HIVEMQ

Optimizing Global Operations and Supply Chain for Automotive Manufacturing using MQTT Sparkplug

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BusinessWire projects the global automotive manufacturing market to reach 1,775.41 billion USD by 2027 rising from 1,424.02 billion USD in 2021 (a CAGR 3.74%) The same report states that the Americas will hold 23% of that market share. AMS & ABB automotive manufacturing outlook survey 2022 results found that supply chain disruptions, which include rising raw material costs, parts shortage, and inventory unpredictability, were perceived as the main challenge affecting the growth of automotive manufacturing.

COVID-19 and the ensuing chip shortages severely hampered the automotive manufacturing industry over the past couple of years. Additional complexities caused by environmentally conscious customers and the government initiatives to reduce emissions by pushing for vehicle electrification didn't help. While in the short term, hybrid vehicles will continue to dominate; it seems clear that the industry is moving towards purely electric models. Electric vehicle (EV) manufacturing will impact OEM assembly plants and the Tier 1 and 2 suppliers.

All of these factors have accelerated the digital transformation journey amongst automotive manufacturing OEMs, Tier 1 and Tier 2 suppliers. Industry 4.0 and Industrial IoT will allow machine builders and integrators to equip their manufacturing lines with low-cost sensors that stream data to the enterprise or cloud for analysis. This analysis enables the tracking of the performance of operations right down to the component level. Combining this data with a digital twin of the factories allows operations to build an accurate representation of the process that helps problem resolution, continuous improvement, remote visualization, flexible planning, and change management. These would also enable global visibility into supply chains and electrification.

Over the years, the automotive manufacturing industry has invested heavily in enterprise systems, automation, and advanced product technologies. Automotive manufacturers are realizing ROI on their investment and refining their manufacturing processes by beginning to embrace IIoT. In addition, they are starting to measure the success of digitization initiatives which validates their efforts and helps them see the ROI of their investments. This whitepaper explores how IIoT in general and more specifically MQTT, Sparkplug are enabling the automotive manufacturing industry to help improve their worldwide operational efficiency, reduce supply chain disruptions and enable their push towards electrification.

How IIoT is Improving Automotive Manufacturing

The automotive industry, including manufacturing, is experiencing heightened regulatory scrutiny both in the US and globally, especially with the added complexities of electrification. This scrutiny is occurring in several areas, including quality control activities around manufacturing operations, materials used for manufacturing, and driver safety.

IIoT technology is making it possible to automate Automotive Manufacturing operations, optimize supply chains and enable digitized quality management. With the help of smart sensors and advanced gateways, companies can easily monitor the performance of a system in real time, automatically adjust parameters for optimum industrial efficiency, and ensure better productivity at all stages.

Some of the ways IIoT is benefitting Automotive Manufacturing include:

1. Getting access to real-time visibility of operations throughout the manufacturing process right from supply chain to production to distribution is key especially with trends like electrification, and lighter auto body materials becoming prevalent.
2. Allowing for modular automation in a manufacturing plant, helping to scale automotive production per market demands. This is important as the need to make cheaper, fuel-efficient, and feature-rich vehicles in different configurations continue to increase.
3. Identifying bottlenecks among several processes within a plant, while also indicating equipment utilization, which increases machine efficiency, reduces replacement costs, and increases productivity of the automotive plant.

4. Enabling faster, continuous, and feasible data collection from several processes in a manufacturing plant required for quality control and reporting purposes.
5. Powering the latest manufacturing best practices like additive manufacturing, and mass customization through advanced data processing and analytics.

How MQTT Addresses Connectivity Challenges in Automotive Manufacturing

The first step towards successfully implementing IIoT in Automotive Manufacturing is to establish connections to manufacturing machines, processes, databases, applications and supply chains to make the data available to the enterprise data center in a secure, scalable, and reliable way. However, data connectivity and availability is a big challenge for the following reasons:

1. Disparate systems from different vendors that can't natively talk to each other due to proprietary communication protocols.
2. Legacy infrastructure that requires updating.
3. Manual processes that only experienced technicians understand pose bottleneck challenges, especially for regulatory reporting.
4. Connectivity silos in different sections of the factory floor make it challenging to move data.

Automotive Manufacturing companies need a solution to consistently overcome these connectivity challenges and bring their IIoT together to reap the benefits. MQTT is a lightweight publish/subscribe-based protocol created to overcome such connectivity challenges by:

1. Establishing MQTT clients that can talk to proprietary systems and then consolidate data to a centralized MQTT broker on-premise or in the cloud.
2. Connecting to existing infrastructure, creating a standard data layer, and pushing data to make it available to any cloud or enterprise system.
3. Moving data in poor connectivity or harsh environmental situations.

Here are some of the advantages of using MQTT in Automotive Manufacturing:

1. With MQTT, all messages are published to a central MQTT broker, and all MQTT clients connect to the broker, subscribe to specific topics and receive updates. This broker serves as the 'single source of truth.'
2. Decoupling of data through the broker that MQTT offers provides a significant advantage when it comes to creating and managing new assets.
3. The publish/subscribe technology on which MQTT is based works much better than the poll/response that OPC UA or other protocols use, especially regarding reducing network latency and cellular costs.
4. The smaller and more efficient message sizes of MQTT packets help to reduce network bandwidth usage and costs.

HiveMQ: An Enterprise MQTT Platform for Optimizing Supply Chain and Enhancing Quality Compliance

HiveMQ is an MQTT-based messaging platform designed for fast, efficient, and reliable data movement between manufacturing machines, processes, applications, and supply chain components to enterprise data locations on-premises or in the cloud. Adopting the HiveMQ broker enables customers to optimize the supply chain and automate the creation of quality reports for optimizing manufacturing machines, processes, and regulatory reporting.

HiveMQ provides the following features to power bidirectional data movement in Automotive Manufacturing, thus enabling Industry 4.0 and IIoT:

Reliability: HiveMQ supports MQTT's three quality of service (QoS) levels to control whether a message is sent at most once, at least once, or exactly once. This makes it possible to establish reliability rules for specific messages to help improve automotive manufacturing quality.

Security: HiveMQ ensures the secure transfer of IIoT asset data with industry standards such as TLS, secure WebSockets, and state-of-the-art cipher suites. Support for authentication and authorization includes X.509 certs, username/password, IP-based authentication, and an API

that allows for custom authentication, authorization, and permission logic, such as OAuth 2.0 integration. This ensures highly secure connections between factory systems and 3rd party systems to enable the automotive manufacturing supply chain.

The HiveMQ Enterprise Security Extension (ESE) makes it easy to integrate third-party enterprise security systems into HiveMQ, including support for authentication and authorization using SQL databases, OAuth 2.0, and LDAP. ESE also supports:

- Pre-processing of authentication and authorization data from MQTT clients and x509 client certificates
- A structured access log for tracking security-related device information
- Fine-grained authorization rules to specify permissions for specific clients or a group of clients
- Access control for the HiveMQ Control Center

Scalability: HiveMQ scales with underlying hardware. The non-blocking, multi-threaded approach allows more than 20,000,000 concurrent device connections across multiple locations]worldwide while maintaining high-speed throughput and adding minimal latency. This is especially useful to ensure data is transferred quickly when automotive factory legacy equipment has inefficient data bandwidths. This is also useful when data needs to be brought from automotive manufacturing factories and machines worldwide efficiently into one centralized location for advanced reporting and analytics.

High-Availability Clustering: HiveMQ is architected with a distributed and masterless cluster architecture, which means there is no single point of failure, and the cluster can grow and shrink at runtime without losing data or availability. Support for Kubernetes, OpenShift, and cloud platforms like Azure, AWS, and Google, makes it possible to automatically scale HiveMQ to high availability requirements of Automotive Manufacturing plants and reduce disruptions.

Extension Framework: HiveMQ has an open API and flexible extension framework that enables integrating automotive manufacturing IIoT machine, process, application, and supply chain data into existing enterprise systems. The extension framework allows developers to quickly create extensions for custom data processing, device authentication, and device authorization mechanisms. HiveMQ also provides a marketplace of pre-built extensions for Kafka, MongoDB, and other systems.

The HiveMQ Enterprise Extension for Kafka is particularly interesting for streaming automotive manufacturing data analytics. Apache Kafka is a popular open-source streaming platform that shares data between back-end systems and applications. The HiveMQ extension solves the difficulty of using Kafka for IIoT by seamlessly integrating MQTT messages into the Kafka messaging flow.

Full support of MQTT 5: HiveMQ provides full support for MQTT 5, the most recent version of the MQTT protocol. MQTT 5 includes new features that make it easier to develop reliable systems and integrate the MQTT data into other systems and is the preferred choice for Automotive Manufacturing applications.

HiveMQ is 100% compliant with all versions of the MQTT specification. MQTT 3 and MQTT 5 clients can communicate with HiveMQ simultaneously. All features, such as topic wildcards, persistent sessions with offline queuing, retained messages, and quality of service levels, are available at scale.

Sparkplug Adds Additional Data Context to Automotive Manufacturing

MQTT is designed to push data to and from thousands of remote devices across numerous sites to the enterprise. Sparkplug is a new open-source software specification that sits on top to add context to the data, thus extending use cases. Sparkplug provides MQTT clients with a framework to integrate data and provide context by defining data models. HiveMQ is fully Sparkplug compliant.

In the Sparkplug architecture, devices, EoN (Edge of Network) nodes, and the SCADA/IIoT hosts connect to a central MQTT broker to publish and subscribe to data. The SCADA/IIoT host is the central application that Automotive system operators use to remotely manage and monitor the overall state of the Automotive Manufacturing systems. The advantage here is that, unlike a traditional SCADA system, the

SCADA/IoT host is not responsible for directly establishing or maintaining device connections. That is managed by EoN nodes used to connect legacy infrastructures. Devices and sensors collect data and pass it on to the upper layers. MQTT applications, or secondary applications, participate in Sparkplug communication and can generate and process MQTT messages.

Automotive Manufacturing IIoT Use Case Reference Architectures

Here are common architectures for global operations and supply chain optimization seen in Automotive Manufacturing:

Use Case 1: Auto global operations optimization
Automotive Manufacturing operations are typically global in nature. They produce products or parts at multiple global locations which then need to come together. They usually have standardized scorecards with key performance indicators (KPIs) for different factories through which they track efficiencies and monitor performance. They need all this to be centralized. They typically use HiveMQ brokers in each location to consolidate the data from each factory and have that bridged into a central enterprise location where they can be analyzed or monitored.

There are two significant advantages to using a HiveMQ Broker in this scenario. The first is that it provides a very scalable solution that load balances the control data from different systems in remote locations, worldwide. Secondly, it offers tools that securely pass that data into the enterprise location through the bridge extension without complex networking.

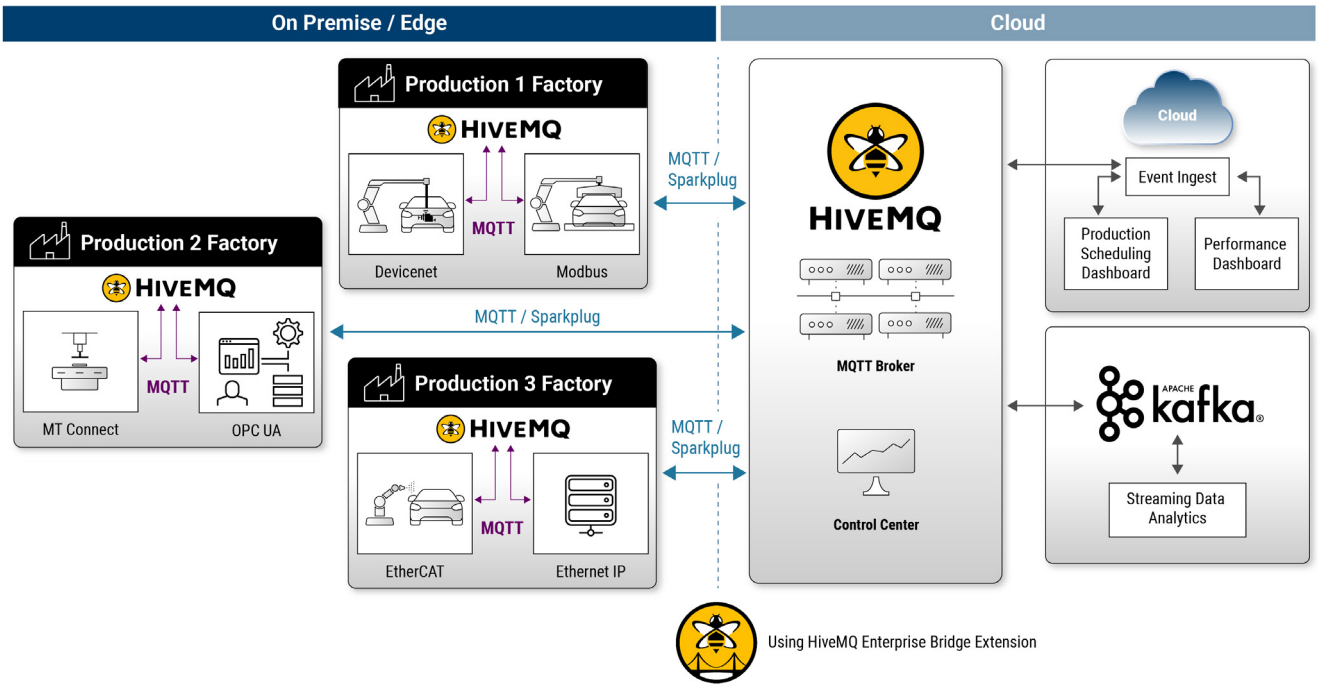

Figure 1: Use Case 1 - Auto Global operations optimization

Use Case 2: Auto Supply Chain Optimization

The Automotive industry, like many other manufacturing industries, was hit hard by supply chain disruptions, especially with the chip shortages. Based on that, automotive supply chain managers want to trigger necessary workflows from a centralized location based on leading indicators derived from sourcing, supplier inventory, and shipping. Global supply chain performance data flows through the HiveMQ Broker to the cloud provider's infrastructure, where it is ingested and then analyzed or monitored.

In this use case, the HiveMQ Broker is highly scalable and balances the load of the control data and process data being received from various locations. In addition, it provides highly secure communication between HiveMQ and the remote systems or cloud with features like TLS/SSL support, OAuth 2.0, X.509 certificates, and similar features . This ensures the secure transmission of data, especially from external systems.

Conclusion

Many Automotive Manufacturing organizations are digitizing their operations, and IIoT technologies are at the forefront. This push to digitize and enable IIoT comes with challenges, including unreliable networks, legacy infrastructure, costly bandwidth, inefficient protocols, and complex systems. The MQTT protocol addresses all these challenges and provides a simple and reliable way to connect to various systems and bring data to the enterprise.

The HiveMQ Enterprise MQTT broker is the platform best suited to enable Automotive Manufacturing supply chain optimization and regulatory reporting due to its performance scaling capabilities, implementation of all MQTT 5 features, and professional support services. In addition to MQTT, Sparkplug provides additional benefits to Automotive Manufacturing companies by enabling mission-critical, real-time OT operations.

Contact us to discuss how the HiveMQ enterprise MQTT platform can help solve your connectivity needs securely and reliably, enabling your IIoT and digital transformation journey.

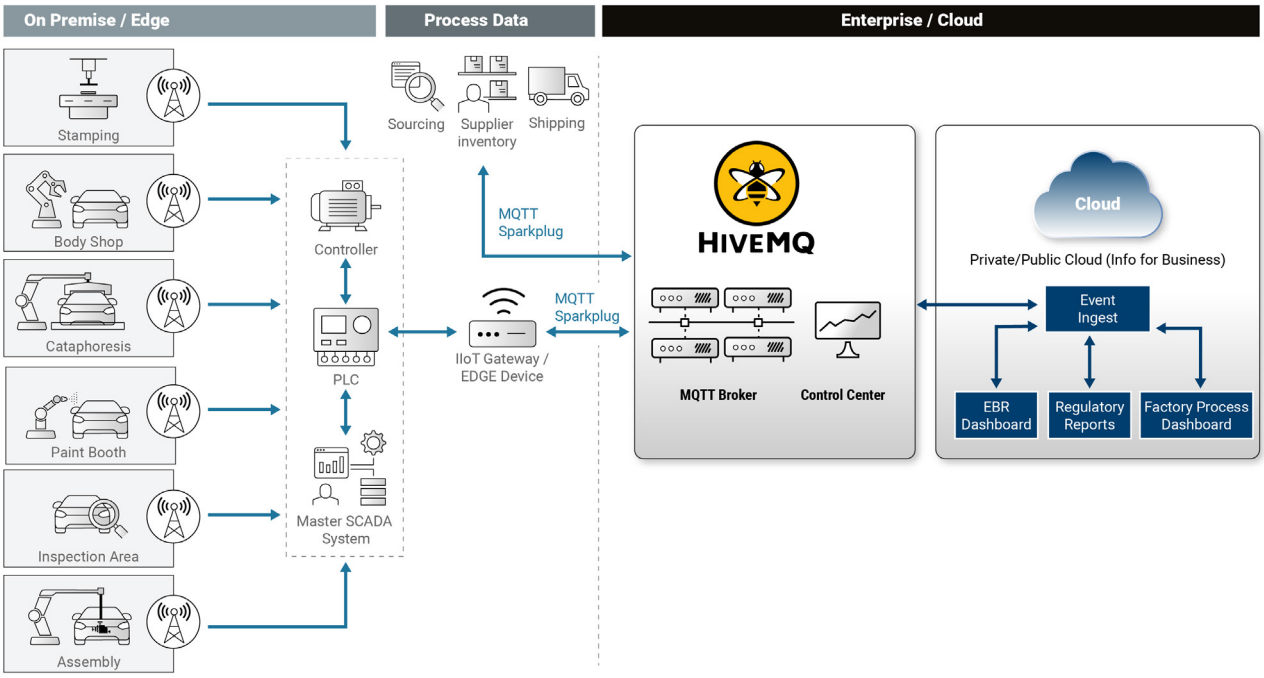

Figure 2: Use Case 2 - Auto Supply Chain Optimization

Partners in Optimizing Automotive Manufacturing Needs

HiveMQ provides the data platform to support supply chain management, regulatory reporting, process optimization, and quality management in a secure and reliable way. Contact us to discuss how the HiveMQ enterprise MQTT platform can help optimize your automotive manufacturing needs.

Contact Us

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