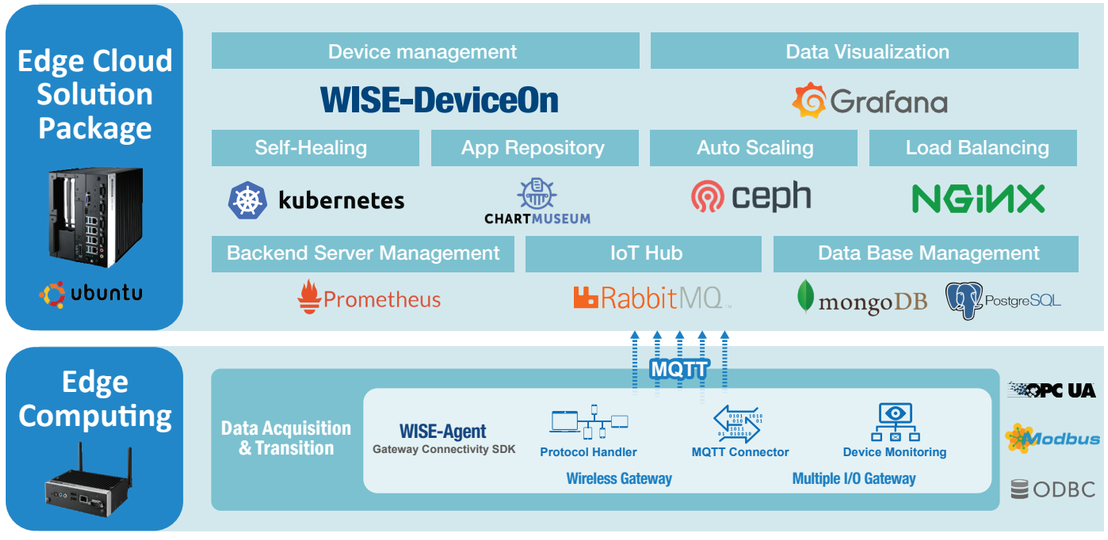
Architect Your Edge Cloud Solution: Kubernetes Containerized or Windows Server Management

Today, many varieties of intelligent applications are implemented on cloud platforms which help enterprises improve productivity and flexibility. Many Small and Mid-size Enterprises (SME) have chosen to use public clouds out of cost considerations. But enterprises in certain industries like semiconductors and CNC manufacturing have deeper concerns over data sensitivity, internet security, and site restrictions—in short, they would prefer to have their own private cloud. However, most private cloud systems are designed for large businesses, requiring large capital investment and system infrastructure, making them unaffordable for medium and small businesses. To address the needs of SME for private cloud services, Advantech recently rolled out edge cloud solution—an all-in-one solution incorporating Advantech hardware and WISE-DeviceOn IoT device management software to provide data collection, management, visualization, and other on-demand microservices. The system offers high scalability and SME customers can manage all their resources from one convenient terminal. They can also choose additional services to create and organize their own private cloud system that will fit their needs and their budget.

Kubernetes and Windows each offer unique advantages in their own ways

To boost flexibility and scalability, Advantech designed their edge cloud solution with a dual architecture. Both Linux-based Kubernetes and Windows Server environments are supported. Kubernetes, is currently the most prevalent container management architecture for Linux. It was created to address the shortfalls of traditional architectures for data centers in terms of system relocation flexibility. In contrast, traditional architectures require resources to migrate data to other platforms, while Kubernetes is an open source platform for managing containerized workloads which can be moved anywhere quickly and conveniently. For example, if a manufacturer wants to move their company's data from a public cloud platform to a private cloud each with different architectures, containerized management will be the most efficient way.



Edge Cloud Solution Architecture

Just like app developers traditionally have had to create different versions of programs for iOS and Android mobile platforms, with a containerized management approach they can simply move their data containers to another platform for reuse without the need to redevelop programs. Kubernetes helps a lot in shortening system development time and increasing operational flexibility.

The Windows server architecture, on the other hand is simple and easy to use, on which users can access all the services and advantages of WISE-DeviceOn directly without extra development effort. So, even SME which do not have strong in-house teams of developers can quickly build their own systems and integrate, manage, and visualize their data themselves. All this can be done via the simple and easy-to-use interface provided by Edge Cloud Solution along with Advantech's technical support.

Looking at the two versions in practice, Edge Cloud Solution for Kubernetes runs on the Linux Ubuntu OS distribution, while the Windows Server runs on Windows Server 2016. In terms of expansion, users of Kubernetes only have to increase hardware to extend the original system performance seamlessly; while the Windows server can run WISE-DeviceOn only on standalone system. In terms of integration, Kubernetes allows the same microservices to be implemented on different architectural platforms and therefore has greater system flexibility.

For the application of AI, Windows server has fewer tools for machine learning, while the Kubernetes's machine learning platform Kuberflow supports various open source software—such as Tensor Flow and Caffe, which is the main reason why most AI developers prefer Kubernetes for their AI development environment.

Though private clouds keep data within the enterprise and reduce the possibility of leaks, it is not practical for most SME to construct their own private cloud. In addition to the huge investment on hardware and equipment, it also necessary for the establishment of an IT team specialized in developing, maintaining, and supporting the system. Also, it's difficult to precisely assess the total length of time needed for system development, and after

Platform	K8s	Windows
User	Developer	Operator
Operation System	Ubuntu + K8s	Windows Server
Scalability	Scalable	Standalone
*Data Throughput	15,000 messages/sec	20,000 message/s
Application Architecture	Microservices	Monolithic
AI Extensibility	Unified AI platform (Kubeflow, Tensorflow)	Limited (Trained ML models)

Edge Cloud Solution Platform Selection

the system goes online it will require another period of time for testing and debugging before it can truly fit the needs of end user. For many SME sized manufacturers whose resources are restricted, the capital, manpower, and time required for developing their own private cloud would be too much.

Advantech Edge Cloud Solution is well-prepared for building in Kubernetes functionality

Compared to competing private cloud solution products in the market, Advantech's Edge Cloud Solution delivers more in terms of platform management, device management, and application potential. In terms of platform management, the containerized management mechanism of Edge Cloud Solution allows independent development and management, which in turn allows IT people to apply different containers and renew versions at any time, without the need to change the overall structure when making changes to programs.

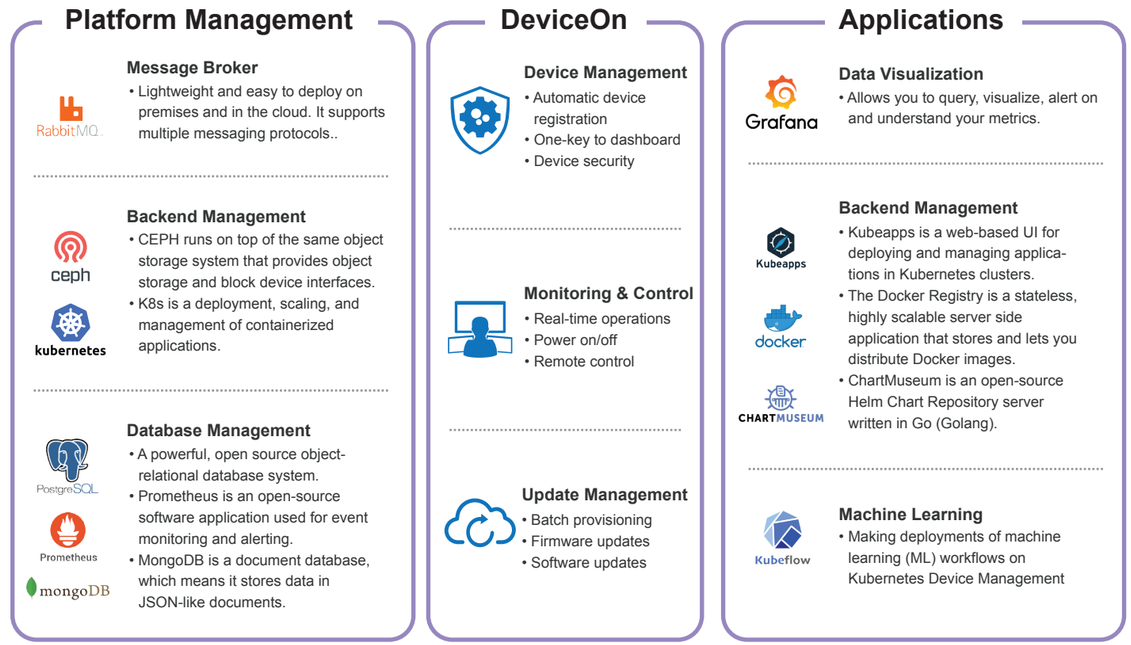
The traditional cloud platform management method adds virtual machines to the operating system for running programs, but under this environment the migration of data and programs will be limited. While the containerized management packs each application program into an independent environment, and all container data are stored in standardized Docker Image files. In this way, any system, whether Windows or Linux, may reconstruct the same containers via the Image files and execute the same programs as long as the system supports Docker.

Kubernetes takes a step further by optimizing container management and added value services. For example, if an application requires three Docker image files for executing a task, a conventional Docker system will use Docker-Compose to connect all containers, while Kubernetes will put in more resources to implement automated management over the containers in the application—such as adding containers automatically to the application once the container loads reach preset thresholds, or automatically restarting application programs if a program breaks down, so as to restart system operation. By doing it this way, Kubernetes enhances system scalability and reliability.

To satisfy external needs, system storage capacity has to be expanded as well to accommodate the increased number of containers, which is more difficult for the Windows Server architecture, as Windows OS is usually tied to its mainboard and hard drive since it was first installed. To solve this problem, Advantech pre-installed Ceph RBD (Ceph's RADOS Block Devices) file system management software in its Edge Cloud Solution, which virtualizes each storage space at the back end and allows Windows to automatically manage all these virtualized spaces in response to needs at the front end. This Advantech approach reduces the downtime needed for installing new hard disks when storage capacity runs out, compared to the traditional practices of Windows Server that has to stop the system for a long time while major components are replaced.

In addition to optimized container management and storage capacity, Advantech Edge Cloud Solution has other built-in Kubernetes functions—Prometheus for backend monitoring control and Grafana for data visualization. Prometheus collects and monitors application data, datacenters, and computer clusters, and will alert system administrators of events such as insufficient storage or hardware/software malfunctions. The data collected by Prometheus is sent to Grafana for rendering into visual data using tables, charts and diagrams. Notably, in addition to computer cluster data, data from various external devices under the management of DeviceOn also can be displayed on Grafana to quickly view all cross-system information.

For the management of applications, the Advantech Edge Cloud Solution built- in with Kubernetes supports CHARTMUSEUM functions to allow the developer to build their own repository of programs for reuse in other projects. This means developers will not have to start from scratch and move their objects manually each time they begin a new project. This function will help to accelerate the widespread deployment of Kubernetes systems.



Kubernetes-based Edge Cloud Solution Software Stack

WISE-DeviceOn provides more efficient device management

The Edge Cloud Solution is preinstalled with WISE-DeviceOn, an IoT software designed by Advantech for facilitating industrial applications, which when complemented by Kubernetes services, makes the system more efficient in device operation and maintenance, data collection, and visualization.

Management of Industrial equipment in the field can be difficult, such as automated machines in manufacturing, POS and digital signage in retail, and equipment for power generation, where there are many machines distributed in many locations. In the early days when the Internet was not yet available, maintenance engineers would have to go to the field for inspections—sometimes only to find that the equipment had already broken down and they did not have the tools or parts to fix them. Even today, when internet connectivity is ubiquitous, technicians still have to spend a lot of time travelling to conduct repairs and maintenance.

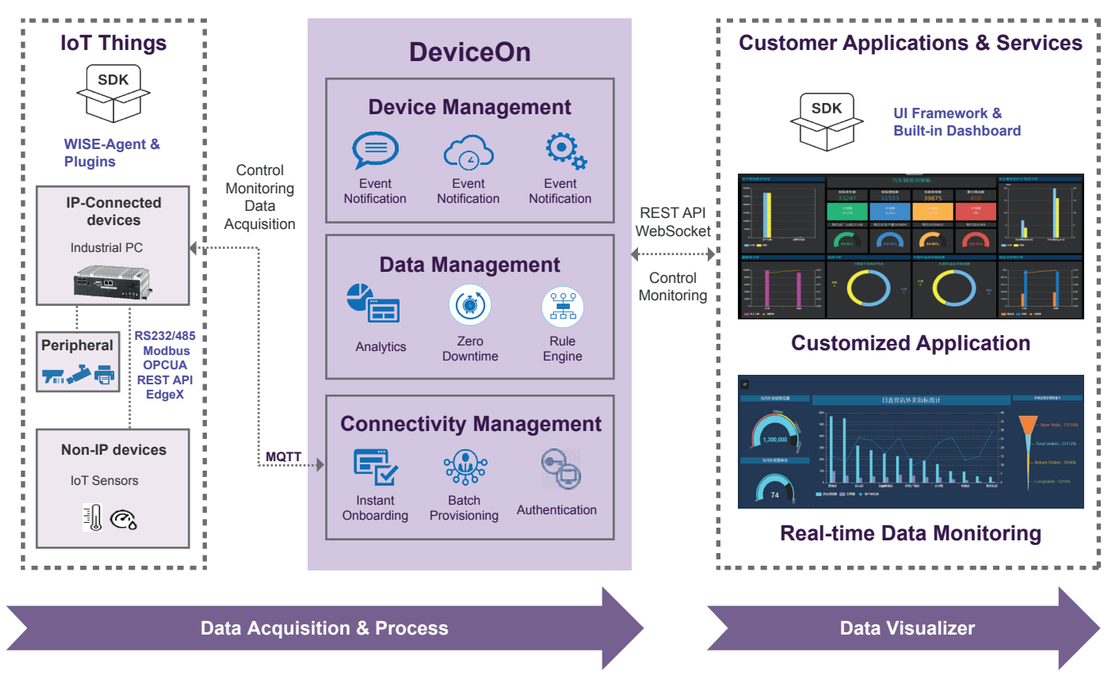
To resolve this problem, WISE-DeviceOn utilizes an intelligent remote monitoring feature to help enterprises remotely diagnose the health of major components in their machines, such as fans and hard disks; mechanical parts inside machines which are more susceptible to damage and if they fail, cause catastrophic results. WISE-DeviceOn will detect the status of all parts and will execute machine learning techniques to implement cumulative analyses of data, so that when estimated rates of failure reach preset thresholds, the system will alert system administrators to schedule maintenance or replace parts to prevent serious downtimes.

In addition to data monitoring, WISE-DeviceOn also allows enterprise users to develop their own applications by providing an easy-to-use development tool kit called WISE-Agent, which contains support for various

industrial communication protocols for wired or wireless devices. Users only have to connect their field devices to WISE-DeviceOn, and WISE-Agent will automatically help to detect and transfer different protocols into an IoT standard format for uploading to the cloud.

On the cloud side, the server will store collected data in a data center and will organize the data according to internal or external applications. For internal applications, WISE-DeviceOn will trim the data and present results in a visual way to allow system administrators to intuitively understand the status of their system and equipment. For external applications, the server provides APIs for users to connect their data to external systems for extended application. WISE-DeviceOn leverages the features of Grafana to create a unified interface. It also provides APIs for developers to integrate all kinds of applications. Grafana has already defined many different panel plug-ins that transform objects and data into graphic visualizations.

In data acquisition, the most prevalent industrial communication protocols are OPC UA and Modbus. Advantech's WISE-DeviceOn also provides related communication interfaces to its edge equipment: Modbus interface for establishing connectivity with edge devices, and OPC UA for communicating with the upper layers in an IT architecture. Via these two methods, SME can acquire field data and transfer it to the Data Service Server in a unified format. Open Database Connectivity (ODBC) is a standard application programming interface (API) so for field equipment and devices that cannot communicate via these two industrial protocols, Advantech provides ODBC APIs . WISE-DeviceOn is highly versatile for data acquisition and management in most scenario cases.



IoT Data Acquisition & Visualization

Powerful system integration supports many applications

The Advantech Edge Cloud Solution with WISE-DeviceOn is now successfully applied in many industries. For example, a TV controller SoC supplier has applied it to their test equipment. This IC maker uses over 200 computers to perform tests on TV modules at any given time; any unexpected breakdown of these test units could impact their production efficiency. To ensure the health and reliability of these test units, the IC designer decided to deploy Advantech's Edge Cloud Solution and edge computing system to implement remote monitoring of all test units in the field. On detecting abnormal signs of any equipment, the company initiated preventive maintenance to quickly preempt failures and downtime. The over the air (OTA) function provided by WISE-DeviceOn allowed the company to remotely update the firmware of all edge devices in batches.

The second application example is for a Print Circuit Board (PCB) manufacturer who took advantage of Kubernetes containerized management technology and Advantech's WISE-DeviceOn platform in developing their own thermal oven baking system. Baking ovens are frequently used in PCB manufacturing as a curing process after printing, soldering, or coating. Semi-finished boards are sent to an oven in batches and baked in stages. The time and temperature for each stage of each batch differs depending on each different product requirements. In the past the temperature profiles are controlled manually by technicians, and a careless error in the process could result in substantial loss. The company decided to introduce an automatic baking system, which utilizes an OTA function provided by WISE-DeviceOn platform to allow the server to input temperature portfolios over the air to various edge devices to carry out and oversee the baking process automatically. The WISE-DeviceOn platform automatically recorded production status of each baking run and connected data to the company's MES system. In this way the company met their digitization targets for their manufacturing process management and because of the flexibility provided by Kubernetes technology, the microservices needed for their baking system could be adjusted and renewed at any time according to their production needs.

The application requirements of these two companies were similar to those of most companies. They decided to deploy a Windows version of the Edge Cloud Solution; while the PCB manufacturer needed to develop their own custom functions, so they chose the Kubernetes version for more convenient development and deployment. Kubernetes has become a preferred route for SME wanting a containerized management platform, and many software and hardware suppliers are developing Kubernetes-related products. Advantech as a bellwether in the automation field will increase development efforts in this regard to provide more powerful and complete cloud service platforms to all our customers.

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