WHITE PAPER

IoT Edge Analytics & Machine Learning for Real-time Device Control

In the Internet of Things (IoT) era, businesses are faced with an increasing demand to instantly respond to an anomaly, fraud, or a potential disaster. Sometimes it becomes mandatory to respond based on the type of device, if it is in a mission-critical or life-saving application, or has a legal or financial impact on businesses. This requires real-time response to the situation, based on the instantaneous sensor data and predictive analysis of historical data.

IoT Edge Analytics and Machine Learning help in achieving this real-time device control with many other benefits.

THINXTREAM®

Introduction

Typical, centralized data analytics systems can analyze and determine the issues causing downtime. However, they cannot do it and respond in real-time. Many IoT devices produce massive amounts of data continuously. Sending this massive data to a centralized data analytics infrastructure (typically in the cloud) and getting processed in the cloud leads to a latency in responding to issues.

In certain situations and IoT device types, we cannot rely on the network connectivity. Intermittent connectivity or the device going offline can be hazardous.

The bandwidth required to transmit all the data collected by thousands of sensors also grows exponentially with the increase in the number of devices. Though secondary in comparison to the critical issues described above, massive data transfers to the cloud and huge cloud computing cycles could also result in high costs.

This white paper shares Thinxtream's experience in addressing these issues with IoT Edge Analytics and IoT Machine Learning solutions.

IoT Edge Analytics

Business can respond to these challenges with IoT Edge Analytics – the collection, processing, and analysis of data at the edge of a network either at or close to a sensor, a network switch or a connected device.

With the rapid growth in connected devices, organizations across industries such as energy, manufacturing, retail, and transportation, are generating huge volumes of data at the edge of the network. Edge analytics enables data analytics in real-time and on site where data collection is occurring. It could be descriptive or diagnostic or predictive or prescriptive analytics.

- Descriptive analytics tells you about what happened or what is happening based on current data,
- Diagnostic analytics provides you with information on why an event occurred,
- Predictive analytics gives you insights on what is likely to happen based on past and current data, and
- Prescriptive analytics offers options on what you can do in the future.

IoT Machine Learning

Complementing IoT Edge Analytics is IoT Machine Learning, which enables computers to learn from data and experiences, and act without being explicitly programmed.

It works by using powerful algorithms to discover patterns in data and construct complex mathematical models using these patterns.

Building and training Machine Learning models require massive computing resources, so it is a natural fit for the cloud. But, inference takes a lot less computing power and is typically done in real-time when new data is available. So getting inference results with very low latency ensures your applications can respond quickly to local events.

Artificial Intelligence (AI) applications augment our capabilities by increasing speed, efficiency and helping businesses achieve more, by intelligently sensing, processing and acting on information.

Platform Choices

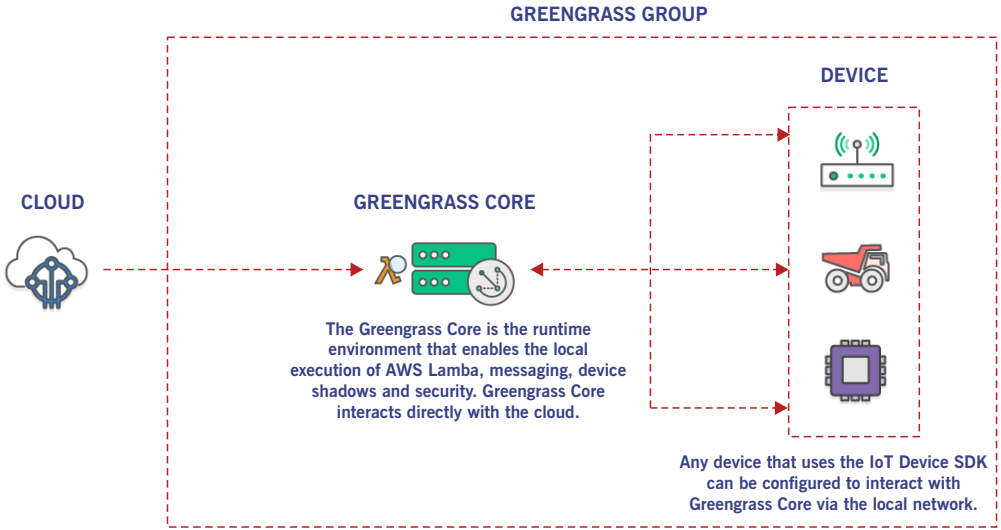

Figure 1. AWS Greengrass Integration

Microsoft® Azure® IoT Hub gives you the best of both worlds. You can use Azure Machine Learning models that are built and trained in the cloud and you can deploy and run Machine Learning inference locally on connected devices.

Azure IoT Edge allows you to move cloud analytics closer to sensors and physical devices. It provides the infrastructure to build configurable pipelines of modules for processing the data locally and monitor the same from the cloud. These modules can be deployed automatically through standard containers like Docker®.

AWS Greengrass® lets you collect sensor data and run analytics locally on devices. The AWS Lambda® functions, running on AWS Greengrass Core, enable you to interact with local sensors, while operating with intermittent connections, receive OTA updates, and reduce the cost of data transmission to the cloud. The AWS Greengrass ML Inference enables you to execute inference locally on AWS Greengrass Core devices using cloud-based models.

Many algorithms are readily available via Azure Machine Learning, Amazon SageMaker®, or open source frameworks like TensorFlow®, Apache MXNet, PyTorch™, etc., to build and train Machine Learning models. Tools like Amazon SageMaker Neo, TensorFlow Lite, Apache TVM, Microsoft's ONNX runtime, NVIDIA® TensorRT, Intel® OpenVINO®, STM32Cube.AI, etc., enable deployment of optimized deep learning and machine learning models on edge hardware. Azure and AWS platforms also support leading open source ML frameworks, and you can use these models with Azure IoT Edge or AWS Greengrass for ML inference at the edge.

Real-time Device Control

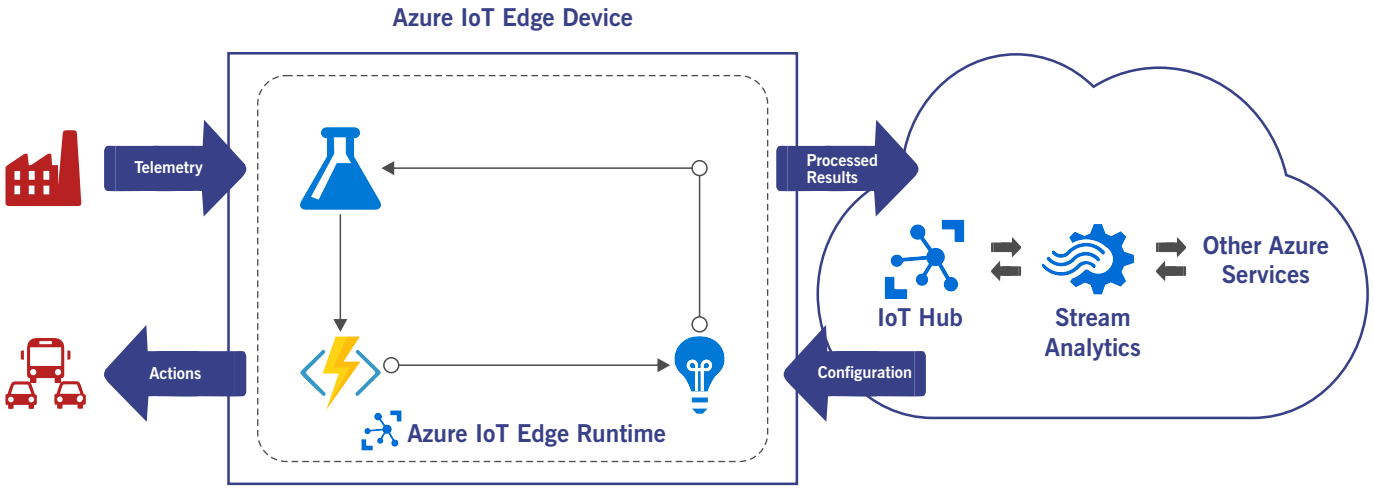

Figure 2. Integration of Azure IoT Edge Device with Azure IoT Hub

We can combine IoT Edge Analytics and IoT Machine Learning modules to solve issues in controlling the connected devices in real-time. This way, you can focus on business insights rather than massive data management generated by sensors. The figure provides the high-level view of such solutions.

Let's focus on the IoT Edge Device to take a closer look at how exactly IoT Edge Analytics and IoT Machine Learning complement each other in controlling the devices in real-time.

For example, a bank can deploy IoT Edge Analytics and Machine Learning locally on Edge devices to detect and stop non-compliant transactions. Processing this data locally, enables a bank branch to have positive impact and react to issues much more quickly, as against the lag time of sending the data to the cloud for processing and analysis, which decreases the value of the data. The processed analysis can be later sent to the cloud for further analysis and training of bank staff globally.

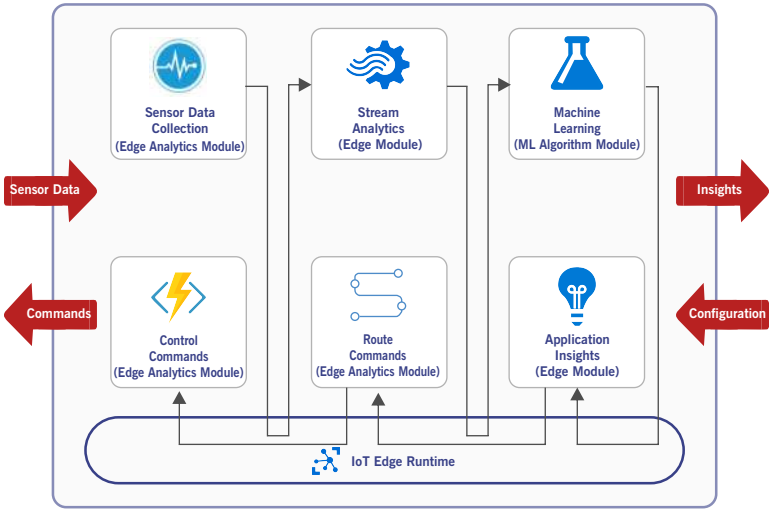

Figure 3. Message flow inside Azure IoT Edge Runtime

Analyzing water quality in drinking water supply systems, swimming pools, etc. in real-time can potentially avoid serious health issues for consumers. Locally-installed IoT Edge devices with computing capabilities can enable real-time quality control and predictive maintenance. They can control the filtration parameters, mixing ratio of quality control additives or even pumping and circulation speeds by using Edge Analytics and Machine Learning algorithms based on the water supply quality parameters, consumer usage and environmental factors. They can also report incidents to the cloud for further analysis and reporting.

Benefits

You get several benefits with local processing on the Edge devices and responding immediately to the changes in telemetry:

- Collect the data locally without losing anything due to intermittent network connections.
- Infer the actions to the changes with more sophisticated, well-tested Machine Learning/AI software modules locally reducing the latency.
- Reduce bandwidth costs by sending only the business insights required for further analysis and controlling devices' behavior from the cloud with the complete IoT solution.
- Update/upgrade the Machine Learning/Edge Analytics modules anytime through easy configuration and via containers.
- Selective processing – the huge volumes of data that is collected at the Edge sources are not all valuable. Edge Analytics helps in quickly isolating interesting data for rich analytics.

Conclusion

IoT Edge Analytics and IoT Machine Learning can deliver quantifiable business benefits and profits by reducing the latency of decisions. This is achieved by processing raw data near the physical device and by scaling out analytic nodes overcoming the bandwidth problem.

As an IoT services provider, Thinxtream has expertise in IoT Edge Analytics and IoT Machine Learning across Azure IoT Hub, AWS IoT and Open Source platforms. By leveraging the IoT expertise built over a decade, Thinxtream ensures cost-effective, quality and timely delivery of IoT solutions.

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Thinxtream Technologies is a global software company with a portfolio of innovative software platforms, components, solutions, patents, competences and services for Internet of Things (IoT) across several industry verticals and applications, successfully enabling leading customers, including Fortune 500 companies, meet their application, product and business goals.

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