intelliTide

The Oil & Gas Well Management Solution - A Case Study

IntelliTide Team

WHITEPAPER

The Business Case

As the Oil & Gas industry is embarking on automation and digitalization initiatives to improve efficiency and reduce costs, it is leading to a tremendous volume of data being generated. As equipment and devices (including oil wells, rigs, wind turbines etc.) are installed with IOT sensors, the volume of data being collected now is already into terabytes per day and increasing. The challenge for the industry is to collect, transfer, store and transform this massive amount of data to provide actionable meaningful insights in real time at a reasonable cost. The success of many of these initiatives will depend on understanding the use cases and capability of the data to solve them, the quick and efficient processing of this data, application of suitable subject matter expertise and finally the ability to derive actionable insights from the vast trove of data.

This whitepaper is based on an in-house project which implements the common use case of managing well devices in the energy industry. The data needs to be leveraged for managing the health of the equipment using analytics (real-time, descriptive and predictive). Almost every drilling, transportation and services company in the energy industry has this business need.

Our team has been engaged in few such projects by global O&G companies.

The Objective

The IntelliTide Well Management Solution is a **scalable cloud-based** application intended to monitor the health of thousands of devices in a well and thus monitor the overall health of the well itself. It is capable of **real-time two-way communication** with the devices thus receiving data inbound from the devices and sending data outbound back to the devices when issuing operational commands.

The Well Management Solution is capable of receiving, storing and processing large volumes of data from many devices across many wells. However, its most valuable feature is its ability to **perform real-time streaming analytics** on incoming data as well as **descriptive analytics on historical data** that helps meet the goal of monitoring and predicting the health of a well.

Features of the Solution

The following are some of the significant features that were implemented in the Well Management solution:

- **Communicate with well devices** by receiving sensor data and issuing commands
- **Real-time streaming analytics** performed on the incoming data to display device status and raise alerts
- **Data quality techniques** applied to enhance the quality of trend detection and pattern recognition
- **Hybrid cloud architecture** to interact with on-premise services
- **Utilizes Azure's PaaS features** to leverage the many benefits offered in a platform as a service model

Solution Architecture

For the architecture we adopted a primarily Microsoft Azure PaaS (Platform as a Service) stack as this is a cloud hosted solution. Since the cloud application has to exchange data with on-premise applications

and gateways, we architected a hybrid cloud solution with secure data exchange between the cloud application and on-prem apps. Some highlights of the architecture we incorporated were:

- **Hybrid Azure cloud** to enable interaction with on-prem services (device firmware, sensor meta-data service)
- **Two-way communication** between IOT devices and solution (commands can be sent to devices)
- Implemented **Microservices** to enable elasticity and ease of deployment of independent components

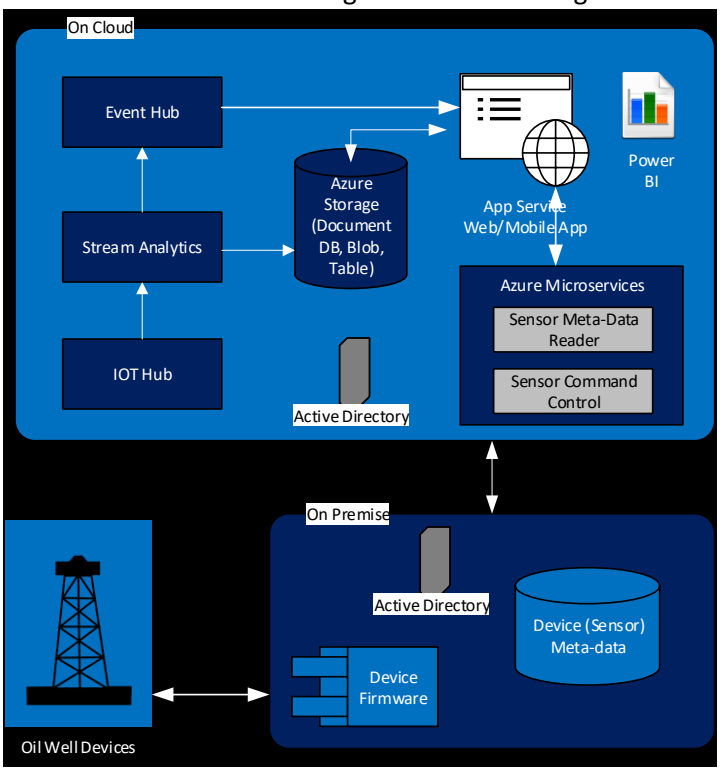
The platforms and tools that powered this solution were:

- **Azure App Service** – hosts the web/mobile app
- **Azure IOT** – talks to device firmware via MQTT protocol
- **Azure Streaming Services and Event Hub** – implemented to monitor device health in real-time and subscribe to incoming events
- **Power BI** – used for visualization and reporting
- **Azure Microservices** – sensor meta-data fetch service and sensor command service implemented as microservices
- **.NET MVC, jQuery and UI frameworks** – the web application was built on this stack
- **IBM Modeler, Python and Spark ML** – used for the analytics

For store the massive volume of data we had to have a scalable and modern database application. Azure provides these following tools just for that purpose that we incorporated:

- **Azure Cosmos DB** – ensures unlimited scale and fast data insertion and retrieval
- **Table and Blob storage** – part of data stored as key/value pairs and some unstructured data as blobs for scale and speed of access

Below is the architecture diagram demonstrating the elements of this solution.



Though the above diagram is self-explanatory here are some salient points:

1. Data from the well IOT devices is collected by the device firmware and a third-party IOT hub and passed on to the IntelliTide cloud solution
2. The IntelliTide solution has Azure IOT hub that process the incoming data and passes the data onto the Stream Analytics module and the Event Hub modules
3. The Stream Analytics monitors the health of each device. Should the readings from a device fall beyond the threshold set by previously configured rules, the Stream Analytics module will alert such a situation to the Event Hub which in turn alerts the web application to alert the user (more details on the analytics in next section)
4. The data also finds a permanent home in the Azure Document DB (Cosmos DB) storage from where the web application also leverages the data
5. The Sensor Command module is used to issue commands to the well devices like shut down or start up commands
6. The Power BI reports provide a useful dashboard of current trend of the health of devices across wells and the overall health of the wells themselves

The Data Model and Data Quality

Creating a structure or a model for the data that is being collected is critical to ensure the quality of data. Designing the models require a good understanding of both the data being collected, data management concepts and the use cases being attempted to solve. Data modeling is not the same as designing tables in relational databases or even creating the document schemas in NoSQL data stores although there are similarities. Data modeling involves an intimate understanding of categories of data like master, transactional and reference data and designing models with a view to improve the quality of data, solve the business use cases and ensure application performance and scale.

We created the data models and implemented the validation rule to filter out the “noise” or irrelevant data and ensure the operational data that was required was of a high quality to ensure the accuracy of the solution output.

The Analytics

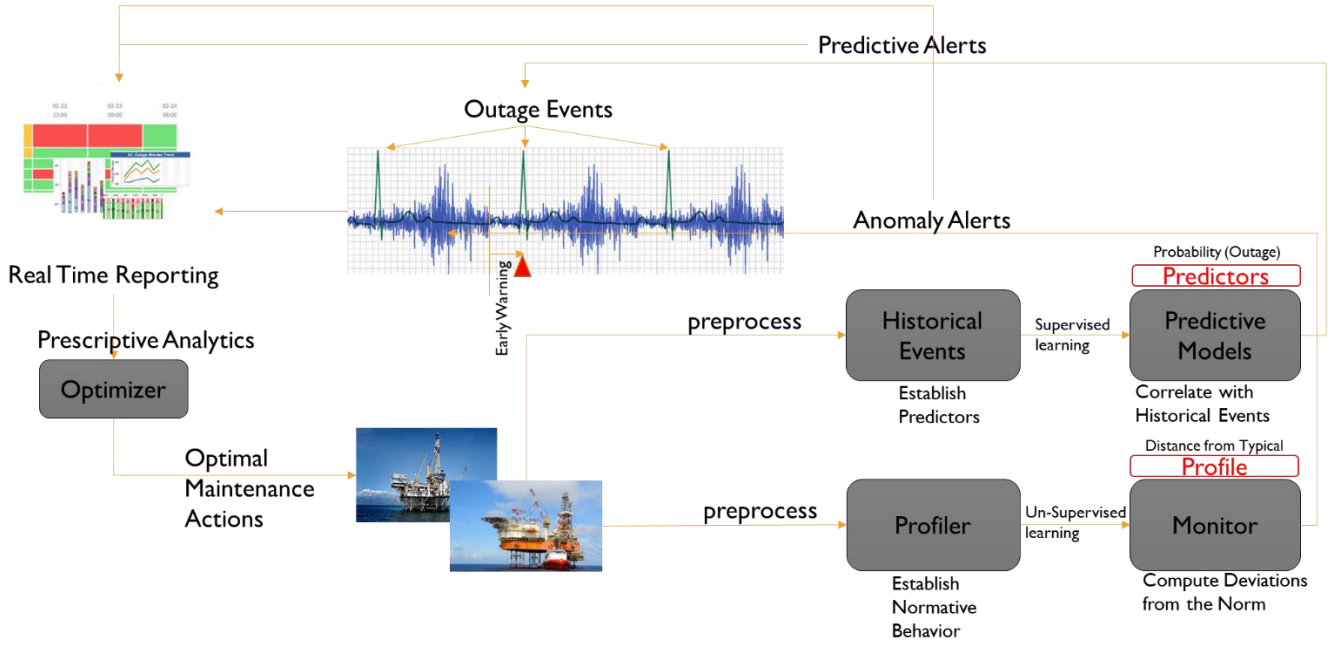
Everything we had setup in the solution so far was to drive towards analyzing the incoming as well as the stored data to perform **real-time “streaming” analytics** and reporting out of the historic data. The streaming analytics is the primary feature of the solution as it enables the prediction of problems with the devices within the well before they occur.

The objective of the streaming analytics is to detect the trends and patterns of each device and correlate with their pre-defined parameters of normal operation. There are two separate paths to deriving early warnings and indicators for future potential problem –

1. First path is an **unsupervised approach** that establishes normative behavior profiles, and in the event that a device is trending away from normative behavior profiles, the job of the analytics service is to alert the user so appropriate action including issuing shutdown commands can be issued by the user.
2. The second path is a **supervised approach**, where the supervised model is calibrated on historical outage/breakdown events, and the calibrated predictive model encapsulates the

relationship between operational data and the outage event. Once calibrated, the predictive model can be deployed to get real-time probabilities of adverse event likelihood enabling early preventive action.

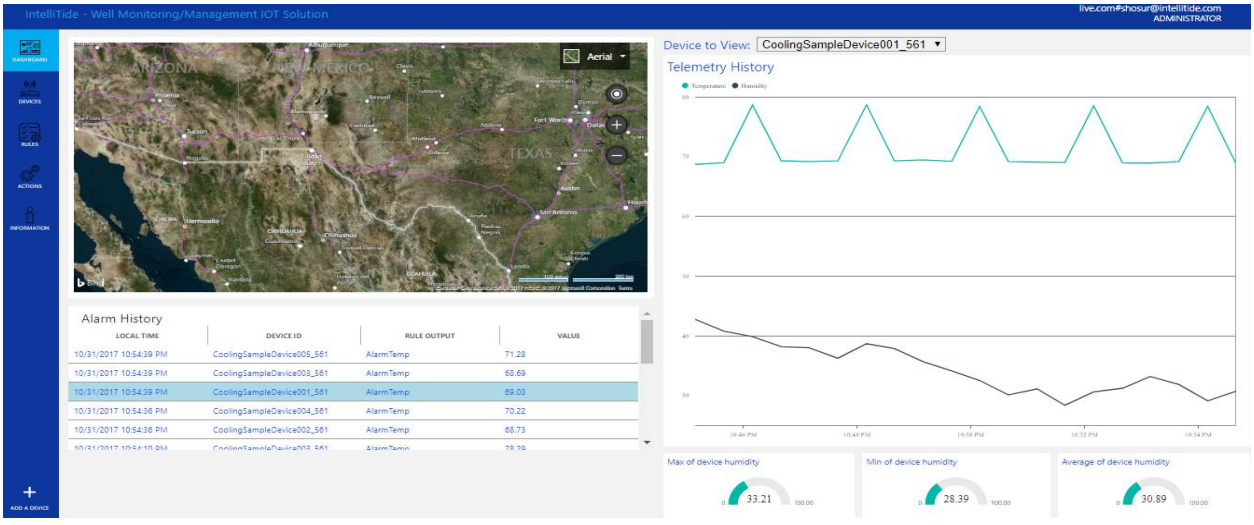
A diagrammatic representation of the streaming analytics component within the IntelliTide Well Management solution is shown here.



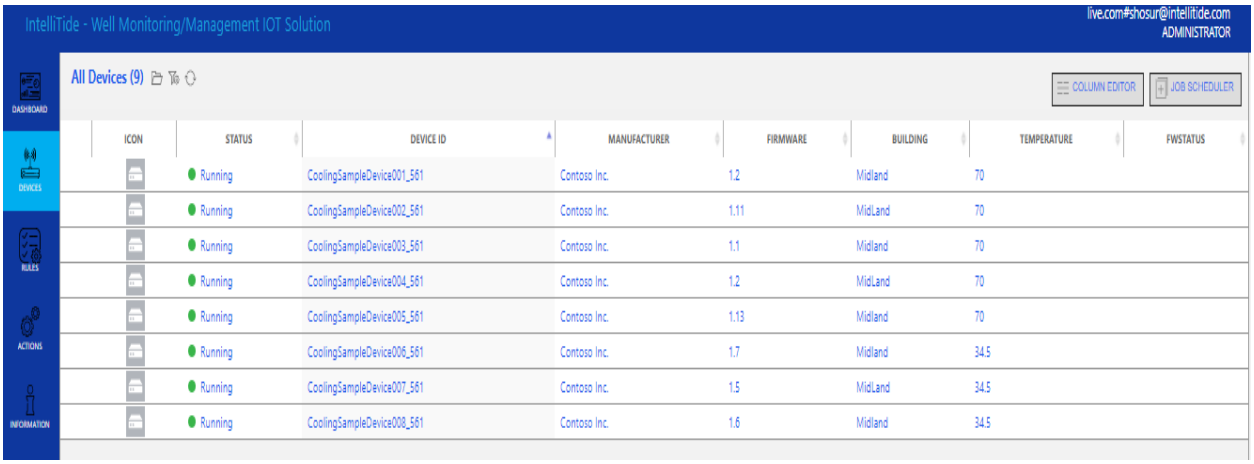
The User Interface

As powerful as the solution's backend tier is the user interface was also designed with a high degree of attention. Here are a few screens from the user interface to enable a user to quickly and clearly notice alerts, efficiently monitor the health of the many wells and well devices and have the ability to easily configure device settings and operational parameters.

Home page displaying real time device readings and telemetry data

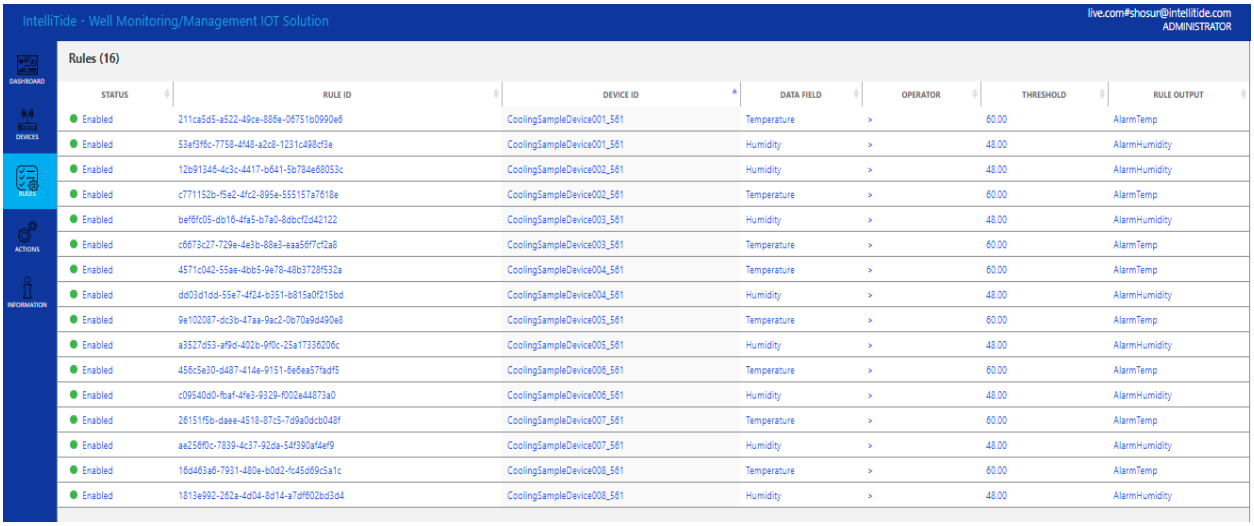


Status Summary page displaying the health status of all devices being monitored



ICON	STATUS	DEVICE ID	MANUFACTURER	FIRMWARE	BUILDING	TEMPERATURE	FWSTATUS
	Running	CoolingSampleDevice001_561	Contoso Inc.	1.2	Midland	70	
	Running	CoolingSampleDevice002_561	Contoso Inc.	1.11	MidLand	70	
	Running	CoolingSampleDevice003_561	Contoso Inc.	1.1	Midland	70	
	Running	CoolingSampleDevice004_561	Contoso Inc.	1.2	MidLand	70	
	Running	CoolingSampleDevice005_561	Contoso Inc.	1.13	Midland	70	
	Running	CoolingSampleDevice006_561	Contoso Inc.	1.7	Midland	34.5	
	Running	CoolingSampleDevice007_561	Contoso Inc.	1.5	MidLand	34.5	
	Running	CoolingSampleDevice008_561	Contoso Inc.	1.6	Midland	34.5	

The Rules page to set individual device properties and tolerance ranges



STATUS	RULE ID	DEVICE ID	DATA FIELD	OPERATOR	THRESHOLD	RULE OUTPUT
Enabled	211ca5d5-a522-49ce-886e-06751b0990e6	CoolingSampleDevice001_561	Temperature	>	60.00	AlarmTemp
Enabled	53ef3f6c-7758-4f48-a2c8-1231c498cf3e	CoolingSampleDevice001_561	Humidity	>	48.00	AlarmHumidity
Enabled	12b91346-4c3c-4417-b641-5b784e68053c	CoolingSampleDevice002_561	Humidity	>	48.00	AlarmHumidity
Enabled	c771152b-f5e2-4fc2-895e-555157a7618e	CoolingSampleDevice002_561	Temperature	>	60.00	AlarmTemp
Enabled	bef6fc05-db16-4fa5-b7a0-8dbcf2d42122	CoolingSampleDevice003_561	Humidity	>	48.00	AlarmHumidity
Enabled	c6673c27-729e-4e3b-88e3-eaa56f7cf2a8	CoolingSampleDevice003_561	Temperature	>	60.00	AlarmTemp
Enabled	4571c042-55ae-4bb5-9e78-48b3728f532a	CoolingSampleDevice004_561	Temperature	>	60.00	AlarmTemp
Enabled	dd03d1dd-55e7-4f24-b351-b815a0f215bd	CoolingSampleDevice004_561	Humidity	>	48.00	AlarmHumidity
Enabled	9e102087-dc3b-47aa-9ac2-0b70a9d490e8	CoolingSampleDevice005_561	Temperature	>	60.00	AlarmTemp
Enabled	a3527d53-af9d-402b-9f0c-25a17336206c	CoolingSampleDevice005_561	Humidity	>	48.00	AlarmHumidity
Enabled	456c5e30-d487-414e-9151-6e6ea57fadf5	CoolingSampleDevice006_561	Temperature	>	60.00	AlarmTemp
Enabled	c09540d0-fbaf-4fe3-9329-f002e44873a0	CoolingSampleDevice006_561	Humidity	>	48.00	AlarmHumidity
Enabled	26151f5b-daee-4518-87c5-7d9a0dcb048f	CoolingSampleDevice007_561	Temperature	>	60.00	AlarmTemp
Enabled	ae256f0c-7839-4c37-92da-54f390af4ef9	CoolingSampleDevice007_561	Humidity	>	48.00	AlarmHumidity
Enabled	16d463a6-7931-480e-b0d2-fc45d69c5a1c	CoolingSampleDevice008_561	Temperature	>	60.00	AlarmTemp
Enabled	1813e992-262a-4d04-8d14-a7df602bd3d4	CoolingSampleDevice008_561	Humidity	>	48.00	AlarmHumidity

Conclusion

Per McKinsey, the Oil & Gas industry on average is running at only 77% efficiency causing a $200 billion annual revenue loss. By other estimates the loss is even higher. O&G companies do realize this fact and are acting aggressively to introduce technology and improve efficiency and performance. However, these automation and digitalization initiatives are not easy or cheap to implement and an experienced team of technical architects, data scientists and O&G SME's are required to create mature solutions that result in decent ROI like the IntelliTide Well Management solution.

To learn more about our capability or explore a partnership write to us at hello@intellitide.com or visit our website: www.intellitide.com