ADVANTECH
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Technical White Paper

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Enable Intelligent Maintenance on Cloud-based WebAccess

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Introduction

The concept of “smart manufacturing” has flourished in recent years. Industry 4.0 will upgrade global industrial capabilities by increasing communication among equipment, devices, and humans via Internet connectivity. A cloud-based IIoT SCADA gateway is a system capable of supporting data storage and performing data communication from data concentrators to data consumers. Its equipment uses sensors/devices that retrieve hundreds to thousands pieces of data per second. A large amount of device data is generated in the manufacturing system. Big data and has a massive influence on industry. A PR Newswire article reported that “Companies that effectively analyze and act on the huge amount of information available today and in the near future will improve decision making and enable the accurate delivery of advanced functionality like predictive insights.”1

Big Data Explained

The exploration of key information is an important issue for big data. Data analysis is used to extract patterns from a dataset and explore hidden relations for further use and make predictions about the status of machines.

Predictions from automation systems are one of the best methods for IIoT implementation. Data science techniques can be applied to process the data to detect early-stage failure and equipment maintenance. For example, clustering is the process of partitioning datasets into classes of similar variables and determining the potential features of each cluster to assist in forecasting.

The predictive results can be applied in the cloud-based IIoT solution to illustrate the data using a graphical component, inform customers of the failure diagnosis, and maintain recommendations via e-mail and SMS. Figure 1 shows how a cloud-based architecture offers extensive flexibility for interconnecting devices, information, predictive maintenance, and services on different types of platforms. In WISE-Pass, large amounts of device data are uploaded to the cloud via the MQTT web socket protocol. All system configurations, project database files, and graphics are stored here in a project node. The project node is a development platform for Advantech WebAccess and a web server for all clients to connect to the development project or remotely monitor and control the system. The SCADA node communicates in real time with automation equipment and controls the equipment via serial, Ethernet, or proprietary communication using multiple built-in device drivers. Advantech WebAccess provides various services to show prediction results, including animated graphic displays, real-time data, trends, alarms, and logs, and predictive maintenance is available in the cloud architecture.

1 “2025-A Day in the Life of Big Data”, PRNewswire
http://www.reportlinker.com/p03548141-summary/A-Day-in-the-Life-of-Big-Data-.html

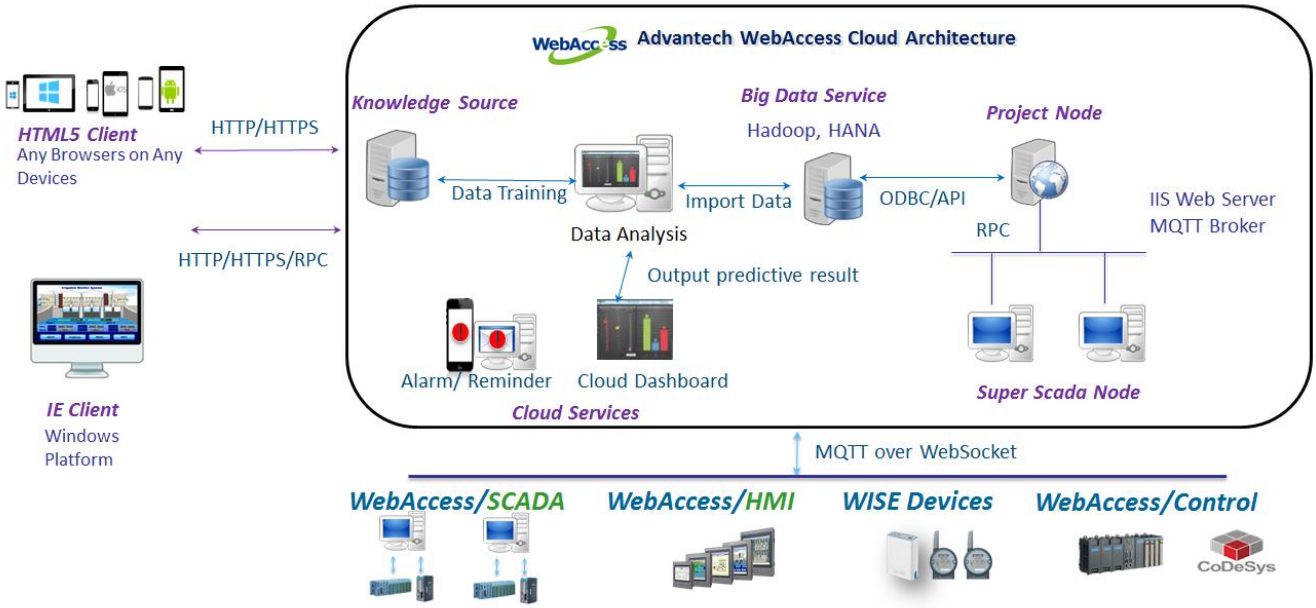

Figure 1- Advantech WebAccess Cloud Architecture

Cloud-based Prediction

The predictive maintenance model is based on the framework of Advantech WebAccess. Figure 2 shows how cloud-based predictions offer the customization of prediction services for interconnecting devices, information, and services using statistical analysis and data science techniques. The large volumes of data streaming from connected devices and sensors can be stored in frameworks such as Hadoop. Historical and real-time data can indicate what may happen in the future. An attribute type of cloud data is defined before conducting the prediction model; the choice of measurement/prediction method depends on the type of variables involved in the analysis. By understanding the data provided by Advantech WebAccess, customers can predict future events to confidently make recommendations that will improve safety, reduce operating costs, and inform the information required for device maintenance.

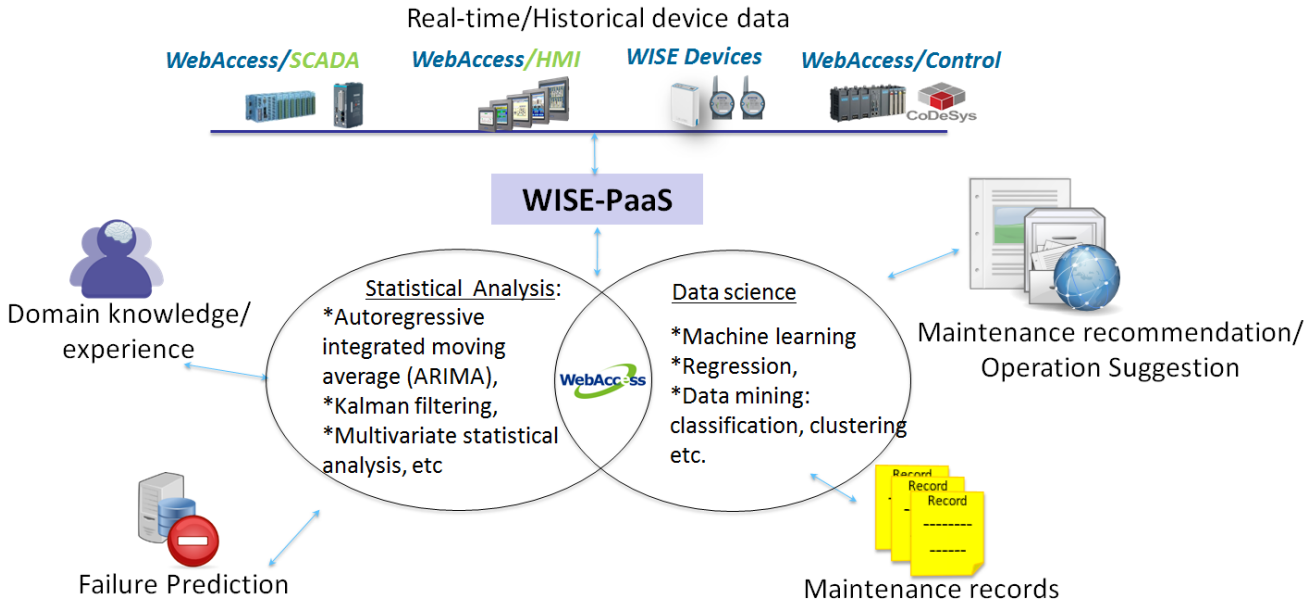

Figure 2- Cloud-based prediction

1. Setting predictive goals and processing original data

The data collected for model development are initially considered as raw that requires organizing and cleaning. In the beginning, predictive goals needs to be set, and the data needs to be prepared in the predictive model. Data from different industries have unique characteristics (e.g., a time continuous state), and different data types have different procedures for measurement. For example, an ordinal variable has a number of categories that have a clear ordering, whereas a nominal variable has a number of categories without any type of natural order. An interval variable permits the comparison of the differences between values to be quantified. The cloud data need to be filtered for unnecessary data, and the attribute of each data type needs to be identified. The suitable data analytic technique is then applied to process the data for estimates based on the predictive goal.

2. Conducting the predictive model by training the data such as regression and classification model

Some prediction modules e.g., Microsoft Azure ML Predictive Maintenance Template and IBM SPSS Modeler exist to implement predictive maintenance. In Advantech WebAccess, the predictive maintenance application can use existing modules and statistical theories to forecast future trends, events, and outcomes. Cloud-based predictions can add the processed data to models, e.g. air conditioning system

maintenance. If customers want to increase predictive maintenance performance, customers can set the goal of the minimax

estimator for the failure rate of an air conditioning system and choose the potential variables. Then, the collected data from Advantech WebAccess are processed to be analyzed using linear regression models. The linear regression model analyzes the relationship between the response or outcome (failure rate of the air conditioning system) and a set of predictor variables (temperature and operating time and speed). This relationship is expressed as an equation that predicts the failure rate estimation as a linear function of the temperature, operating time and speed with different weights. With the real-time temperature and operating time and speed data input in the failure rate estimation, the failure rate can be predicted and results can be deployed using the Advantech WebAccess Service.

3. The predictive results deploy on Advantech WebAccess service.

Using communication with the Advantech WebAccess service, the predictive maintenance results can be integrated with the Advantech WebAccess service to help determine the conditions of in-service equipment and predict when maintenance should be performed. Cloud-based Advantech WebAccess services provide a variety of applications, such as data visualization and customers reminders, and offer extensive flexibility for interconnecting devices, information, and services on any type of platform. Advantech WebAccess 9.0 has enough flexibility to deliver almost any data information to devices and customers.

Machine Learning

Just as humans learn from experts and teachers, so to do does data need training by observation or computation. Machine learning can be viewed in the same way as the learning process for students with the data representing the students. This concept has been applied in several models that use the query mechanism in a training algorithms to enhance the performance of computation. Cloud data from Advantech WebAccess can be filtered as a useful feature for prediction. The expert's knowledge plays an essential role in predictive maintenance. To advance its goal of being customer-centered, Advantech WebAccess also provides an adaptive predictive maintenance solution. In Advantech's WebAccess predictive service, customers can identify expert experience and knowledge as a source that can provide relevant examples for data training (Figure 3). Table 1 shows the advantages of using expert experience in predictive maintenance.

Table 1 the advantages of using an expert's experience in predictive maintenance

• Enhances the resulting prediction accuracy with a small amount of additional complexity. • Increases the computation performance, and achieves information gain with positive lower bound, as the prediction error decreases exponentially with the number of queries. • Provides a more efficient way to deal with large data sets and achieve good clustering and classification results. • Diversifies results leading to a better understanding of the solution. • Reduces the data computation time.

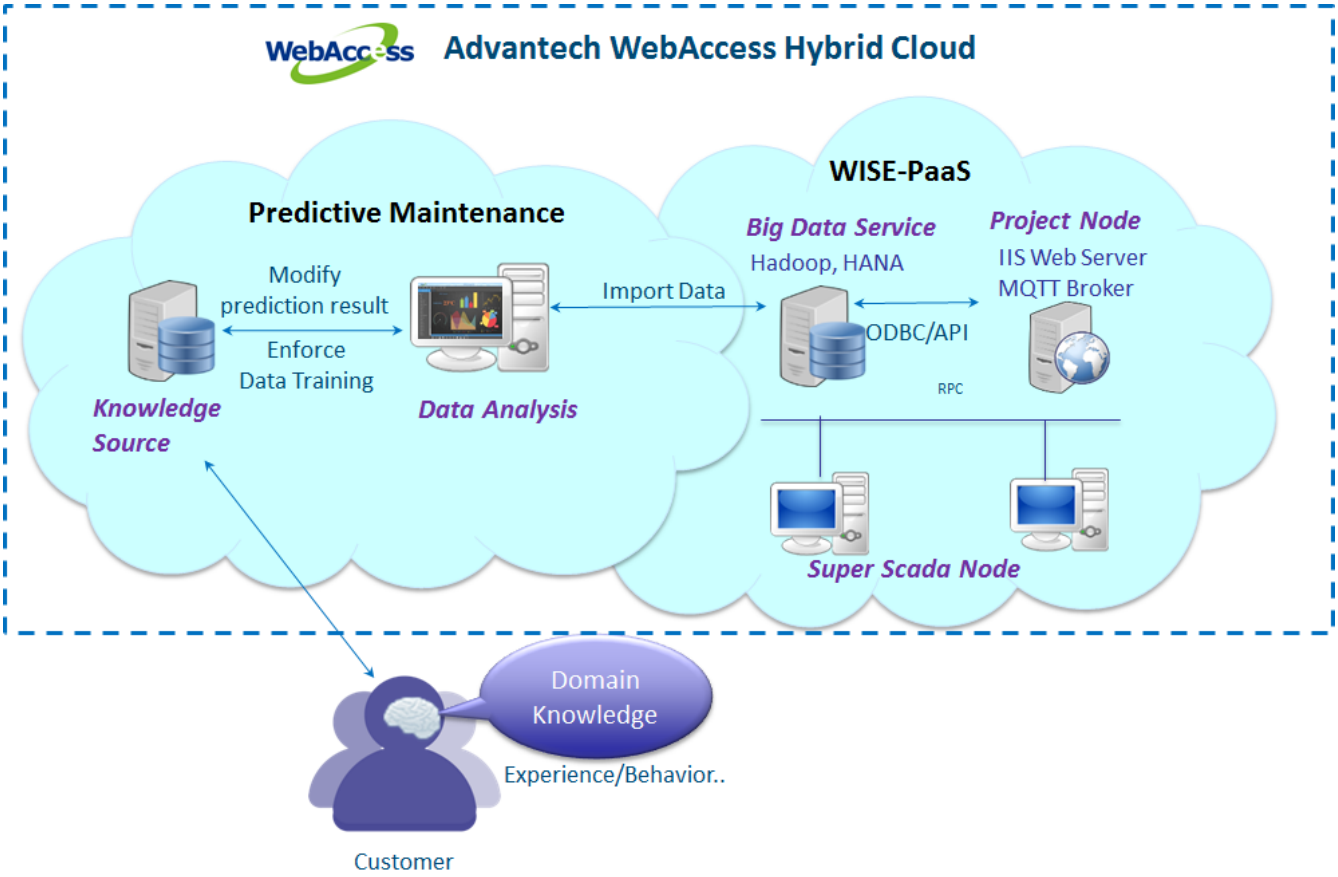

Figure 3- Integrating the expert's experience in the predictive model

Enhancing the Value of IIoT Solutions

Predictive maintenance has been widely applied in various IIoT solutions. Advantech WebAccess provides various services, and predictive results can be applied via data visualizations and notifications for fault diagnosis, prognoses, and maintenance scheduling. The dashboard service can display the graphic predictive results, and the predictive results can alert customers via alarms and reminders of future events via e-mail or SMS. This feature of Advantech WebAccess supports predictive maintenance (Table 2). Various data analytic techniques can make confident real-time recommendations and provide feedback of results to customers via the Advantech WebAccess service. Advantech WebAccess has the advantage that data acquisition and cloud-based visualization tools can more effectively predict trends and display predictive results.

Table 2 Advantech WebAccess Features that can Support Predictive Maintenance

Feature	**Support**
● Remote engineering and support with Advantech WebAccess Cloud Architecture	Failure Monitoring Equipment Diagnosis
● Supports ample drivers, including Advantech I/O, controllers and major PLCs	
● Redundant SCADA, ports and devices - High availability.	
● Advanced SCADA Function: Alarm, Schedule	Maintenance Scheduling
● Excel Report integration for report format customization	Maintenance Report
● Advanced SCADA Function: sending e-mail and SMS	Equipment Maintenance
● Web-enabled video, audio and animation in Advantech WebAccess View	Predictive Visualization
● Business Intelligence Dashboard - cross-browser, cross-platform Advantech WebAccess HMI based on HTML5	
● Open Interfaces - Web Services, Widget Interfaces and Advantech WebAccess APIs	

Example Application

Manufacturing operations, agriculture, and energy facilities can benefit from the application of cloud-based predictive technologies. For industrial operations, the provision of predictive information and determination of potential predictors enable companies to reduce costs, improve safety, increase their industrial capabilities, and prevent costly downtime (

Figure *4*).

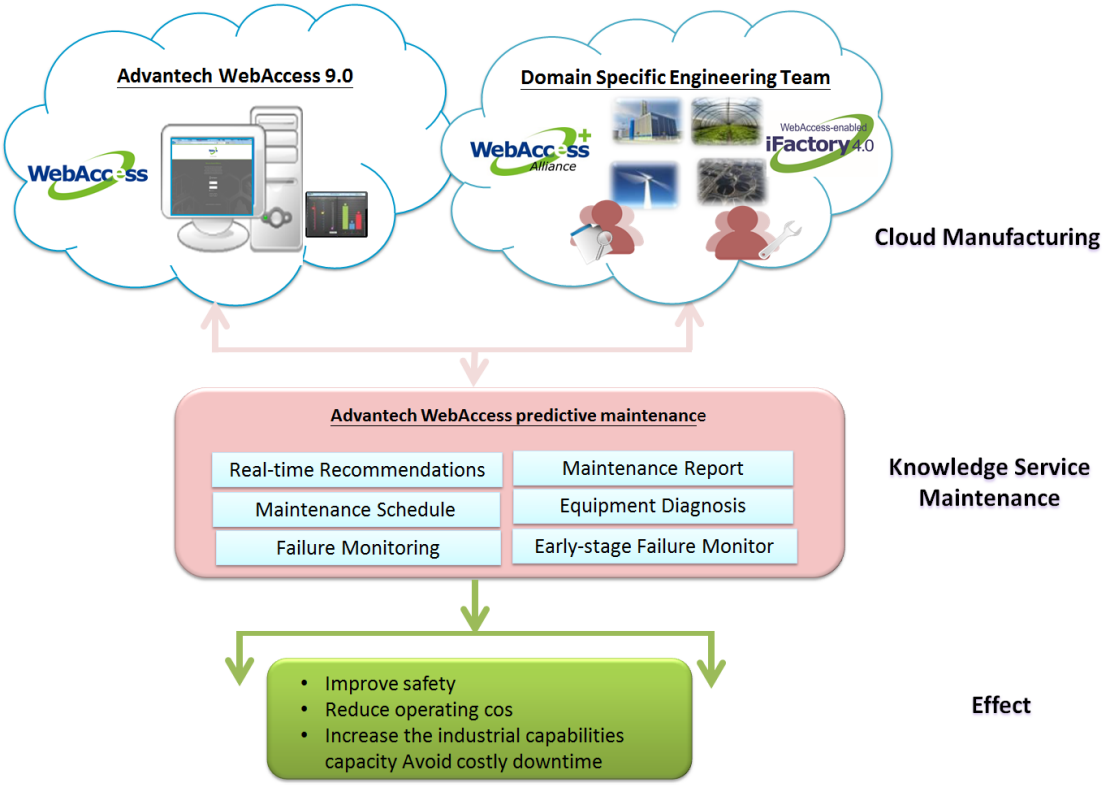

Figure 4- A predictive maintenance application based on Advantech WebAccess 9.0

Consider a factory that has forming machines, cutting beds, and shearing machines. In this case, each machine has a unique maintenance procedure. The framework for predictive maintenance is formed as an integrated model, which is divided into device, modules, and client components. If a customer sets a goal that the minimax estimator for the failure rate of forming machines, the historical data (e.g., failure state, temperature, product capacity, power capacity, pressure, and device type) from a cloud-based device is collected for analysis. The cloud data need to be filtered to eliminate unnecessary data, and the attribute of each data type needs to be identified. Data preparation aims to explore a suitable prediction model and the relation among potential factors, which can improve predictions of the failure rate. Then, the processed data are analyzed using a Bayesian network model. This model estimates features and represents relations and influences among features. With a

real-time feature, inputs such as the product capacity and pressure influence the failure rate estimation in real time, and the failure rate can be predicted and the results can be deployed using cloud-based connectivity. When the

predicted failure probability satisfies the threshold of safety limits, the predictive results provide performance warnings via cloud-based services (Figure 5). Moreover, repair records are sent to the cloud database for further maintenance analysis.

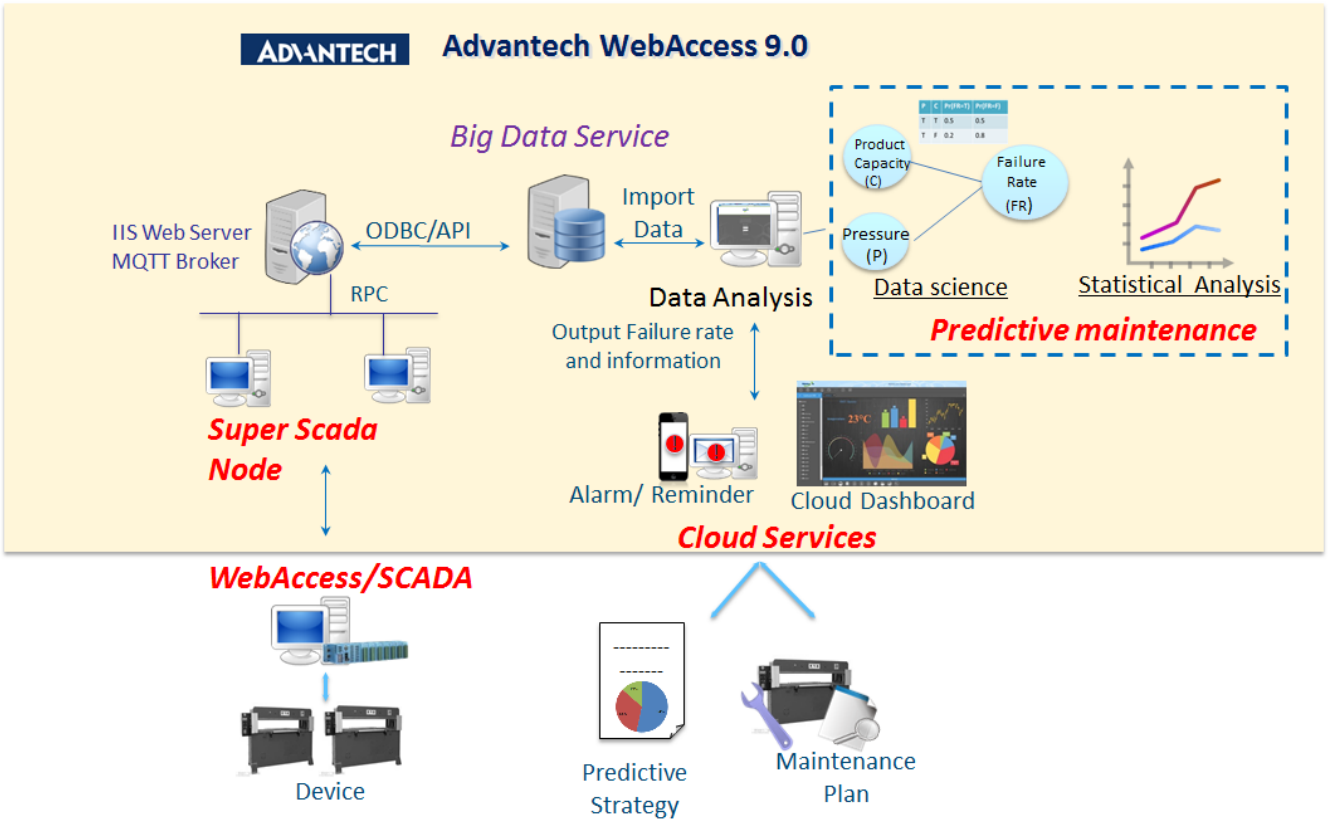

Figure 5- Advantech WebAccess 9.0

Conclusion

The overall goals of intelligent maintenance on cloud-based WebAccess are as follows:

1. To determine the relations between features and the predictive problem.
2. To assess features with regard to early stage failure and maintenance.
3. To customize the maintenance strategy for enhancing equipment working performance.
4. To analyze the effect of different predictors on device performance.