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Unlocking IoT Potential: How MQTT Revolutionizes Device Communication

What Manufacturing Technology Leaders Need to Know

SAFEGUARDING PEOPLE, PLACES & THE PLANET.

In the ever-evolving world of the Internet of Things *(IoT)* and Industrial IoT, the MQTT *(MQ Telemetry Transport)* protocol has emerged as a pivotal technology.

Originally developed for use to facilitate communication with supervisory control and data acquisition *(SCADA)* systems within the oil and gas sector, MQTT is fast becoming the backbone for IoT devices worldwide.

The purpose of this white paper is to help system integrators and manufacturing technology leaders understand how MQTT can address IoT/IIoT challenges while enabling more streamlined and intelligent management of interconnected systems.

MQTT 101

What is MQTT?

Invented and co-designed by Andy Stanford-Clark for IBM in 1999 and published in 2001, MQTT, formerly known as Message Queuing Telemetry Transport, is a small-format communication protocol designed for the efficient transmission of data between embedded devices and sensors and the enterprise.

In a 2021 episode of the IBM Developer podcast, Stanford-Clark explained MQTT's origin:

> *It's really extending the idea of enterprise messaging outside the walls of the enterprise to reach down to what were then called SCADA devices; devices in the field that were gathering data from things like oil and gas pipelines and electricity substations and so on and send that data back into the enterprise to be part of the situational awareness and the business context of the enterprise. We needed a cut-down version of, effectively, enterprise messaging.*

Back then, MQTT was developed to help reduce reliance on costly satellite communications, providing the oil and gas industry with an efficient and cost-effective way to monitor devices and transmit data to their servers.

It's important to understand that MQTT was designed with minimalism in mind—the goal was to create the simplest possible protocol that could reliably ensure messages were sent and received.

An IoT Player

Since becoming an open standard nearly a decade ago, MQTT has primarily facilitated machine-to-machine (M2M) communication across various industries.

Here's how Stanford-Clark explained it on a 2019 episode of the Inductive Conversations podcast:

> *It's designed to be very lightweight, in the sense that it's very easy to implement on small devices, and it's very light on the networks. So, it's non-chatty, and it uses very small messages as far as possible to do its thing. You can think of it as a bit like a postal service. You package up your parcel, wrap it in brown paper, stick an address on it, and sent it into the postal service, and they deliver it from A to B for you. You don't need to worry about exactly how it gets there. You just worry about what will you send, and what will you do with it when it gets there. That's what MQTT does for you. It will take your data. It doesn't care what you send. Payload agnostic, as we say, and it sends it off from A to B, and then B knows what to do with it when it gets there.*

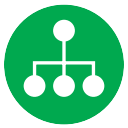
MQTT worked so well that for the first 10 years since being published the protocol remained unchanged. Then in 2013, MQTT became an open-source standard under the management of OASIS *(Organization for the Advancement of Structured Information Standards)*, which still manages the protocol today.

MQTT's Role in IoT

IoT and IIoT technologies have advanced at an unprecedented pace. MQTT has been a key enabler in the expansion and management of connected ecosystems across industries.

Its ability to support vast networks of devices reliably, efficiently, and securely has made it essential for communication in today's IoT/IIoT applications—and for the innovations of tomorrow.

Here's a high-level look at this flexible and widely adopted protocol, now embedded in solutions and hardware used across industries ranging from healthcare, agriculture, manufacturing, and more.



Pub/Sub Transport Protocol

MQTT is a lightweight protocol based on the publish/subscribe model, using a broker to route messages between publishing and subscribing devices.

Event Driven

MQTT minimizes data transfer, publishing only when there's information to send.

Undefined Payload Format

MQTT does not have an industry-standard payload, which means that device manufacturers like MSA can define their own.

Bi-Directional

MQTT enables data to flow to and from devices over a single TCP connection.

High Latency/Low Bandwidth

MQTT performs exceptionally well in transmitting data within resource-constrained, low-bandwidth environments.

Pros and Cons of MQTT in IoT Applications

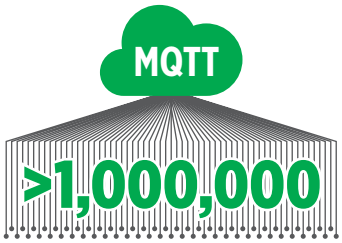
MQTT has overtaken HTTP as the most widely used protocol for IoT devices on the internet. It is also the primary protocol supported by major IoT platforms, including IBM, Amazon, and Microsoft. While MQTT is an excellent protocol and well-suited for IIoT applications, it's not without limitations.

Here's a look at the many advantages of MQTT, as well as a few potential drawbacks of this popular protocol.

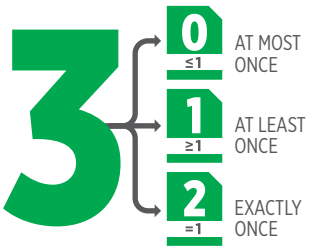
Advantages	Potential Disadvantages
Lightweight: With its small code footprint and low overhead, MQTT was designed for implementation on small devices and limited-resource networks.	**Lacks Advanced Features:** MQTT's inherent simplicity means it can't perform some advanced functions, such as message ordering, expiration, or built-in error handling.
Reliable: MQTT message delivery is highly reliable, thanks to the support of three quality of service (QoS) levels: at most once (0), at least once (1), and exactly once (2).	**May Lack Real-Time Communication:** While designed to operate with less bandwidth, intermittent or unstable connectivity can prevent MQTT from facilitating real-time communication.
Secure: MQTT supports TLS/SSL encryption and authentication mechanisms.	**Lack of Built-In Security:** MQTT does not have out-of-the-box security, relying, instead on network security (TLS/SSL).
Simple Broadcasting: MQTT's bi-directional capabilities enable messaging between devices to the Cloud and the Cloud to devices.	**Bi-Directional Limitations:** MQTT cannot, by itself, enable multiple device communication.
Topic Based: MQTT's publish/subscribe model allows users to subscribe to a topic or topics and receive only those specific messages.	**Downtime Disruptions:** MQTT's reliance on a central broker can be problematic if it goes offline.
Scalable: MQTT has the ability to connect with millions of IoT devices.	**Horizontal Scalability Challenges:** Scaling MQTT horizontally may require additional infrastructure.

MQTT Fast Facts

SIZE OF A MINIMAL
MQTT CONTROL MESSAGE



NUMBER OF DEVICES MQTT
CAN SCALE TO



QUALITIES OF SERVICE
FOR RELIABILITY

Where FieldServer Gateways Fit In

In manufacturing, success depends on staying ahead of the competition. And with the rapid pace of technological change, "business as usual" just doesn't cut it anymore. Instead, manufacturers should seize every opportunity to automate more effectively and produce more efficiently.

For example, let's say you want to reduce your facility's energy consumption by 11%. You can't change what you don't measure. FieldServer gateways help enable you to access, monitor, and manage the sensors and devices controlling temperature, humidity, and other aspects of your HVAC system. It also aggregates and analyzes energy data to help you implement energy-saving strategies and cut costs.

FieldServer IIoT-enabled gateways and cloud solutions help you do exactly that. These solutions empower manufacturers with real-time insights into the performance of their devices, equipment, and sensors. With faster, data-informed decision-making, you'll unlock the benefits of a more efficient and profitable operation—fewer safety issues, greater uptime, and improved quality control.

Are you leveraging MQTT in your IoT environment? If not, what impact could it make on your operations?

Learn more about MSA FieldServer solutions at *MSAsafety.com/fieldserver*

About MSA FieldServer

MSA FieldServer gateways deliver IIoT solutions that supports more than 140 protocols, as well as Cloud connectivity. Our products, technologies, and solutions provide original equipment manufacturers (OEMs) and system integrators with cost-effective, secure solutions to drive both the efficiency of industrial and manufacturing automation systems, as well as support sustainability initiatives.

We can help you seamlessly connect virtually any device to any system—including IIoT and Industry 4.0 networks and systems—empowering you to take control of your automation systems to optimize automation, processes, and predictive maintenance.

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