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Cloud-Based SCADA as an IIot Gateway

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Consumer media is awash with articles concerning the Internet of Things (IoT) and how smarter devices, the things in the IoT, are changing the world. Another hot tech topic is the cloud in all of its forms: cloud storage, cloud-based apps, cloud-powered mobile devices, cloud-hosted virtual machines and other applications.

Yet the IoT and the cloud have much more to offer than consumer-grade conveniences. A fusion of IoT and cloud technologies has specific applications in the industrial automation sector, creating the Industrial IoT (IIoT). Unquestionably, cloud-based supervisory control and data acquisition (SCADA) software provides an ideal gateway to deliver practical and actionable IIoT information to those who need it.

Most IoT discussions to date have focused more on commercial than industrial implementations, but according to a GE/Accenture white paper, this focus should be changed to favor the IIoT because "data created by industrial equipment such as wind turbines, jet engines and MRI machines … holds more potential business value on a size-adjusted basis than other types of Big Data associated with the social Web, consumer Internet and other sources."[1]

Oftentimes consumer-focused discussions about the IoT often revolve around refrigerators and coffee pots chattering with each other, or maybe reporting some details to their users. However, for IoT applications to move beyond curiosities and parlor tricks and into the realm of usefulness, the bits and bytes of available data must be served up within a pertinent context and formed into actionable information.

Of course, the cloud is great for uploading photos and downloading music. But to achieve greater productivity instead of just providing entertainment, we must look at new ways to leverage the unique capabilities offered by the cloud. Cloud-based SCADA software is an established product with the features required to transport, store and present useful IIoT data.

Harnessing cloud capabilities to harvest IIoT factory data and then distribute it to users is a powerful combination. Cloud-based SCADA software is an ideal platform to act as an IIoT gateway, empowering customers to use information and reap significant benefits. This White Paper will examine how industrial data can be transformed into IIoT information via cloud-based SCADA solutions, and will show the many advantages of doing so.

Interfacing to Existing Automation Systems

One overlooked reality is that factories, processing plants, OEM equipment, material handling systems, and remote facilities are often actually quite a bit smarter than realized. Most of these systems are automated by various types and vintages of computer-based control and monitoring systems. This means the foundations are in place for large amounts of data to be provided to cloud-based SCADA systems.

Sometimes the biggest challenge is geographic, when a facility is fragmented into many islands of automation that are not yet integrated with each other or with higher level computing systems. Other times, a site has legacy or proprietary control and monitoring

systems which are not readily tapped for data. Fortunately, there are many solutions available to address each of these situations in a cost-effective and scalable manner.

The good news is that the data available from automation systems is of the very best type for IIoT implementations. As this Wikibon.com article puts it, “Leveraging the Industrial Internet and the torrent of data being created by industrial equipment presents numerous opportunities to improve efficiencies of current operations in the impacted industry sectors.”[2]

IIoT data can concisely define a system’s throughput and performance, and show where it is working well and where it is breaking down. And this is the kind of information that can be acted on to expose unexpected inefficiencies, enable improvements that make a factory work better, and generate significant savings.

Crunching Numbers or Making Connections

Perhaps it is important at this point to develop a distinction between a “data concentrator” and a “cloud-based IIoT gateway”, since the two functions are related but distinct. Both pieces are typically incorporated in a complete IIoT solution. Data concentrators are closest to the data sources, while the gateway is closer to the data consumers.

Any factory-located automation or data acquisition system, however large or small, can act as a data concentrator. These distributed systems, whether they are programmable logic controllers (PLCs), proprietary controllers, or even human machine interfaces (HMIs)—can touch a large number of I/O points. However, not every limit switch status needs to be reported to the outside world, although such information might be critical to automation system operation.

Instead, what makes the most sense is for the local automation or data acquisition system to crunch the numbers and perform real-time control, and to consolidate only the most useful information. Sometimes this information is an actual field signal like a pressure or temperature, while in other cases this information is derived from calculations, alarming logic or other algorithms. Raw field signals are conditioned to remove noise and scaled into proper engineering units to make them most useful. Equipment operating modes and conditions also provide important information, but are not usually based strictly on I/O signals, and thus require some data preparation by the local automation system.

The resulting serviceable information is really what needs to be communicated to supervisory systems so that humans or higher level software can act accordingly. A cloud-based IIoT SCADA gateway is the connection system that aggregates one or more data concentrators and other data sources to perform the communication function from the concentrators to the data consumers.

Data concentrator sources can reside in a single facility, or be distributed over multiple geographical locations. Wired network infrastructure or wireless technologies can be leveraged to interconnect any type of systems. Private and hybrid clouds can be structured on virtual machines or dedicated servers. More than ever, bridges and protocols exist that allow any source to be effectively tapped. Figure 1 shows how Cloud-based SCADA offers

extensive flexibility for interconnecting devices, information and services—all over any type of platform.

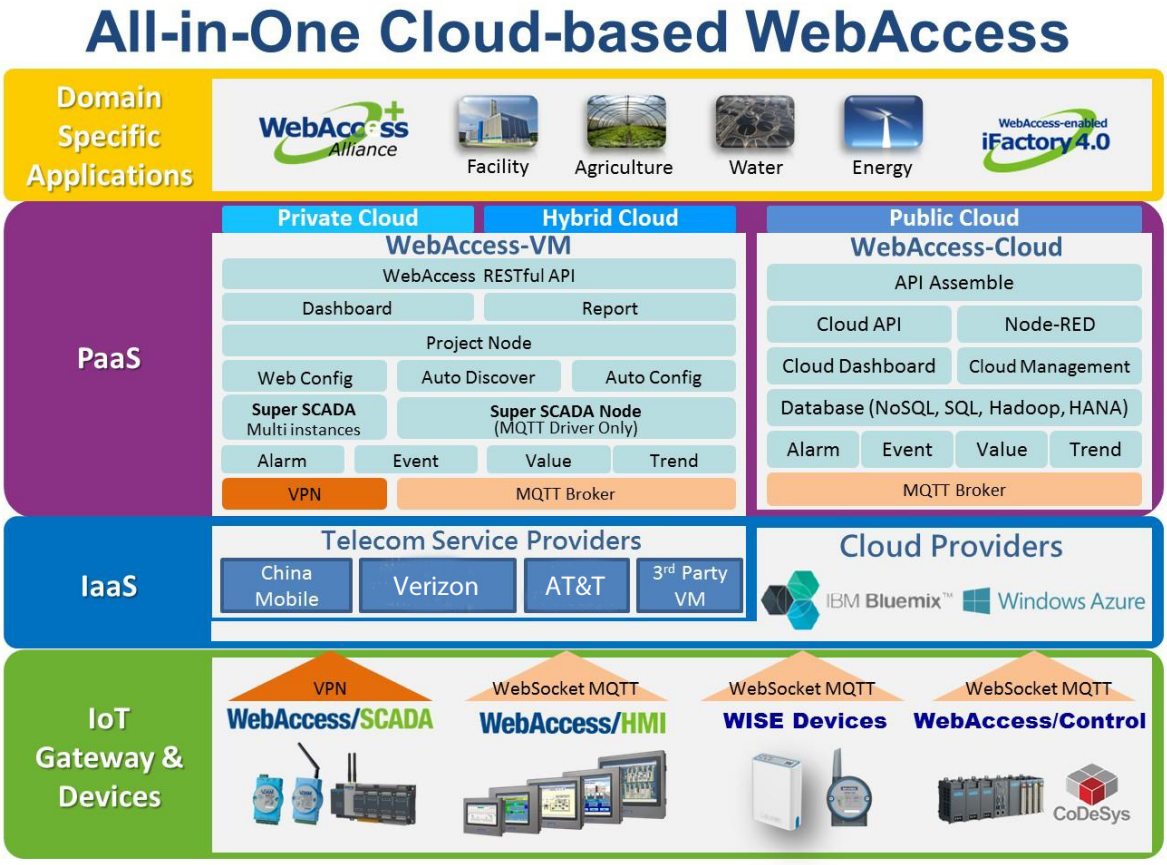

Figure 1

In a sense, the SCADA gateway is also a concentrator of sorts. While the data concentrator pre-processes and refines various data streams locally, the gateway consolidates various data concentrator streams into a single common accessibility platform. Gateways continue the concentration process at a higher level of functionality, and can offer other direct capabilities such as diagnostics and SCADA.

For example, cloud-based SCADA systems can add intelligence to data by executing pre-programmed routines to show patterns and predict incidents before they occur. This can be done by applying certain business intelligence rules to data, producing actionable information.

Fourth Time's a Charm

Why are data concentrators and cloud-based IIoT SCADA gateways more relevant than ever? The quick answer is the fourth industrial revolution; dubbed “Industry 4.0”.[3] Industry 4.0 is concerned with IIoT power, and with increasing communications among devices, machines, and humans via Internet connectivity to empower smart manufacturing. This is a

progression from the three previous industrial revolutions which centered around water and steam power, electric power and computing power.

Creating true value is the goal of Industry 4.0, but how is this achieved? Deutsche Bank Research finds that factories, logistics and even products become smarter to support the required functionality. The concept encompasses “not only value creation per se, but also work organization, business models and downstream services. It does this by using information technology to link up production, marketing and logistics and thereby captures all resources, production facilities and warehousing systems. The reorganization thus extends from the energy supply and smart power grids through to advanced mobility concepts ...”.[4]

A cloud-based IIoT SCADA gateway occupies a space in the middle of the requisite Industry 4.0 technologies. Data is generated at IIoT devices, and it is consumed by mobile users and business applications. The gateway is what gathers all of the pre-processed information and makes it effectively available for these end users or data consumers.

Another aspect to consider is who will be integrating the IIoT with the cloud. Traditionally, operations technology (OT) automation engineers have handled the control systems and related equipment, while information technology (IT) professionals have handled business computers and networks. The nature of data concentrators and cloud-based IIoT gateways is that the two disciplines now interact and actually overlap. Therefore, for effective IIoT implementations, the relationship between OT and IT must be carefully cultured and managed. The first step is to identify the data.

All about the Data

When it comes to smart manufacturing information sometimes “more is better”, but “better is best” all the time. This means that even though it is possible to transmit every possible signal, a better strategy is to make good decisions about what is provided to the gateway. It is important to remember that excessive data may be treated as an intractable mass, blurring effective use of the valuable information buried within. Good data pre-processing choices will transform disorganized data into targeted and useful information. Table 1 explores some of the key IIoT data characteristics.

Table 1: Key IIoT Data Characteristics

- Industrial automation and data acquisition systems handle a multitude of raw real-time field data
- These systems can pre-process raw data and act as a reliable IIoT information sources by putting this information into context
- Industrial automation and data acquisition system data can come from small embedded machine controllers with just a few I/O up to plant wide automation systems with hundreds of thousands of tags
- Data can be continuous, scheduled or event-driven
- Established SCADA systems are powerful enough to process and network field data
- IT systems handle processed data
- Databases or other applications needed to bridge the two systems
- Intelligent data transfer is most efficient

The most straightforward data sources consist of process signals like flows, levels, pressures and temperatures. But what constitutes a “good” value, and what defines a “bad” situation that requires attention? The system designer must provide enough information to put these types of signals into context.

Certainly high and low alarm thresholds can be established as the first line of defense in identifying good and bad values. Yet alarming and logging doesn’t always tell the whole story in a way that can guide users toward corrective action to counter developing off-spec conditions.

Going even further, it might be appropriate to identify process conditions as optimal, average or substandard—even if they are not in a fully alarmed situation. This higher order of pre-processing will flow through the gateway and allow users to make more effective decisions.

Analyzing every source of industrial data in an operation can be a daunting task. Sources can range from embedded machine controls (which may be predefined with limited access or locked-down completely), to PLCs and programmable automation controllers (PACs), up to a distributed control system with hundreds of thousands of tags. The key is to divide and conquer by initially selecting sources expected to provide the best value.

One strategy is to pick a few small and simple data sources and systems as a first project, even if they may not offer the absolute best return. An air compressor system might be a good example. When the test cases are proven, one can focus on more complex data that will help improve high-value product processing.

Data comes in many flavors such as discrete (on and off) and analog (reported over a scaled range). It can be continuously reported, scheduled on a time basis (such as hourly or daily), or generated in an event-driven manner (such as when a batch completes).

Consider the best way to elevate useful information to users. For instance, knowing whether a photoeye is on or off on a conveyor may not be very helpful at a supervisory level, but counting how many items passed a checkpoint during the last rolling hour or during a shipping campaign may describe the operation’s efficiency in a useful manner at a glance.

Sometimes it is not necessary to reach all the way down to an automation controller in order to obtain IIoT data. Many systems incorporate HMIs, operator interface terminals (OITs) and SCADA systems which are primarily used to provide automation system visibility to operators, and to allow them to initiate commands. As it turns out, all of these products are very mature and quite powerful enough to gather and process data, and to make this data available on the network. This may actually be the preferred solution for smaller skid equipment where each package has its own controller and OIT.

As the data harvesting activity proceeds, keep in mind that IT systems are tailored to provide processed data. Common networking protocols and methods are quite good at handling

large data blocks such as videos and computer files. This contrasts somewhat with the comparatively smaller-sized blocks of industrial data. OT and IT systems are still a good fit for interconnectivity, but these differences must be understood, and accounted for as required.

Databases are one method of preprocessing data on a larger scale, and can represent an effective option for bridging OT systems to the IT level. Similarly, a dedicated application such as a third-party historian may be the right choice to archive large amounts of historical data, and then perform calculations or reporting on it so that only the pertinent results are offered to the gateway.

Intelligent data transfer is the goal. In an IIoT report, McRock Capital explains it this way. "The IIoT is connecting the physical world of sensors, devices, and machines with the Internet and, by applying deep analytics through software, are turning massive data into powerful new insight and intelligence."[5] Instead of promoting every bit of data up to the cloud, IIoT adopters must invest some up-front effort to define what is available and useful, which in turn will pay benefits in efficiency. Next we examine why the cloud is a natural gateway for IIoT information.

Why Look to the Cloud?

The "cloud" is already used extensively for serious business applications such as e-commerce and banking. It is an easy extension to imagine the cloud as an ideal technology for handling IIoT data in a rigorous and highly secure manner. There are many inherent benefits and features of using a cloud-based IIoT gateway, as outlined in Table 2.

Table 2: Cloud-Based SCADA IIoT Gateway Benefits and Features

- Compatible with legacy interfaces like RS-232/485
- Connects with contemporary industrial field buses
- Handles many common industrial protocols such as Modbus and EtherNet/IP
- Can also handle vendor-specific protocols
- Uses common web protocols
- Designed for advanced Ethernet, TCP and UDP connectivity
- Operates over various established media such as wired Ethernet, Wi-Fi, and cellular data networks
- Offers redundancy capability
- Provides local storage, and store-and-forward capability
- Network Data Security

Possibly the greatest characteristic is flexibility. Even though cloud-based configurations use the latest Internet technology, they are modular enough to incorporate legacy media and communications methods.

For example, RS-232/485 serial implementations using protocols such as Modbus have been workhorses in the industrial automation arena for decades. Many serial-based instruments, controllers, and other proprietary devices remain in service today with no driving justification for replacement. Fortunately, there are bridging devices available to empower

such legacy devices to be useful IIoT data sources by converting proprietary protocols to standard Ethernet-based outputs.

Although communication media and protocols are moving to standardization, there are still many technologies in active service. Examples of industrially-oriented contemporary field busses include Profibus, Foundation Fieldbus and DeviceNet—each implemented on a variety of media. In fact, many industrial protocols are purposely implemented on several types of media ranging from serial to Ethernet to enhance their flexibility. Other protocols are somewhat tailored to industries, such as BACnet and LonWorks for building automation, and DNP for the power industry. Add to this the fact that some device manufacturers still use vendor-specific protocols, and there remains a wide variety of communication methods.

Cloud-based gateways have the ability to roll up all these varied communication methods into a common platform. Each connection is translated as needed, so that the end user is presented with a unified structure. The cloud-based gateway itself uses common web protocols and advanced Ethernet, TCP and UDP connectivity to ensure required levels of performance.

An extended physical reach is possible because a cloud-based gateway can operate over any sort of established media. A new installation might rely primarily on wired and wireless Ethernet, and could aggregate many sources via the local ISP service and the Internet. However, retrofit situations and remote locations might take advantage of telecom data connectivity over LTE, 3G or even GPRS wireless networks. Figure 2 depicts how Cloud-based SCADA can act as a centralized pivot point for harvesting IIoT information from industrial automation systems using a wide variety of media and protocols.

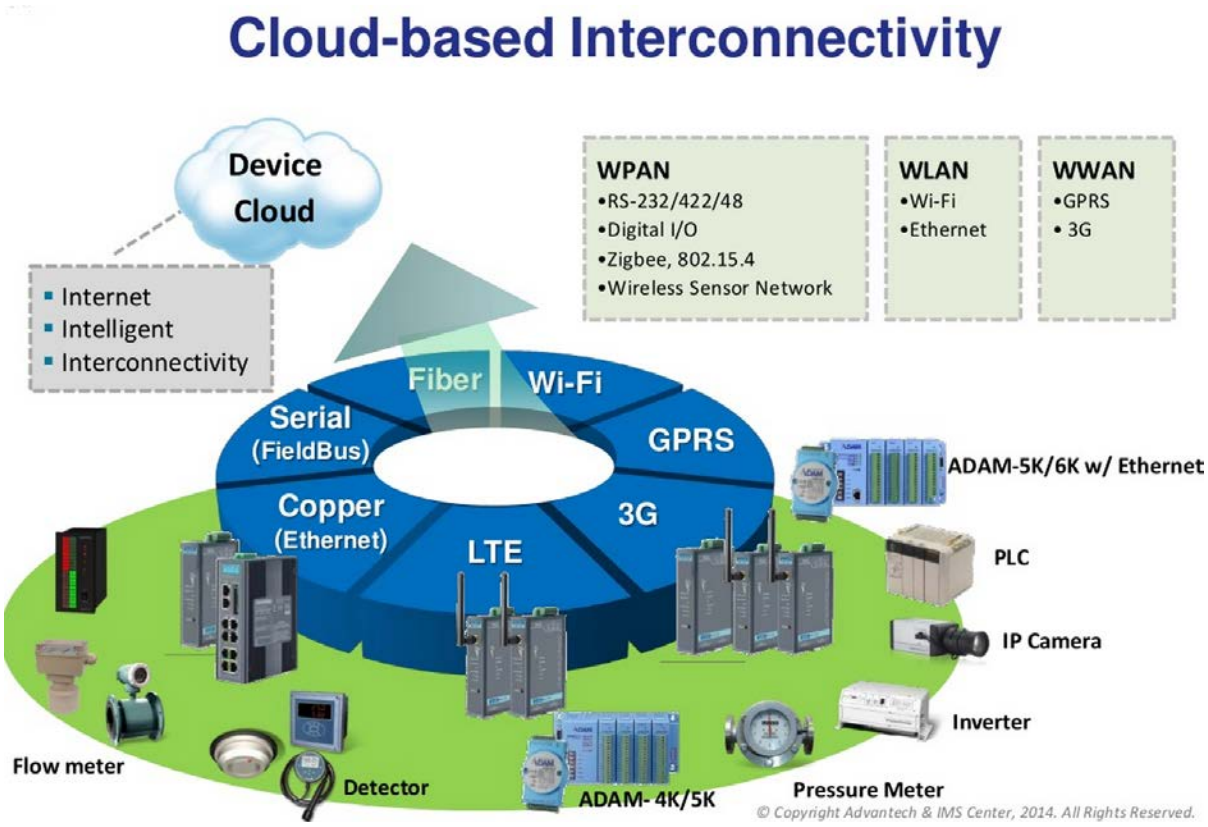

Figure 2

Other capabilities expand the effectiveness of a cloud-based gateway. For instance, redundancy capabilities improve system uptime in the event of a failure. Similarly, local storage combined with store-and-forward capability allows information to be buffered during a failure, and then transferred when service is restored. Even though IIoT information is less critical than direct local real-time control, users still demand reliable communications performance.

Harnessing IIoT information is not just a specialized laboratory experiment. Instead, companies everywhere are moving to add visibility to their current operations using these technologies.

Application Example

Many application domains can benefit from applying cloud-based IIoT technologies. Energy generation, water treatment, manufacturing operations, and even campus facilities and agriculture all have distributed systems in place which need to be monitored and acted upon from control room locations and by mobile users. Putting the right information in the hands of operators and maintenance technicians enables to them to respond quickly.

Consider a factory with a typical assortment of equipment. There is power switchgear, where the main incoming electrical supply and the major subfeeds already have power monitoring devices. A boiler system has standalone controls that monitor the incoming gas flow and the

steam production and pressure. Incoming plant water usage and makeup water to the boiler are tracked with standalone transmitters. Freestanding skids with dedicated controllers and OITs from several vendors provide soft water and compressed air, while another digital control system handles the HVAC duties. The main process is automated by a handful of PLCs and PACs.

As with many locations, each of these equipment areas is as island of automation because they were added incrementally and there was no driving need to have them interact, beyond perhaps some simple on/off interlocks. But instead of having technicians constantly make the rounds, or worse wait until something fails outright, there are methods to roll up each of these IIoT sources and elevate them to a common cloud-based SCADA gateway.

Since energy usage is always a key concern, the power monitoring devices should be tapped to provide instantaneous kW usage and alarm signals, possibly via a Modbus interface or a local I/O device. Either of these devices could be plugged into the plant-wide automation network, which is likely to route near the electrical room.

For the boiler and other standalone skids, the automation system vendors would need to be approached to find out what connectivity methods are available. A common interface could be Modbus over Ethernet. With such a connection established, the boiler could provide gas usage and steam flow information, as well as any trouble signals.

Water flow transmitters might be located quite a distance from wired Ethernet, so those signals could be captured using 4-20mA analog input transmitters that convert the signals to Wi-Fi. Fortunately the HVAC controls typically have several interface options, with BACnet being quite popular.

All of the IIoT data points so far have been of the utility type, necessary in order to paint a picture of energy and water usage in the plant. However, the real heart of the operation consists of the process control PLCs. Any contemporary PLC will likely already have Ethernet connectivity using EtherNet/IP, Modbus TCP or Profinet. A cloud-based SCADA system will have native drivers for each of these protocols, and many more. The challenge will be modifying the PLC programs to gather the best production metrics, such as output rates, overall efficiency, and any other parameters that usefully describe the system.

With each building block of IIoT data, whether from an individual transmitter, a hardware gateway device, or a larger PLC-based data concentrator—the usefulness of a cloud-based SCADA IIoT gateway grows. Within the plant, the SCADA system can provide a consolidated dashboard for management, indicating instantaneous and recent performance. Out in the cloud, analytic programs can use the energy and production data to report on improving (or degrading) trends. Supervisors anywhere can use mobile devices to check on the heartbeat of their operation, and to be apprised on any conditions requiring response (Figure 3).

Figure 3- Advantech WebAccess SCADA Software

Conclusion

The industrial-based IIoT is rising in prominence, perhaps even faster than the commercial IoT. Cloud technologies are a mature and secure way to handle consumer and banking data, and are more than up to the challenge of securely handling manufacturing data.

A cloud-based SCADA system can act as a centralized pivot point for harvesting IIoT information from industrial automation systems. Such a system harnesses all the performance and capabilities of today's powerful Internet applications, with enough flexibility to access almost any vintage of data source. Add to this the ability to reach out to connect data over many types of wired and wireless media, and it is evident that cloud-based SCADA is an ideal method to implement Industry 4.0 and fully harness the power of the IIoT.

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