



Predictive Asset Maintenance with Edge Compute

Asset Disruption Impacts Business

Outages or other operational disruptions in manufacturing, logistics, industrial, transportation, oil & gas, construction, rail, aviation, healthcare or utility industries create margin and revenue pressures within an environment of regulatory constraint. Challenges with managing assets that are diverse, complex, and spread over large geographical areas are coupled with trying to balance spending either too much on preventative maintenance or not enough before corrective maintenance or even a catastrophic failure. Asset tracking and maintenance now require predictive and cognitive capabilities to ensure optimal asset lifecycles and efficient

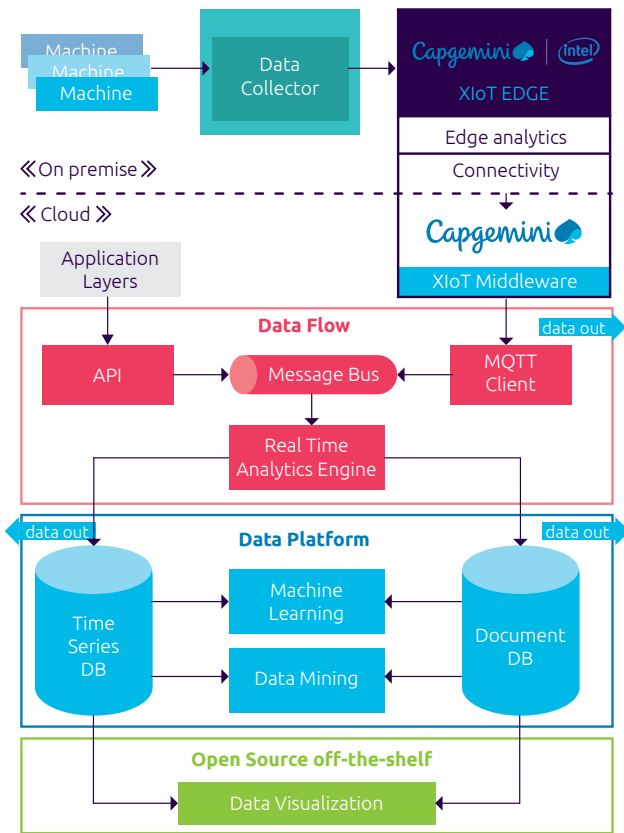
operations that positively impact the bottom line. As a result, asset-intensive industries have accelerated their adoption of IoT as a means to both collect new and additional operational data and enable improved predictive asset management through deeper data analysis, and Gartner predicts by 2022, that spending on IoT-enabled predictive maintenance will increase to \$12.9 billion, up from \$3.4 billion in 2018. Improving operational efficiencies through predictive asset maintenance has led to substantial savings of up to 40% reduction in maintenance costs in some cases.¹

Capgemini solution for quicker response at the edge

Capgemini's Predictive Asset Maintenance solution addresses these industry issues and intelligently monitors assets, aggregates machine behavior data sent from each asset at the edge using powerful Intel based technology, analyzes it, and recommends precise responses and actions, predicting when a machine or device failure might occur or when maintenance is required. The solution centrally

tracks an asset in near real time, applies predictive and pre-emptive models, and continually integrates IT-OT across the asset management value chain, sending notifications and tying in field service management actions. The solution reports machine conditions to field personnel who can take appropriate actions based on text message or email notifications and alerts.

Figure 1: Predictive Maintenance Solution



Connectivity - Connects assets/machine PLC to monitor performance in near real time.

Monitoring and alerts – The “Data flow” module machine monitor activates alerts when thresholds are exceeded or during non-compliant operation to trigger first level predictive maintenance

Smart, predictive and cognitive supervision - The “Data platform” module calculation engine and dedicated database provide advanced monitoring functionalities using advanced methods such as drift anticipation and machine learning based on statistical exploitation of CMMS operation and maintenance reports

Visualization – Offers customizable and personalized dashboard modules for desktops, tablets or smartphones

Predictive Asset Maintenance Analyzes More Data More Extensively to Provide More Insights and Targeted Actions

How does the solution work?

- For each machine, sensors connect to a single Intel based gateway using USB or 100MbE, which is connected directly to the cloud
- Running on the edge device, software recovers data at regular intervals from each machine’s Programmable Logic Controller [PLC] or internal computer
- Analytics are performed locally at the edge to limit the data bandwidth burden passed to the cloud, and local storage is used for backup in case of a network shutdown
- The XIoT platform streams data securely in real time between the plant and cloud
- The solution continuously monitors machine data / exceeded thresholds, and uses predictive/cognitive algorithms to create smart monitoring alerts via texts or emails to management and field personnel

- The solution uses Intel hardware to provide compute intelligence and hardware-level security at the edge.
- A dashboard allows users to query, visualize, and understand metrics no matter where they are stored

Special features include a time series data lake which records massive amounts of sensor data and tracks real time trending data. The solution’s computation engine performs computations on highly sampled raw data by taking sensor data from each asset and predicting breakdowns. The engine algorithms track trends, measure health and visualize the real time results on the dashboard. Field service automation is added based on specific alerts sent via email or text message. Additional cognitive capability can be added to pinpoint which part of which machine is destined to fail and in what time period. This cognitive capability requires massive amounts of historical data from multiple machines and locations in the ecosystem.

Predictive Asset Maintenance Solution Benefits

1. Reduces unscheduled production stops (breakdowns) - The system detects machine behavior deviation trends and optimizes production and asset maintenance costs
2. Minimizes financial and safety risks by avoiding equipment failure, anticipates breakdowns and determines their root causes, and provides enhanced asset performance
3. Interacts with maintenance operators and field service personnel in near real time
4. The XIoT open platform connects any device, is highly scalable, enables rapid device deployment, supports organic or any partner edge and cloud analytics, delivers advanced security at scale, is deployed As-A-Service model, and supports any type of IoT application in any vertical sector
5. Decreases time for intervention and diagnosis - The solution detects drifts, thresholds and non-compliant behaviors to enable quick intervention at the right place
6. Characterizes maintenance efficiency, and improves processes and methods by predicting intervention duration and needed spare parts
7. Ensures proper machine operation inside range of optimal efficiency and fatigue - Ensures machine settings are compliant and manages operator adjustments
8. Uses machine event history and data recording to capitalize knowledge and experimental scenarios as a valuable and historical data source
9. Asset lifecycle - Uses factual indicators and deep and precise asset knowledge to improve decision-making about useful life and retirement

Customer Success

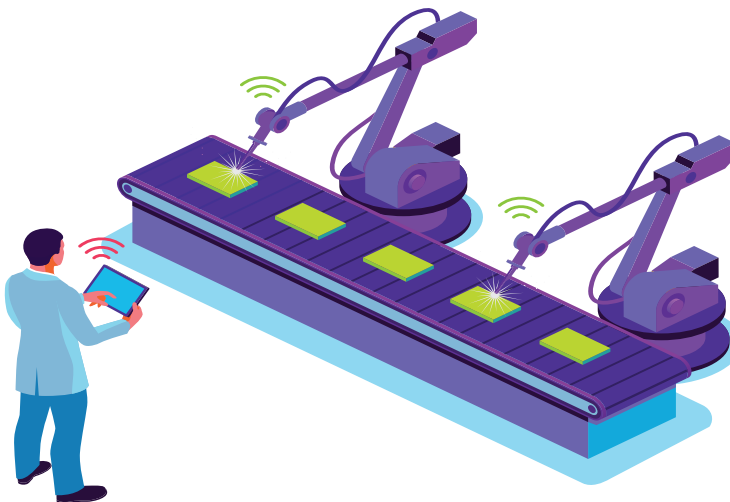
A major European aircraft and airline supplier experienced an extended machine outage due to machine spindle issues, whereby replacing the spindle did not fix the issue. After two months of trial and error, the company determined the issue was due to an electrical problem. They wanted to fix future incidents like this, and improve operations, performance and availability for their programmable milling machines. The manufacturer requirements included:

- Connecting machines to make data available for Industry 4.0, and validate connectivity for different machine types
- Improving machine repair/maintenance operations (primarily spindle).
- Evolving its operations from full preventive maintenance to condition based maintenance

Capgemini worked with the company to provide an end to end predictive maintenance solution and to confirm Proof of Value. The solution connected several kinds of machines and scaled to add new machines, and delivered customized analytics to reduce maintenance costs and improve worker productivity with condition based maintenance, predictive maintenance, monitoring and dashboarding

Providing near real-time interaction between the application, management and field service end users, the solution detects deviation from steady state operations, determines operational abnormalities and sends alerts to notify end users about machine troubles and estimated time of failures, dispatching automated work orders to field personnel.

Fine-tuning settings to prevent false alerts through built-in machine learning continuously evolves the solution to improve performance and asset life.



Predictive Asset Maintenance Delivers Results

Capgemini's Predictive Asset Maintenance solution improves production capabilities and extends service life. The solution will help solve future machine issues quickly because each machine is continually monitored. Solution connectivity

will also allow deployment of new services by leveraging automatic, ubiquitous and comprehensive reporting, recording and maintaining accurate historical data for machine learning, and process improvement.

Figure 2: Predictive Asset Maintenance End to End Architecture

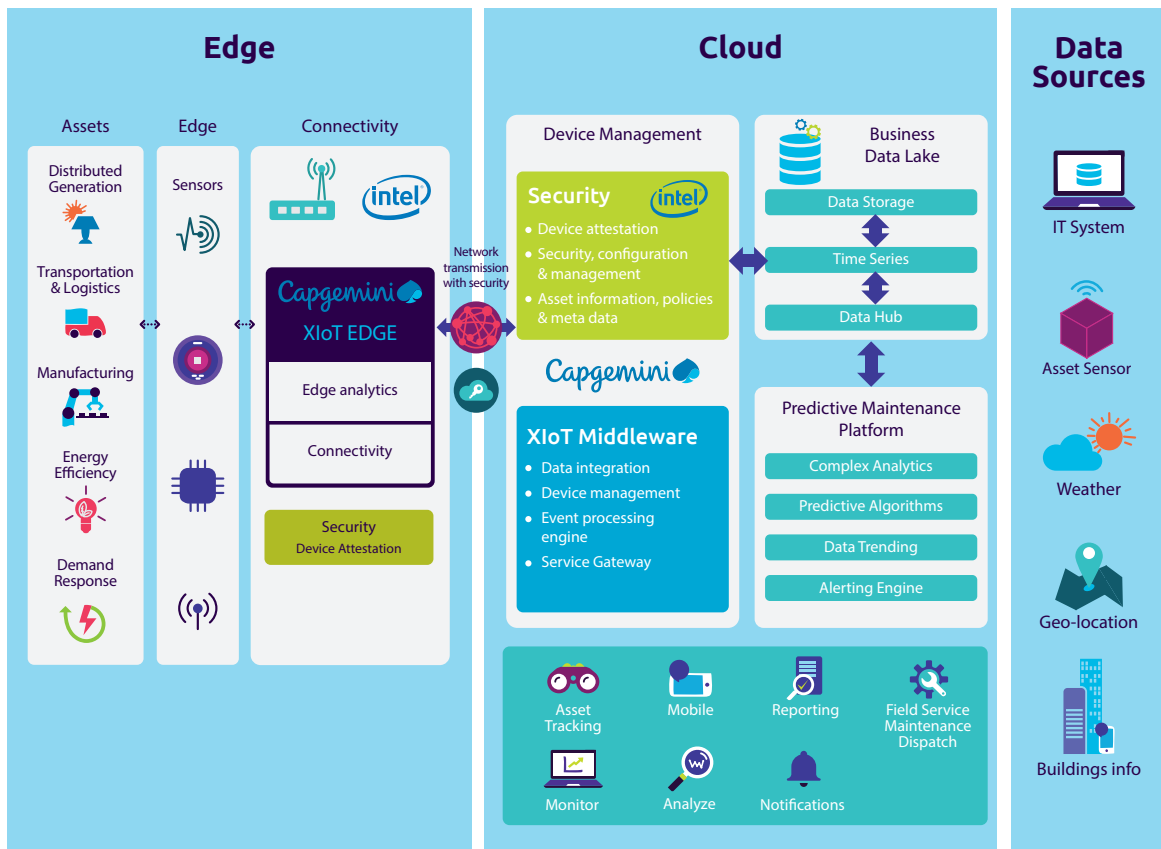


Figure 3: Machine Behavior – A Summary Dashboard displays real time contextual data such as ambient conditions, product consumption rates, spindle location and other performance measurements

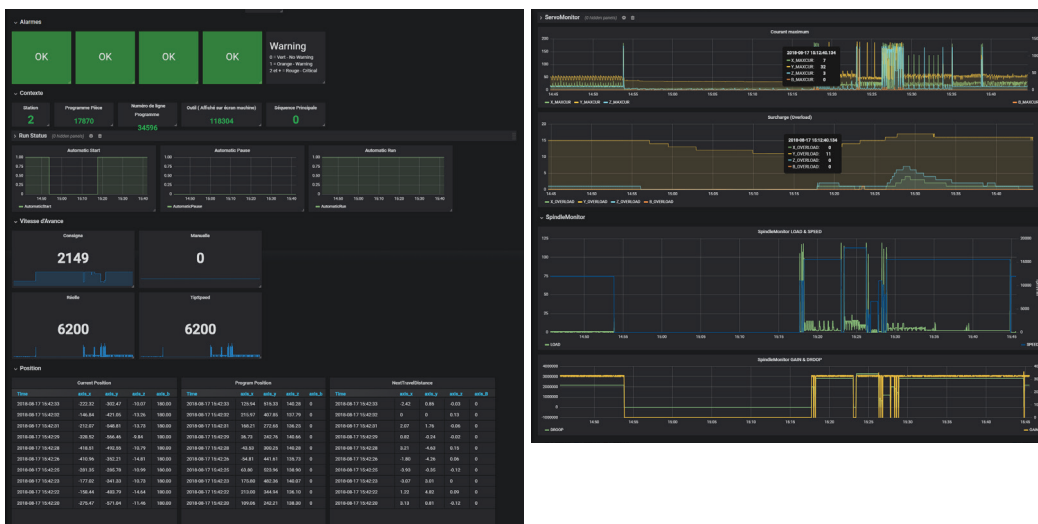


Figure 4: Identifies issues and provides additional focus - *Sensors and gateway monitor real time vibration inside the compliant range, notifying managers of deviation/out of range conditions beyond normal operations*



The solution uses Intel server processors and gateways/NUC hardware to provide compute intelligence and hardware-level security at the edge.

Capgemini's Best in Class XIoT Platform

Capgemini's Predictive Asset Maintenance solution runs on a world class security accredited XIoT platform that leverages Intel® architecture and Intel® IoT Gateways that live at the edge of the end-customer network. The IoT gateways connect sensors embedded in tracked assets to the public cloud, which hosts the Capgemini XIoT platform and the asset monitoring and predictive maintenance applications.

Best-in-Class Data Security:

The XIoT is the only if not one of the first security accredited IoT platforms that provide end-to-end data security from edge devices to the cloud. Security is managed at each level in the architecture. XIoT is one of the first comprehensive security certified IoT solutions (Edge to cloud) available in the market that's flexible to specific needs across IoT enabled industries

Scalability, Agility, and Innovation:

The XIoT platform architecture is based on standardized and open IoT reference architectures. It is capable of connecting millions of assets across the globe. With a defined, repeatable foundation for device connectivity, edge-to-cloud data delivery, and reduced complexity, customers can scale and grow the solution for business agility and continue to innovate on a future-proof platform.

Flexibility and Accelerated Time-to-Value:

The XIoT platform can host analytics from any source and provides purpose-built accelerators that overcome the barriers of cost and complexity to increase the time-to-value. The XIoT platform offers flexibility to integrate third party components and choose from a myriad of major cloud service providers. The platform is modular to easily integrate separate components such as analytics or big data providers. XIoT can be deployed on a private, hybrid or public cloud.

Integrated Pricing Model:

The XIoT platform bundles hardware, internet-based applications, and systems integration services and sells the entire solution as a single package. Clients don't have to pay an up-front fee to access the platform.

Value-added Digital Services:

Predictive Asset Maintenance and Intelligent Asset Monitoring solutions, both end-to-end offerings, feature more than just the XIoT platform advantages. These solutions also offer cloud-connected digital services that help fully integrate the system across your business processes and maintenance organization.

End-to-end IoT services:

With our end-to-end IoT services, we guide you through every step of your journey to digital transformation excellence in asset optimization. Our repertoire of services includes IoT strategy, innovation portfolio management, solution design and delivery, rapid concept and design prototyping, and global deployment. With Capgemini and Intel, you can be confident in choosing solutions that are efficient, security-accredited, and focused on driving business outcomes that keep you ahead of your competition.



IoT Solutions
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About Capgemini

A global leader in consulting, technology services and digital transformation, Capgemini is at the forefront of innovation to address the entire breadth of clients' opportunities in the evolving world of cloud, digital and platforms. Building on its strong 50-year heritage and deep industry-specific expertise, Capgemini enables organizations to realize their business ambitions through an array of services from strategy to operations. Capgemini is driven by the conviction that the business value of technology comes from and through people. It is a multicultural company of over 200,000 team members in more than 40 countries. The Group reported 2018 global revenues of EUR 13.2 billion.

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