# AIME-BASED IOT SYSTEM FOR MONITORING & CONTROL OF AIR QUALITY
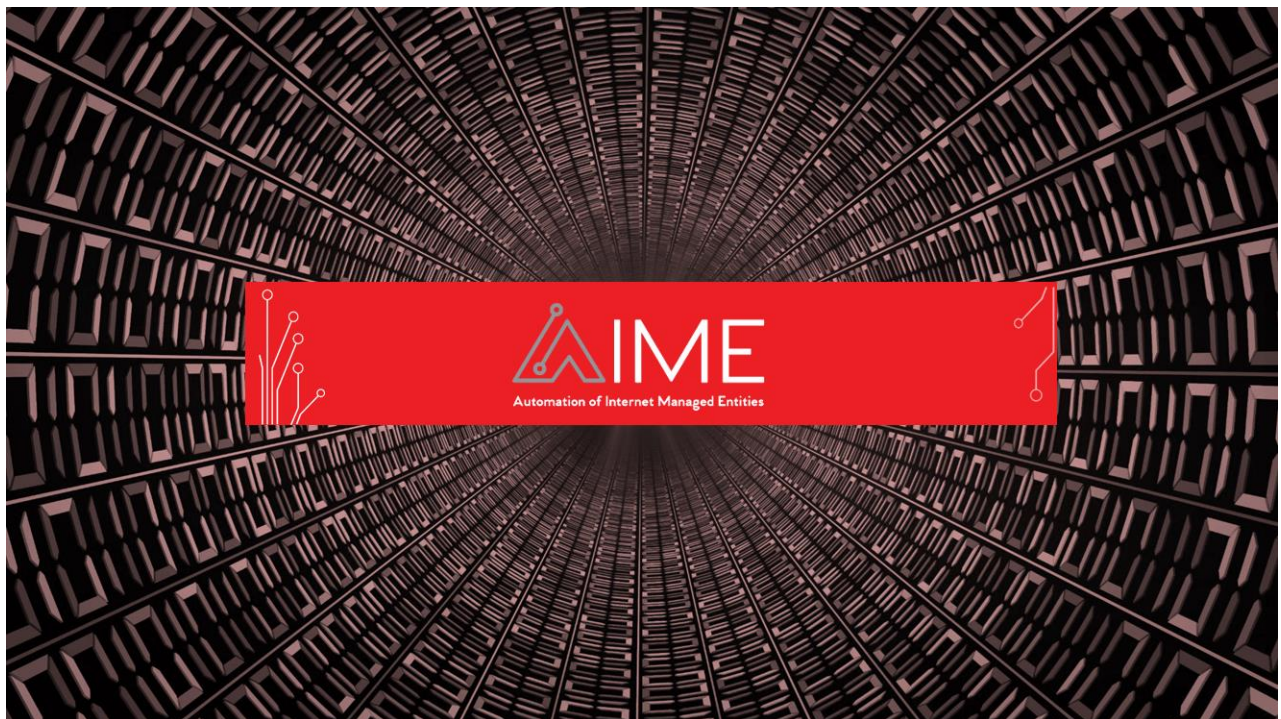


# WHITE PAPER

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# ABSTRACT

## What is IIoT?

The 4th industrial revolution and especially the IIoT is reshaping the world of manufacturing today.

IIoT stands for Industrial Internet of Things. It brings together critical assets, advanced predictive and prescriptive analytics, and centralized monitoring of the manufacturing infrastructure, enabling unprecedented levels of efficiency, productivity, and performance.

IIoT continues transforming the industry and will soon become vital for a successful business, with those who have not adopted it failing to compete successfully with their fully digitalized rivals.

## WHAT IS AIME?

AIME is an Edge & Core IoT application enablement platform (AEP) that helps companies build complete IoT systems, ensuring business and digital transformation. AIME offers a high-level uniform language for data collection, data flow, Edge connectivity, administration and configuration of IoT devices.

We address issues such as energy efficiency, sustainability, resiliency and data security by making smart IoT devices even smarter, keeping operations close to the endpoint as much as possible and significantly reducing data traffic between IoT devices and system Core.

AIME supports system scalability and continuous development of processes, allowing changes on-the-fly with

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little to no downtime when making reconfigurations.

AIME includes IoT firmware and communication functionality. AIME is an Arduino-based Framework, capable to run on any RTOS.

We use Microcontrollers (MCUs) to manage the underlying IoT Infrastructure. Thanks to AIME's unique flexibility, we are able to orchestrate **unlimited number and types of IoT hardware**, and work even in **areas with no Internet coverage**.
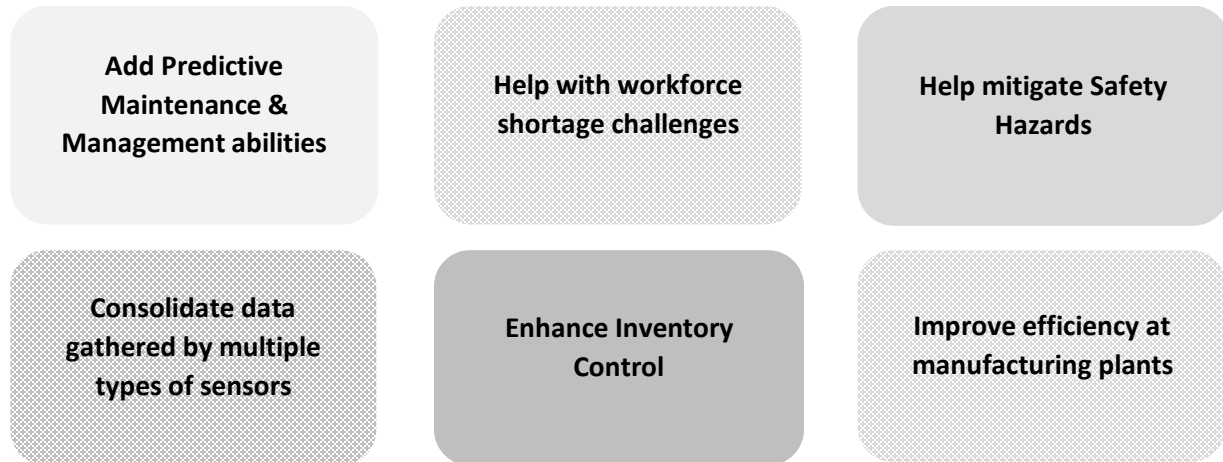
## AIME FOR IIoT

The engine behind AIME is available for use in all industrial or business buildings and facilities.

We offer Digital Transformation Services, allowing businesses to switch to **Predictive Maintenance** from Reactive and Routine Maintenance. We create actionable insights which can be used in multiple ways to improve efficiency, predictability and control.

## What Can We Do for Your Business?

| | | |
|---|---|---|
| **Remote monitoring of areas excluded by existing Management Systems, using Sensors** | **Automatic or remote manual start/stop of HVAC & other systems, using Actuators** | **Guaranteed monitoring & control even in areas with no Internet coverage** |
| **Integration & Data Exchange with existing Systems, incl. raising incident data** | **Displaying information or incident data on E-Paper Displays** | **Notifying responsible staff via Web Interface in case of incident, or raising alarm** |
| **Act independently of other systems upon registering incidents** | **Real-time reaction upon incidents, even in areas with no Internet** | **Receive signals from Vertical Systems to start/stop HVAC & other systems, using Actuators** |

## Industry Pains Addressed by AIME

| | | |
|---|---|---|
| Add Predictive Maintenance & Management abilities | Help with workforce shortage challenges | Help mitigate Safety Hazards |
| Consolidate data gathered by multiple types of sensors | Enhance Inventory Control | Improve efficiency at manufacturing plants |

## Integration with Existing Vertical Systems

We can integrate AIME with:

- MOM (Manufacturing Operations Management) Systems
- CRM (Customer Relationship Management) Systems
- BMS (Building Management Systems) or BAS (Building Automation Systems)
- FSM (Field service management) Systems
- ERP enterprise resource planning Systems
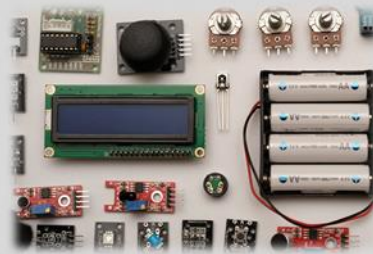- Other existing industrial systems
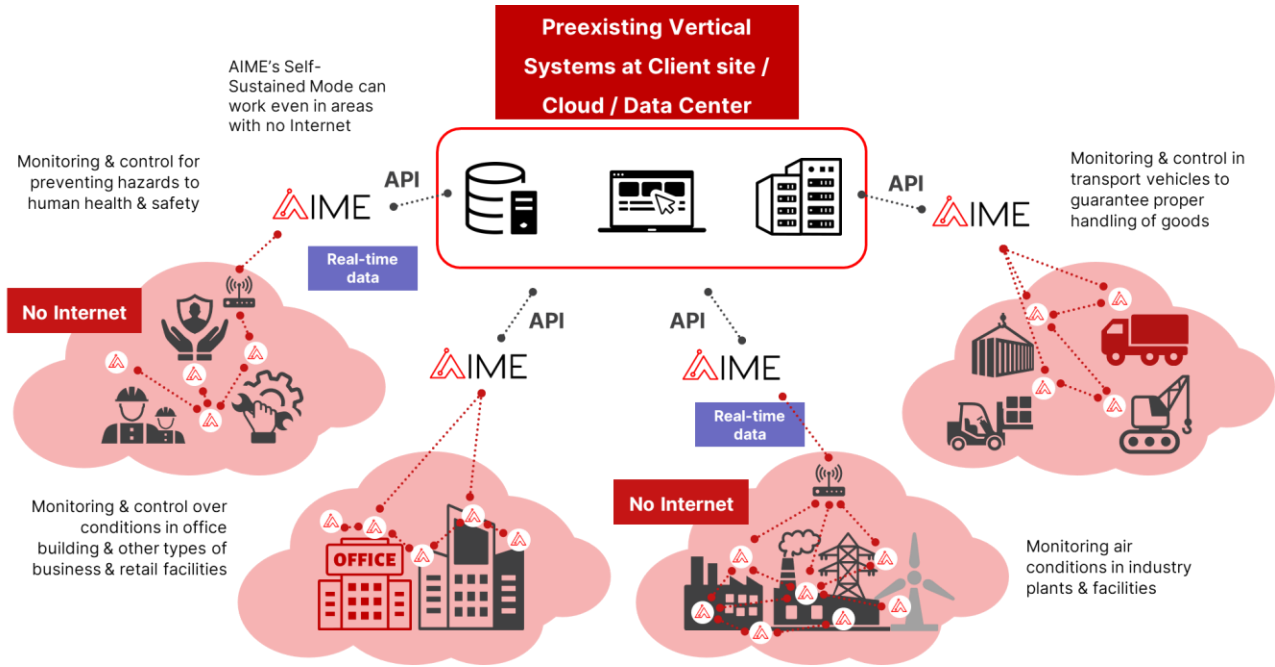
# AIME COMPONENTS

## HARDWARE & DEVICES

AIME is able to orchestrate unlimited number and types of IoT hardware, ensuring system scalability and continuous development of processes.

We deliver & install IoT devices by renowned manufacturers at reasonable price, including:



## IoT-Enabled Sensors

○ Temperature, Humidity, Acidity, Wind, Light level, Presence & many more

## Microcontrollers (MCUs)

- For controlling Sensors & Actuators
- Data processing at Device level



## IoT Actuators

- For controlling mechanical & other devices & mechanisms



## E-paper Displays

- Shelf labels
- Information & Status Displays



## Management Boards

- Serves for managing Sensors & Actuators
- Customizable for each client
- Connectivity options include: Wi-Fi, Wi-Fi mesh, GSM, LoRa mesh. Bluetooth/BLE, NBIoT and LoRa WAN enabled.

## IoT-ENABLEMENT PLATFORM

Our AIME platform can be used for **data collection, data flow, Edge connectivity, administration and configuration of IoT devices**. Our solution supports both "**Thick Edge**" and "**Thin Edge**" functionality, making it perfect for a multitude of applications.

We offer AIME on a **PaaS** (Platform as a Service) basis.

We can build networks or swarms of IoT-enabled Devices and orchestrate them.

## PRODUCT LIFECYCLE

**1.    DEPLOYMENT**
AIME is installed as a firmware on compliant devices. Installation happens wirelessly, with the Integrator being in close proximity to the device.
Initial configuration happens exactly after that with the help of AIME Manager software tool.
**2.    USAGE**
The device start working right away and all features are now available: remote monitoring of IoT Sensors, remote control of Actuators, communication between IoT devices, remote update, remote configuration, etc.
**3.    MONITORING**
Remote monitoring of Sensor measurements and control over actuators happens in real-time using standard Web Browser.
**4.    RECONFIGURATION & UPDATE**
After initial deployment and configuration, subsequent reconfigurations and updates happen remotely, using standard Web Browser.

# AIME FEATURES

The following features are readily available or can be seamlessly added as customizations upon AIME Platform:

## 24/7 MONITORING

- Every aspect and component of a building can be monitored via IoT-enabled sensors
- Our Platform is sensor-agnostic. By default, we support a number of commonly used sensors, but we can easily incorporate all types of sensors required by Clients.
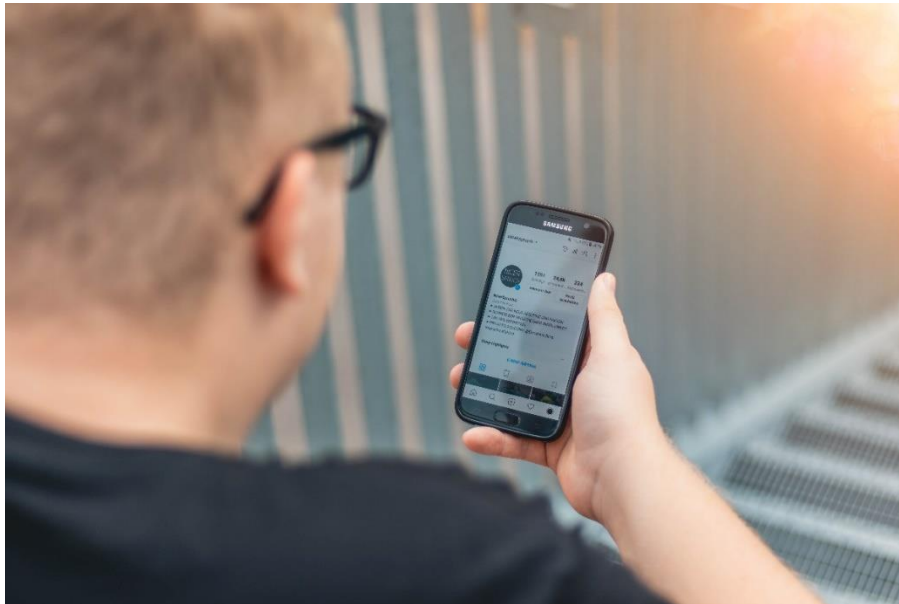
## DEVICES MANAGEMENT / PREDICTIVE MANAGEMENT

AIME's architecture allows seamless **Systems Management** via Actuators. Each actuator is an IoT Device which can convert a control signal into mechanical motion, eventually triggering actions in HVAC or other types of systems.

- AIME manages Actuators for both switch on/off cases, and voltage regulation
- Signals sent to Actuators can be both **manual** (triggered by an operator) or **automatic** (action gets executed automatically based on real-time Sensor measurements and preset logic). This logic can be built as AIME-based extension on a per-case basis. Examples include:
    - Send warnings in case of specific or critical events, usually upon reaching preset value measured by an IoT Sensor. In this case, an **employee can trigger an action**, either on-site or remotely using our mobile user application.
    - Train the IoT system to **act automatically upon certain events**. For example, a facility management system can be turned on or off automatically right after a measurement has reached specific value (ex. temperature, humidity, human presence, etc.)

All measurement thresholds, other types of events, warning types, and automatic actions are fully customizable as per client/use case in all cases.

The combination between IoT-enabled Sensors and Actuators can be effectively used to implement **Predictive Management** logic for managing facilities and is applicable for multiple use cases.

## DATA MANAGEMENT & PROCESSING AT DEVICE LEVEL

AIME provides smart **data processing mainly at Device Level**, eliminating most data traffic and information security threats.

- We use Microcontrollers (MCUs) together with IoT Sensors to incorporate functionality at endpoint level
- We provide initial data processing at Device Level
- We provide smart way of data collection from hardware sensors
- We make MCUs smart enough to make their own decisions based on Clients' business processes
- Processing happens in real-time
- We keep most data locally
- AIME's architecture allows us to design and build **Micro-clouds** or **Swarms of IoT Devices**

## DATA TRANSFER

Data transfer happens at the following levels:

- Between IoT devices in a Local Swarm
    - If needed, this communication can happen only using radio signals (LoRa Mesh) in **areas with no Internet coverage**. If the Local Swarm needs to be connected to other parts of the IoT System, one IoT Device at the end of the Swarm must act as a Gate and forward the communication.
- Between IoT devices and local or internet MQTT Server
- Between IoT devices and HTTP Server
- Between MQTT Server and HTTP Server
- We transfer only meaningful data as defined by user, not ANY data
- By avoiding to transfer useless data, AIME helps minimize traffic
- We save data cost for moving data
- We prevent clogging the whole system with dark IoT data

- We provide multiple communication technologies: Wi-Fi, GPRS, Wi-Fi Mesh, LoRa Mesh; integration with NBIoT

## INTEGRATION

AIME offers seamless vertical integration with preexisting business systems, incl. Maintenance Systems, ERP Systems, CRM solutions, etc.

- AIME presents data in normalized and standardized way using compressed and structured format
- We are also flexible at using client-defined formats for exchanging data through API
- AIME's output data can be used by our Clients in Big Data, AI (Artificial Intelligence) and ML (Machine Learning) platforms

## SECURITY

We provide Security by design using TLS and RSA encryption in mesh communication between devices; user and password are assigned to each device and to each communication channel. No raw data transmitted or received at all.

Our **Self-sustained Mode** – mode with no human input and/or Internet connection – gives an extra layer of protection by keeping and processing business data locally at the IoT Devices, without exposing it to unauthorized personal or in public Internet.

## SYSTEM UPDATE

We offer changes on-the-fly in configuration for data collection and edge functionalities without the need to flash new firmware:

- Remotely via Internet

- On-site by trained technician. No need to open any physical control panels; operation can be done by Wi-Fi.

- We also offer OTA capabilities for easy firmware upgrade and maintenance

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# AIR QUALITY MANAGEMENT WITH AIME

AIME can be used for monitoring & control over environment parameters (Climate Control).

Smart IoT sensors can be installed in all rooms or manufacturing spaces and whole buildings, and can monitor multiple air aspects. In addition, AIME can control heating, ventilation or other types of systems automatically to prevent unfavorable air conditions.

This allows managers to identify and make informed decisions on how to ensure their facilities are operated and maintained to optimal efficiency.

The following is a non-comprehensive list of:

- Sensors which can be installed by Predistic and orchestrated by AIME
- Examples of real-time actions which AIME can be programmed to execute automatically

| | AIME Measurements | AIME Actions |
|---|---|---|
| | Air temperature | <ul><li>Start automatically HVAC system</li><li>Notify responsible staff in Web application</li><li>Show warning on an E-paper Display</li><li>Start alarm</li><li>Send incident data to Vertical Management Systems in real-time</li></ul> |
| | Air humidity / Condensation | <ul><li>Start automatically HVAC system</li><li>Notify responsible staff in Web application</li><li>Show warning on an E-paper Display</li><li>Start alarm</li><li>Send incident data to Vertical Management Systems in real-time</li></ul> |
| CO2 | Carbon Oxide & Carbon Dioxide | <ul><li>Start automatically HVAC system</li><li>Notify responsible staff in Web application</li><li>Show warning on an E-paper Display</li><li>Start alarm</li><li>Send incident data to Vertical Management Systems in real-time</li></ul> |

| | | |
|---|---|---|
| ☣ | Volatile organic compounds (formaldehyde, CH4) | • Start automatically HVAC system<br>• Notify responsible staff in Web application<br>• Show warning on an E-paper Display<br>• Start alarm<br>• Send incident data to Vertical Management Systems in real-time |
| 🔥 | Smoke & Fire | • Start automatically HVAC system<br>• Start automatically Fire Extinguisher or Suppression System<br>• Notify responsible staff in Web application<br>• Show warning on an E-paper Display<br>• Start alarm<br>• Send incident data to Vertical Management Systems in real-time |
| ☁ | Dust | • Start automatically Electrostatic Filters<br>• Notify responsible staff in Web application<br>• Show warning on an E-paper Display<br>• Start alarm Send incident data to Vertical Management Systems in real-time |
| 💡 | Lightning Level | • Motion-triggered lighting<br>• Control lightning systems/window blinds/etc. to automatically adjust light level<br>• Notify responsible staff in Web application<br>• Show warning on an E-paper Display<br>• Start alarm<br>• Send incident data to Vertical Management Systems in real-time |
| ⏲ | Air Pressure | • Start automatically HVAC system<br>• Notify responsible staff in Web application<br>• Show warning on an E-paper Display<br>• Start alarm<br>• Send incident data to Vertical Management Systems in real-time |

> **Note**: More types of Sensors & Actuators can be added on demand

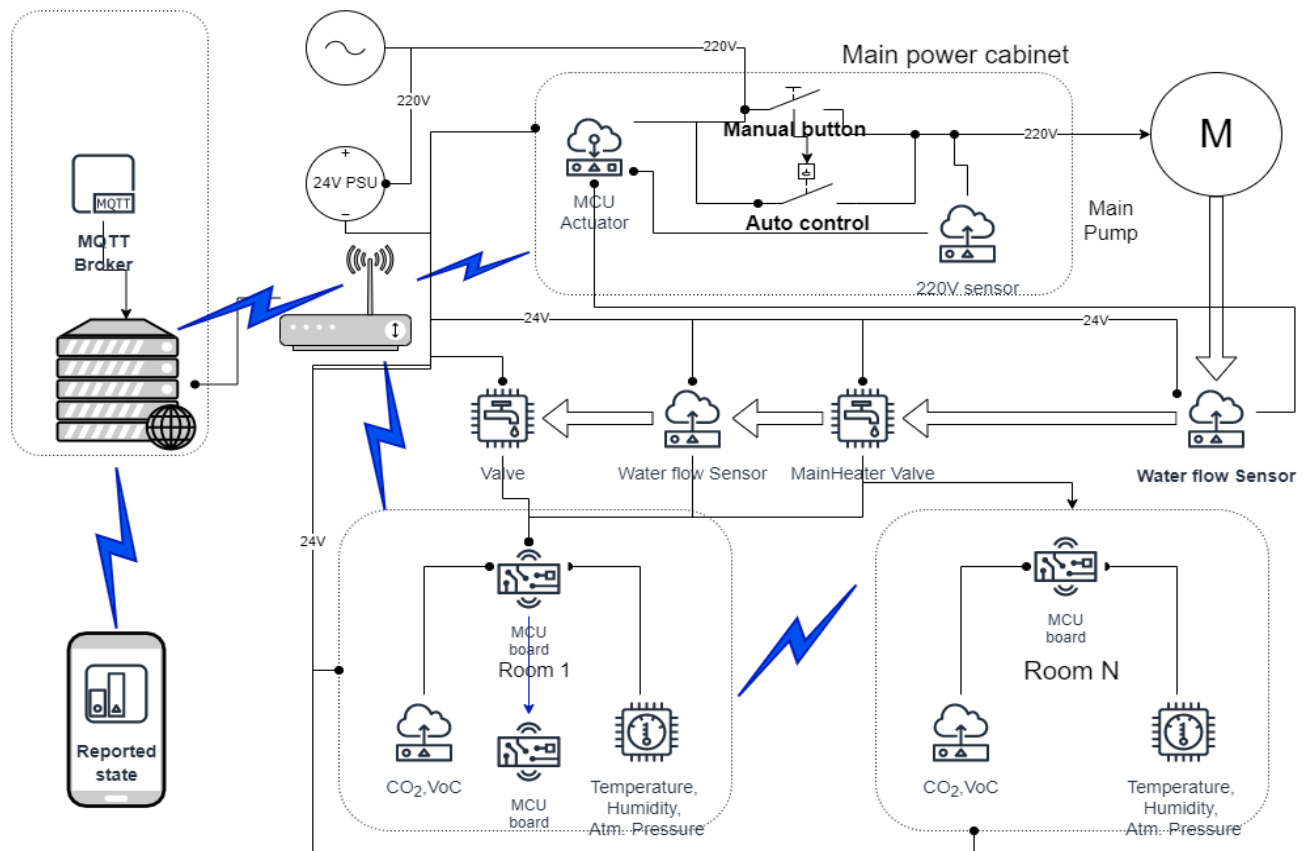## USE CASE: MEASURING & CONTROLLING AIR QUALITY IN MULTIPLE ROOMS

The following Use Case demonstrates AIME's ability to control multiple Air Quality Sensors & Actuators in *N* number of rooms.

**Sensors** included:

- Temperature, Humidity, Air Pressure, CO2, VOC

**Actuators** included:

- Water flow control
- Heating Control

## Hardware Technical Parameters:

- Included sensors brand: **Bosch**

- Temp Range: -40C to 85C

- Humidity Range: 0 - 100% RH, =-3% from 20-80%

- Pressure Range: 30,000Pa to 110,000Pa, relative accuracy of 12Pa, absolute accuracy of 100Pa

- Altitude Range: 0 to 9.2 km, relative accuracy of 1 m at sea level, 2 m at 9.2 km.

- eCO2: The equivalent CO2 (eCO2) output range is from 400ppm up to 29206ppm. eTVOC The equivalent Total Volatile Organic Compound (eTVOC) output range for CCS811 is from 0ppb up to 32768ppb.
- Light Lux meter: 0..65535 Lux. Lux sensor can be used for special proposes: range from 188 µLux up to 88000 Lux with IR spectrum sensitivity.
- Capacitive soil or sand or ore humidity meter: 1%-100%
- Ultrasonic non-contact level meter for plastic or non-metallic tanks with wall thickness <10mm
- Liquid flow measurement for water:  - 1.75MPa 2-50L/Min+-5% -10-80°C

## Notes:

- More types of Sensors & Actuators can be added on demand
- Different number of rooms can be covered by the solution
- Internet coverage is not mandatory
- The number of IoT devices (sensors, microprocessors, actuators, can vary depending on room size, architecture specifics and obstacles
- We can command industrial systems using standard interfaces incl. RS485 (MODBUS), RS232.

## OUR ADVANTAGES

- **CUSTOM SOLUTION**: We provide custom solutions based on our flexible AIME Universal IoT Platform, customized and upgraded after client's requirements

- **EASY INTEGRATION**: Integration with existing vertical management solutions, with data required to provide **Predictive Management** and real-time **Data-driven Management**.
- **MAXIMUM SECURITY**: Option for **keeping sensitive data secure locally** at the facility or within the company

  Additional option for **connecting to a public Cloud service**

- **RESILIENCY AND SUSTAINABILITY**: Use cases and IoT devices can be added or changed in system's lifecycle. Sensor or Actuator settings can be changed any time, even after installation. This happens on the fly, with no system downtime.
- **OFFLINE MODE**: Possibility to build **Swarms of IoT Devices** even in areas with no Internet access
- **MAINTANENCE**: Continuous support & troubleshooting
- **SELF-SUSTAINED MODE**: The system can be automated to work without human interaction/control and/or without Internet

## OUR OFFER

We offer AIME on a **PaaS** (Platform as a Service) basis. We build **Networks or Swarms of IoT-enabled Devices** and orchestrate them, and deliver the required hardware.

Our low-level networks/swarms can be integrated with any preexisting Management Systems via APIs. We are able to convert the exchanged data into any format required by the Client.

Our offer is suitable for companies who need to build the processes locally in their own infrastructure and for those who need to transfer data to Data Center/Cloud.

It is also suitable for companies which need to add IoT infrastructure to their business and integrate it with a preexisting Management System.

## BENEFITS

- Increased equipment lifetime
- Increased plant safety
- Fewer accidents with negative impact
- Energy consumption savings and lower greenhouse emissions due to optimizations
- Real-time monitoring and management
- Planning and working with informed decisions

- Reduction in operational and maintenance costs
- Reduction of operational risks
- Overall improvement in business efficiency
- More reliable business