DIGITAL TRANSFORMATION

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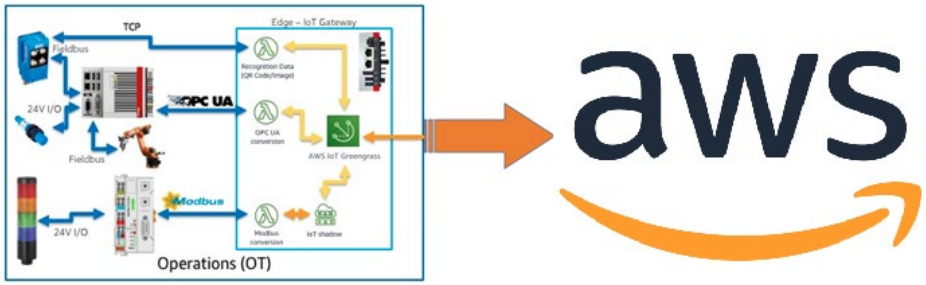
LOCAL ARCHITECTURE

AWS IoT Greengrass Core is an open-source, lightweight runtime for Internet of Things devices that can run on any edge device based on Linux or Windows and communicate with AWS cloud services. This runtime enables the development, deployment, and management of a range of IoT functions, such as data gathering, processing, modeling, analysis, machine learning, case predictions, anomaly detections, and more.

Each edge device subscribed to the cloud model will receive data streams as they are published, without the need to wait for a file document like JSON to accumulate. This leads to improved data accessibility and faster response times for processing analytics and machine learning tools. The creation of a digital twin based on such data streams requires less effort compared to traditional methods, which involve creating a 3D virtual representation and comparing it to real-world data.

In the context of manufacturing, there is a significant amount of data collected from various equipment and processes, and the ability to stream this data in is a major advantage. With AWS, processing big data from multiple sources is not a challenge. The data can be processed in pipelines, where AI/ML algorithms can be applied to gain deeper insights into the metrics, regardless of the data formats or sizes. This platform-agnostic approach creates a new way of thinking about processing and analyzing large-scale industrial data, as it increases the availability and relevance of the data.

To extract data streams, an industrial PLC with pre-installed AWS IoT Greengrass Core can collect relevant data from communication



interfaces such as OPC UA, Modbus, Profinet, Ethernet/IP, EtherCAT, and more. In some cases, local IO systems or custom data interfaces may be necessary. Once the data is gathered, it will be pre-filtered and streamed into AWS Cloud Services according to two principles: low-volume data will be transported bi-directionally via MQTT protocol, and high-volume data will be transported via AWS IoT Stream

Manager. To ensure data security, the entire data traffic between the local edge device and cloud services will be encrypted using the Advanced Encryption Standard (AES-256).

CLOUD SERVICES

As outlined previously, manufacturing generates millions of data metrics that can be streamed to the cloud for processing. AWS Web Services provides modern, secure, and efficient handling of such data, offering a range of almost 200 different tools and services to choose from. Here are a few components that are typically used in this process:

MESSAGE BROKERS

AWS IoT Core is a message broker that facilitates the connection of industrial IoT devices to AWS cloud services. This platform offers a variety of features, such as AWS IoT Greengrass component deployments, device shadows, remote actions, fleet management, data encryption, custom routing, and more. Additionally, AWS IoT Core supports the following IoT protocols:

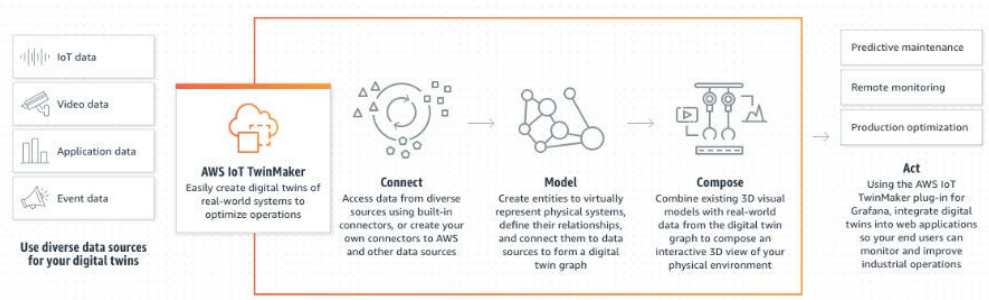
- MQTT (Message Queuing and Telemetry Transport)
- MQTT over WSS (Websockets Secure)
- HTTPS (Hypertext Transfer Protocol - Secure)
- LoRaWAN (Long Range Wide Area Network)

AWS Kinesis Data Stream and Data Firehose are responsible for ingesting and storing data streams from high-volume sources, loading streaming data into data lakes and data stores, and providing real-time analytics tools. These platforms integrate with several common data sources, such as:

- Real-Time Streaming ETL
- Real-Time Log Analytics
- Real-Time IoT Device Monitoring
- Logs, Events and Data Collections
- Mobile Data Collection
- Security Monitoring

DIGITAL TWINS

The AWS IoT TwinMaker offers the necessary resources to construct digital twins, which aid in optimizing building operations, boosting production output, and enhancing equipment performance. By utilizing data from various sources, it generates virtual representations of physical environments and integrates existing 3D models with real-world data. This technology enables the creation of a comprehensive view of manufacturing operations in less time and with minimal effort. The system models equipment, spaces, processes, and systems in a knowledge graph, which is capable of connecting to data from diverse locations. Entities within the digital twin are digital representations of elements that encompass their capabilities, including physical equipment, concepts, and processes. These entities have associated components that provide relevant data and context. One of the most common use cases of this technology is enhancing field operations in manufacturing plants and increasing equipment uptime.



DATA ANALYTICS

AWS IoT Analytics is a fully managed service that simplifies the process of running and implementing sophisticated analytics on massive amounts of IoT data, eliminating the need to be concerned about the typically high cost and complexity involved in developing an IoT analytics platform. This service provides an effortless way to conduct analytics on IoT data, obtain insights, and make better and more informed decisions for machine learning use cases and IoT applications. Through AWS, data can be streamed in to facilitate predictive maintenance analysis, which helps capture the equipment's state. The resulting information aids in identifying potential or upcoming anomalies before they can negatively impact production. By utilizing the platform to monitor and deduce equipment status, health, and performance in real-time, issues can be detected by identifying streaming data, resulting in an extended lifespan for the equipment, a safer environment in the manufacturing plant, and an overall increase in efficiency.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Bridge Automation plans to leverage AWS's ability to containerize models that facilitate various processes such as classification, regression analysis, visual inspection, predictive maintenance, and more. When it comes to storing data in the cloud, subsets of the data are subjected to machine learning, depending on the objective. The data is loaded into ML models as it is received, resulting in the model being trained in real-time, online. This remarkable advantage enables the model to learn more accurately and quickly. Moreover, it is possible to establish connectivity between cloud-based ML models and local edge devices, allowing the device to modify its course of action based on the decision received from the model running on it. This feature would prove highly beneficial in situations where devices need to make time-sensitive changes based on the data they are collecting.

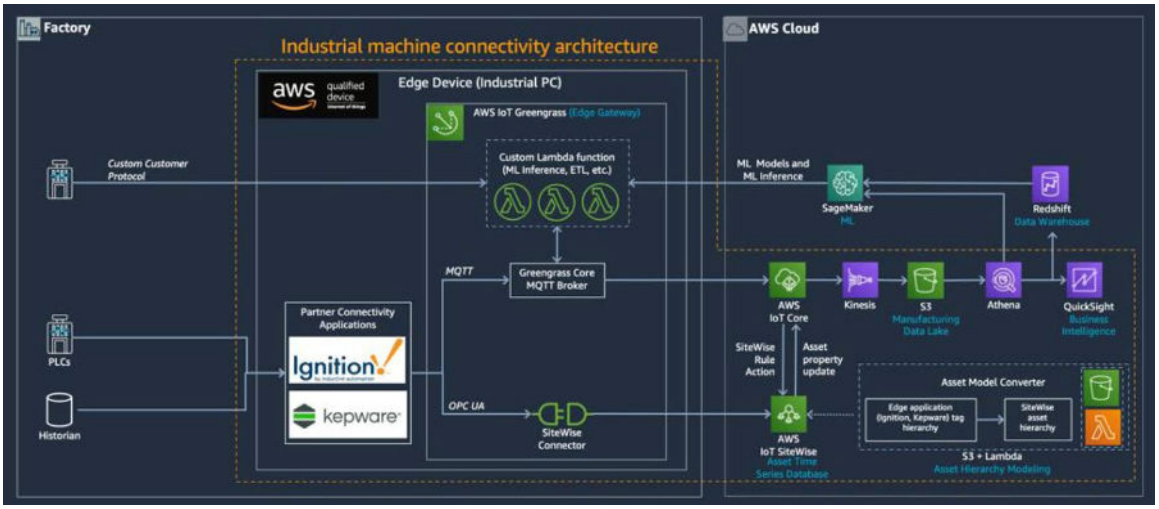
By utilizing AWS IoT SiteWise, data can be reliably gathered from multiple facilities, organized, and made accessible and comprehensible without necessitating additional software development. We can index

and tag information regarding equipment or processes across numerous facilities, rendering it readily available for use in applications. Previously, companies were required to dispatch a technician to diagnose an issue and then send another technician to rectify the problem. However, we can now remotely diagnose an issue and only dispatch technicians when necessary to fix it.

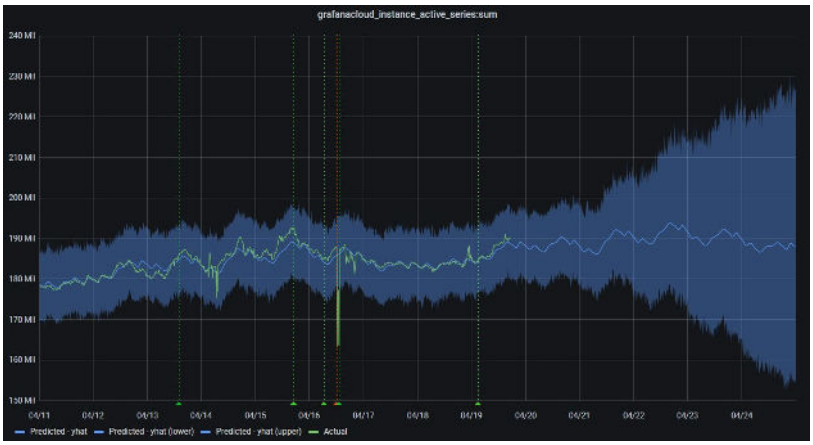
Having visibility across industrial facilities enables streamlining of operations, as well as the identification of production gaps and waste. With IoT SiteWise, models of industrial processes and equipment can be created across multiple facilities, and live and historical asset data can be discovered and visualized automatically using customizable charts and dashboards. SiteWise Monitor provides the ability to launch a web application with customer asset data within minutes using AWS, offering industrial engineers the visibility needed to address issues or spot differences across facilities. SiteWise Monitor also facilitates the creation of a centralized, authoritative source of information that provides a better understanding of operations, improves processes, and reduces waste across the customer organization.

AWS IoT SiteWise provides on-premises software, SiteWise Edge, through AWS IoT Greengrass, that securely connects to and reads data from equipment or local historian databases. By modeling the equipment and environment in the cloud, SiteWise Edge uses the same models locally to maintain consistency across both cloud and on-premise environments, reducing duplication, effort, and development costs. Customers can choose where to use and store data across multiple locations, such as keeping data on-premises for data residency requirements or local edge applications. Data can also be sent to AWS IoT SiteWise or other AWS services in the cloud for additional storage and further analysis. SiteWise Edge allows users like process engineers to visualize equipment data in near real-time on the shop floor, even when connectivity to the cloud is not available. Additionally, AWS Lambda is a serverless, event-driven compute service that enables us to run code for virtually any type of application or backend service without provisioning or managing servers. AWS Lambda functions can be triggered in most AWS services and SaaS applications for various use cases, such as processing data at scale, running interactive web and mobile applications backends, and creating event-driven applications.

Below is an example of the architecture for handling data streams in a factory setting:



FRONT END



The integration of sensor data monitoring has become more efficient and seamless than ever before. By integrating with AWS Grafana Dashboards, end-users can now display business intelligence in the plant and visualize all processes happening in real-time. This example image shows predicted values compared to actual data, with the shaded blue representing the confidence of the model. Bridge Automation can utilize our machine learning technology to send results directly to Grafana as they stream from the cloud. This allows any decline in the performance of Programmable Logic Controllers (PLCs) to be detected before it has a negative impact on production.

In this scenario, the data is collected from the machine and subjected to ETL, following which an analysis is performed to obtain the machine's "health score" and specific metrics that may be contributing to the decline in the score. The ways in which data can be displayed are infinite. To meet the customer's requirements, Bridge Automation can provide a comprehensive front-end customization service.

In addition, we are capable of creating APIs for third-party systems that run on any publicly addressable web service. By using Amazon API Gateway, we can produce customized client SDKs to link back-end systems to server applications, mobile applications, or services on the web. The customer has various

API types to choose from, including HTTP API, WebSocket API, REST API, REST API Private, GraphQL, and Pub/Sub.

CONCLUSION

The AWS Web Services offer an extensive range of services that can revolutionize the manufacturing industry and provide valuable insights to the end-users for effective plant management. These out-of-the-box capabilities enable seamless integration with existing equipment, allowing for secure data extraction and device control, resulting in meaningful insights.

Bridge Automation can serve as a partner to assist in the transformation of manufacturing plants into highly efficient digital facilities, prepared to tackle contemporary challenges. The adoption of AWS Web Services enables the continuous gathering, analysis, and secure handling of data, employing the same technology as Amazon.com.

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