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USING OF SENTIENCE PLATFORM FOR INTEGRATION OF INTELLIGENT SYSTEMS AND DEVICES INTO CLOUD

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Abstract: *In this paper considered unique Sentience hardware-software cloud platform which provides special cloud framework for multiple devices and systems for connectivity to cloud and taking maximum advantageous from this connectivity. Cloud-connected solutions is next step in industrial IT-technologies which allows to decide many earlier problems by totally different way.*

Keywords: *IOT, IIOT, Cloud Computing, Sentience platform, Application Programming Interface (API), User Interface (UI), Big data, Azure, Edge, Software as a Service (SaaS), Original Equipment Manufacturer (OEM), layer.*

Introduction

To introduce Sentience platform, we firstly have to remember what IIoT platform is.

The IIOT (Industrial Internet of Things) is the intelligent application of digital technology to solving the automation needs of an analog world. IIoT could equally be called the Intelligent Internet of Things. There are two fundamental pillars to IIoT: digital automation systems, and the Internet itself. Although current Distributed Control System (DCS), Production Automation System (PAS) and Discrete manufacturing systems have been described as IIoT solutions, they are not true IIoT systems without the Internet, and Internet based cloud-borne technology. That is not to say that today's automation systems are outmoded; they do in fact play an important role joining with the Internet and Cloud Computing to form an IIoT architecture. And, given the widespread adoption of digital Industrial Automation systems to current manufacturing operations, their evolution to IIoT must be managed in an intelligent and beneficial manner [1].

IIoT concept is expressed by simplified architecture demonstrated by figure 1.

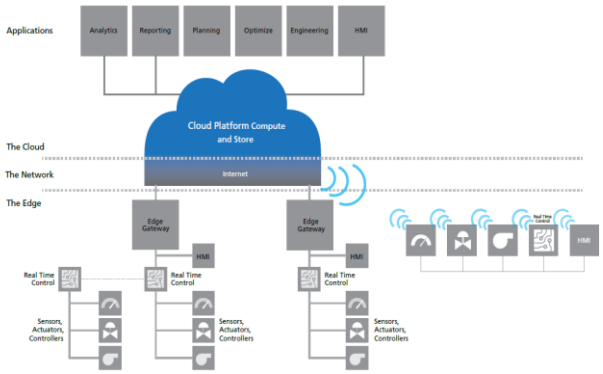

Figure 1. ***IIOT simplified architecture***

1. Statement of a problem

There are three important aspects to the IIoT, and if you get all three right you can extract huge value.

The first is data consolidation. Multiple disparate systems of data have to be brought together. Only then can you identify the root causes of problems that simply weren't visible before.

Second, you need to be able to move that data, in a secure fashion, from the plant into enterprise systems where you can leverage the advanced analytics and expertise that exists across the organization.

The third essential aspect of the IIoT is the ability to securely tap the domain expertise of a whole ecosystem of partners in the cloud, where other organizations such as process manufacturers (OEMs) can help solve additional problems. It's not only process of monitoring, it's process of taking that diagnostic knowledge of the OEM and licensors and original equipment embedding it in an application that can predict and prevent failure [2].

The idea seems like very clear but simple applying of IoT concept in industrial application will not work.

A fundamental difference is that the IIoT aims to enhance the operation and management of industrial production processes, many of which involve exothermic reactions for which safety is a primary concern. Security of IIoT-based systems is also of paramount importance not just from a safety perspective, but also in cases of the production of essential and strategically important goods and services. This concern results in more stringent security, reliability and availability requirements as well as the ability to continue operation with intermittent access to Internet resources.

When failures do occur, the system must continue operation where possible or degrade gracefully, deterministically and safely.

Another distinction of the IIoT is that a factory or processing plant is a very long-lived, capital-intensive asset requiring long-term support in the face of rapid technological advances. This reality requires support for existing, ageing equipment and infrastructure and a means of protecting investments in intellectual property. As a result, many devices that will form part of the IIoT will continue to communicate via existing, often older protocols and will need special mechanisms to integrate them into the wider IIoT environment [3].

2. The concept of the problem decision

Sentience platform is hardware-software IoT platform developed by Honeywell company. Key difference of Sentience platform that it is considered to accommodate all directions of spectrums of different businesses lines worldwide.

Conceptually, there are 6 layers of integration to Sentience platform (refer to figure 2).

L1 layer includes all the hardware devices with sensors that can either connect directly to the Internet/Cloud or only connect to local edge or gateway solutions. This is market domain-specific and where Honeywell businesses add unique differentiated value in their markets.

Unlike consumer segment IoT devices, many industrial segment IoT devices are often grouped by and managed at the buildings, campuses, factories and plants; they don't always connect to the Internet/Cloud directly. This is where L2 Edge and L3 Gateway solutions come in, they provide cloud connectivity, security and control, while enabling local management, administration and operations that require fast responses. L2/L3 is largely common across Honeywell and not domain-specific.

L4 cloud layer provides an elastic scale-out foundation for device/asset management, data management and analytics services - core Application Programming Interfaces (APIs) and services that are common across any business application and not domain-specific.

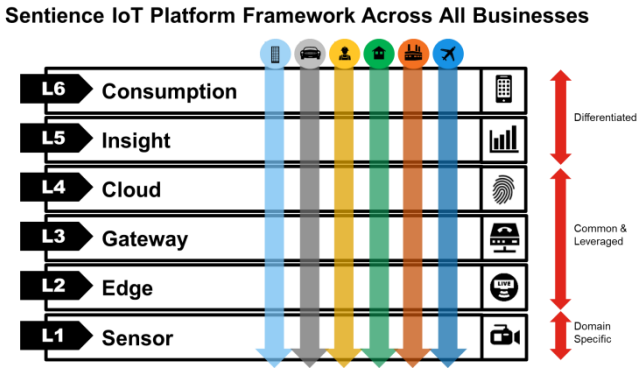

Figure 2. Sentience IOT platform framework

Insight and Consumption layers are domain-specific where businesses build differentiated offerings for their markets.

3. Realization of the concept

One of key conceptual elements of any IIOT-platform is Edge [4]. Honeywell Sentience Edge is a software platform that provides device connectivity, device management and data analytics capabilities at IoT edge. It helps industrial businesses to securely connect legacy devices as well as the new generation smart infrastructure to the IoT cloud. It also provides necessary capabilities to collect data from IoT edge devices and analyze it locally to enable those devices operate independently of cloud.

Honeywell Sentience Edge Platform is comprised of three layers:

- **Device Layer** which consists of sensors and actuators that instrument and modify the environment,
- **Edge Layer** which processes the data received from devices and exercises real-time and/or supervisory control, and
- **Gateway Layer** which acts as an interface between the IoT cloud and the edge

As data generated by industrial IoT endpoints grows, streaming all of the information to the cloud for management, analysis and decision making can be costly, inefficient and sometimes impractical or even impossible. Sentience Edge Platform solves this by providing a decentralized and distributed architecture which is modular, scalable, flexible and trusted, especially for latency critical industrial IoT use cases.

Sentience Edge is designed to secure all communications between Sentience Edge and global instances of Honeywell Sentience IoT Cloud through Transport Layer Security (TLS).

It also secures communication between the edge and tenant instances of Sentience IoT Cloud through AMQPS (AMQPS over WebSockets for C# and AMQP over HTTPS for Java).

Sentience Edge performs crypto operations, such as encryption and decryption of communications through hardware security modules or software security capabilities. It also restricts edge-to-cloud (outbound) connections and does not allow any cloud-to-edge (inbound) connections. Additionally, Sentience Edge allows only whitelisted commands to be sent from cloud to edge.

Another very important success factor in implementation of Sentience platform is rightly established mechanism of big data management.

The Large Scale Data Transfer service is designed to upload large volume data files to Sentience IoT Cloud securely and reliably. Further, it notifies the applications running on the cloud to access the files for additional processing. First, the Sentience Edge application must provision itself in Sentience IoT Cloud with the permission to access File Upload Service and request a secure SAS token from the service. Upon receiving the SAS token, the application can upload the files to Sentience Cloud. The Sentience Edge Large Scale Data Transfer service supports image files, audio/video files and files containing structured or unstructured data. The maximum supported file size by this service is limited to 4TB and the service leverages secure connectivity to transfer the data.

To drive further analytics and data monetization Sentience platform considers robust data

acquisition and management capability. This could be visually illustrated by figure 3.

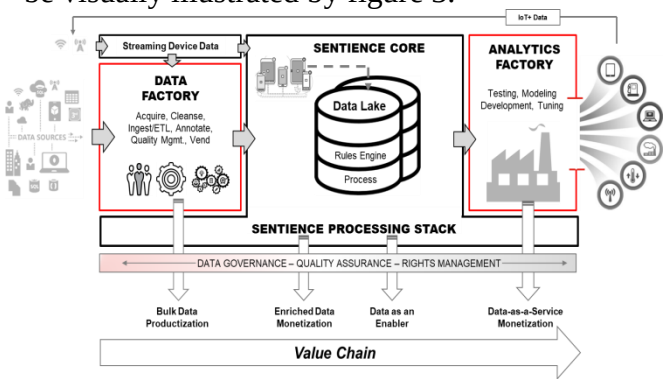

Figure 3. ***Data management in Sentience platform***

There are several stages considered in Sentience platform to manage big data from multiple sources:

1) Data ingestion. The ability to access data across input source types (i.e. API, s3, Azure File Store, plus additional) and support multiple file formats (i.e. JSON, CSV, plus additional) for ingestion into the Sentience Data Lake. Support the ability to schedule and automate ongoing ingestion processes. Ability to define set of required data elements for ingestion based on business requirements. To support ingestion, processes are defined for capture of meta data and reference data needs. All raw data sources are stored for future reference and evaluation. Business users can leverage the processes and templates created to capture requirements and initiate ingestion of data into the Sentience Data Lake. With support across multiple sources and file formats, the ingestion process can be configured to ensure your business requirements are met while all supplemental work to support data governance and data quality are incorporated.

2) Data processing. Ability to transform, enrich, and process data per business requirements (in motion and at rest). Ability to define a logical data model, build a physical data model, and store transformed data in that model in the Sentience Data Lake. Ability to apply defined data quality checks on data and provide reports of those metrics. Support business requirements by incorporating transformations, data quality checks, or enrichment of data sets through this data process. Ensure data conforms to defined data models to enable consumption of data into analytic models or products.

3) Data Consumption. Ability to vend data to Data Scientists as files via WASB (Windows Azure Storage Blob), or from a Sentience database such as Hive. Ability to provide data for analytic models using Hive. Ability to visualize data in a limited manner using Zeppelin and Tableau. Ability to use Azure Data Catalog [5] for limited data cataloging and allow Data Scientists search capability on the data sets in the Sentience Data Lake. Driven by consumption need, data can be provided across multiple formats. Meta data is captured in data catalog to enable data discovery and understanding of data elements. To assist in awareness, data hand-off will include all necessary documentation and background on data source.

4) Data Governance. The goal of Data Governance is to manage Honeywell's critical data assets by using roles, responsibilities, polices, and procedures to ensure the data is accurate, consistent, secure, has clear rights, and aligns with Honeywell's objectives. Benefits are advanced statistical analysis and model management, data monetization through products and services.

5) Ensuring of Data Quality. Data Quality involves managing and assessing data items deemed as critical to business operations and associated management reporting. The key elements of a good data quality program include establishing a baseline, continuous improvement, appropriate metrics, and score-carding. These data quality dimensions will be used to assess the quality of the data: Completeness, Consistency, Validity, Accuracy, and Timeliness.

6) Data Rights Management. Data Rights: Before processing data, Honeywell must ensure that it has all necessary rights to process that data for all intended purposes – including all current and future intended purposes. Other Rights: In addition to securing rights to process data, Honeywell must ensure that it has secured all necessary rights to provide Connected Products and SaaS offerings to customers and end users on an ongoing basis. In order to utilize the data effectively across the organization, it is critical that data use rights and security are in place.

7) Reporting & Monitoring. Data quality monitoring and reporting based on a well-understood set of metrics provides important knowledge about the value of the data in use, and empowers knowledge workers with the ability to determine how the data can best be used to meet their own business needs. Metrics and scorecards that report on data quality, audited and monitored at multiple points across the enterprise, help to ensure data quality is managed in accordance with real business requirements. The data quality function itself, the metrics used for monitoring the quality of data can actually roll up into higher-level performance indicators for the business as a whole.

8) Persisting time series data in data lake. Sentience already has the capability to store real-time data from IoT devices in a time series database. This new feature augments the existing capability by persisting the real-time feed of the data into the Sentience data lake. Enables data scientists to access raw real-time data from the Sentience data lake without using the access API for the time series database.

9) Sentience Data Ingestion User Interface (UI Alpha). The Sentience data ingestion UI is part of the Sentience Studio and provides a GUI-based (Graphic User Interface) mechanism for transferring data files from supported sources to Sentience blob storage. Currently supported data sources include Amazon S3 [6], Azure Blob Storage and any local machine. This is the Alpha release of the data ingestion tool and requires approval from Data Factory for access. The Alpha version is suitable for lightweight data needs. For ingesting huge amounts of data (over 2 GB) or large number of files, or data that requires processing during ingestion, it's recommended to use one of the other supported tools, such as, NiFi, Flume, Sqoop or Azure Data Factory. Makes it easy for data stewards, data engineers and business analysts to bring new data into Sentience. Does not require deep technical expertise in any of the other supported data ingestion tools in Sentience.

Conclusion

Sentience platform is pioneer world class IOT platform for wide range of industrial and non-industrial customers. The scientific approach in the concept of Sentience platform considers creation of holistic cloud and cloud-connected infrastructure for interfacing with all kinds of applications which perform bullet functions. This does not only creates access to global expertize for solving and predicting the problem but bears unique possibilities of comparative analysis of similar problems around the world with further prediction or conclusion of any problem.

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