



▶▶ Under the patronage of **H.E. Dr. Abdullah Belhaif Al Nuaimi** - Minister of Infrastructure Development



▶▶ 17th Edition

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Under the Theme:

**Enhancing Maintenance
Through Big Data Management**

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**Application of Big Data
Analytics to Promote The
Development of
Infrastructure Services**

▶▶ Introduction

- ❖ **Water Treatment Plant (WTP)** is an important infrastructure to ensure human health and the environment. In its development, aspects of environmental **safety and health** are of concern.
- ❖ **Smart WTP** is a water station that is managed using software-based tools such as **data analytics, visualization, and predictive analytics**.
- ❖ **Smart WTP management system** is developed to manage **Big Data information flows from many sensors and smart devices** that allow for real-time responses and **Internet of Things (IoT)** Cloud platforms services.
- ❖ **Smart WTP operators** should **consistently evaluate** their water management practices to ensure that the plant is operating efficiently, thus **minimizing energy costs and improving water purity and quality conservation parameters**.

►► Motivations

❖ Rationalize water consumption:

- **The water shortage** is the main constraint and a major limiting factor facing the implementation of the country future economy. In industry, several actions are required to rationalize water uses.
- Water treatment plant **operators** should regularly **monitor and analyze** the plant's water treatment performance to ensure systems are operating with the most efficient equipment and technology. Plants should retrofit **their water flow process by measuring and control the pumps state, flow rates, valve state, pressure, and water level of tanks with smart real time electronic system to reduce water waste and energy consumption.**

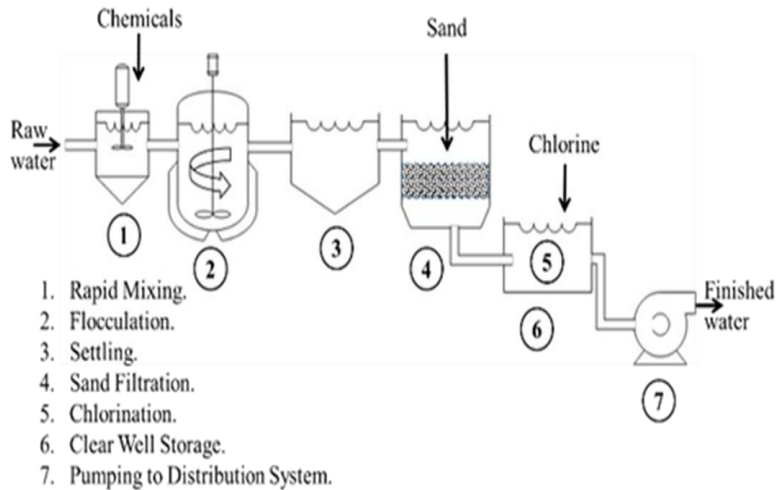
❖ Purification of water:

- **The ability to drink pure water** is quite imperative for maintaining a healthy body and keeping the body safe from germs and diseases. Purified water is described as water that has been filtered or processed for the purpose of making it free from impurities or pollutants such as chemicals or pathogens, etc.
- Our system provides solution for **measuring and optimizing the level of Total Dissolved Solids (TDS) in water** which is considered a very important factor because many of these dissolved salts, metals, and minerals are considered to be contaminants

▶▶ Smart WTP System

- ❖ **Our proposed system solution based on big data monitoring and analysis** of Smart Water Treatment Plant (SWTP) sensor's reading using IoT hardware devices that have an internet connection to a IoT Cloud platform.
- ❖ **The Cloud platform** have the capability to **manage, analyze and decision making based on the Big Data analytics** to:
 - **Predict risk**
 - **Operate risk management plans**
- **That to overcome the failure scenarios and minimize the downtime operation** of the Smart WTP.

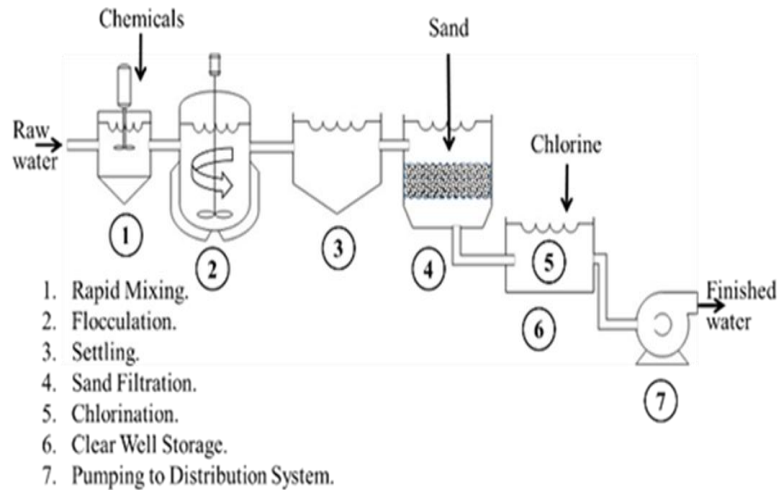
▶▶ Water Treatment Plant (WTP)



The main processes in water purification can be summarized as follows:

1. **Rapid Mixing or Coagulation**, It is used to mix **alum solution** with turbid water and the mixing is either in a tank equipped with a mechanical dump before it enters the grouting basins where objects or solid parts are removed to avoid the hinder of pumps and minimize any subsequent purification. Chemicals like **aluminum sulfate** are added to the water to neutralize the particles electrically and to aid in making them "sticky" to coalesce and form **large particles called flocs**.
2. **Flocculation**, It designed for assembling the soft flakes formed in the previous stage to form a larger flake that is easily deposited by plodding.

▶▶ Water Treatment Plant (WTP)



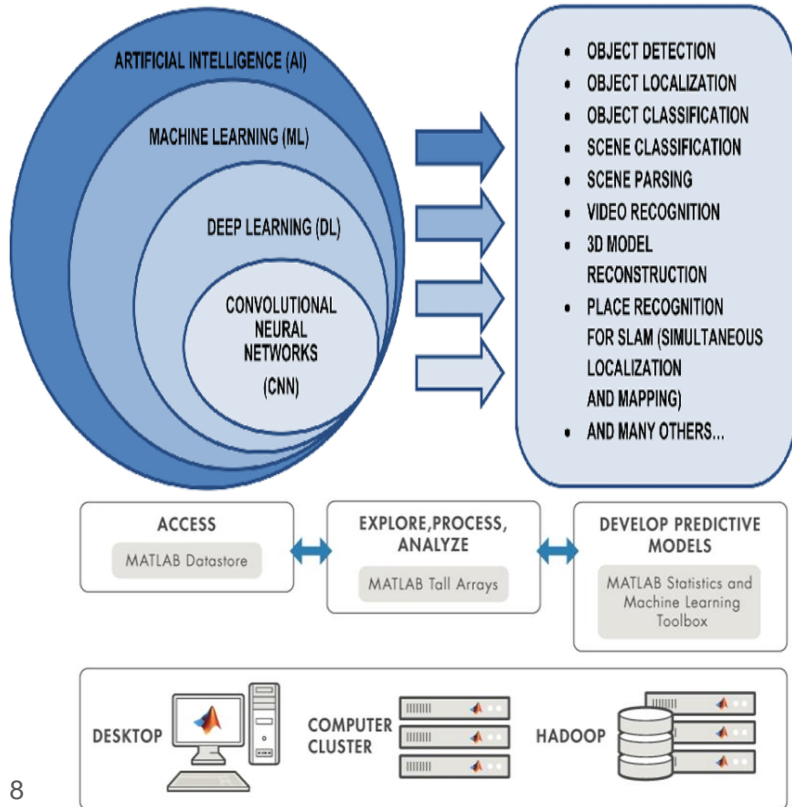
3. **Settling tanks** are designed to minimize turbulence and allow the particles to fall to the bottom.
4. **Sand Filtration**, The water passes through the sand filter to remove the impurities as water from the settling basins enters the filter and seeps through the sand and gravel bed, through a false floor, and out into a clear well that stores the finished water.
5. **Chlorination and Sterilization**, to eliminate the harmful bacteria and pathogens. Using chlorine, ozone, and ultraviolet radiation.
6. Clear Well Storage.
7. Pumping to Water Distribution System (WDS).

►► Big Data and Big Data Analytics

- **Big Data** refers to the large amounts of data which is **pouring in from various data sources and has different formats**. It is something that can be used to analyze the insights which can lead to better decisions and strategic business moves.
- **Data Analytics** is the science of examining raw data with the purpose of **drawing conclusions about that information**. It is all about discovering useful information from the data to support **decision-making**.

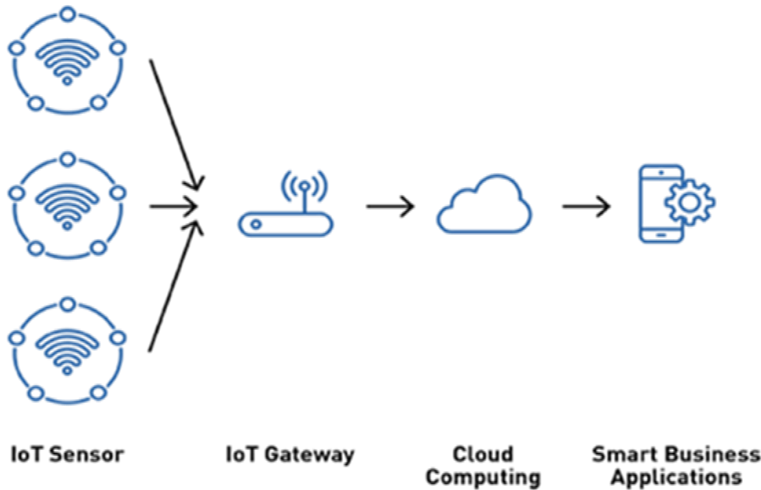


►► Big Data Analytics Technology



- ❖ **Data Analytics** involves inspecting, cleansing, transforming & modeling data. It also involves **solving a problem** in various ways to arrive at the solution and on the other hand, it involves to design and construct new processes for **data modeling and production using various prototypes, algorithms, predictive models, and custom analysis.**
- ❖ **Such as Artificial Intelligence (AI) and Machine Learning / Deep Learning and Neural Network Applications.**
- ❖ Big data relates more to technology (Hadoop, Java, Hive, etc.), distributed computing, and analytics tools and software.
- ❖ **MATLAB®** Software provides a single, high-performance environment for working with big data.

▶▶ Proposed Solution Sections



❖ IoT Sensors.

- Water Purity Meter , Total Dissolved Solids (TDS), Flow Rates Meter, Water Velocity, and Pump State Meter.

❖ IoT Platforms.

- Arduino, and Espressif (ESP).

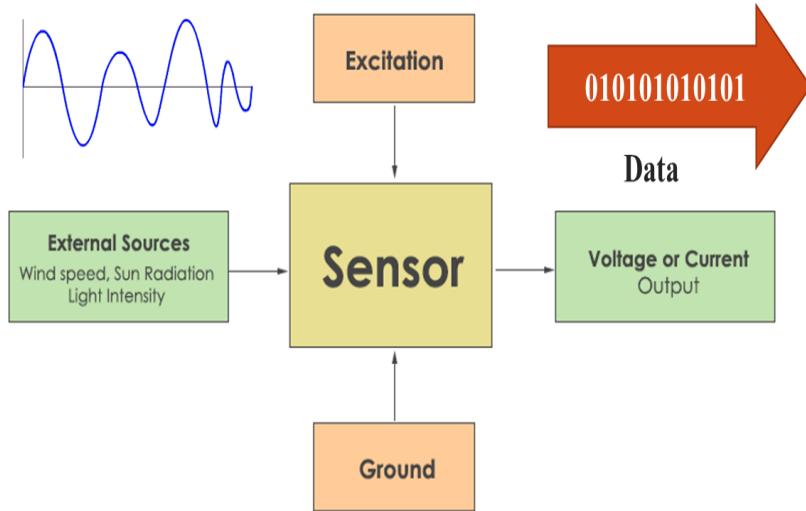
❖ IoT Gateways.

- Raspberry Pi.

❖ Cloud Platforms.

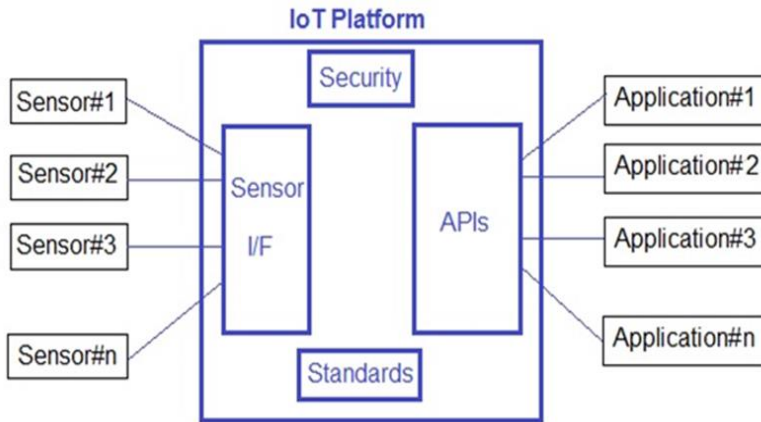
- ThingSpeak, Microsoft Azure, or Arduino IoT Cloud .

▶▶ IoT Sensors



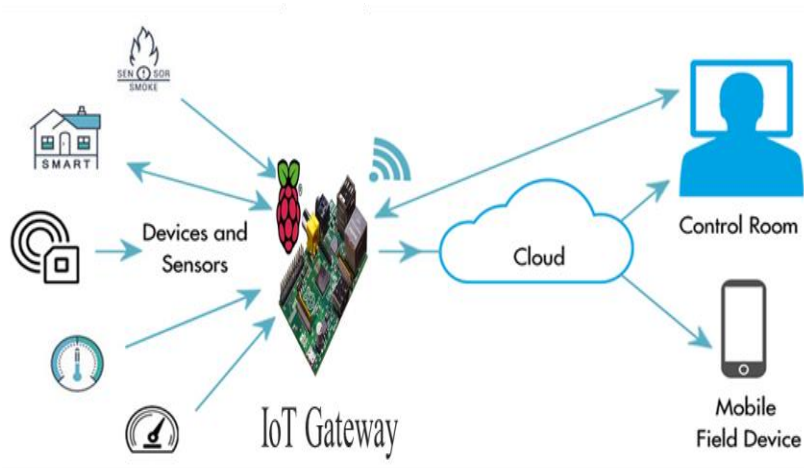
- ❖ **IoT Sensor** is an electronic sensor which is a device designed to indicate or measure something about the environment which it is operating.
- ❖ This information or data is created mechanically or electrically and transmits the environment information by creating an electrical signal.
- ❖ **Smart sensor** could include sensor probe and signal conditioning module to interface into the analog input port of microcontroller development board or IoT Platform.

▶▶ IoT Platforms



- ❖ It could refer to **communication modules, Microcontrollers, and SoC modules** with features that make them desirable for use in the development of IoT devices.
 - **Particle.**
 - **Adafruit .**
 - **SparkFun.**
 - **Espressif (ESP).**
 - **Arduino.**
- ❖ **Arduino and ESP boards** were made taking the IoT in consideration, and all of them have different features making them more suitable for specific IoT solution. Arduino also has a cloud service dedicated to be used by certain Arduino .

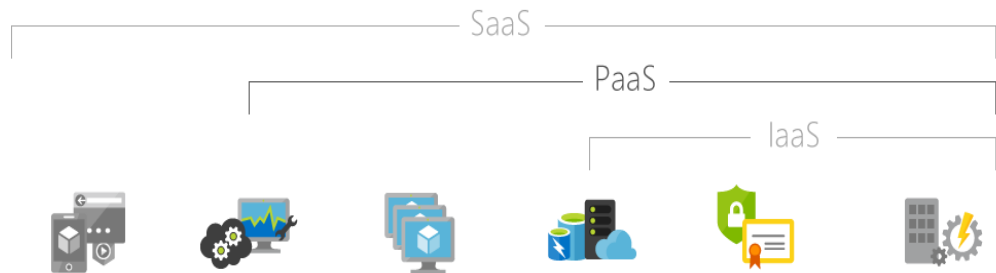
▶▶ IoT Gateways



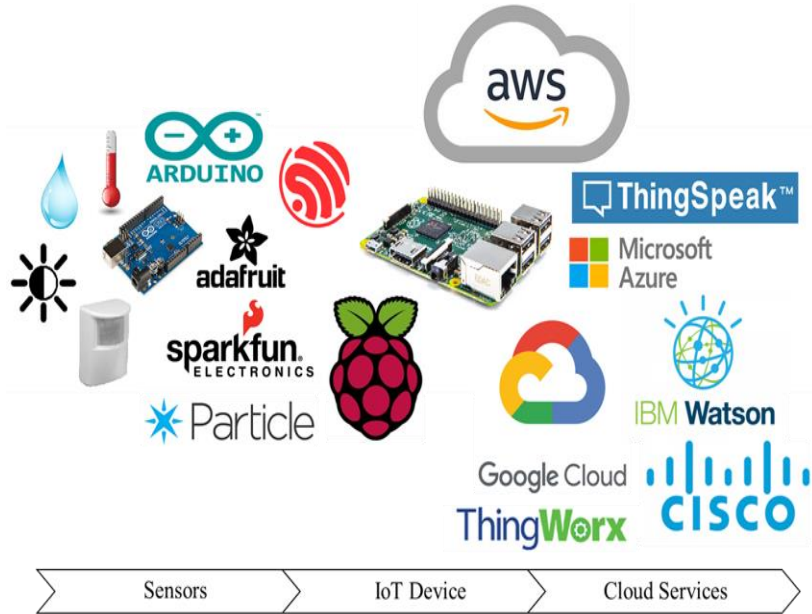
- ❖ **An Internet of Things (IoT) gateway** is a physical device or software program that serves as the **Connection Point or Access Node** between the cloud and controllers, sensors and intelligent devices.
- ❖ **A gateway provides a place to preprocess that data** locally at the edge before sending it on to the cloud such as Raspberry Pi platform.
- ❖ **Raspberry Pi** is a good platform for connecting Arduino board with sensors to IoT cloud Platform and enabling development of Smart IoT solutions.

►► Cloud Platforms

- **Cloud Platform** is the **software infrastructure for a cloud computing service**, which includes applications that let users create and manage their own accounts.
- A cloud service is any service made available to users on demand **via the Internet from a cloud computing provider's servers** as opposed to being provided from a company's own on-premises servers.
- **Most cloud computing services fall into four broad categories: infrastructure as a service (IaaS), platform as a service (PaaS), server less, and software as a service (SaaS).** The system software components (OS, virtual machine monitor, etc.) are called the **Cloud Stack**.

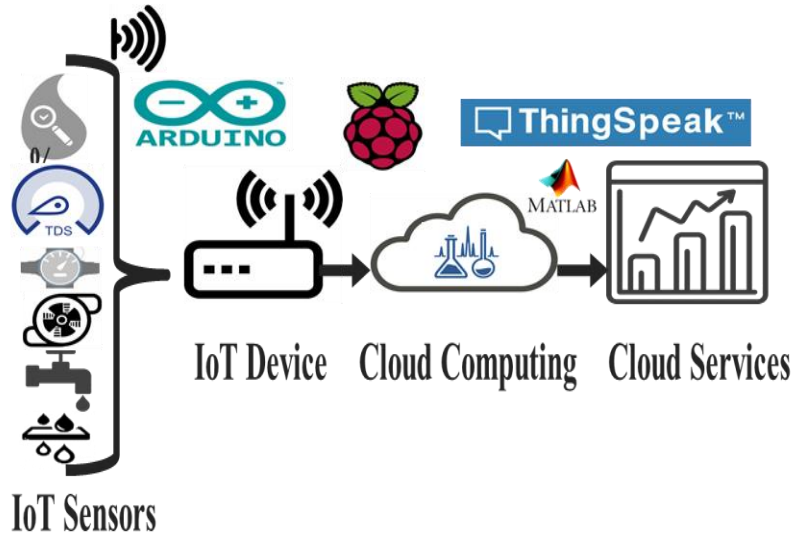


▶▶ Cloud Platforms



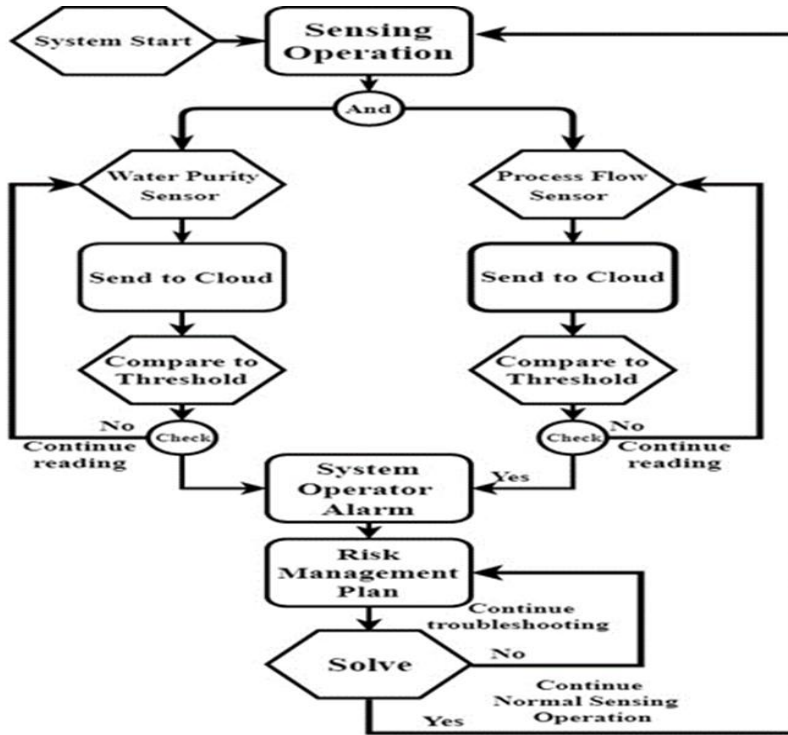
- There are many Cloud Platforms service provider such as **Thingworx 8** IoT Platform powered by Thingworx company, **Microsoft Azure** IoT Suite powered by Microsoft, **Google Cloud's** IoT Platform powered by Google, **IBM Watson** IoT Platform powered by IBM, **AWS** IoT Platform powered by Amazon, **Cisco** IoT Cloud Connect powered by Cisco, **Oracle** IoT Platform powered by Oracle, **ThingSpeak** IoT Platform which is an open-source platform, and **Arduino IoT** Cloud powered by Arduino.

▶▶ Proposed Solution Description



- Our proposed solution makes the **total monitoring and control** of two main parameters: **water purity and flow process control systems parameters**. Each system includes many parameters related to each system performance.
- The parameters monitoring will be done using **smart sensors that connected to IoT Cloud platform**. And the control of them will be done using the **IoT Cloud services**.

Proposed Solution Description



- The **water purity** and the **process flow** parameters will be sensed periodically and sent to the IoT Cloud to be compared with a **threshold factor** that was calculated for each one to ensure that normal conditions.

►► The Main System Design Parameters

1. For **water purity meter**, it contains chlorine, turbidity, alkalinity, hardness, dissolved oxygen, conductivity, and pH of water that are all merged to identify the water purity sensed factor ; The level of Total Dissolved Solids (TDS) in water is very important factor because many of these dissolved salts, metals, and minerals are considered to be contaminants, TDS is directly related to the quality of water as well as the quality of water purification systems.

2. For **flow process control** parameter, there are many parameters sensed and monitored such as flow rates (m³/hr), Water Velocity (m/s), Detention time (s), Flow continuity, pressure, water level of tank, valve state, pump state, and pump rotation speed (rpm), Control Valves, Chemical Feed Systems, Electrical Systems and Maintenance of the Anthracite/Sand Filters. All these parameters are merged to identify the process flow sensed parameter.

All the sensing data that include the water purity or quality system measuring and flow process control system measuring could be consider as a **Big Data**.

▶▶ Risk Management Solution

- ❖ We can **detect defective portions** by performing periodic maintenance and inspection.
- ❖ We can **reduce the failure rate** by replacing parts at the designated period based on checks of the past infections and promote preventive maintenance.
- ❖ In case of the failure, we will take a **fast trouble-shooting action** based on the past periodical inspection data and recover the facility at the early time.
 - **Low cost** desalination biological processes for water treatment.
 - **Water quality** compliance asset management.
 - **Decision support and plant control.**

►► Conclusion

- **Our proposed solution will improve the overall management services** on the on-site processing of SWT and enable the supervisory control of the overall system.
- It keeps the facility intact and contributes to the stable operation of the SWTP digital infrastructure system. This offers the **proven reliability and the safety to SWTP system operation.**
- Moreover, it can be used to **manage more than one SWTP in different geographical locations using the same Cloud platform.** Furthermore, it solves many operating problems and overcomes the general obstacles in using smart solutions.
- It enables **powerful risk management decisions** with access to high-fidelity enterprise Big Data generated by the IoT Cloud platform services.
- This novel solution could be considered a novel solution that **combines the Big Data Analytics and online real-time system management, with a traditional relational database management system** in water treatment filed.

►► Contact us:

Thank You

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