**WISE-PaaS**

**TECHNICAL WHITEPAPER**

**WISE-PaaS**

**Platform Architecture and Services**

V 0.9



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# Introduction

The purpose of IoT is to connect with pervasive IoT devices and applications to exchange information using internet transfer protocols. The gap between the device sensors and data networks is filled by this IoT Platform, called WISE-PaaS. Such a platform connects the data network to the sensor arrangement and provides insights using backend applications to make sense of plethora of data generated by hundreds of sensors.

A new McKinsey Global Institute (MGI) report, in 2025, the output value of Internet of Things will be mainly in industrial applications. The focus of the IoT is not on connecting smart home devices, but rather on connecting industrial assets with particular emphasis on Smart Factories, Smart Cities, Healthcare, Intelligent Retail & Hospitality, outdoor transportation & logistics, Power & Energy, Mining & Construction, and so on and so forth.

Being one of the early entrants into the industry PC manufacturer, Advantech realizes that trend of IoT will bring tremendous changes to the world and expects to devote itself to act as the pushing hands like its slogan says “Enabling an Intelligent Planet”. As a leading manufacturer of industrial PC, Advantech leverages its understanding of all kinds of asset models and operations applied in wild range of industrial fields to create new values for industrial customers. The WISE-PaaS platform provides a set of development tools, services, solution ready packages and best practices that rapidly enable those customers to bridge the gap between software and operations to drive incredible value and innovation.

This whitepaper introduces the cloud architecture required for the IoT platform and the services orchestration provided for developer to rapidly achieve the IoT solutions.

The WISE-PaaS platform offers the following features and advantages:

* **Easy connectivity of devices to the platform with secure communication**
* **Remove complexity from IoT application development**
* **Sharing platform (multi-tenant) among developers for rapid development**
* **Secure and Robust IoT Data Storage**
* **Integrated analytics model for analyzing complex big data**
* **Elastic architecture for hybrid cloud deploying (Public and On-premise) and industrial Edge IoT solutions**
* **Rapid IoT application build-up with minimal up-front investment**
* **Solution oriented services (Solution Ready Packages) to create real business value for industrial applications**

# Architecture Overview

WISE-PaaS is a flexible, innovative and highly available platform with comprehensive industrial services that provides customers the ability of fast-connect intelligent edge devices to the cloud and rapidly develop, deploy and operate all kinds of IoT applications to enable industrial use cases. The service components include:

**WISE-Agent**

WISE-PaaS is a software development framework to communicate and exchange information between the Edge device and WISE-PaaS Cloud, called WISE-Agent SDK. The WISE-Agent SDK contain code that facilitate building devices and applications that connect to and are managed by WISE-PaaS Cloud.

**WISE-PaaS Connectivity**

WISE-PaaS Connectivity provides fully managed service that enables reliable and secure bidirectional communication communications among cloud backend IoT Hub, Edge gateways and IoT sensor devices.

**WISE-PaaS Device Management**

WISE-PaaS provides the features and applications that enable device and back-end developers to build robust device management solutions. Through the Platform built-in dashboards and applications, developer can easily manage, browse, configure, monitor and provision their managed IoT devices.

**WISE-PaaS Cloud**

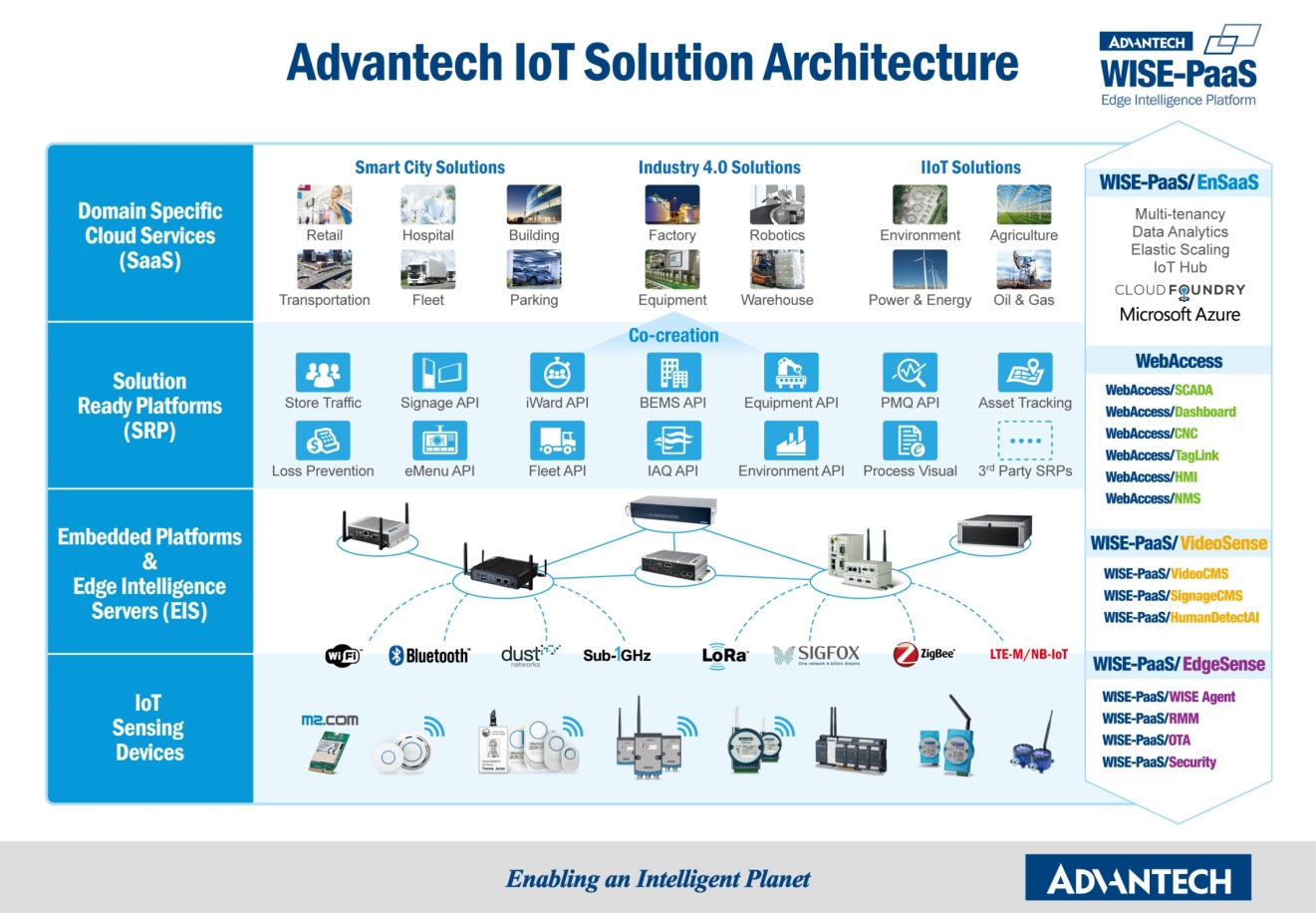
WISE-PaaS IoT Cloud is made and optimized for industrial sectors like factory, transportation, retail and healthcare. It helps in development of IoT applications that can process real-time operational data aiding better decision making.

**WISE-PaaS Industrial Services**

WISE-PaaS provides industrial services that developers can use to build, test and run Industrial Internet applications.

**WISE-PaaS Visualization**

WISE-PaaS provides visualization tools that developer can use to visualize both real-time and historic data sent from registered devices in the Platform. Visualized data flow control tool is also provided to facilitate the development of solution business logic.



# WISE-Agent

WISE-Agent is a software development framework to communicate between the Edge device and WISE-PaaS IoT Cloud. The WISE-Agent framework provides a rich set of user-friendly, intelligent and integrated interfaces, which speeds up the development, enhances security and makes agent application easier and simpler to establish a bi-directional connectivity to the WISE-PaaS Cloud.

Devices and data sources in an IoT solution can range from a simple network-connected sensor to a powerful, standalone computing device. Devices may have limited processing capability, memory, communication bandwidth, and communication protocol support. The WISE-Agent, is written in C language and follow the [ANSI C Standard](https://en.wikipedia.org/wiki/ANSI_C), enable you to implement client applications for a wide variety of devices.



**Lightweight**

The WISECore, extracts the core functions to a single library, is focused on the handshake protocol to communicate with WISE-PaaS Cloud. Developer can integrate this small library into a resource restricted platform easier.

**Connectivity Protocols**

To support various connectivity protocols, WISE Connector, the common connectivity APIs is defined for developers to connect devices to various protocols supported Cloud by changing Connector Module at compile time.

# Connectivity

WISE-PaaS IoT Connectivity is comprised of Cloud Backend Connectivity and Edge Connectivity. Up north, Cloud Backend Connectivity (IoT Hub) enables reliable and secure bidirectional communications between millions of IoT Edge devices and a cloud backend IoT Hub. Down south, Edge Intelligence Gateway provides the connectivity of legacy industrial devices through wired or wireless technologies. It integrates technologies and internet protocols for IoT devices to run domain-specific application, collect and aggregate sensing data and send to cloud.

## Cloud Connectivity

WISE-PaaS Cloud Connectivity, called IoT Hub, is a scalable, high-throughput and bidirectional message bus. It is built on RabbitMQ, an open-source, high-throughput messaging system which provides a low-latency platform for handling real-time data feeds. It can be used to wire micro-services together using open protocols, connect stream data to analytics, and feed event data to multiple applications to react in real time. It can also be used to bridge to your on-premise messaging infrastructure to create a hybrid cloud IoT solution.

In order to ensure the data is isolated, protective and dedicated for specific customer tenant. Besides the sharing IoT Hub service, the service also can be subscribed into customer’s exclusive IoT space to create a dedicate instance of either single or cluster service deployment.

## Edge Connectivity

WISE-PaaS Edge Connectivity includes two layers of protocol adapter, Southbound and Northbound adapter. Southbound adapter provides the connectivity through industrial protocols like Modbus, OPC-UA, LoRa, Sub-1G and other protocols for M2I (Machine to Intelligent Gateway) to collect sensing data from IoT end-nodes. Northbound adapter provides the connectivity using Internet protocols to connect Edge devices and send IoT data to WISE-PaaS Cloud. There are several supported Internet protocols like MQTT, AMQP, HTTPS and WebSockets.

# Device Management

IoT Devices range from constrained sensors and single purpose microcontrollers, to powerful gateways that route communications for groups of devices. The device management feature enhances the WISE-PaaS IoT Platform service for managing devices. The WISE-PaaS facilitates Device Management, by hosting the DM Server on the Platform and DM Agent on the Devices.

A crucial part of creating a successful enterprise IoT solution is to provide a strategy for how operators handle the ongoing management of their collection of devices. With these DM information transferred from Agent to Server, IoT operators and developer can have easily develop usable, reliable tools and applications that enable them to focus on the more strategic aspects of their jobs. The Device Management featues include:

* **Provision**: Securely provision new devices to IoT Hub and enable operators to immediately discover device capabilities.
* **Configure**: Facilitate bulk configuration changes and firmware updates to devices while maintaining both health and security.
* **Monitor**: Monitor overall device collection health, the status of ongoing operations, and alert operators to issues that might require their attention.
* **Retire**: Replace or decommission devices after a failure, upgrade cycle, or at the end of the service lifetime. Use the device twin to maintain device info if the physical device is being replaced, or archived if being retired. Use the IoT Hub identity registry for securely revoking device identities and credentials.
* **Reboot/Reset** - The back-end app informs the device through a direct method that it has initiated a reboot/reset.
* **Firmware/Software Update** - The back-end app informs the device through a direct method that it has initiated a firmware update.
* **Predictive Maintenance** - The solution helps determine the condition of in-service equipment in order to predict when maintenance should be performed.

# Cloud

The WISE-PaaS Cloud is an innovative industrial IoT platform that combines managed platform as a service (PaaS) with scalable infrastructure as a service (SaaS). It provides a rich set of industrial cloud services that developers can easily integrate to create and build business applications for different industrial scenarios.

## Cloud Infrastructure

The major challenges with Industrial IoT implementations are identification of things within the internet, management of massive amount of data, integration of Industrial IoT strategy with existing infrastructure, and utilization of the power of cloud computing. Industrial IoT connects all the machine and devices within the industry to produce valuable data or information that is used for analysis and exchange information between industry and consumer. Often the system cannot identify the data related with things and mix up with consumer data. At the same time, the data becomes massive in size to handle and insight generation becomes complex in nature. The data can be related with real-time production data, user integration with software, and machine. Another challenge is to integrate IIoT strategies with existing systems that includes M2M communication, big data analytics technology, cyber security, HMI system, and SCADA.

WISE-PaaS cloud architecture incorporates some functions such as data security in the platform, data integrity while collecting data, security at the edge point, platform scalability to handle massive amount of data, system compatible industrial equipment, data capability issues, high focus on big data and AI technologies, control over dashboard, platform interoperability, platform compatible equipment, separate APIs, cloud agnostic IoT platform, and predictive analytic.

For Pubic cloud services, Advantech partners with major cloud providers, such as Amazon Web Services (AWS), Google Cloud Platform, and Microsoft Azure to build out a dedicated cloud infrastructure able to optimize for industrial workloads. Advantech also leverage Cloud Provider Interface (CPI) that serves as an abstraction layer above the specified IaaS, so that the platform service also can be easily migrated to On-Premise host server to provide private cloud or hybrid cloud services.

## Cloud Foundry

WISE-PaaS is based on Cloud Foundry that enables you to rapidly create, deploy, and manage your cloud applications.

Cloud Foundry is not vendor specific and does not lock you into proprietary software or cloud infrastructure, so it can be run in Public, Private, VMWare, Azure, AWS, GVP, OpenStack-based and other clouds. Cloud Foundry abstracts the underlying infrastructure needed to run a cloud, letting you focus on the business of building cloud applications. Cloud Foundry supports multiple development frameworks like Java™ code, Spring, Ruby, Node.js, and custom frameworks. It also offers support for MySQL, MongoDB, PostgreSQL, Redis, RabbitMQ, and custom services.

## Security and Privacy

Security and privacy issues should be examined very seriously because aside from the fact that IoT handles huge amounts of sensitive data (personal, business data, etc.), it also brings about an influence to the physical environment with its control abilities. Cyber-physical environments must thus be protected from any kind of malicious attacks. WISE-PaaS keeps you secure with the following measures to prevent from security threats:

* **Minimizes network surface area**
* **Isolates customer applications and data in containers**
* **Encrypts connections**
* **Uses role-based access controls, applying and enforcing roles and permissions to ensure that users can only view and affect the spaces for which they have been granted access**
* **Ensures security of application bits in a multi-tenant environment**
* **Prevents possible denial of service attacks through resource starvation**
* **Provide application security services, User Account and Authentication (UAA) Service and Access Control Service for building a secure industrial application**

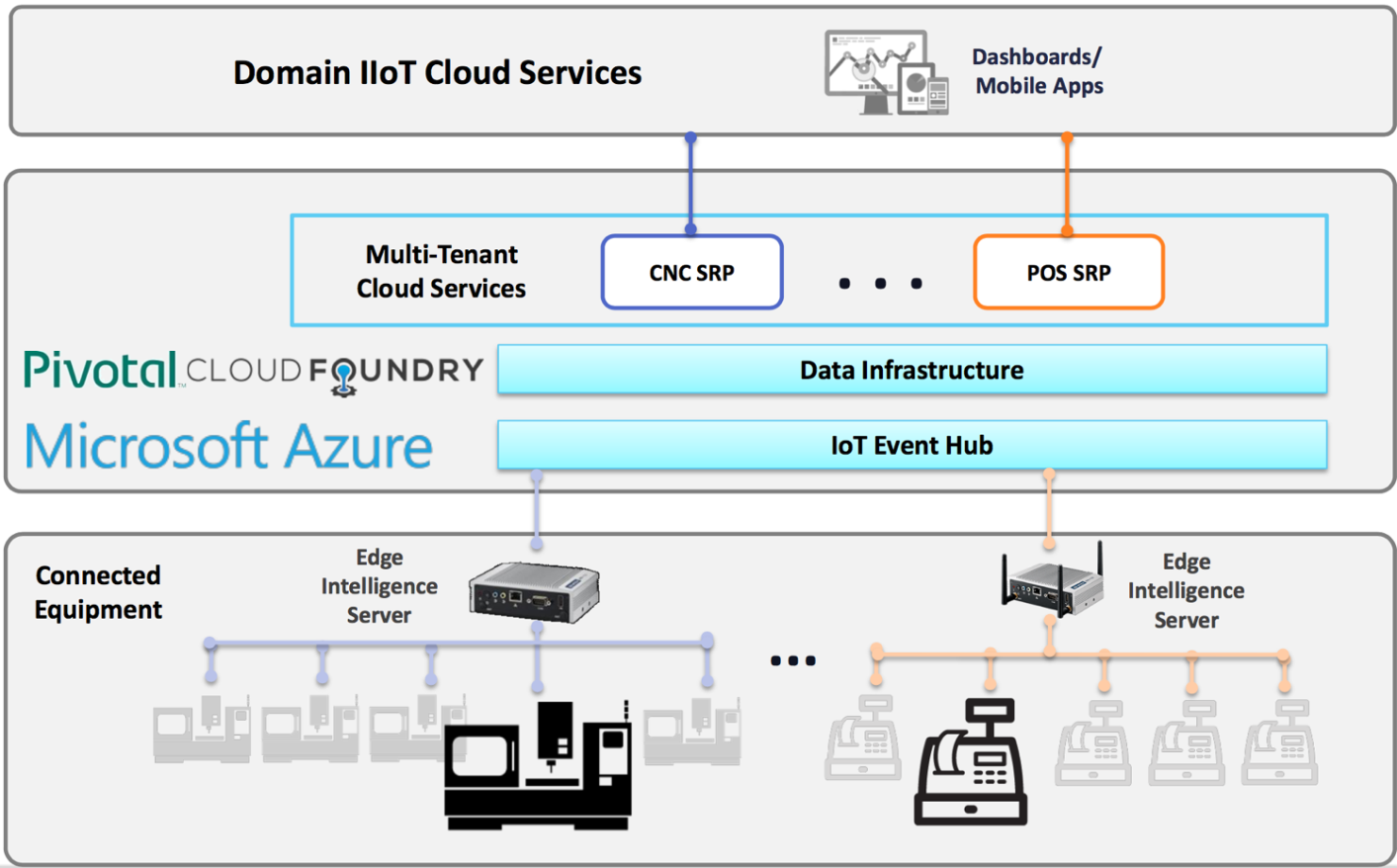
## ****Scalability****

Traditional enterprise application developers will be struggling to build scalable applications. Typically, they were forced to provision high-end, expensive hardware capable of scaling-up to handle the highest envisioned load. That was not only expensive, but also difficult, as developers had to add capacity when more scale was required.

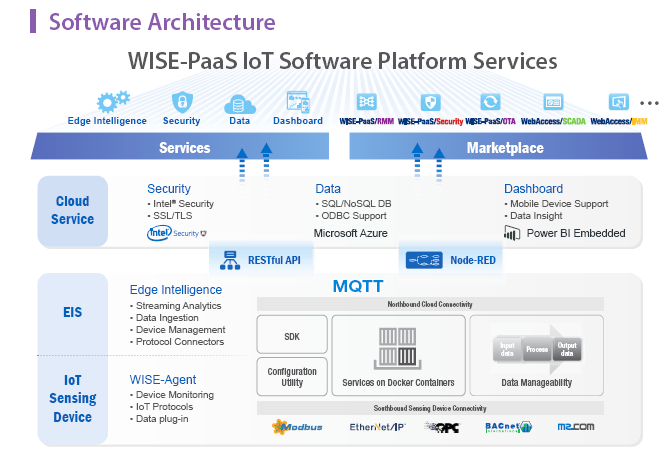
With WISE-PaaS, you no longer have to make large investments in hardware to test out or run a new app. Instead, we manage it all for you and only charge for what you use. You can develop in a cloud without borders, where you can connect your private services to the public WISE-PaaS services. You and your team can access the apps, services, and infrastructure in WISE-PaaS and use existing data, systems, processes, PaaS tools, and IaaS tools.

Cloud computing solved many challenges, but developers were still required to perform a significant amount of work to manage scalability at the application layer. PaaS solutions provide developers the tools they need to create cloud-native scalable applications. To follow the methodology of “[THE TWELVE FACTORS APP](https://12factor.net/)” is also a good way to develop a cloud-native application.

WISE-PaaS manages the complexity of scale so that developers can focus on creating applications that drive industrial value, and bring cloud computing into the currently under-connected industrial world reliably and inexpensively.



# Services



For System Integrator and Developer, WISE-PaaS offers a set of ready-to-use services that you no longer have to be concerned about installing software or dealing with virtual machine images or hardware. As a leader of Industrial computer manufacturing, Advantech leverage its understanding of wide range of industrial devices and protocols, so WISE-PaaS provides not only pure cloud services but also complete Cloud-Edge integrated services to facilitate the customer the development of IoT solution.

The platform services that is based on the three key components to accomplish the IoT solution:

* **IoT Sensing Devices: Provides Device Sensing services include, Monitoring, industrial protocol connecting and data plugins.**
* **Edge Intelligence Servers (EIS): Provides edge intelligence services include edge side streaming analytics, data ingestion, device management and protocol connectors.**
* **Cloud Services: Provides end-to-end security service, data infrastructure service, data analytics $ visualization service and DevOps service.**

The WISE-PaaS IoT software Platform service would provide the marketplace to fulfill diverse IoT software utility adoption, the customer can select and purchase any kinds of IoT software solution on this marketplace without installation.

## Edge Intelligence Services

Advantech WISE-PaaS IoT software platform services that is based on the three key components to accomplish the IoT solution, the IoT Sensing Device, Edge Intelligence Server (EIS) and Cloud Service, Advantech would focus on the edge device development to provide the EIS software suite includes the southbound sensing device connectivity that is handling diverse sensing protocols such as Modbus, OPC, BACnet, Wireless IP/Non-IP, and so on. Those protocols would be plugin module to do data communicate to WISE-PaaS and monitoring sensor status and processing the data normalization tasks.

The EIS is mainly handling the northbound cloud connectivity and Intelligence facilities, there are based on the micro service container to modularize the different cloud connection and device management. The EIS intelligence facilities are also adopting micro service container to deal with the data ingestion workload such as data pre-processing and cleaning. The most valuable facility on EIS software suite is streaming analytics, Advantech would provide the IPC device PMQ (Predictive Maintenance and Quality) to prove the concept of prediction on edge field for real-time analytic and upgrade the analytic module that is also based on the micro service container technology from the cloud service for updating more accuracy analytic purpose, the customer can leverage such framework to develop their own analytic module or PMQ module with EIS open standard architecture. The entire open standard would be following the MQTT protocol and the Docker container technology as foundation framework.

The Edge interface would have RESTful API, MQTT and Node-Red to facilitate customers to develop their application depends on their resource constraint, the Node-Red and configuration utility are easy implemented the solution by user-friendly UI by simple steps. Moreover, The SDK with MQTT sample code and RESTful API interface and document require the advance developer to design and develop the rich IoT application to fulfill their requirement.

## End-to-End Security Services

WISE-PaaS platform provides the layered security polices and services that can be used by application developers to secure their end-to-end applications include:

**Platform Security**

**Platform adopts the User Account and Authentication Service (UAA) to secure the platform services and provide a single sign on for applications. UAA comply with OAuth2 specification that supports all the core OAuth2 token grant types. By default, the UAA issues base64 encoded JSON tokens, based on the**[**JSON Web Token (JWT)**](http://tools.ietf.org/html/draft-ietf-oauth-json-web-token)**specification. WISE-PaaS uses role-based access control (RBAC), with each role granted permissions to either a tenant org or a specified space.**

**Data Security**

**Platform provides data security with SSL/TLS in the communication and leveraging the Intel Security on the Edge device and cloud security management.**

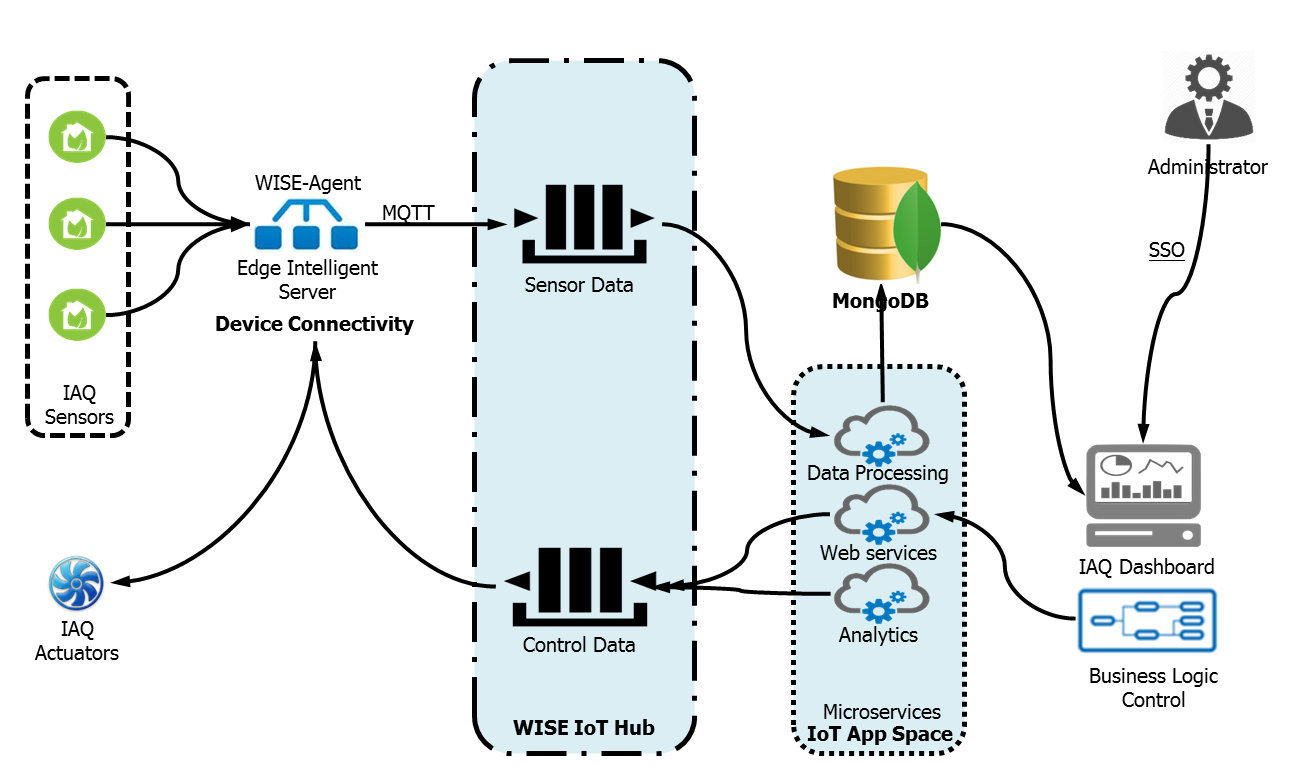
**Application Security**

**Platform runs the application inside a secure container and secures containers through the following measures:**

* **Running application instances in**[**unprivileged**](https://docs.cloudfoundry.org/concepts/container-security.html#types)**containers by default to increases security by eliminating the threat of root escalation inside the container.**
* **By limiting functionality and access rights of containers to mitigate against container breakout and denial of service attacks.**
* **Only allowing outbound connections to public addresses from application containers. This is the original default. Administrators can change this behavior by configuring ASGs. For more information about ASGs, see the**[**Application Security Groups**](https://docs.cloudfoundry.org/adminguide/app-sec-groups.html)**topic.**

## Data Infrastructure Services

The Data Infrastructure Services enable IoT application developers to bring data into WISE-PaaS cloud and make it available for their industrial applications. The data is brought in by Edge devices that provide local intelligence to cleanse and aggregate data upfront and establish the connection with WISE IoT Hub to send data through the WISE-Agent. After converging data, WISE-PaaS provides the IoT App Space that developers can deploy the backend micro-services to receive and pre-process the data, as well as develop web services and data-related analytics, ultimately store the data in the appropriate type of data storage, whether it be a non-SQL/time-series data storage for sensor data, or a RDBMS for application and management data. PostgreSQL DB and Mongo NoSQL DB are of the standard offering and also support ODBC standard interface for integration. And last but not least, the dashboard would be the last mile of IoT application to show up the IoT value with visualization facilities such as Azure PowerBI or Tableau.



## Data Analytics Services

WISE-PaaS offers data science capabilities that enable a feedback loop between operational and historical analytics. Operational analytics at the edge ensure the efficient operation of assets, but those analytics can be improved over time based on historical analysis. For example, an operational analytic might continually monitor the temperature of an asset and initiate a shutdown in the event of unacceptable operating temperatures. However, after collecting years of data across many assets, it could be determined that the threshold should vary by the physical elevation of each asset. In that case, a new analytic that takes elevation into account could be created and then be deployed to the Edge devices associated with assets of that type around the world. Data Analytic services provide a framework for developing and embedding advanced analyses in business operations. This framework can be used to manage the execution of analytics through configuration, abstraction and extensible modules. It can also serve as a sandbox for analytic testing. An analytic is a function or small program (often a physics-based algorithm) that processes machine data. It can be used directly by an application or at a step in the orchestration of multiple analytics, where the output of one analytic can be the input for another. The inputs and outputs for each analytic are typically expressed as parameters to enable an analytic to be reused for different use cases.

## Data Visualization Services

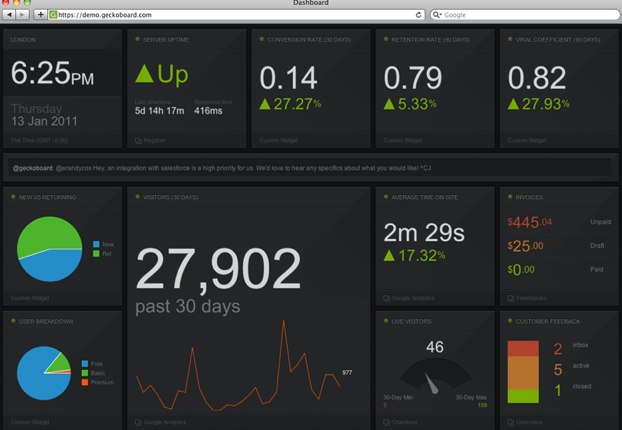
Data visualization tools have been important in democratizing data and analytics and making data-driven insights available to workers throughout an organization. They are typically easier to operate than traditional statistical analysis software or earlier versions of BI software. This has led to a rise in lines of business implementing data visualization tools on their own, without support from IT.

Data visualization software also plays an important role in big data and [advanced analytics](http://searchbusinessanalytics.techtarget.com/definition/advanced-analytics) projects. As businesses accumulated massive troves of data during the early years of the big data trend, they needed a way to quickly and easily get an overview of their data. Visualization tools were a natural fit.

**Real-time Data Monitoring:**

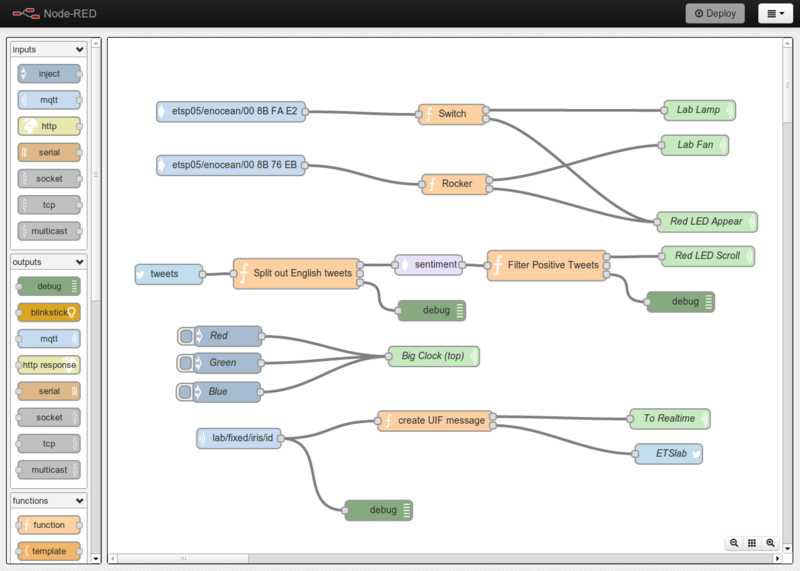
Freeboard is an open source, turn-key HTML-based "engine" for dashboards. Besides a nice-looking layout engine, it provides a plugin architecture for creating data sources (which fetch data) and widgets (which display data) - freeboard then does all the work to connect the two together. Another feature of freeboard is its ability to run entirely in the browser as a single-page static web app without the need for a server. The feature makes it extremely attractive as a front-end for embedded devices which may have limited ability to serve complex and dynamic web pages.

WISE-PaaS integrates this open-source project with some customized features as an add-on application for developers to build real-time, interactive dashboards and visualizations in minutes using the intuitive drag & drop interface.



**Visualized Data Flow Control:**

WISE-PaaS also integrate another visualization tool, Node-RED, an open source visual editor for wiring the internet of things, to provide a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click. It is wrapped as an application form that can be deployed into developer’s IoT APP space. Developer can use this application to receive data from IoT Hub, pre-process data, control rule-based data flow and execute their own business logics. These steps can be complete within a few minutes and even without write codes.



## Solution Ready Packages (SRPs)

WISE-PaaS provides the integrated IoT solutions with cloud and Edge ready package for extensive industrial applications that can be separated for four domain focus**:**

**WebAccess: Industrial Data Acquisition and Visualization**

WebAccess/SCADA

WebAccess/Dashboard

WebAccess/CNC

WebAccess/TagLink

WebAccess/HMI

WebAccess/NMS

**WISE-PaaS/VideoSense: Intelligent Video and Multimedia Management**

WISE-PaaS/VideoCMS

WISE-PaaS /SignageCMS

WISE-PaaS /HumanDetectAI

**WISE-PaaS/EdgeSense: Edge Intelligence and Sensing Integration**

WISE-PaaS/VideoCMS

WISE-PaaS /SignageCMS

WISE-PaaS /HumanDetectAI

WISE-PaaS/VideoCMS

WISE-PaaS /SignageCMS

WISE-PaaS /HumanDetectAI

**WISE-PaaS/EnSaaS: Platform for Enabling Cloud Service Providers**

Multi-tenancy

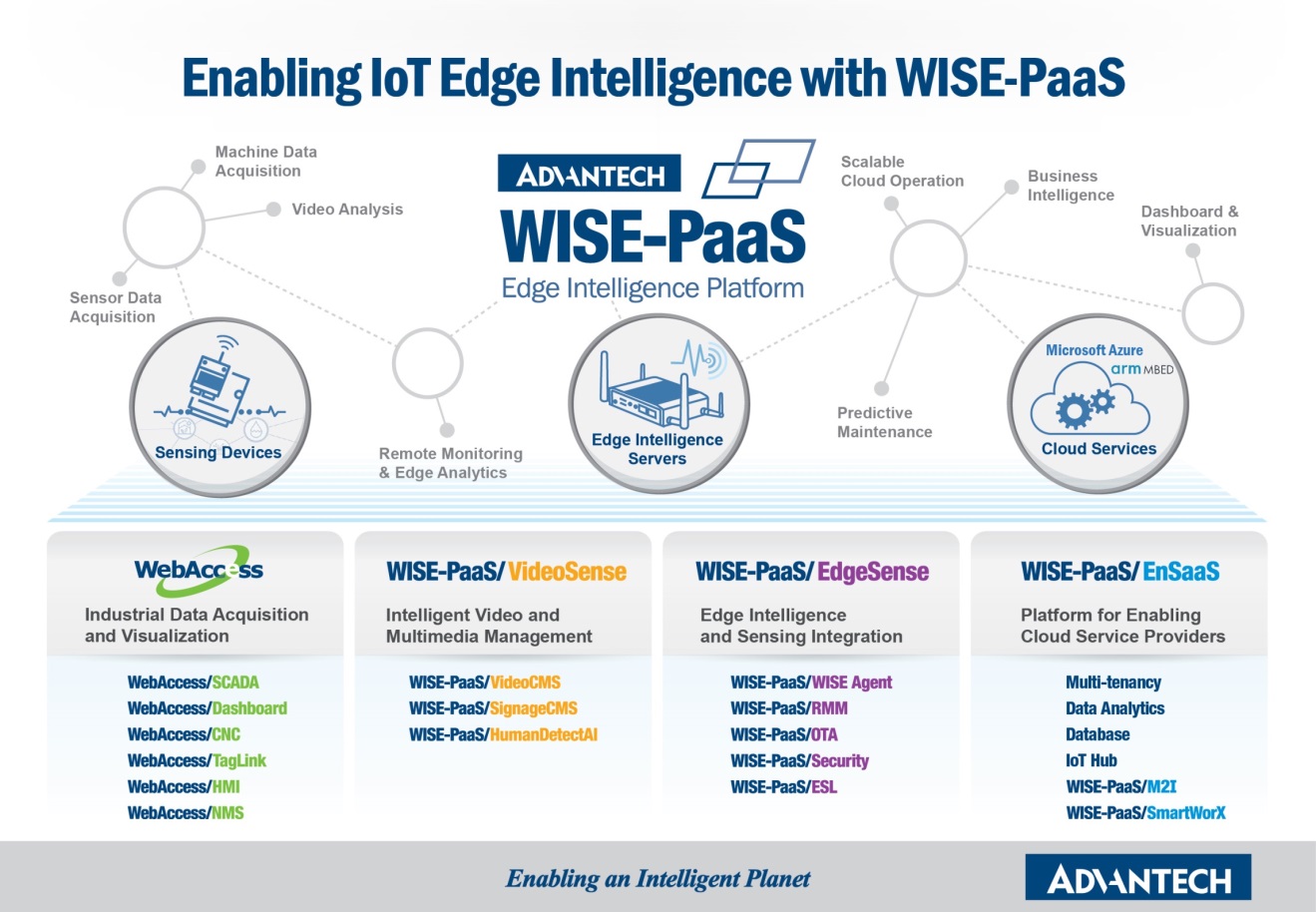
Data Analytics

Database

IoT Hub

WISE-PaaS/M2I

WISE-PaaS/SmartWorx



# Conclusion

WISE-PaaS provides IoT service orchestration that you can assemble quickly to support any industrial workloads. With WISE-PaaS platform, you’ll find a complete set of highly available services that are designed to work together to build sophisticated scalable applications. You can aggregate the data and operational capabilities of intelligent devices to enable industrial scenarios and improve business processes, enhance analytics and predictive maintenance for real-time asset optimization. Establish a secure connectivity between industrial equipment and cloud, have access to highly durable storage, low-cost compute, high-performance databases, management tools, and more. All this is available without up-front cost, and you pay for only what you use. These services help organizations move faster, lower IT costs, and scale.