importance of Memory Selection

For both IoT gateways and edge servers going into industrial/smart manufacturing deployments, memory selection is extremely important. Decision makers should consider a full-solution evaluation; including: qualification and product availability timelines, obsolescence management, performance, and quality and reliability requirements.

For example, commercial electronic components move to next-generation silicon lithography every 18-24 months. This is not ideal for smart manufacturing deployments because planning, qualification and execution can take longer than the duration of typical mainstream component availability. Smart manufacturing deployments need to ensure that the equipment bill of material (BOM) does not change since initial costs associated with qualification, BOM control and early obsolescence of a product, as well as long-term quality and reliability, can significantly impact factory deployment schedules and total cost.

Micron has been collaborating and servicing industrial customers for over 25 years and has deep understanding of customer pain points and business requirements in this market, and, as a result, has initiated Micron's Industrial Quotient (IQ). Micron's IQ reflects the mindset that the right electronic components and storage solutions selected up front in the design process matter to long-term success. Micron's full industrial portfolio embraces this mindset—it helps you meet not only functional product requirements, but also helps ensure long-term quality and reliability of your product, in wide range of rugged environments or industrial use cases, while keeping the product life cycle management simple, which can drive down total cost of ownership (TCO).

IQ = Lower TCO in IIoT

Application-Specific Optimization

Experience from extensive product- and use-case collaboration with our global partners helps you get to market faster.

Ruggedized Products

Ruggesized products help your designs deliver consistent performance across extreme conditions such as temperature, thermal cycling, shock, humidity and more.

High-Reliability Products

High reliability from our rigid design and testing processes increases memory endurance to help you meet and exceed longer product lifecycle requirements.

Extensive Quality Testing

Extensive QA testing helps ensure the consistent and high-quality memory that your demanding IIoT products require in mission-critical applications.

Product Longevity Program

Product longevity for eligible products via our Product Longevity Program extends our standard product lifecycle support, adding value to your Micron memory choice.

Example: Micron's IQ and Choosing an SSD for IoT Gateways and Edge Servers

When it comes to local data storage in IoT gateways and edge servers, it is highly advisable that customers consider Micron's industrial SSDs over typical client SSDs or traditional HDDs because of their performance, increased longevity and reliability.

Figure 2 shows lifecycle availability of a typical client SSD that's designed for and targets mainstream computing applications vs. Micron's industrial SSD portfolio, illustrating the importance of properly selecting an SSD for smart manufacturing applications.

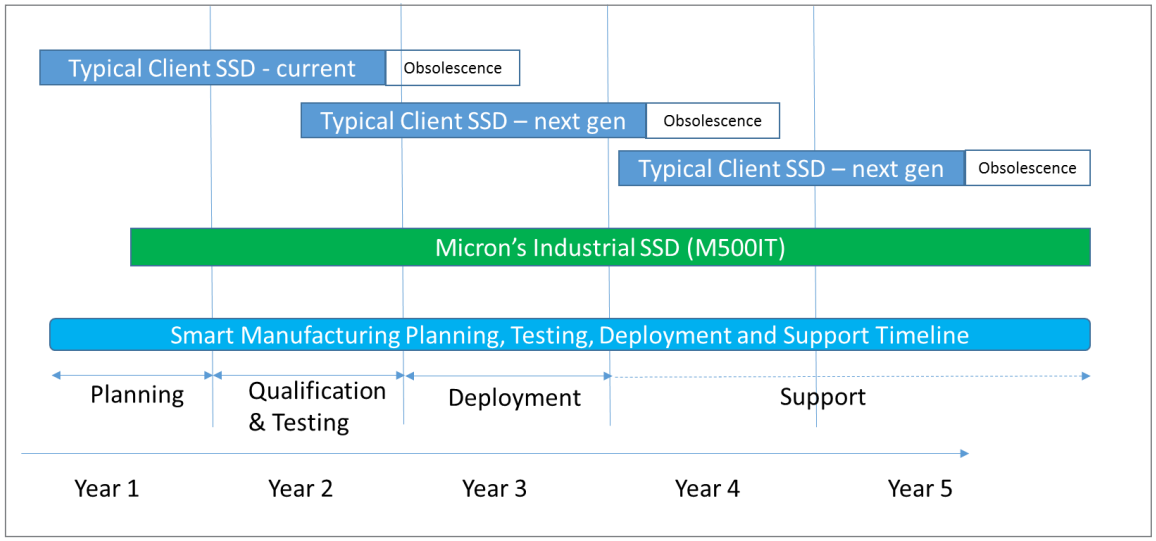

Figure 2: Micron's Industrial SSD (M500IT) longevity vs. Typical Client SSD Availability and Obsolescence

In addition to longer lifecycles, Micron's industrial SSDs offer several advantages over HDDs, including:

- >10X lower annualized failure rate (AFR)[2]
- Fast transfer speeds
- Low power consumption
- High durability against shock and vibration
- Light weight
- Smaller, embedded form factors

Industrial SSDs are a better choice over typical client SSDs as they are tested for ruggedness, quality, increased longevity and reliability. The lower cost risks associated with typical client SSDs are generally not realized until the products are qualified and shipped, and they may lead to longer term field issues and replacement expenses in extreme environments.

2. Based on Backblaze Hard Drive Stats for Q1 2017 (May 9th 2017)

Micron's M500IT SSD

Micron understands the storage requirements of edge servers and IoT gateways, and offers one of the most rugged and robust industrial SSD product lines in the industry—the Micron® M500IT SSD. Built to withstand industrial applications' rigorous demands through an extended operating temperature range, robust data security, data path and data-at-rest power loss protection, the M500IT SSD provides responsive performance at a lower power budget. The M500IT multi-level cell (MLC) and single-level cell (SLC) NAND flash-based SSDs are available in 2.5-inch SATA form factors for traditional disk drive loading systems as well as mSATA for compact designs.

Data and IP confidentiality is extremely important in industrial/smart factory applications. The M500IT SSD offers 256-AES encryption and TCG Opal 2.0 compliance for data security, with advance erase/sanitization features. The M500IT SSD also comes with Micron's free Storage Executive software to help manage the SSD. Among many other features, Storage Executive enables drive health monitoring, sanitize/erase operation, check drive status, report generation, secure firmware updates, and it offers life-cycle management.

The M500IT SSD is available for long-life, 5 years from the time of introduction vs. typical 2 years for standard SSDs, making them a great choice for deployments and serviceability in IoT gateways and edge server applications.

Memory Requirements for IoT Gateways

IoT gateways are typically based on x86 or ARM processors with weather-resistant high-speed connections through cellular, Wi-Fi and copper or fiber options. These solutions are usually fan- and filter-less, requiring memory solutions that are high-quality, high endurance products with extended temperature support and product longevity.

For DRAM, the IoT gateway typically uses **DDR3** or **DDR4** technology with low power DRAM (**LPDDRx**) being used by some power-critical applications. Boot up is done through **serial** or **parallel NOR**, while storage is done with **SLC NAND**, **e.MMC** or **e.MCP** products. Additional storage can be provided through **microSD** and small form factors such as mSATA industrial **SSDs**.

Memory Requirements for Edge Servers

Edge Servers are typically based on high-end x86 processors like Intel® Xeon™ processors, and they need to meet NEBS shock and vibration requirements as well as a temperature rating of -40 °C to 55 °C operating (in some environments the requirement may go from -40°C to 85°C).

These solutions are also fan- and filter-less with weather-resistant, high-speed connections through cellular, Wi-Fi and copper or fiber options. Memory requirements are **8-32GB DDR3/4** modules and booting is done through **serial NOR**. Storage can be provided through **microSD** and **SSDs**.

Since products need to withstand vibration and shock, **industrial-grade 2.5-inch SATA SSDs** are ideal for these solutions.

Conclusion

IoT gateways and edge servers are predicted to be a critical element in smart manufacturing deployments. Choosing the right memory and storage solutions that provide application-tailored reliability, quality, performance and longevity will be the key to successful deployments with the best return on investment.

Micron has been a trusted advisor to our embedded customers for over 25 years. We truly understand the unique needs of this market and have developed deep application-level expertise and a portfolio designed with that in mind. Most importantly, we bring to the market a mindset to deliver sustainable value to our customers—because we firmly believe that IQ Matters in our customers' success.

Learn more at www.micron.com/embedded.

Introducing the Industrial Quotient: the new "IQ" needed for success in Industrial Internet of Things

M500IT Automotive and Industrial SSD product brief

Micron's Industrial Quotient (IQ) is all about making intelligent choices for your industrial product design that not only help you meet functional product requirements, but also ensure the long-term reliability and quality of your designs in a wide range of rugged/industrial use cases — while keeping the product life cycle management simple.

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